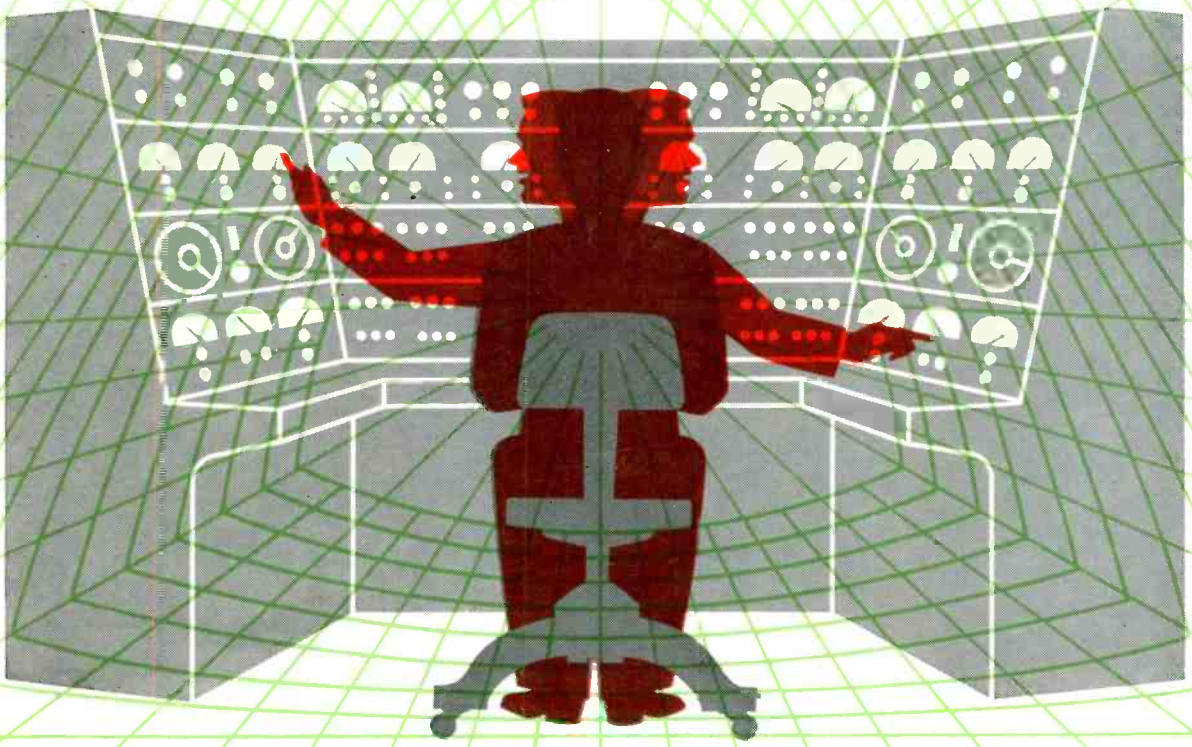
ELECTRONIC INDUSTRIES

A CHILTON PUBLICATION

Another New EI Special Staff Report!

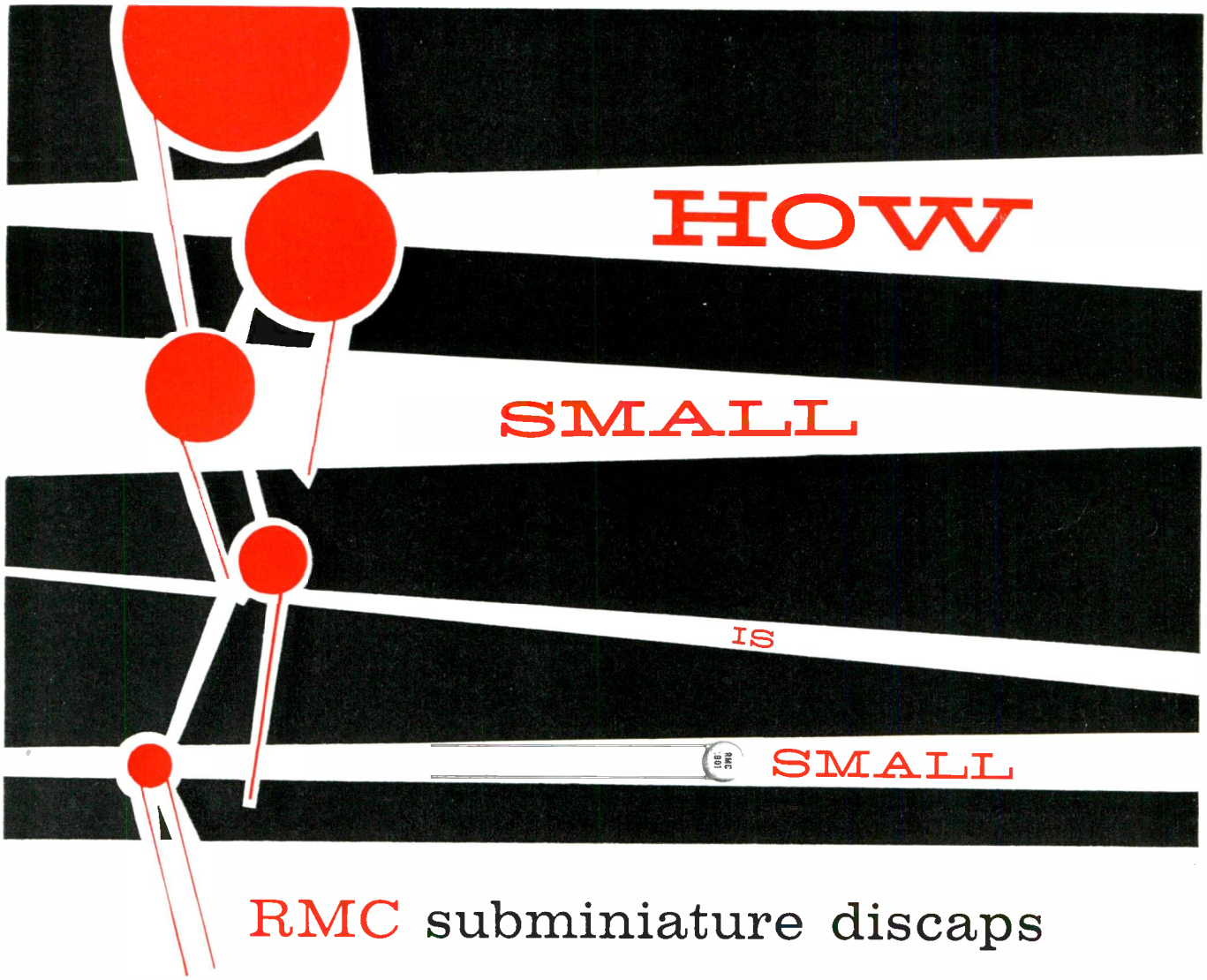
"HUMAN FACTORS"

— In Engineering Design . . . . . See page 85



- Digital Computing Systems For Process Control — *See page 70*

February
1960



RMC subminiature discaps

SPECIFICATIONS

POWER FACTOR: 1.5% Max. @ 1 KC (initial)
WORKING VOLTAGE: 500 V.D.C.
TEST VOLTAGE (FLASH): 1000 V.D.C.
LEADS: No. 22 tinned copper (.026 dia.)
INSULATION: Durez phenolic (1/8" max. on leads)—vacuum waxed
STAMPING: RMC—Capacity—Z5U
INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms
AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms

Small is a relative term and at RMC subminiature better describes Type SM DISCAPS. These DISCAPS meet the specs of EIA-RS-198 for Z5U ceramic capacitors and are available as described in the table below. Type SM DISCAPS show minimum capacity change between +10°C and +65°C.

Capacity	Max. Dia.	Max. Lead Len.	Meas. Between Leads	Tolerance
.800	.235	1½"	.150	GMV
.001	.235	1½"	.150	GMV
.0015	.285	1½"	.250	GMV
.005	.390	1½"	.250	±20% +80% −20%
.01	.510	1½"	.375	±20% +80% −20%
.02	.675	1½"	.375	+80% −20%

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RMC

RADIO MATERIALS COMPANY
A DIVISION OF P. R. MALLORY & CO., INC.
GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.
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ELECTRONIC INDUSTRIES

ROBERT E. McKENNA, Publisher • BERNARD F. OSBAHR, Editor

Outlooks and Reviews

LAST year, in the January issue editorial, we called attention to the excellent report issued by the Electronics Division of the Business and Defense Services Administration of the U. S. Department of Commerce. This report, entitled "Electronic Industries-Outlook for 1959 and Review of 1958," contained a wealth of statistical information that would interest all electronic marketing managers.

The new report "Electronic Industries-Outlook for 1960 and Review of 1959" has just been issued. Again, another exemplary statistical review! In the main, the overall figures in this report tend to agree with information published in our last month's annual review issue. The new report is eight pages long with four more pages of tabular data.

We were surprised to learn that this information would be made available to interested parties upon written request. We suggest that all electronic marketing managers avail themselves of this opportunity.

Our recent investigations also uncovered the fact that the Business & Defense Services Administration, U. S. Department of Commerce, Washington 25, D. C. is now issuing some 88 similar reports in other fields. Some of these are of direct interest to electronic marketing. Others have only an indirect interest, while the remainder have little or no significance. Nevertheless, in the interest of completeness and of keeping EI's marketing readers fully informed, we are listing below a complete list of "Outlook for 1960 and Review of 1959" reports currently available:

We'd recommend keeping this list handy as a good starting reference for analyzing new electronic equipment markets for consumer, commercial and industrial applications. Our market research department will also maintain a complete file of reports in our Philadelphia headquarters for reader reference purposes.

1. Air Conditioning and Refrigeration Equipment
2. Alkalis and Chlorine
3. Aluminum
4. Aluminum Foil Packaging
5. Anti-Friction Bearing
6. Automobile
7. Boating
8. Bookkeeping and Accounting Machines
9. Book Publishing
10. Cast Iron Soil Pipe and Fittings
11. Chemical and Allied Products
12. Chemical Fertilizer
13. Commercial Central Station Protective Signaling
14. Commercial Printing
15. Communications Equipment
16 Construction
17. Construction Machinery and Equipment
18. Converted Flexible Packaging Products
19. Copper
20. Cotton Broad Woven Goods
21. Dairy Plant Equipment
22. Domestic Record Communications (Telegraph)
23. Domestic Telephone Communications
24. Electrical Construction Material
25. Electrical Equipment
26. Electrical Transmission and Distribution Equipment
27. Electronic Industries
28. Farm Machinery & Equipment
29. Ferroalloy
30. Ferrous Castings
31. Fibre Box
32. Flat Glass
33. Folding Carton
34. Food and Beverage
35. Freight Car
36. Games and Toys
37. Gas Turbine
38. Glass Container
39. Hand Tools
40. Hides and Skins
41. Household Appliance
42. Household Furniture
43. Hydraulic Turbines
44. Industrial Gases
45. Integral Horsepower Motors
46. International Telephone & Telegraph Communications
47. Iron and Steel
48. Jewelry
49. Large Diesel Engine
50. Lead
51. Leather
52. Lumber
53. Machine Tool Industry (Metal Cutting & Forming Types)
54. Magnesium
55. Man Made Fibre Broad Woven Goods
56. Material Handling Equipment
57. Men's and Boys' Clothing
58. Metal Can
59. Mining Machinery
60. Motion Picture
61. Newspaper Publishing
62. Nickel
63. Oil Field Equipment & Machinery
64. Paper and Board
65. Paper Bag
66. Paper Shipping Sack
67. Periodical Publishing
68. Photographic Products
69. Plastics Materials
70. Power Boiler
71. Pressed and Blown Glassware
72. Printing Trades Machinery
73. Pulp and Paper Machinery
74. Pumps, Compressors, Fans and Blowers
75. Scientific and Process Control Instruments
76. Shoes
77. Softwood Plywood
78. Steam Turbine
79. Steel Forging
80. Steel Shipping Container
81. Sulfuric Acid
82. Table Flatware and Holloware
83. Tantalum and Columbium
84. Textile Machinery
85. Titanium
86. Truck and Truck Trailer
87. Warm Air Furnace
88. Woolen and Worsted Manufacturing
89. Zinc

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ELECTRONIC INDUSTRIES, February, 1960. Vol. 19, No. 2. A monthly publication of Chilton Company, Executive, Editorial & Advertising offices at Chestnut & 56th Sts., Phila. 39, Pa. Accepted as controlled circulation publication at Phila., Pa. $1 a copy; Directory issue (June), $5.00 a copy. Subscription rates U. S. and U. S. Possessions: 1 yr. $10.00; 2 yrs. $18.00 Canada 1 year, $12.00; 2 yrs. $20.00. All other countries 1 yr. $18.00; 2 yrs. $30.00.

ELECTRONIC INDUSTRIES

Vol. 19, No. 2 February, 1960

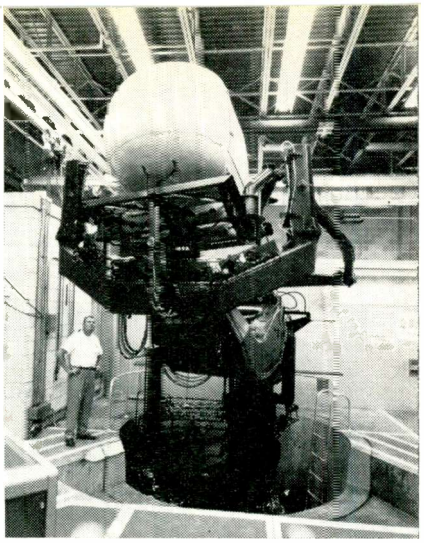
MONTHLY NEWS ROUND-UP

NEW PRODUCTS & TECH DATA

DEPARTMENTS

BPA NBP

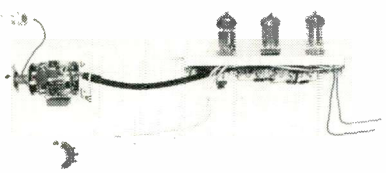
Highlights of this issue



Human Engineering

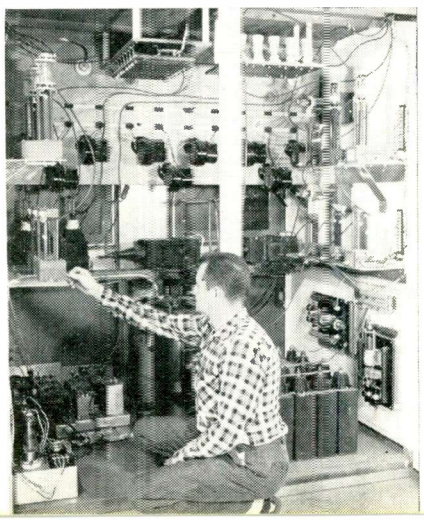
General-Purpose Computers

TPR Recording

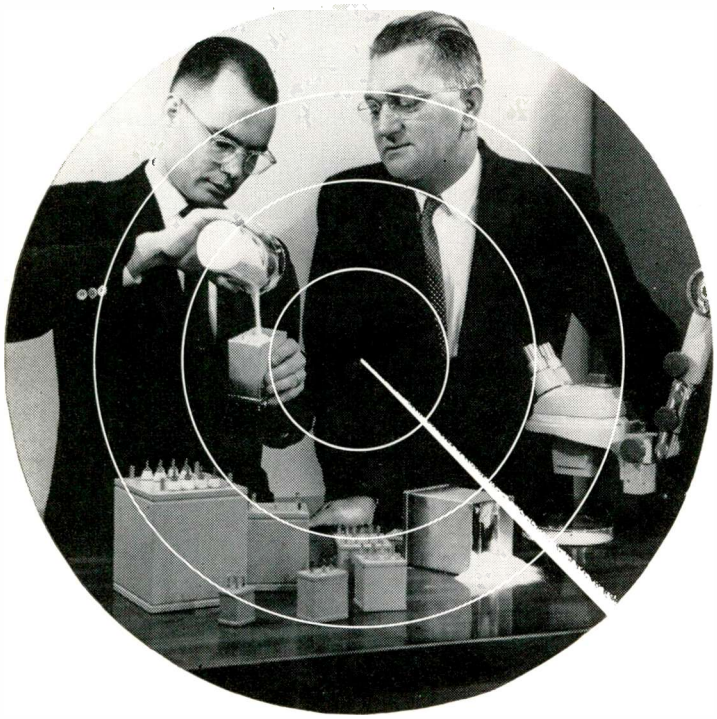


Trigger Circuits

100 KW Transmitter



RADARSCOPE



DE-POTTING SIMPLIFIED

At Bell Labs powdered alumina (aluminum oxide) is poured into container housing electronic component by R. S. Key and L. W. Kirkwood. Alumina acts as potting agent, protecting against humidity. When part is to be repaired, powder is poured out.

