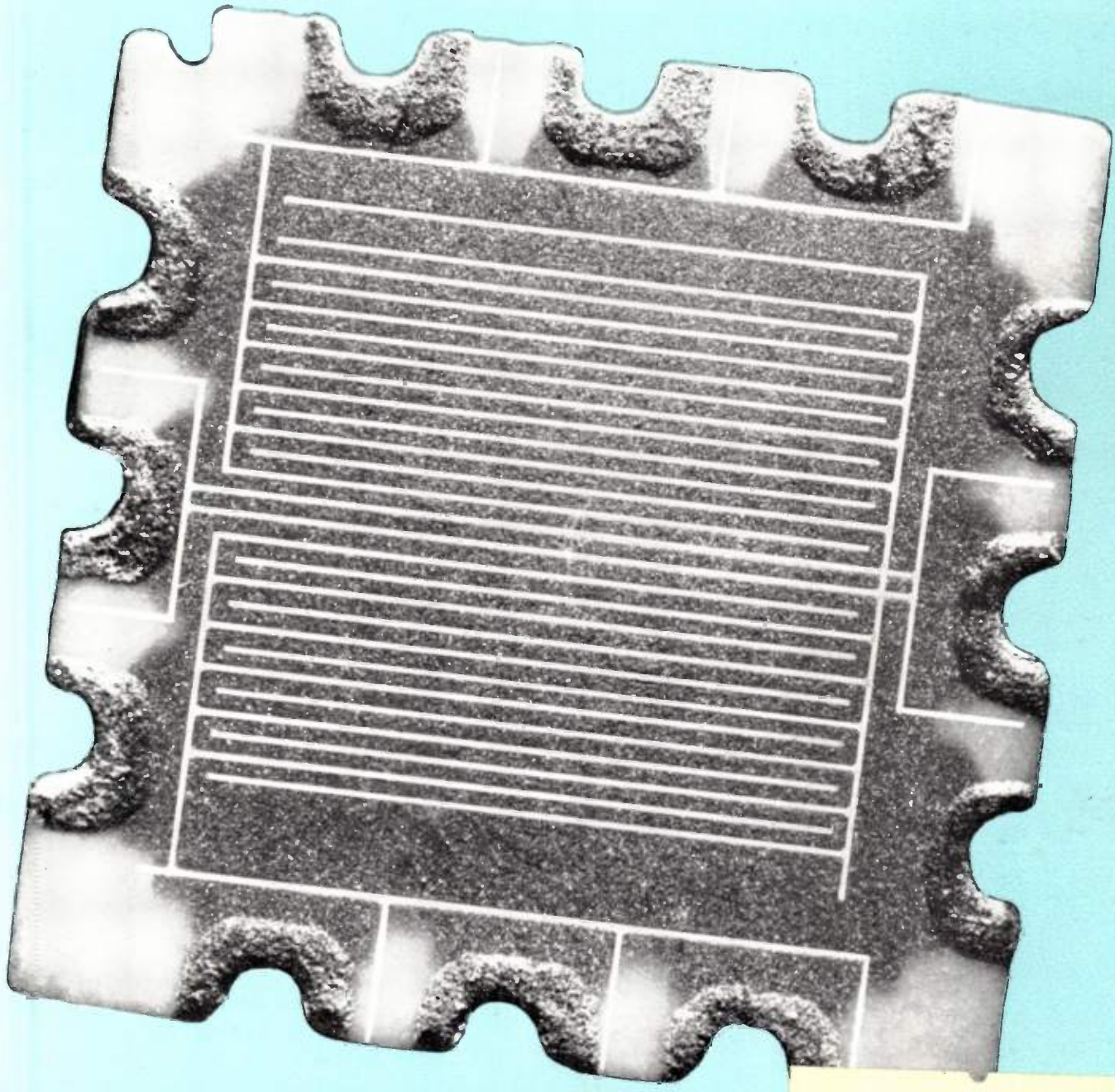
Medical Ultrasonics: What's New

page 28

DECEMBER 11, 1959

electronics

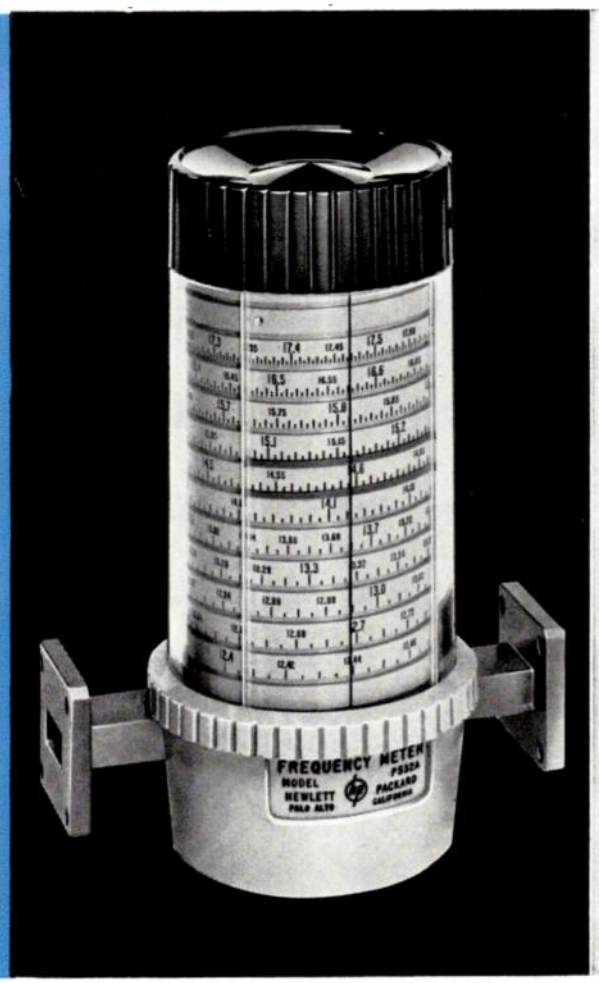
A McGRAW-HILL PUBLICATION VOL. 32, No. 50 PRICE SEVENTY-FIVE CENTS



Micro-Element Resistor

page 49

Wide band, direct reading, 0.1% accuracy FREQUENCY METERS 5.2 to 40 KMC!



NEW H, K AND R BAND MODELS

Now hp offers you high quality, moderately-priced precision Frequency Meters covering the important J, H, X, P, K and R microwave bands.

On models 532A (H through R band) frequency is read directly in KMC on the large, precisely-calibrated spiral scale. No charts or interpolation are required. Accuracy is high, typically 0.1%.

Model 532A Frequency Meters comprise a special waveguide section mounting a high Q resonant cavity tuned by a choke plunger. No sliding contacts are used, and the waveguide section transmits virtually full power at resonance. A dip in output indicates resonance. Tuning is by a precision lead screw, spring loaded to eliminate backlash. Scale lengths of 77" calibrated in 5 MC increments are typical.

For J band work (5.20 to 8.20 KMC) Model 530 Frequency Meters are offered (see Table). These instruments are similar to Model 532A except tuning is by a micrometer, and readings are converted to frequency by a chart on the instrument.

SPECIFICATIONS

Model	Accuracy	Frequency Range KMC	Fits Waveguide Size (in.)	Length (in.)	Price
J530A	0.1%	5.85 - 8.20	1½ x ¾	4	$120.00
J530B	0.1%	5.20 - 7.05	1½ x ¾	4	150.00
H532A	0.08%	7.05 - 10.0	1¼ x ⅝	6¼	195.00
X532A	0.08%	8.20 - 12.4	1 x ½	4½	150.00
P532A	0.1%	12.4 - 18.0	.702 x .391	4½	210.00
K532A	0.1%	18.0 - 26.5	½ x ¼	4½	230.00
R532A	0.2%	26.5 - 40.0	.360 x .220	4½	250.00

Other specifications: Models 532A: Resetability 0.01%, backlash 0.005%, SWR at resonance 1.3:1 approximately.

For complete details, call your hp representative or write direct.

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hp® complete instrumentation for microwave measurements

electronics

DECEMBER 11, 1959

A McGRAW-HILL PUBLICATION
Vol. 32 No. 50

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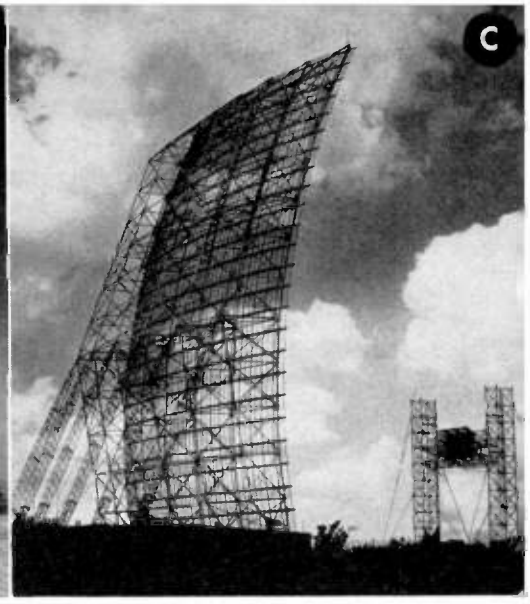


ANTENNA PROBLEMS?

ASK KENNEDY!

A TRACKING ANTENNAS — *A 60-foot satellite tracker points skyward. 28- and 84-foot models also available.*

B SCATTER ANTENNAS — *One end of a scatter link showing two 120-foot antennas. 28- and 60-foot models are also available.*

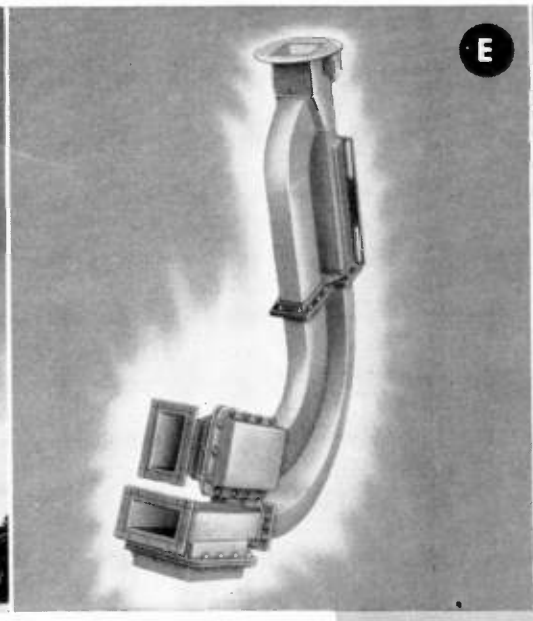
C RADAR ANTENNAS — *A giant radar antenna forerunner to the BMEWS Program. Dozens of conventional types are also available.*

D RADIO TELESCOPES — *An 84-foot radio telescope listens to the heavens whisper. 28- and 60-foot models are also available.*

E WAVEGUIDE COMPONENTS — *A dual polarized feed with two waveguide inputs. Other large size components include many types of horns, duplexers, transitions, straight sections and bends.*

F FIELD SERVICE — *Kennedy Field Service engineers erect an 84-foot radio telescope. Other services include site selection, constructon, personnel training and servicing.*

G RESEARCH AND DEVELOPMENT — *Kennedy's antenna service includes basic R & D in microwave propagation.*



THE solution to antenna problems begins when someone says: "Let's ask Kennedy!"

A few of the many reasons why are shown on this page. These Kennedy antennas are setting new standards for all-weather reliability and versatility wherever they serve throughout the free world.

Kennedy antennas come in many shapes and many sizes. But whatever the type, and whatever the conditions under which it must serve, Kennedy can offer a design that fully measures up to specifications.

Kennedy Field Service engineers are available to install antennas anywhere in the world. It's a part of the complete, integrated service that is still another reason why more and more people in electronics are "asking Kennedy" about antenna problems.

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electronics

December 11, 1959 Vol. 32, No. 50

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SHOPTALK . . . editorial

MEDICAL ELECTRONICS. We find ourselves printing more and more material on the uses of electronics in medicine, and these articles always show high readership scores. Our readers are interested in what their industry is doing to help the sick and injured.

Many readers are doing more than just reading about medical electronics. Engineers are in many cases donating their talent and time to designing, building and operating life-saving instruments; a group of telephone engineers in Illinois builds needed instruments after work, a New Jersey executive works with a hospital heart-operation team on weekends.

Making life more satisfying for the seriously disabled is another field in which our people can make rewarding contributions. Even a simple electromechanical contrivance can help a polio victim turn book pages with a mouth stick, or adjust bed height. Similar devices can brighten the lives of thousands at home or in hospitals.

More such activity could be organized through local professional society chapters, radio clubs, educational and other institutions. Undoubtedly work like this is going on. We would like to hear about it.

W W MacDonald

EDITOR

Coming In Our December 18 Issue . . .

ELECTRONICS FOR ROAD-BUILDING. More than $100 billion will be spent on highway construction in the United States over the next 15 years. To find out the role electronics is playing in this enormous program, Midwestern Editor Harris interviewed officials in charge of the largest highway research program so far undertaken.

Next week, Harris describes the instrumentation developed for studies on a nine-mile test highway constructed in Illinois. You'll read about a new strain gage for measuring pavement deflection, a profilometer for measuring variations in highway riding surface and a nuclear surface gage for checking the density of roadbed material.

AIEE HIGHLIGHTS. As brought out in a recent ELECTRONICS report (p 93, Oct. 23), there is an increasing demand for more communication facilities and better transmission quality. Associate Editor Perugini attended the AIEE Fall Meeting in Chicago recently, heard several papers explaining how microwave, telegraph and telephone systems are being used to meet these demands. Perugini's conference roundup describing these developments will appear next week.

HARMONIC ANALYSIS. Making an harmonic analysis of a complex wave can be a tedious process. E. T. Sohlberg of Sanborn Co., in Waltham, Mass., presents a chart that simplifies the task considerably. Use of the chart to find the amplitude and phase of the fundamental, second and third harmonics, and the location of the baseline is explained.

FADING RATE RECORDER. Recent radio propagation studies have required an instrument capable of recording average fading rates simultaneously with the signal strength recordings at h-f and vhf. J. W. Koch, W. B. Harding and R. J. Jansen of the National Bureau of Standards in Boulder describe a fading rate recorder that provides a continuous strip-chart recording of the average fading rate of the received signal.

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Type	Base	D.C. Operating Voltage	Current Range	Regulation
OA2WA **CK6626/OA2WA** **CK6073, OA2**	Miniature	150 v.	5 — 30 ma.	2 v.
OB2WA **CK6627/OB2WA** **CK6074, OB2**	Miniature	108 v.	5 — 30 ma.	1 v.
OC2	Miniature	75 v.	5 — 30 ma.	3 v.
CK5787	Subminiature	98 v.	5 — 25 ma.	3 v.
CK5787WA	Subminiature	98 v.	5 — 25 ma.	1.5 v.
CK6542	Subminiature	148 v.	5 — 25 ma.	2 v.
Corona Voltage Regulators				
CK1038	Subminiature	885 — 915 v.	5 — 55 μa.	15 v. max.
CK5962	Miniature	700 v.	2 — 55 μa.	15 v. max.
CK6437	Subminiature	700 v.	5 — 125 μa.	15 v. max.
CK6438	Subminiature	1200 v.	5 — 125 μa.	20 v. max.

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VOLTAGE REFERENCE TUBES

Type	Base	D.C. Operating Voltage	Current Range	Regulation	Voltage Jump Max.
CK5651	Miniature	85 v.	1.5 — 3.5 ma.	1.5 v.	0.1 v.
CK5651WA	Miniature	85 v.	1.5 — 3.5 ma.	1.5 v.	0.005 v.
CK5783	Subminiature	85 v.	1.5 — 3.5 ma.	3.0 v.	0.1 v.
CK5783WA	Subminiature	85 v.	1.5 — 3.5 ma.	2.4 v.	0.005 v.
CK6213	Subminiature	130 v.	1.0 — 2.5 ma.	1.0 v.	—

CIRCLE 51 ON READER-SERVICE CARD

COLD CATHODE RECTIFIER TUBES

Type	Construction	Base	Max. Peak Inverse Voltage	Peak Plate Current	Max. D.C. Output Current
OZ4A/1003	Double Diode	Octal	880 v.	330 ma.	110 ma.
CK1005	Double Diode	Octal	450 v.	210 ma.	70 ma.
CK1006	Double Diode	4-Pin.	1600 v.	600 ma.	200 ma.
CK1007	Double Diode	Octal	1200 v.	510 ma.	85 ma.
CK5517	Diode	Miniature	2800 v.	100 ma.	12 ma.
CK6174	Diode	Miniature	2800 v.	30 ma.	3 ma.
CK6659	Diode	Subminiature	2800 v.	40 ma.	8 ma.
CK6763	Diode	Miniature	2800 v.	100 ma.	12 ma.

CIRCLE 52 ON READER-SERVICE CARD

Detailed technical data bulletins on any of these types are yours for the asking. Better yet, ask to have a Raytheon sales engineer drop in for a firsthand appraisal of your application and prototype needs — no obligation, of course. Write directly to Dept. 2528.

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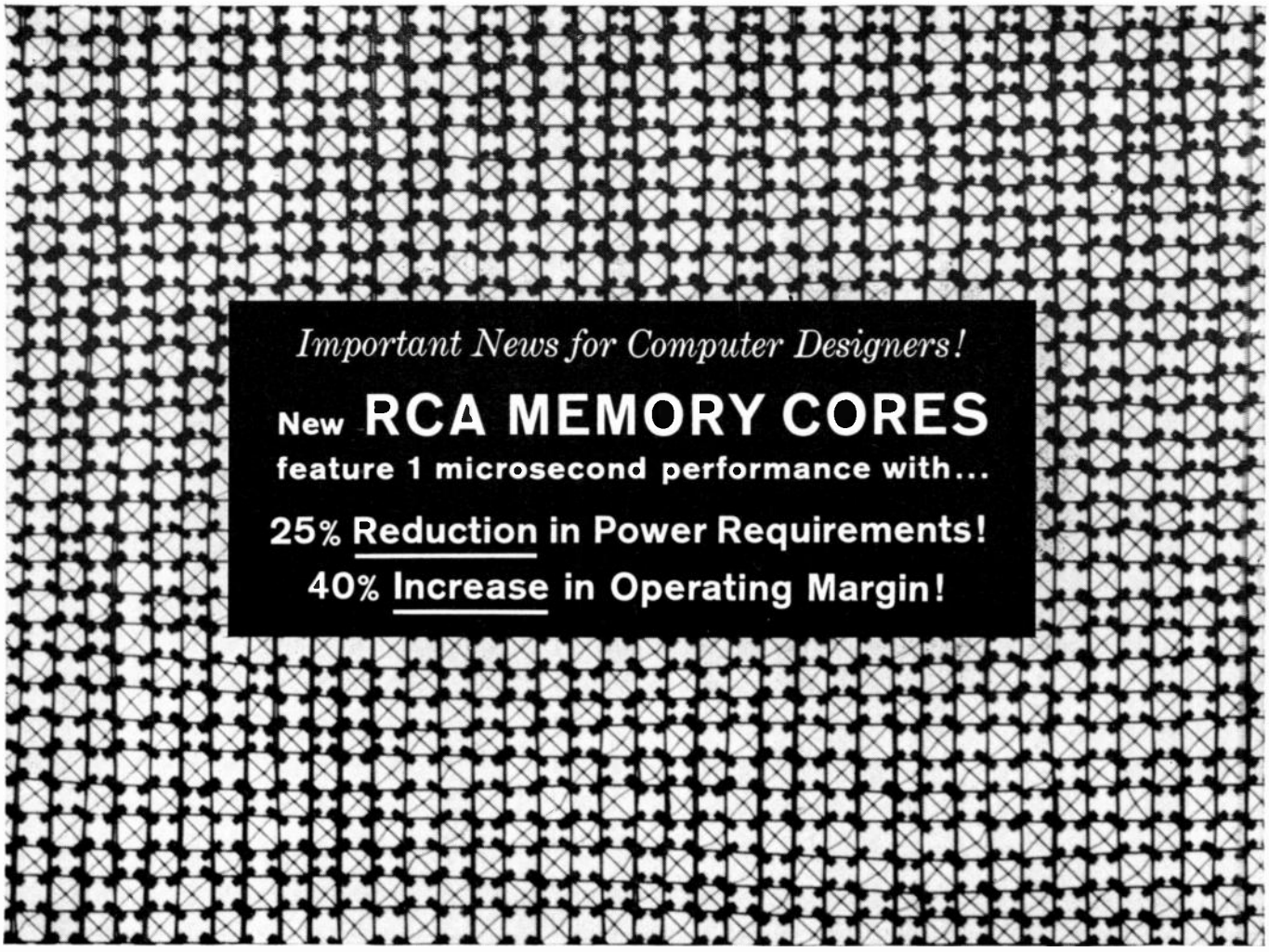

Dramatic improvement over present standard cores offers greater design flexibility, top performance in high-speed coincident current memory applications

New 1-μ sec memory cores 226M1 (XF-4028) and 228M1 (XF-4257) developed at RCA's Materials Lab in Needham Heights, Mass., represent an important step forward in ferrite core design for military and commercial computers. See chart for the significant improvements in power requirements and operating margin now possible in 1-μ sec operation.

Call your local RCA Field Representative and learn how the new 226M1 and 228M1 can fit into your new computer designs. He can also give you information on the entire line of RCA Ferrite Memory Cores, Planes and Stacks available to meet your specific design requirements. For technical data, write RCA Commercial Engineering, Section L-19-NN-2, Somerville, N. J.

NOMINAL OPERATING CHARACTERISTICS AT 25°C

Type	Size	Full Driving Current (Im) (ma)	Partial-Write Current (Ipw) (ma)	Pulse Rise Time (T_r) (μsec)	Switching Time (T_s) (μsec)	Response	
						"Undisturbed 1" (μV_1) (mv)	"Disturbed 0" (dV_z) (mv)
228M1 (XF-4257)	.080" x .050" x .025"	620	310	0.2	1	160	18
226M1 (XF-4028)	.050" x .030" x .015"	380	190	0.2	1	75	10

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KH-RKH

FOR USE UNDER CRITICAL PRESSURE AND LEAKAGE CONDITIONS —Hermetically sealed plugs with steel shells, steel contacts, and Canseal glass insulators for true hermetic sealing. Electro tin plating over cadmium plate over copper flash provides highly receptive surface for soldering and corrosion resistance.

RK

FOR FLUSH OR SEMI-FLUSHMOUNTING —Cannon RK Plug assemblies are equipped with an external threaded coupling nut which is the reverse of the standard K Series. Note: RK will mate only with RK's.

TBF-K

FOR CARRYING CIRCUITS THROUGH BULKHEADS

Cannon TBF-K Bulkhead Plugs feature a double-faced construction allowing mating at both ends. Pin inserts. Single piece shell.

RLKL-LKL

FOR TV AND OTHER PANEL SWITCHING OPERATIONS —Quick connect and disconnect RLKL Plugs are designed for one-hand fast disconnect use on TV station program switching panels and similar type operations. Feature a quick coupling means. Latch-lock secures plug to mated fitting (RLKL receptacle). Thumb pressure releases it.

FW-K FWR-K

FOR OPEN FLAME PROTECTION AGAINST HIGH TEMPERATURES —Cannon K Firewall Plugs are available in straight and angle 90° shell types. Wall mounting receptacles also available. Phenolic or fireproof inserts of glass-filled materials. Crimp type contacts. Cannon originated the firewall connector and continues to be the leader in this important field.

SK-M7-21C

FOR USE IN TELEPHONE "BEEPER" AND SIMILAR APPLICATIONS —Widely used on telephone recording units known as "beepers." Adaptable for other similar applications.

K ACCESSORIES —Cannon K Series Accessories include Straight and Angle 90° Junction Shells, Dust Caps, Bonding Rings, Gland Nuts, Clamps, and Dummy Receptacles to hold and protect plugs when not in use.

Cannon has available a wide variety of other Plug designs FOR EVERY CONCEIVABLE APPLICATION...including aircraft and electronic Plugs conforming to Specification MIL-C-5015D; Unit-Plug-In Rack/Panel and Modular; Audio and Low-Level Circuit Plugs; Miniature and Sub-Miniatures; Coaxial RF Series Plugs, Printed Circuit Plugs; GM Plugs and Cannon Plug/Harness Systems: "Kwik-Term" Terminals and DC Solenoids.

FOR ADDITIONAL INFORMATION on the typical designs illustrated...other configurations for your specific applications...or the design, engineering and manufacture to your special needs...write to **Cannon Electric Company**—3208 Humboldt Street, Los Angeles 31, California. Please refer to Dept. 120.

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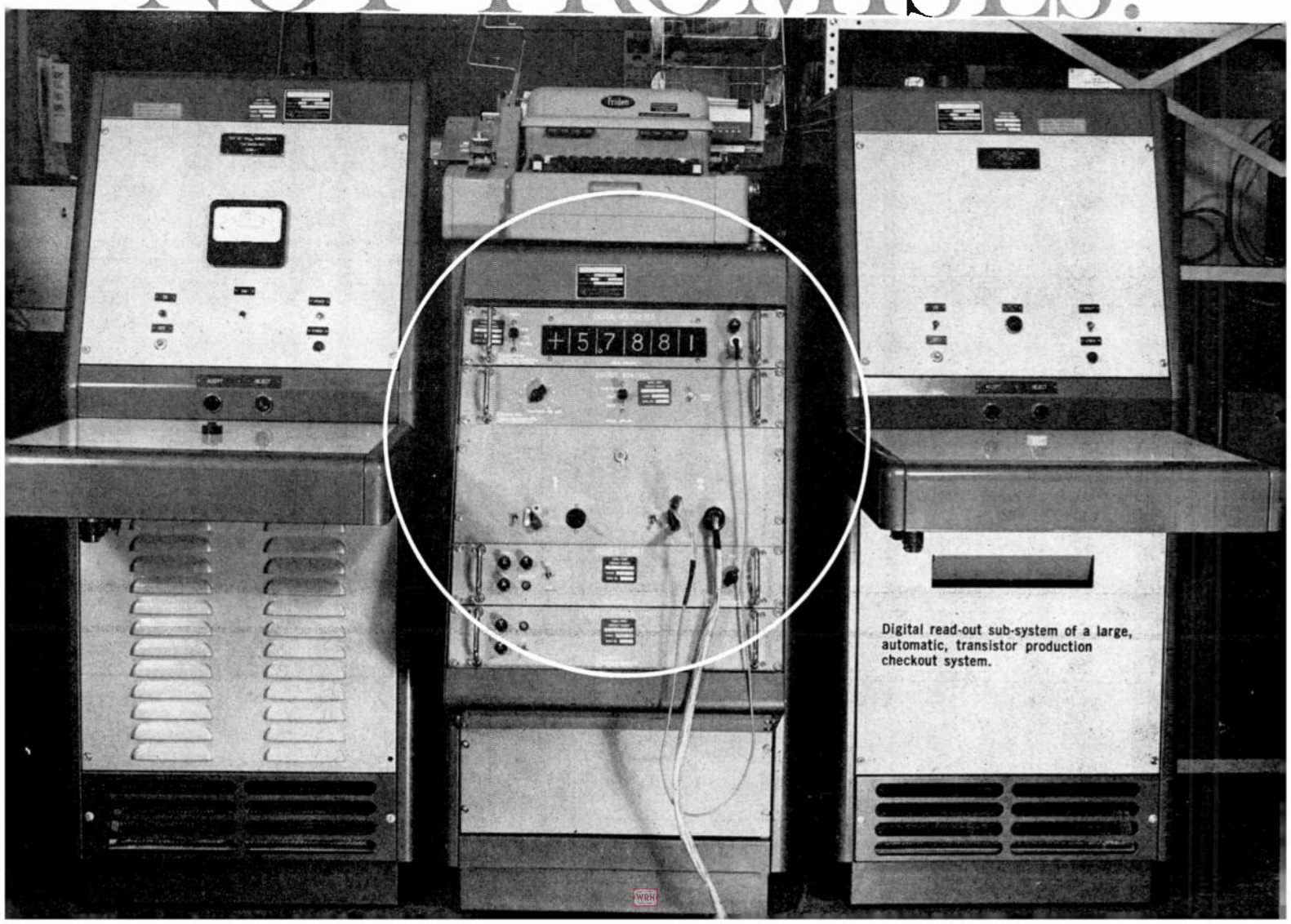
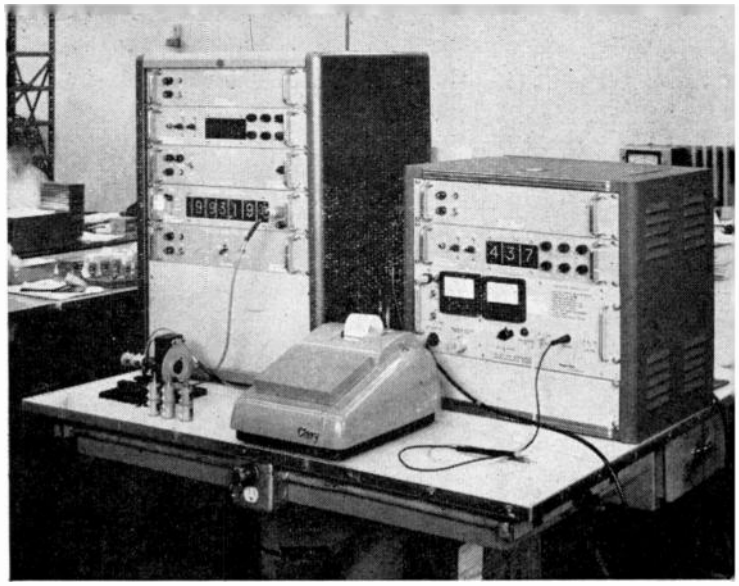


Digital read-out sub-system of a large, automatic, transistor production checkout system.

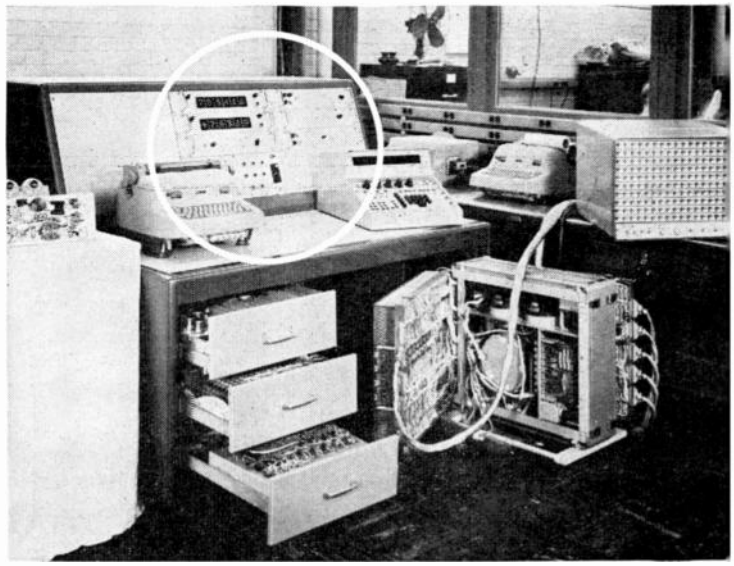
Sub-system for the ground support equipment on the B-58 Hustler program. Measures AC and DC single-ended voltages and ratios, and AC and DC differential voltages and transients. Chosen for its excellent operating characteristics under adverse environments.



Resistance measuring system — Used as a secondary standard to make accurate, resistance measurements required for checking linearity of multi-turn potentiometers.

Systems shown here are typical of more than 200 designed and built by EI and now in use. They range in complexity from data logging systems for automatic scanning, measurement and recording of data from multiple transducers.... to high speed, automatic checkout systems for missile and aircraft...to systems for automating industrial processes.

Because of the EI modular design approach, many of these systems can be delivered on virtually an off-the-shelf basis, eliminating the long delivery times usually associated with system development. This approach also results in a low cost system because the modules are manufactured in large quantities. Cost is almost a linear function of performance capabilities desired.



Multi-purpose digital measuring and recording system measures AC volts, DC volts, ohms and ratios. Prints and punches information for immediate reading by the operator and subsequent data reduction.

you get MORE with EI systems!

MORE VERSATILITY

AC and DC voltages, AC and DC voltage ratios, ohmic resistances, capacitance, frequency, phase, inductance, time, or combinations of these basic input quantities can be accepted by the EI system.

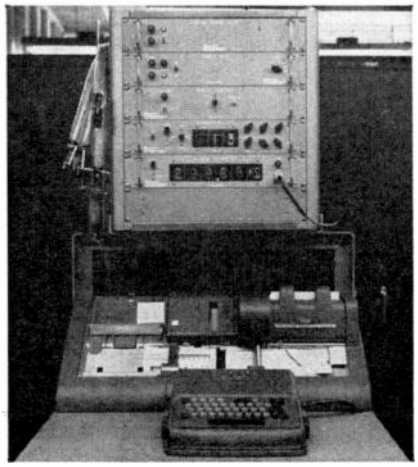
MORE RELIABILITY

Maximum use is made of solid-state and MIL-type components which are designed into conservatively-rated, field-proven circuits. All vendor-supplied parts are exhaustively tested and evaluated.

MORE FLEXIBILITY

Expansion of the EI system can be made by simply adding appropriate new modules. This approach eliminates new engineering development costs each time needs change; minimizes system obsolescence.

Why not talk over your digital system requirements with your EI Sales Engineer? His system experience will be a valuable help in solving your problem.



Resistor scanning unit — Scans large numbers of resistors, measures values from 0.1% to 0.01% and records the information on punched cards. Operation is automatic and operates entirely unattended.

Electro Instruments, Inc.

3540 AERO COURT, SAN DIEGO 11, CALIFORNIA

DIGITAL INSTRUMENTS FOR MEASURING AC/DC VOLTAGES, AC/DC RATIOS, RESISTANCE, CAPACITANCE, AND FREQUENCY • X-Y RECORDERS & ACCESSORIES • DC AMPLIFIERS

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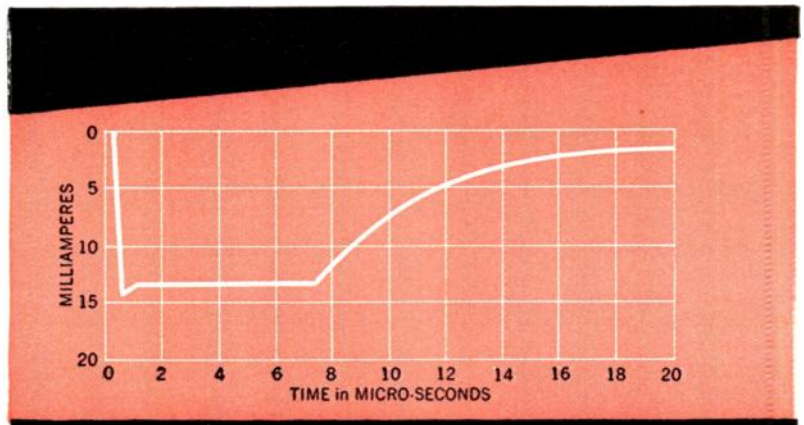
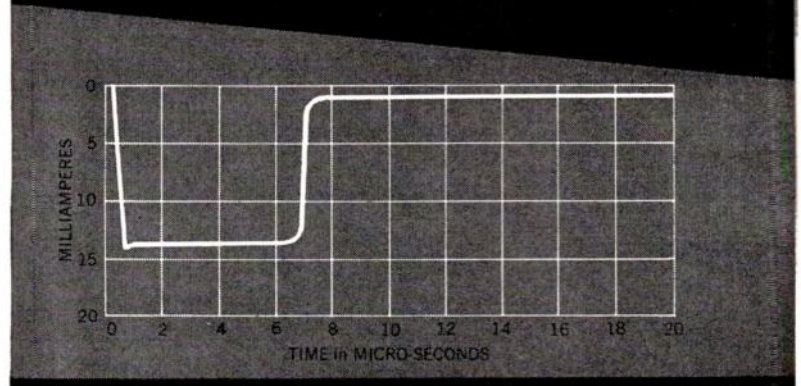
Available in stud and wire-in types having a wide range of characteristics, meeting MIL specifications.

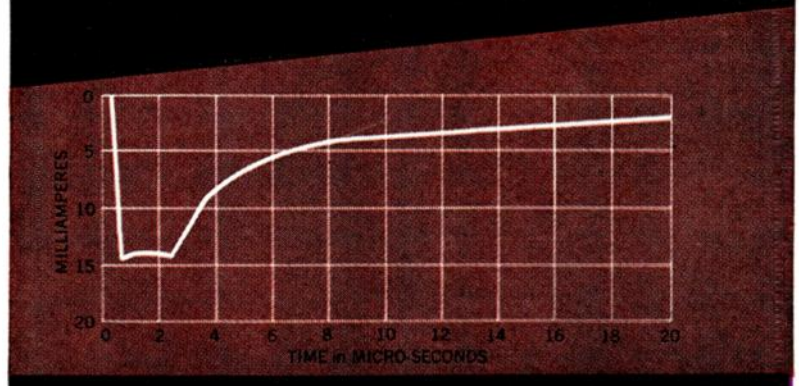
Available NOW, in production quantities.



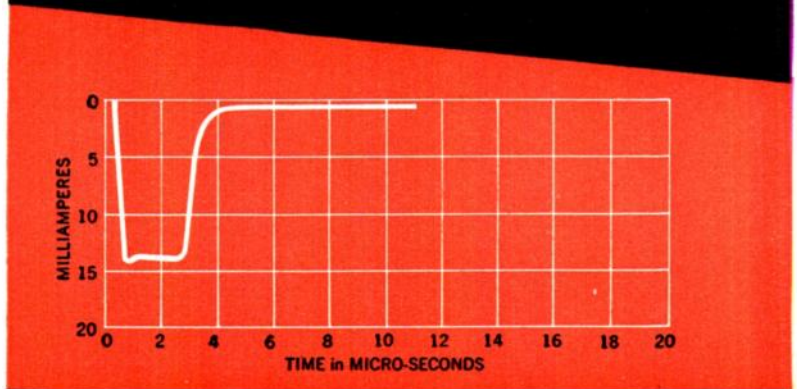
SOME silicon rectifiers give you slow start — slow rise



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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ELECTRONICS NEWSLETTER

THERMIONIC GENERATOR TUBE has converted rocket exhaust heat into useful levels of power during preliminary evaluation tests announced by RCA and Thiokol Chemical Corp. The RCA tube has produced up to 270 watts of power directly from the heat source—an output of nearly 80 watts per pound of its 3½-pound total weight. In tests the device was coupled to a Thiokol solid-fuel rocket motor. RCA and Thiokol engineers say actual and simulated rocket tests show the feasibility of using light-weight thermionic tubes to produce the power needed during a missile's launching and upward flight. They say thermionic devices could power a rocket's guidance, telemetering and related electronic gear during the operating life of the rocket motor.

Navy airborne tactical data system for early warning and weapon control has been delivered by Litton Industries. The system, AN/ASQ-54, was produced under contract to BuAer's Air-to-Air Control Branch, now undergoes flight tests by Lockheed in the WV2-E Constellation.

MINUTEMAN ICBM study contract for $118,000 involving launch control system communication techniques has been awarded to GE's Heavy Military Electronics Department by associate contractor Boeing. GE says it will determine the feasibility of low, medium and high frequency systems. Five other companies received study contracts from Boeing. Four different communication methods, plus "hybrid" techniques involving combinations of methods, will be evaluated under the study contracts which total more than $1 million.

British Trade Fair to be held in Moscow in 1961 will include exhibits of British electronics companies. The fair, sponsored by the Association of British Chambers of Commerce with the support of the Government, is regarded as a "stepping-off ground" for trade relations between Britain and the USSR. A reciprocal Soviet exhibition will be held in London later in 1961.

ICBM-TRACKING RADAR to identify warheads thousands of miles away will be developed for the Advanced Research Projects Agency by Raytheon under a contract of about $15 million. Named "Pincushion" because of its microwave beam pattern resemblance, the new 80-ton radar will make microwave measurements of ICBM's outside the earth's atmosphere, compiling a billion bits of data on each run. Raytheon says it's scheduled for late 1961 delivery, and will be used in conjunction with mid-Pacific missile tests. "More than a dozen needle-narrow beams fired from the parabolic, five-story high antenna will help produce sharp, high-definition target "pictures," says the company.

SOLID-STATE 440-MC BEACON TRANSPONDER developed by Texas Instruments has responded from a Thor-Able missile 1,300-mi in space to MIT Lincoln Laboratories' Millstone Hill radar. It was the first time the Millstone radar had been used successfully beyond skin-tracking ranges. TI says the Millstone radar-beacon transponder combination could track over a greater distance than the 1,300-mi achieved on September 17. Feat came despite failure to orbit the missile. System is capable of 40 continuous hours of operation on self-contained batteries, weighs 6.3-lb and occupies 0.058 cu ft.

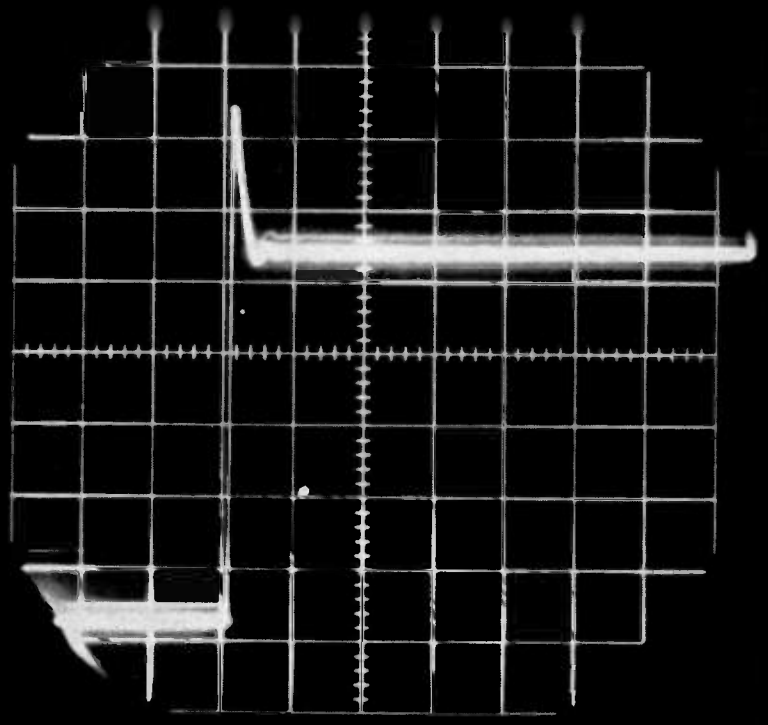
TIME DIVISION MULTIPLEXING SYSTEM is being developed for Britain's electronic telephone exchanges by the General Post Office Research Laboratories and an all-industry joint electronic research committee set up in 1956. Committee pools the R&D of Automatic Telephone and Electric, Ericsson Telephones, General Electric, Siemens Edison Swan and Standard Telephones and Cables. First of the new exchanges is slated to be operational in 1961 at a 1,000-line public exchange in North London. Experimental model is already operating.

Five-pen continuous-line recorder has been designed in Vienna by Siemens & Halske as part of a control system for industrial furnaces and plants. Company says a complete operational survey may be obtained from a single 18-in. wide strip chart, which permits accurate time comparisons.

TV CAMERA TUBE which permits color broadcasts to originate under normal black-and-white lighting levels is announced by GE. The GL-7629 image orthicon tube is physically and electrically interchangeable with standard camera tubes. It requires 1/10th to 1/20th the light required by standard image orthicons, either black-and-white or color, says GE. Tube sensitivity is due to a two millionths-of-an-inch-thick target of magnesium oxide. Target uses electron conduction, a reversible process, which GE says virtually eliminates image retention ("stickiness") and extends tube life.

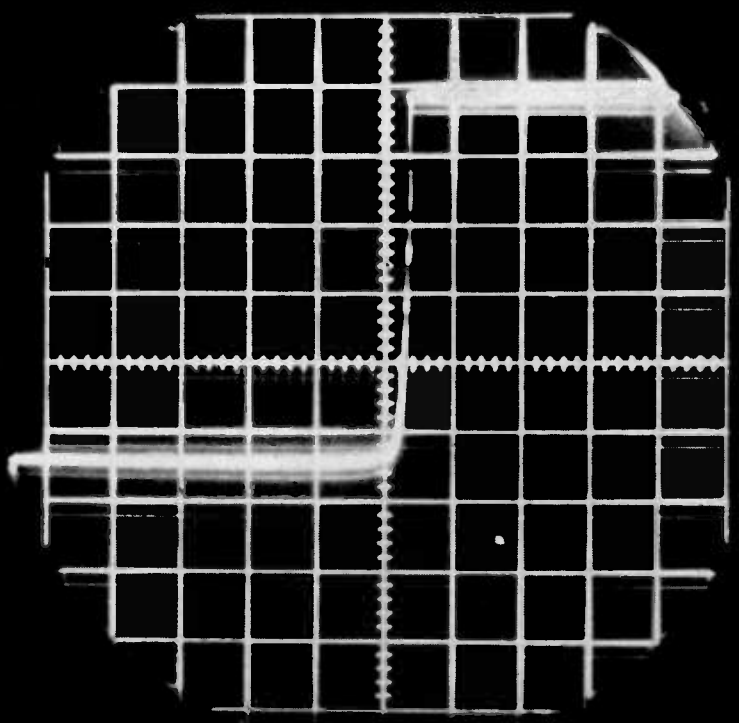
Seventh Army Stock Control Center in Zweibrucken, West Germany, will be supplied with a Mobidic (mobile digital computer) data processing system under a series of Army Signal Corps production contracts just reported by Sylvania.

MICROWAVE COMMUNICATIONS LINK between Alaska and the rest of continental U.S. will be constructed by RCA Victor Co. of Montreal under contract to Canadian National Telegraphs. Expenditure of close to $25 million in two years is expected.



of power supply turn-on at 28v setting. Scope settings: 5v per cm vertical, 0.2 sec. per cm horizontal.