ANTI-SUB ELECTRONICS is one of the more lucrative fields of detection apparatus. Two hundred million dollars has been voted for ASW electronics for the fiscal year of 1960. The biggest chunk is going to sonar. Shipboard radar and magnetic anomaly detection are getting the next largest allocations.

FM IS FINALLY making the big leap, after so many disheartening false starts. In the past year FM commercial authorizations have climbed from about 690 to 825. Some 665 stations are now on the air as compared with 570 a year ago.

SEMICONDUCTOR AGREEMENT has been signed by Philco and CBS Electronics. CBS will set up two production lines to make Philco precision etched transistors this spring. CBS will market them independently.

VACUUM TUBE IMPORTS have raised an additional problem—how to determine the source of origin. There is some thought that imports should be marked indelibly with the country of origin. The Canadians already have made this a matter of law. An amendment that took effect on December 1, 1959 added electron tubes to the list of items that have to be marked with the country of origin.

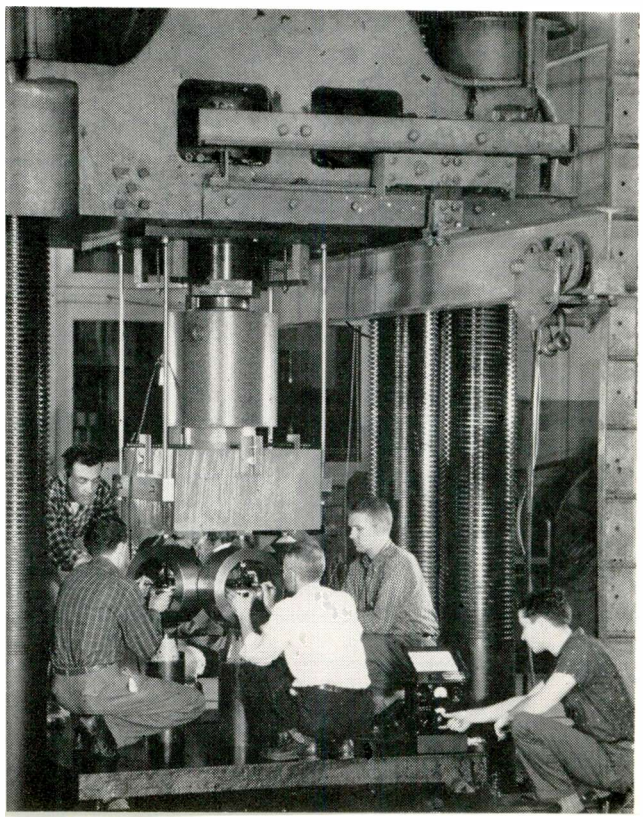
AIR COLLISIONS can be avoided with the air navigation devices available now, if suitable data-smoothing techniques are used, says the Naval Research Lab. Use of coding and redundancy would allow many aircraft to exchange data very reliably on a radio frequency channel. Reports on a recent study of the problem are contained in "Some Probability Aspects of the Aircraft Collision Problem," by U. S. Naval Research Lab, available from Office of Technical Services, U. S. Dept. of Commerce.

23-IN. PICTURE TUBES will spearhead 1960 TV sales, predicts Admiral's Ross Siragusa.

NEW MASER of titanium dioxide, or rutile, makes higher frequency operation possible. They are being explored separately by MIT and RCA. At MIT a rutile maser, pumped by a 70 KMC klystron, amplified signal frequencies from 26 to 40 KMC. The gain bandwidth product was 10 to 40 MC. Input saturation power was 10 millimicrowatts. RCA used chromium-doped, and then iron-doped, titanium dioxide maser, operating at frequencies up to 23 KMC.

FOR ROCKET TESTING

Calibrating the 1,500,000-lb. capacity load cell (vertical cylinder) at National Bureau of Standards. The cell will be used in tests of a 1,500,000-lb. thrust rocket engine now under development at the Rocketdyne Div. North American Aviation, Inc.



30,000,000 WORDS/SEC can be transmitted with new systems developed by Sperry Gyroscope Co. First applications are expected to be in special communications systems. Eventually they will be applied to computers. One of the components is a microwave diode switch capable of switching 700,000,000 bits of information per second.

CITIZENS RADIO is only a little over a year old, but it is already finding itself in trouble. There have been so many violations that the FCC is considering more rigid specifications on equipment. Surveys show that well over half of the licensees of Class D citizens radio are violating the regulations in some way; either by exceeding the 10-mi. distance limitation, being off frequency, or overmodulating their signal. Most unhappy are the equipment manufacturers. If the FCC restrictions or requirements for their equipment become more elaborate, prices must rise as well, putting more and more of the equipment beyond the reach of the average user.

LOW COST FM RECEIVERS are flooding the market. And they are not only Japanese. A number of American manufacturers have units selling in the $20 to $25 range, both tuners and complete receivers. Sarkes Tarzian, marketing a $19.95 FM receiver, is trying to interest FM stations in filling the role of a retail outlet. The idea makes sense, because both parties have similar aims. Sarkes Tarzian wants to sell receivers and the FM stations want to enlarge their audience. Cheap, readily available receivers could be a happy solution.

ELECTRONIC IMPORTS were up more than 250% in 1959 compared with 1958. Exports declined slightly. The rise is chiefly due to the increased shipments of radio receivers from Japan. Japanese shipments of radio receivers of all types to the U. S. have climbed from 641,000 in 1957 to almost 5½ million in 1959. In dollars this represents 5.3 million in '57 against 50 million in '59. From the United Kingdom the U. S. is importing more than twice as much as it is exporting. The only area of U. S. exports that is increasing is radio and TV broadcast equipment, which is up approximately 65%, largely in TV studio equipment.

EPOXY RESINS are finding increasing use in laminated plastics. Dr. Norman A. Skow, Technical Director of Synthane Corp., predicts, "Epoxies will not replace phenolics but they may eventually surpass phenolic laminates in production volume. Epoxies now open the door to usages not previously thought possible for laminated plastics." Epoxies are offering superior electrical and mechanical properties under conditions of humidity and dampness.

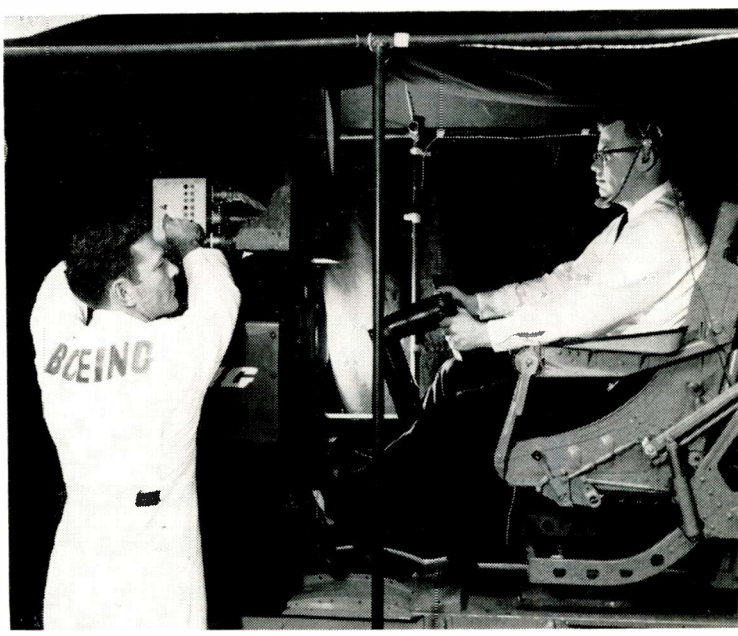
SIMULTANEOUS BROADCAST of two or more independent transmissions on different wavelength can be made by a new shortwave radio transmitter developed by Marconi. Service on one frequency can be put on a second frequency before discontinuance on the first frequency. Transmitter uses a distributing amplifier dispensing with tuning controls. There is no complex stage-by-stage retuning of amplifiers to change frequency. One application seen is ground-to-air communications.

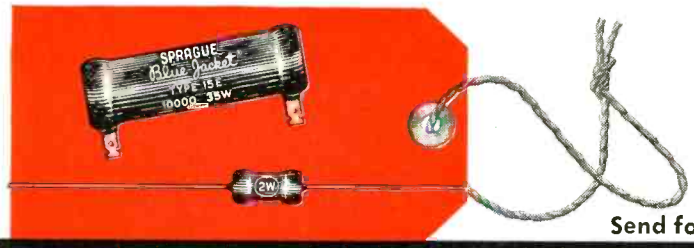
NEW TV FILM TECHNIQUE developed by Kodak Research Laboratories allows a standard 35-mm projector to be used for television use. The method changes the film "pull down" sequence of movie projector so that the projector can be used with Vidicon TV storage tubes. Conversion is less expensive than more complex systems for showing standard 35-mm films on TV. Unit prevents flicker in televised movie, since film "pull down" is synchronized with vidicon tube.

COMPUTER SALES will depend largely on the manufacturers' ability to develop systems tailored to the needs of individual customers. This was the message delivered to more than 200 representatives of electronic companies at a recent EIA marketing conference in New York. The conference participants were warned that the "piece meal" approach to marketing computers will create operating chaos for businesses seeking to progress through automation.

FLIGHT SIMULATION

Flight simulator is integrated with electronic analog computer and equipment test mockup at Boeing Wichita, Kans. plant. It enables Boeing research engineers to determine both dynamic and pilot reaction characteristics during critical maneuver conditions.





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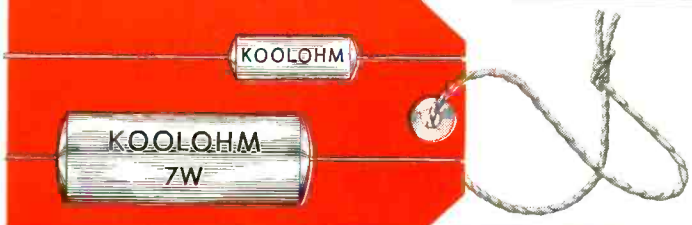

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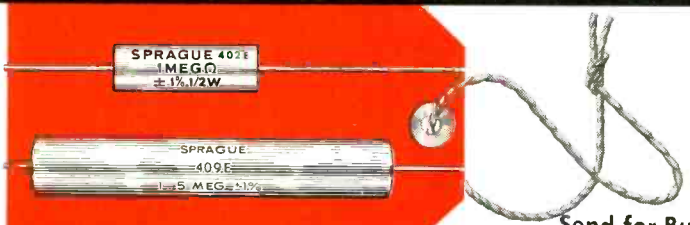

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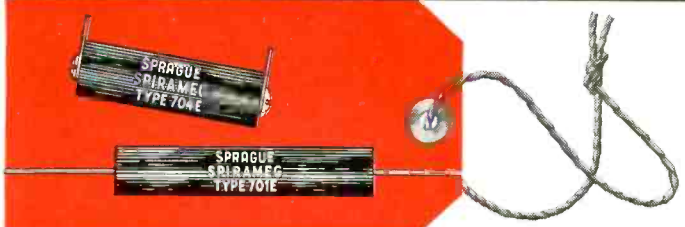

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As We Go To Press . . .

Report on Binary Color TV System

A special EIA subcommittee studying color picture concepts advanced by Dr. Edwin H. Land, head of the Polaroid Corp., has turned in its report. They recommend that he, and others, be encouraged to continue their basic studies, but that the FCC color TV signal be left unchanged at this time.

The subcommittee stated that the FCC signal "permits continued investigation of Dr. Land's method without deterioration of pictures reproduced by receivers making full use of the information present in the signal." The FCC color signal "carries simultaneously the information for three-color reproduction and for methods outlined by Dr. Land" and "does not result in a large increase in the cost of receivers."

3 Dimensional X-Ray Checks Out Missiles

A simple method that allows three dimensional study of x-ray films to find faulty parts of missiles and space vehicles before launch has been perfected.

Engineers at Convair, producer of the Atlas, take two x-ray films of each component from different angles. The films are studied using two modified x-ray film viewers and a mirror system which produces a stereo-like view.

HOURLY RATES

Scientific and engineering organizations can now rent time by-the-hour on International Business Machines Corp. 709 computers at Datacenters in midtown New York and Poughkeepsie, N. Y. Users supply their own programmers and operators. The system can handle up to 42,000 additions per second. Multiplications are 5,000 per sec.

HIGH LEVEL PHOTOS

Radar and aerial cameras carried by this huge, 2 million ft³ balloon photographed the earth's surface from over 100,000 ft. The flight, conducted by Goodyear Aircraft Corp., assisted by General Mills technicians, was part of an Air Research and Development Command research program. Engineers will study the aerial radar photographs in evaluating the characteristics of radar at stratospheric altitudes.

Men Replace Machines in New Defense System

A new system of air defense control, developed by Boeing Airplane Co., uses men instead of machines. Called "MANTRAC" for Manual Tracking Capability, the system provides an accurate, economical method of tracking hostile airborne weapons in areas where the highly developed SAGE system or other electronic systems are not available.

MANTRAC uses simple mathematical triangulation, with positions plotted on a large plexiglas map. The map is criss-crossed with lines and lettering separating and identifying zones in the area. Plotters plot the direction of attacking aircraft on separate plexiglas panels which can be rolled into position behind the main map. The plane's position is determined by intersecting lines.

Teamwork and practice are essential to this operation and a system of electronic "war gaming" has been devised in which one part of the group serves as an attacking force and the other operates the MANTRAC system.

Experimental 3-D TV Shown In Chicago

Westinghouse Electric Corp. demonstrated an experimental three-dimensional TV at the recent Home Furnishings Show in Chicago.

The 3-D TV requires two cameras equipped with Westinghouse's "Permachon" tube. Each camera stores and transmits separate images which appear side-by-side on the receiver tube.

The viewer uses a pair of polarized glasses to get the three-dimensional effect.

Westinghouse also demonstrated a Civil Defense, two-band radio equipped with an automatic radiation detector, and a portable TV set powered by a thermoelectric generator. The thermoelectric generator is powered by a butane gas flame.

Warning Network To Aid in Rescue Work

The Office of Civil and Defense Mobilization's National Warning System (NAWAS) has been ordered to assist military and civil authorities in rescue operations for downed aircraft. The system has already been used for this purpose on three different occasions.

The NAWAS net has 276 warning points from coast to coast. It maintains round - the - clock readiness to flash warning of the approach of hostile craft.

FOR EXCEPTIONAL SERVICE

Top Honorary Dept. of Defense medal was presented to Wladimir A. Reichel (center) chief of basic design for Norden Div., United Aircraft Corp. James H. Wakelin, Asst. Secretary of the Navy (left) presented the medal. Vice Admiral John T. Hayward, Deputy Chief of Naval Operations looks on.

ELECTRONIC SHORTS

▸ Naval research lab has developed ferromagnetic waveguide dummy loads for radar bands that can operate at all temperatures up to the present military limits.

▸ The Federal Aviation Agency is reorganizing its Bureau of Research and Development. The new structure has 10 divisions—5 program and 5 staff divisions. Program divisions are concerned with research and development of new FAA systems. Staff divisions advise and assist the director of the bureau.

▸ Emerson Radio & Phonograph Corp. demonstrated new high and low altimetry techniques for the Navy Dept. The demonstrations are in the art of absolute radar altimetry from touchdown to maximum operating altitudes. Discussions included applications like navigation of aircraft and missiles, parachute release devices, drone control, and scoring systems.

▸ The "prime detector" in the Navy's high-altitude balloon observations of the planet Venus, which yielded evidence of water vapor and the possibility of life on Earth's nearest planetary neighbor, was a multiplier photo tube developed by ITT Corp.

▸ A portable water purification and demineralization system for use with supersonic aircraft has been delivered to the Air Force. The F-105 uses water injection to get an extra ton of thrust on initial take-off. The unit, built by Republic Aviation Corp., will be used as ground support equipment for the F-105 Thunderchief, now in service with TAC. The demineralizer is designed for use at "austere sites" where water needs must be supplied from rivers, streams, or swamps.

▸ The new Army-developed material, gallium phosphide, may solve the heat barrier problem faced by electronic parts in nose cones of missiles. It has been used in a diode which has withstood temperatures seven times higher than silicon and germanium. One projected use is in building solar-cell power plants for space stations.

▸ The General Services Administration is selling a Government-owned industrial property near Huntington, West Virginia. The building had been used to build electronic devices for the Navy and is still equipped for electronic production. The plant has approx. 140,000 feet of factory space.

▸ Teflon insulated wire is being color coded with a new technique that uses rapid evaporation of a duPont solvent to stabilize coating inks so they will not migrate. With the new process, developed by Spectra-Strip Wire & Cable Corp., uncolored wire can be stocked and coded almost any color at the point of use.

▸ The EIA has approved "in concept" Department of Defense Instruction 3232.7—"Uniform Technical Documentation for Use in Provisioning End Items of Material." The EIA Spare Parts Committee said that "the instruction has encouraged some agencies of the military services to expand documentation requirements," although the opposite effect had been anticipated.

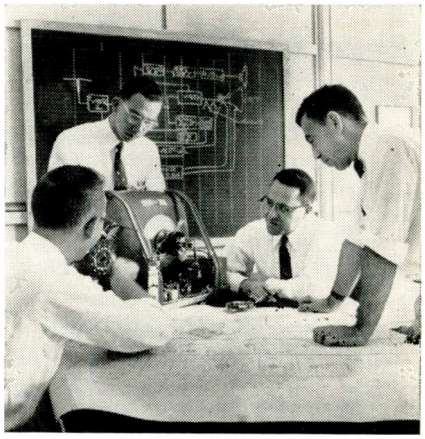
▸ Infrared detecting cells of indium antimonide will be produced on a pilot line basis under a contract awarded Lansdale Tube Co. by Manufacturing Methods Div. of Air Materiel Command's Aeronautical Systems Center.

▸ Missile and satellite fasteners made from the nearest thing to an antigravity structural metal yet developed will be produced in a new Exotic Metals Laboratory just opened by Standard Pressed Steel Co., Jenkintown, Pa. The $100,000 pilot plant operation is the first in the fastener industry to fabricate featherweight beryllium—one-fourth the weight of steel and currently more costly than gold—into threaded parts.

▸ The Navy has turned to electronic data processing to keep track of its weapons and ammunition in shore bases and ships located around the world. The Navy's RCA 501 system will become a chief logistics aid to the newly established Bureau of Naval Weapons.

As We Go To Press (cont.)

CHANNEL SELECTOR



Westinghouse Electric Co. engineers work on development of new TV channel selector. The Company's forecast for TV sales during 1960 emphasized that the basic consumer demand was still for well-operating TV sets that look nice. Gimmicks, the Company says, are secondary factors, especially if they increase the cost.

More for Defense Dollar Seminar

A seminar of top-level representatives of the country's defense administration, military services, Congress, and industry is being arranged in Washington. They will meet to develop specific proposals for giving taxpayers more defense per dollar.

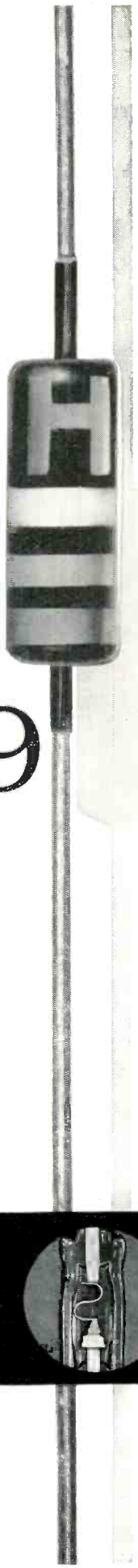
The seminar will be held March 15 in the Statler-Hilton Hotel. It is expected to be attended by several hundred persons from government and industry with responsibility for marketing and planning in the defense area. Seminar will precede EIA's Spring Conference March 16-17 which will feature the association's annual Government-Industry Dinner March 17. The seminar is being sponsored by EIA's Military Products Div. under the chairmanship of Sidney R. Curtis, Sr., Vice President of Stromberg-Carlson.

WESCON Deadline

Papers for the 1960 Western Electronic Show and Convention technical sessions should be registered by May 1. Complete texts (or detailed summaries) plus 100-200 word abstracts should be sent to: Chairman of the Technical Program, Richard G. Leitner, WESCON Business Office, 1435 South La Cienega Blvd., Los Angeles 35, Calif. WESCON, 1960 is August 23-26.

4 day delivery: Fused Silicon Diodes

1N645 1N646 1N647 1N648 1N649



Hughes now offers you immediate delivery on five medium power fused silicon glass diodes—types 1N645, 1N646, 1N647, 1N648, and 1N649.

These Hughes diodes feature a Dumet-stud heat sink for small size and the popular Hughes glass package for proven reliability. Widely used in power supplies, magnetic amplifiers and similar circuits, these Hughes diodes are specially designed to meet the severe environmental requirements of such military equipment as missile telemetering links, airborne radar, and communication gear.

For immediate delivery of these Hughes diodes write, wire or phone the Hughes distributor or Semiconductor Division Sales Office nearest you...or write Hughes Semiconductor Division, Marketing Dept., Newport Beach, California.

Specifications

Type	Max. Working Voltage	Min. Forward Current @ specified voltage*	Max. Reverse Current at working voltage* (μA)	DC Current Io (μA)
1N645	225V	400 mA @ 1.0V	.2	400
1N646	300V	400 mA @ 1.0V	.2	400
1N647	400V	400 mA @ 1.0V	.2	400
1N648	500V	400 mA @ 1.0V	.2	400
1N649	600V	400 mA @ 1.0V	.2	400

* @ 25° C

SEMICONDUCTOR DIVISION

the West's leader in advanced ELECTRONICS

HUGHES PRODUCTS

Resolution up to 800 lines per diameter possible with new HUGHES flat-face TONOTRON® Tubes!

These newest products of HUGHES are especially designed to give you dramatically improved resolution in applications such as: shipborne and ground based radar, sonar, air traffic control, instrumentation, industrial TV, and many others.

HUGHES flat-face storage tubes, now available in quantity, enable you to increase display capability by a factor of 4. Display readouts are easier and more accurate because of the new picture clarity, sharper focus and finer detail provided by the optically-flat face and high light output of these new TONOTRON® Tubes from HUGHES.

Write today for full information and engineering assistance on your applications: HUGHES, Vacuum Tube Products Division, International Airport Station, Los Angeles 45, California. For export information, please write: **Hughes International,** *Culver City, California.*

FEATURES:

- Axial writing gun
- Electrostatic focusing
- Electromagnetic deflection
- P20 aluminized phosphor

Creating a new world with ELECTRONICS

HUGHES

VACUUM TUBE PRODUCTS DIVISION

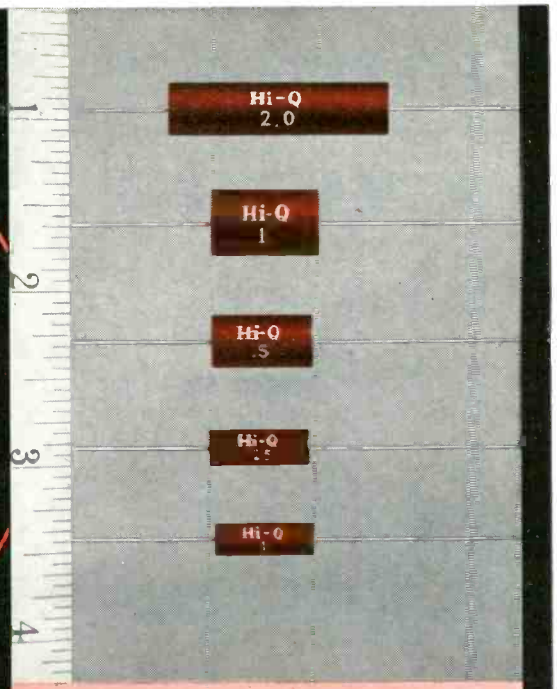
FIRST 7" & 10" FLAT-FACE STORAGE TUBES

another FIRST from HUGHES!

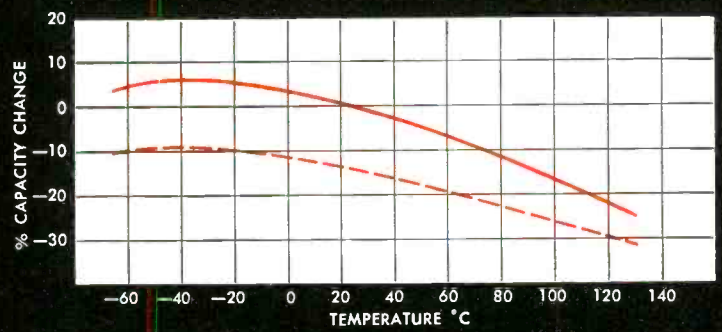
An entirely NEW concept in ceramic capacitors

CEROL*

HIGH CAPACITY HIGH RELIABILITY ROLLED CERAMIC CAPACITORS*



TYPICAL CEROL CAPACITOR TEMPERATURE CHARACTERISTIC TYPE CL 90



Specifications for Cerol Capacitors, Type CL90

Part Number	Cap. Mfd.	D Max. in.	L Max. in.
CL90V104AM	.1	.210	.690
CL90V254AM	.25	.260	.690
CL90V504AM	.5	.350	.690
CL90V105AM	1.0	.480	.690
CL90V205AM	2.0	.400	1.44

Cap. Tol. = ±20%
P.F. = 2% Max.
T.C. (0 Voltage) = +15% −25% over temperature range of −55°C. to 125°C.
T.C. (100 V. applied) = +15% −35%
Working Voltage = 100 VDC at 85°C. derate to 50 VDC at 125°C.
Test Voltage = 300 VDC
Insulation Resistance = 100 Meg.—Mfd. minimum
Series Resistance < .25 ohms at 8 to 10 mc.
Other requirements per MIL-C-11015B
Leads axial #22 gauge 1½" ±⅛" long

New from Hi-Q . . . a major breakthrough in the design and construction of ceramic capacitors that provides extremely high capacity ceramic units in ranges previously unattainable. CEROL capacitors are rolled ceramic capacitors in the high capacitance range of paper and plastic film dielectrics but in much smaller physical sizes and with superior electrical characteristics.

Designed for general applications in bypass-coupling, filtering and blocking circuits, CEROL capacitors offer excellent electrical characteristics for critical applications in decoupling and pulse circuits where low series resistance at high frequencies together with extremely miniature sizes are required. The extremely low series resistance of CEROL capacitors makes them ideal for computer applications.

CEROL capacitors are currently available in capacitance ratings of .1, .25, .5, 1.0 and 2.0 mfd for operation at 100 VDC at temperatures between −55°C to 85° and at 50 VDC up to 125°C. Capable of withstanding severe environmental conditions CEROL capacitors will meet or surpass all the applicable requirements of MIL-C-11015B.

Write today for detailed information on these remarkable new capacitors to . . .

Hi-Q® DIVISION

*TRADE MARK

AEROVOX CORPORATION

OLEAN, NEW YORK

Coming Events in the electronic industry

A listing of meetings, conferences, shows, etc., occurring during the period January-March that are of special interest to electronic engineers

Jan. 31-Feb. 5: Winter General Meeting, AIEE; Hotel Statler-Hilton, New York City.

Feb. 1-4: Instrument - Automation Conf. and Exhibits, Instrument Society of America; Sam Houston Coliseum and Rice Hotel, Houston, Tex.

Feb. 1-4: 2nd Southwest Heating & Air-Conditioning Exposition, American Soc. of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; Memorial Auditorium, Dallas, Tex.

Feb. 1-5: Committee Week, American Soc. for Testing Materials; The Sherman Hotel, Chicago, Ill.

Feb. 2: The Handling of Radioactive Samples for Emission Spectroscopy and Spectroscopic Properties of Photographic Emulsions, Society for Applied Spectroscopy; New Yorker Hotel, New York City.

Feb. 3-4: 6th Annual Midwest Welding Conference, Armour Research Foundation, American Welding Society; Illinois Institute of Technology, Chicago, Ill.

Feb. 3-5: Winter Meeting, IRE (PGMIL); Biltmore Hotel, Los Angeles, Calif.

Feb. 4: Seminar — Automation and Your Production Program, ASTE; Detroit, Mich.

Feb. 5-6: Industrial Management Engineering Conf., Illinois Institute of Technology; Illinois Institute of Technology, Chicago, Ill.

Feb. 10-12: Solid State Circuits Conf., AIEE, IRE, Univ. of Pennsylvania; University of Pennsylvania & Hotel Sheraton, Phila., Pa.

Feb. 11-12: Cleveland Electronics Conf., IRE, AIEE, ISA, Physics Society, Case Institute of Technology, Western Reserve Univ.; Engineering and Scientific Center, Cleveland, Ohio.

Feb. 11-12: Winter Meeting, Relay Committee, Pennsylvania Electric Assoc.; Bellevue - Stratford Hotel, Phila., Pa.

Feb. 11-13: 1st ERA National Convention, Electronic Representatives Assoc.; Drake Hotel, Chicago, Ill.

Feb. 14-18: Annual Meeting, AIME; Hotels Sheraton-McAlpin and Statler-Hilton, New York City.

Feb. 16: Educational Seminar, Assoc. of Electronic Parts & Equipment Manufacturers, Inc.; Niles, Ill.

Feb. 16-18: 1st National Symposium on Nondestructive Testing of Aircraft and Missile Components, Soc. for Nondestructive Testing, Southwest Research Inst.; Hilton Hotel, San Antonio, Tex.

Feb. 18-19: Symposium — Engineering Aspects of Magnetohydro-Dynamics, AIEE (Basic Sciences Committee); Univ. of Pennsylvania, Phila., Pa.

Feb. 18-20: Winter Meeting, National Society of Professional Engineers; Broadview Hotel, Wichita, Kans.