TRANSISTOR KILLER: THE VOLTAGE SPIKE...



TAMED BY NEW PERKIN MTR DC POWER SUPPLIES

The voltage spike in the top photo could destroy the transistors in your circuit in microseconds. This one happens to be a "turn-on" transient—one of several treacherous, instantaneous overshoots encountered in the everyday use of dc supplies. For *complete* protection against line *and load* transients, use new Perkin MTR power supplies. Combining the best two solid-state regulation principles, they use magnetic amplifiers for high efficiency and transistors for instantaneous regulation and low ripple. Made without tubes or moving parts, they give you long, trouble-free service. They're ideal for continuous-duty and unattended operation. Perkin MTR units sustain shorts and overloads indefinitely without suffering internal damage or shooting spikes into the load. After shorts, they resume normal operation automatically. And their protection is constant . . . even if an internal transistor fails, your Perkin MTR power supply *continues* to regulate smoothly and safely!

PERKIN

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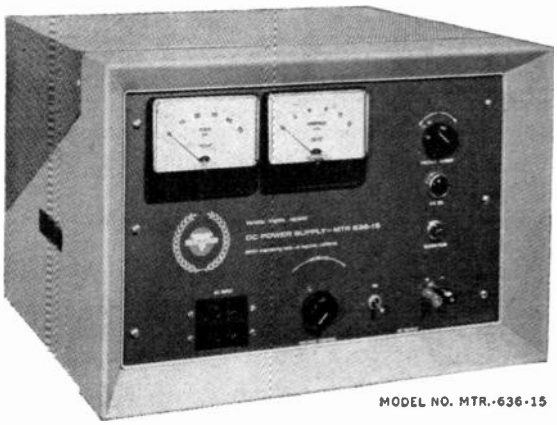
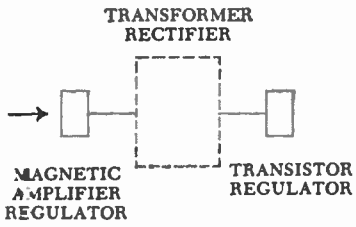


MODEL NO. MTR.-636-15



NEW SOLID STATE REGULATION PRINCIPLE:

magnetic amplifiers for efficiency and reliability, transistors for fast response

Rugged magnetic amplifiers provide steady-state regulation of line and load. Fast-acting transistors suppress ripple and transients. Because the transistors function only during instantaneous line and load changes, their actual use is held to a minimum. MTR units thus have far better dynamic regulation than magnetic amplifier-regulated power supplies and much higher reliability than fully transistorized supplies.

PERKIN / MTR REGULATED LOW-VOLTAGE DC POWER SUPPLIES *prompt delivery*

Model No.	D.C. Output		Static Regulation		Dynamic Regulation		A.C. Input 60 CPS		Ripple
	Volts	Amps	Line	Load	Line†	Load††	Volts	Phase	RMS
MTR060-1 A	0-60	1	±10MV	±25MV	±10MV	± .2V	95-135	1	2MV
MTR060-5 A	0-60	5	±10MV	±25MV	±10MV	± .3V	95-135	1	2MV
MTR036-5	0-36	5	±10MV	±10MV	±10MV	± .2V	105-125	1	1MV
MTR036-15	0-36	15	±10MV	±10MV	±10MV	± .2V	105-125	1	1MV
MTR636-15	6-36	15	±25MV	±50MV	±25MV	±.75V	105-125	1	5MV
MTR636-30	6-36	30	±25MV	±75MV	±25MV	±.85V	105-125	1	5MV
MTR615-5	6-15	5	±10MV	±50MV	±0.1%	± .2V	105-125	1	3MV
MTR28-2	24-32	2	±0.1%	±0.1%	±0.1%	± .2V	105-125	1	5MV
MTR28-3	24-32	3	±0.1%	±0.1%	±0.1%	± .3V	105-125	1	5MV
MTR28-5	24-32	5	±0.1%	±0.1%	±0.1%	± .3V	105-125	1	5MV
MTR28-10	24-32	10	±0.1%	±0.1%	±0.1%	± .4V	105-125	1	2MV
MTR28-30	24-32	30	±0.1%	±0.1%	±0.1%	± .5V	105-125	1	5MV
MTR28-100	24-32	100	±0.1%	±0.1%	±0.5%	±2.0V	208/230/ 460 ±10%	3	20MV

†For 10V step change on 115V nominal input units; 10% step change on Model MTR 28-100

††For changes no load to full load or full load to no load. On fractional load changes, specifications are improved.

All models have Automatic Current Limiting protective circuitry which eliminates fusing. Voltage and current are automatically reduced to a safe level on overloads of 125% rated output and above, including dead short circuits. Overloads and shorts can be sustained indefinitely without damage to the power supply. All units available standard 19" rack or cabinet mount. Dynamic impedance down to 25 milliohms.

WRITE FOR COMPLETE PERKIN CATALOG on tubeless power supplies and new technical article on dc power sources for transistorized circuits.

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St. Louis, Mo.—PArkview 1-6403
San Diego, Calif.—ATwater 3-2081
San Francisco, Calif.—EMerson 9-3354
Seattle, Wash.—PArkway 3-9000
Syracuse, N.Y.—GIbson 6-0220
Washington, D.C.—JUniper 5-7550
Agincourt, Canada—AXminster 3-7011

WASHINGTON OUTLOOK

THE FISCAL 1961 DEFENSE BUDGET, which will account for at least half the electronics industry's market next year, has finally been approved by the Administration. Details will be kept under official wraps until next month when the budget goes to Congress. But enough has leaked out to provide broad outlines for the future.

For the electronics industry, the outlook is for still another increase in defense business. Total spending is expected to go well over the $5-billion mark, compared to about $4.9 billion this year. These sums cover research, development, and procurement of aircraft, missile and ship electronics and of so-called "pure" electronics and communications not tied to any specific weapon system.

Aircraft electronics will probably remain close to this year's $1.7-billion level. Missile electronics spending will leap beyond the current $1.3-billion volume. Expenditures on other military electronics and communications will exceed this year's $1-billion total.

Military research and development on electronics, now amounting to about $650 million, will also rise.

But while the total volume of defense business in electronics remains healthy, the much-touted squeeze on the military budget will result in cutbacks, cancellations and stretchouts for many electronics contractors. Just as significantly, many producers will be hurt by failure to receive new contracts on which they have banked to continue production runs and development work or to start new production operations.

The emphasis on stabilizing total defense spending at the $41-billion level is resulting in a wide series of project slashes. As plans shape up now, the Pentagon will stretch out or reduce production of Convair's B-58 bomber, Boeing's Bomarc B antiaircraft missiles, IBM's Sage air defense computer, naval antiaircraft missiles, and other major equipment.

In addition to the cuts made in next year's budget request, the Pentagon is also rejuggling funds voted by Congress for this year. On the plus side, the Air Force is being allowed to buy Martin's Mace missile (Goodyear-AC, guidance). Congress failed to vote funds for the project. But the Air Force is using money earmarked for other projects.

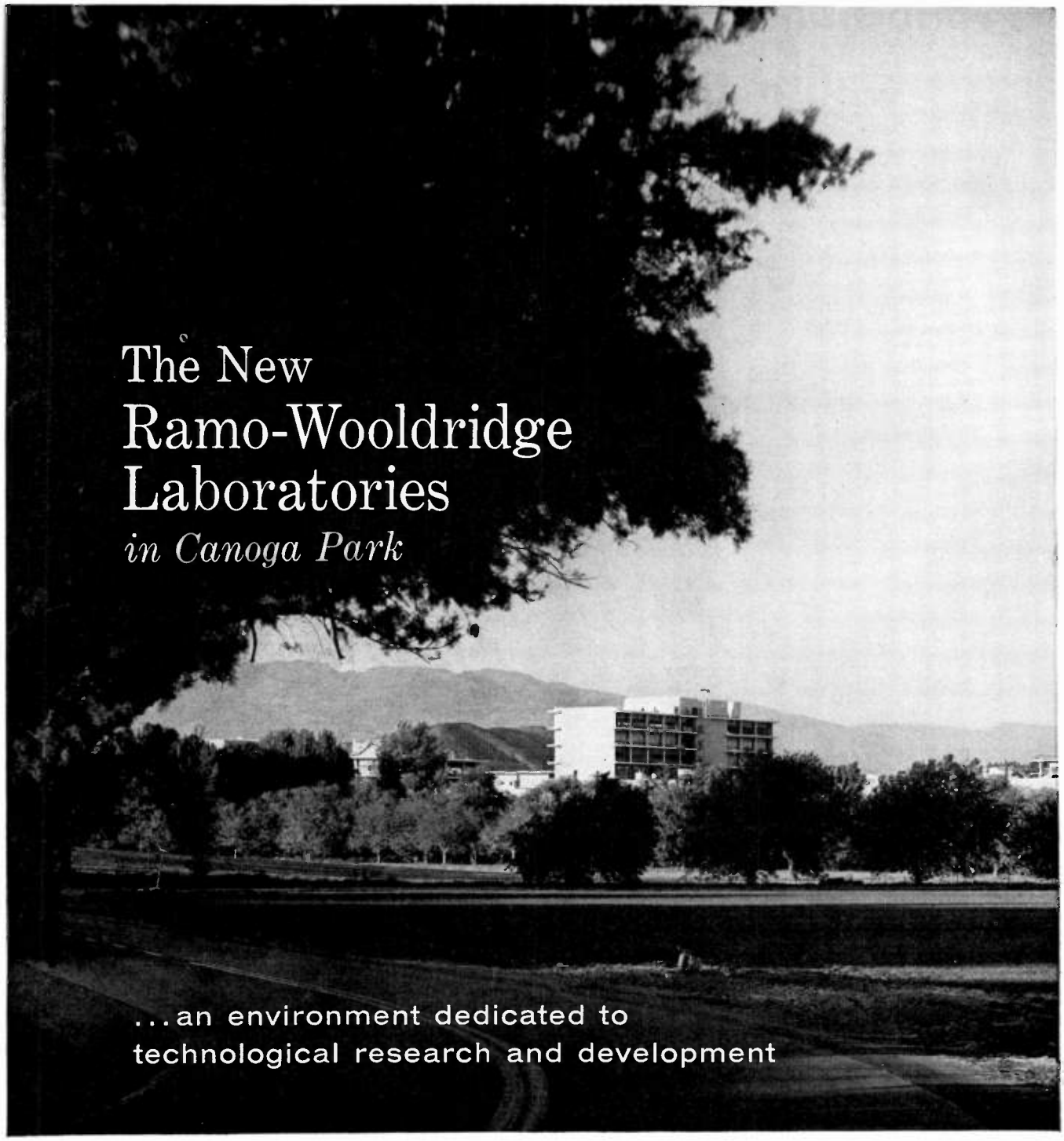
On the other hand, the Navy is being forced to trim its shipbuilding program—including procurement of shipborne electronic systems. New shipbuilding orders this year will total $1.6 billion, $380 million under the original shipbuilding contract plans.

The Navy has just announced details of the 1960 program. Missing were 10 new ship starts (two nuclear submarines, three missile frigates, and smaller craft) and nine ship conversions (including a missile cruiser) which had been previously authorized.

- **Word has leaked out** that the Air Force's Titan ICBM has survived the latest scrutiny of budget plans. There had been talk, for the second successive year, of scaling down or even killing the project. Guidance contractors for Titan are Bell Telephone-Remington Rand on a radio-command system, AC on an all-inertial system.

- **Among the key projects slated for a speed-up next year:** The Air Force's Atlas and Minuteman ICBM's. GE and Burroughs are contractors on a radio-command guidance system for Atlas, Arma for an all-inertial system. North American Aviation's Autonetics division is contractor on Minuteman's guidance system.

  Still unknown: The rate of development effort approved for the Air Force's B-70 bomber, air-launched ballistic missile, and Dynasoar projects. Each represents a vast new market for electronics.



The new Ramo-Wooldridge Laboratories in Canoga Park, California, will provide an excellent environment for scientists and engineers engaged in technological research and development. Because of the high degree of scientific and engineering effort involved in Ramo-Wooldridge programs, technically trained people are assigned a more dominant role in the management of the organization than is customary.

The ninety-acre landscaped site, with modern buildings grouped around a central mall, contributes to the academic environment necessary for creative work. The new Laboratories will be the West Coast headquarters of Thompson Ramo Wooldridge Inc. as well as house the Ramo-Wooldridge division of TRW.

The Ramo-Wooldridge Laboratories are engaged in the broad fields of electronic systems technology, computers, and data processing. Outstanding opportunities exist for scientists and engineers.

For specific information on current openings write to Mr. D. L. Pyke.

THE RAMO-WOOLDRIDGE LABORATORIES

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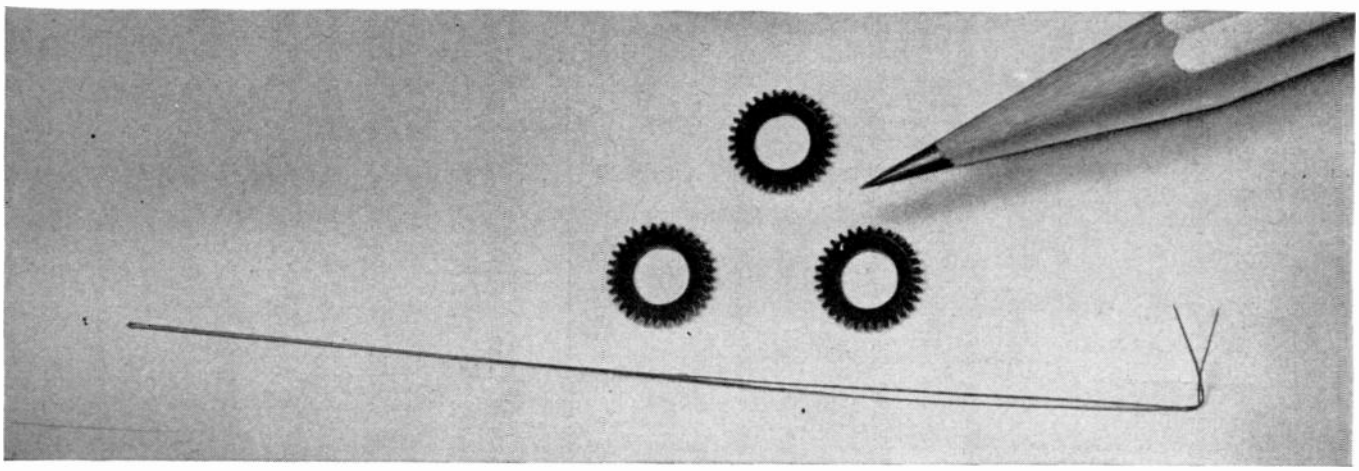
Production Inspection is Faster and Easier with a J&L Optical Comparator

. . . and its extreme versatility enables you to perform inspections that used to be "impossible"!

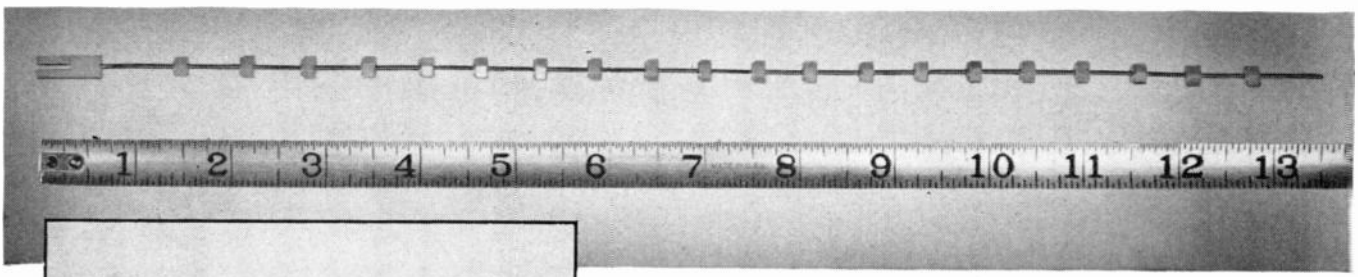
More and more electronics manufacturers throughout the country are using Jones & Lamson Optical Comparators in their quality control operations. Small shops, as well as the giants, have learned that a J&L Comparator pays for itself in very short order.

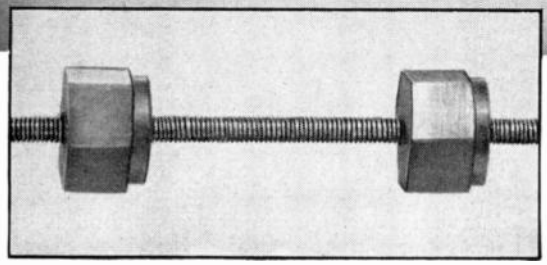
The Comparator's ability to measure and inspect, through shadow magnification, all sorts of parts and objects with extreme precision and speed makes it ideally suited for checking electronics components, especially those which are tiny or intricately contoured.

Investigate how the J&L Comparator can help you make your production operations more efficient . . . and more profitable. Write today for a free copy of our new illustrated catalog No. 5700.

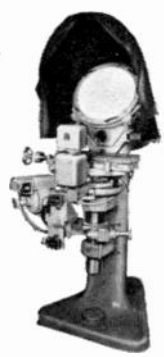


For Instance — A customer writes: "One of our assemblies, containing 32 separate circuits, measures only 5/16" dia. by 1" long. The parts which go into this assembly must have perfect shape and tension, which are impossible to check by mechanical means. Two such parts are these .005" dia. gold wires, and precisely toothed brush spacers. Since using the J&L Optical Comparator in our inspection, assembly failure due to malfunction of either of these two parts has virtually disappeared."





This precisely-threaded rod (used in calculating machines) is of .047" dia. stock, 120 pitch, with continuous threading along its entire 12" length. Threading accuracy and critical dimensions are measured and checked speedily and efficiently with a J&L Comparator.



Model PC-14

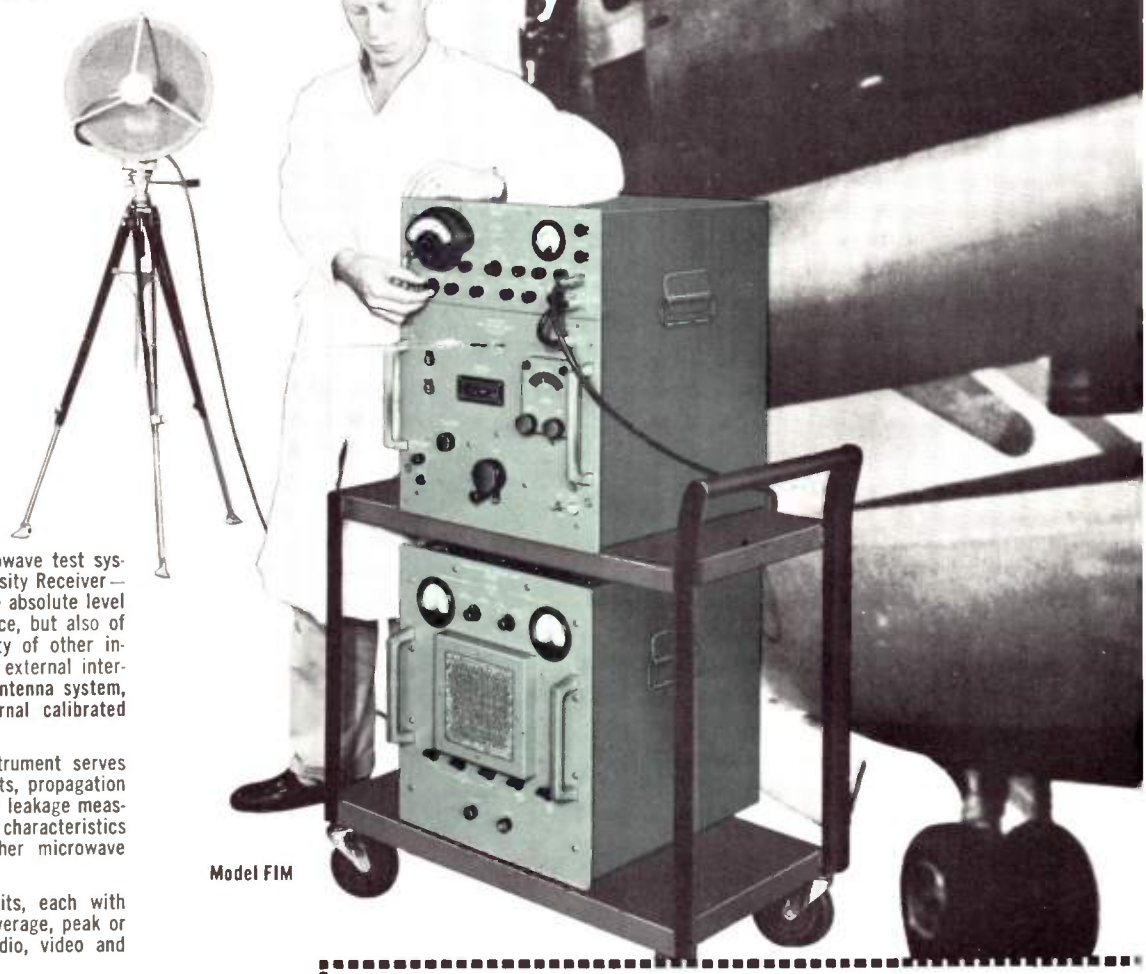
JONES & LAMSON

JONES & LAMSON MACHINE COMPANY, Dept. 710, 539 Clinton Street, Springfield, Vermont

CALIBRATED MICROWAVE FIELD INTENSITY RECEIVER

1000 to 10,000 mc

Absolute measurements of microwave interference and susceptibility



Model FIM

POLARAD

Polarad Model FIM is approved Class A MIL SPEC under MIL-I-006181C (MIL-I-22600) and Ramo-Woolridge Weapons System Specification WDD-M-PRO-2

For the first time, one single microwave test system—Polarad Model FIM Field Intensity Receiver—is capable not only of measuring the absolute level of radiated or conducted interference, but also of determining the signal susceptibility of other instruments and components to such external interference. It combines a **calibrated antenna system,** a **calibrated receiver** and an **internal calibrated signal generator.**

This versatile precision test instrument serves also for field intensity measurements, propagation studies, antenna pattern analysis, r-f leakage measurements, analysis of r-f signals—and characteristics of transmitters, receivers, and other microwave components.

Four sensitive plug-in tuning units, each with UNI-DIAL control. Meter indicates average, peak or quasi-peak value of r-f signals. Audio, video and recorder outputs.

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MAIL THIS CARD
for detailed specifications. Ask your nearest Polarad representative (in the Yellow Pages) for a copy of "Notes on Microwave Measurements"

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- ☐ Model FIM Calibrated Field Intensity Receiver EI
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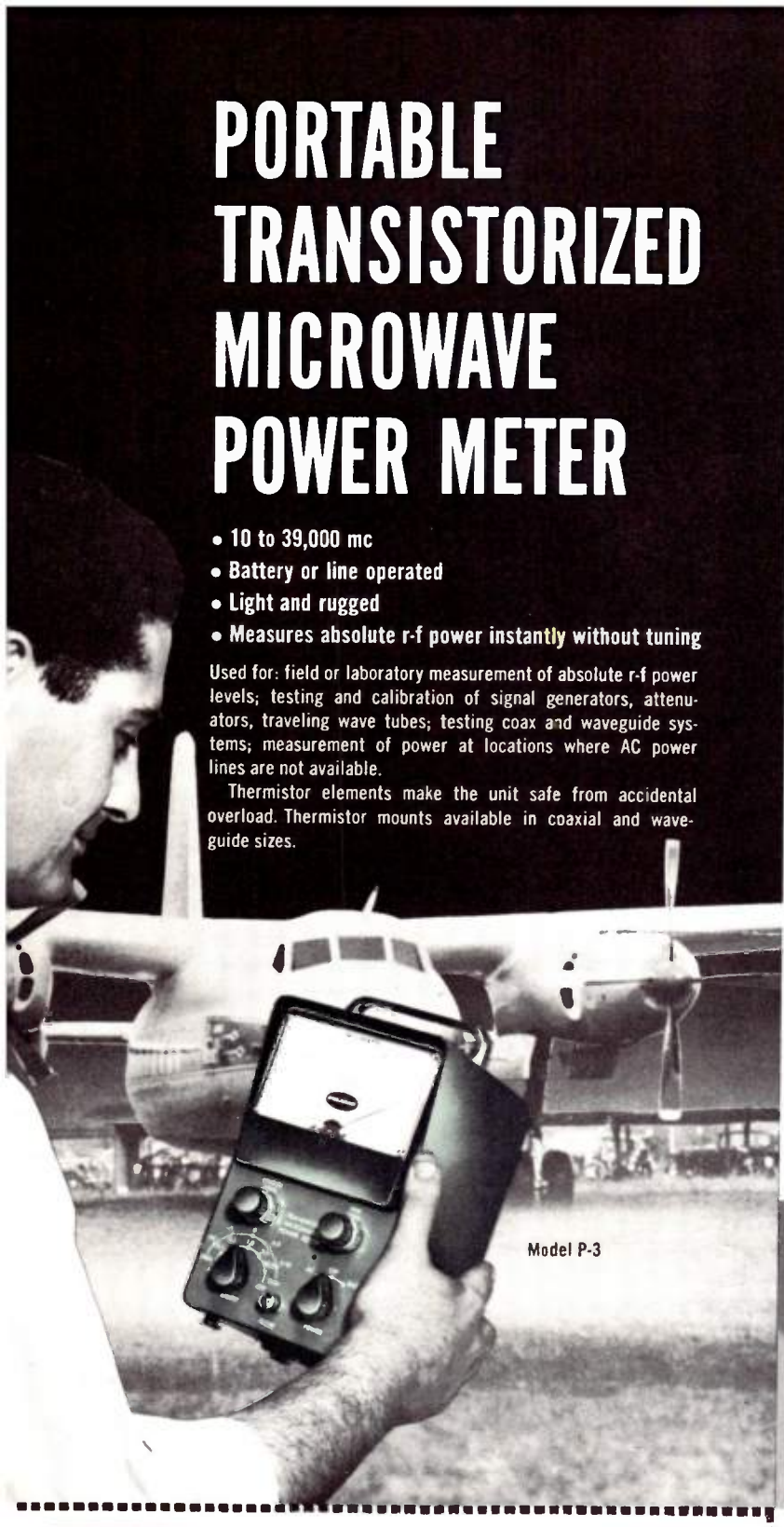
PORTABLE TRANSISTORIZED MICROWAVE POWER METER

- 10 to 39,000 mc
- Battery or line operated
- Light and rugged
- Measures absolute r-f power instantly without tuning

Used for: field or laboratory measurement of absolute r-f power levels; testing and calibration of signal generators, attenuators, traveling wave tubes; testing coax and waveguide systems; measurement of power at locations where AC power lines are not available.

Thermistor elements make the unit safe from accidental overload. Thermistor mounts available in coaxial and waveguide sizes.



Model P-3

MICROWAVE TUBE TESTER

Simplified Test Saves Engineering Man Hours

No guesswork. No need to fire up complete equipments to determine microwave tube performance. Model K-200 gives rapid, positive decision on costly microwave tubes. Quickly pays for itself by enabling you to reclaim questionable tubes from salvage. Allows Incoming Inspection to check tubes upon receipt and throughout warranty period, without tying up expensive personnel.

Tests all microwave tubes including internal and external cavity types, pencil triodes, rocket and lighthouse tubes. A scroll indicates quick setups to test for filament continuity, short circuits, static d-c tests, life tests, and dynamic tests.

Model K-200

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No Postage Stamp Necessary If Mailed in the United States

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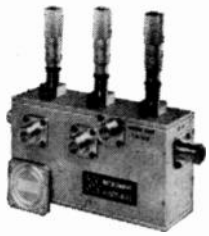
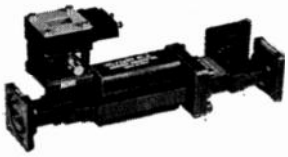


New parametric amplifiers for 4 to 14 db improvement in receivers operating within the 100-1500 mc range.

New ruggedized magnetrons for increased reliability of air-borne systems.



New ferrite duplexers, isolators and circulators for advanced systems.

New computer diodes with recovery times lower than 4 mμ secs.

New Varactor diodes that reduce receiver noise to as low as 1 db.

New duplexer tubes that guarantee crystal protection up to 1000 hours and at elevated temperatures.

New solid-state limiters that protect receivers without external bias.

PROGRESS AT MICROWAVE

has a unique 12-month pattern . . .

This pattern of progress at Microwave Associates during the past 12 months reveals a unique combination of solid state and microwave competence. It shows a new-development pace unmatched by any other single source in the microwave field. It promises that your own microwave system planning can benefit from close cooperation with our skilled team of physicists, metallurgists and engineers. Let's move ahead *faster . . . together!*

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CIRCLE 19 ON READER SERVICE CARD

NOW...FROM NORTH ELECTRIC 4 & 6 POLE RELAYS FOR MILITARY AND INDUSTRIAL APPLICATIONS

North Electric Buys RCA Relay Designs, Equipment

Announcement was made today that North Electric Company has purchased from the Radio Corporation of America all designs, manufacturing equipment, machinery and tooling used in the manufacture of their line of relays.

Included in the purchase were machinery, tooling and design for 2, 4, and 6 pole hermetically sealed subminiature relays and design data for micro-miniature types not heretofore produced by RCA or North Electric. The purchase price was not disclosed.

Commenting on the acquisition, William Tucker, president of North, indicated that this is an important step in a program intended to place North in a stronger position in the relay field. Concurrently, new type relays which have been developed in the North laboratories are being released for manufacture. These, together with the RCA relays, should add several million dollars in sales in 1959.

The program includes plans for expanding the North Research and Development facilities for the development of additional types that will give North a pre-eminent position in the relay market.

Machinery and equipment is now being removed from RCA's plants in Camden, N. J., and is expected to be set up and operating in the Galion plant within 60 days.

Reprinted from the Galion Inquirer, Feb. 19, 1959

Subminiaturized, ruggedized, hermetically sealed relays—designed for superior performance and maximum reliability in missile and airborne applications, these relays meet and exceed the stringent specifications of MIL-R-5757A, B, C and MIL-R-25018 (USAF).

4 and 6 PDT relays available for AC, DC and Dry Circuit use.

For full spec data and complete listing of types available, write—

INDUSTRIAL DIVISION

NORTH ELECTRIC COMPANY

4913 SOUTH MARKET STREET, GALION, OHIO

NORTH 75 GREATEST YEAR

New Stock Split Planned

THREE-FOR-ONE STOCK SPLIT for **Ampex Corp.**, Redwood City, Calif., is now approved by corporation directors. The decision will be submitted to shareholders for vote at a special meeting slated for Jan. 25.

• A new cooperative firm, **National Electronics Facilities Organization,** has been founded on Long Island. Made up of six companies, the new entity reportedly has total assets of $25 million and will go after military contracts. Companies involved are: **Servo Corp., General Transistor, Blount Brothers, Specialty Electronics Development Corp., Nytronics** and **Technical Research Group, Inc.** A seventh company, **Dade Associates,** Garden City, L. I., will administer NEFO's affairs. The directors of the new corporation are men who have founded their own companies and raised them to the $5-million to $10-million sales bracket. A spokesman for the group points out that NEFO is not a merger and stresses that outside their procurement activities the companies will remain independent and even compete against each other.

• **Beckman Instruments,** Los Angeles, announces acquisition of **Harold Kruger Instruments,** San Gabriel, and **Tool-Lab Inc.,** Escondido, both in California. Initial cash investment of about $130,000 was involved. The San Gabriel firm manufactures chemical analysis gear, metering pumps and Teflon connectors for laboratory and industrial use. Tool-Lab makes electric meters which will now be marketed by Beckman's Helipot division, manufacturer of potentiometers, servomotors, monitoring gear and related equipment.

• **Chesapeake Instrument Corp.,** Shadyside, Md., reports work processed during the first six months of this year was at the $450,000 level, as compared with $300,000 for 1958. For the same period, billings rose from $190,000 to about $385,000. Total profit for the interval is roughly $60,000, as compared to $16,000 last year. Chesapeake manufactures electroacoustic, ultrasonic, underwater sound and anti-submarine warfare equipment. The firm is five years old.

• **Missile Systems Corp.,** North Hollywood, Calif., announces consolidated earnings of $114,351 for the six-month period ended Oct. 31. This is equivalent to 36 cents a share on the 316,421 shares of common stock outstanding. Consolidated sales for the period were $623,116. In the period between Apr. 30 and Oct. 30, MSC backlog went from $503,784 to $1,885,913, an increase of 275 percent. F. W. Bailey, company president, says the increase in orders will bring second-half sales to more than $1 million. The firm makes components and assemblies for the missile and aviation industries.

25 MOST ACTIVE STOCKS

WEEK ENDING NOVEMBER 27

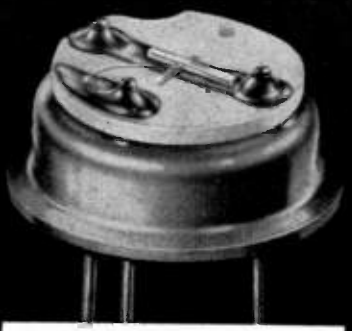
	SHARES (IN 100's)	HIGH	LOW	CLOSE
Univ Control	2,290	21⅝	19⅛	19⅜
Avco Corp	1,544	15¾	14½	15⅝
Sperry Rand	1,249	24⅝	22⅞	24⅝
Elec & Mus Ind	1,232	12	11⅛	11⅜
RCA	1,171	70⅜	65¾	69
Raytheon	1,127	55⅜	51	53⅛
Varian Assoc	1,078	53	47⅛	50¾
Gen Electric	865	90½	84	89⅞
Lear	828	21¼	18⅝	20¾
Gen Dynamics	722	48⅜	43⅞	47⅞
Int'l Tel & Tel	706	40⅜	37⅜	38⅝
Clarostat Mfg	671	17½	13½	15⅞
Gen Precis Equip	478	60	50¾	59
Cons Electronics	472	56⅛	46¼	56⅛
Ampex Corp	463	137	126	129¾
Skiatron	443	6⅝	5⅞	6¼
Philco Corp	440	28¾	26¾	27
Loral	434	36⅜	30½	34⅝
Siegler Corp	427	35¼	32⅛	32⅛
Westinghouse	413	101⅛	98	100⅞
Gen Transistor	404	35⅛	31⅛	31⅛
Burroughs	387	34½	33⅛	33⅝
Zenith Radio	357	125¾	118¾	119¼
Packard-Bell	314	46¼	40	42½
Int'l Bus Mach	308	433	408	428

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., investment bankers.

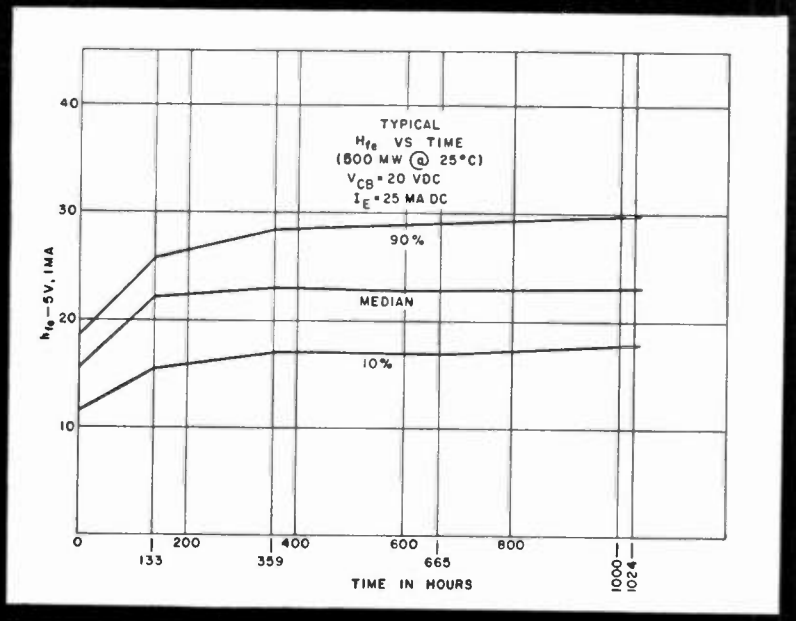
DIVIDEND ANNOUNCEMENTS

	Amount per Share	Date Payable
Assembly Prods	$.05	Jan. 5
Collins Radio	.50	Jan. 2
Friden	.25	Dec. 23
Hoffman Electncs	.15	Dec. 31
Radio Condenser	.10	Dec. 21

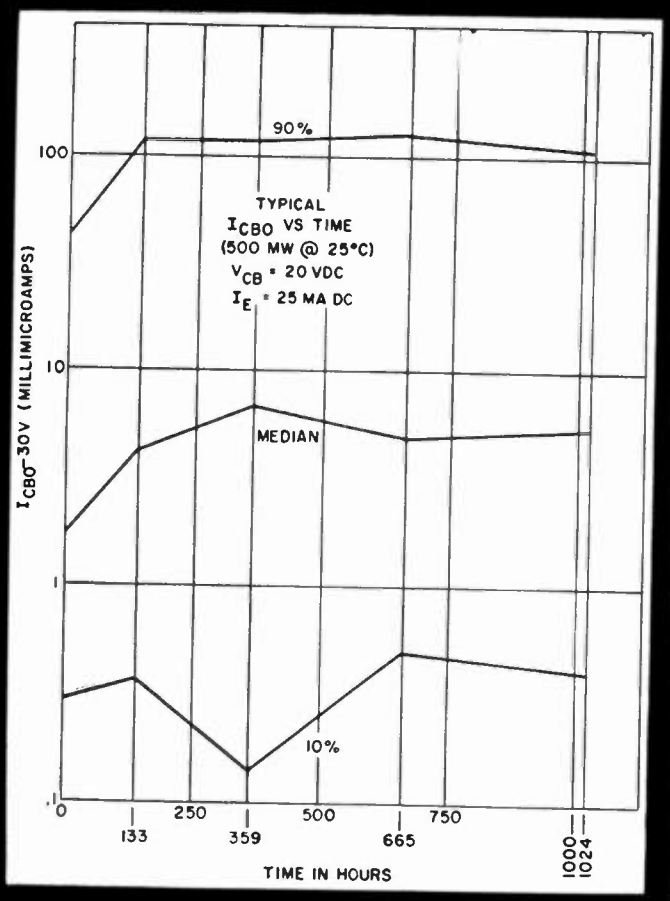
New silicon triodes dissipate

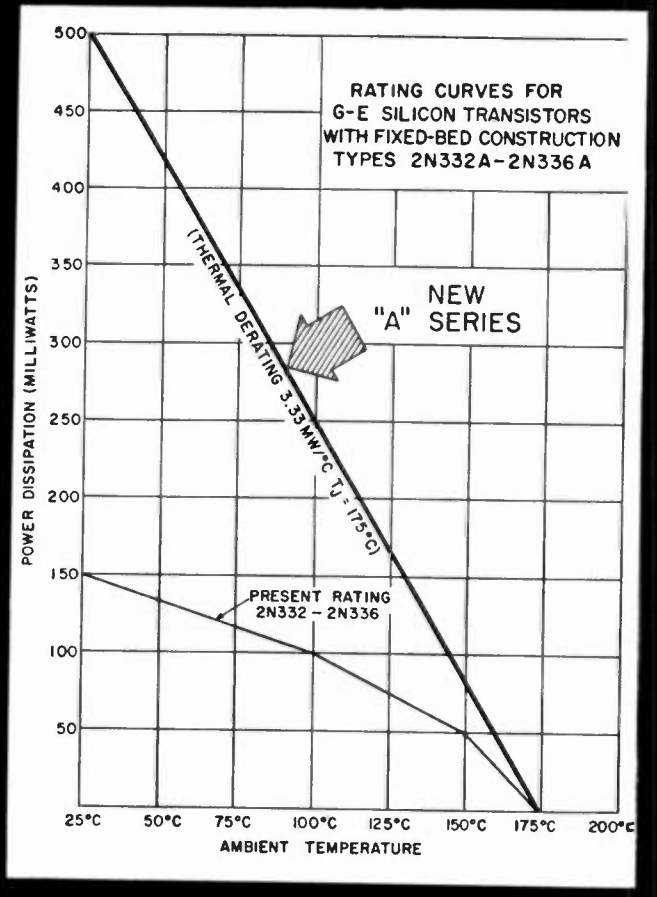


Greatly magnified photo of silicon transistor showing Fixed Bed Construction. All parts are firmly fastened, with no suspended parts except wire lead. Transistor reacts as a solid block in resisting shock and vibration. Power dissipation is inherently higher.



Power dissipation of the 2N332A-through-2N336A silicon transistors (see chart below) ranges from 500 mw at 25°C to 83 mw at 150°C without heat sink. Note also (see chart below, left) the extremely low I_{CBO} throughout 1000 hours of testing. Nearly 90% of units fall within 100 mμa. Beta spread (chart above) is stable out to 1000 hours.





500 mw without heat sink at 25°C

FIXED BED MOUNTED TRANSISTORS 2N332A-through-2N336A ALSO FEATURE:

4 VOLT V_{EB} . . . GUARANTEED 45 VOLT V_{CE} . . . .005 μa MAX. I_{CBO}

AT 25°C AND 30 VOLTS . . . PHYSICAL AND ELECTRICAL STABILITY

The 2N332A-through-2N336A line of silicon NPN triodes is a new series of amplifier and switching transistors capable of much higher performance than ever before achieved.

Collector dissipation without heat sink is 500 mw at 25°C . . . 83 mw at 150°C. Since reliability is related to junction temperature, even those designs which do not require maximum-rated power may be enhanced greatly by this device series because of the wide safety-factor potential provided.

FOUR OTHER ADVANTAGES—Collector-to-emitter voltage is guaranteed at 45 volts. Collector leakage current is a maximum of 500 mμa at 30 volts and 25°C. Collector-to-emitter leakage current is 60 μa at 150°C. Minimum cutoff frequency is 2.5 mc, typical f_{ab} is 10 to 15 mc.

FIXED BED MOUNTING—Fixed Bed Mounting is an exclusive G-E construction technique which contributes to the extreme stability obtained by this series of transistors. Storage and operating tests have resulted in a performance rate of better than 99.2% after 1000 hours.

Besides the demonstrated electrical characteristics, General Electric's silicon transistors can absorb physical punishment far beyond normal specifications. All parts are solidly fixed together and react as a solid block in resisting shock and vibration. Test units have been fired from a shotgun, struck with a golf club and rattled freely in an auto hubcap for 700 miles—and worked afterward.

IMMEDIATELY AVAILABLE—All types are available now from warehouse stock. Call your General Electric Semiconductor Sales Representative for complete details on the "hot" transistor line that operates the coolest. General Electric Company, Semiconductor Products Dept., Electronics Park, Syracuse, N. Y.

TYPE 2N333-THROUGH-2N335 SILICON TRANSISTORS MEET MIL-T-19500/37A SPEC.

Designing to the new MIL-T-19500/37A Spec? General Electric types 2N333, 2N334 and 2N335 can be supplied from warehouse stock to meet this specification.

SPECIFICATIONS

Absolute Maximum Ratings (25°C)

Voltage:		
Collector to Base	V_{CB}	45 volts
Collector to Emitter	V_{CE}	45 volts
Emitter to Base	V_{EB}	4 volts
Current		
Collector	I_C	25 ma
Power		
Collector Dissipation RMS	P_C	500 mw @ 25°C (Free Air)
	P_C	83 mw @ 150°C (Free Air)
Temperature		
Storage	T_{STG}	−65 to 200°C
Operating Junction	T_J	−65 to 175°C

Electrical Characteristics (Typical at 25°C)

		2N332A	2N333A	2N334A	2N335A	2N336A	
DC Characteristics							
Forward Current Transfer Ratio (low current) (I_C=1 ma, V_{CE}=5 V)	h_{FE}	16	27	36	45	75	
Saturation Voltage (I_B=1 ma, I_C=5 ma)	V_{CE} (Sat)	.5	.45	.42	.4	.4	volts
Cutoff Characteristics							
Collector Current (V_{CB}=30 V; I_E=O; T_A =25°C)	I_{CBO}	1	1	1	1	1	mμa
Collector Emitter Current (V_{CE}=30 V; I_B=O; T_A =150°C)	I_{CEO}	60	60	60	60	60	μa
Low Frequency Characteristics (V_{CB}=5 V; I_E= −1 ma; f=1000 cps)							
Forward Current Transfer Ratio	h_{fe}	16	30	38	52	95	
Input Impedance	h_{ie}	750	1300	1700	2000	3700	ohms
Output Admittance	h_{oe}	3.5	5.0	6.0	7.0	8.0	μmhos
Output Admittance	h_{ob}	.25	.2	.18	.15	.13	μmhos
High Frequency Characteristics (Common Base) (V_{CB}=5 V; I_E= −1 ma)							
Output Capacity (f=1 mc)	C_{ob}	7	7	7	7	7	μμf
Cutoff Frequency	f_{ab}	10	11	12	13	15	mc
Power Gain (common emitter) (V_{CE}=20 V; I_E= −2 ma; f=5 mc)	G_e	11	11	12	12	12	db

GENERAL ELECTRIC

Planning Foreign Markets

PREPARING to market abroad? If so, thorough market research is essential because conditions overseas may be quite different from the domestic scene, says Philip Patton, marketing vice president of Lenkurt Electric. He spoke at the recent Western Electronics Manufacturers Association panel meeting on "Doing Business With the World."

Company Objectives

A company's objectives in looking to foreign markets may be threefold: to have an additional outlet for U. S.-produced goods, to manufacture outside the United States for sales in a foreign country, and to manufacture outside the country for sales back to the states, says Patton.