Feb. 18-21: Distributor, Representative, Manufacturer Conf., Electronic Representatives Assoc.; El Mirador Hotel, Palm Springs, Calif.

Feb. 19-23: 3rd International Electronic Parts Show, National Federation of French Electronic Industries, Paris, France.

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

Feb. 22-26: Engineering Materials & Design Exhibition & Conf.; Earls Court, London, England.

Feb. 24: Reliability Symp., American Society for Quality Control, Los Angeles Section; Statler Hilton Hotel, Los Angeles, Calif.

Feb. 24-26: Seminar—Cost Reductions Through Plastic Tooling, ASTE; St. Louis, Mo.

Feb. 25-26: Semi-Annual Meeting, Univac Users Assoc.; Greenbrier Hotel, White Sulphur Springs, West Va.

Feb. 25-26: Scintillation Counter Symposium, IRE, AIEE, AEC, NBS; Washington, D. C.

Mar. 1-2: Seminar—Optical Tooling Methods in Manufacturing, ASTE; Los Angeles, Calif.

Mar. 3-4: Seminar—Metal Forming Methods for Tomorrow's Manufacturing, ASTE; Los Angeles, Calif.

Mar. 4-5: Meeting, The American Physical Society; Houston, Tex.

Mar. 6-9: Gas Turbine Power Conf. & Exhibit, ASME; Rice Hotel, Houston, Tex.

Mar. 8: Annual Meeting, Assoc. of Electronic Parts & Equipment Manufacturers, Inc.; Chicago, Ill.

Mar. 8-9: Seminar—Some Problems of Machining Space Age Metals, ASTE; San Francisco, Calif.

Mar. 8-11: Audio Engineering Soc. Convention; Alexandria Hotel, Los Angeles, Calif.

Mar. 9-11: Temperature Measurement Symposium, ISA; Deshler Hilton Hotel, Columbus, Ohio.

Mar. 9-11: 3rd Navy Science Symposium, "Naval Problems in Electromagnetic Radiation," Office of Naval Research; Naval Ordnance Test Station, Pasadena, Calif.

Mar. 10-11: National Flight Propulsion Meeting (Classified), IAS; Cleveland, Ohio.

Mar. 17-18: Synchro Design and Testing Symposium, U. S. Navy, Bureau of Naval Weapons; Dept. of Commerce Auditorium, Washington 25, D. C.

Mar. 21-24: IRE National Convention, IRE (All PG's); Coliseum & Waldorf Astoria Hotel, New York City.

Mar. 21-24: Meeting, The American Physical Soc.; Detroit, Mich.

Mar. 22: 9th Annual SSB Dinner & Hamfest, SSB Amateur Radio Assoc.; Hotel Statler-Hilton, New York City.

Mar. 23-26: Electrical Industry Show and Lighting Exposition, Electrical Maintenance Engineers Assoc. of Calif.; Shrine Exposition Hall, Los Angeles, Calif.

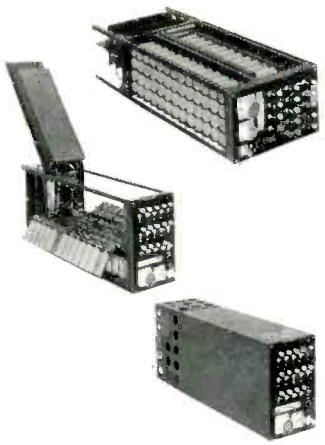
Mar. 29: Spring Meeting, The Material Handling Institute, Inc.; Pittsburgh-Hilton Hotel, Pittsburgh, Pa.

Abbreviations

AEC: Atomic Energy Commission
AIEE: American Institute of Electrical Engineers
ASTE: American Society of Tool Engineers
IAS: Institute of the Aeronautical Sciences
IRE: Institute of Radio Engineers
ISA: Instrument Society of America

FROM SYSTEM SPECS TO BREADBOARD TO FINISHED PRODUCT IN 75 DAYS!

That's the record set by the manufacturer of this complex airborne Time Code Generator — thanks to the compatibility of proven EECO T-Series Circuit Modules and the flexibility of the EECO Breadboard Kit.



Airborne Time Code Generator illustrates high-density packing obtainable with T-Series circuits.

Hinged arrangement of mounting panel facilitates accessibility.

The finished package weighs only 20 lbs.; measures 5" x 8" x 20⅜". Unit generates 14-digit Point Mugu code, modulating a 1 kc carrier plus a dc time code. Three sine wave and four pulse outputs are also provided, all with only 96 T-Series circuits and 77 watts of input power.

Designed and developed for testing the fire control of manned supersonic aircraft under actual flight conditions at altitudes up to 80,000 feet, this Time Code Generator employs T-Series circuits throughout. Required accuracy of 1 part in 10^5 was easily obtained.

HIGH DENSITY, LIGHT WEIGHT

The total package contains 96 T-Series Circuits, 14 filament-type EECO Minisig Indicators, and power converters (the beginning of our line of compact 12-volt EECO Power supplies for use with T-Series circuits) — all within a volume of ½ cubic foot. In spite of this terrific packing density, the equipment still retains extreme ease of accessibility and weighs only 20 lbs. No cooling is required.

T-SERIES VS. VACUUM TUBE CIRCUITS

The use of T-Series transistorized Germanium circuits throughout resulted in great savings as against equivalent equipment designed around vacuum tube circuits. Here are some startling comparisons:

	T-SERIES	VACUUM TUBE
SIZE	800 cu. in.	8,000 cu. in.
WEIGHT	20 lbs. (including power converters)	160 lbs. (plus fan and power supply)
POWER	77 watts	650 watts (plus power for fan)

SAVE TIME AND MONEY

You, too, can develop the most complex equipment in record time with these proven EECO circuits and systems development aids. They'll save you time and money in four major areas:

1. **DESIGN** — You can devote full time to system design problems or unusual circuit requirements, knowing that routine circuit detail has been compatibly pre-engineered and packaged for you.
2. **BREADBOARD** — The unique EECO Breadboard Kit and plastic circuit cards enable you to set up, change, or take down experimental arrangements quickly — without waste of time or materials. Unit contains all necessary permanent wiring to accommodate any regular T-Series circuit. All other circuit interconnections are made by patch cords or plugs, with prepunched circuit cards to guide you.
3. **PRODUCTION** — Your production problem is reduced to one of mounting sockets on panels or chassis and providing simple socket-to-socket wiring. Plug in the appropriate circuits and the system is complete.
4. **CHECKOUT** — The extreme reliability of T-Series circuits eliminates the need for circuit "debugging." Checkout time is reduced to a bare minimum.

Why not let proven EECO T-Series circuits and systems development aids help you solve your equipment design problems?

If you have not already requested your copy of our new Catalog No. 859, write us today on your company letterhead.

ENGINEERED ELECTRONICS Company

ENGINEERED ELECTRONICS COMPANY
(a subsidiary of Electronic Engineering Company of California)
506 East First Street • Santa Ana, California

Look for us at the ISA Instrument-Automation Conference / Houston, Texas, February 1-4

Electronic Industries' News Briefs

Capsule summaries of important happenings in affairs of equipment and component manufacturers

EAST

NORTH HILLS ELECTRIC CO. will soon move into their own newly designed factory-office building in Glen Cove, L. I., N. Y.

REPUBLIC ELECTRONICS, Farmingdale, L. I., N. Y., has just been awarded a $362,000 contract from Army Ordnance Corps, Rossford Arsenal. Contract is for design and production of a portable electronic engine ignition analyzer for use in field maintenance of Army aircraft engines.

METALIZING INDUSTRIES, INC., subsidiary of Accurate Specialties Co., Inc., has located in a plant at 338 Hudson St., Hackensack, N. J. The new subsidiary was formed to produce a complete line of metalized ceramic components. They also have facilities for plating conductive coatings on various materials.

THE GABRIEL CO., Electronics Div., has opened their new $2 million electronics plant in Millis, Mass. The new research-engineering and manufacturing center will employ 275 people and will replace present facilities in Needham Heights, Mass.

TUCOR, INC., has acquired Wiltec Electronics, Inc., of So. Norwalk, Conn. Wiltec manufactures various types of special-purpose gaseous and vacuum miniature and subminiature thyratrons, indicating devices, and other special type of tubes.

PERMACEL, New Brunswick, N. J., is marketing its new Permacel 423 Teflon Film Tape, a two mil Teflon tape with a pressure-sensitive adhesive.

HAZELTINE CORP., Little Neck, N. Y., has received a follow-on contract for 32,000 sonobuoys by the United States Navy. Including repair kits, the contract totals more than $4 million. Hazeltine is currently producing 12,000 sonobuoys for the Navy's anti-submarine warfare program.

ACF INDUSTRIES, INC., Erco Div., has been awarded a $2,732,000 Navy contract for the production of 5 electronic flight and tactics simulators. The simulators are for the Naval Training Device Center, Port Washington, N. Y.

WALTHAM PRECISION INSTRUMENT CO. has purchased the Electric Motor Div. of the Advanced Products Co., North Haven, Conn. This division is being moved to Waltham where it will resume full scale production in the very near future.

TEXTRON ELECTRONICS, Providence, R. I. and **MIDWESTERN INSTRUMENT,** Tulsa, Okla., jointly announced that if Midwestern stockholders consent Textron Electronics will acquire Midwestern for exchange of stock shares.

FILTORS, INC., Port Washington, N. Y., manufacturers of sub and micro-miniature relays, announced that its licensee in Canada, Marsland Engineering Co., is now in volume production of their line of relays under their license agreement.

PHILCO CORP. has awarded a construction contract for their Research Center, to be located on a 25-acre site in Blue Bell, Montgomery County, Pa. The 2-story structure will provide 200,000 sq. ft. of space.

SYLVANIA ELECTRIC PRODUCTS, INC., has announced plans for construction of a multi-million dollar electron tube manufacturing plant in Brookville, Pa. The 100,000 sq. ft. installation will replace 3 existing facilities totaling 60,000 sq. ft. in Brookville.

POLARAD ELECTRONICS CORP. has added 85,000 sq. ft. to its Long Island City facilities to meet the growing demand for its line of industrial microwave instruments. This brings the company's plant area to about 240,000 sq. ft.

UNION CARBIDE CORP., Silicones Div., has placed on sale 2 new type of low shrink silicone rubber stock for cable and wire insulation. The 2 new types are designated K-1347 and K-1357.

U. S. TRANSISTOR CORP., Syosset Industrial Park, L. I., has started production of germanium pnp alloy junction transistors.

LIFSCHULTZ FAST FREIGHT have announced freight reductions in several areas for the handling of electronic equipment.

GENERAL ELECTRIC CO.'s Power Tube Dept. has received an order for ignitrons valued at approximately $2 million. They will be used in 66 rectifier-type electric locomotives ordered by the Pennsylvania Railroad.

RAYTHEON CO.'s Industrial Tube Div. has changed its name to the Industrial Components Div. to reflect an expansion of its product lines. The expansion will be achieved both by building a line of non-microwave electronic components and by broadening the scope of the tube lines.

WESTINGHOUSE ELECTRIC CORP. has been awarded a $15 million contract by Rome Air Material Area to develop a new radar system. The new radar system will be capable of providing 3-dimensional warning information 6 hrs. after air delivery to their sites. Equipment is so designed that a complete system with all auxiliary equipment including heaters, air conditioners, and shelters, can be transported by helicopter.

MID-WEST

AVCO CORP., Crosley Div., has received a $900,000 letter contract for prime research and development to update its ASG-15 fire control system. The contract was let by the U. S. Air Force's Aeronautical Systems Center at Wright-Patterson Air Force Base.

ZENITH RADIO CORP., Chicago, Ill., has begun construction of a new $1,250,000 addition to the company's 1500 N. Kostner Ave. manufacturing plant.

THOMPSON RAMO WOOLDRIDGE INC., has acquired Radio Industries, Inc., producer of transformers used extensively in radio and TV products, and ceramic disc capacitors. Radio Industries, Inc. has their headquarters in Des Plaines, Ill. with other plants in Chicago and Marshall, Ill.

EITEL-McCULLOUGH, INC., manufacturer of Eimac electron-power tubes, has reached an agreement that will make National Electronics, Inc., and Industrial Tubes, Inc., of Geneva, Ill., wholly owned subsidiaries.

HARRIS-INTERTYPE CORP., Cleveland, Ohio, has completed an agreement for the acquisition of Polytechnic Research and Development Co. from the Polytechnic Institute of Brooklyn. The acquisition is the 6th since 1953 for Harris-Intertype.

SEL-REX CORP., Nutley, N. J., has purchased the Meaker Co., Chicago, Ill. The Meaker Co. is a pioneer manufacturer of automatic systems for continuous and batch metal processing or finishing.

WEST

INTERNATIONAL ELECTRONIC RESEARCH CORP., Burbank, Calif., has announced the change of their name of Electronics International Co. to ELIN Div. of International Electronic Research Corp.

SMITH-FLORENCE INC., has organized a new electronics manufacturing corporation, located in the Commodore Industrial Park in Seattle, Wash. It will specialize in precision industrial and laboratory electronic test instruments for the military and commercial markets.

TECHNOLOGY INSTRUMENT CORP. of California has opened a new environmental test laboratory in Newbury Park to serve the electronics, missile and aircraft industries in Southern California.

HUGHES AIRCRAFT CO., Newport Beach, Calif., has announced price reductions of up to 10% on all their pnp fused junction transistors.

LOCKHEED AIRCRAFT CORP. will form a new subsidiary, the Lockheed Electronics Co. Goal of the expansion program is further diversification in electronics. The new corporation will include the recently acquired Stavid Engineering, Inc., and the Lockheed Electronics and Avionics Div. (LEAD).

CONSOLIDATED ELECTRODYNAMICS CORP., DataTape Div., has delivered a magnetic tape recorder/reproducer built to the National Aeronautics and Space Administration to record telemetered data from Project Mercury, the nation's first manned orbital space flight.

TELEMETER MAGNETICS, INC. of Los Angeles, Calif., has been awarded a contract to develop airborne digital programmers for a space exploration vehicle. It was awarded by the Jet Propulsion Laboratory of the California Institute of Technology.

PHOTOCIRCUITS CORP., Glen Cove, N. Y., has started construction of a new plant at Anaheim, Calif. The new half-million-dollar facility will be handy to the West Coast electronic and aviation industries.

FAIRCHILD SEMICONDUCTOR CORP. is expanding its distributor sales program. The distributors will assure off-the-shelf availability of all Fairchild semiconductors. These distributors have been chosen because of their ability to stock the full range of products, the size and activity of their industrial sales force, and their strategic location.

DOUGLAS AIRCRAFT CO., INC., has established the Douglas Computing Service to sell excess computing machine time to other corporations. They have established a scale of hourly rates for each type of machine they have available.

BLAINE ELECTRONETICS, Van Nuys, Calif., has just delivered major antenna equipment to the Douglas Aircraft Co. The equipment will be used by Douglas's El Segundo Div. at their antenna pattern measurement range.

AUTONETICS, div. of North American Aviation, Inc., has received a $350,000 contract from the Air Force. Contract is for an inertial guidance system of the type produced for the Navy's Polaris subs. This system will be used to improve tracking of the Army's Pershing missile during missile test flights.