But before deciding upon any of these approaches, he says, consider the need for a specific product. Is it one that can be adapted into the economy and technology of the country? Other questions: What's the size of the market, present and future? Can the customer pay? Is his currency convertible? Can he deliver the cash to you at home?

Attitude Toward U. S.

The attitude of a country toward the U. S. is important. Unfortunately, some nations shun American-made products. Others respect U. S. technology, and offer far less sales resistance. "What about competition, both from other companies within the United States and from foreign manufacturers?" asks Patton. "Most foreign countries have protective tariffs and much cheap labor, giving them big advantages to start with."

Foreign customers must be given more than the usual amount of auxiliary services. Can you easily get your people to their plants? Foreign marketing calls for bringing customers to the states, both for technical education and for public relations.

Is there a troublesome language barrier? Remember that because of different technologies and education, foreign trade entails greater customer education obligations. Instruction manuals and catalogs must be translated into foreign languages.

Case Histories

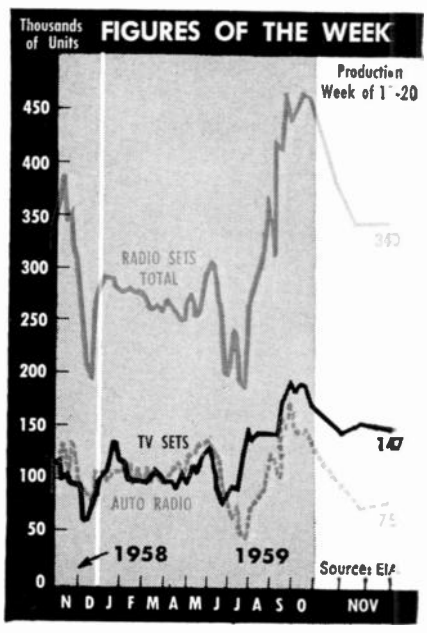
Drawing from Lenkurt marketing case histories, Patton explained how the above theories were worked out in practice.

In 1948, Lenkurt found it was unable to sell U. S.-made products in Canada because of prohibitive tariffs. Result: The company opened a plant in Vancouver.

In Italy, the firm discovered insufficient business to justify setting up a plant, and for various reasons could not sell U. S.-built products there. In this case, it was decided to license Automatic Electric of Italy to build Lenkurt products.

"Once you've decided all requirements of your market study are met," cautions Patton, "concentrate on small and particular areas. Don't try to take on the whole world at once."

• **F-m radio set production** is running more than 100 percent ahead of last year. F-m sets made during the first nine months of this year totaled 367,804, compared with 176,061 during the similar three quarters in 1958. Last September's production totaled 76,942. It was 41,408 in September, 1958.



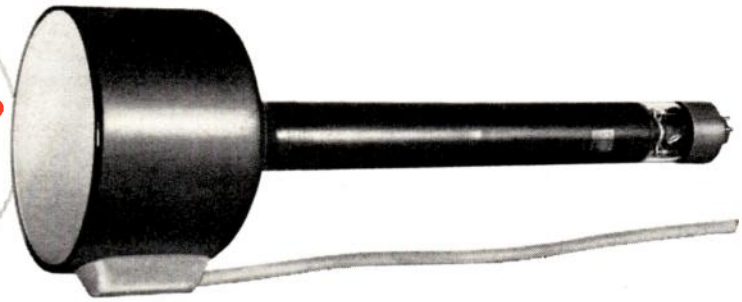
product of the pioneer

FEATURES

- Eliminate need for extra gadgetry (no centering-beam magnets)
- Spot sizes are guaranteed to be no longer than advertised
- Spot size at beam currents higher than any comparable tube
- UNPRECEDENTED!—Offered in 3 phosphors: P1, P11, P16

for
Flying Spot Scanners, Precision Radar, Photographic and Intermediate Film Transmission Systems

YOUR HIGH RESOLUTION PROBLEMS . . . RESOLVED!



Our resolution will continue to be the highest and most extensive available —without gimmicks!

Another first—Du Mont's high-resolution line of cathode-ray tubes is now available in *three different phosphors*. Du Mont, the pioneer in high-resolution cathode-ray tubes, is not only the leader in such *developments*—but the leader in *producing* a variety of such tubes to satisfy the many needs of industry. When spot sizes become smaller, and the useful variations in such tube types becomes greater—they will first come from Du Mont!

DU MONT HI-RESOLUTION TUBES FOR IMMEDIATE DELIVERY			
Tube Size	**Spot Size***	**Type**	**Phosphor Types (fine grained)**
3"	0.8 mil	Magnetic deflection and magnetic focus	P1, P11 or P16
5"	1 mil	"	"
7"	1.5 mils	"	"
3"	0.8 mil	Magnetic deflection and electrostatic focus	"
5"	1 mil	"	"
7"	1.5 mils	"	"
DU MONT SUPER HI-RESOLUTION TUBES FOR IMMEDIATE DELIVERY			
3"	0.7 mil	Magnetic deflection and focus	P1, P11 or P16
5"	0.7 mil	"	"

* We GUARANTEE that the specifications given are the maximum spot sizes (measured by shrinking raster method).

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SILICON TRANSISTORS

JAN TRANSISTOR		Minimum Current Gain (B)	Maximum Collector Voltage (Volts)	Typical Cut-off Frequency (MC)	Maximum I_{co} @ 25°C and V_c Max. (μa)	FEATURES
	JAN-2N118	10	30	10	1	• Only Jan Silicon Transistor

SMALL SIGNAL		Minimum Current Gain (B)	Maximum Collector Voltage (Volts)	Typical Cut-off Frequency (MC)	Maximum I_{co} @ 25°C and V_c Max. (μa)	FEATURES
	2N333	18	45	7	50	• Low I_{co} • Operation to 175°C • 200 mw Power Dissipation
	2N335	37	45	10	50	
	2N480	40	45	11	.5	
	2N543	80	45	15	.5	
	ST905	36	30	10	10	

HIGH SPEED SWITCHING		Typical Cut-off Freq. (MC)	Maximum Collector Voltage (Volts)	Maximum Collection Saturation Resistance (ohms)	Max. Power Dissipation @ 100°C ambient (MW)	FEATURES
	2N1139	150	15	60	500	• High Frequency Operation • Low Saturation Resistance • Low I_{co}
	2N337	20	45	150	50	
	2N338	30	45	150	50	

MEDIUM POWER		Max. Power Dissipation @ 25°C Case (Watts)	Maximum Collector Voltage (Volts)	Minimum DC Current Gain (B)	Typical Rise Time (μsec)	Typical Fall Time (μsec)	FEATURES
	2N545	5	60	15	.3	.5	• Fast Switching • High V_c • Rugged Construction
	2N547	5	60	20			
	2N498	4	100	12			
	2N551	5	60	20			
	2N1140	3	40	20	.2	.1	

HIGH POWER		Maximum Power Dissipation . . 25°C Case (Watts)	Minimum DC Current Gain (B)	Typical Collector Saturation Resistance (Ohms)	Maximum Collector Voltage (Volts)	FEATURES
	ST400	85	15 @ 2 Amps	1.5	60	• High Current Handling Ability • Low Saturation Resistance • Rugged Construction
	2N389	85	12 @ 1 Amp	3.5	60	
	2N424	85	12 @ 1 Amp	6.0	80	

Write for Bulletins: TE-1353 and TE-1355

SILICON DIODES

FEATURES	Fast Switching and High Frequency Types Ratings @ 25°C				Military and High Conductance Types Ratings @ 150°C			
		Max. Inverse Voltage (Volts)	Max. Average Fwd. Current, (ma)	Inverse Recovery Time (μsec)		Max. Inverse Voltage (Volts)	Max. Average Fwd. Current (ma)	Max. Inverse Current (μa) @ V
• Recovery Times Under 15 μsec • High Conductance Combined With Fast Switching • Subminiature Size • High Inverse Resistance	1N808	100	100	.3	JAN 1N457	60	25	5 @ 60
	1N809	200	100	.3	JAN 1N458	125	25	5 @ 125
	1N658	120	200	.3	JAN 1N459	175	25	5 @ 175
	1N659	55	100	.3	1N485B	180	50	5 @ 175
	1N643	110	100	.3	1N488A	380	50	25 @ 380
	JAN 1N251	30	75	.15	1N464	175	40	30 @ 125

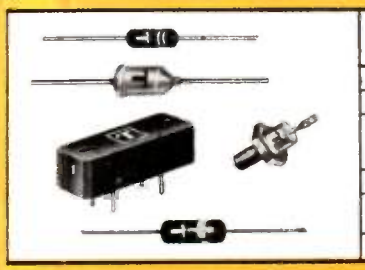
Write for Bulletin TE-1350

SILICON RECTIFIERS

Ratings @ 150°C Case Temperature		Peak Recurrent Inverse Voltage (Volts)	Maximum Average Forward Current (ma)	Maximum Inverse Current (ma)	FEATURES
Subminiature Glass	1N689 1N649	600 600	150 150	0.2 0.2 (@ 25°C)	• Reliability at High Temperatures • High Efficiency • Rugged Construction • Hermetic Sealing • Low Thermal Resistance
Miniature	TJ60A TJ30A	600 300	200 200	0.5 0.5	
Axial Leads	SL715 1N547	1500 600	100 250	0.2 0.3	
Military	JAN 1N256	570	200	0.25 (@ 135°C)	
Stud Mounted	TM155 TM67	1500 600	400 3000	0.5 0.5	
Medium Power	TR402 TR601	400 600	Amps 20 10	 5 5	
High Power	TH402B	400	50	15	

Write for Bulletin TE-1351

SILICON REGULATORS AND REFERENCES

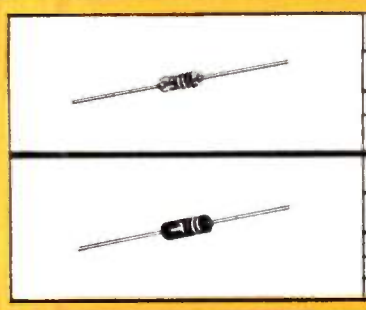


	Voltage Range (Volts)	Maximum Dynamic Resistance (ohms)	Maximum Current @ 25°C (ma)	@ 125°C (ma)	FEATURES
Subminiature — SV-5	4.3-5.4	55	50	10	• Long-term stability • Operation up to 150°C • Small size, easy mounting • Hermetically sealed
Miniature — SV-815	13.5-18	120	40	8	
Power — SV-924	20-27	8	55°C (amps)* .4	(ma)* 100	
Stabistor — SG-22	.64	40	150	25	
Reference — SV-3176	8-8.8	15	Temp. Coefficient ±.001%/°C		
Ref-Amp — 3N44	8.3-9.8		±.002%/°C		

*Case temperature ratings

Write for Bulletin TE-1352

SILICON CAPACITORS

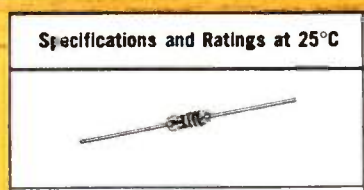


Ultra High Frequency Types — Ratings @ 25°C							FEATURES
	Cut-off Freq. (mc)	Capacity (μμf) @ V Max.	@ −0.1V	Q @ −4V @ 50Mc	@ 100Mc	Maximum Working Voltage	
SCH-51	5000	.35	2	100	50	10	• Subminiature Size • High Q • High Temperature Operation
SCH-52	5000	.8	4	100	50	7	

High Frequency Types						
				Q @ −4V At 5mc	At 50mc	
SC-1		4.4	24	350	35	22
SC-5		25	120	350	35	11
SC-15		120	360	350	35	6

Write for Bulletin PB-45

GERMANIUM DIODES



FEATURES

- Milli Microsecond Switching
- Superior Forward Conductance
- High Inverse Resistance
- Uniformity and Stability
- Gold Bonded Construction

Specifications and Ratings at 25°C	Forward Current @ +1V (ma)	Inverse Current at Specified Voltage (μa @ V)	Max. Oper. Voltage (volts)	Description
JAN-1N270	200	100 @ −50	80	JAN TYPES
JAN-1N277	100	250 @ −50 @ 75°C 75 @ −10	100	
JAN-1N281	40	500 @ −50 30 @ −50	60	
JAN-1N126	5	500 @ −50 30 @ −10	60	
JAN-1N198	5	250 @ −50 @ 75°C 75 @ −10	50	
1N283	200	20 @ −10	20	COMPUTER TYPES
T16G	40	100 @ −50	60	
1N278	20	125 @ −50 @ 75°C	50	HI-TEMPERATURE TYPES
T22G	40	20 @ −10 @ 75°C	15	
T9G	100	20 @ −50 2 @ −10	60	HI-RESISTANCE TYPES
1N67A	5	50 @ −50 5 @ −5	80	
T8G	100	20 @ −100 5 @ −10	100	
S570G	10	30 @ 6	Recovery Time .002 (μsec)	MILLI-MICROSECOND SWITCHING

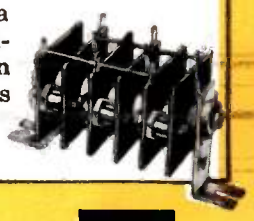
Write for Bulletin TE-1300 & TE-1319

GERMANIUM COMPUTER TRANSISTORS

	Minimum Current Gain (B)	Maximum Collector Voltage (volts)	Typical Cutoff Freq. (MC)	FEATURES
2N427	40	15	8	• High FrequencySwitching • Low Saturation Resistance • Uniform Input Characteristics
2N428	60	12	13	

Your local authorized TRANSITRON DISTRIBUTOR now carries in-stock inventories for immediate delivery.

Transitron's TD series of rectifier stacks offer a wide range of ratings in seven standard circuit configurations. High voltage cartridges, quads, plug-in assemblies, and many other special encapsulations are also available. Your inquiries are invited.
Write for Bulletin TE-1342.



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Medical Ultrasonics: What's

High-power systems serve as scalpels, low-power systems as body mappers. Devices are becoming both more sophisticated and more practical

DEVICES for producing nonionizing radiation used for therapy and diagnosis are simultaneously becoming more sophisticated and more practical. This trend was shown in papers given by doctors, engineers and scientists at the 12th Annual Conference on Electrical Techniques in Medicine and Biology held last month in Philadelphia. Also, papers of a general nature were given with emphasis on instrumentation.

Ultrasonic Neurosurgery

Focused high-energy ultrasonic beams have been used to produce circumscribed destruction of deep-seated ganglia (a benign growth) in the brains of animals (ELECTRONICS, p 53, May 15). According to F. J. Fry of the University of Illinois, the technique has been developed to the point where a fairly standard pattern of procedural steps has been established for treating humans.

Because bone absorbs ultrasonic energy, a portion of the skull between the ultrasonic radiator and the point to be irradiated is removed. The skin flap is sewn into place and allowed to heal. Since the patient's head must be extremely rigid during exposure, a head holder is used having four stainless steel pins which are inserted in cup-shaped indentations previously drilled into the patient's skull.

During the operation, the patent's head is accurately positioned by the holder. A four-beam ultrasonic focusing device is then used to irradiate the selected area through the skin flap.

Presently, the portion of the skull removed is replaced following the operation. If a solid, acoustically transparent material having a low rate of acoustical absorption were available, it could be inserted in place of the bone during the preliminary operational procedures.

Success of this type of operation was demonstrated in a film showing preoperative and post-operative condition of a patient with a nonpatterned hyperkinetic disorder and another with Parkinson's disease. In both cases recovery of full motor control was achieved.

Ultrasonography

By using pulsed-echo ultrasound in the mc range, D. H. Howry and J. H. Holmes the University of Colorado Medical Center obtained cross-sectional pictures of various regions in a living human body. An ultrasonic camera for the same purpose was recently described (ELECTRONICS, p 124, Sept. 11).

A somagram, as the ultrasonic picture is called, of good definition has been produced by a compound circular scanning technique. Electrical pulses activating a piezoelectric crystal are used to propagate ultrasound. The sound waves are focused, passed through a water medium and permitted to impinge on the subject. Echoes produced are reflected back to a transducer, and the resultant electrical signal is amplified and presented on a crt.

The transducer head scans sectorially, producing a cross-sectional picture of the object in the plane of radiation. Since the majority of normal tissues are mirror-like reflectors, only those structures can be seen which present a normal surface to the beam. This problem is overcome by mounting the transducer on an arm rotating about the object. The 360-deg exposure largely eliminates "spooks" resulting from multipath reflections and reduces sonic shadows thrown by some structures.

A somagram taken of a living leg and a photograph of a pathological specimen of the same leg showing the same cross-section were compared on a slide. The somagram gave a more detailed picture of the leg structure and tissues.

Ultrasonic Eye Diagnosis

Another paper, presented by G. Baum of New York University and I. Greenwood of NYU and General Precision Labs, described use of ultrasonographical techniques for accurately diagnosing disorders occurring in eyes opaque to light or occurring behind the retina of normal eyes.

Using a pulsed ultrasound sector scanner similar in operation to that described previously, a map-like display of a cross-section of the eye is produced on an intensity modulated crt. Compound scanning by moving the transducer through 90-deg arc around the eye is under development.

This technique provides a nonsurgical method of evaluating eye

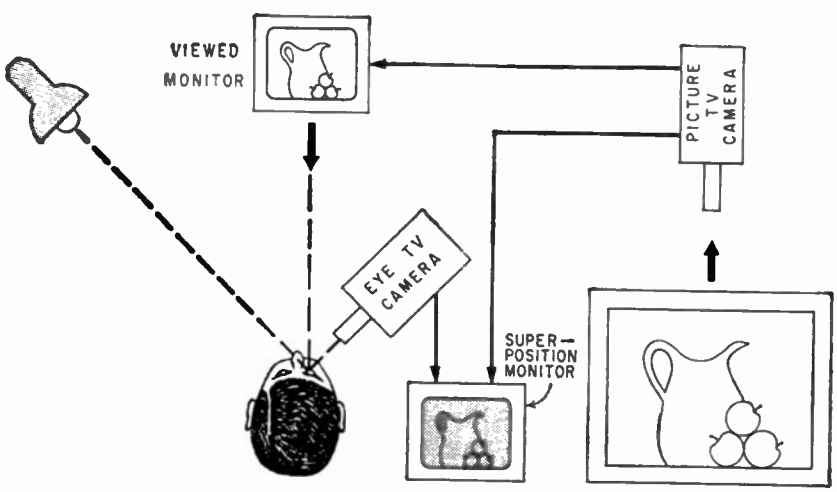


FIG. 1—Television eye tracking system shows how subject scans a picture. White dot on superposition monitor indicates fixation point

New

lesions to determine if they are cystic or solid. Also, the relationship of a foreign body to soft tissue can be seen and the body accurately located.

Electronic Hematocrit

Since resistivity of blood is a function of the volume concentration of cells in the blood, blood cell concentration can be determined electrically. This principle is utilized in a transistorized portable electronic hematocrit described by K. H. Okada and H. P. Schwan of the University of Pennsylvania. The instrument measures the resistance of a small sample of blood and converts this value into its equivalent volume concentration value. An associated cell contains the 0.02-cc blood sample which is easily obtained by the finger-prick technique.

Resistance measurements are made using an off-balance bridge excited by a 10-kc transistor oscillator. A thermistor in one arm of the bridge compensates for temperature dependence of blood's resistivity. A feedback amplifier builds up the signal to a sufficient level for a standard detector and meter circuit. Output of the meter is calibrated directly in percent blood cell volume.

A system for tracking the movement of the eye in relation to the field viewed was described by E. Llewellyn-Thomas and N. H. Mackworth of the Defense Research Medical Labs in Canada. (Another technique was described in ELECTRONICS, p 67, Sept. 25). Besides diagnosing visual field defects, the ORML system will provide psychologists with a tool for studying mental-visual correlation and reflexes.

The system operates as shown in Fig. 1. Corneal reflection of light from surface of eye follows the subject's gaze. This reflected light spot is viewed by the eye tv camera whose output is combined with the output of the picture tv camera in the superposition monitor. The picture produced has a bright spot superimposed on the scene which corresponds to the area viewed by the cornea.

By mounting photocells on the face of viewed monitor, the eye spot can be used as a control mechanism. This would permit areas that have been examined to black out or the areas being examined to be illuminated.

Possible uses of the system were demonstrated in films showing eye movement patterns of an electronics engineer studying a circuit diagram, a pilot looking for the runway of an unfamiliar airport, and people viewing a painting, searching for a number among rows of numbers and being tested for quality of peripheral vision.

Exhibitor demonstrates Lester A. Dine Co. electronic flash camera used to take black and white or color closeups. Projection of eye closeup is shown at lower right

NASA to Alter Patent Rules

WASHINGTON—New patent regulations for the National Aeronautics and Space Administration seem assured. Recently, NASA proposed an amendment to its present restrictive patent policy. The amendment meets much of industry's complaint against the policy.

Involved Process

When Congress set up the space agency, it laid down patent rules much like those in use by the Atomic Energy Commission. For research and development contracts, NASA takes title to all inventions. In some cases, NASA can waive its patent ownership, but getting a waiver is an involved process.

Now, NASA has proposed that its patent rules be changed, giving the agency the option to take title to inventions that may result from R&D contracts. Whether or not the government is to take patent titles will be determined when a contract is written, however, before any inventions are accomplished.

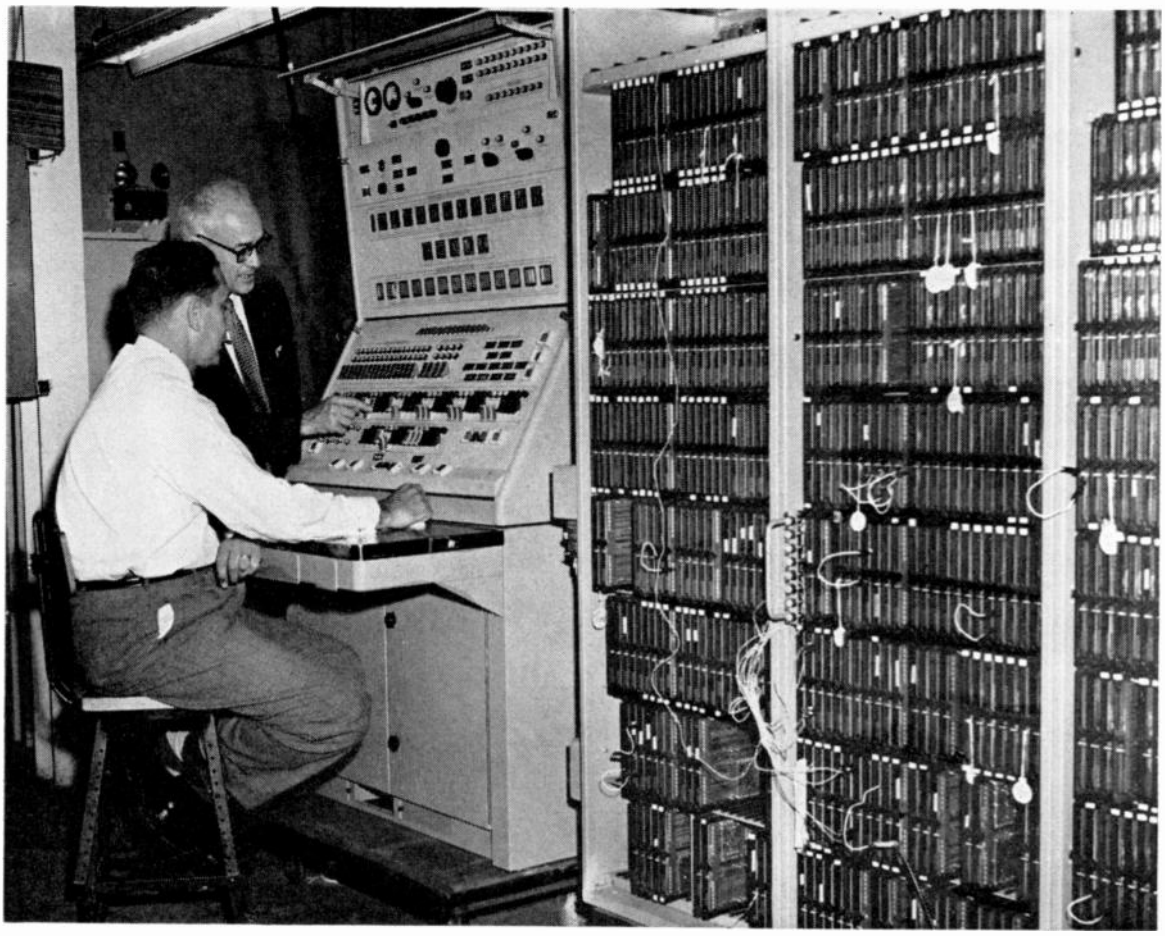
The proposal to liberalize NASA's patent policy was made public at hearings conducted last week by the House Astronautics and Space Patent Subcommittee.

Industry has been complaining about NASA's patent rules for months. It thinks the agency should follow the same procedure used by the Department of Defense and other government agencies. Under this setup, the government doesn't take title to inventions but gets to use them royalty-free.

The House hearings on the matter were followed by similar hearings by the Senate Small Business Monopoly Subcommittee. Before both Congressional bodies, industry spokesmen argued for a liberalization of the NASA patent rules.

Observers look for Congress to rewrite the space agency's patent regulations early next session.

Combat Data Processing Enters



A sample program is inserted through console into the central processor during system test at Data System Operations Laboratory in Needham, Mass.

New mobile digital computer will be delivered soon to Ft. Monmouth, N. J. System operates in either fixed station or trailer

DELIVERY of the first Mobidic to the Army's Signal Research and Development Labs at Fort Monmouth, N. J., in the near future will mark the opening of a new era in battlefield data processing, Army strategists believe.

Mobidic (mobile digital computer) is a solid-state large-scale general-purpose computer developed by Sylvania for field army use in either trailer or fixed station. It is being tested for application to command decisions involving logistics, scientific computation, battlefield surveillance.

The air-transportable system is the largest in the Fieldata family of Army computers, designed to aid staff tacticians in extracting essential information from a mass of raw data and providing the command with timely and accurate summary information.

Plan Many Jobs

Jobs projected for it include the processing of field army personnel records and requirements; allocation of the spectrum for corps-level communications; computation and display of battle-area fallout patterns, with the aid of remote sensing elements; storage of intelligence data and display of enemy situation maps, including location of hostile forces and their weapons capability; combat status of all elements of the command; storage and display of weather data; tactical operations and fire support coordination; status of supply, transportation, evacuation and medical services; and quick derivation of analytical battlefield forecasts.

The unit is a military-inspired computer, not a business device modified for the military. Sylvania says it has not yet decided whether or not to enter the computer in the commercial field. "It may gravitate into business," says one of its builders, citing design advances in areas common to the military and business.

Cost of the average computer system, requiring 300 sq. ft. of floor spacing, is said to be about $2 million, including trailer. Fixed system might cost less. Commer-

New Era

cialized versions would have no need for ruggedized environmental, operational and maintenance features.

Design Features

The system is a synchronous parallel computer using 38-bit pure-binary words. Clock rate is 1 mc. Its magnetic-core memory has a capacity of 4,096 words, and a total of 7 memories can be used, giving a maximum capacity of 28,762 words. Repetitive random-access time is 8 microseconds.

Sensitivity of ferrite material to ambient temperature variations, coupled with exacting environmental conditions involved in field army use, led to development of an electronically-compensated memory, giving operational constancy from −25 F to 125 F without external controls.

For speed and reliability, circuits are completely transistorized. Circuitry was designed to be capable of operating at 5 to 10 mc for conservative operation at the computer rate of 1 mc.

Input-output converters can each handle up to 63 in-out devices. Real-time registers allow multiplexing of two or more computers into integrated data processing networks, also allow the computer to operate directly into wire or radio communications systems.

A program-interrupt feature is incorporated in the system. This feature permits an operator to interrogate the computer during real-time operation, and allows the computer to respond. It is also used during remote-control operations, when control data is transmitted to the system through the real-time registers.

Extensive marginal-check circuits are incorporated in the unit to facilitate maintenance.

Sylvania is now working on the next generation field army computer. This will probably also be a vehicle-mounted system with electronic component density reduced by a factor of 10, and a faster and perhaps smaller input-output system.

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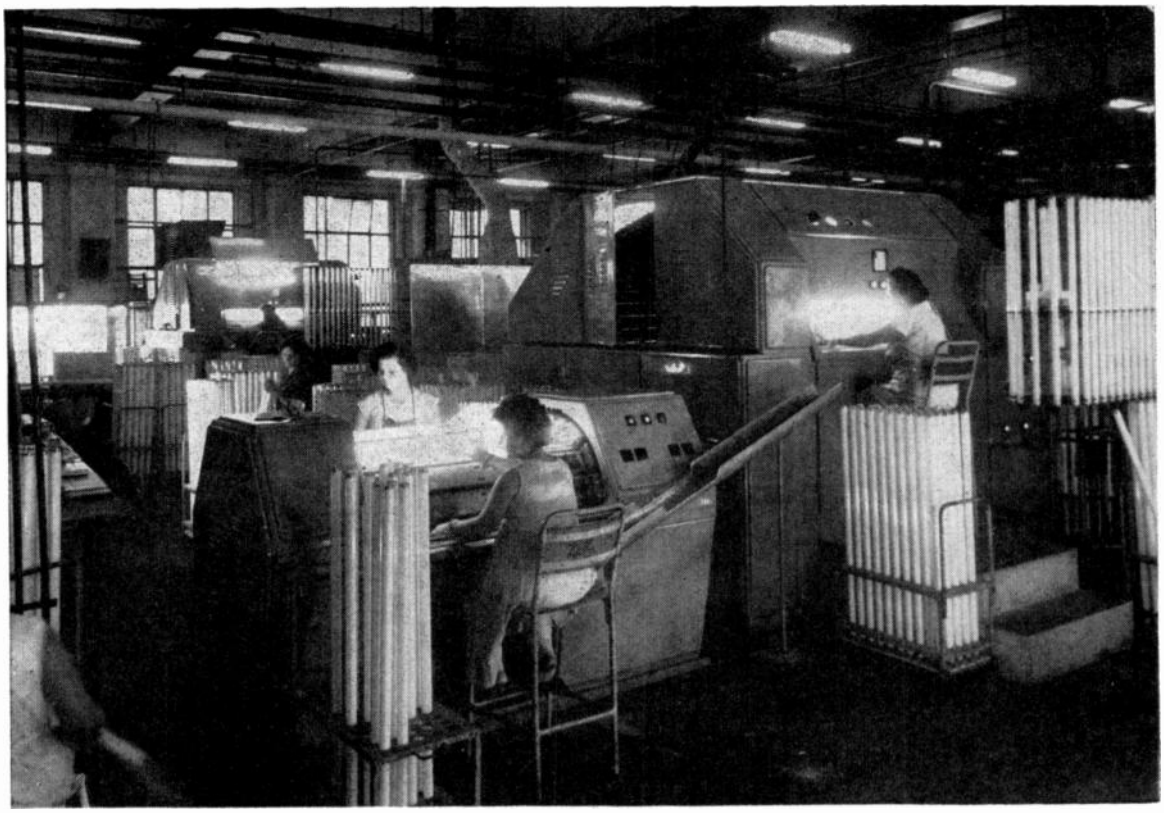

Electronic instruments are used to test finished fluorescent tubes made in a Hungarian lamp factory

What's Going On In Hungary

Electronics industry there is advancing rapidly, reports a U. S. engineer just back from a technical symposium in Budapest

DEVELOPMENT of the electronics industry in Hungary may have been aided inadvertently by U. S. actions. This was suggested by Don Sinclair, vice president and chief engineer of General Radio in summarizing his recent visit to a Budapest technical symposium sponsored by the Hungarian Academy of Sciences.

"Our export boycott of strategic goods may well have stimulated the growth of this expanding, improving industry. Other factors are involved, but whether through need or circumstance, the Hungarians have developed this industry from the ground up—probably with little direct assistance from the USSR," he says.

"The high caliber of the papers delivered at the convention and the good production methods, test facilities and manufactured equipment that were observed during visits to Hungarian factories showed the industry's advance."

Most papers presented at the symposium were by Hungarians; other papers came from other nationalities on both sides of the Iron Curtain. Among other Hungarian talks was one describing a new and advanced microwave-relay system.

The Hungarians frequently start from scratch in developing an electronics system. They will design and develop system components such as antennas or microwave tubes rather than buy them from foreign sources. Design and development starts with a study of world literature on the topic and proceeds step by step, often repeating work done elsewhere.

Make Own Parts

Self-sufficiency carries through to the factory floor. Production men in Hungary cannot select from a wide array of standardized and reliable components, consequently make their own parts. They do import components, however, when the domestic product is markedly inferior.

Compared to its American counterpart, a Hungarian electronics plant has a great deal of tooling. About 70 out of 1,000 employees work on tooling, mainly with Russian-made machine tools.

Quality of manufactured electronic equipment is good. Television receivers and such consumer gear works well and is made for rugged use. The Hungarians don't worry much about appearance as a rule, although models made for export are much more stylish than those for home consumption.

Test equipment and methods are good. Production techniques seem adequate, although production people frequently evolve them from the ground up. Sometimes this approach leads to off-beat techniques; for example, rather than dip etched-circuit boards into a solder bath, one plant used a solder-filled heated template that goes against the board's soldering points, and then forces solder through holes onto these points.

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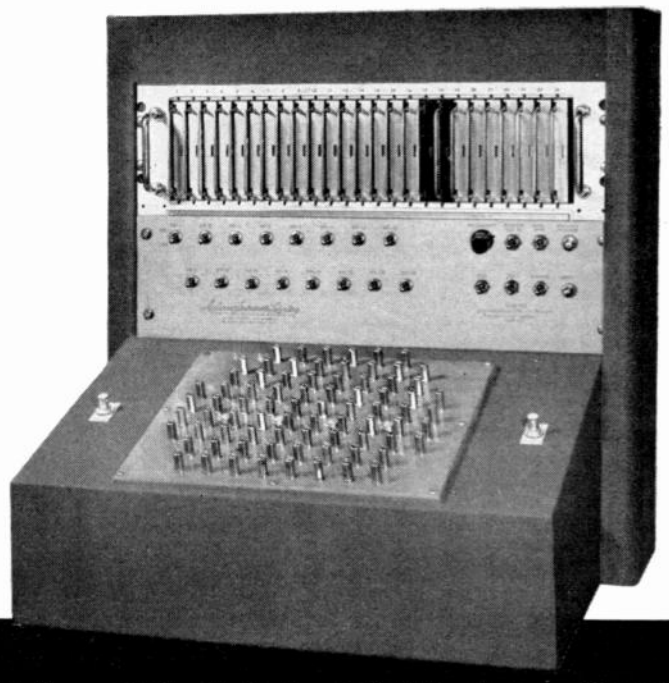

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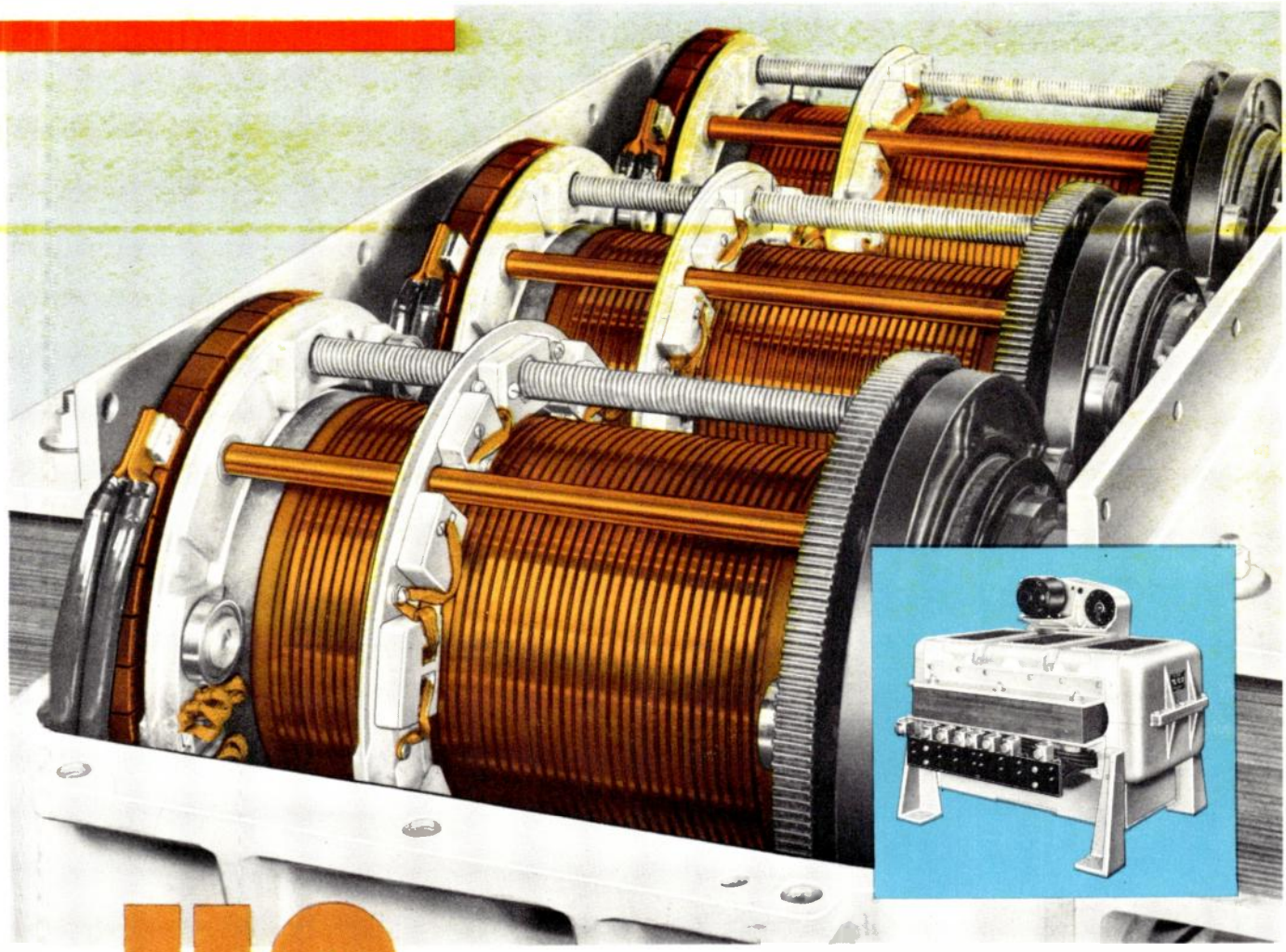

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* The Superior Electric Company's U.S. Patent No. 2,864,992.

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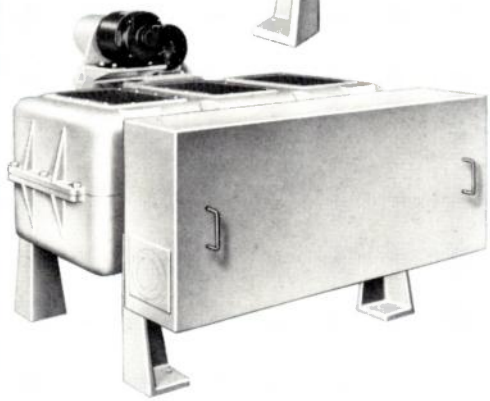


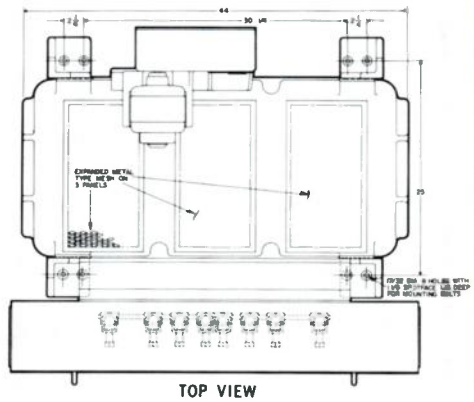
TYPE 2HCB200-3Y (FORCED AIR COOLED)

INPUT:	240 VOLTS	60 CYCLES	3 PHASE
OUTPUT:	0-270 VOLTS	360 AMPERES	168 KVA

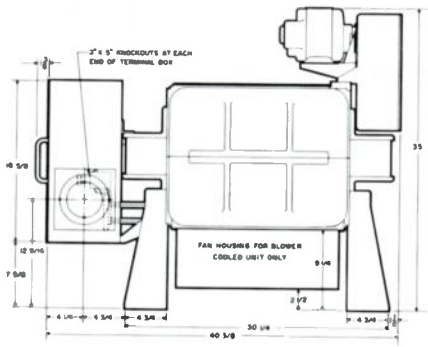
TYPE 2HC200-3Y (CONVECTION COOLED)

INPUT:	240 VOLTS	60 CYCLES	3 PHASE
OUTPUT:	0-270 VOLTS	200 AMPERES	93.5 KVA

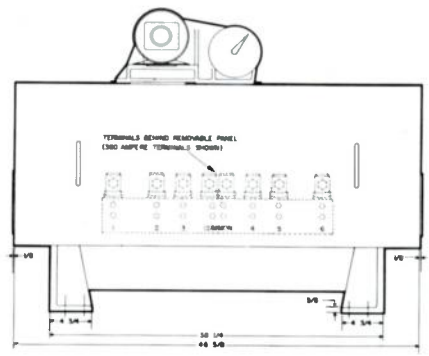
OUTLINE DIMENSIONS



TOP VIEW



SIDE VIEW



FRONT VIEW

TYPES

Two 240 volt, 3-phase types are offered. Type 2HC200-3Y is cooled by normal convection. Type 2HCB200-3Y is similar in construction but incorporates fans for forced air cooling of the coils. Output rating of the forced air cooled type is nearly double that of the convection cooled type. Types for 480 volt, 3-phase duty are available also.

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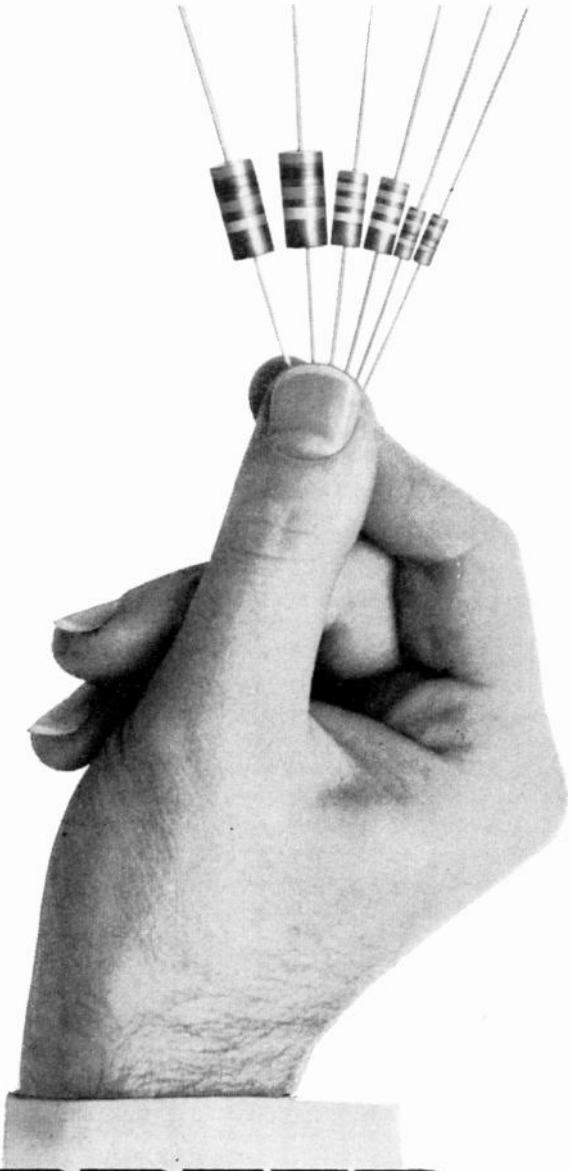

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Air Group Adopts

Airlines Electronic Engineering Committee specifies standards for single-sideband gear, discusses cockpit indicators and transistors

DALLAS—STANDARDS for single-sideband communications systems for use by commercial airlines were adopted by the Airlines Electronic Engineering Committee at a recent three-day meeting here. The group also deliberated on specs for cases, mountings and other form factors of air transport indicators.

An administrative session the first day involving airline representatives only tentatively approved plans for the ssb specs, indicator form factors, and also for transistors. The general sessions during the following two days okayed the ssb plan "with minor changes," tabled the indicator specs and didn't take up the transistor problem at all. AEEC, which formulates standards for electronic equipment and systems for airlines, also reviewed Tacan-compatible distance-measuring equipment and self-contained navigation aids, decided that no changes were needed in existing specifications for either.

The committee's radar-beacon project was also discussed and tabled. AEEC heard the Federal Aviation Agency's proposal for a three-pulse sidelobe-suppression and reflection-suppression technique, now being coordinated with the United Kingdom. Since FAA has not yet reached agreement with UK on an international standard on sidelobe suppression, committee action on beacons was postponed.

Various methods of allocating available frequencies in the 5,000-mc weather-radar band were discussed and passed on to future sessions. One airline has proposed a 3-channel split of the C band. Aeronautical Radio Inc., of which AEEC is a part, has proposed a 2-channel split.

Other items discussed included the characteristics of such things as life-raft radio beacons and passenger announcement tape reproducers, with the main purpose of determining industry interest. Of the two, the tape reproducers seem to have the most backing: at least two airlines see a need for them.

At AEEC meeting, engineers from Northeast Airlines and Collins Radio inspect new 860E-1 distance-measuring gear built by Collins. Unit gives accurate distance up to 200 nautical miles from ground beacon

Key action of the meeting was approval of a published Arinc characteristic (numbered 533), covering a single-sideband communications system. This characteristic covers the requirements for an airborne transmitter-receiver capable of transmitting and receiving h-f radio intelligence in the following forms:

(1) Single-sideband full-carrier transmission of voice and tone signals plus a-m double-sideband reception; and

(2) Single-sideband suppressed-carrier transmission plus ssb suppressed-carrier reception of voice and other signals where exact frequency synchronism is not critical.

Urge New Circuits

The characteristic also calls for floating-carrier ssb transmission and reception of voice and data signals which require synchronization in frequency but not phase; plus transmission and reception capabilities for special data applications with separate external modulation and demodulation circuits.

Implementation of the latter two,

Standards

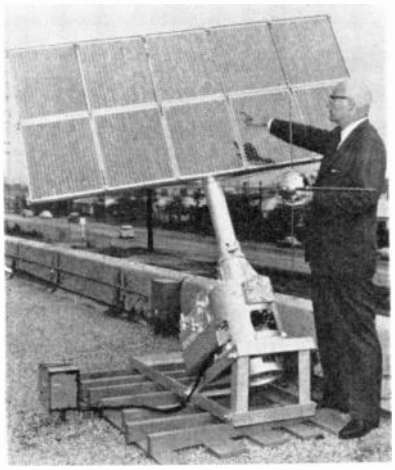
however, isn't required now. The characteristic says sufficient space and capabilities for future plug-in assemblies should be made. Manufacturers were encouraged to develop any circuits necessary to accommodate them.

Committee endorsement of Mil Std 201, a preferred list for transistors used in airborne equipment, is expected soon. It is anticipated, however, that the military list will be cut back considerably, since it includes more types than airline equipment requires. Airline needs will be resolved in a near-future working session involving airlines, manufacturers and the military.

AEEC has also thought about drawing up airline tube procurement specifications, but committee spokesmen say action on this was neither needed nor appropriate.

The purpose of the published Arinc characteristic numbered 408 is to provide design criteria for the indicators used with certain commercial airline electronic systems. The committee gave a general endorsement to this spec, but concluded that additional work with manufacturers remains to be done before it can be made final.

Energy Converters



Size of "Big Bertha," energy converter containing 7,800 solar cells, can be compared with the tiny converters used in Vanguard I. H. L. Hoffman, president of Hoffman Electronics, demonstrates. The large converter will be used in mass production of silicon solar cells at Hoffman's new Semiconductor Center in El Monte, Calif.

100,000,000

100 MILLION

actual size

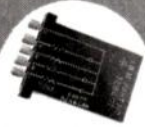
Phono Cartridge Compensating Circuit

Contains 6 fixed resistors. Component Density 1510 /in.³ (2,610,000 /ft.³)

Telephone Line Detector

Contains 6 resistors and 5 capacitors. Component Density 46 /in.³ (80,000 /ft.³)

½ actual



Computer Arc Suppressor

Contains 4 resistors and 4 capacitors. Component Density 8.3 /in.³ (14,350 /ft.³)

¼ actual

TV-Height, Linearity and AGC Control Unit

Contains 3 variable and 4 fixed resistors. Component Density 70 /in.³ (121,000 /ft.³)

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Space: High Road to Peace?

Scientists and engineers describe new communications and instrumentation systems

WASHINGTON, D. C.—A vigorous military space program will, more than any other one endeavor, promote world peace. This was the theme of Air Force Director of Advanced Technology Brig. Gen. H. A. Bushey's address before the American Rocket Society meeting here.

Assuming that we must have space capability second to none for national survival, he pointed out that military space systems are not unpeaceful. They should act as "burglar alarms" or "policemen of space," and not a threat to the peaceful world, he said. The Air Force now has full responsibility for military systems, boosters, and launchings.

Leonid I. Sedov, chairman of the Astronautics Commission of the Soviet Academy of Sciences and leader of the five-man Russian scientific team attending the rocket meetings, said that because of the immense costs of space research it is "not only desirable but necessary that we cooperate." He praised the U. S. effort and added that it should produce "great successes" in the future.

Tells About Systems

Three specific space systems were described by Gen. Bushey as "policemen of the air"—communications, early warning, and reconnaissance satellites.

The simplest of the communications satellites is the passive reflector used to reflect radio signals, which is being developed under NASA.

Another type is the delayed tape recorder and transmitter which were used to broadcast the President's message a year ago from an orbiting Atlas. By this method, communications between any two locations on earth could be transmitted in less than 30 minutes. This is considered useful, Gen. Bushey said, but not fast enough.

Another type, the relay satellites, could be spaced 120 degrees apart and cover most of the globe. "With lower altitude polar satellites, they could give an instantaneous global military network," he said.

The second policeman of the air, the early warning satellite (an infrared detection device), could see the fiery rocket plume of the ballistic missile and send a radio alarm, he explained.

A-Power Generator

The reconnaissance satellite, SAMOS, would theoretically make it possible to detect whenever an enemy was mounting an attack.

A small atomic-powered electric generator was described by Atomic Energy Commission chairman John A. Cone. Designed to provide electricity for satellites and space ships, it is about the size of a 5-gallon can and weighs only 220 lb. However, it would take about 400 lb of shielding to protect electronic equipment against atomic radiation from the device and two or three times as much to protect photographic film.

Of special interest was the report of four scientists who have successfully embedded a tiny, 2-oz radio transmitter inside a dog's body and connected it to the animal's heart.

The experiment was described by Ben L. Ettelson, president of Spacelabs, Inc., and Dr. Leslie Laeburn, senior technical staff member. An electrocardiogram was successfully transmitted from the dog over a considerable distance. Heart performance was measured without wires attached to the dog.

The transmitter can be used in other ways to determine biological effects of space environment at the time they occur. The radio transmitter, 3 in. long, 1 in. wide and ¾ in. thick, was inserted entirely within the chest cavity. The dog recovered quickly from the hour's operation. The transmitter was powered by a small rechargable battery and was capable of sending signals 50 feet. The battery had an initial charge good for four hours.

MEETINGS AHEAD

Jan. 11-13: Reliability & Quality Control, National Symposium, ASQC, IRE, EIA, AIEE, Statler Hotel, Washington, D. C.

Jan. 31-Feb. 5: Comparison of Control Computers, Winter General Meeting, AIEE, New York City.

Feb. 3-5: Military Electronics, Winter Convention, Biltmore Hotel, Los Angeles.

Feb. 10-12: Solid-State Circuits Conf., AIEE, IRE, Univ. of Penn., Philadelphia.

Feb. 11-13: Electronic Representatives Assoc., Annual Convention, Drake Hotel, Chicago.

Feb. 20-29: Component Parts and Electronic Tubes, International Exhibition, Porte de Versailles, Place Balard, Paris.

Mar. 21-24: Institute of Radio Engineers, National Convention, Coliseum & Waldorf-Astoria Hotel, New York City.

Apr. 4-7: Nuclear Congress, EJC, PGNS of IRE, New York Coliseum, New York City.

Apr. 11-13: Protective Relay Engineers, Annual, A&M College of Texas, College Station, Texas.

Apr. 11-14: Weather Radar Conference, American Meteorological Society and Stanford Research Institute, San Francisco.

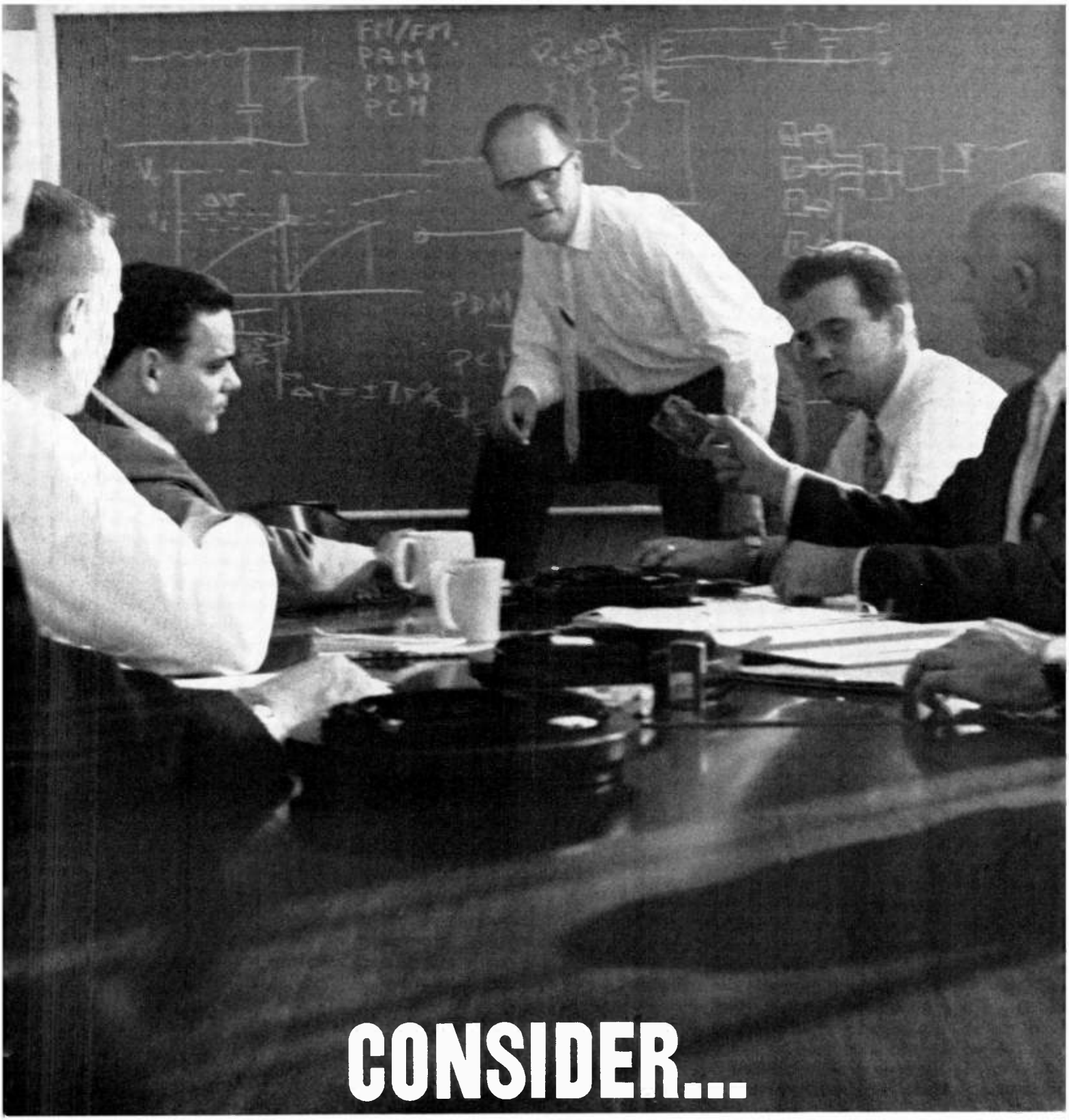
Apr. 18-19: Automatic Techniques, Annual Conf., ASME, IRE, AIEE, Cleveland-Sheraton Hotel, Cleveland.

Apr. 19-21: Active Networks & Feedback Systems, International Symposium, Department of Defense Research Agencies, IRE, Engineering Societies Bldg., N. Y. C.

Apr. 20-22: Southwestern IRE Conf. & Electronics Show, PGME of IRE, Shamrock Hilton Hotel, Houston, Texas.

Aug. 23-26: Western Electronic Show and Convention, WESCON, Ambassador Hotel & Memorial Sports Arena, Los Angeles.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 86.



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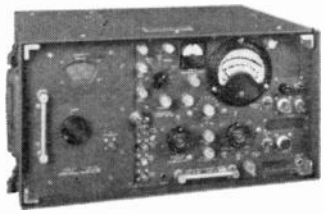

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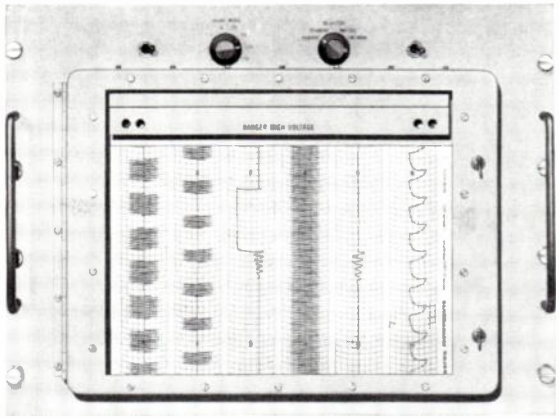

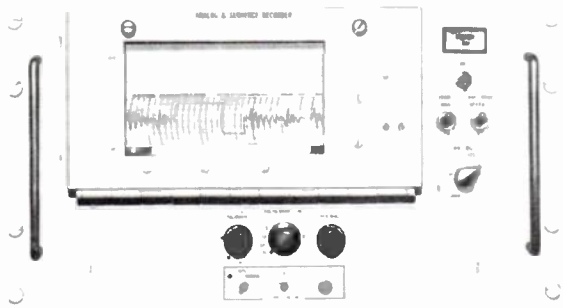

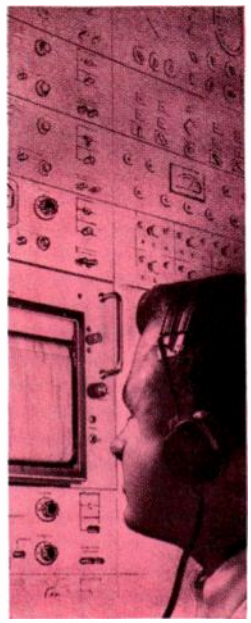

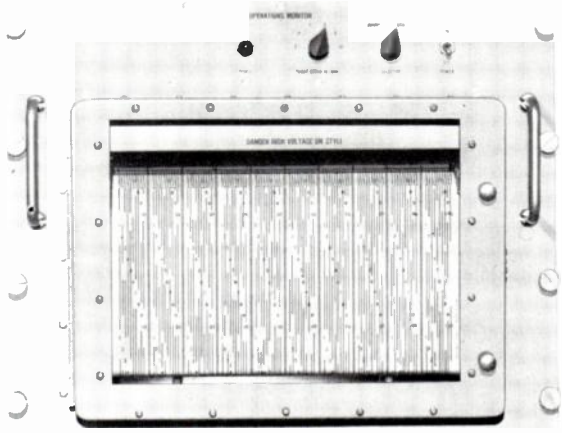

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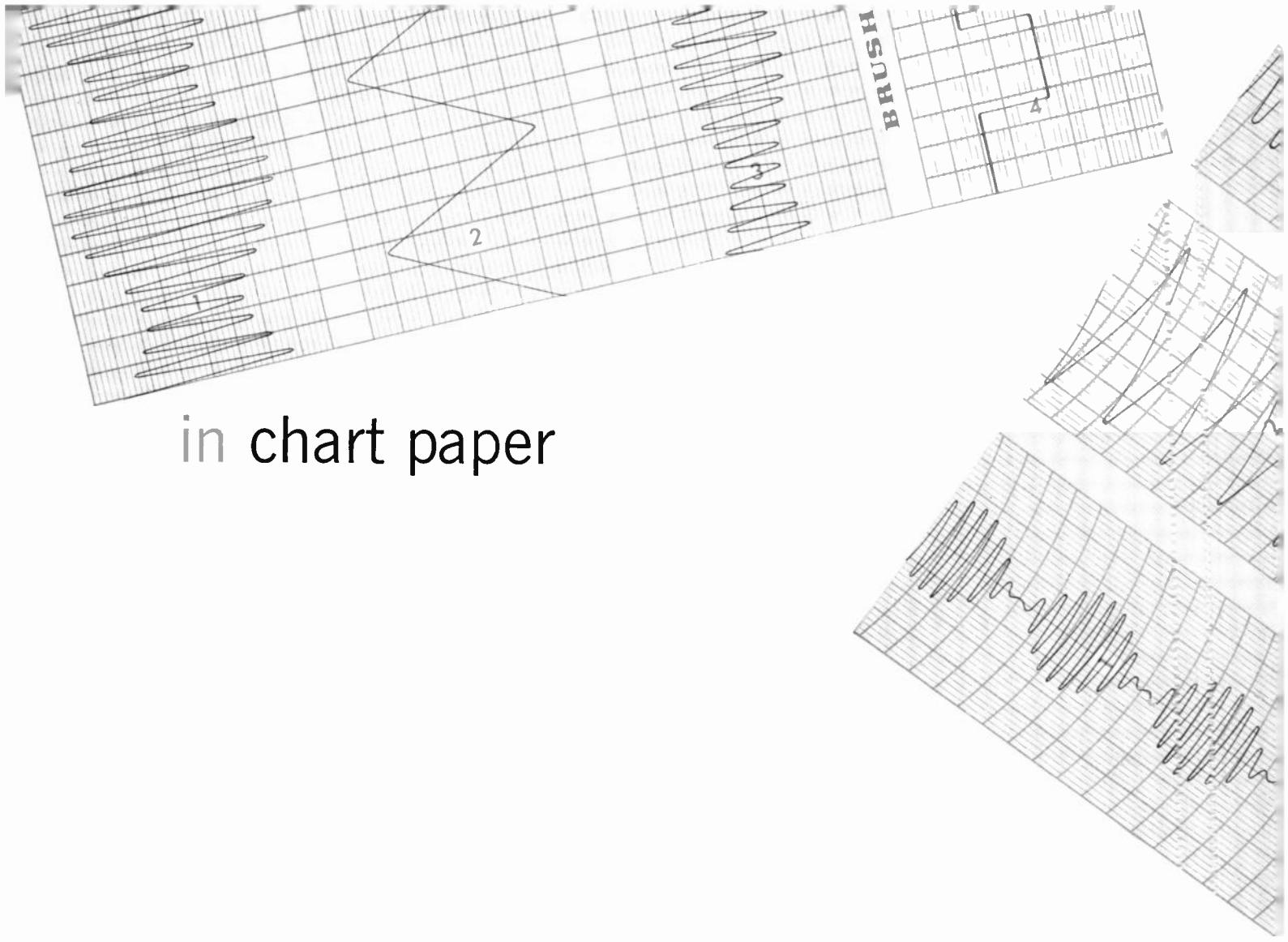

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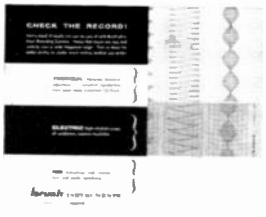

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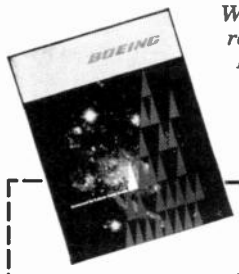

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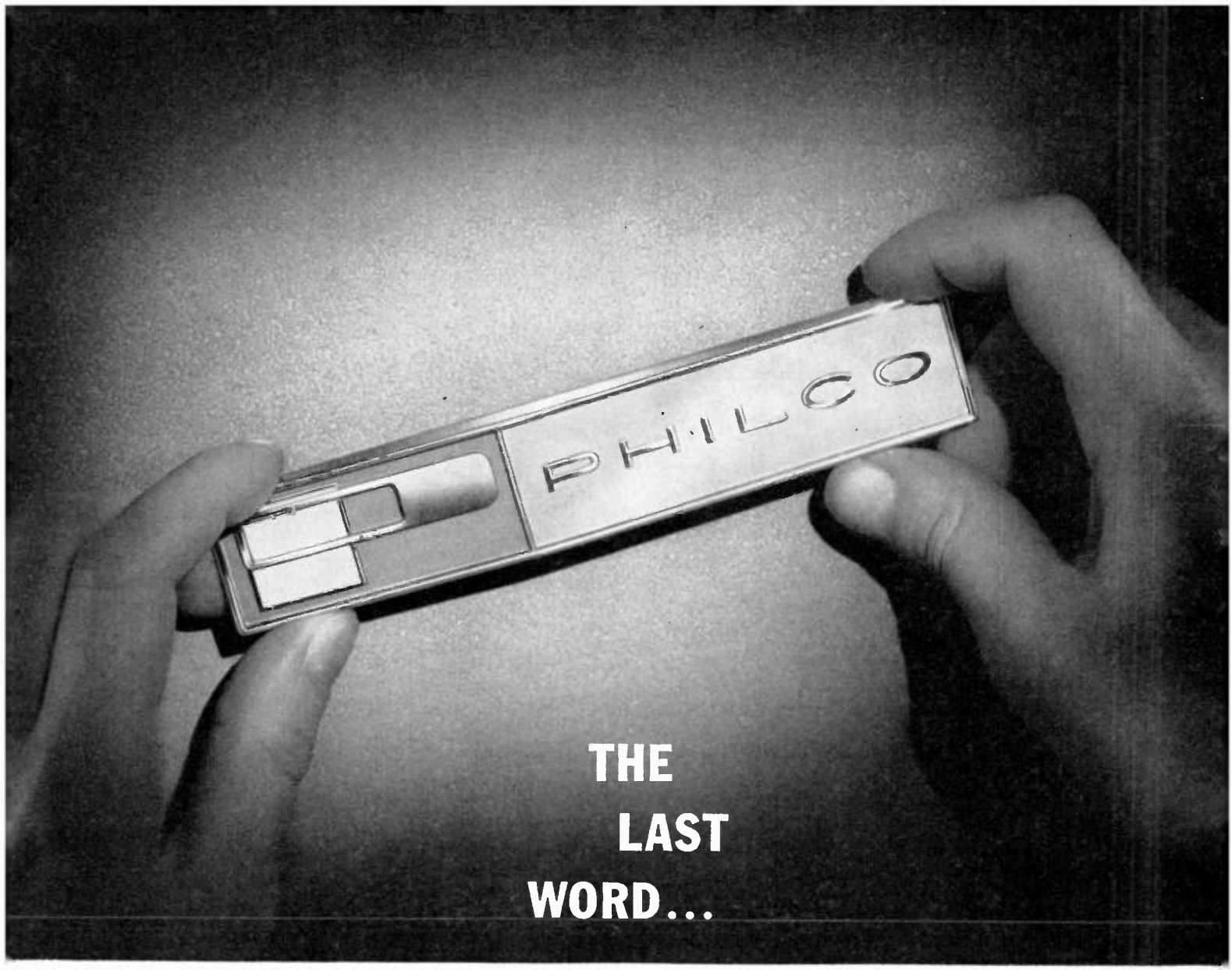

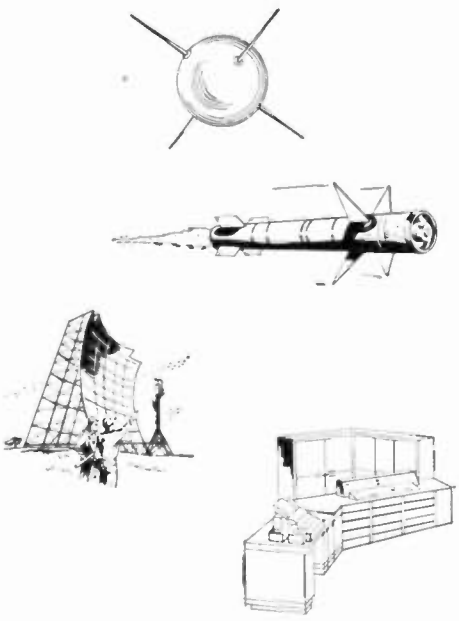

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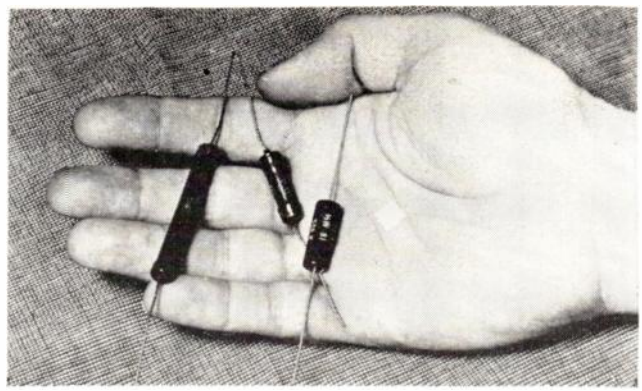


Comparing tiny micro-element resistor (square) with ordinary resistors emphasizes weight and size reduction

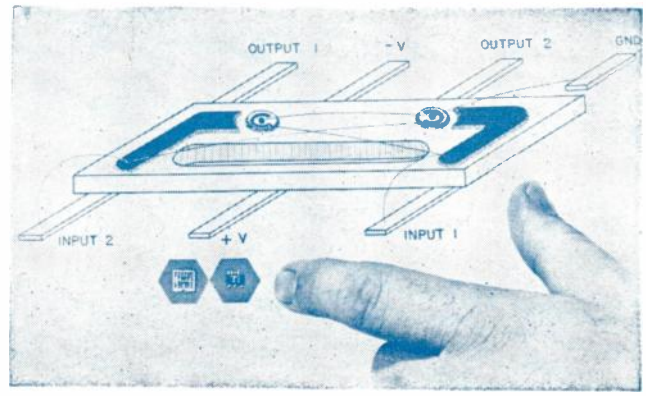


FIG. 1—Small size of a Texas Instrument bistable multivibrator is indicated. Enlarged view at top shows construction details

Three Approaches to Microminiaturization

Construction methods for fabricating extremely small electronic circuits and components are outlined in detail. Article also examines future applications

By **ROBERT LANGFORD**, Chief Engineer, Weston Instrument Div., Daystrom, Inc., Newark, N. J.

MICROMINIATURIZATION WORK sponsored by the military services is progressing along three lines. These lines can be identified and typed by the method of component mounting used.

In this discussion, type A includes those circuits in which single-function components (such as resistors) are mounted on individual wafers. These wafers are then wired together along the edges. Thus, the circuits are made up of single components on a plurality of wafers.

Circuits in which a discrete number of different-function components are placed on a single wafer are classed as type B. Here there are a plurality of components on a single wafer. This is often called the two-dimensional concept.

Type C identifies circuits in which nondiscrete components, virtually indistinguishable from one another, are mounted on a single wafer. This technique is also known as the three-dimensional concept. Roughly, the chronological order of investigation in these military programs has been from A to C. Individual types are discussed in reverse chronological order.

TYPE C—In this method resistors, capacitors, inductors, diodes, transistors and other electronic devices are mounted together on one surface of a single wafer. The various elements are indistinguishable from each other and are indistinguishable as individual components. Components can be recognized only by their functional characteristics (Fig. 1).

This three-dimensional type of design is viewed as giving the ultimate in size reduction. It will permit packing densities well in excess of one million parts per cubic foot. Depending on the individual type of micro-element, packing densities might run as high as five hundred million parts per cubic foot.

Type-C design is based on the fact that semi-

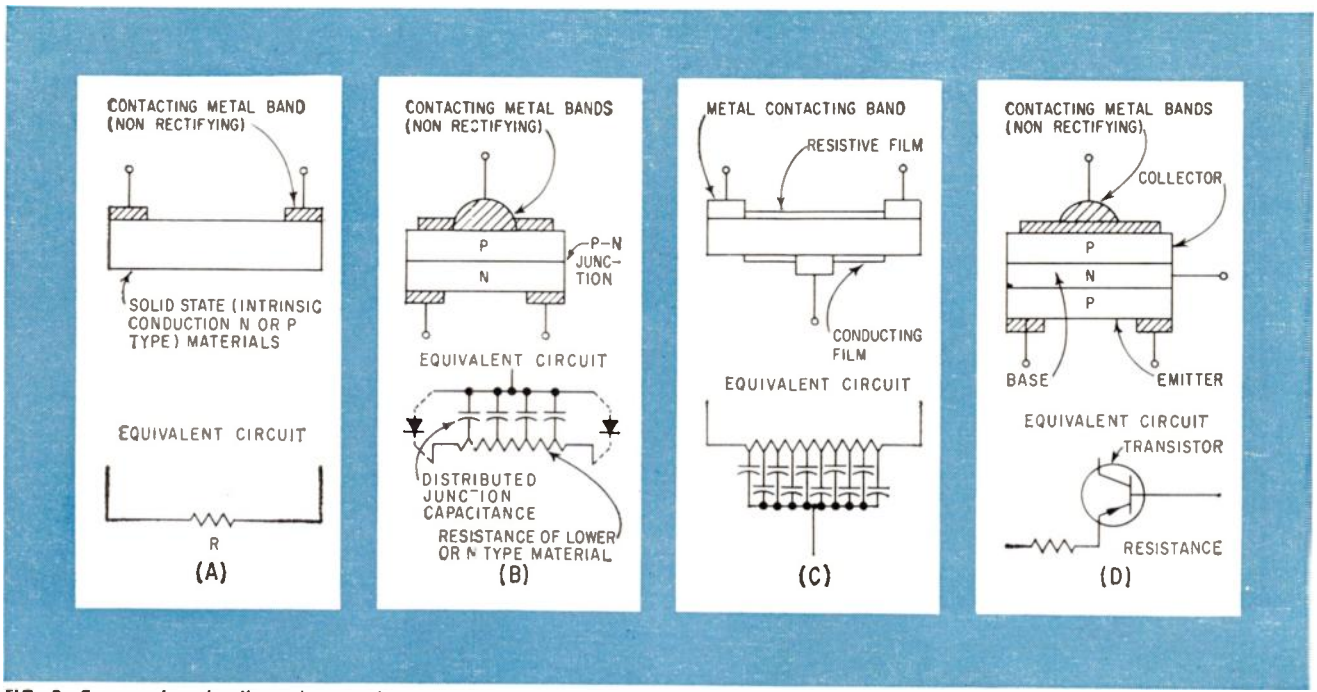


FIG. 2—Construction details and equivalent circuits for resistor (A), capacitor (B), resistance and capacitance combination (C) and combined circuit (D) used in three-dimensional approach

conductor materials, such as germanium, silicon and some intermetallic compounds now undergoing study, can be changed from insulators to conductors by employing impurity agents. The idea is not to have discrete lumps of resistance, inductance and capacitance connected by wires; rather it is to use an individual small piece of germanium to make a smooth transition from resistance to inductance to capacitance as desired.

If a resistor were needed in a circuit it would be possible to appropriately dope the semiconductor to very low resistance at each end to obtain leads. However, it would be preferable to have the resistor shaped so that it takes all the available space between the connection points. Under these conditions, Fig. 2A, no leads are required. The resistor is a semiconductor material appropriately doped and uses, probably, considerably less of the impurity.

Table I—Available Micro-Elements

Resistors: metal film—4 psi micro-element, range 10 to 200 k
Capacitors: precision type—up to 39 $\mu\mu$f single layer, to 1500 $\mu\mu$f multi layer
general purpose—5000 $\mu\mu$f single layer
electrolytic—50 microfarad-volts, solid tantalum
Inductors: Toroids—Q greater than 100, 4.3 to 50 mc, up to 1.5 mh
Diodes: low-frequency detector 1N277 equivalent
fast switching computer silicon 1N643 equivalent
Transistors: Equivalent of 2N109, 2N140 and 2N384
Switching Transistors: 2N404, 2N700
Crystal: 45.91 mc
Zener diodes: regulator types 1N665, 1N667, reference 1N430
Reactance modulators AFC and FM: V39 and V566
Reactance tuner: V27E and V58E

It is possible to make a capacitor by using the barrier layer capacitance existing across the *p-n* junction of a diode as shown in Fig. 2B. However, this method gives an unneeded rectifying property. Use of two diodes connected in opposite directions solves this problem but may introduce unwanted resistance. The preferred construction is an insulating form of semiconductor sandwiched between two conducting zones. Provided the sandwiched form is thin enough, it should be possible to reach appropriate values of capacitance. Other circuit elements are shown in Fig. 2C and D.

Theoretically this concept, one of the most advanced being used, seems good. However, only a few practical samples have been made. Because virtually all of the components are synthesized from solid-state materials, continued advances in this approach, currently called molecular electronics, depend upon development of materials. Unfortunately, one of the major limitations of solid-state materials is the presence of voltage and temperature coefficients that run as high as several thousand parts per million per volt or degree C. What this really means is that these materials do not make linear components under normal use.

TYPE B—This two-dimensional concept embraces the idea of constructing the complete circuit using distinguishable components of resistance, capacitance, and inductance on the same wafer. This concept is not new; manufacturers have supplied resistance and capacitance units for several years. In the two-dimensional concept, Fig. 3, each component is applied onto the wafer in turn and then copper or silver is evaporated in a vacuum to connect the various components.

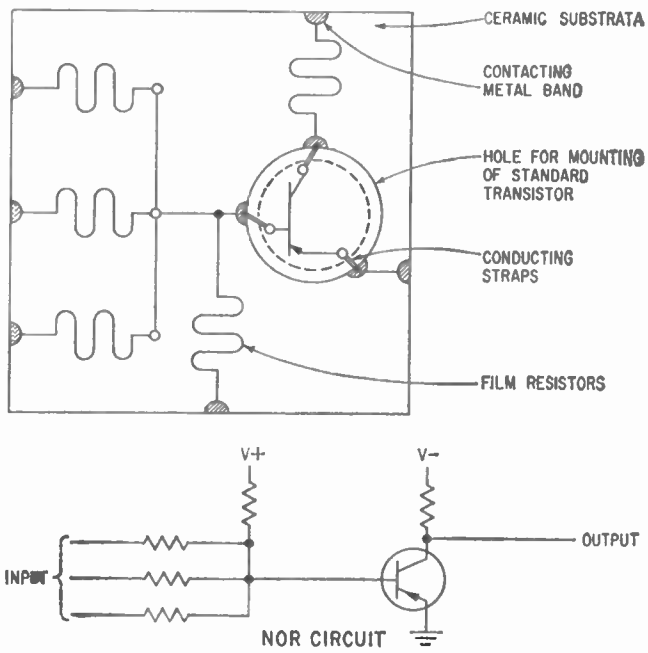


FIG. 3—Two-dimensional technique is an extension of concept used to make resistor and capacitor units

With the exception of crystals, batteries and chokes, it is now possible to deposit, in thin-film form, virtually all major components. Resistors are made from carbon, tin oxide or metal films. General-purpose capacitors can be made by applying metal on both sides of a high permittivity substrate. Electrolytic capacitors are made by reactive sputtering of tantalum, and diodes and transistors can be lithographed in thin film form on a substrate surface. Each of these individual components is deposited on the wafer and then adjusted to value as required. The final interconnections are made by evaporating copper or silver connectors.

The major problem of this concept is a low yield in manufacturing. The average yield for individual thin film components is 50 percent. Placing a plurality of these components on a single wafer multiplies the yield in strict geometric progression, so that as few as four components on a single wafer will reduce the yield to 6 percent. To those engaged in this art it invariably seems that 99 percent of the work on the wafer is finished and then the one fatal mistake occurs, resulting in rejection of the whole wafer.

Ultimate automation of this process can be easily foreseen since most of the problems on how to deal with individual components are well along the road to being solved. Resistors and capacitors can be adjusted to value accurately and some control can be maintained over diodes and transistors. However, many important raw materials breakthroughs are needed before this process can become a manufacturing proposition. These breakthroughs are needed to improve the reliability of deposition and adjustment of individual components.

TYPE A—This is one of the earliest concepts, having been founded during such projects as Tinkertoy, which was geared to the use of the vacuum tube. The basic idea is that a single component is applied on an individual wafer, and then the wafers are connected one on top of another by soldering or welding wires along the edge, Fig. 4. This simple concept has many values which may not be immediately apparent.

The complexity factor or yield of complete circuits can be made 100 percent even though the yield on individual parts may be 50 percent. A simple selection process separates the good and bad components and then usable components are soldered into place in the assembly. If final encapsulation has not taken place, it is possible, even after soldering, to replace a component should it fail or be unsatisfactory.

The techniques used in this single-wafer concept bear directly on much of the experience obtained in using conventional circuits. This means that much of the knowledge gained in designing electronic circuits can be used directly, with only minor changes, in microminiaturizing circuits. Systems of proven performance can be redesigned and repackaged to 10 percent of both their present size and weight.

SUMMATION—All three types are being vigorously pushed. Current military pressure is fairly evenly divided among these three lines. One school of thinking insists that, to meet the demands of the immediate future, present day equipment can be microminiaturized with great benefits to the services and is using concept A.

The B concept of two-dimensional circuits is finding favor in systems and equipment whose applications fall somewhere between the commercial and military. Computers, in which it is desirable to have individual circuits such as shift registers, adders and inverters on standardized single wafers which can be plugged in or replaced, fall into this category. Although it is appreciated that there will not be much accomplished with type C in the near future, this approach has the best long range possibilities. For these reasons, it is virtually certain that the work on all three types will continue.

Since it bears the closest relationship to present day circuits, concept A can be immediately employed on existing circuits. There is, however, a small but

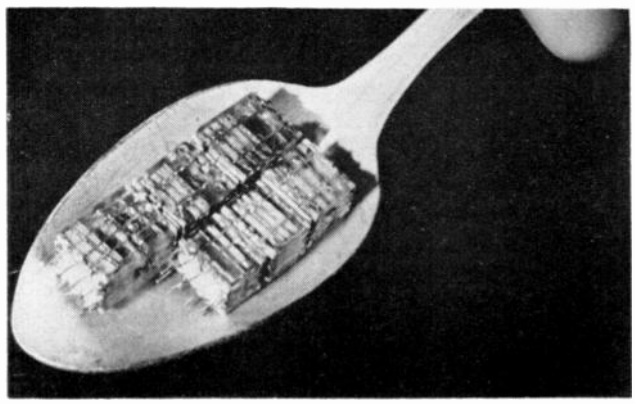


FIG. 4—Stacked RCA micromodule shows means of interconnecting wafers by soldering or welding wires

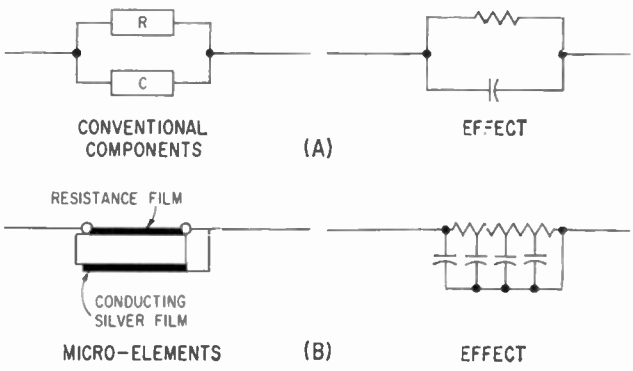


FIG. 5—As components are reduced in size they act less like lumped parameters (A) and more like distributed parameters (B)

important difference between components presently used and components developed using the type-A approach. Present day circuits use components with lumped parameters; the resistor concentrates resistance in one small lump, a capacitor concentrates capacitance in one small lump between two terminals. Thus, if a design engineer were to specify a filter combination of a resistor and capacitor in parallel (Fig. 5A) he would know the performance or transfer function of this combination.

As size is decreased in the microminiature concept, individual components turn from lumped to distributed parameters. If the resistance and capacitance filter of Fig. 5A were to be placed on a single wafer the capacitance would be divided somewhere between the start and finish of the resistance as shown in Fig. 5B. When transfer characteristics are required in microminiaturized form, the actual numerical values of the deposited components could be substantially different from the numerical values of the conventional components used to obtain the same effective circuit.

With this reservation, the type-A scheme permits manufacture of most of the amplifiers, oscillators and detectors of the present day. For this reason, type-A construction handles both analog and digital types of circuits. It is probable that type B would be as effective if and when the yield problem is overcome

The emphasis on further decreases in size and the use of semiconductor materials of high temperature and voltage coefficients severely limit the applications of the type-C method. Lack of the ability to adjust and to keep component values constant limit type-C circuits to logic type functions in which it is necessary to differentiate only between two set situations such as ON or OFF. It is virtually certain that type C will be confined to logic or digital circuits unless major breakthroughs unforeseen at this time can be made.

INDIVIDUAL MICRO-ELEMENTS—The starting point for designing a typical resistor micro-element is the initial alumina blank as shown in Fig. 6A. Silver lands are then deposited from silver resinate paste which is fired on at high temperature. Figure 6B shows the resistive metal film applied over these silvered lands. In the completed resistor (Fig. 6C) isolation lines are inserted to separate the various lands and circuits. Later, these isolation lines are continued to adjust the resistors to the desired value.

The shape of the ceramic substrate used has been standardized. This standardization in shape applies to all of the various components supplied by individual manufacturers. Use of these standardized components makes possible the assembling of micromodules using these micro-elements. Typical micro-elements are listed in Table 1.

TYPICAL UNITS — Typical micromodule units available include a binary divider, 4.3-mc r-f amplifier, 4.3-mc mixer, 8-kc sawtooth generator, time modulator, 192-kc oscillator, clipper, pulse generator, output amplifier and pulse shaper. Although most of the circuits are analog in nature, there are no barriers to the assembly of adders, converters, shift registers and other digital circuits which would make possible a fairly full range of building blocks for digital as well as analog circuits.

The only limitations on circuit performance will be those created by the range of circuit components available and those caused by stray effects resulting from interconnecting the various elements.

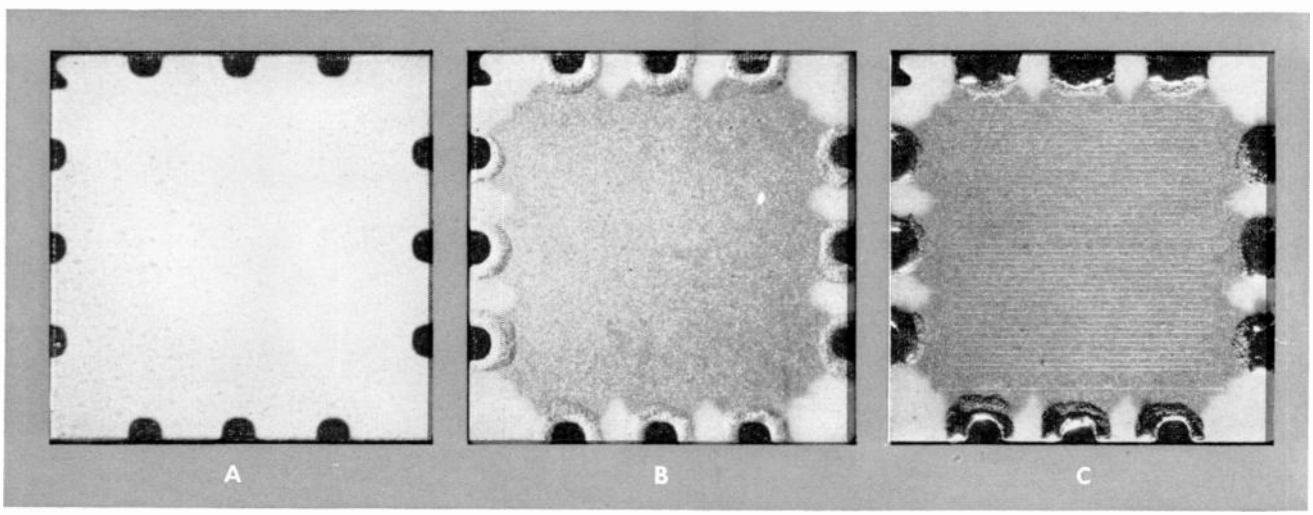
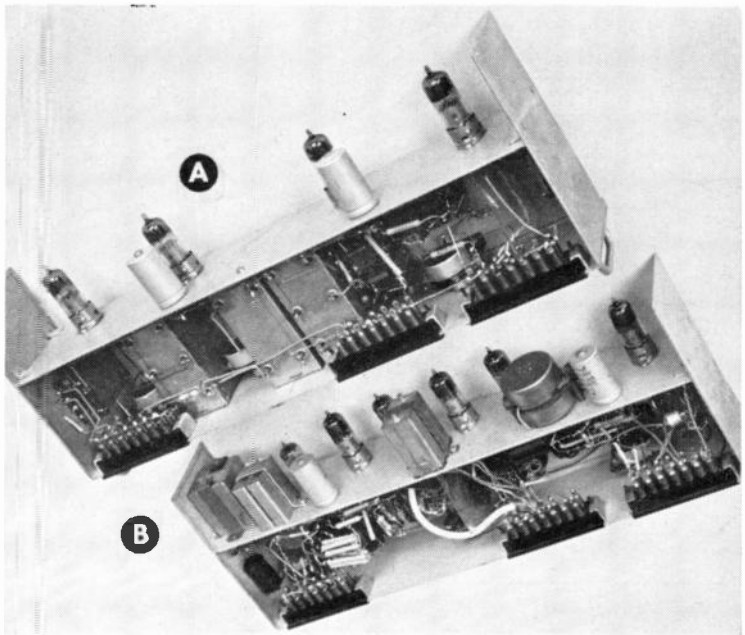


FIG. 6—Steps in micro-element resistor construction include alumina blank (A), metalized blank (B) and completed resistor (C). Wafer in (C) has two 100-k resistors on the front and two 100-k resistors on the back



Frequency channel of a FRENA system is shown in A; amplitude channel in B

Complete assembly of a FRENA system mounted in rack

Voice Radio Systems For High Noise Paths

When other radio links fail because of noise, this system still works. Frequency and amplitude components of speech are transmitted on separate channels

By J. A. GREEFKES and F. de JAGER,
Phillips Research Laboratories, N. V. Philips' Gloeilampenfabrieken, Eindhoven, Netherlands

AIRCRAFT CARRIER Saratoga, the city of New York, and Leopoldville in the Belgian Congo have at least one thing in common: radio noise level is high. Under the worst conditions of radio noise, two-way radio conversation is about as clear as speech on a subway platform with an express roaring by. Noise above this level completely breaks down the communications link.

Radio noise is inevitable. Lightning and sunspot activity, automobile ignition systems, electric motors and relays, interchannel crosstalk, transmitters of radio, radar and tv signals—these and many other sources produce radio noise.

The methods of suppressing noise have practical limitations. Eventually, as the signal to noise ratio falls, all suppression means become inadequate and communication is impossible.

Single-sideband speech becomes unintelligible when the signal to noise ratio is about 10 db. With f-m, the limit on the signal to noise ratio is about the same. A new communications system, in its most refined form, can operate at a signal to noise ratio of 4 db. Other versions of the system do not give as much improvement but still allow operation at ratios of 8 db in one case and 6 db in another.