Good anywhere in or out of this world

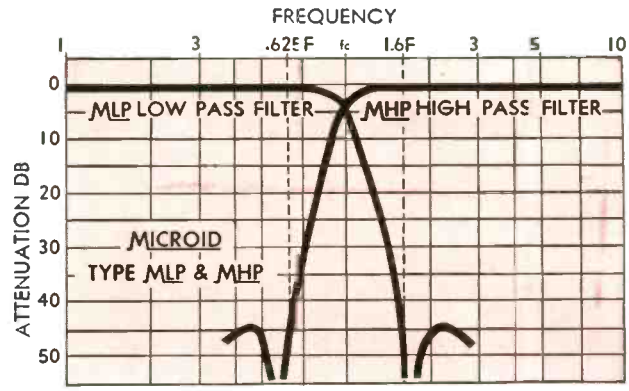
This system adds greatly to your credit when applied to the development of communications, telemetering, control and other devices. Under terms of membership, a wide range of toroids, filters and related networks are available. These include a complete line of inductors, low pass, high pass and band pass filters employing the new micro-miniature *MICROID* ® coils so valuable in transistorized circuitry. Type *MLP* and *MHP MICROIDS* are micro-miniature counterparts of the popular Burnell types TCL and TCH low pass and high pass filters. The band pass filter results when cascading a TCL with a TCH filter.

Sizes of MLP and MHP MICROIDS

400 cps to 1.9 kcs — 11/16 x 1 15/16 x 1/2
2 kcs to 4.9 kcs — 11/16 x 1 5/8 x 1/2
5 kcs and up — 5/8 x 15/16 x 1/2

Weight of all MLP and MHP Microids—approx. .3 ozs. each

Send now for your free membership card in the Space Shrinkers Club. And if you don't already have our Catalogue #104 describing Burnell's full line of toroids, filters, and related networks, please ask for it.



Note: First informal meeting of Club members will be held in Burnell Booths 2919-2921 during the IRE Show, New York Coliseum, March 21-24. See you there.

Burnell & Co., Inc.
PIONEERS IN microminiaturization OF
TOROIDS, FILTERS AND RELATED NETWORKS

EASTERN DIVISION
DEPT. I-29
10 PELHAM PARKWAY
PELHAM, N. Y.
PELHAM 8-5000
TELETYPE: PELHAM 3633

PACIFIC DIVISION
DEPT. I-29
720 MISSION ST.
SOUTH PASADENA, CAL.
MURRAY 2-2841
TELETYPE: PASACAL 7573

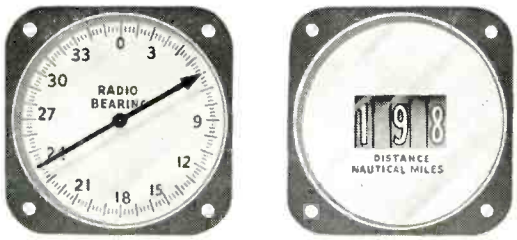
Circle 7 on Inquiry Card

Miniaturization means only active components G-E subminiatures use to give miniaturization

HOFFMAN TACAN: MEETS 780% - HIGHER AGREE* SPEC!

*Advisory Group on Reliability of Electronic Equipment, which has set a new standard of 150 hours mean-time-to-failure for TACAN.

General Electric subminiature tubes with heat-resistant glass have played a key role in advancing the reliability of Hoffman Electronics Corporation's new ARN-21C to nine times that of older TACAN equipment.



Compactness is a feature... transmitter, receiver, and electronic computer functions all are grouped in one "black box" that measures only 8 by 11 by 17 inches. Heat build-up necessarily is substantial.

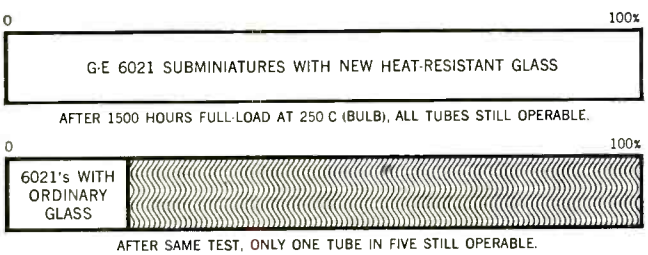
In General Electric subminiature tubes, Hoffman found the answers to their pressing need for tubes that would stand up to heat *with no sacrifice in reliability.* 28 G-E subminiatures are used in the ARN-21C.

heat. Tubes  are the that can withstand heat. new heat-resistant glass with reliability.

ACTUAL SIZE

WHAT TESTS SHOW

Life tests of G-E subminiatures with new heat-resistant glass prove that high-temperature operation has no adverse effect on reliability. Check the total absence of failures with G-E type 6021 after 1500 hours at 250 C, against the high failure rate of ordinary 6021's under the same conditions!



Type 6021 is a key tube in Hoffman's TACAN circuit. Glass electrolysis—cause of 90% of tube failures at high temperatures—has virtually been eliminated by General Electric in the 6021 and other subminiature receiving tubes.

SPECIFY FOR RELIABILITY

Small...smaller...smallest! The trend in electronic equipment is *down* in size, *up* in reliability requirement. Heat is the gremlin ready to play hob with your circuitry, unless you take steps to specify devices that are completely dependable when temperatures rise sharply.

General Electric subminiature tubes are proved performers at high temperatures. And their small dimensions give you the extra compactness you need to meet tight equipment size limitations. Telephone your nearest General Electric Receiving Tube Department office below!

NEW YORK	CHICAGO	LOS ANGELES
WIsconsin 7-4065,6,7,8	SPring 7-1600	GRanite 9-7765

Progress Is Our Most Important Product

GENERAL ELECTRIC

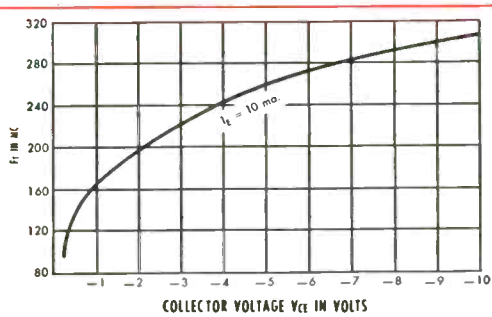
431-201

Circle 8 on Inquiry Card

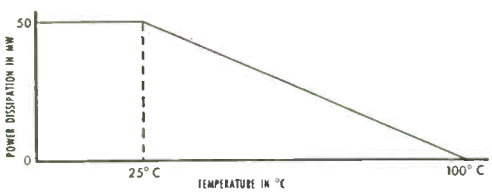
PHILCO ANNOUNCES NEW ULTRA HIGH-SPEED SWITCHING TRANSISTOR

WITH CADMIUM ELECTRODES ...IN TO-9 PACKAGE

SIMPLE 20MC BINARY STAGE



TYPICAL GAIN-BANDWIDTH PRODUCT, f_T VS. COLLECTOR VOLTAGE



DERATING CURVE

*MADT . . . TRADEMARK PHILCO CORPORATION for Micro Alloy Diffused-base Transistor.

New MADT* 2N1500 Provides Increased Power Dissipation

Here is another Philco "break-through" in the design and manufacture of high frequency, ultra high-speed switching transistors! This new Micro Alloy Diffused-base Transistor (MADT*) uses cadmium electrodes in place of indium. The higher thermal conductivity of cadmium insures cooler-running junctions for any given power dissipation and provides an extra margin of safety as added assurance of reliable performance.

The new 2N1500 offers the designer these important advantages:

- 100° C maximum junction temperature
- low collector capacitance
- low saturation voltage
- high Beta and excellent Beta linearity with temperature and current
- low hole storage time (Typical: 7 mμsec)

In electrical characteristics, the 2N1500 is similar to 2N501, which has been thoroughly field-proven in many military and industrial computer applications. It is manufactured on Philco's exclusive fully-automated production lines to the highest standards of uniformity. For complete specifications and applications data, write Dept. **EI-260.**

Max. Ratings		Typical Parameters				
T_{STG} °C	V_{CB} volts	t_r mμsec	t_s mμsec	t_f mμsec	h_{FE}	$V_{CE(SAT)}$ volts
100	—15	12	7	4	35	—0.1

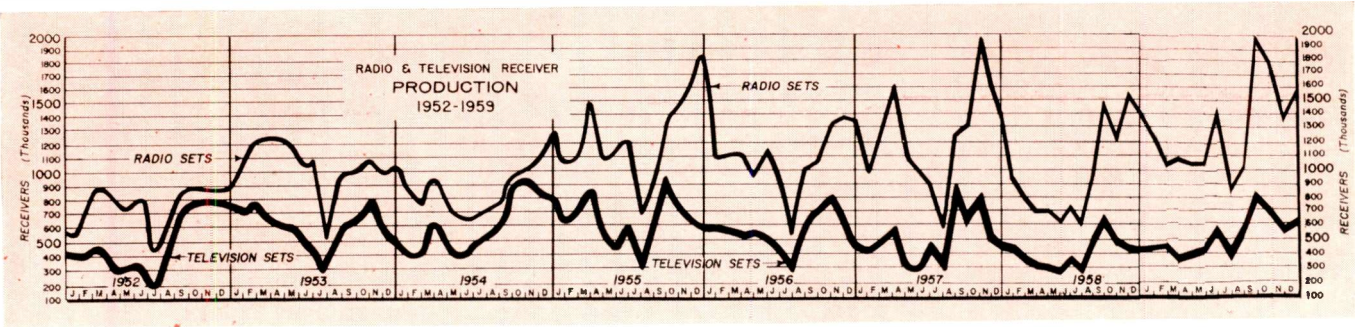
AVAILABLE IN PRODUCTION QUANTITIES . . . and in quantities 1-99 from your Philco Industrial Semiconductor Distributor.

PHILCO®

LANSDALE DIVISION / LANSDALE, PENNSYLVANIA

TRANSISTOR CENTER U.S.A.®

Circle 9 on Inquiry Card



GOVERNMENT ELECTRONIC CONTRACT AWARDS

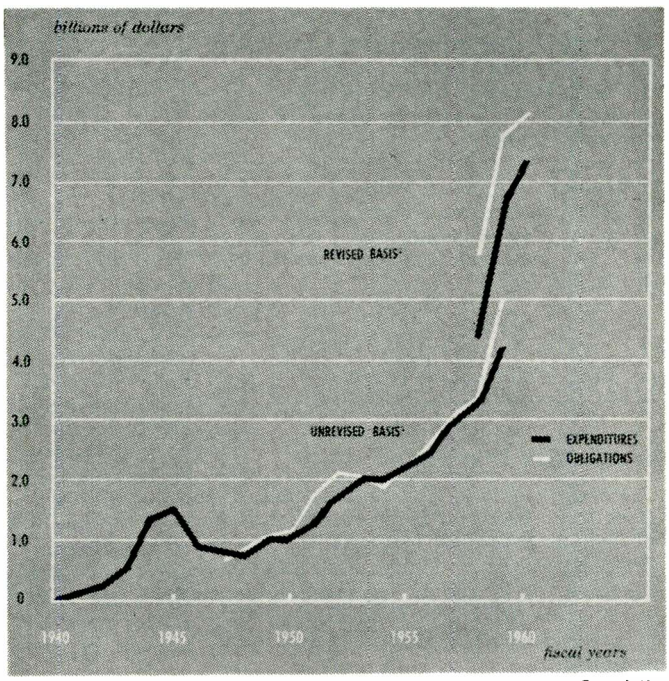
This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in December, 1959.

Accelerometers	34,815
Adapter, coax to waveguide	14,220
Amplifiers, a-f	29,086
Analyzers, spectrum	147,816
Antennas & systems	2,247,182
Batteries, dry	497,455
Batteries, storage	363,310
Beacon, antenna	68,862
Cable assemblies	155,455
Cable, electronic	163,034
Cable, telephone	26,334
Capacitors	25,143
Cells, solar	47,660
Coils, r-f	52,475
Computers	106,754
Connectors & connector adapters	443,248
Decoders, audio	76,199
Diodes, semiconductor	69,615
Filters, band-pass	174,600
Fuseholders	47,319
Fuses, cartridge	97,188
Handsets	51,447
Insulators	89,672
Loudspeakers	81,916
Measuring system, electronic	502,181
Meters, frequency	726,796
Meters, ohm	29,215
Microphones	32,910
Oscillators	85,750
Oscilloscopes	25,690
Oscillographs	55,608
Power supplies	522,178
Radomes	170,635
Radar sets	3,802,000
Receivers, radio	173,391
Receiver/transmitters	93,650
Rectifiers	44,920
Recorders/reproducers & accessories	456,019
Regulators, voltage	327,060
Relay, armature	138,432
Resistors	196,851
Signal generators	196,878
Solenoids	31,025
SSB equipment	72,246
Switches	316,682
Switches, waveguide	168,163
Switches, pressure	97,496
Switches, rotary	116,554
Switches, thermostatic	85,351
Systems, radar	3,000,000
Synchros	115,060
Tape, magnetic	66,250
Teleprinters	161,000
Test sets, radar	31,815
Test sets, radio	49,942
Test equipment	418,993
Transformers	518,042
Transmitters	234,963
Transponders	58,560
Tubes, electron	6,166,527
Tubes, magnetron	1,143,111
Wire	1,181,249

TRENDS IN FEDERAL EXPENDITURES FOR R & D[1]

1. Data include funds for both conduct of research and development and increase of R&D plant. Pay and allowances of military personnel in R&D included in totals in 1955 and subsequently.

Last month's Contract Awards appear on page 182.



—Bureau of the Budget, National Science Foundation

TOTAL INDUSTRY SHIPMENTS
ELECTRICAL MANUFACTURING INDUSTRY

(All data in millions of dollars. Includes Exports and Interplant Transfers)

ELECTRICAL PRODUCTS	1958	1959 Preliminary	1960 Forecast
Consumer Products*	$ 5,406.1	$ 6,029.8	$ 6,301.1
Lighting Equipment*	1,313.7	1,442.1	1,538.8
Industrial Electronics and Communications Equipment*	5,266.0	5,843.6	6,332.8
Industrial Equipment *	3,006.8	3,462.8	3,750.8
Building Equipment	688.0	748.5	797.2
Insulating Materials *	316.9	403.7	441.4
Insulated Wire and Cable	1,307.5	1,503.6	1,654.0
Generation, Transmission and Distribution Equipment*	2,047.0	2,079.4	2.242.3
Total Electrical Manufacturing Industry	$19,352.0	$21,513.5	$23,058.4

* The definition of electrical products included in these groups has been changed as of December 1959. Therefore data previously released are not comparable.

The data contained in this table, for 1958, 1959 and 1960 are comparable.

—NEMA Statistical Department

EI's International News

JAPAN

Japanese Firm Expands

Tokyo—The Tokyo Shibaura Electric Co., Ltd. will add 10 billion yen to its current capitalization of 15 billion yen—approximately $70 million dollars. The company is offering to its stockholders the right to subscribe to three additional shares for each five held. Approximately 10% of the shares are U. S. owned.

Toshiba is one of Japan's leading producers of electronic and electrical equipment. Its major overseas research contact is with international General Electric, a div. of General Electric Co. Sales to the U. S. (mostly transistors and transistor radios), totaled $10 million this year.

The ten billion yen will be divided between consumer and industrial products with consumer goods production and research getting 60% and industrial 40%.

UNITED KINGDOM

Buy British Klystrons

Chelmsford, Eng.—The Collins Radio Company, Cedar Rapids, Iowa has placed a $100,000 order with the English Electric Valve Co., Ltd., Chelmsford, England, for their Klystron type K350 which will be used in American-built Doppler Navigation equipment.

The K350 is a forced-air cooled, two-resonator klystron oscillator with mechanical tuning covering the frequency range from 8500 to 10,000 MC. An output power of approximately 1 watt is available.