System Operation

The basic idea of the new system is to split voice sounds into their frequency and amplitude components, to transmit the two types of information on separate channels, and then to recombine the separate components into the original sounds. This system is called FRENA, from the words frequency

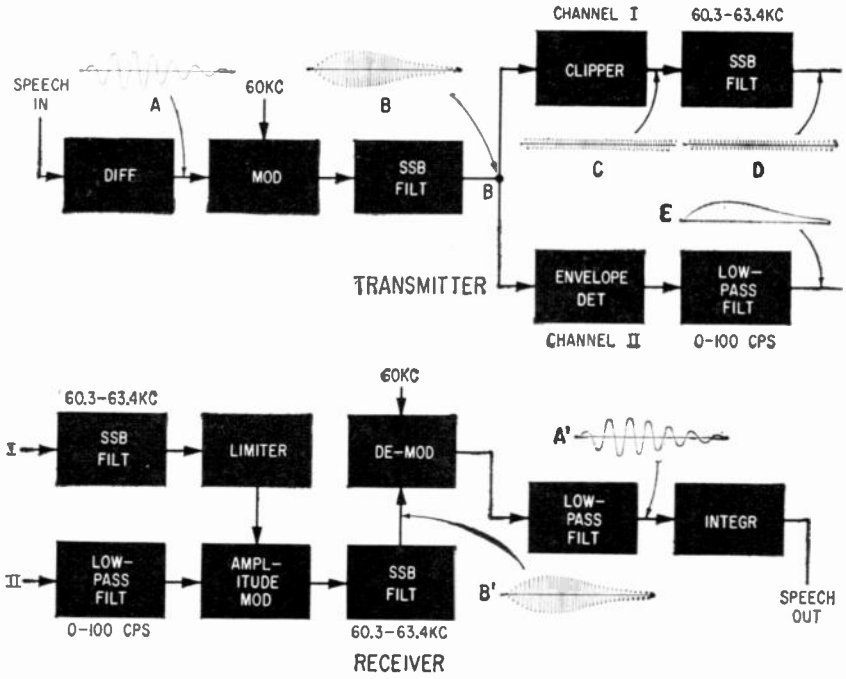


FIG. 1—Frequency and amplitude components of speech are separated and transmitted in two channels. The receiver reproduces the original speech to a close approximation

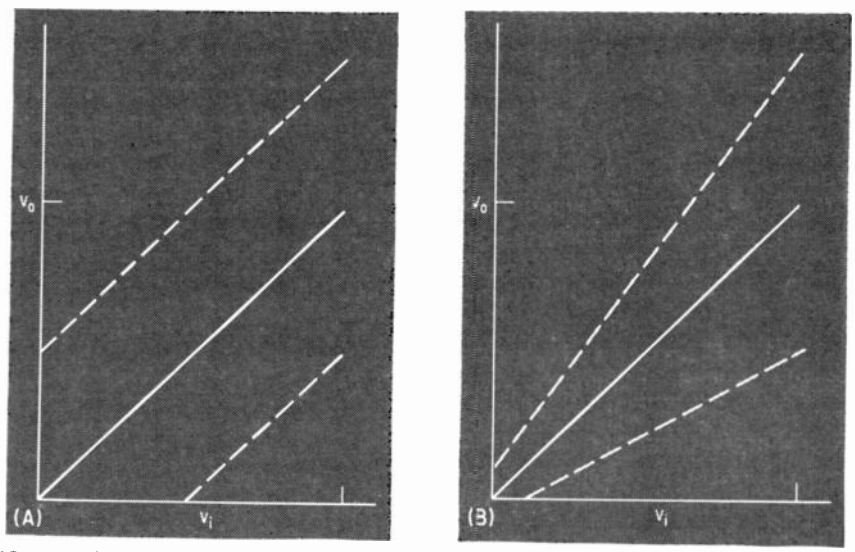


FIG. 2—Dashed lines indicate the uncertainty in the output signal V_o for a given input. Usual system (A); effect of amplitude modulator (B)

and amplitude.[1]

Speech sounds are clipped up to 30 or 40 db. Intelligibility of the clipped speech is good and distortion is held down by clipping a single-sideband signal. Many of the distortion components fall outside the wanted frequency band.

Frequency information is found in the zero crossings of the clipped ssb signal; amplitude information is found from the speech envelope. Transmission of the two signals is adapted to their different demands with respect to bandwidth and signal-to-noise ratio.

Block diagrams of the transmitter and receiver are shown in Fig. 1. At the transmitter, a differentiating network gives preemphasis for a more uniform frequency spectrum. The signal is then ssb modulated, filtered and applied simultaneously to a clipper and an envelope detector. Channel I contains frequency information and channel II contains amplitude information. Channels I and II are transmitted at convenient frequencies. Because ssb filters for 60 kc were available, this frequency was used for the carrier.

At the receiver, the two signals are fed to an amplitude modulator. The resulting signal, after filtering, B', has great similarity to the original signal B. After demodulation, filtering, and integration for spectrum equalization, an output very like the original speech is obtained.

Differences between input and output signals result from the limited bandwidths of channels I and II. There is some distortion but little loss of intelligibility. Communication is practical at a s/n ratio of 8 db—a 2-db improvement over a ssb system.

Noise Reduction

If the s/n ratio is below 10 db, the improvements of f-m pulse-position-modulation or pulse-codec-modulation over a-m are no longer effective and these systems behave even worse than ssb transmission.[2] At this noise level, ssb is also poor if the system is used linearly, but a certain amount of clipping or more refined nonlinear techniques can help.

Noise reduction with FRENA will now be explained. Suppose the s/n ratio in the frequency channel (channel I) to be 3 db. The signal is then slightly greater than the noise. Still, the signal retains enough of the zero-crossings for good intelligibility of speech. In this channel both noise and speech power are constant. When the speech amplitude is varied in the amplitude modulator at the receiver, the accompanying noise is varied in the same proportion. Instead of adding a constant noise, as in usual systems, the noise varies in proportion to the instantaneous amplitude of the speech signal. Thus the uncertainty in the output signal is much smaller, as is shown in Fig. 2. Figure 2A shows the uncertainty of output voltage V_o, for a given V_i, in usual systems. Figure 2B shows the effect of the amplitude modulator at the receiver.

The change favors the small speech signals which would otherwise be lost in the noise. In fact, it has been found that the noise power may equal the speech power if the noise is reduced in the same

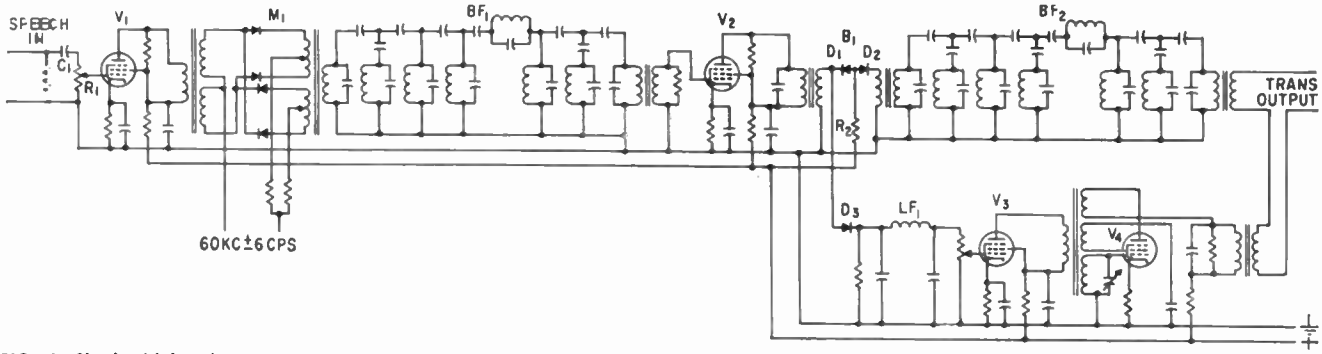


FIG. 3—Single-sideband transmitter separates frequency and amplitude components of speech

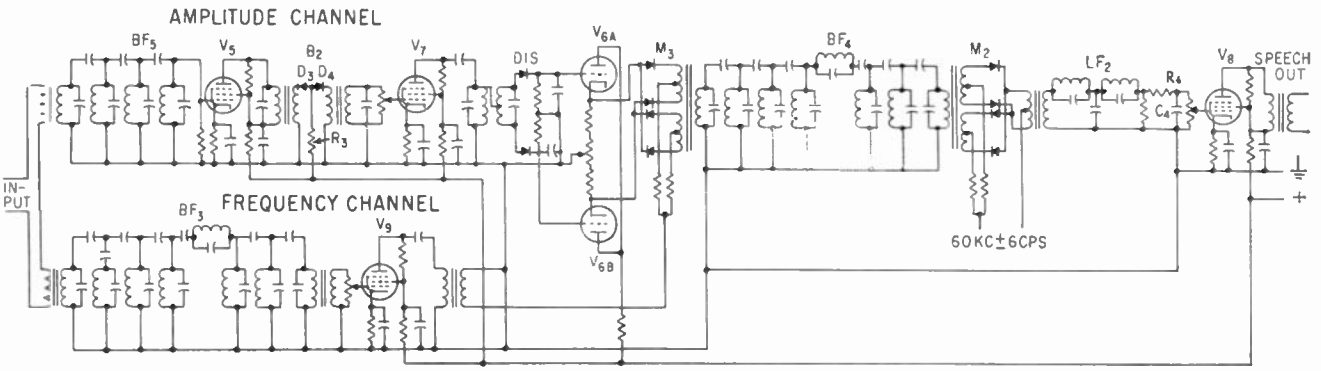


FIG. 4—Receiver for transmitter of Fig. 3 reproduces speech for conditions of high noise in the transmission path

proportion and rhythm as the instantaneous speech amplitude.

There is also noise in the amplitude channel (channel II). This channel, however, has a restricted bandwidth of about 100 cps, compared to 3,000 cps in the frequency channel. The decreased bandwidth means the amplitude channel has a s/n ratio 15 db higher than the frequency channel. The envelope is thus transmitted with a s/n of 15 + 3 = 18 db, while the frequency information is at s/n of 3 db.

F-M for Envelope

Transmission of the amplitude information can be further improved by using f-m for the amplitude channel. Here the s/n ratio is 18 db, sufficiently above the breakdown value for f-m. The s/n ratio in the output signal is raised to about 30 db by using a frequency deviation ratio of 4.

If the bandwidth of the amplitude channel is reduced to 50 cps, there is more distortion in the signal. If the bandwidth is made larger, distortion is less but the noise has more effect. With a bandwidth of 100 cps, a fairly good transmission of speech is possible for a s/n ratio of only 6 db for the whole system.

An f-m transmitter for the amplitude information is shown in Fig. 3; the receiver is shown in Fig. 4.

The voice signal to the transmitter is differentiated by R_1C_1 (Fig. 3), amplified by V_1, then modulates a 60-kc carrier. The upper sideband is passed by BF_1, further amplified by V_2, then clipped. About 30 to 40 db of clipping is obtained. With no input to the clipper, the currents through D_1 and D_2 are equal. With a signal, the current through D_2 is cut off for negative polarity signals and doubled for positive. The clipping device is thus independent of the input signals. Filter BF_2 suppresses distortion signals outside the passband.

Diode D_3 develops the envelope information. Low-pass filter LF_1, which cuts off at 100 cps, passes the signal to V_3 for amplification and modulation. Bandwidth of the envelope transmission path is about 500 cps.

Frequency Modulation

Change of anode current of V_3 (Fig. 3) produces frequency modulation by changing the inductance of the resonant circuit of oscillator tube V_4. Tube V_4 has positive feedback for anode current and negative feedback for the current of the second grid. With an increase of a-c voltage at the anode, the current of the second grid increases and anode current decreases. The re-

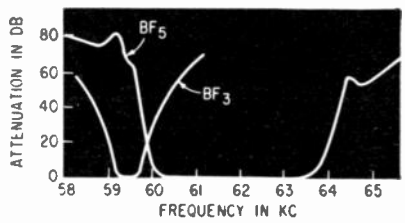


FIG. 5—Bandpass characteristics of the filters for the receiver of Fig. 4

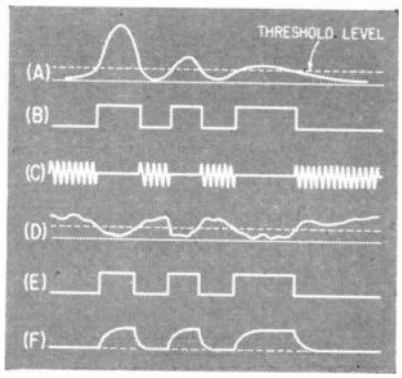


FIG. 6—Amplitude information of the coded version of the system is transmitted as a square wave

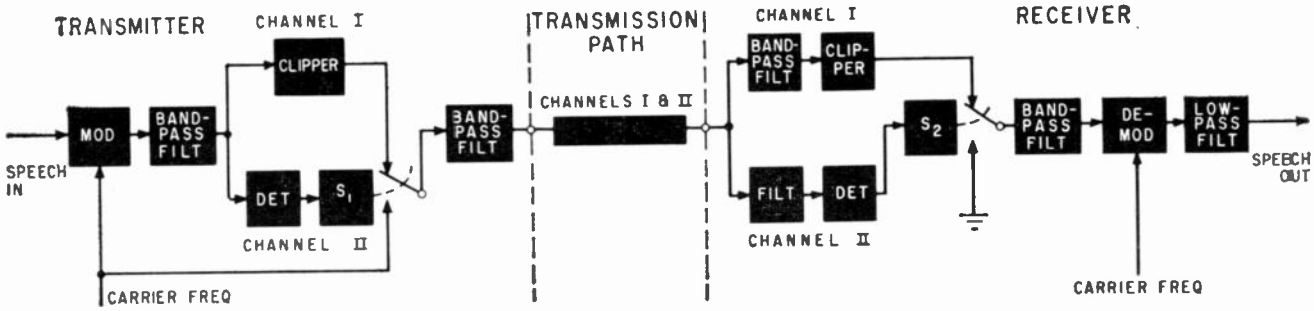


FIG. 7—Coded system, called FRENAC, can produce intelligible speech when transmission path s/n ratio is as low as 4 db. When the speech level is below a preset value, electronic switch S_1 allows only the carrier frequency to be transmitted. This signal operates S_2, thus silencing the receiver

sult is a limiter action for the anode voltage; amplitude modulation of the carrier is thus avoided.

Filters at the receiver separate the frequency and amplitude channels. Characteristics of the filters are shown in Fig. 5.

The output signal of filter BF_5, (Fig. 4), containing envelope information, is amplified by tube V_5, clipped in a clipper B_2, amplified again by V_7, then detected by a Foster-Seely detector. Cathode followers V_{8A} and V_{8B} are a balanced input for amplitude modulator M_3. Modulator M_3 produces a ssb signal and also acts as a clipper for the frequency signal. Amplitude variations in the frequency channel, caused by interference and noise in the transmission path, are thus suppressed.

The output signal of the modulator is a square wave; filter BF_4 suppresses the unwanted components. The signal is then demodulated with a 60-kc carrier frequency in modulator M_2. The cutoff frequency of low-pass filter LF_2 is 3,600 cps. Integration by R_1C_1 equalizes the effect of differentiation at the transmitter input. The circuit of V_1 is a typical audio amplifier.

Coded System

For s/n ratios of the order of 3 db, the power consumption in the amplitude channel is unattractive (because the s/n ratio in the frequency channel is reduced to zero db). It is then advisable to transmit the amplitude and frequency information separately, so that each channel uses the total transmitter power. The amplitude information is then no longer transmitted on a linear scale, as with FRENA, but as a square wave. Distortion in a system like this is somewhat higher but transmitting the amplitude information as a telegraph signal permits fairly good noise suppression.

The basic principle is illustrated in Fig. 6. The envelope, A, is compared with a preset threshold value. The wave of B indicates values above the threshold. Wave trains of a pilot frequency are transmitted, C, when the speech signal is below the threshold. In the intervals when the speech envelope is above the threshold, clipped ssb modulated speech of the same amplitude is transmitted in the frequency channel.

The received detected signal is shown in D, from which the noise can be eliminated by slicing at the half-top value. The reconstruction, E, of the original square wave B, has only small phase distortions. The sharp edges in this square wave are smoothed by an R-C circuit. The final approximation F to the original envelope, A, is applied to the amplitude modulator in the same manner as before.

Amplitude variations are thus coded at the sending end in the most elementary 0-1 code. This information, transmitted through a narrow frequency band, enables the receiver to distinguish between speech and noise in transmission media with a s/n ratio of only

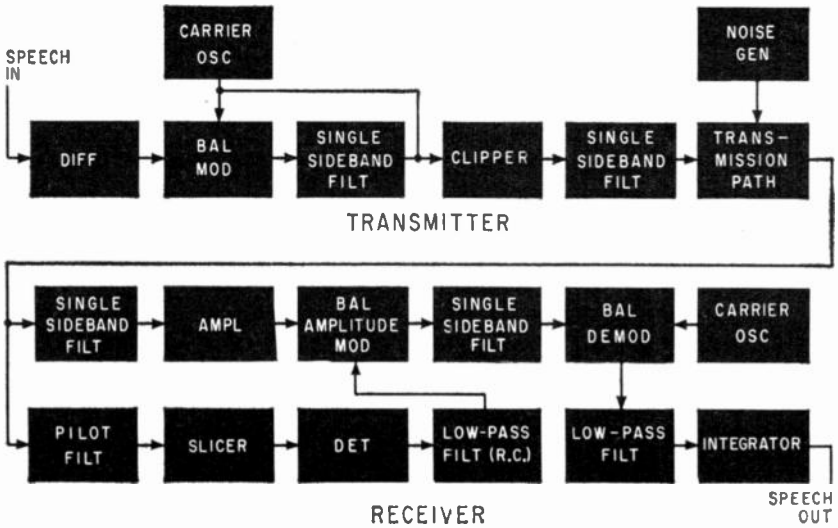


FIG. 8—The coded system can be realized from the block diagram. The silencing pilot voltage, which is over-ridden by high-level speech, is applied at the input of the transmitter clipper

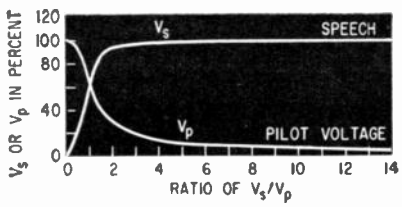


FIG. 9—When the speech to pilot voltage ratio V_s/V_p is 3 or more, the speech signal dominates the transmitter output

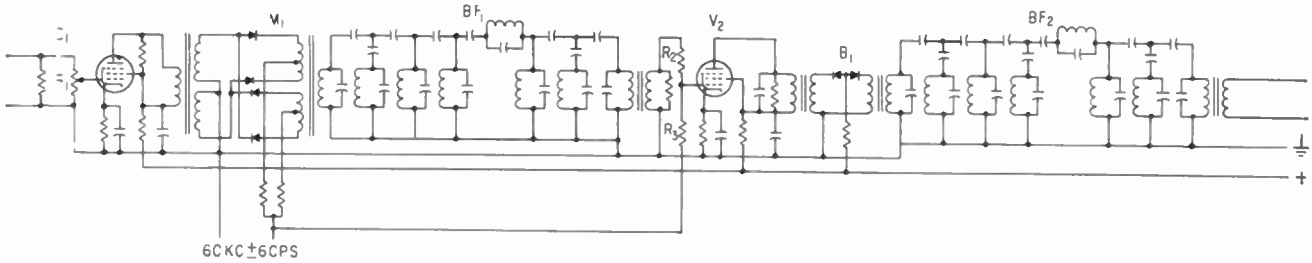


FIG. 10—Practical transmitter for the FRENAC system. The pilot carrier voltage is applied to the grid V_2

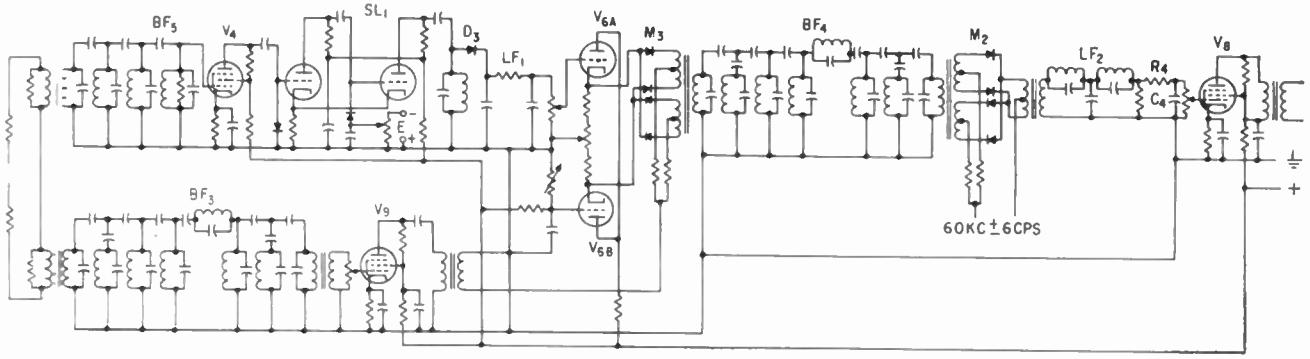


FIG. 11—Practical receiver for FRENAC system. Tubes V_{6A} and V_{6B} form a balanced input to modulator M_3

3 db. The system, which is called FRENAC, from frequency and amplitude coded, can be realized according to the block diagram of Fig. 7. Two electronic switches are used in the system. One switch is controlled by the speech envelope at the transmitter and the other by the output signal of a pilot filter at the receiver.

Modified System

A somewhat different version of the FRENAC system is shown in the block diagram of Fig. 8. In this modified system a constant pilot voltage is added at the input of the clipper in the transmitter. If the magnitude of the pilot voltage is such that it is just clipped, then for strong signals essentially only the ssb signal is transmitted. In the absence of an input signal, however, only the pilot signal is transmitted. The output voltage of the ssb signal V_s, and pilot signal V_p, are shown in Fig. 9 as a function of V_s/V_p. For a clipping value of 30 db, the circuit acts nearly as an electronic switch.

An advantage of the method is that the input level of the system is not too critical, because there is no threshold for the speech signal; for low levels the clipper acts as a linear network.

The schematic of a transmitter based on Fig. 8 is given in Fig. 10;

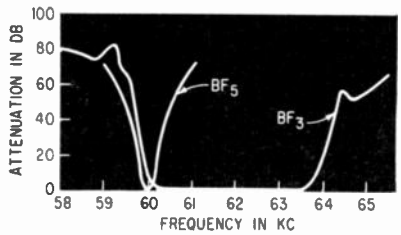


FIG. 12—Bandpass characteristics for filters used in the receiver of Fig. 11

the receiver is shown in Fig. 11. The frequency channel of this system is identical to the frequency channel previously discussed. The bandpass filter BF_1 of Fig. 10, however, is shifted from the 60 to 64-kc band to 60.2 to 64.2 kc. The shift is necessary because the band from 59.9 to 60.1 kc is used for the pilot signal that carries the information of the amplitude channel. The constant pilot voltage that is added at the input of the clipper is applied to the first grid of V_2. Its level can be adjusted by R_2 and R_3.

Modified Receiver

At the receiver, Fig. 11, the amplitude channel is selected by filter BF_5, which has a bandpass of 200 cps. The characteristics of this filter and the normal ssb filter are shown in Fig. 12. The output signal of BF_5 is amplified by V_4, sliced by slicer SL_1 and rectified by D_3. The slicer is a circuit used in pulse-code modulation systems. The detected wave is smoothed by network LF_1, which has a time constant of 0.01 second. The output signal corresponds to E of Fig. 6.

Tubes V_{6A} and V_{6B} form the input of the balanced modulator M_3, which modulates the frequency signal. The demodulation equipment is identical to that of the FRENA system previously described.

Simulated System

The complete assembly of an experimental FRENA system is shown in the photograph. Panel 1 contains the carrier oscillator and the integrating and differentiating equipment. Panel 2 is a normal panel of a 48-channel carrier telephone system. Panel 3 is the frequency channel and panel 4 the amplitude channel. In all the panels, transmitters and receivers are assembled together. Panel 5 is a noise generator, used for adding noise in the transmission path of the system. Panel 6 and 7 are supply panels.

REFERENCES

(1) Philips Technical Review, 19, p 73, 1957/58

(2) F. de Jager, Les limites théoriques de la transmission en cas de niveau de bruit élevé, pour différents systèmes de modulation continue et de modulation codée. *Onde électrique*, 34, p 675, 1954

Selecting a Deflection Yoke

This checklist covers all physical and electrical yoke parameters together with their determining conditions

By **HENRY O. MARCY,** President, Syntronic Instruments Inc., Addison, Illinois

DEFLECTION YOKE design requires a close correlation between yoke, c-r tube and circuitry. One must consider the wide choice of c-r tubes and the scans presented on these tubes for such displays as radar PPI's, random-located characters, and rasters of all frequencies. Many of these scans use time sharing to add index lines and other data.

The most common scan is the conventional raster. The horizontal frequency is from 100 to 1,000 times the vertical and the current waveforms are generally linear sawteeth with rapid retrace. Such a scan dictates a yoke with two perpendicular pairs of coils. Frequency range of the yoke is very broad with an upper limit beyond 70 kc for the conventional tv scan and higher for the precision high-resolution scans. It would appear that the vertical impedance could be many times the horizontal. However, this disparity greatly increases the problem of cross talk, which in turn causes line pairing and wiggles or hooks in the lines.

Another common scan is the polar display of the PPI. Such a scan suggests a rotating-coil deflection yoke. For centered PPI's this is usually the best approach. On the other hand, a polar sector or off-centered PPI is often easier with a fixed two-axis yoke. Each of these axes is driven by a sine- or cosine-resolved sweep.

Random displays are used to present position information in reference to a grid or map. Although the data is presented in sequence, signal locations on the display c-r tube are random. A random display requires a yoke with very rapid recovery (settling). Each signal must appear in its true position (within less than a spot size) regardless of the location of the previous signal. Ordinarily, this requires recovery to 0.1 percent of a one-diameter deflection. Second-order effects like the residual magnetism in the yoke core or small flux losses in shields or metal parts surrounding the yoke become critical. The longer the settling time, the less is the displayed information. Today, settling in 10 μsec is a practical limit.

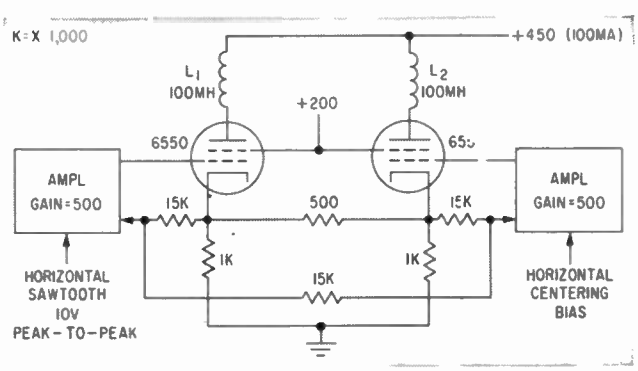


FIG. 1—Driver circuit for yoke L_1, L_2

Characteristic of yoke driving circuits is the usual requirement that the c-r beam must be deflected in both directions for each axis. With a single-ended deflection yoke this requires a reversal of current in the yoke. This reversal may be obtained by resonating the yoke with a capacitor, as in the typical horizontal sweep circuit of television. Reversal may also be obtained by means of a bridge circuit employing tubes for the four arms and bridging the yoke. Some simplified bridge circuits use resistors or chokes for one, two or three of the arms. Finally, the reversal of current may be obtained by using *pnp* and *npn* transistors working in parallel.

A push-pull yoke differs from the single-ended yoke in having two windings per axis, one for each direction. This arrangement allows the use of simple undirectional circuits.

Often special requirements cause an emphasis on certain refinements such as accurate alignment of coils, symmetry, reduction of pin-cushion, reduction of cross-coupling and freedom from small residual effects, to mention a few. Typical of these applications are the display scopes of ground-control-approach systems for landing aircraft.

Many yoke designs are available. These fall into two groups, aiding and bucking (Fig. 2). Bucking coils are especially advantageous as pre-centering coils where the length of the entire yoke must be small, perhaps as little as ½ inch.

Table I is a guide to help a designer select a yoke. The data under the example column is for a representative problem involving selection of the yoke shown in Fig. 1 (yoke L_1, L_2). This yoke must give a single linear line scan across the diameter of a 5ZP16 c-r tube in 1,000 μsec. Retrace time is 100 μsec. Acceleration of the 5ZP16 is 25 kv. Beam-alignment magnets center the scan.

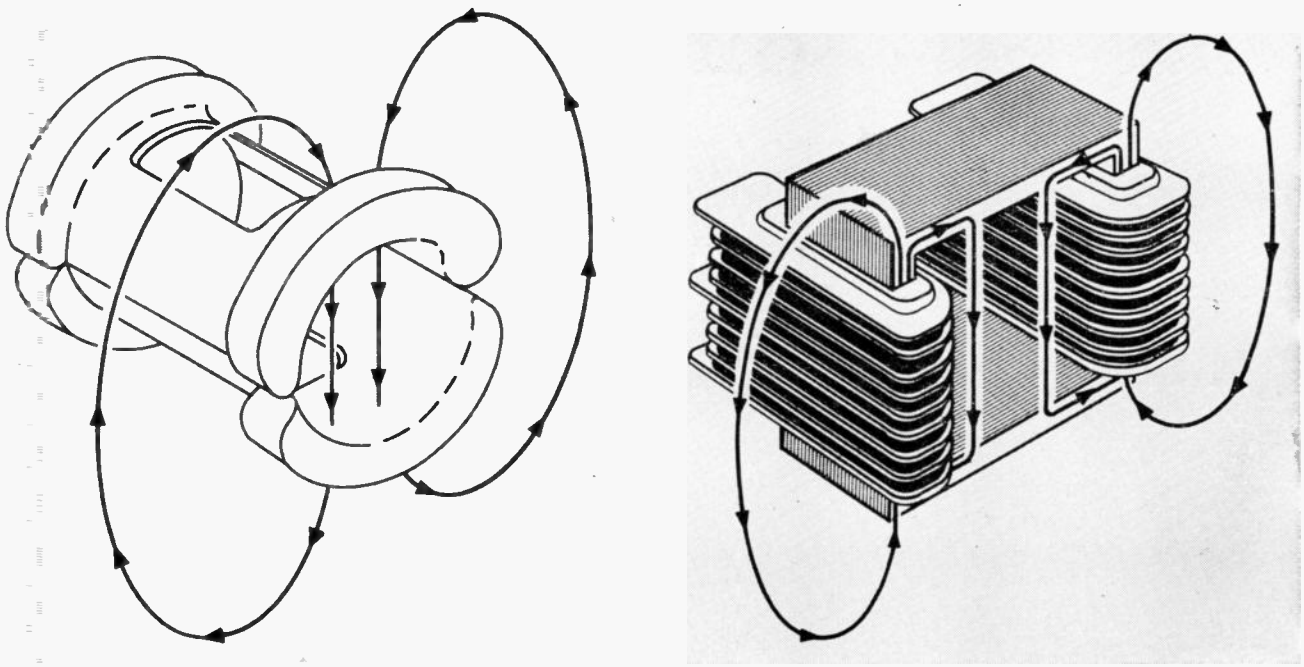


FIG. 2—Aiding coils (left) have cores of various shapes, materials, or have no core. Bucking coils use square or toroidal cores; their advantage as pre-centering coils results from absence of front and back "ears" characteristic of aiding coil yokes

Table I—Factors Involved in Selecting a Yoke, and an Example

Yoke Parameters	Typical value	Example	Conditions Determining Yoke's Requirements
Inside diam	0.8 to 3 in.	1.5 in.	C-R tube neck diam
Effective length	0.5 to 4 in.	3.8 in.	C-R tube deflection angle and location of electron gun or focusing device with respect to yoke
Deflection axes	Single or X and Y	Single axis	Type of scan
Single-ended or push-pull		Push-pull	Circuitry
L/R ratio	250 to 1,500 μsec	500 μsec	Circuitry and linearity requirements
Inductance	100 μh to 4 h	100 mh/½ axis	Impedance matching to drive circuit
Resonant frequency	3 kc to 5 mc	>20 kc	Duty cycle and prf
Settling time	10 μsec to 1000 μsec	<100 μsec	Applies particularly to time sharing or random displays
Core material	Ferrites,[b] air, etc.	Mu-metal	Efficiency, Q, frequency and permissible residual effects
Power dissipation	4 w to 20 w	2 w	C-R tube deflection angle, anode voltage and the fastest rate of scan including retrace
Voltage rating	100 v to 5,000 v	600 v (peak)	C-R tube, cicuitry, and scan rates
Deflection efficiency	80 to 90%	85%	Efficiency is in terms of allowable effective field length and outside diam of c-r tube neck. Dissipation of yoke drivers is usually a circuit limitation
Resolution	Center-to-edge spot ratios 1.2 to 5	1.2, if dynamic focusing provided	Values involve deflection angle and face-plate curvature of c-r tube
Linearity	0.5% to 3%	1% of diam[d]	Resolution, linearity, pincushion are interrelated. Compromise depends on c-r tube. Possibilities exist for circuit correction. External fixed or dynamic magnets may be used in conjunction with yoke
Pincushion	0.5% to 5%	Not applicable	
Line straightness	0.1% to 2%	0.2%	Alignment of yoke with electron beam is an important factor
Alignment accuracy[a]	0.1 to 2 deg	Not applicable	Scan requirements
Cross-talk limit	Up to 80 db	Not applicable	Related to wiggles, uneven sweep rates and lack of interlace
Shielding		Mu-metal shield[e]	To prevent interaction of yoke fields with focus field, electron gun, or with external metals. Such metals may cause residual effects or losses detrimental to settling time
Mechanical	Yoke types[c]	Alignment nec[f]	Scan requirements
Size and weight		2 lb (airborne)	Ground or airborne equipment
Life vs environment		As required	Environmental specifications such as MIL-C-18388

(a) between deflection axes, (b) also high-Ni alloys, (c) rotating and fixed, (d) max position error, without circuit correction, (e) 3.5-in od × 0.005-in thick disk at rear of yoke shields gun, (f) must provide accurate alignment adjustments with yoke to avoid trace curvature

Solid-State Digital

Up to 13 bits can be converted from Gray to straight binary with this reliable, simple, code converter. Basic building block is a circuit composed of a magnetic core, a single junction transistor and an RLC delay

By **REUBEN WASSERMAN**, Associate Division Head, **and WILLIAM NUTTING**, Technical Staff Member, Digital Systems Division, Hermes Electronics Co., Cambridge, Mass.

IN SOME SYSTEMS it is advantageous to handle information in both Gray and binary code form. Gray code, which derives its usefulness from its property of changing one and only one digit in proceeding to a next higher or next lower number, is often used to prevent ambiguities in readings and then, in a final stage, is converted by some means to straight binary form.

The Gray-to-binary code converter shown in Fig. 1 accepts up to 13 bits of Gray information from an analog to digital shaft encoder, converting it to straight binary code. Binary results are presented on an array of gas tube display bulbs.

Elements of this converter such as dynamic flip-flops, logical gates, adders and shift registers are all constructed from a basic circuit composed of a magnetic core, a single junction transistor, and an RLC delay. Theory and operation of this converter is best understood, therefore, by first considering the functioning of the basic magnetic core logic circuit.

Magnetic Core Logic

The small toroidal ferromagnetic cores used are characterized by rectangular hysteresis loop and microsecond switching time. Information storage in these cores is based on the fact that a core with a rectangular hysteresis loop is capable of storing one binary bit in the form of its flux. Figure 2A shows how a binary bit ONE is stored as a positive residual flux ($+B_r$) and binary digit ZERO is stored as a negative residual flux ($-B_r$) in the opposite direction.

A magnetic storage core consists of several windings on a toroidal magnetic core (Fig. 2B). If a negative pulse is applied to the core through the shift winding, a voltage is induced in the output winding if the digit stored is ONE ($+B_r$), and a negligible voltage is induced if it is a ZERO ($-B_r$). The induced voltage is large enough to magnetize another core of identical construction. Binary digits can thus be transferred from one core to another.

However, in applying the magnetic core to a shift register in which all information is to be stepped along simultaneously, temporary storage or delay at the output of each core is required in order that the core can transfer its information before receiving new information from the preceding core. Therefore, the core storage element comprises two essential units—the magnetic core for permanent storage and an RLC delay circuit for temporary storage.

Other uses for magnetic cores, in addition to delay and storage, are in power amplifying and AND, OR, and INHIBIT circuits. Power amplification can be derived by adding a transistor which then serves as the power driver. The core lends itself to two elementary logical functions of OR and INHIBIT, from which it is possible to synthesize all other digital logical functions. Therefore, a circuit composed of a magnetic core, a transistor, and an RLC delay forms an ideal computer building block in constructing dynamic flip-flops, logical gates, adders, and shift registers.

Table I—Gray and Binary Codes

Decimal	Gray	Binary
0	0000	0000
1	0001	0001
2	0011	0010
3	0010	0011
4	0110	0100
5	0111	0101
6	0101	0110
7	0100	0111
8	1100	1000
9	1101	1001
100	1010110	1100100
1000	1000011100	1111101000

Table II—Sequence of Conversion After Each Shift Pulse

	Cores									
Time	10	11	12	13	C_2	C_1	1	2	3	4
t_0	0	1	1	0	0	0	–	–	–	–
t_1	–	0	1	1	0	0	0	–	–	–
t_2	–	–	0	1	1	0	0	0	–	–
t_3	–	–	–	0	0	0*	1	0	0	–
t_4	–	–	–	–	0	0	0	1	0	0
t_5	–	–	–	–	–	–	0	0	1	0

*Binary bit is complemented

Basic Circuit

The circuit of Fig. 3, which serves as the basic building block in the Gray-to-binary converter, uses a *pnp* junction transistor, and therefore is wired in such a fashion that the circuit resembles a blocking oscillator. If the core is in either of two saturated states, ($+B_r$) or ($-B_r$), the permeability of the core is low and the gain around the feedback loop is less than unity. On the vertical slope of the B-H curve the permeability is high so that loop gain is well above unity and regeneration is possible.

To analyze the Fig. 3 circuit, consider the transistor connected as a grounded emitter and the core initially in the ONE state. The transistor is normally cut off. A small trigger pulse is applied which is sufficient

Code-to-Code Converter

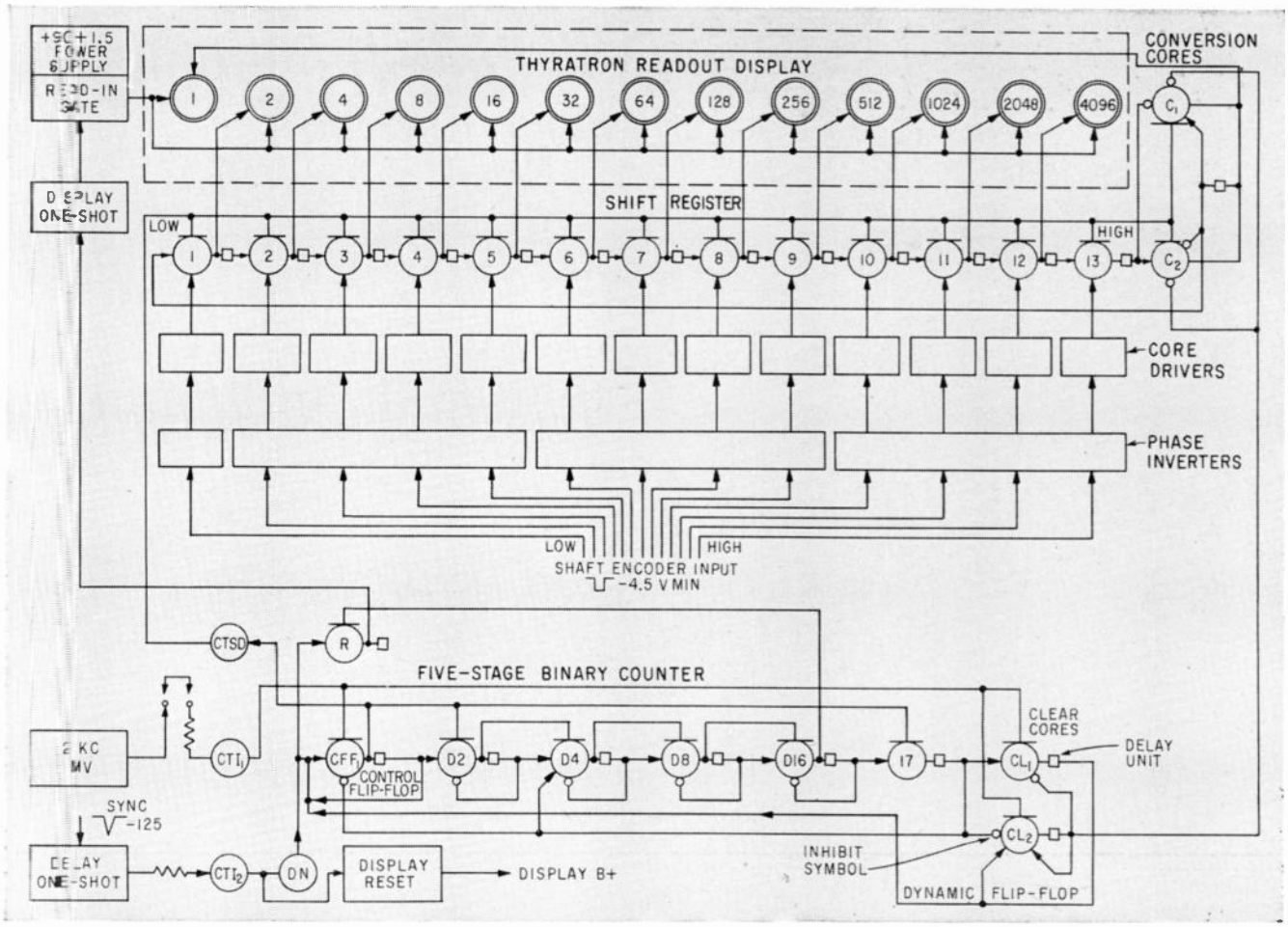


FIG. 1—Core logic diagram of complete thirteen bit Gray-to-binary converter

to change the state of the B-H curve. The resulting flux change induces a negative voltage on the base of the transistor and causes collector current to flow. This current flows in the same direction as the trigger current pulse and therefore shifts the core further, inducing a larger negative voltage on the base. This in turn will further increase the collector current. The cycle continues until the core is completely shifted, at which time the feedback-loop gain falls below unity and the transistor ceases to conduct. The result is that the core has been completely shifted and a large pulse of current has passed through the collector and supplied power to the load.

If, however, the core was initially in the ZERO state and the same trigger pulse was applied, there would be a negligible voltage developed on the base since the gain is sufficiently below unity, and regeneration would not take place. The core can then be reset to the ONE state by feeding current in the proper direction through the insert winding. While the core is being reset, a positive voltage appears on the base of the transistor which tends to drive it further into cutoff, preventing any output at this time. If, however, as the current pulse is applied to the insert winding an equal magnitude of current is applied simultaneously to the inhibit winding, the effect of the reset pulse will be cancelled and the core will remain in the ZERO state.

Successive stages of the Fig. 3 basic circuit form the shift register. All the stages with ONES stored change their state to ZEROS after being triggered, and during regeneration supply energy to the output. The output current pulse is delayed before it resets the following stage to the ONE state. In this manner, information is advanced one stage after each shift pulse.

Dynamic Flip-Flop

The dynamic flip-flop (see Fig. 1) is actually a one-stage shift register in a closed loop circuit which can exist in two dynamic states. If, for example, the state is initially ONE, the trigger pulse will switch the core to ZERO and, after a time delay, the core's own output will reset the core back to ONE. The state of the flip-flop can be changed to ZERO by applying a signal to the inhibit winding while the delayed output of the core is trying to reset itself, thereby preventing the core

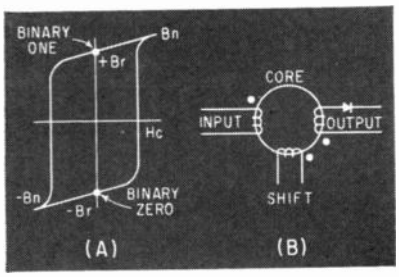


FIG. 2—Rectangular hysteresis loop (A) allows binary storage. Pulses through windings on toroidal magnetic cores (B) transfer binary information

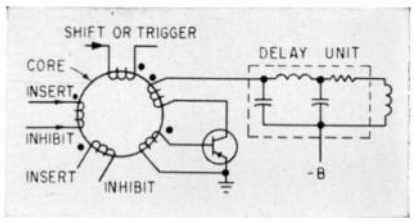


FIG. 3—Basic building block circuit for constructing many of the converter elements uses core, transistor and RLC delay unit

from being reset. In the ZERO state the next trigger will have no effect and the flip-flop will remain in the ZERO state until such time as the core is reset to ONE by an external insert pulse.

Binary Counter

To analyze the binary counter circuit which appears in Fig. 1, assume that the first stage (*D*2) is ZERO. A trigger pulse will then have no effect as there will be no regeneration. However, if the first stage is ONE and a trigger pulse appears, one of two possibilities will occur. If the second stage was in the ZERO state, the output current passing through its trigger winding will have no effect. However, the delayed output of the first core will reset the second core to the ONE state, or to use a simple terminology, will write a ONE in the second stage. If this second stage was already ONE, it will be switched to ZERO by the collector current or undelayed output of the first stage. The delayed output of the second stage passing through its own inhibit winding will prevent the delayed output of the first stage from writing a ONE into the second stage. It then becomes evident that this is a bistable device which changes its state every time an input pulse is applied, and puts out a pulse identical to the input pulse for every second input pulse. This essentially is the operation of a binary counter.

Timing Generation

Circulation rate of the converter register is determined by the internal clock which runs at a 2-kc rate. Clock output is fed into a core-transistor input amplifier (*CTI*) which is similar to a Schmitt Trigger in the sense that it triggers on a minimum voltage input pulse. Its output is a current pulse for shifting or triggering, inserting or inhibiting.

Shift Operation

The magnetic core shift register, consisting of cores 1-13, initially stores all thirteen bits of the Gray coded word to be converted. After a short delay, allowing all the inputs to be read into their respective cores, the information is shifted along into the two converter cores, C_1 and C_2, which in operation resemble a combination of the dynamic flip-flop described above and an exclusive OR gate. Table I shows the relationship between the Gray and binary codes.

Operation of cores C_1 and C_2 can be traced in Fig. 1. Initially assume that the Gray code number 0110 (represents decimal 4) is stored in cores 10 to 13, with high order bit in core 13. Cores C_1 and C_2 are both in the binary ZERO state. Table II shows the sequence of conversion after each time or shift pulse.

At time t_2, core C_2 stores a binary ONE, which is the first high order binary ONE of the Gray code number. At time t_3, core C_1 emits the binary ONE which complements the next binary bit in sequence from core 13, or, in other words, converts the binary ONE to binary ZERO. At t_4 and t_5 the information is shifted two places to the right and the converted information is now stored in cores 1-4.

Output of cores C_1 and C_2 is connected to core 1 to make a circulating register in order that all thirteen bits are stepped along to the right (high order first), and the converted code is read back into core 1. The register is shifted thirteen positions and the original input information is converted to straight binary form. The register is shifted once more and the outputs of core C_1 and cores 1-12 are sensed or looked at simultaneously by the gas tube display.

Control Counter

In order that the register be circulated the proper number of shift positions a control counter, which consists of a control flip-flop, CFF_1, and a five-stage counter, *D*2, *D*4, *D*8, *D*16, and 17 is incorporated (see Fig. 1). The control flip-flop is a dynamic flip-flop which is turned on by a pulse from CTI_2. CTI_2 gives an output pulse whenever any new input information is inserted. Since CFF_1 is triggered continuously by CTI_1, once reset to ONE it will produce output pulses at a 2 kc rate. The output of CFF_1 is fed into *CTSD* which provides the proper shift pulse current to all the register cores as well as the two converter cores. After the fourteen

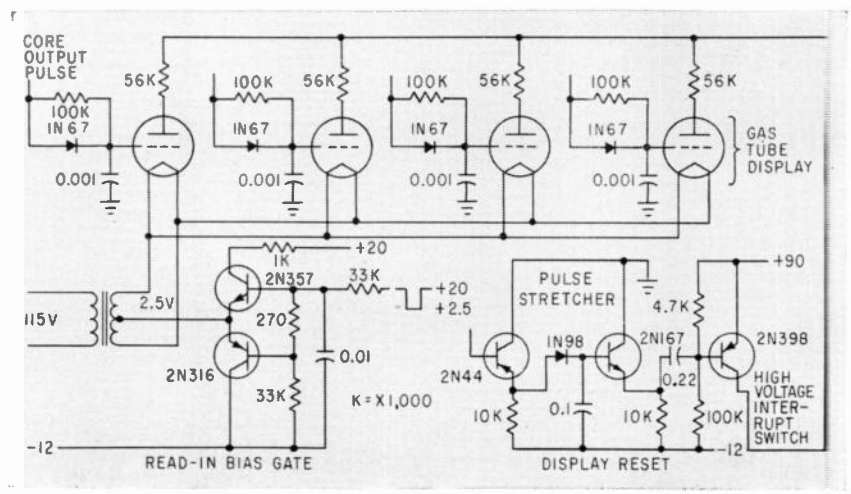


FIG. 4—Circuit used for gas tube read-out display

output pulses, CFF_1 is inhibited by the output of the counter, core 17 in particular. The counter is basically the binary counter described earlier, arranged in cascaded stages and with a feedback connection from core 17 to core $D4$.

Clear Cores

Cores CL_1 and CL_2 (Fig. 1) clear the register and converter cores of any ONES stored in them following a word conversion and thus prepare for accepting new input information. This is done by resetting the control flip-flop so that it will generate fourteen more shift pulses and at the same time inhibit both converter cores so that any ONES entering from the register will be canceled. This means fourteen inhibit pulses are required as well as the shift pulses.

Clear cores CL_1 and CL_2 are connected much like the converter cores in a dynamic binary counter. A single pulse from core 17 is used to write a ONE into CL_1. The next trigger pulse from CTI_1 will cause an output from CL_1 which writes a ONE into CL_2 as well as into CFF_1. With CFF_1 reset it will produce a train of pulses; CL_2 will also until the second output pulse from core 17 shuts it off. CL_2 output then inhibits both C_1 and C_2.

Readout Display

After thirteen shifts all the information is converted except the last bit and that bit is written into the converter cores. During the following, or fourteenth shift, all the input information is converted and is shifted out of core C_1 and cores 1-12. At the thirteenth shift there is an output from the counter core $D13$ which shifts the Read (R) core which was reset to ONE by CTI_2. The output of R triggers a static one-shot which gates the level of the filament center-tap of the thyratron display bulbs so that any ONES shifted out of cores C_1, 1-12 at the time of the fourteenth shift pulse will cause the associated thyratrons to ignite.

These display bulbs (Kip "Memolites", manufactured by Transistor Electronics) remain on until the next input sync pulse occurs. When the next sync pulse occurs, a static delay one-shot circuit is triggered, and its output triggers CTI_2. The undelayed output of CTI_2 triggers the static display circuit shown in Fig. 4, which extinguishes the gas display bulbs by dropping their plate voltage below the ionization point.

The bulbs are extinguished only when new input information is to be received. Therefore, the single pulse from CTI_2 which triggers indirectly from the input sync pulse and directly from the input-delay one-shot, activates the display reset. This pulse, however, is short. Therefore, two *npn* transistors in a cascaded emitter follower circuit, with a pulse stretcher between them (see Fig. 4), control a high-voltage

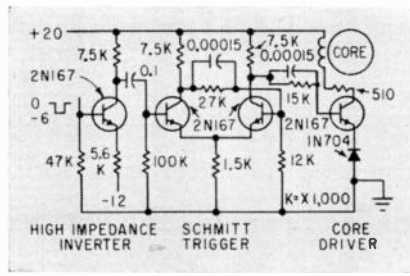


FIG. 5—Phase inverter, in addition to phase reversal, provides isolation between the negative input pulse and the core driver

pnp transistor in series with the thyratron plate voltage. The *pnp* transistor, normally conducting with only a few volts drop across it, is shut off by the stretched pulse, causing the full plate supply of the thyratrons to be dropped across it. The transistor stays shut off for 500 to 600 microseconds.

Phase Inverter

The phase inverter (Fig. 5) is a single *npn* transistor which in addition to phase reversal of the input signal provides isolation between the negative input pulse and the core driver. The output of the analog to digital shaft encoder is directly coupled to the base of the transistor and requires that the external input be at ground level or be capacitively coupled into the converter. The output of the phase inverter is capacitively coupled to the input of the core driver. There are thirteen phase inverters and core driver circuits, one for each input bit.

Each core driver uses two *npn* transistors connected in a Schmitt trigger circuit with discrimination level including the phase inverters of -4.5 v ± 10 percent.

Any signal below that level is disregarded.

However, any signal in range from 6 to 12 v will cause a pulse output from the Schmitt, the duration of which is dependent on the duration of the input signal. This output is direct-coupled to an *npn* transistor in a grounded emitter circuit. This transistor is normally cut-off and uses a Zener diode in its emitter circuit to insure its cut-off until the output pulse of the Schmitt trigger exceeds the Zener breakdown voltage. This is necessary to prevent false read-in of the cores if the transistor is not fully cutoff. The insert winding of a register core and a series limiting resistor make up the collector load of this transistor.

When the Schmitt trigger emits a pulse, this driver supplies a 30 ma current pulse, writing a ONE into its associated core.

The minimum duration pulse for writing a ONE results from a 6 microsecond input pulse to the phase inverter.

Read-In Gate

The read-in gate, which appears in Fig. 4, is a two transistor amplifier employing complementary symmetry to provide a low-impedance path for the filament return of the thyratron display bulbs at either of two operating levels. The input to the read-in gate is the output of the display one-shot which is directly coupled through a series resistor to the bases of the *npn* and *pnp* transistors. Another resistor, from the bases to the negative supply, forms a voltage divider which determines the normal output operating point. When the negative gate occurs, the read-in gate output, which is connected directly to the filament center-tap of the thyratron display bulbs drops to -5 v allowing the output of the register cores to ignite their respective bulbs at the fourteenth shift pulse. Before the next pulse the level is returned to $+5$ v (normal) and prevents any further core outputs from triggering the bulbs.

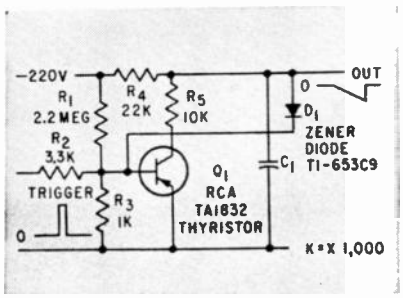


FIG. 1—Sawtooth pulse generator uses a semiconductor switch, Q_1, whose amplitude is controlled by Zener diode D_1

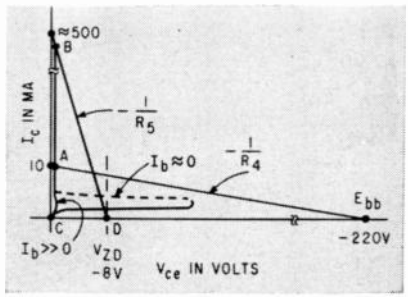


FIG. 2—Curve shows the operating characteristics of the high-speed switching transistor, TA 1832

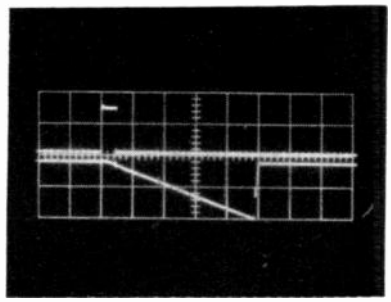


FIG. 3—Typical input trigger and output waveform obtained with the sawtooth generator

How to Generate Accurate

Designers present simple, reliable circuits that generate stable sawtooth and rectangular pulses. Output pulse widths, amplitudes and waveform timing are independent of the active elements in the circuit

By C. A. VON URFF and R. W. AHRONS,
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SAWTOOTH and pulse generators are important building blocks in many electronic systems. In the past, complexity and increased power consumption has been the price paid to obtain desired reliability and stability.

Excellent switching characteristics of a high-speed switching transistor (Thyristor)[1], controlled by a Zener diode, now make it possible to construct two simple circuits that consume little power. Simplicity, low power consumption and small size are some of the desirable features which these circuits provide.

Sawtooth Generator

Linearity and amplitude stability of the generated sawtooth are usually of prime concern in the design of a sawtooth generating circuit. There are many ways of achieving these requirements. The method chosen is to use only a small part of the R-C charging curve and an amplitude controlled switch, shown in Fig. 1.

In this circuit R_1 and C_1 form the basic charging circuit. Transistor Q_1 is used as the switch and the amplitude is controlled by 8-v Zener diode D_1. Figure 2 shows the transistor characteristic curve with load lines and operating points.

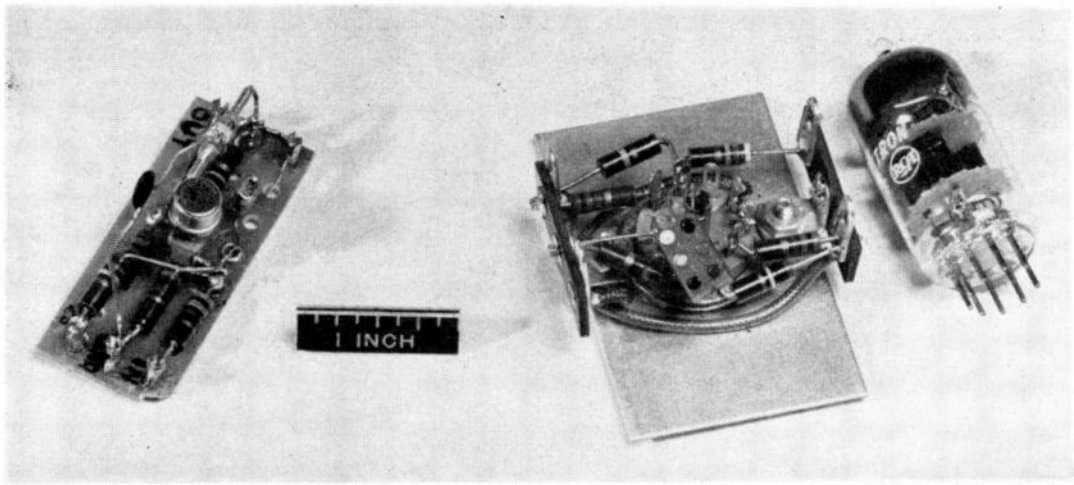
At point A the transistor is conducting with current set by R_4 and E_{bb}. While the transistor conducts, the voltage across the capacitor is zero because of the low conducting resistance of the transistor and the small current flow. Therefore, the starting voltage of the sawtooth is always the same, with no voltage jitter. This forms a built-in clamp.

When a positive pulse is applied to the base, the transistor turns off (point A to point C, along the $I_b >> 0$ curve Fig. 2) and the capacitor starts to charge (point C to D along $I_b \approx 0$ curve Fig. 2). As the voltage across the capacitor reaches the breakdown voltage of the Zener diode, the diode conducts, current flows through the diode into the base of the transistor and the transistor switches to high-conduction.

Since the voltage on C_1 can not change instantaneously, the voltage, V_{ZD}, appears across R_5 and the transistor (point D Fig. 2). Discharge of C_1 takes place through R_5 and the forward resistance of the transistor. This is a short time as $R_5 =$ 10 ohms and $R_f = 3$ to 5 ohms. Resistor R_5 limits the peak current and prevents damage to the transistor.

Linearity

The degree of linearity achieved with this circuit depends on the portion of the R-C charging curve used. Here an 8-v diode was used and the supply was −220 v. Using the for-



The entire pulse generator circuit, left, is shown alongside its equivalent tube version

Sawtooth and Pulse Waves

formulas given in the box, the linearity deviation, $(t_2 - t_1)/RC$ is 0.001. This is acceptable for all but the most stringent requirements.

Sawtooth Amplitude

The amplitude of the sawtooth, determined by the breakdown voltage of the Zener diode, is independent of the transistor characteristics. Thus the transistor characteristics can vary over wide limits without affecting circuit performance. Zener diode characteristics, which are important, are stable with life and temperature. A typical figure is 0.06 percent per deg C. The most important feature needed in the Zener diode is a sharp break at low values of operating current.

If the impedance of the trigger pulse source is too low, the feedback pulse from the Zener diode will be shorted, and the transistor will fail to switch states. Resistor R_2 isolates the base feedback circuit from the trigger generator and R_1 gives a slight forward bias.

The amplitude of the trigger needed to switch the transistor off is directly proportional to the magnitude of collector current at the time of switching. Since the required trigger increases with increasing collector current, the designer operates close to the sustaining current to minimize the required trigger power.

When trying to obtain narrow sawtooth outputs it is important to use a trigger pulse narrow with respect to the output pulse. Otherwise, interaction between the trigger pulse and output waveform results. However, a greater amplitude is required with a narrow trigger pulse than with a wide trigger. The narrowest sawtooth obtained was about 1 to 2 μsec. Typical waveforms obtained with this circuit are shown in Fig. 3.

Pulse Generator

A most desirable feature in pulse generator design is having the output pulse width and amplitude independent of the tubes or transistors. This independence of active elements is achieved in this pulse generator by using the transistor only as a switch, Fig. 4.

The transistor is normally conducting. Hence, voltage V_1, Fig. 4, is approximately zero. When a positive trigger pulse is applied to the base of the transistor, the transistor switches to low-conduction and V_1 rises to the supply voltage. Diode D_1 is back-biased and C_1 starts to charge through R_3 toward the supply voltage.

Capacitor C_1 continues to charge until the voltage across it is equal to the breakdown voltage of Zener

LINEARITY DEVIATION

The method chosen to define deviations from linearity first computes the time required to charge to a given voltage, based on exponential charging. The method then computes the time required for linear charging where the linear charge has a slope given by the slope of the exponential at the origin.

Using these definitions: t_1 = linear charge time to charge to V_{ZD}; t_2 = exponential charge time to charge to V_{ZD}; V_{ZD} = breakdown voltage of Zener diode; E_{bb} = supply voltage of circuit; E_{bb}/RC = slope of exponential at time $t = 0$.

And this formula:

$$\frac{t_2 - t_1}{RC} = \left\{ ln\left[\frac{1}{1 - \frac{V_{ZD}}{E_{bb}}} \right] - \frac{V_{ZD}}{E_{bb}} \right\}$$

The degree of linearity is defined by substituting known values

$$\frac{t_2 - t_1}{RC} = \left\{ ln\left[\frac{1}{1 - \frac{8}{220}} \right] - \frac{8}{220} \right\}$$

$$\frac{t_2 - t_1}{RC} = [0.001]$$

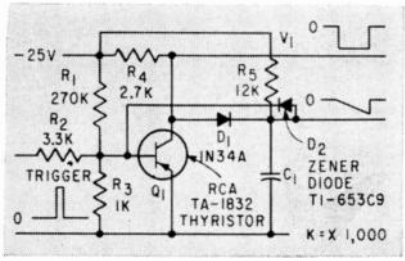


FIG. 4—Rectangular pulse generator operates in almost the same manner as the sawtooth circuit of Fig. 1. Independence of active elements is achieved by using the transistor only as a switch

diode D_2. At this point the Zener diode conducts, sending a negative pulse of current back into the base of the transistor, turning the transistor on. Voltage V_1 now drops to approximately zero. The collector waveform is therefore a rectangular pulse.

If this circuit is to operate at high repetition rates, C_1 must be discharged rapidly. This is done by diode D_1 and the conducting transistor. When the collector voltage, V_1, drops back to zero, the anode of D_1 is at ground potential. Due to the voltage on C_1, the cathode is at a negative potential. Hence, the diode is forward biased and C_1 rapidly discharges through D_1 and the conducting transistor.

As soon as C_1 discharges completely, D_1 stops conducting and the circuit is ready for another operation. This pulse generating circuit has as an ultimate limit in repetition rate—the output pulse width.

Resolution Checks

Double-pulse resolution checks showed that for reliable operation the circuit requires an extra 10 percent of output-pulse-width dead period between triggers. That is, if 10-μsec pulses are being generated, the triggers can be no closer than 11 μsec. This statement is also true for the sawtooth-generating circuit since the pulse and sawtooth circuits operate in almost the same manner. Feedback isolation, furnished by R_2 and R_1, provides a slight forward bias.

The excellent rise and decay times of the output pulse are shown in Fig. 5. The delay between the start of the trigger and the start of the output pulse is of interest. It is due to the fact that the circuit operates well above sustaining current; therefore, there is a delay while the trigger pulse forces the collector current to drop to the point where the unit can switch off. The effect is noticeable also in the output of the sawtooth generator circuit, Fig. 2.

By adding a high impedance audio generator across C_1, the sawtooth and pulse circuits not only generate an output pulse for every trigger but the output pulses have their trailing edges modulated at an audio rate. This results in a simple pulse-length-modulation scheme.

Circuit Stability

Twenty four unselected transistors were checked to see if their characteristic covered the expected production spread.

Tests using these transistors were conducted on both circuits to determine if changing the transistor affects the output pulse width. In this test, the limit transistors produced only a 1.6-percent deviation in pulse width, a tolerable error for most applications. Data taken to determine the effect of varying the trigger pulse width and amplitude showed that a change of 5 to 1 in pulse amplitude or 10 to 1 in width produced less than a 1-percent change in output pulse width.

Temperature Effects

Since semiconductors are used, changes in ambient temperature have an affect on circuit performance. The first test in this area determined the effect of temperature on overall circuit performance over a range of 10 to 80 C. This test evaluates the effect of variations in back resistance of the transistor and the temperature coefficient of the Zener diode. A variation from 10 to 80 C resulted in only a 1-percent deviation in output pulse width.

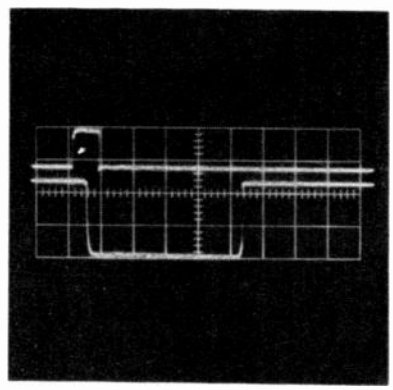


FIG. 5—Input trigger and output wave obtained with the rectangular pulse generator. Note the excellent rise and decay times of the output pulse

Variation in required trigger amplitude with temperature was also checked. Any change here is due to changes in I_{co}. Over 20 to 80 C there is required a 4-to-1 increase in trigger pulse amplitude.

Output waveforms with durations as short as 1 to 2 μsec are possible with these circuits, and in all cases the required trigger power is small.

These circuits should find wide use in any field where small size, low power consumption, small trigger requirements and excellent timing stability are desired.

Thyristor

Operation of the Thyristor is similar to that of the thyratron hence the similarity in names. It is specially constructed so that at some critical value of collector current, called the breakover current, α_{cc} becomes greater than unity.

In the grounded-emitter configuration when α_{cc} becomes greater than one, the collector current increases and the voltage across the unit drops to a very low value. In the Thyristor, this action is regenerative and once the unit is switched, the base current can be discontinued and the thyristor will stay in the high-conduction mode. This feature of the device makes it especially suited to switching service.

The inherent switching time of the Thyristor used in these circuits is 0.1 μsecs when used in the high-conduction, low-conduction method of operation.

In contrast, when the Thyristor is used in the region below the breakover current and kept out of saturation, it is capable of switching times in the order of 20 milli-μsecs. In the high-conduction state the current is usually limited by the external circuit resistance since Thyristor resistance is 3 to 5 ohms.

Bibliography

(1) Mueller, C. W., Hilibrand J., The Thyristor, A High Speed Switching Transistor, PGED of IRE, Jan. 1958.
(2) Sylvan, T. P., Solid State Thyratrons Available Today Electronics, Mar. 6, 1959.

Sum and Difference Mixer Design Charts

Interference charts quickly show which unwanted harmonics of two signals will cause interference. Fixed frequencies and a-m modulation can be handled

By R. F. BAUM, The W. L. Maxson Corp., New York, N. Y.

WHEN TWO FREQUENCIES are heterodyned in a nonlinear device, not only is the desired sum or difference frequency obtained but also a great number of spurious responses. A filter, tuned to discriminate against undesired frequencies, usually follows the mixer. The circuit designer must still locate all the spurious responses to select the input frequencies and to determine the bandwidth and cutoff rate of the filter.

The large number of possible beat frequencies resulting from harmonics require extensive tabulation. A complicating factor is that the inputs are often not fixed frequencies but cover a given band. Charts presented in this article locate the critical interference regions. These areas can then be subjected to rigorous calculation. Design of the mixer itself, and the use of balanced mixers to hold down spurious responses, will not be considered.

Chart Derivation

The design box gives the definition of symbols and lists the equations that are used. All possible output frequencies are given by Eq. 1 and n_1 and n_2 can take any positive and negative integer values. If for a distinct pair n_1, n_2 the frequency f_m becomes negative, there exists the pair $-n_1$, $-n_2$ which gives the same frequency with positive sign. The charts therefore can be restricted to positive output frequencies.

Eq. 6 and 7 are for mixers whose output is the sum and difference frequency of its input frequencies respectively. Eq. 7 is derived by writing Eq. 1 and Eq. 5 with a negative sign. Frequency f_1 is always the higher of the two input frequencies. Eq. 6 and 7 then become identical but for the sign of the last term. Eq. 8 therefore applies in all cases of fixed frequency operation.

Eq. 8 indicates a linear relationship between the output $y = f_m/f_f°$ and the input $x = f_1/f_f°$ for any particular pair $n_1 - n_2$. The charts contain all lines up to $|n_1| + |n_2| = 7$ and, as mentioned previously, discard the negative y plane and are restricted to the practically useful ranges of $y < 2$ and $.5 < x < 2$.

Furthermore the x axis is shifted by one unit in the upwards direction. This allows us to read the new ordinates in terms of $\Delta f_m/f_f°$ which is the ratio of the deviation of the output frequency from the filter center frequency $f_f°$.

The interpretation of the last two terms in Eq. 6 and 7 as line shift or line thickness will be clarified in following examples.

Example of a Sum Mixer

An output frequency of 100 mc is to be obtained by adding two frequencies. Referring to the sum mixer chart, Fig. 1, it is clear that the higher frequency cannot be allocated to a point on the x axis crossed by any interference line. Of the many possible frequency allocations,

SYMBOLS

f_m	mixer output frequency
f_f^0	center frequency of filter
f_1^0	center frequency of input f_1
f_2^0	center frequency of input f_2
Δf_m	deviation of mixer output frequency from f_f^0
Δf_1	deviation of input frequency f_1 from its center f_1^0
Δf_2	deviation of input frequency f_2 from its center f_2^0
n_1	order of harmonic of $f_1 = \pm 0, 1, 2, \ldots$
n_2	order of harmonic of $f_2 = \pm 0, 1, 2, \ldots$
f_1	high input frequency
f_2	low input frequency

EQUATIONS

(1) $f_m = n_1 f_1 + n_2 f_2$
(2) $f_1 = f_1^0 + \Delta f_1$
(3) $f_2 = f_2^0 + \Delta f_2$
(4) $f_m = f_f^0 + \Delta f_m$
(5) $f_f^0 = f_1^0 + f_2^0$
(6) $f_m/f_f^0 = (n_1 - n_2)\, f_1^0/f_f^0 + n_2 + n_1\Delta f_1/f_f^0 + n_2\Delta f_2/f_f^0$ (Sum mixer)
(7) $f_m/f_f^0 = (n_1 - n_2)\, f_1^0/f_f^0 + n_2 + n_1\Delta f_1/f_f^0 - n_2\Delta f_2/f_f^0$ (Difference mixer)
(8) $f_m/f_f^0 = (n_1 - n_2)\, f_1^0/f_f^0 + n_2$ (Fixed frequency, sum or difference mixer)

the point $f_1''/f_f^\circ = 0.775$ is tentatively chosen. It lies in the center of a relatively clear region and the resulting input frequencies, $f_1 = 77.5$ mc and $f_2 = 22.5$ mc, are readily available.

A horizontal line drawn through the selected point intersects 6 interference lines close to the x axis. These are listed in Table I, Case 1, with the ordinates of the intersection points $\Delta f_m/f_f^\circ$ and the corresponding deviation Δf_m. Interference line 2, −3 indicates a beat of the second harmonic of f_1 (155 mc) with the third harmonic of f_2 (67.5 mc). The beat frequency is 87.5 mc, Δf_m is −12.5 mc and $\Delta f_m/f_f^\circ$ is −0.125 as indicated by the chart.

Table I—Sum Mixer Example

Interference lines of harmonic order n_1, n_2	Case 1 (Fixed Frequencies) $\frac{\Delta f_m}{f_f^0}$	Case 1 Δf_m in Mc	Case 2 (Frequency Shift) $\frac{\Delta f_m}{f_f^0}$	Case 2 Δf_m in Mc
2, −2	0.100	+10	0.15	+15
0, 5	0.125	+12.5	0.125	+12.5
1, 2	0.225	+22.5	0.25	+25
0, 4	−0.100	−10	−0.100	−10
2, −3	−0.125	−12.5	−0.075	− 7.5
1, 0	−0.225	−22.5	−0.200	−20

Frequency Shifts

Assume that in the previous example the input frequency f_1 can shift upward by an amount $\Delta f_1 = 2.5$ mc. According to theory this will cause all lines in the chart to shift in the vertical direction by an amount $\Delta = n_1 \Delta f_1 f_f^\circ = 0.025 n_1$. Because n_1 is positive for all lines listed in Table I and since Δf_1 has been assumed to be positive, all shifts are positive in this example.

Interference lines with $n_1 = 0$ correspond to harmonics of the lower input frequency and require zero shift.

The effects of 2.5 mc frequency shift have been entered in Table I under Case 2. Note that upward shifts in the lower half plane (or downward shifts in the upper half plane) will increase the required selectivity of the output filter, since the spurious output frequencies move closer to the filter center frequency.

An upward shift of the lower frequency f_2 would not cause al lines to shift in the upward direction, since in the suprious output of 2, −2 and 2, −3 the sign of n_2 is negative. These two lines therefore would move downward.

Sum Mixer With A-M Modulation

Let input frequency f_1 be a-m modulated at rates up to $f_{1\max}$ = 2.5 mc. Possible sidebands ex-

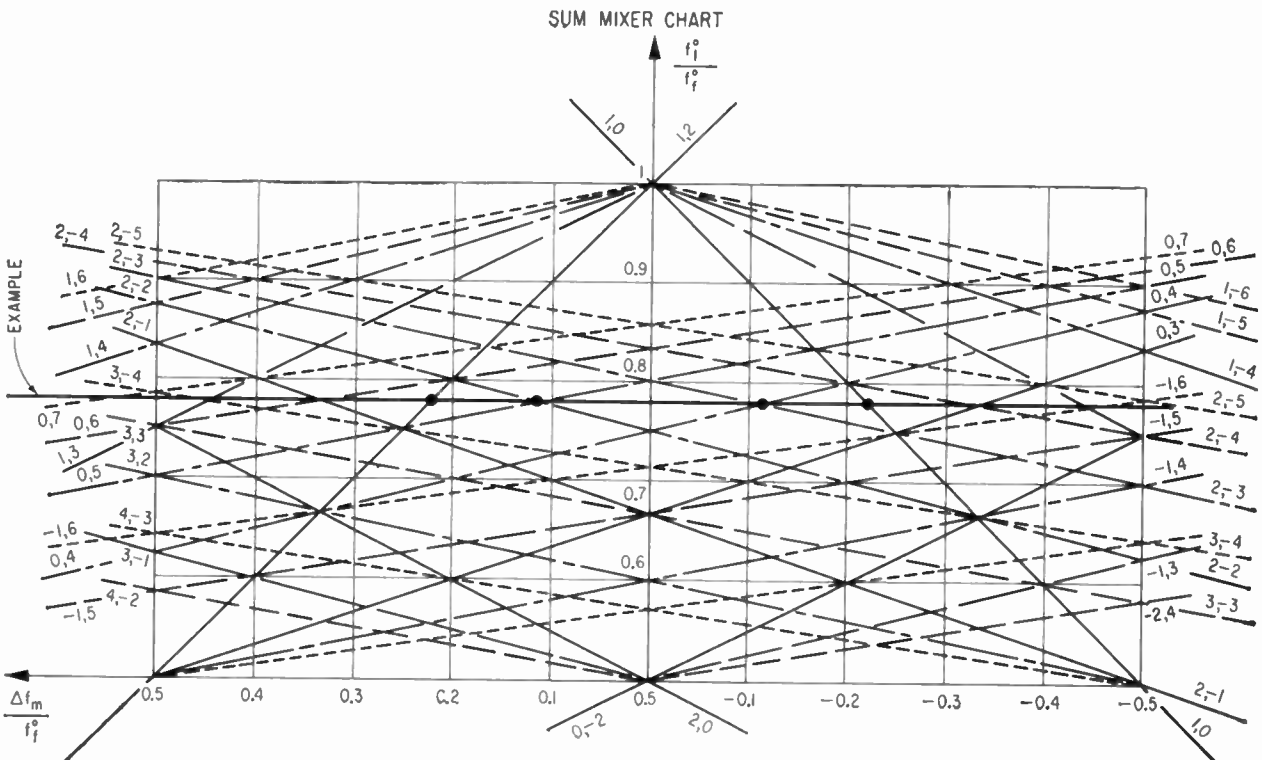
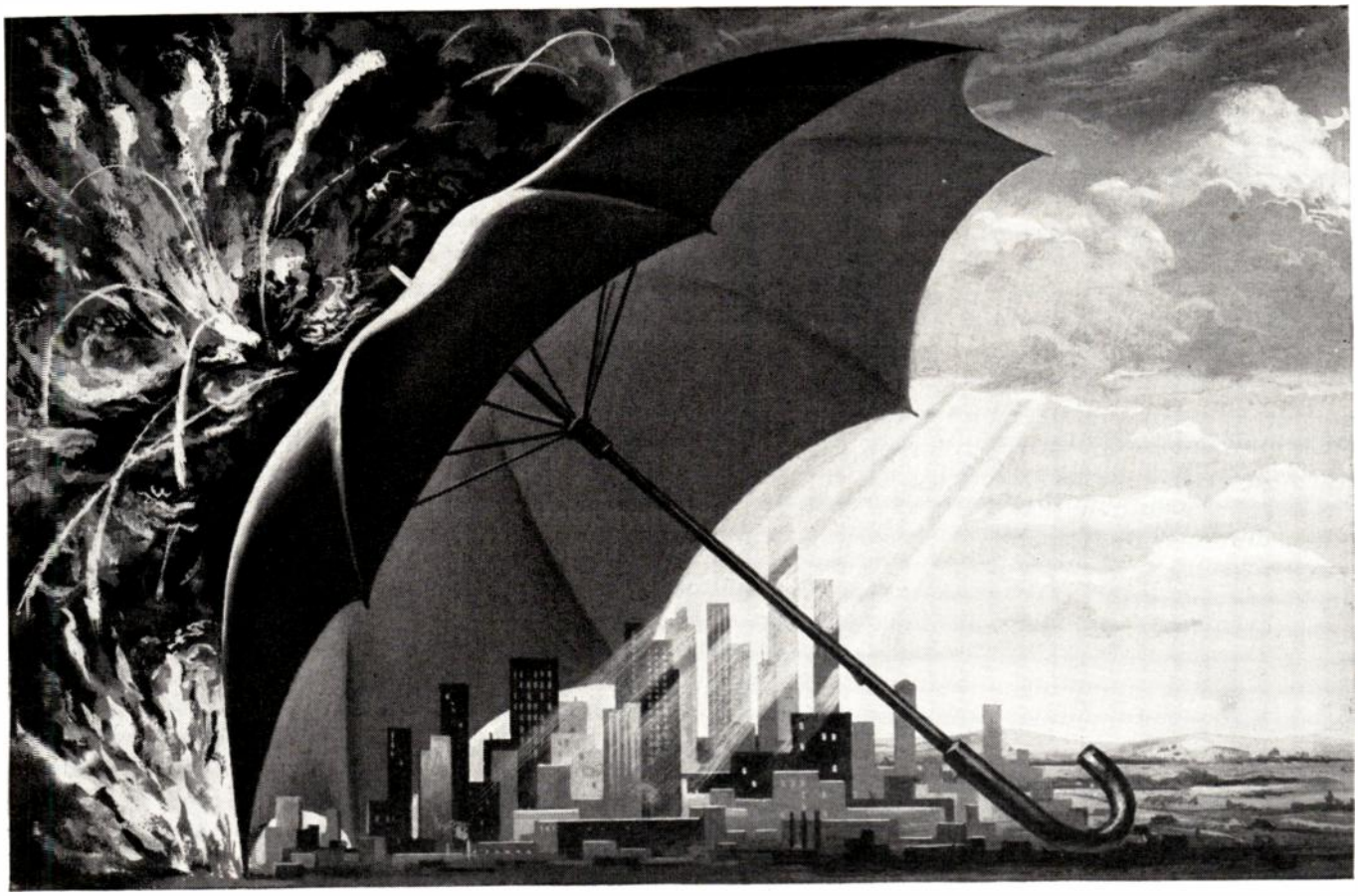


FIG. 1—Example is for the case described in the text. Results are listed in Table I. Only a few of the interference points are tabulated since the others are likely to be small in magnitude and to be far from the pass band of the filter



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URGENT PROBLEMS RELIABLY SOLVED

tend over the band $f_1'' \pm f_{1max}$. The only difference between this and the previous example is the undetermined sign of f_1. Therefore, shifts can occur in either direction and the lines in the chart can be imagined to have a thickness (measured in the vertical direction) of $2\Delta = 2n_1\Delta f_{1max}/f_f°$.

The passband of the filter obviously must extend over $2\Delta = 2\Delta f_{1max}/f_f''$. This is illustrated in Fig. 2, where the filter characteristic is also shown. If along the line $y = f_1°/f_f° = 0.775$ any thick interference line overlaps the passband region, it becomes impossible to reject this interference.

When thick interference lines overlap the passband, the designer must look for a different set of frequencies from which to obtain the desired result. The chart is well suited to finding the new frequency set. The lines are first enlarged to their proper thickness and the frequencies are then selected so a realizable filter can be designed. If no such location can be found, the interference must be tolerated or else rejected by other means, such as a balanced mixer.

Example of Difference Mixer

Comparison of the charts for sum and difference (Fig. 3) mixers shows that, for a given $\Delta f_m/f_f''$, the number of interference lines is less in a difference mixer and decreases rapidly as the ratio $f_1''/f_f°$ increases. Since as a rule the requirement on spurious rejection is strict, the difference method of mixing seems desirable. On the other hand, the higher the input frequencies the more difficult it becomes to meet stability requirements. From the standpoint of stability alone, a sum mixer is usually preferred.

Assume as in the first example that the lower frequency $f_2 = 22.5$ mc is a convenient frequency. Then, for $f_m = 100$ mc, $f_1''/f_f'' = 1.225$. The difference mixer chart shows possible interference close to the axis at the lines 0,5 and 0,4.

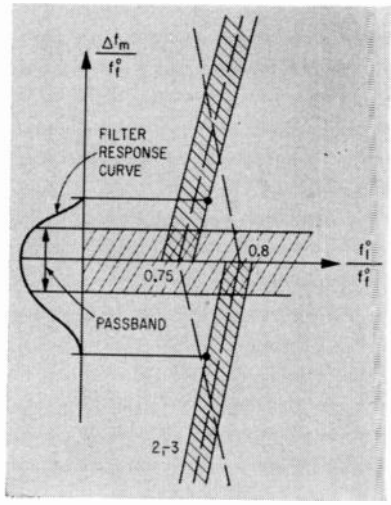


FIG. 2—With a-m modulation, the lines can be assumed to have thickness. Filter specifications can be determined from the interference pattern

Line 0,4 indicates the fourth harmonic of the lower frequency which can be removed by a balanced mixer. If this is done, this line need not be considered and it is seen that a better operating point results when f_2 is set at 25 mc. The same ideas of line shifts and thickness also apply to difference mixers.

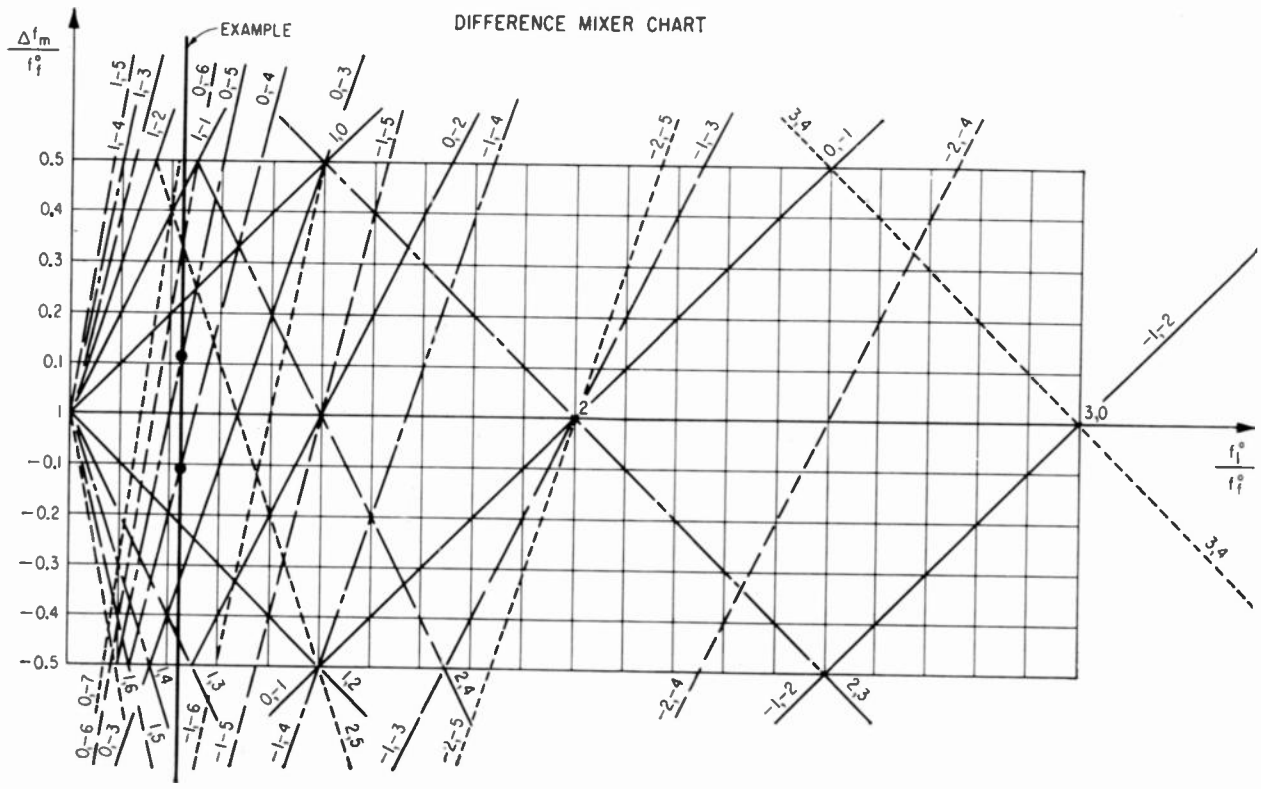
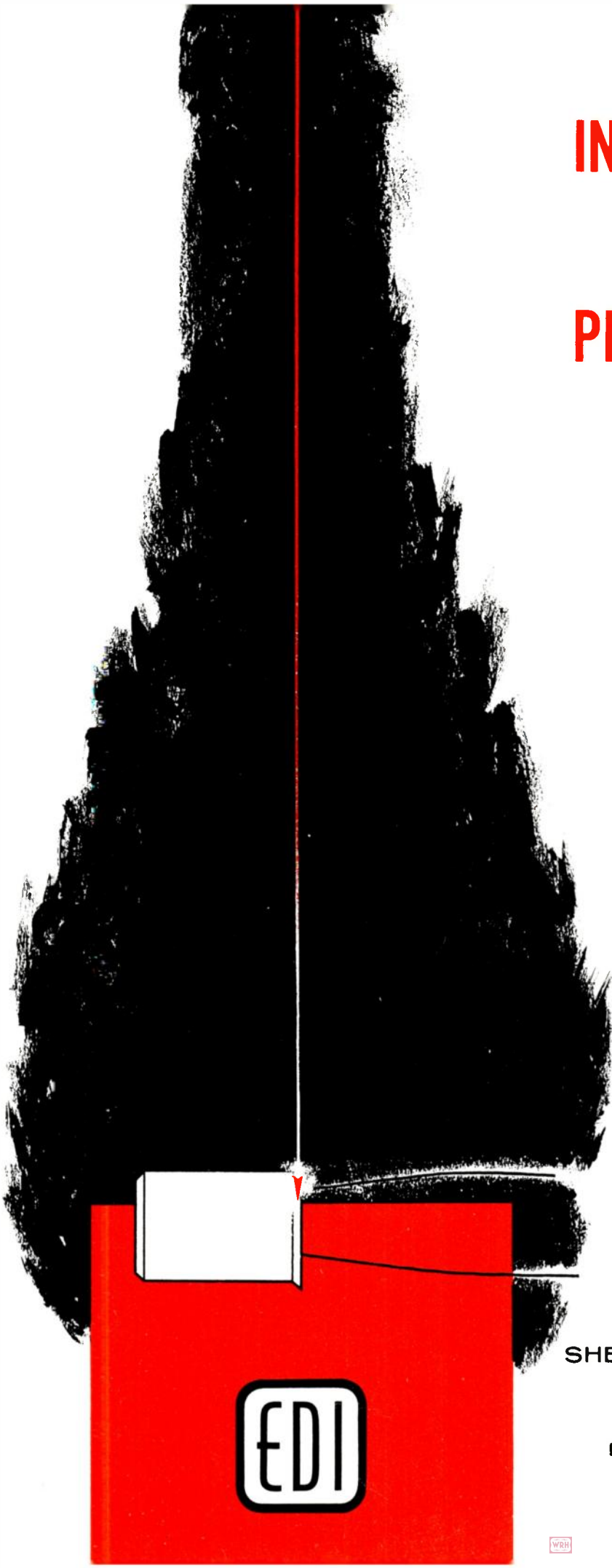


FIG. 3—Example shows two interference points near the x axis parameter. These are the most troublesome beats since they can occur within or close to the pass band of the filter.



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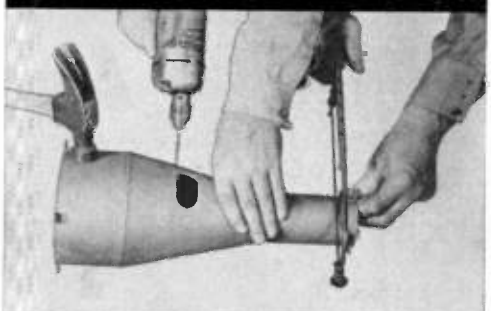

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Verifying System Reliability

RELIABILITY of complex electronic and electromechanical systems continues to plague engineers and engineering management. Marvin A. Dean of Sperry Gyroscope Co. division of Sperry Rand Corp. offered a solution for system developers at the Fourth IRE Instrumentation Conference.

The proposed method, called test packages, combined with adequate part qualification testing, could reduce cost and time spent in obtaining reliability data. The following description was abstracted from Dean's paper.