Open New Plant

Gloucester, Eng.—Daystrom, Inc. has opened a new manufacturing plant in Gloucester, England. William H. Westphal, President of Daystrom International Operations Group said that it will be operated by the company's British subsidiary, Daystrom, Ltd. The company has been using leased facilities in England for over a year.

The new facilities will be used to produce and distribute the company's do-it-yourself electronic kits. The first offerings include test equipment, high fidelity and stereo components, and amateur radio transmitters.

EUROPE

Form New Subsidiary

Zug, Switzerland — Varian Associates, Palo Alto, Calif., has formed a new Swiss subsidiary, Varian, A.G., with main offices at Zug, Switzerland and research and amplications laboratories at Zurich. The company's product areas include: microwave tubes, scientific instruments, and high vacuum devices.

Dr. Warren Proctor, formerly director of the instrument div. in Europe, is Managing Director and Chairman of the Board. Other members of the new firm's board are: Dr. Hugo E. Frey, of Niederer, Kraft, & Frey, Zurich; and Dr. Oswald Aepple, legal adviser of Swiss Credit Bank.

Acquire Share of Italian Firm

Turin, Italy — Hamilton Standard, Div. of United Aircraft Corp., Windsor Locks, Conn. has completed negotiations leading to the purchase of a 50% interest in Microtecnica, Inc., of Turin, Italy. Microtecnica, in existence since 1928, manufactures marine and aviation navigation instruments, optical, mechanical testing instruments and servo-mechanisms.

Jailed For Export Law Violation

From time to time reports are received of convictions of people or firms who have violated the provisions of the U. S.'s Export Control Law. The penalties often involve suspension of export privileges, fines, reprimands etc. However, a jail sentence was meted out in a recent case.

Minthorne International Co., Inc., an export company of New York City, and Edwin J. Sorkin, the company's office manager, were sentenced recently by Judge Edward J. Dimock, in the Federal Court for the Southern District of New York. Minthorne was fined $5,000 and Sorkin was sentenced to 60 days.

The two-count indictment charged the defendants with having exported in 1956 a strategic electronic tube, valued at about $440, without obtaining the required validated export license from BFC, and with having falsely described the tube on the Customs export declaration as a different tube, valued at about $15, which could be shipped to West Germany without prior application to BFC.

The tube was shipped to a firm identified as Germar Weiss, Frankfurt, Germany. BFC had notified the defendents that it would reject all applications for licenses to export goods to this firm, because of its activities in trans-shipping goods to Soviet bloc destinations.

Reports on Hungarian Trip

D. B. Sinclair, (center), General Radio Co., V.P., presents a report on his recent trip to Budapest, Hungary, where he attended a Colloquium on Microwave Communication, at the invitation of the Hungarian Academy of Sciences. Panel members of the International session at NEREM look on. (Left to right): T. Isobe, Univ. of Tokyo; A. P. H. Barclay, Philips Electronic Industries, Ltd., Canada; and C. H. Zierdt, Jr., General Electric Co., Syracuse, N. Y.

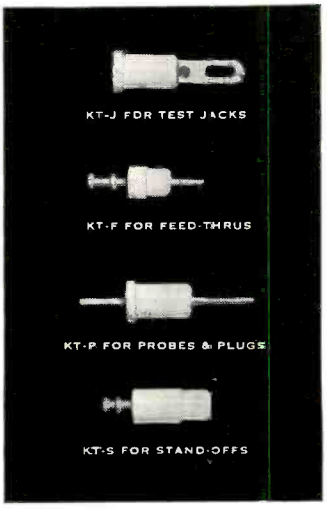
PUERTO RICO

Branch Plant on Mainland Reverses Puerto Rican Trend

San Juan—Reversing the trend which has seen American industry open hundreds of affiliates in Puerto Rico under the Commonwealth's industrial program, one of the plants has opened a branch plant in New Orleans.

The plant, a branch of Caribe Electric Battery Corp., will produce batteries for export to Latin America. The parent plant in Puerto Rico produces batteries mainly for the island market.

(*Continued on Page* 26)

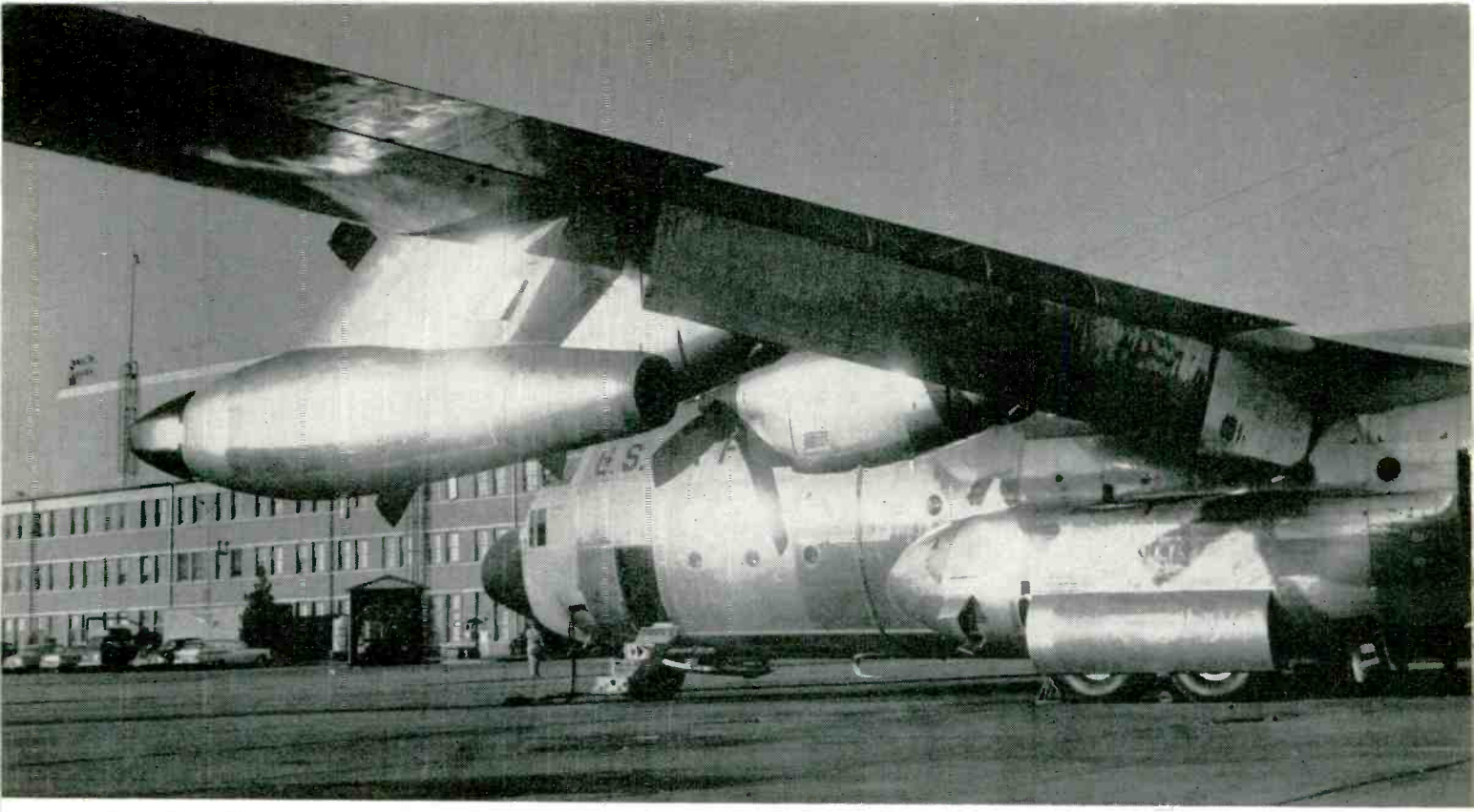


PERMANENTLY INSTALLED IN 4 SECONDS OR LESS by pressing the self-fastening insulator through pre-drilled mounting holes. The resilient properties of the "Teflon" insulation secures the terminal and provides permanent vibration proof installation, with no soldering or screw attachment needed to hold terminal in place. New Cannon "**KT**" Terminals offer simplified electrical connection especially adapted for circuitry in microwave communications, radar, scientific instrumentation and other crowded space applications. ▪ **VOLTAGE RATINGS FROM 2380 V. TO 4250 V.** (Sea Level) depending on size of terminal. Special types are available where higher operating voltages are encountered. ▪ **TEFLON BUSHINGS** available in diameters of 0.148" to 0.264." Terminal lengths range from 0.120" to 2.500." Standard pin diameters are 0.040," 0.046," 0.050," and 0.078." Pin material is brass with 0.0003" silver plate. A wide variety of finishes, colors and soldering lugs can be supplied to order. ▪ "KT" Terminals are immediately available in a wide variety of sizes and shapes. Cannon also produces special configurations for specific applications: Write for Cannon Catalog KT-1. Please refer to Dept. 201 Cannon Electric Company—3208 Humboldt Street, Los Angeles 31. Factories in Los Angeles, Santa Ana, Salem, Toronto, London. Paris, Melbourne and Tokyo. Distributors and Representatives in the principal cities of the world.

CANNON PLUGS

Circle 10 on Inquiry Card

QAM-4-TERM



LANDS ON A DIME

Lockheed Aircraft's Boundary Layer Control C-130 Hercules can land with a ground roll as short as 460 ft. Note the 90-degree angle of the flaps. They can be swung down vertically for sharp take-offs and landings.

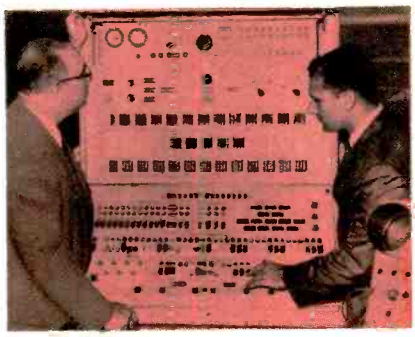
Snapshots . . . of the Electronic Industries

EYE FOR AIR DEFENSE

Giant rotating radar antenna reflector is 120 ft wide and 36 ft high. It is part of the prototype AN/FPS-24 Search Radar designed for the Air Force by General Electric Co's Heavy Military Electronics Dept., Syracuse, N. Y.

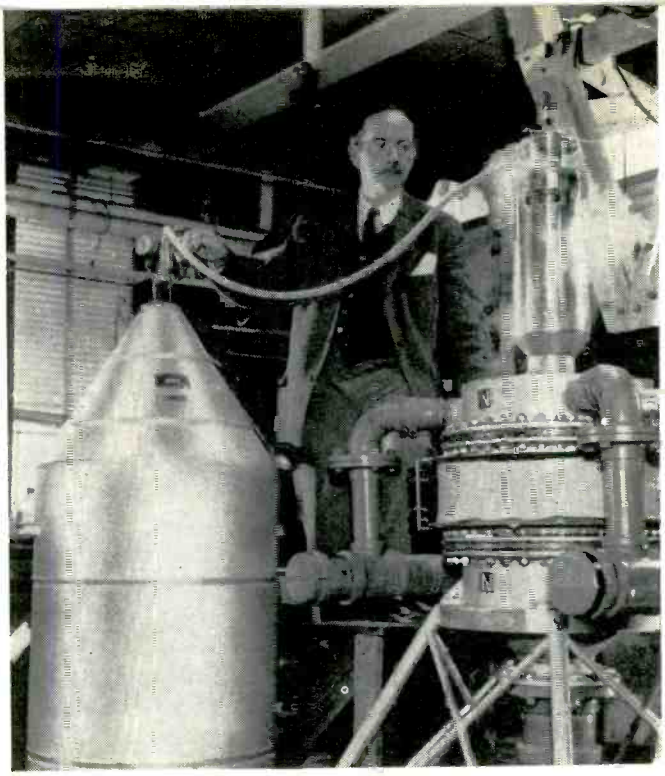
STANDARDS SEMINAR

General Radio Co., West Concord, Mass., sponsored this seminar-workshop clinic on precision inductance and capacitance measurements at low frequencies. Over 20 specialists from the U. S. and Canada attended the 3½ day symposium.



MOBIDIC ON DISPLAY

Sylvania engineers, Robert Thomas (left) and Lawrence O'Connor inspect the MOBIDIC console at the Company's Data Systems Operations, Needham, Mass. The Army Signal Corps has ordered the computer system for the Seventh Army Stock Control Center in West Germany.



RESEARCH NEAR ABSOLUTE ZERO

Transferring nitrogen into stainless-steel, helium research dewar at Naval Research Lab. Objective is the investigation of the longitudinal and transverse magneto-resistance of copper. Dewar was built by Hofman Labs., Inc.

LANGUAGE TEACHER

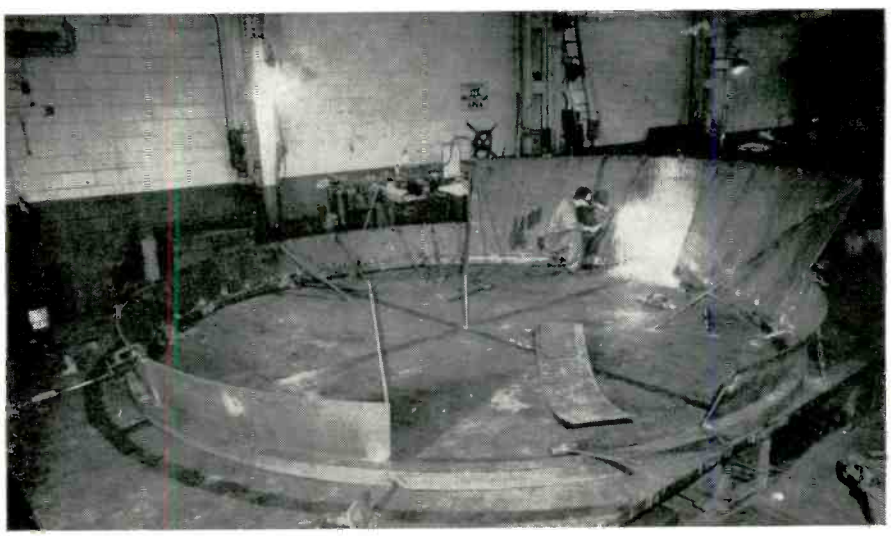
New method of teaching foreign languages, the electronic language laboratory, is demonstrated on TV station KTLA, Los Angeles. Pre-recorded daily lessons are fed into 32 separately controlled positions. The student can play back his own recordings and compare his pronunciation with his instructor's.

$4,000,000 WORTH OF COMPUTERS

Largest single shipment of General Electric computers—more than $4,000,000 worth—is loaded for shipment to Bank of America sites and a Gov't installation in Southern California.