Reliability test programs can be planned for the part, assembly or equipment level, or for any combination of them. Alternatively, a formal testing program can be rejected in favor of gathering field data. Each level of testing has advantages but also has disadvantages.

Part and Equipment Tests

Failure rates of common electronic and electromechanical parts under average shipboard conditions range from less than one per million part-hours for resistors and capacitors, to six for motors and relays, to as high as 52 for high-voltage transformers.

Minimum test time required for verification of failure rates is a function of confidence level desired. For a failure rate of 1×10^{-6}, minimum time is 3 million part-hours for a 90-percent confidence level assuming a Poisson failure distribution. This time would be possible only if no failures occurred during the test period.

Part testing might include, at one extreme, a sample of 3 million parts operated for only one hour. Results would be obtained rapidly, but the part and fixture costs would be very high. The sample would not have reached wearout, but parts left would far exceed foreseeable requirements. At the opposite extreme, one part could be operated for 3 million hours (over 300 years).

A compromise between the extremes also presents problems. Depending on relative costs, part populations between 300 and 3,000 and test times between 10,000 and 1,000 hours, respectively, seem practical for frequently used low-cost items. But to test 300 synchros costing about $100 each would cost $30,000, with test fixture costs added.

Testing at the part level would cost more than development and manufacture of the end product. Part testing is only economical for the part manufacturer, who can select samples from and amortize testing costs over large available quantities.

Test Packages

Testing complete equipment under simulated use conditions would only confirm or deny equipment reliability goals. It would be necessary to reopen the development effort to use the data. Instead, the value of such data is as a control on reliability of the manufacturing process and as a long range source of information and control of development programs.

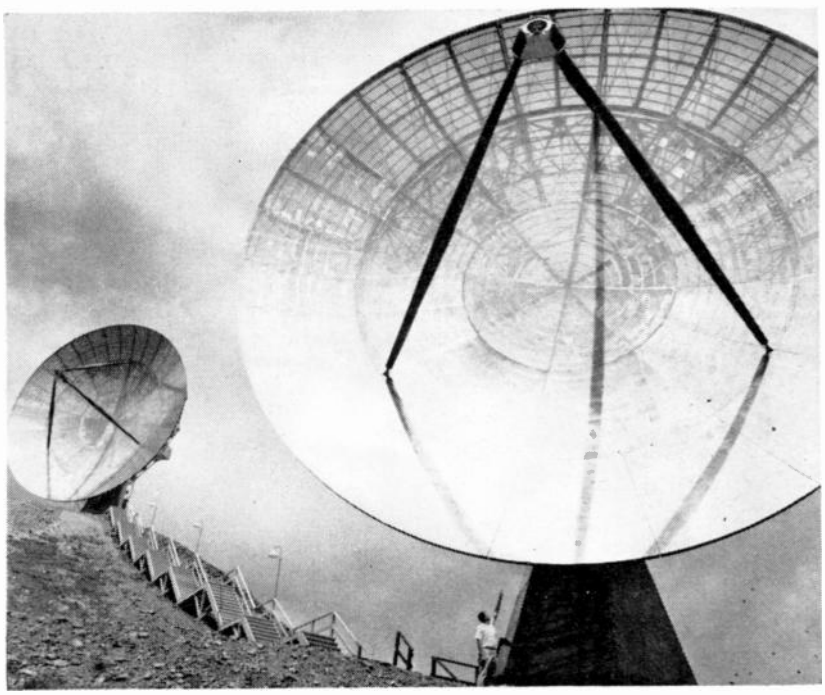
Testing at some intermediate level of complexity is indicated. For example, by applying the product rule for the components of a typical servo amplifier from an analog computer, it was found that overall failure rate was 66×10^{-6}. Minimum test time is only 66,000 part-hours.

Since it is a servo amplifier, the test package might comprise the entire servo loop. Input indicators and simulators and output indicators would be included, as well as the motors and synchros with which the amplifier normally functions. Since all devices possible are those intended for use in the final equipment, they are included as part of the reliability calculation. Failure rate of one such package was found to be 117×10^{-6}, reducing test time to 33,000 part-hours.

Benefits

A package for reliability tests has two important statistical properties. Assuming each test package to be a

Antennas for Propagation Studies



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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
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SC-36-0.5	0-36	0-0.5
SC-36-1	0-36	0-1
SC-36-2	0-36	0-2
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SC-3672-1	36-72	0-1

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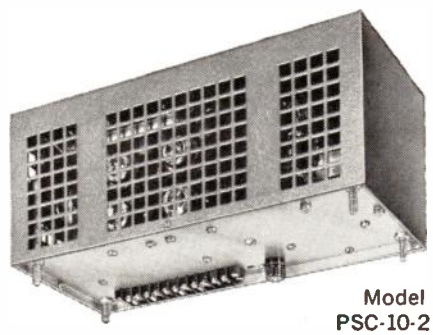
PSC-15-2	12.5-17.5	2
PSC-20-2	17.5-22.5	2
PSC-28-1	22.5-32.5	1
PSC-38-1	32.5-42.5	1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part, total number of parts requiring testing is reduced. Also, test time per package is less.

The prime requirement for a successful test package program is that it be preceded by an adequate part and circuit qualification program. The proposed program is meant to determine statistical reliability of the equipment, not to indicate poor design. Design failures only mask random failures, and random failures must be distinguished from part wearout.

It is necessary that the program be adequately monitored. Test packages should be designed as self-indicating devices and their operating limits must be adequately specified.

The test package program is not a substitute for reliability analysis, but is a complementary function.

Video Tape Recorder Uses Only One Head

VIDEO tape recorder developed in Japan requires only one revolving magnetic recording head. It is said to eliminate horizontal stripes in the reproduced picture (venetian-blind effect), simplify editing of tape and improve tape feeding.

The system was developed over a five-year period by a research team headed by N. Sawazki of the Tokyo Shibaura Electric Co., Ltd. Production is expected to start before the end of the year.

The single recording head, which replaces the four heads now used, records an entire television field in a single diagonal track across the 2-in. tape. Because only one head is used, there is no need for matching four heads with similar characteristics. No problems can result from variations in head spacing around the drum nor from contraction or expansion of the tape.

Electronic switching between heads is eliminated, and the system requires only one recording and reproducing amplifier. Editing is simplified because tape speed can be increased and decreased, held stationary or reversed.

In operation, the tape is looped once spirally around a cylinder. Guides on the cylinder hold the tape in the correct position. A motor inside the cylinder drives the

head at 3,600 rpm, and the tape is fed at 15 ips. The head records in straight diagonal lines across the tape. Each of the evenly spaced parallel lines contains one field of the television picture.

Magnetic Drum Stores Tv X-ray Pictures

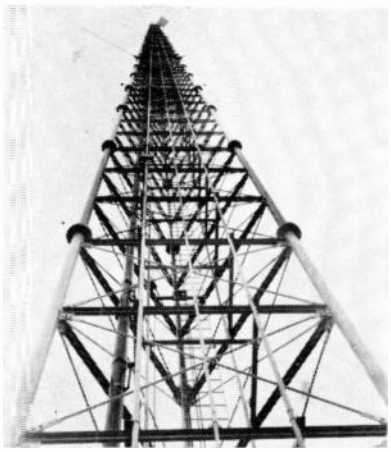
TIME consumed in developing x-ray photographic negatives is eliminated by using a magnetic drum storage. Ten x-ray pictures, transmitted over a closed-loop tv system, are stored on one drum.

The new medical equipment, developed by Philips of Eindhoven, Holland, and C. H. F. Muller AG of Hamburg, W. Germany, also subjects the patient to considerably smaller doses because of a high-sensitivity x-ray image amplifier.

The magnetic drum storage, similar to those used in computers, permits the diagnosing physician to examine the pictures as often and as long as he requires. The 12-in. diameter drum is 11 in. wide and is driven by a 3,000-rpm synchronous motor. One revolution takes 1/50th sec, the field frequency of European tv transmissions.

Each of the ten channels is 2 mm wide, equivalent to ten frames for each drum. The tv picture is recorded with a resolution of 300 lines and a maximum bandwidth of 2 mc.

Tall Television Tower



Antenna tower, 154 ft higher than the Empire State Building, is located in Raymond, Maine. Coaxial switches, diplexers and the 6⅛-in. coaxial transmission line (left in photo) were produced by Dielectric Products Engineering subsidiary of Ironite

How to Choose Precision Fine Wire

By EUGENE COHN, President, Secon Metals Corp., White Plains, N. Y.

A SMALL LENGTH of precision fine wire is the heart of many complex components or devices. For such applications special wire is absolutely necessary. Where special wire is needed, a proper understanding of wire properties is essential to design a device that has a minimum number of variables.

What Properties are Important?

There are times when it seems difficult to define wire needs exactly. Although the designer may be thoroughly familiar with his own product, he may not realize which of the many physical and electrical properties are extremely important. Requirements are seldom alike. Adherence to minute and special peculiarities of the individual product should be the watchword. An open mind and a willingness to investigate new and old materials is essential. Such factors as yield, shrinkage and reliability may be most important.

Table I was compiled as a first step in defining wire needs. This table indicates the specific wire properties that are important for certain devices. Several examples will show that some of these properties are of utmost importance and others are routine.

Some wire properties are obtained by drawing the wire to a certain size, others are obtained by a combination of drawing and heating. Alloying may produce the desired results. Other properties may be produced by electroplating or enameling or coating after the wire has been drawn.

Very often pairs of properties needed on a finished wire are such that one cannot be developed without sacrificing the other. For example annealing for straightness lowers tensile strength. Low resistance and low temperature coefficient of resistance work against each other. Alloys achieve a low temperature coefficient, but alloying always raises specific resistance. Therefore the best set of physical

Table I—Defining Fine Wire Needs for Specific Devices

1. Resistance
2. Wt/Unit Length
3. Tensile Strength
4. Elongation
5. Yield Point
6. Strain Factor
7. Roundness
8. Torsion Constant
9. Temp Coeff of Resist High
10. Temp Coeff of Resist Low
11. Straightness
12. Cleanliness
13. Homogeneity
14. Electroplate Metal Type Amount Density
15. Enamel Type & Amount
16. Spooling
17. Corrosion Resist
18. Withstand High Temp
19. Hysteresis
20. Precise Control of Metal Purity for Reproducibility

Filament Wire	1, 2, 3, 11, 12, 13, 16, 20
Fuse Wire	1, 2, 4, 9, 10, 11
Galvanometer Suspension	1, 2, 8, 11, 13, 19
Grid Wire	2, 3, 4, 5, 11, 12, 14, 16
High Tensile Components	1, 3, 15, 18
Light Weight Moving Coils	1, 3, 11, 15, 16
Potentiometer Wire	1, 3, 7, 10, 11, 12, 13, 15, 16, 17
Resistance Thermometers	1, 4, 9, 13, 15, 18, 20
Semiconductors	3, 4, 5, 11, 12, 13, 16, 20
Strain Gage Wire	1, 4, 6, 10, 11, 12, 13, 19
Tabbing Ribbon	3, 4, 5, 11, 12, 16

Electrical and physical properties of precision fine wire. For each design area (filament wire, fuse wire, etc.) the wire properties are indicated which, if not carefully controlled, can lead to trouble in the finished component or device

Table II—Pure Metal Wire Data Sheet

Metal[a]	Readily Avail to (in diam)	Specific Resist[b] (ohms cmf)	Conduct vs Cu[b] (percent)	Temp Coeff of Resist	Tensile Strength[c] Hard (psi)	Tensile Strength[c] Enameled (psi)	Wt of 20 cm at 0.001
Copper	0.0007	10.26	101	0.00395	48,000	22,000	0.97
Silver	0.0007	9.8	106	0.0038	39,000	22,000	1.1
Platinum	0.0007	63	16.45	0.00395	68,000	57,000	2.15
Nickel	0.0005	44.4	23.3	0.0067	90,000	87,000	0.87
Gold	0.0005	14.3	72.5	0.0039	36,000		1.98
[d]	0.0004	16.2	64	0.00339	120,000	95,000	0.89
Aluminum	0.0006	17.3	59.8	0.00446	8 400	2,300	0.28
[e]	0.0007	13.84	75	0.00287	53,000	31,000	0.67

a—Cu, Ag, Pt and Ni 99.999 percent pure; Au 99.99+ percent pure; b—All reading on fine wire below one mil; c—Tested on 0.001 wire; d—High tensile Magnet wire, iron free, 99.999 percent pure; e—Aluminum clad Cu. 20.

This list is far from complete and is to be used as a guide. All values including the smallest readily available size can often be bettered substantially. Many of these wires can be supplied insulated. There is much material similar to this, mostly unpublished which is one of the many reasons why the engineer with a wire problem should consult wire specialists.

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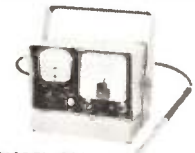

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P. O. BOX 22234 HOUSTON 27, TEXAS MOhawk 7-7405

and electrical properties for a given problem often is an educated compromise.

Where Will the Wire Be Used?

For resistance thermometer wire, a high temperature coefficient of resistance is important. The final purity of the metal itself is paramount. Temperature coefficient of resistance will not change from shipment to shipment or from spool to spool when the purity of the metal is constant. The probability of variables is minimized when quality control is infinitely exercised.

For strain gages, the purity of the metal is not nearly as important as the strain factor. Strain-gage wire must be drawn and supplied in such a manner that is has an elongation at which gages can be wound and used, but at which the wire itself will not stretch during winding.

For precision potentiometers, a low temperature coefficient of resistance is very desirable. High tensile strength is very important for the fine sizes. The wire has to have a hardness such that it does not wear when the wiper is applied to it. The wire must be supplied round so that linear windings can be made. Potentiometer pickoffs in most transducers must have extremely light wiper pressure. Noble metals must be used to prevent oxidation and subsequent contact resistance. Precision resistors do not have this oxidation problem. Therefore the extra cost of precious metal is not justified.

Table II outlines the availability of various low tensile strength wires in extremely small sizes. Wire specialists are often able to recommend the proper metal or alloy wire for specific use if the desired electrical and physical properties are defined. There is much similar material compiled on wire problems, a lot of it still unpublished.

Crackle-Free Potentiometer

MOST POTENTIOMETERS in common use are resistors with a movable tapping, and the changes in output voltage resulting from movement of the sliding contact are not com-

pletely continuous. Consequently crackling arises while the slide is in motion. In measuring instruments, amplifiers and radio and tv receivers, such phenomenon may be objectionable.

Research at Philips Gloeilampenfabrieken, Einhoven, Netherlands, on the cadmium sulphide photoconductive cell, suggests that one application of CdS photo-resistors is a crackle-free-potentiometer[1]. By putting a fixed resistor in series with a CdS photo-resistor, changes in the luminous flux incident on the photo-resistor cause its resistance and hence the voltage across its electrodes to change.

The luminous flux can be altered by changing the current flowing through the filament of an incandescent lamp, the thermal inertia of the filament precludes abrupt changes in the light emission, so that no crackling arises.

A crackle-free potentiometer satisfying the requirements of the volume control in an ordinary radio receiver can be obtained by combining a CdS photo-resistor, which must have a dark resistance of at least 10 megohms, with a fixed resistor having a value of about 2 megohms.

REFERENCE

(1) N. A. de Gier, W. van Gool and J. G. van Santen, Photo-resistors Made of Compressed And Sintered Cadmium Sulphide, *Philips Technical Review*, p 277 July 29, 1959.

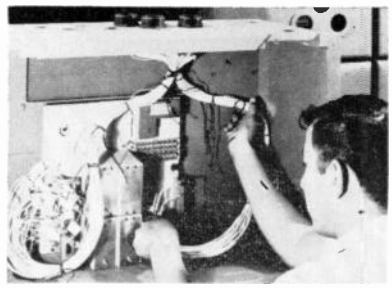
Tap-Proof Cable

COMPANIES using tv, telephones, or wire photos in internal communications networks can be sure their lines are free of eavesdroppers by means of a tap-proof, tamper-proof cable just made available to private industry.

The cable, made by Mosler Research Products, Inc., of Danbury, Conn., provides absolute protection against tapping by direct contact or induction. An alarm is sounded automatically.

Communications circuits are covered by successive layers of foil sheathed in plastic and connected to a highly sensitive relay apparatus which responds to changes in electrical current as low as two one-millionths of an ampere.

Mockups Help Production Planning



Industrial engineer plans wiring in wooden mockup of computer equipment

Cable harness is prepared on mockup board containing wooden subassemblies and terminal blocks. Detailed wooden subassemblies are on bench in foreground

WOODEN MOCKUPS are used by Librascope, Inc., Glendale, Calif., to help develop efficient techniques for data processing and computer system production.

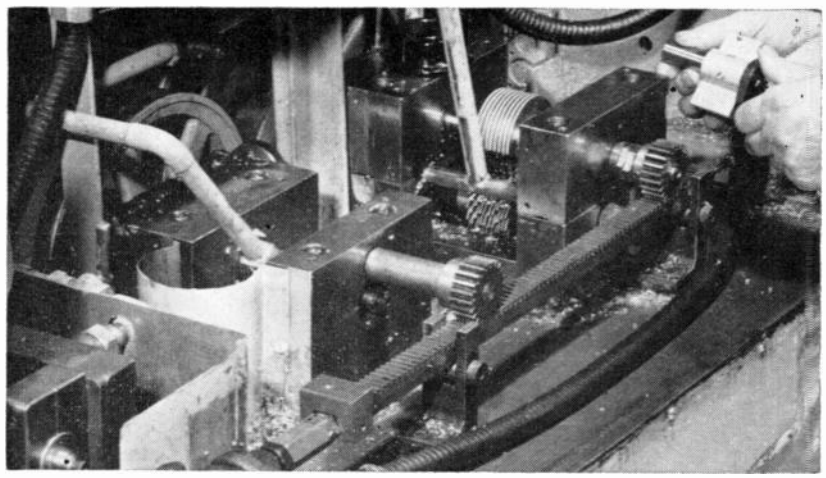
Mockups, the firm reports, reduce the lag between design and production of complex systems. The wooden models are set up when a unit is in final design stages. In defense equipment, particularly, dimensions and configuration of cabinetry are specified in advance.

Dummy subassemblies, meters and other integral components are also constructed of wood and placed in the mockups to determine arrangements most suitable for production and servicing. During final design, necessary minor changes are made.

When a mockup is completely assembled, cabling is designed and provisions are made for special channels, clamps or other means of maintaining wire positions during dynamic stress. Color coding is established. After cabling has been worked out, harness boards are prepared in advance of production. These boards also contain dummy assemblies and terminal blocks for exact measurement of wire lengths and harness configuration, so harnesses can be prepared in advance.

At the same time, mountings, casting and production tooling are planned. In some cases, a second stage mockup of metal castings will be hand-fitted and modified to obtain the most efficient designs for foundry and machine shop production. The needs for production handling equipment, assembly fixtures and storage are also determined.

Capacitor Parts Cut from Blocks



Semiautomatic machine setup which mills variable capacitor plates from aluminum extrusions. Air cylinder drives gear bar

ONE-PIECE PLATE ASSEMBLIES for instrument-grade variable air capacitors can be machined from solid aluminum more economically than by conventional punching, stacking and soldering methods, according to General Radio Co., West Concord, Mass.

The method also improves mechanical sturdiness and stability, and produces inherently good linearity and control of capacitance magnitude, the firm says. Cumulative spacing errors made possible by piece tolerances on a stacked structure are avoided.

Shaped extruded rods are gang milled in a lubricant bath. The

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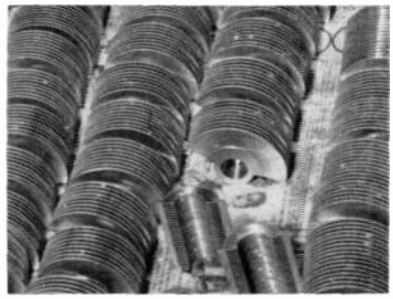


Capacitor parts after milling

tungsten carbide tool is resharpened after 1,000 pieces and 2,000 pieces and is discarded after 3,000 pieces. Production speed is 40 pieces an hour.

Oscillating Rod Steps Series Coil Winder

COIL WINDER escapement mechanism recently developed by Geo. Stevens Mfg. Co., Inc., Chicago, Ill., uses an air-oscillated rod to automatically step the wire feed from coil to coil. With control gearing, it permits unattended winding of connected series coils.

Two rows of notches are cut in the circular rod (Fig. 1A). Distance between the notches equals distance between coil positions on the winding mandrel. The rows of notches are staggered ⅛th turn or 60 degrees on the rod. The rod is oscillated through a ⅛th turn by a solenoid operated air cylinder. The cylinder rotates the rod each time a coil is completely wound. As the rod turns, the spring loaded trigger of the wire guide support (Fig. 2) is freed from the notch by the turning action. The collar is pulled to the left by the spring-loaded tape and the trigger is caught in the next notch.

The action, similar to that of a gear ratchet, progresses the wire

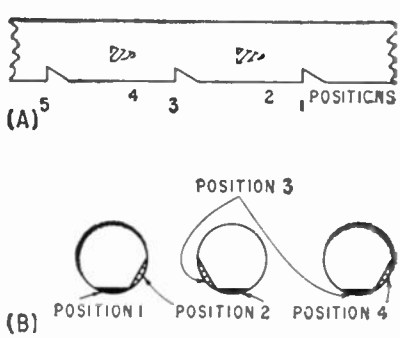


FIG. 1—Oscillating rod

support down the rod. As shown in Fig. 1B, a counter-clockwise turn moves the stop from position 1 to 2, a clockwise turn moves it from 2 to 3 and so on. The movements are almost instantaneous.

When the trigger is seated in a notch, a secondary level winding mechanism causes the notched bar to reciprocate, laying a preset number of turns on the corresponding coil form on the mandrel. To ac-

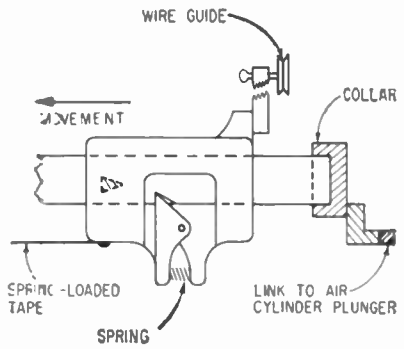
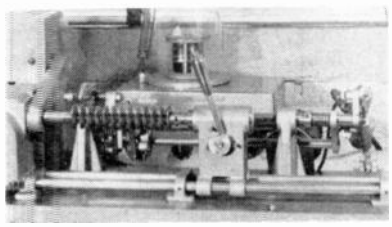


FIG. 2—Triggering mechanism

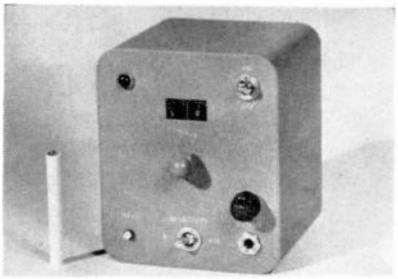


Machine series-winding coils

complish this, gearing must be placed in the secondary winding mechanism. An additional gear train in the mandrel movement acts as a resetting counter. This gearing determines the number of turns placed on each individual coil by 360 degree oscillation of the notched bar and by moving the wire guide to the next winding station.

When the last coil in a series is wound, the wire guide triggers a snap-action switch, magnetically braking the machine. Changes in wire size, winding pitch and turns per coil are adjusted by resetting gears. Setup takes about 15 minutes. Variac controls winding speed up to 1,200 rpm and yet the exact turn count and crossover point per coil is obtained. If tolerances are broader than plus or minus 3 turns per coil, winding speeds up to 3,200 rpm can be achieved. Wire tension is friction-adjusted by a capstan. Wire sizes 17 to 46 are handled.

On The Market



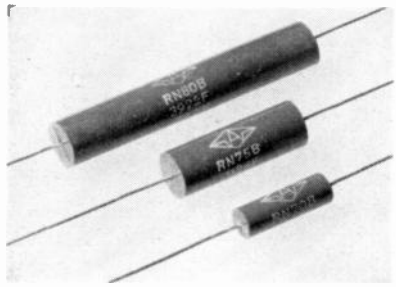
Vibration Instrument for accelerometers

UNHOLTZ-DICKIE CORP., 2994 Whitney Ave., Hamden 18, Conn. The Dial-A-Gain, an accelerometer sensitivity standardizer, converts all accelerometer sensitivities to a convenient 1 v/g, allowing direct reading of acceleration on any vtvm. Unit includes a cathode follower input and a precision amplifier with a continuously variable gain control dial, calibrated directly in accelerometer sensitivities. Dial-A-Gain eliminates external cathode followers normally used, and is available with single or multiple inputs. Complete specs are available.

CIRCLE 301 ON READER SERVICE CARD

Precision Resistors carbon-deposited

AEROVOX CORP., Hi-Q Division, Olean, N. Y. Type CPM Carbomold molded carbon-deposited resistors are encapsulated in a strong reinforced moisture and heat resistant plastic. They are normally supplied in ±1 percent tolerance and are



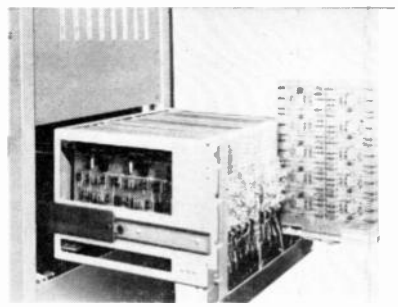
available in ranges from 10 ohms to 5 megohms in the ½ w size, 10 ohms to 10 megohms in the 1 w size and 30 ohms to 20 megohms in 2 w size. Designed for full load at 70 C and derated to zero load at 150 C, they meet and exceed the insulation resistance requirements of MIL-R-10509C.

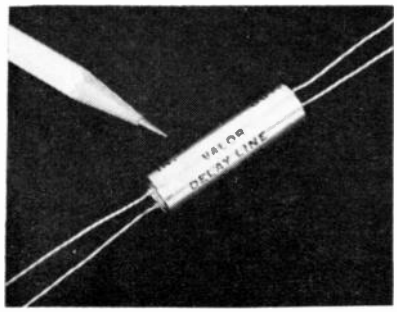
CIRCLE 302 ON READER SERVICE CARD

Quantizer transistorized

COMPUTER EQUIPMENT CORP., 1931 Pontius Ave., Los Angeles 25, Calif. Model LFQ-20 quantizer has a resolving time of 20 milliμsec, is accurate to one part in 10^7 per day. It accepts time-varying input signals and reads out the time of each interval in digital code. The digital readout is a salient feature of the fully-automatic equipment. In essence, it is a time to digital converter compatible with a variety of digital data handling equipment. It is easy to service because of a swing-out circuit card arrangement. Unit meets military specs.

CIRCLE 303 ON READER SERVICE CARD





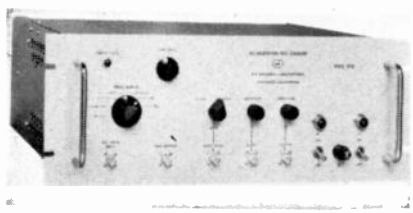
Delay Line subminiature

VALOR INSTRUMENTS INC., 13214 Crenshaw Blvd., Gardena, Calif. A 1 μsec delay line with a 0.2 μsec rise time is available in a 0.4 in. by 1.5 in. metal case. The 10C5-5/14 precision lumped constant unit is suitable for p-c and transistor applications. Characteristic impedance is 1,400 ohms; attenuation, 3 percent; temperature characteristic — 0.03 percent/deg C; temperature range, — 55 C to + 105 C; built to MIL specs; molded in hermetically sealed brass tube with leads brought out through glass-to-metal end seals.

CIRCLE 304 ON READER SERVICE CARD

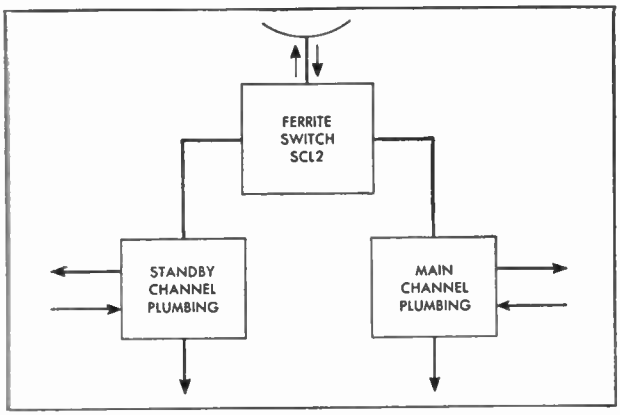
Pulse Generator two outputs

E-H RESEARCH LABORATORIES, INC., 1922 Park Blvd., Oakland 6, Calif. Model 120B pulse generator features a rise time of less than 2.5

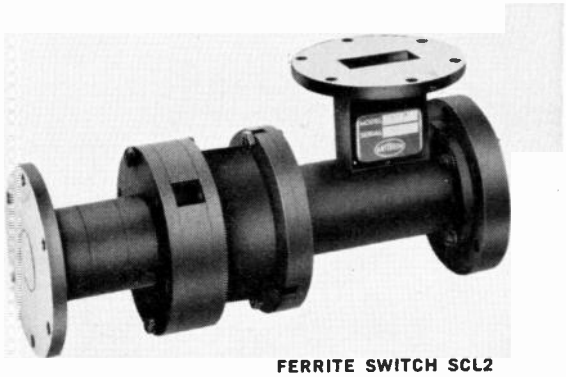


milliμsec. Two independent outputs are available providing precision pulse widths from 2.5 to 25 milliμsec, and repetition rates from 10 cps to 10 mc which may be controlled externally. A fast flexible gating input is available for com-

THREE-POSITION FERRITE SWITCH FOR C-BAND



TYPICAL MICROWAVE CIRCUIT in which Raytheon ferrite switch is now being used. Switch has three positions: antenna to main channel; antenna to standby channel; antenna to both channels simultaneously.



FERRITE SWITCH SCL2

FERRITE SWITCH IS ACTIVATED when fault is detected in sensing unit. Receiver fault causes switch to transfer to intermediate position for comparison of main and standby. Normal baseband receiver noise and pilot tone allow switch to complete switchover.

TYPICAL SPECIFICATIONS

	SCL2
Frequency range (mc)	6,575-6,875
Isolation, minimum	20db
Isolation, maximum	30db
Insertion loss, minimum	0.5db
Insertion loss, maximum	0.8db
Power, average	10 watts
Power, peak	1 kw
VSWR, minimum	1.02
VSWR, maximum	1.28
Type of switch	SPDT reciprocal
Coil current	400 ma
Coil resistance	60 ohms
Length	8 in.
Waveguide	RG-50/U*

*Mates with

ADVANCED SWITCHOVER PROTECTION PERMITS MORE RAPID AND FLEXIBLE OPERATION THAN EVER BEFORE

A completely new ferrite switch has just been introduced by Raytheon. The device, which is controlled by a specially designed switchover unit, provides foolproof switchover protection. It has three positions, connecting:

1. antenna to main channel
2. antenna to standby channel
3. antenna to both channels simultaneously

In the third position, the received signal is divided equally between the arms feeding the main and standby receivers.

This allows an actual comparison of the two receiver signals before switching and eliminates the need for complex and unreliable signal injection systems.

To learn more about this significant development or other important Raytheon advances in microwave ferrite devices, please write to the address below stating your particular area of interest.

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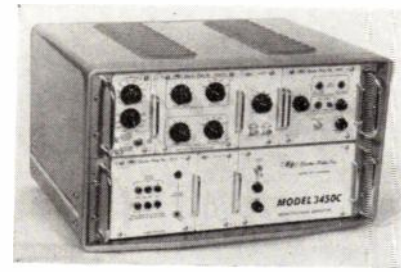
plex pulse-time and pulse-amplitude selection. A positive 15 v trigger output may be used to initiate timing cycles or trigger an oscilloscope.

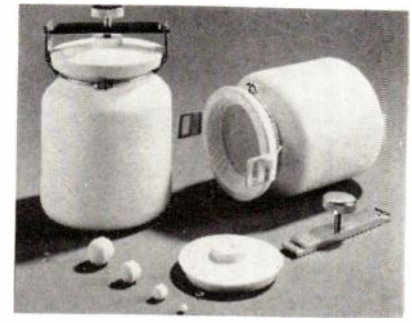
CIRCLE 305 ON READER SERVICE CARD



Pulse Generator high output power

ELECTRO-PULSE, INC., 11861 Teale St., Culver City, Calif. Model 345CC pulse generator provides high output power and fast rise time pulses at repetition rates to 2 mc. Features include wide range variable pulse delay and duration, high resolution controls, and automatic overload indication. Output amplitude is stabilized by power regulators and pulse output is presented d-c coupled with base line at chassis ground. Instrument is constructed entirely of plug-in printed wiring modules, allowing extension to multiple pulse requirements and providing maximum accessibility for maintenance.

CIRCLE 306 ON READER SERVICE CARD



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(Continued on p 92)

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CIRCLE 307 ON READER SERVICE CARD

D-c Power Supply transistorized

DYNAMIC CONTROLS CO., 1955 Massachusetts Ave., Cambridge, Mass. A fully transistorized d-c power supply, having a rating of 4 to 35 kv at 0 to 4 amperes, mounts in a 19 in. rack, 3½ in. high, 10 in. deep. It is fully enclosed for bench use. Subassemblies make all parts easily accessible. Output voltage is continuously variable by a single knob on the front panel. Regulation is 0.1 percent for load and line variations with no internal adjustments. Unit operates from a 105-125 v, 60 cps input.

CIRCLE 308 ON READER SERVICE CARD

SSB Receiver general-coverage

HAMMARLUND MFG. CO., INC., 460 W. 34th St., New York 1, N. Y. The HQ-180 ssb receiver is an 18-tube superhet circuit with automatic noise limiter. It is triple conversion from 7.85 mc to 30.0 mc, and dual conversion from 540 kc to 7.85 mc. It offers the operator a choice, or combination of slot filter, selectable sideband, tuned i-f, bandspread and separate linear detector in tuning the desired sideband signal. A new h-f crystal filter is used at 3035 kc to improve selectivity and shape factor of the first i-f amplifier. The slot filter is adjustable ±5 kc over the passband for up to 60 db attenuation. Cabinet model is priced at $429, plus $10 for optional clock-timer.

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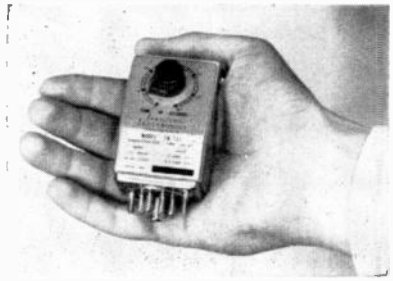
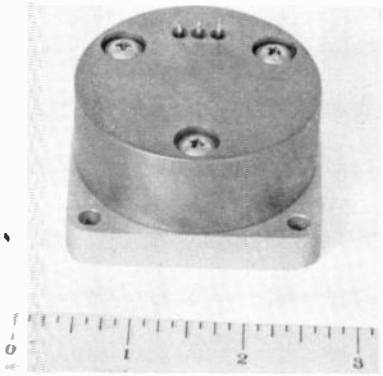


Timing Module solid state

SYRACUSE ELECTRONICS, 1014 East Fayette St., Syracuse 10, N. Y. TR-301 is a solid state a-c operated timing module. It features very high

reliability, repeatability accuracy under voltage fluctuations. The delayed time is infinitely variable over the specified range which is from milliseconds to several minutes. Switching capacity is 5 amperes resistive at 120 v a-c.

CIRCLE 310 ON READER SERVICE CARD



Accelerometer gas-damped

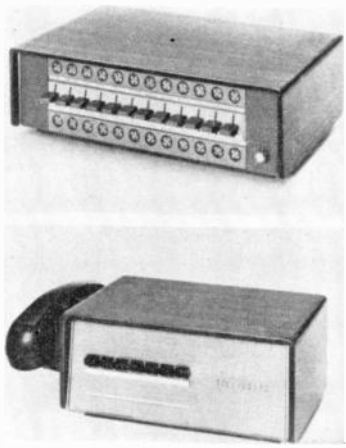
WIANCKO ENGINEERING CO., 255 N. Halstead, Pasadena, Calif. This accelerometer is ideally suited for aircraft and missile control applications. Constant damping over wide, rapidly changing temperature spans is achieved by a gas-damped seismic system that results in highly stable, accurate and reliable performance in severe environments. Ranges are ±1.0 g to ±25 g; damping, 0.65 critical at 75 F; temperature range, −65 to +250; zero and sensitivity drift (−25 to +180 F), less than 2 percent of range/100 F; linearity, less than 1.0 percent of acceleration span; hysteresis, less than 0.1 percent of acceleration span.

CIRCLE 311 ON READER SERVICE CARD

Silicon Diodes meet military specs

RHEEM SEMICONDUCTOR CORP., 327 Moffett Blvd., Mountain View, Calif. Type numbers RD1356-1359 have high back resistance, up to 50,000 megohms at 25 C. Forward conductance is 100 ma at +1 v. Breakdown voltages range up to 200 v. Units are available now in the standard subminiature glass package.

CIRCLE 312 ON READER SERVICE CARD



Intercom System transistorized

DICTOGRAPH PRODUCTS INC., Jamaica, N. Y. The executive (top) and master (bottom) stations are part of a new fully transistorized intercommunication system. The executive station has a "magic-eye" which indicates who is calling and automatically leaves a message if the executive is away from his desk. It features hands-free operation, right-of-way priority, an advanced acoustical design with two-channel

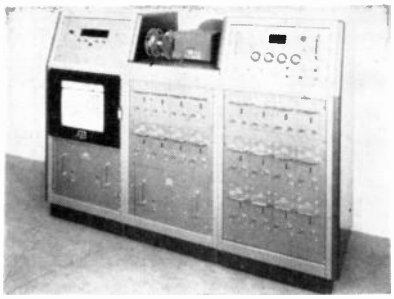
transistorized amplifier and a conference circuit. The standard cabinet can house three different size stations permitting contact with 12 to 24 people. The master stations can be converted to any one of five size stations allowing contact with 6 to 23 points and more as needed.

CIRCLE 313 ON READER SERVICE CARD

Toroidal Inductors and transformers

UNIVERSAL TOROID COIL WINDING, INC., 171 Coit St., Irvington 11, N. J. High frequency toroidal inductors and transformers featuring extremely low distributed capacity and high coupling coefficient are offered with encapsulated or encased construction. These toroids are wound with a new process yielding excellent Q for operation up to 105 C

CIRCLE 314 ON READER SERVICE CARD



Recording System automatic

DATEX CORP., 1307 So. Myrtle Ave., Monrovia, Calif. Digital recording system designed for the automatic testing of vacuum tubes on a mass production basis is available. With appropriate input modifications it may be used for any recording of data where input variables in the form of emf's in the 0-to-10 mv range are available. The system will sequentially select up to 200 input variables and digitally record each variable with 3-digit point identifi-

cation via a motorized tape punch. The data is recorded in an 8-channel code suitable for use with an IBM 046 or 047 tape-to-card converter. Cycle time per data point is 1 sec. Maximum time per recording cycle is 15 min. System accuracy is ± 0.5 percent of full scale.

CIRCLE 315 ON READER SERVICE CARD

Data Plotting Board transistorized

COMPUTER SYSTEMS, INC., 611 Broadway, New York 12, N. Y. Model MC-3302 data plotting board plots one d-c analog signal or two signals simultaneously, on a 30 in. by 30 in. surface. Plotting sensitivity is 20 in./v; input impedance one megohm or greater, regardless of sensitivity setting. The electroluminescent panel provides completely diffused, glare-free illumination without fluorescent noise.

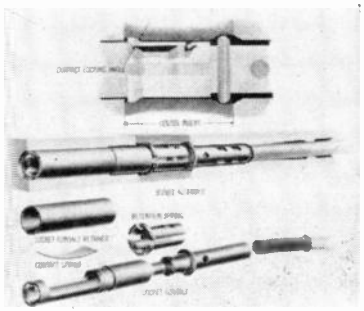
CIRCLE 316 ON READER SERVICE CARD

Decimal Scaler 10^8 count capacity

RADIATION INSTRUMENT DEVELOPMENT LABORATORY, INC., 5737 South Halsted St., Chicago 21, Ill. Model 49-19 is a fast (1 μsec resolving time) decimal scaler with total count capacity of 10^8. Unit includes

Argonne type A61 linear amplifier, precision discriminator and fixed mercury pulse generator, as well as an electrometer type h-v supply continuously variable between 500 and 5,000 v. Preset count to 10^6 is provided along with an electrically reset elapsed timer.

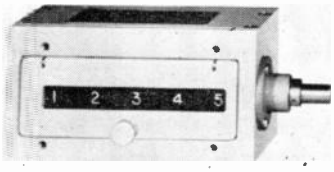
CIRCLE 317 ON READER SERVICE CARD



Miniature Connector high retention

THE DEUTSCH CO., Municipal Airport, Banning, Calif., announces a miniature connector with insertable contacts guaranteeing retention of a minimum of 25 lb. Basic to this high retention value are: a special hard plastic center insert which retains the contact; the contact retention spring, designed to accurately fit into the retaining angle of the hard insert to hold under compression, rather than sheer; and the simple insertion tool which allows the operator to slip the contact into a positive position of engagement.

CIRCLE 318 ON READER SERVICE CARD

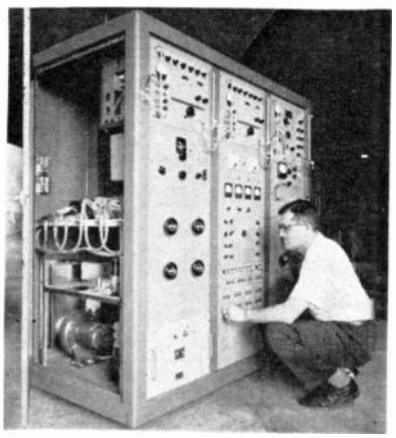


Contacting Counters shaft driven

PHOTOCON RESEARCH PRODUCTS, 421 North Altadena Drive, Pasadena, Calif. The 1100 and 1200 series counters are compact, light weight instruments designed for telemetering shaft rotation and position. The 1100 series have electrical contacts which correspond with each number on each wheel; the contacting coun-

ters in the 1200 series are furnished with precision resistors mounted between contacts. Counters for each series are available with either 3, 4 or 5 wheels, each indexed from 0 to 9. An external reset wheel can be provided when shaft rotation in only one direction is required.

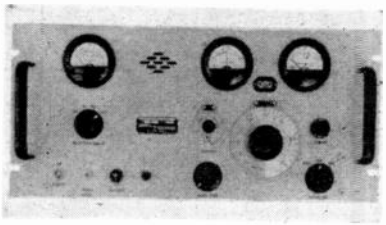
CIRCLE 319 ON READER SERVICE CARD



Signal Source
10-watt

LEVINTHAL ELECTRONIC PRODUCTS, Stanford Industrial Park, Palo Alto, Calif. Designed to fill the needs of component laboratories and antenna ranges, the model 229T is a composite instrument covering the entire spectrum from 1 to 11 kmc in four segments: 1 to 2, 2 to 4, 4 to 8, and 8 to 11 kmc. Features are c-w operation plus internal modulation for pulse, square-wave, and f-m output. There are also provisions for external modulation. Special attention has been paid to voltage regulation and filtering to minimize incidental f-m and a-m.

CIRCLE 320 ON READER SERVICE CARD

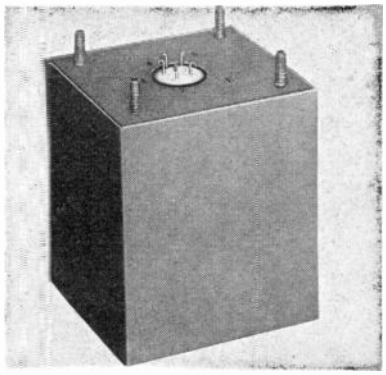


Telemetry Receiver
versatile unit

GENERAL ELECTRONIC LABORATORIES, INC., 8521 Second Ave., Silver Spring, Md. Type 11B1 was designed specifically for use in f-m, f-m, pdm/f-m, and pcm/f-m sys

tems Noise figures of less than 7 db are obtained over the entire band from 215 to 265 mc. Other features include reduced intermodulation and interference and increased linear operating range. The user can select either crystal-controlled or continuously-tunable (vfo) modes of operation by simply positioning a switch on the front panel. He can also select the optimum bandwidth for his particular telemetry application through the use of plug-in second i-f amplifiers with bandwidths of 100, 300, 500 and 750 kc (standard).

CIRCLE 321 ON READER SERVICE CARD



Transformer phase splitting

UNITED TRANSFORMER CORP., 150 Varick St., New York 13, N. Y. A practical means for operating 3 phase devices where only single phase is available is provided by UTC phase splitting transformers. The P-4674 unit shown provides 115 v, 400 cycles 3 phase to a 90 va gyro power supply. Input is 115 v, 400 cycles single phase. Unit is 2¾ by 3 by 3½ in. and weighs 3¼ lb; meets MIL-T-27A requirement to Grade 4, Class S, Life X.

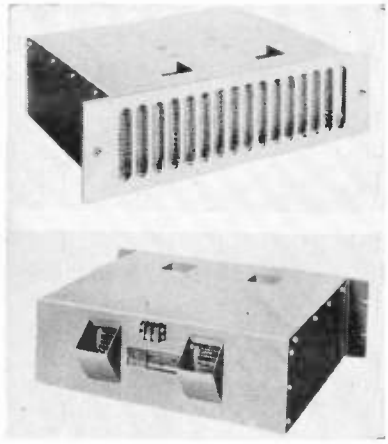
CIRCLE 322 ON READER SERVICE CARD

Crimping Tools for connectors

THE DEUTSCH CO., Municipal Airport, Banning, Calif., announces a pneumatic automatic crimping tool for use with DS and DRS miniature environmental connectors with snap-in contacts and crimp-type terminations. One hundred or more contacts—pins or sockets—may be loaded into the tool at once. These

contacts are fed, one at a time, in positive position, into the jaws of the tool. With a press of the button, each is firmly fixed to the wire with an 8-indent crimp.

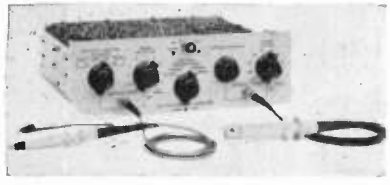
CIRCLE 323 ON READER SERVICE CARD



Rack Mounted Blower
double exhaust

McLEAN ENGINEERING LABORATORIES, INC., P. O. Box 228, Princeton, N. J. Model 4EB300 is a double exhaust rack mounted blower for electronic cabinet cooling applications. It produces 250 cfm with a very quiet air delivery. It features vertical and diagonal exhausts with ventilators available on the front and rear of the cabinet. The filter is easily removable from the front without removing the unit from the cabinet. The motor meets federal specification CC-M-636A.

CIRCLE 324 ON READER SERVICE CARD



Amplifier
voltage/current

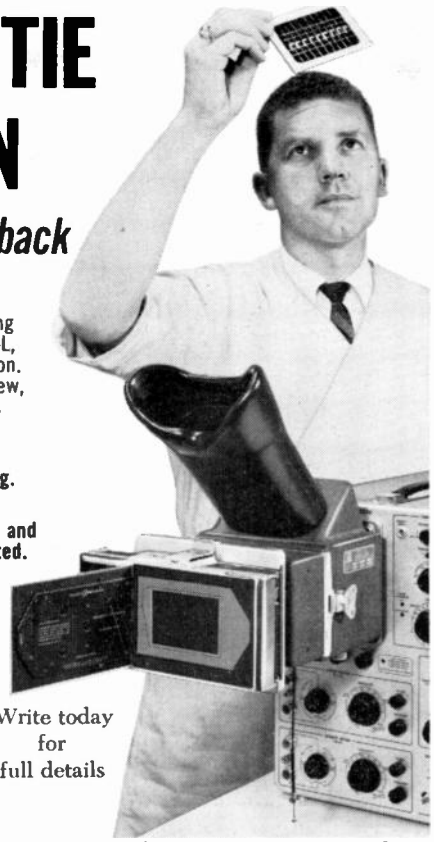
HEWLETT-PACKARD CO., 275 Page Mill Road, Palo Alto, Calif. Model 154A dual channel amplifier permits direct observation of current waveforms as well as voltage waveforms when plugged into model 150A/AR oscilloscope. It has a current-sensing probe which clamps around a wire providing fast measurement and observation of current from 50 cps to 8 mc; sensitivity is ca i-

Slides in only **2** *minutes*

with this **BEATTIE**

OSCILLOTRON

using a Polaroid® Land back



Now you can project transparent slides of oscilloscope traces just minutes after recording with Polaroid ® Land Projection Film, Type 46-L, used in this new Beattie Direct View Oscillotron. Also produces 60 sec. paper prints with the new, very fast Polaroid ® 3000 Speed Film. Records up to 10 traces on a single frame and offers these many other advantages:

- **Direct binocular view of CRT while recording.**
- **Non-reversed image.**
- **Camera swings back for easy access to lens and shutter, or lifts off completely. Can be rotated.**
- **Electric shutter-actuator available.**
- **Attaches easily to bezel of 5" CRT. Adaptable to other sizes. No special tools.**

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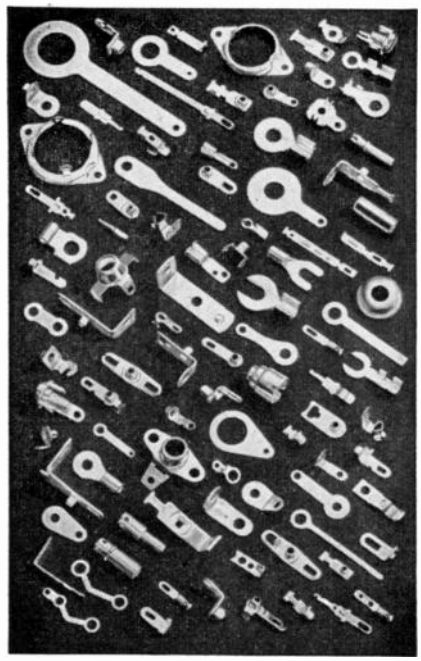

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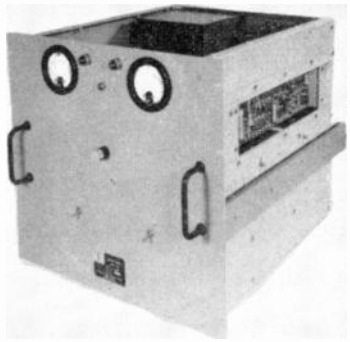
CIRCLE 101 ON READER SERVICE CARD

brated from 1 ma/cm to 1 ampere/cm in a 1-2-5 sequence. The clamp-around probe eliminates loading, voltage drop due to resistor insertion and the breaking of circuits. Sensitivity of the voltage channel is 50 mv/cm to 20 v/cm and bandwidth is d-c to 10 mc. Price is $430.

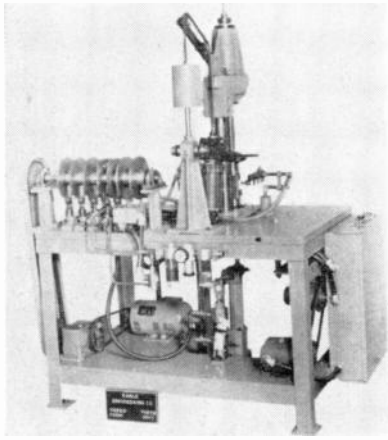
CIRCLE 325 ON READER SERVICE CARD



D-C Power Supply
all solid state

DYNATRONICS, INC., Box 2566, Orlando, Fla. All solid state d-c power supply features a regulated output of ±100 to 250 v with a 6-ampere continuous load. Unit is designed for mounting in standard 19 in. relay racks.

CIRCLE 326 ON READER SERVICE CARD



Button Stem Machine
single head

KAHLE ENGINEERING CO., 3322 Hudson Ave., Union City, N. J. A single head button stem machine for the c-r tube industry features automatic programming. An unlimited variety of different size and model tube button stems can be produced with the machine. Once the parts are loaded by hand, the operator pushes a but-

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Deluxe Coils is daily turning out self-supporting and bobbin wound miniature coils for electronics manufacturers. Temperature, humidity, lighting and sound are carefully controlled for extremely accurate winding of #48 through #56 gauge wire.

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CIRCLE 134 ON READER SERVICE CARD

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JONES BARRIER Terminal Strips

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No. 2-142


No. 2-142-¾ W


No. 2-142-Y

Shown: Screw Terminals—Screw and Solder Terminals—Screw Terminal above, Panel with Solder Terminal below. For every need.

Six series meet every requirement: No. 140, 5-40 screws; No. 141, 6-32 screws; No. 142, 8-32 screws; No. 150, 10-32 screws; No. 151, 12-32 screws; No. 152, ¼-28 screws.

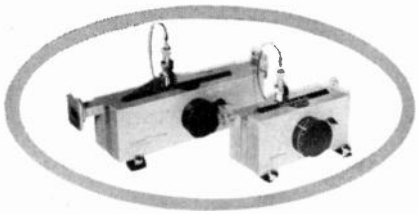
Catalog No. 22 lists complete line.

Jones — HOWARD B. JONES DIVISION
CINCH MANUFACTURING COMPANY
CHICAGO 24, ILLINOIS
DIVISION OF UNITED-CARR FASTENER CORP.

CIRCLE 135 ON READER SERVICE CARD

STANDING WAVE DETECTORS

—exceptionally accurate



You get the accuracy that results from perfect parallelism between slot and waveguide axis... between probe travel and waveguide axis. Only 30 seconds needed to equip a D-B slotted line to measure adjacent frequency bands. Range: 5.8 KMC to 140 KMC—covered by a *minimum* of units, to stretch your budget. Literature on request.

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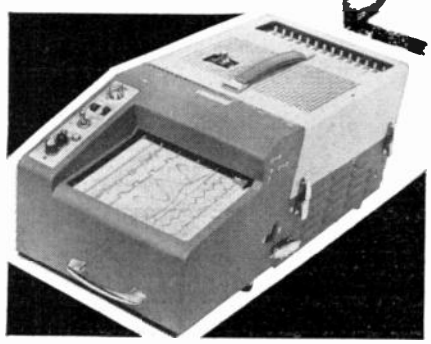
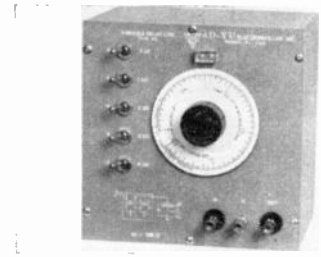


CIRCLE 103 ON READER SERVICE CARD

ton and a mechanical programmer completes the operation in from 1 to 6 minutes, depending on stem size, and number of lead wires. In sequence, the programming steps are: preheat; heat; first press; push up; second press; fire polish; anneal.

CIRCLE 327 ON READER SERVICE CARD



Delay Lines
variable type

AD-YU ELECTRONICS LAB., INC., 249-259 Terhune Ave., Passaic, N. J. Type 611a series consists of a continuously variable delay line serving as a fine control for time variation of which the smallest incremental time delay that can be achieved is less than 0.08 millimicrosec, and a step variable delay line serving as the coarse control with total delay up to 32 μsec. Type 611b series consists of a 12-position tapped delay line and a step delay line with total delay up to 32 μsec. The tapped delay line is used as a fine control and the step is used as coarse control.

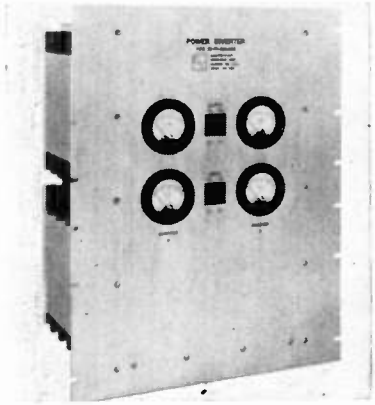
CIRCLE 328 ON READER SERVICE CARD

Shielding Beads
expanded line

FERROXCUBE CORP. OF AMERICA Saugerties, N. Y., has expanded its line of single and multiple hole shielding beads to provide a wider range of parameters for use in h-f communications, radar and microwave circuits. Included in engineering sample kit SBC-1, now being offered at $10, are 4 different sizes

of shielding beads, an epoxy potted choke core utilizing 3 shielding beads and a representative cross-section of ferrite threaded cores and multi-hole choke cores for miscellaneous circuit work.

CIRCLE 329 ON READER SERVICE CARD



Power Inverter transistorized

ELECTRODYNAMIC INSTRUMENT CORP., 2508 Tangley Road, Houston 5, Texas. A 2 kw d-c/a-c inverter will supply a 2 kva output or two 1 kva outputs of 120 v, 60 or 400 cps, single phase from an 11-14 v d-c or 22-32 v d-c source. Frequency stability is ± 0.01 percent. Efficiency at full load is about 85 percent. Solid-state circuit design throughout eliminates the need for standby power or warm-up time.

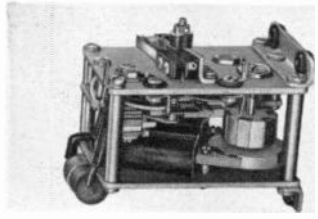
CIRCLE 330 ON READER SERVICE CARD

High-Vacuum Pumps small, compact

ULTEK CORP., 920 Commercial St., Palo Alto, Calif. Series 110 UlteVac high-vacuum pumps are designed for use as permanent appendages on large electron tubes, and are also suitable for miscellaneous types of industrial and laboratory applications such as maintaining high vacuum in vacuum-jacketed vessels. They are used on special-purpose tubes to extend cathode life by re-

moving micro amounts of gas liberated during operation. They pump 0.7 liter per sec. Pump unit and accompanying magnet together weigh 1.6 lb, and the magnet is 2 in. o-d.

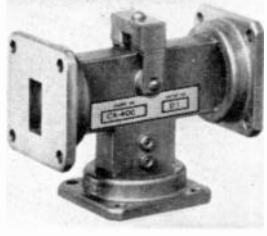
CIRCLE 331 ON READER SERVICE CARD



D-C Motors improved design

AMGLO CORP., 4325 No. Ravenswood Ave., Chicago 13, Ill. Constant speed d-c motors and timers have been improved in design to provide high accuracy of speed even with wide voltage and load fluctuations. They provide a dependable means for controlling circuits from a battery or other d-c power supply. With operating voltage ranging from 3 to 110 v, d-c and 0.06 to 2 w input, torque up to 150 in. oz can be produced at 1 rpm. Suitable speed from 900 rpm to 1 rev in 24 hr or more can be provided.

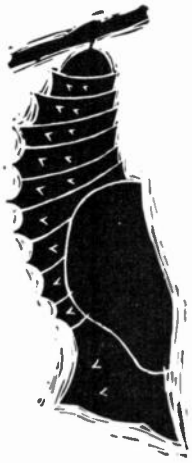
CIRCLE 332 ON READER SERVICE CARD



Tee Circulator compact unit

RANTEC CORP., Calabasas, Calif. The CX400 tee circulator is a compact, broad band, 3 port device, having 15 db isolation and 0.4 db insertion loss over the frequency range 9.1-9.9 kmc. In the band center the insertion loss is approximately 0.1 db making the unit very useful for maser and parametric amplifier applications. Unit is rated at 1 kw peak, 100 w average power. The specifications are applicable over the range −55 C to +72 C. Circulator is 3.1 in. long, and weighs ¾ lb.

CIRCLE 333 ON READER SERVICE CARD



METAMORPHOSIS

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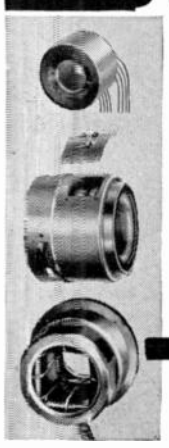

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CIRCLE 107 ON READER SERVICE CARD

Literature of

P-C QUALITY CONTROL. Bureau of Engraving, Inc., Industrial Division, 500 S. Fourth St., Minneapolis 15, Minn., has published a 36-page AF approved technical manual entitled "Quality Control Manual for Printed Circuit Boards and Board Assemblies." It may be obtained by writing on company letterhead.

INDUSTRIAL RECTIFIERS. Ferkin Engineering Corp., 345 Kansas St., El Segundo, Calif. An illustrated six-page technical paper on semi-conductor industrial rectifiers is now available free upon letterhead request.

SILICONE RUBBER COMPOUNDS. General Electric Co., Waterford, N. Y. Product and application data on the complete family of RTV (room temperature vulcanizing) silicone rubber compounds is available in a 12-page bulletin, GDS-170A.

CIRCLE NO. 375 READER SERVICE CARD

UNIVERSAL LINEAR OPERATOR. George A. Philbrick Researches, Inc., 285 Columbus Ave., Boston 16, Mass., has released a 4-page folder on the model K5-U universal linear operator, a new building block of analog computing systems.

CIRCLE NO. 376 READER SERVICE CARD

HERMETIC CONNECTORS. The Deutsch Co., Municipal Airport Banning, Calif. How to install hermetic connectors is described in Technical Notes P & PM No 60-2.

CIRCLE NO. 377 READER SERVICE CARD

PRECISION POTS. Maurey Instrument Corp., 7924 S. Exchange Ave., Chicago 17, Ill., has available a complete catalog of single turn, wire-wound precision pots from ½ in. diameter to 3 in. diameter.

CIRCLE NO. 378 READER SERVICE CARD

DYNAMIC ENVIRONMENT CONTROL. Barry Controls, Inc., 700 Pleasant St., Watertown 72, Mass. A bulletin describes the company's capabilities for the solution to many problems in the fields of shock, vibration and noise. Request copies on letterhead only.

the Week

METER-RELAY. Assembly Products Inc., Chesterland, Ohio. A new continuous reading meter-relay which shows the signal level even while control circuits are energized, is described in 4-page bulletin S-2.

CIRCLE NO. 379 READER SERVICE CARD

RELAYS. The Amerelay Corp., 130 County Courthouse Road, New Hyde Park, N. Y. Form A-101MM is a two-color catalog page on Dualseal microminiature case relays.

CIRCLE NO. 380 READER SERVICE CARD

SERVOMOTORS. Helipot Division of Beckman Instruments, Inc., 2500 Fullerton Road, Fullerton, Calif. Comprehensive details of the company's size 15 servomotors are contained in a 16-page catalog.

CIRCLE NO. 381 READER SERVICE CARD

VACUUM THERMOCOUPLES. Vacuum Products Inc., 19 Beechwood Ave., Mt. Vernon, N. Y., has published a bulletin listing specifications, applications and prices for a line of vacuum thermocouples.

CIRCLE NO. 382 READER SERVICE CARD

SUBMINIATURE FUSES. Littelfuse Inc., 1865 Miner St., Des Plaines, Ill. A 4-color catalog page illustrates and gives complete technical information on subminiature fuses known as Microfuse.

CIRCLE NO. 383 READER SERVICE CARD

THERMAL TIME DELAY RELAYS. Ortron Electronics Corp., Orange, N. J. Catalog No. 100 contains a complete line of economical as well as quality commercial and military thermal time delay relays.

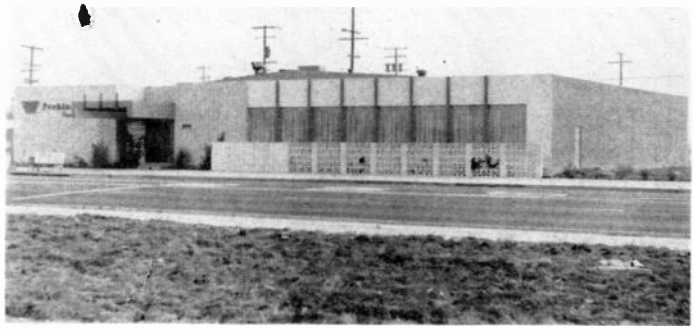
CIRCLE NO. 384 READER SERVICE CARD

RESISTORS. Tech-Ohm Resistor Corp., 36-11 33rd St., Long Island City 6, N. Y., announces availability of the 1959-60 edition of its resistor catalog.

CIRCLE NO. 385 READER SERVICE CARD

MINIATURE CONNECTORS. H. H. Buggie Division, Burndy Corp., Box 817, Toledo 1, Ohio. A new catalog specification insert features Buggie Bantam electronic connectors.

CIRCLE NO. 386 READER SERVICE CARD



P-E Opens R&D Facilities

PERKIN-ELMER CORP. recently opened advanced research and development facilities in a 15,000-sq-ft plant in Los Angeles to serve defense and space industries in 11 western states. The new operation makes available to that area the 22-year-old Connecticut firm's broad experience in precision optics, electronics, digital circuits, computers and systems.

Initial plans call for a staff of about 100 scientists, engineers and other personnel within a year.

Leslie J. Cook, formerly a member of the senior staff at Thompson Ramo Wooldridge, has joined Perkin-Elmer as manager of the new operation. He says the west coast operation is equipped to undertake: (1) work involving electronic-mechanical-optical systems and equipment; (2) medium and smaller contracts and subcontracts for R&D projects relating to systems and equipment for missiles and aircraft; and (3) application of modern scientific developments to problems outside the normal range of interest of companies specializing in missile and aircraft work. The last of these would include the use of infrared devices for weapons of limited warfare, specialized commercial systems and the like.

A. D. Kurtz Joins Kulite

ANTHONY D. KURTZ was recently appointed general manager and executive vice president of Kulite Semiconductor Products, Inc., Ridgefield, N. J. He will be responsible for research, development, and production activities in semiconductor materials and devices.

For the past three years Kurtz has been director of research of the Semiconductor Division of Minneapolis-Honeywell Regulator Co. Prior to joining Honeywell, he was associated with Clevite Transistor Products as senior engineer in charge of diffused device development.

Name Maccallum Sales Manager

SKYDYNE INC., Port Jervis, N. Y., has promoted William F. Maccallum to the position of sales manager. He has served the company in different capacities for over 15 years, starting in the purchasing department, eventually becoming director of purchases and then assistant sales manager.

Burton Board Elects President

THE BOARD OF DIRECTORS of the Burton Mfg. Co., Santa Monica, Calif., has named William J. Miller president. He was the president of TransElectronic Inc., Canoga Park, Calif., a wholly-owned subsidiary of Burton.

In his new capacity, Miller assumes charge of all Burton's divisions and subsidiaries.

Appoint Brown To New Post

MALCOLM F. BROWN, JR. has been named to the newly-created post of assistant to the vice-president of engineering by Resdel Engineering Corp., Pasadena, Calif.

Prior to joining Resdel, Brown was Chief, Ballistic Missile Office, Los Angeles Ordnance District. He has also served in project and production engineering capacities with Beckman Instruments, Helipot and Rutishauser Corp.

Resdel designs and manufactures advanced instrumentation systems and subsystems for missiles and space vehicles.

Elect Campbell Operations V-P

ELECTION of Richard A. Campbell as vice president in charge of op-

Jack Carroll

Managing Editor, **electronics**
Holds Partial Staff Meeting

Resumé:

Carroll, John M., (seated in photo) Lehigh University, BS, Hofstra College, MA in Physics, member several I.R.E. committees. Naval electronics, World War II. Electronics engineering officer during Korean war. Background in engineering derives from experience with the National Bureau of Standards, Naval Research Laboratories, Liberty Aircraft, American Instrument Co. Author of technical books for McGraw-Hill Book Company.

Present Occupation:

Jack Carroll is responsible for "getting-out-the-book" each week within the framework of editorial policy formed by W. W. MacDonald, Editor of **electronics.** Jack is occupied with editorial makeup, with the accuracy of editorial content, with scheduling the workload of a 26-editor staff to provide maximum coverage of technical developments and business information.

References:

Jack is a dedicated man—dedicated to the interests of the readers of **electronics** magazine. His prime goal is to help edit a publication which will be required reading for the important people in the electronics industry – a publication that will fill the needs of design-research, production, management. If you are not receiving the publication that is edited to keep you best informed, if you are not a subscriber, or if your subscription is expiring, fill in the box on the Reader Service Card. Easy to use. Postage is free.

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erations of Pacific Semiconductors, Inc., Culver City, Calif., has been announced. He succeeds Warrer B. Hayes, who joins the PSI parent company, Thompson Ramo Wooldridge, as assistant for new enterprises to Dean E. Wooldridge, president.

Campbell, who has served as manager of the engineering department since 1956 and has been associated with PSI since its inception in 1954, will be responsible for engineering, manufacturing, reliability and sales department functions.

IRE Announces 1960 Awards

HARADEN PRATT, former telecommunications advisor to the President, and Harry Nyquist, former Bell Telephone Laboratories scientist, are among those named to receive IRE awards in 1960. Presentation of the awards will take place at the 1960 IRE International Convention banquet next March 23 at the Waldorf-Astoria Hotel in New York City.

Pratt, secretary of the IRE and consulting engineer, will receive the 1960 Founders Award "for outstanding contributions to the radio engineering profession and to the IRE through wise and courageous leadership in the planning and administration of technical developments which have greatly increased the impact of electronics on the public welfare."

Nyquist, also a consulting engineer, will receive the 1960 Medal of Honor, the highest annual technical award in the field of electronics. He will be given the award "for fundamental contributions to a quantitative understanding of thermal noise, data transmission and negative feedback."

Four additional awards wil be given as follows:

1960 Morris Liebmann Memorial Prize Award, to J. A. Rajchman of RCA Labs "for contributions to the development of magnetic devices for information processing."

1960 Browder J. Thompson Memorial Prize Award, to J. W. Gewartowski of Bell Labs, for his paper entitled "Velocity and Current Distributions in the Spent

Beam of the Backward-Wave Oscillator" which appeared in the October 1958 issue of IRE Transactions on Electron Devices.

1960 Harry Diamond Memorial Award, to K. A. Norton of National Bureau of Standards "for contributions to the understanding of radio wave propagation."

1960 W. R. G. Baker Award, to E. J. Nalos of General Electric Co., for his paper entitled "A Hybrid Type Traveling-Wave Tube for High-Power Pulsed Amplification" which appeared in the July 1958 issue of the IRE Transactions on Electron Devices.

EIMC Appoints R. L. Paullus

RICHARD L. PAULLUS, manager of the Western Electronic Manufacturers Association (WEMA), has been appointed electronics research officer, Electronics Investment Management Corporation, San Diego, Calif. He will join EIMC January 1, 1960, and will make his office in Los Angeles.

Prior to joining WEMA, Paullus was secretary-manager of the Electronics Committee, Los Angeles Chamber of Commerce.

News of Reps

North Atlantic Industries, Inc., Westbury, N. Y., names **Stanley Enterprises**, Seattle, Wash., as regional rep for its northwest sales territory. Stanley will service Washington, Oregon, Idaho and Montana, and will cover both industrial and government facilities in these states for North Atlantic's complete line of airborne ground support and laboratory instruments and instrument systems.

Valpey Crystal Corp., Holliston, Mass., has named **Long and Associates** of Redwood City, Calif., sales rep for its line of quartz crystals, temperature control ovens, packaged oscillators and precision optics. Territory to be covered includes northern California, western Nevada and Hawaii.

COMMENT

Retaining Rings

We received our copy of the November 20 issue of ELECTRONICS . . . and should like you to know how tremendously pleased everyone here is with Howard Roberts' article on retaining rings ("How Rings Aid Design," p 88, Nov. 20). The presentation is extremely handsome —you are to be complimented for a truly fine job . . .

We hope to prepare reprints of the article for distribution to our representatives, distributors, and others who may have interest in the material . . .

LEN KIRSCH
WALDES KOHINOOR INC.
LONG ISLAND CITY, N. Y.

More Grammar

U. L. Upson's letter (Comment, p 139, Nov. 13) is praiseworthy in intent but unfortunately incorrect in detail. Both of the uses of *comprise* to which he refers are correct, on the authority of *Webster's New International Dictionary:*

"*comprise:* 3a. To consist of or be made up of; as, 'his family *comprises* five sons'; 3b. To make up or constitute; as, 'the chapters that *comprise* Part One.'"

ALAN SOBEL
POLYTECHNIC INSTITUTE OF BROOKLYN
BROOKLYN, N. Y.

The dictionary's function is historical; that is, to record standard usage, whether good or bad. It is not an authority except in this sense. One of the editor's prime functions is normative; that is, to exert a controlling influence on usage. While definition 3b may be in current usage, we will still try to preserve the original sense, which, as we remarked on Nov. 13, is related to "comprehend."

Underwater Dangers

You have carried stories about damage done to transatlantic cables, allegedly accidentally, by Soviet trawlers. You have also carried article after article about

Soviet advances in oceanography.

Surely you can put two and two together. If the Soviets (as you also have reported) are building up their submarine fleet, then it all fits together. On the one hand, they have an enormous and capable submarine fleet—200 or more ships, some nuclear, some missile-armed. They are also conducting a research program to map the ocean floor, giving them sure knowledge of topography so that they will know whence to strike and where to hide. We know they monitor the cable that connects Jupiter, Fla., to Puerto Rico; we can be certain that they know the location of every link in the Caesar chain.

And no doubt they are now monitoring the Western Union and AT&T cables. Multiconnector cables are difficult to monitor without going in on the cable; but it would be a simple matter to break the cable, patch in a repeater box and monitor station, then drop the bugged rig and break the cable again a couple of miles down. It could be done in an hour, and by the time the Coast Guard and repair crews got there, the trawler could be standing innocently by the new break, sheepishly (or arrogantly, as the case may be) apologizing for an accident.

Meanwhile, with the red herring having successfully worked, the security of all our transatlantic traffic may be being broached—including such State and Defense Department traffic as passes over the cables.

Besides, all this activity in oceanography will make it very simple—if an emergency does arise—to interrupt the cables and cut us off from the world.

It all adds up to one thing: danger.

LEIGH SANDERS

NEW YORK CITY

The same idea occurred to us at the time of the cable breaks, and we passed it quietly along to the Navy. Whether the Navy took it seriously we don't know; whether danger is the sum of all these facts we also don't know. Anyway, we trust that the Keepers of the Powder Magazine are keeping our powder dry.

EXPLORE NEW AREAS AT IBM IN RESEARCH AND DEVELOPMENT OF SEMICONDUCTORS

IBM's explorations in the semiconductor field include theoretical and experimental studies in basic semiconductor science as well as development of advanced devices and technologies. In one current research project, for example, a better physical understanding of the origin of the negative resistance characteristic of the Esaki diode is being sought. At the same time, development engineers are exploring applications of this device and have already produced a new solid state oscillator of exceptional simplicity in the 3,000 megacycle range. To date, this represents the deepest incursion into the microwave region via semiconductor electronics. In another project, an NPN double-diffused high-speed drift transistor has been developed that will greatly accelerate logical switching and high-power core driving. Both exploratory investigation and development of these and related electronic devices are expanding at a rapid pace at IBM. To further these programs, well-qualified specialists are required for all areas of device exploration.

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1P21	30.00	6C4W	2.50	398A/5603	4.50	5639	2.50
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1P28	13.50	C6J	9.00	403A/6SK5	1.00	5643	2.50
2AP1A	2.50	6J4	1.00	403B/5591	2.50	5644	2.50
2BP1	4.50	6J6W	.60	404A/5847	10.00	5646	2.00
2C36	25.00	6L6WGA	2.50	408A/6028	2.50	5647	2.50
2C39A	7.50	6L6WGB	2.00	409A/6AS6	2.00	5651	.75
2C39B	16.50	6SJ7WGT	1.25	416A	50.00	5654/6AK5W	1.25
2C40	7.50	6SL7WGT	1.25	417A/5842	10.00	5656	4.00
2C43	7.50	6SN7WGT	.75	418A	15.00	5670	1.25
2C50	4.25	6V6GTY	.60	420A/5755	7.50	5672	1.25
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2C52	1.75	6X5WGT	1.35	422A	8.50	5676	.65
2D21	.50	7MP7	17.50	429A	8.50	5678	1.10
2D21W	.85	12DP7	7.50	GL-434A	5.00	5684/C3J/A	12.50
2E22	3.00	FG-17	3.85	450TH	35.00	5686	2.00
2E24	2.25	HK-24	1.25	450TL	45.00	5687	1.50
2E26	3.35	26Z5W	1.50	575A	15.00	5691	5.25
2J51	50.00	35T	4.75	578	5.00	5692	4.25
2K25	8.00	35TG	1.75	631-P1	4.00	5693	3.75
2K26	30.00	FG-57	5.00	673	15.00	5703	1.00
2K29	25.00	FG-67	5.00	676	27.50	5704	1.00
2K30	50.00	BL-75	5.00	677	27.50	5718	1.00
2K33A	150.00	FG-95	13.00	715C	7.50	5719	1.00
2K34	85.00	100TH	9.00	719A	6.50	5721	125.00
2K35	150.00	FG-105	25.00	721B	4.00	5725/6AS6W	1.25
2K41	60.00	FG-172	17.50	723A/B	3.00	5726/6AL5W	.85
2K42	125.00	HF-200	15.00	725A	3.50	5727/2D21W	1.25
2K44	100.00	212E	25.00	726B	3.50	5740/FP-54	50.00
2K45	30.00	231D	1.50	726C	7.00	5744	.75
2K47	85.00	244A	5.00	750TL	50.00	5749/6BA6W	.75
2K50	50.00	245A	3.50	803	1.50	5750/6BE6W	1.50
2X2A	.85	249B	5.00	804	15.00	5751/12AX7W	1.50
3AP1	1.00	249C	5.00	805	3.00	5763	1.35
3B24W	3.00	250R	5.00	807	1.20	5777	150.00
3B25	3.00	252A	6.00	807W	.85	5783	2.25
3B28	3.00	254A	2.00	809	3.75	5784	3.00
3C22	25.00	257A	3.50	810	12.50	5787	3.00
3C23	5.75	259A	2.75	811	3.50	5794	3.75
3C24/24G	2.00	262B	3.00	813	8.50	5800	4.00
3C45	4.00	264C	3.50	814	1.00	5801	3.00
3D22	12.50	267B	5.00	815	1.50	5803	2.00
3E29	5.00	271A	10.00	816	1.75	5814A	1.50
3J21	25.00	272A	3.00	828	7.50	5824	1.85
3J31	35.00	274A	3.50	829B	7.50	5828	3.00
3K21	125.00	275A	4.00	832	3.00	5829	.60
3K22	125.00	283A	3.00	832A	6.50	5829WA	1.20
3K27	150.00	287A	2.00	833A	40.00	5837	67.50
3K30	75.00	QK-288	150.00	836	1.25	5839	3.00
3KP1	10.00	293A	4.50	837	1.00	5840	2.00
4-125A	25.00	HF-300	25.00	845	7.50	5841	2.25
4-400A	40.00	300B	6.50	866A	1.50	5844	.75
4B31	17.50	304TH	25.00	866 JR	1.25	5851	3.25
4C35	17.50	304TL	35.00	872A	1.75	5852	2.85
4E27	9.50	310A	4.75	884	1.00	5854	.85
4J52	25.00	311A	3.00	885	.85	5876	6.00
4X150A	6.75	313C	1.50	889RA	75.00	5879	1.00
4X250B	32.50	323A	6.50	913	7.50	5881/6L6WGB	2.00
5BP1A	9.75	328A	3.00	918	.75	5886	3.85
5C22	15.00	329A	5.00	927	.85	5894	17.50
5CP1A	9.75	336A	3.00	931A	3.50	5896	1.85
5LP1	6.75	337A	2.50	959	.65	5899A	2.75
5R4GY	1.00	339A	5.00	1000T	100.00	5902	2.50
5R4WGY	2.00	347A	2.50	1500T	120.00	5903	6.00
						5915	.75
						5930/2A3W	3.75
						5932/6L6WGA	2.50
						5933/807W	1.00
						5948/1754	75.00
						5956	12.50
						5963	.75
						5964	.90
						5965	.75
						5967	7.50
						5969	7.50
						5975	2.00
						5977/6K4A	1.50
						5981/5650	20.00
						5987	6.50
						5992	3.00
						5993	4.00
						6004	.60
						6005/6AQ5W	1.35
						6021	2.00
						6032	10.00
						6037/QK-243	20.00
						6045	1.35
						6062	1.35
						6072	2.25
						6073	.85
						6080	3.25
						6080WA	4.50
						6087/5Y3WGTB	3.00
						6097	1.25
						6098/6AR6WA	4.00
						6099	.80
						6100/6C4WA	1.35
						6101/6J6WA	1.15
						6106	1.00
						6111	2.75
						6112	2.75
						6115/QK-351	45.00
						6130/3C45	5.00
						6134/6AC7WA	3.25
						6135	1.50
						6136/6AU6WA	1.50
						6136/6SK7WA	1.50
						6146	3.90
						6151	3.50
						6152	4.50
						6177	50.00
						6186/6AG5WA	2.00
						6189/12AU7WA	2.00
						6197	1.75
						6199	30.00
						6201/12AT7WA	2.25
						6202/6X4WA	1.75
						6211	.65
						6236	150.00
						6247	6.00
						6263	12.50
						6264	10.00
						6265	2.50
						6282/BL-11	65.00
						6336	10.00
						6350	1.35
						6352	6.00
						6386	5.00
						6390	125.00
						6438	4.75
						6463	1.25
						6482	9.50
						6517	200.00
						6626/OA2WA	2.50
						6627/OB2WA	2.50
						6754	15.00
						6897	16.50
						8013A	3.00
						8020	1.25

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INDEX TO ADVERTISERS

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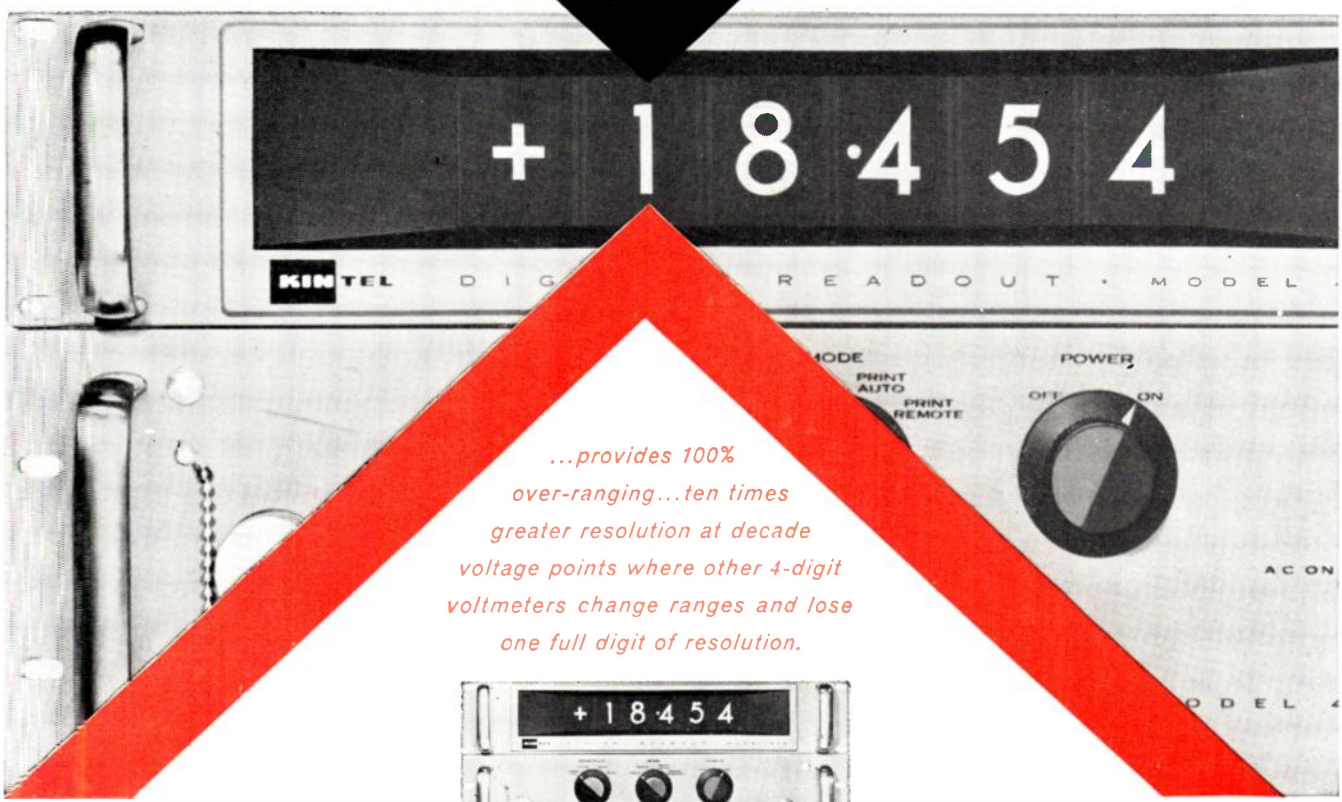
CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

ADVERTISERS INDEX

● See advertisement in the June, 1959 Mid-Month ELECTRONICS BUYERS' GUIDE for complete line of products or services.

This Index and Reader Service Numbers are published as a service. Every precaution is taken to make them accurate, but ELECTRONICS assumes no responsibilities for errors or omissions.

This unique "extra" fifth digit...



...provides 100% over-ranging...ten times greater resolution at decade voltage points where other 4-digit voltmeters change ranges and lose one full digit of resolution.

The KIN TEL Model 501 4-digit, over-ranging digital voltmeter measures DC from ±0.0001 to ±1000.0 volts with 0.01% ±1 digit (of reading) accuracy. An extra fifth digit in the left decade indicates "0" or "1" to provide ten times greater resolution at decade (1, 10, 100) voltage points than standard 4-digit voltmeters. Ranging and polarity indication are entirely automatic. The measured voltage, decimal point and polarity symbol are displayed on an in-line readout in a single plane–no superimposed outlines of "off" digits.

An adjustable sensitivity control permits decreasing sensitivity to allow measurement of noisy signals. Ten-line, parallel input printers can be driven directly, and converters are available for driving other types of printers, typewriters, and card or tape punches. The input may be floated up to 25 volts DC above or below chassis ground with no degradation in performance, and up to 250 volts DC with slight decrease in accuracy. Stepping-switch drive coils are energized with DC as in telephone-type service to provide long, trouble-free operation.

The 501 is one of a complete line of KIN TEL digital instruments. Others include AC converters, AC and DC preamplifiers, ratiometers, and multi-channel input scanners.

IMPORTANT SPECIFICATIONS

Display...Six decades display 5 digits (Left digit "0" or "1" only), decimal point, polarity symbol. Ranging and polarity indication are automatic. Projection system readout employs bayonet-base lamps with 3000-hour minimum life rating. Readout contains no electronic circuitry and can be remotely mounted.

Automatic Ranges...±0.0001 to ±1000.0 volts DC in four ranges: 0.0001 to 1.9999; 02.000 to 19.999; 020.00 to 199.99; 0200.0 to 1000.0

Accuracy...0.01% ±1 digit (of reading).

Input Impedance...10 megohms on all ranges at null.

Reference Voltage...Chopper-stabilized supply, continuously and automatically referenced to standard cell.

Stepping-Switch Drive...DC voltage within stepping-switch manufacturers rating applied by transistor drive circuit at rate of approximately 20 steps per second.

Controls...Three: on-off; sensitivity; and mode of operation (standby, normal, print auto, print remote).

Printer Drive...Built-in for parallel input printers. Automatic or remote.

Dimensions and Net Weights...Control unit: 45 lbs, 5¼"H x 19"W x 16"D. Readout: 10 lbs, 3½"H x 19"W x 9"D.

Price: $2995

KIN TEL manufactures electronic instruments for measurement and control, and closed circuit TV. Representatives in all major cities. Write for detailed literature or demonstration.

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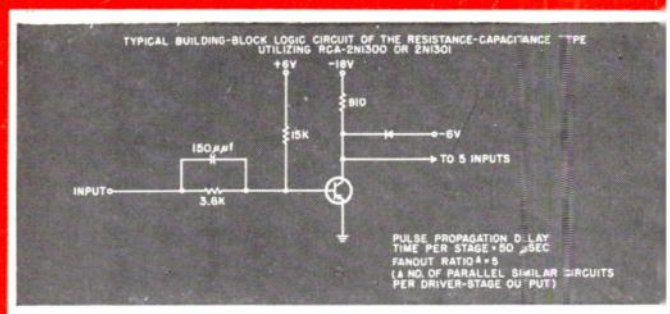
MESA

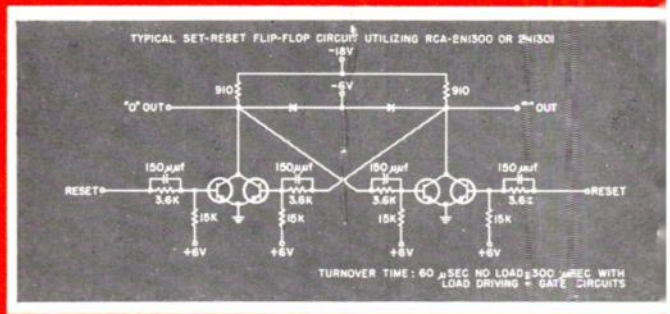
COMPUTER TRANSISTORS

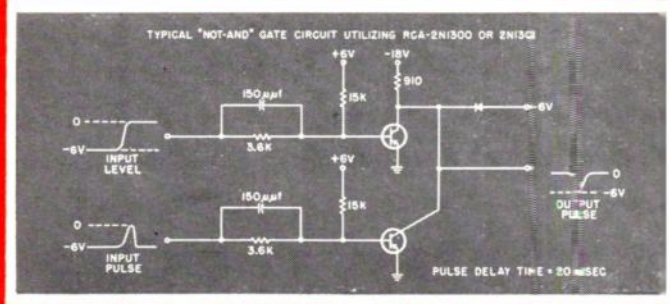
2N1300 · 2N1301

feature

HIGH POWER DISSIPATION
FAST-SWITCHING TIMES
AT LOW COST







RCA TYPE	Maximum Ratings—Absolute-Maximum Values							Characteristics: Common-Emitter Circuit, Base Input—Ambient Temperature = 25°C		
	Collector-to-Base Volts	Collector-to-Emitter Volts	Emitter-to-Base Volts	Collector Ma.	Transistor Dissipation Milliwatts			Minimum DC Current Transfer Ratio		Gain-Bandwidth Product▲ Mc
					at 25°C	at 55°C	at 71°C	at collector ma = −10	at collector ma = −40	
2N1300	−13	−12	−1	−100	150	75	35	30	—	40
2N1301	−13	−12	−4	−100	150	75	35	30	40	60

▲For collector ma = −10 and collector-to-emitter volts = −3

RCA's Germanium P-N-P Mesa Transistors 2N1300 and 2N1301 combine low-cost and quantity availability with these major benefits for designers of switching circuits:

- high power dissipation—150 milliwatts maximum at 25°C, 75 milliwatts maximum at 55°C
- fast switching times—made possible by high frequency response and low total stored charge
- rugged Mesa structure—with an extremely small base width to insure top performance at high frequencies
- high current transfer ratio—permits high fanout ratios (number of paralleled similar circuits per driver-stage output)
- high breakdown-voltage and punch-through voltage ratings—result of the diffusion process
- high current ratings—improves overall system speed
- especially well suited for use at pulse repetition rates up to 10 Mc
- rugged overall design—units have unusual capabilities to withstand severe drop tests and electrical overloads
- electrical uniformity—a result of the diffused-junction process used by RCA in the manufacture of Mesa Transistors

Contact your RCA Field Representative for prices and delivery. For technical data, see your HB-10 Semiconductor Products Handbook, or write RCA Commercial Engineering, Section L-19-NN2, Somerville, N. J.

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