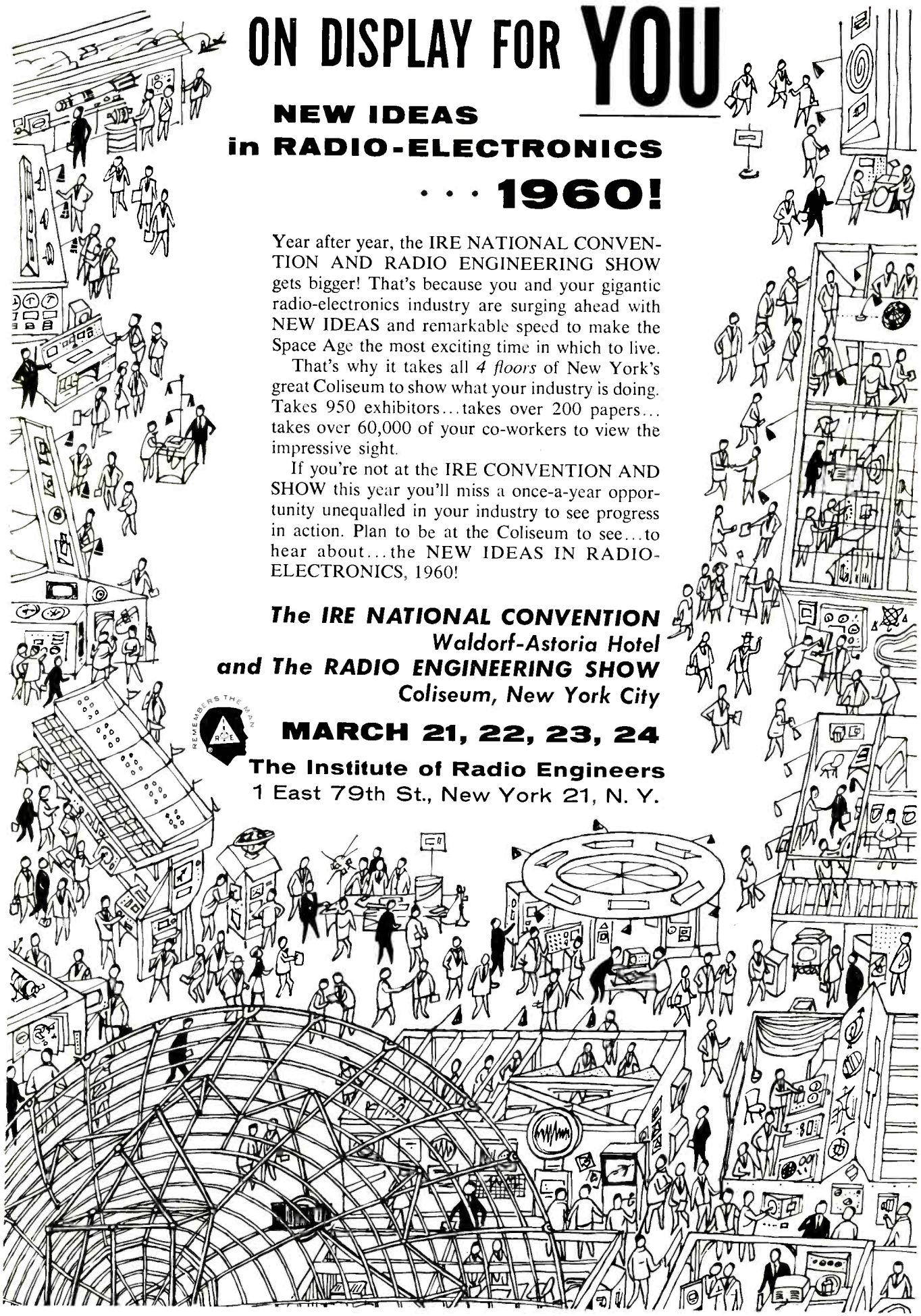
STEEL "RING" FOR ATOMIC REACTOR

Cone-like "ring," part of a gas and radiation sealing system, is fitted and electric arc-welded in eight sections so it can be accurately re-assembled at the Enrico Fermi Atomic Power Plant, Monroe, Mich. The R. C. Mahon Co., is building the ring.



INSTALL COMPUTER

IBM RAMAC 650 is installed in Endicott Johnson Corp's main shoe plant in Endicott, N. Y. Frank A. Johnson (standing) said that the computer would slash delivery time by 75%. It will eventually control work flow through the company's 27 plants.



ON DISPLAY FOR YOU

NEW IDEAS in RADIO-ELECTRONICS ... 1960!

Year after year, the IRE NATIONAL CONVENTION AND RADIO ENGINEERING SHOW gets bigger! That's because you and your gigantic radio-electronics industry are surging ahead with NEW IDEAS and remarkable speed to make the Space Age the most exciting time in which to live.

That's why it takes all *4 floors* of New York's great Coliseum to show what your industry is doing. Takes 950 exhibitors...takes over 200 papers... takes over 60,000 of your co-workers to view the impressive sight.

If you're not at the IRE CONVENTION AND SHOW this year you'll miss a once-a-year opportunity unequalled in your industry to see progress in action. Plan to be at the Coliseum to see...to hear about...the NEW IDEAS IN RADIO-ELECTRONICS, 1960!

The IRE NATIONAL CONVENTION
Waldorf-Astoria Hotel
and The RADIO ENGINEERING SHOW
Coliseum, New York City

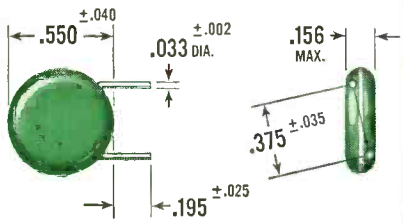
MARCH 21, 22, 23, 24

The Institute of Radio Engineers
1 East 79th St., New York 21, N. Y.

The beauty of this Capacitor is more than skin deep!

A-B QUALITY

ACTUAL SIZE TYPE A CAPACITORS

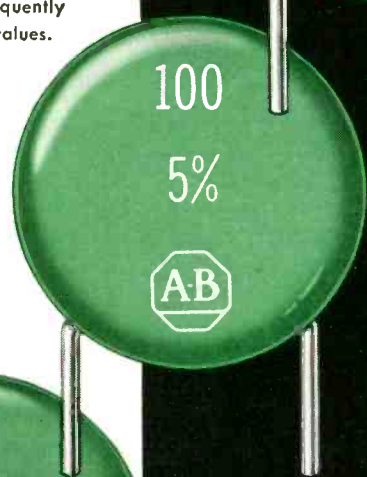


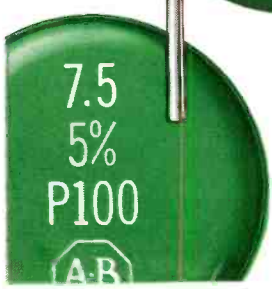
Allen-Bradley Type A capacitors are available in the most frequently used types and capacitance values.

General Purpose Type in capacitance values from 10 mmf to .01 mmf.

Stable Type in capacitance values from 10 mmf to 0.1 mmf.

Temperature Compensating Type in characteristics from N4700 to P100, and in capacitance values from 10 mmf to 510 mmf.





Type A Capacitor...

One size for all values...

Designed for high speed assembly

Compare the attractive Allen-Bradley Type A ceramic capacitors with all the rest....you'll see instantly why more and more engineers are specifying them and will not accept substitutes —because there aren't any! The exclusive "Auto-Coat" process makes possible—for the first time—a capacitor of real beauty, precise physical uniformity, plus consistent and reliable quality and performance.

The smooth, tough insulating coating and the inherent mechanical uniformity of Type A capacitors permit easy hand or accurate automatic insertion on printed boards. Also, the "Auto-Coat" process prevents rundown on leads—costly wire cleaning and crimping to prevent soldering failures are unnecessary.

For full information on the *superior* physical and electrical properties of A-B Type A capacitors, send for Technical Bulletin 5401.

ALLEN-BRADLEY

Quality Electronic Components

Allen-Bradley Co., 1342 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

Circle 12 on Inquiry Card

International News

(*Continued from Page 25*)

CANADA

Build Units for SAGE

Waterloo, Ont. — Raytheon Canada, Ltd., Waterloo, Ont., has been awarded a $1,350,000 contract from the Canadian Commercial Corp., a government agency, to produce 60 transistorized position indicator units for the SAGE air defense system. They will be installed at SAGE centers in the U. S. to monitor early warning data received from radar installations on the Arctic DEW line, the southermost U. S. sites, and coastal stations.

MIDDLE EAST

Add Israel to Telex Net

Tel Aviv—RCA Communications, Inc., has added Israel to its global telex network, establishing customer-to-customer teleprinter service between this country and the U. S.

Telex service is somewhat similar to overseas telephone except that subscribers communicate by teleprinter instead of telephone instruments. U. S. Telex service is available to more than 40,000 commercial firms and government agencies equipped with RCA or TWX teleprinters. The service is provided in Israel by the Ministry of Posts, Telegraphs, Telephones and Radio.

SOUTH AMERICA

Joint U. S., Brazilian Venture

A new plant for the manufacture of appliance controls will be built in suburban Sao Paulo, Brazil, by a newly formed subsidiary of Robertshaw-Fulton Controls Co., Richmond, Virginia. The subsidiary, to be known as Robertshaw-Fulton Controls do Brasil S/A Industria E Eomercio, will be owned by Robertshaw-Fulton and several Brazilian firms including Serma-Maguinas Contabeis E Servicos Gerais S/A Sao Paulo, Metalurgica Wallig S/A, Porto Alegre; Metalurgica Paulista S/A, Sao Paulo; Fundicao Brasuk S/A, Sao Paulo; and Parmet Participacoes Metalurgicas S/A, Rio de Janeiro.

The plant will be built in the community of Guarulhos on Rodovia Presidente Dutra, a superhighway connecting Sao Paulo and Rio de Janeiro. First production is scheduled for early 1960.

SPRAGUE CUP TYPE

TANTALEX® CAPACITORS

now better than ever!

Sprague's NEW "Cup Type" Liquid-Electrolyte Sintered-Anode Tantalex Capacitors offer several major improvements in cup capacitor design: elimination of fluctuation in capacitance during operation; elimination of "early failures" from internal short-circuiting as sometimes occurs with other brands of cup capacitors; and large values of capacitance in small physical size. But there's more...

Rated for −55 C to +85 C operation without voltage derating (to +100 C with 15% derating), these capacitors provide equipment designers with long operating life, long shelf life, outstanding capacitance stability, and very low leakage currents.

Sprague "cup" capacitors are available in two series: Type 131D for industrial, communication, and general military equipment; Type 132D for the severe vibration requirements and close performance parameters of military aircraft and missiles. Type 131D, moderately priced and furnished in the comparatively wide capacitance tolerance of −15, +75%, is especially suited for filter, coupling, and bypass applications where this wide tolerance is permissible. Type 132D is furnished as standard in the closer capacitance tolerances of −15, +20% and −15, +50%.

Complete data on Types 131D and 132D Capacitors is given in Engineering Bulletin 3710A. Write Technical Literature Section, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

SPRAGUE®
THE MARK OF RELIABILITY

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

A real heel might test a Fusite Terminal like this

...but he won't make it leak!

The adherence between glass and metal in a Fusite Hermetic Terminal is an easily demonstrated fact. There are several theories as to *why* our exclusive V-24M glass actually chemically bonds to the metal components. Cobalt and certain other metallic oxides in the glass oxidize the iron in the metal which is taken into solution. It is believed that through the solution of iron, a gradual decrease of the difference of thermal expansion between the glass and metal takes place at the glass-metal interface. This inter-fusion of the two dissimilar materials gives Fusite Terminals their ability to withstand great mechanical and thermal shock and still pass Statiflux tests for glass cracks, hydrostatic pressure tests and helium mass spectrometer leak detection.

This fusion is reinforced by a strong compression of the metal ring around the glass made possible by a favorable thermal expansion balance of the glass, pins and housing.

The combination of fusion and compression provides a terminal so rugged that leaker rejection rate of components into which our terminal is fabricated is practically nil, even when roughly handled and subjected to extreme temperature changes.

Samples for your own testing are yours for the asking.

Write Dept. G-1.

INSULATE ELECTRICALLY · GLASS TO METAL · SEAL HERMETICALLY

FUSITE TERMINALS PROTECT PRODUCT PERFORMANCE

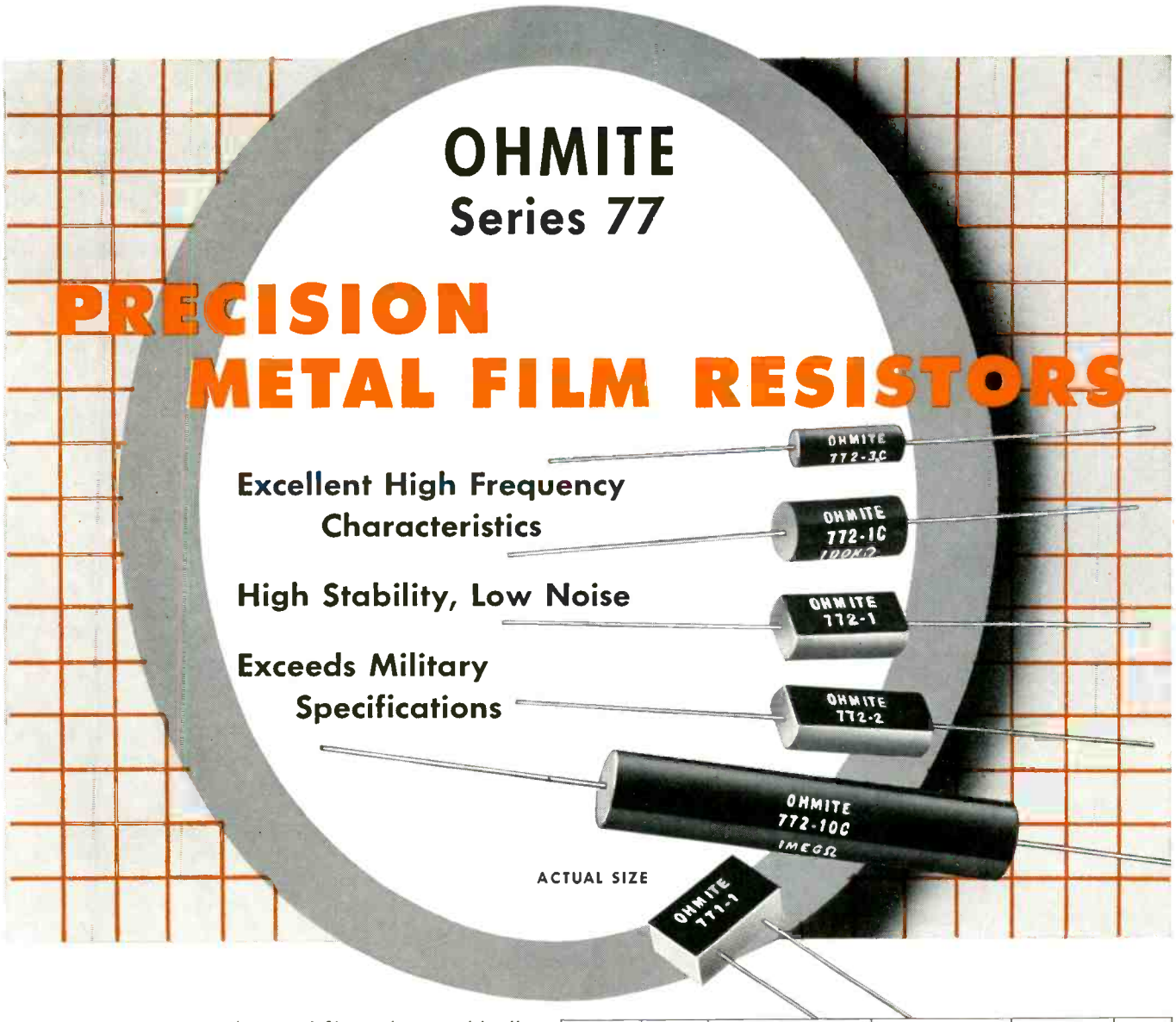
THE FUSITE CORPORATION

6000 FERNVIEW AVE., CINCINNATI 13, OHIO

Woodford Mfg. Co., Versailles, Kentucky.

In Europe: FUSITE N. V. Konigsweg 16, Almelo, Holland

NOW PRICED WITH PRECISION WIRE-WOUNDS!



At last you can get quality metal film resistors, with all their advantages, at prices competitive with precision wire-wound units. In fact, some values are actually priced lower.

EXCEEDS MILITARY SPECIFICATIONS—Ohmite metal film precision resistors exhibit great stability under load at ambient temperatures of 150°C and higher, as well as in high humidity. Stability in storage is also excellent. A shelf-life test (covering a period of 4½ years) of 93 units in the 60 to 300 K-ohms range showed less than 0.05% maximum change in resistance. This stability together with low temperature co-efficient, low noise level, and unexcelled high frequency characteristics, are the reasons why Series 77 metal film resistors are demanded for both military and industrial applications.

Write for Bulletin 155

Ohmite Basic Style	MIL Sizes	Dimensions (Inches)		Full Wattage Rating at		Min.–Max Ohms	Max Rated Volts
		Length	Diameter	125°C Amb.	150°C Amb.		
771-1	—	11/16	.400	½	¼	25-250K	350
771-2	—	⅞	.600	½	¼	251K-400K	350
772-3C	RN65* RI92†	⅝	15/64	¼	⅛	50-125K	300
772-3CJ	RI92†	⅝	15/64	½	¼	50-85K	300
772-1	—	⅝	21/64	½	¼	25-250K	350
772-1C	—	⅝	21/64	½	¼	25-250K	350
772-2	RN72* RI94†	13/16	21/64	½	¼	25-400K	350
772-2C	RI94†	13/16	21/64	½	¼	25-400K	350
772-2CS	RN70* RI94†	13/16	19/64	½	¼	25-350K	350
772-2J	RI94†	13/16	21/64	1	—	25-400K	350
		13/16	21/64	—	½	25-150K	350
772-2CJ	RI94†	13/16	21/64	1	—	25-400K	350
		13/16	21/64	—	½	25-150K	350
772-8	RI96†	1 3/32	13/32	1	½	100-1 meg	500
772-8C	RN75* RI96†	1 3/32	13/32	1	½	100-1 meg	500
772-10	—	2 7/32	27/64	2	—	200-2.5 meg	750
772-10C	RN80*	2 7/32	27/64	2	—	200-2.5 meg	750

*MIL-R-10509C †MIL-R-19074B

NEW 2-WATT SIZE

OHMITE®
OHMITE MANUFACTURING COMPANY
3662 Howard Street, Skokie, Illinois
QUALITY Components

RHEOSTATS RESISTORS RELAYS TANTALUM CAPACITORS TAP SWITCHES VARIABLE TRANSFORMERS R. F. CHOKES GERMANIUM DIODES

Tele-Tips

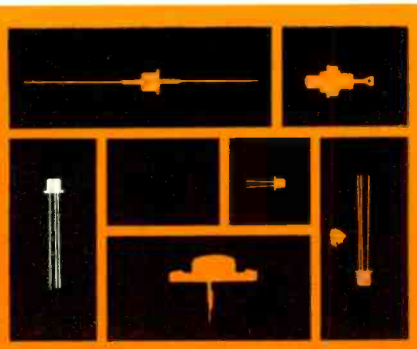
ELECTRONIC SUCCESS stories are getting out of hand. Even people within the industry are being deluded by visions of astronomical profits. Datex Corp. of Monrovia, Calif., asked their employees to estimate the percentage profit of the company. Of those who would venture a guess, 5 estimated the profit at between 21% and 30%; 13 said between 11% and 20%; 12 said 6% to 10%. Only 6% guessed that the company made 5% or less. Actually, the net profit of Datex was about 4½%.

CLOSED CIRCUIT TV is in use by 133 educational systems including schools, hospitals, etc. Closed circuit and on-the-air instruction now reaches between 8,000 and 10,000 schools, and an estimated 10 million students. The figures are from the Joint Council on Education TV.

THE ELECTRONIC FARM predicted for the future will have Farmer Brown directing his work by a 2-way personal radio from the comfort of his home. He will grade his fruits and vegetables automatically and use long range weather forecasting from a satellite in his crop planning. His farm machinery will run on solar and atomic energy.

WHICH SPEAKER are the bass frequencies coming from? Theorists claim that the low frequency sounds lack direction, so that the sound of a bass fiddle would seem to be coming from somewhere in between the two speakers. But two GE engineers reported at the recent AES meeting that it is true—frequencies below 100 cycles/sec. do have direction. As test subjects, the engineers used 29 GE Radio Receiver Dept. employees, including secretaries, engineers, experts and non-experts. When a sound of a musical instrument containing a certain frequency tone was heard through the stereo system, those participating in the test were asked which speaker the sound was coming from. The response curve that was plotted proved that low frequencies do have "direction."

(*Continued on page 44*)



MOTOROLA announces a NEW QUALITY ASSURANCE PROGRAM "MEG-A-LIFE" offering ADVANCE CERTIFICATION of COMPONENT RELIABILITY

This new Motorola "Meg-A-Life" quality-assurance program provides users of semiconductor devices with:

1. Written certification of reliability with orders of 100 units or more.
2. Established specifications as severe as those required for military units.
3. Close quality control tolerances, with minimum and maximum parameters, AQL and inspection levels completely specified.

Under this new Motorola program, each production lot of a "Meg-A-Life" branded device is subjected to complete electrical, mechanical, environmental and life tests identical to those required for Military approved units. The purchaser receives written certification that units passed the specified tests and a copy of the actual test results is made available.

All tests and sampling are made in accordance with military specifications . . . representing the most adverse conditions under which the devices would be used. The Motorola "Meg-A-Life" certificate provides the industrial user with an assurance of reliability never before possible and makes possible the elimination of duplicate testing.

The first available Motorola "Meg-A-Life" devices are the 2N650A, 2N651A and 2N652A Industrial Alloy Transistors. Other Motorola semiconductors will be announced under the "Meg-A-Life" brand.

NEW MOTOROLA "MEG-A-LIFE" INDUSTRIAL ALLOY TRANSISTORS

Motorola types 2N650A, 2N651A and 2N652A are the first to be offered under the Motorola "Meg-A-Life" brand. Units are designed to provide extremely reliable amplifier and switching service in the audio frequency range.

- Meet or exceed mechanical and environmental requirements of MIL-S-19500 • PC = 200 mw
- Operating and storage temperature: to 100°C
- BVCBO = 45 volts • BVCER (R = 10K) = 30 volts

Type Number	h_{fe} (VCE = 6V, IE = 1 ma)	
	MIN.	MAX.
2N652A	100	225
2N651A	50	120
2N650A	30	70

FOR COMPLETE INFORMATION and specifications on "Meg-A-Life" Industrial Alloy Transistors, contact your Motorola Semiconductor District Office:

RIDGEFIELD, NEW JERSEY
540 Bergen Boulevard
WHitney 5-7500
from New York WI 7-2980

DETROIT 27, MICHIGAN
13131 Lyndon Avenue
BRoadway 3-7171

CHICAGO 39, ILLINOIS
5234 West Diversey Avenue
Avenue 2-4300

MINNEAPOLIS 27, MINNESOTA
7731 6th Avenue
LIberty 5-2198

HOLLYWOOD 28, CALIFORNIA
1741 Ivar Avenue
HOllywood 2-0821

IN CANADA WRITE:
MOTOROLA, Inc.
Semiconductor Products Division
4545 West Augusta Boulevard
Chicago 51, Illinois

OUTSIDE USA & CANADA WRITE:
MOTOROLA INTERNATIONAL, S. A.
4545 West Augusta Boulevard
Chicago 51, Illinois

Semiconductor Division
MOTOROLA

5005 EAST McDOWELL ROAD • PHOENIX, ARIZONA

for voltage stabilizing... rectifying...controlling...

THERE'S A RAYTHEON GAS DIODE TO MATCH YOUR TOUGHEST POWER-SUPPLY 'SPEC'

VOLTAGE REGULATOR TUBES

Type	Base	D.C. Operating Voltage	Current Range	Regulation
0A2WA **CK6626/0A2WA** **CK6073, 0A2**	Miniature	150 v.	5 — 30 ma.	2 v.
0B2WA **CK6627/0B2WA** **CK6074, 0B2**	Miniature	108 v.	5 — 30 ma.	1 v.
0C2	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.

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.	—

COLD CATHODE RECTIFIER TUBES

Type	Construction	Base	Max. Peak Inverse Voltage	Peak Plate Current	Max. D.C. Output Current
0Z4A/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.

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.

Small order and prototype quantities available directly from your local Raytheon electronics parts distributors.

Want to Receive Our Technical Data Regularly? We'll be happy to keep you informed of latest technical developments, new products, design tips, etc. An application for addition to our new Technical Information Mailing List is yours for the asking. Write on your company letterhead directly to: W. J. Davis, Dept. 2528, at division address listed.

RAYTHEON

Industrial Tube Subdivision

INDUSTRIAL COMPONENTS DIVISION

57 Chapel Street, Newton 58, Massachusetts

RELIABLE MINIATURE AND SUBMINIATURE TUBES • HARD-GLASS POWER TUBES • GAS TUBES • CATHODE RAY TUBES • STORAGE TUBES

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CLEVELAND, WInton 1-7716 • **BALTIMORE,** SOuthfield 1-1237 • **ORLANDO, FLA.,** GArden 3-1553 • **NEW YORK,** Plaza 3-3900 • **BOSTON,** Bigelow 4-7500
GOVERNMENT SALES: BOSTON, Bigelow 4-7500 • **WASHINGTON, D. C.,** MEtropolitan 8-5205 • **DAYTON,** BAldwin 3-8128

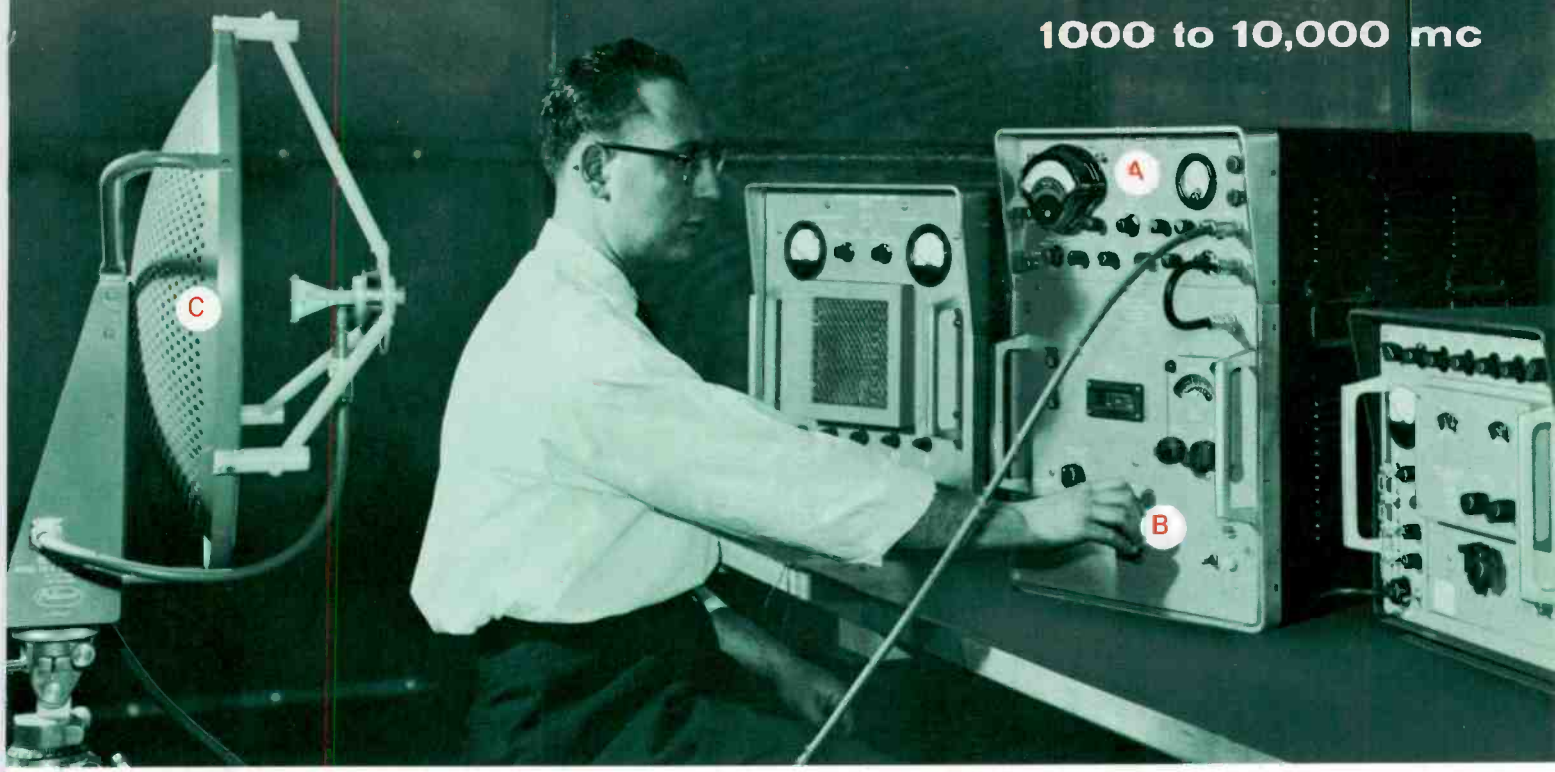
Circle 53 on Inquiry Card

Circle 18 on Inquiry Card →

Exclusively from Polarad...

CALIBRATED MICROWAVE FIELD INTENSITY RECEIVER SYSTEM

1000 to 10,000 mc



Model FIM being used to check radiated interference against MIL-I-26600

The complete integrated Model FIM includes:

- **A monitoring unit.** Meter indicates average, peak or quasi-peak value of r-f signals. Outputs for video, audio and recorder.
- **R-F Plug In Tuning Units.** Four units cover the frequency range 1000 to 10,000 mc. UNI-DIAL tuning control tunes both the receiver and internal signal calibrator.
- **Calibrated Antenna System** complete with tripod and a calibrated omni-directional Broadband antenna or a separate directional antenna to match each R-F tuning unit.

Use this precision instrument for antenna pattern and shielding analysis, r-f power and voltage measurements, determination of field intensity, signal propagation patterns and other microwave parameters.

Determines absolute level of radiation, leakage and interference by comparison with an internally generated CW signal. Also measures signal susceptibility

FREE LIFETIME SERVICE ON ALL POLARAD INSTRUMENTS

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

POLARAD ELECTRONICS CORPORATION

43-20 34th Street, Long Island City 1, N. Y. © P.E.C.

Representatives in principal cities.

MEPDI

POLARAD ELECTRONICS CORPORATION:

Please send me information and specifications on:

- ☐ Model FIM Calibrated Microwave Field Intensity Receiver
- ☐ Model N-1 Precision Noise Generator (see reverse side of page)

POLARAD

My application is_____

Name_____

Title_____ Dept._____

Company_____

Address_____

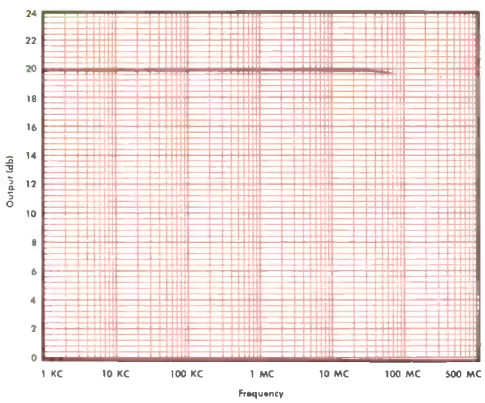
City_____ Zone_____ State_____

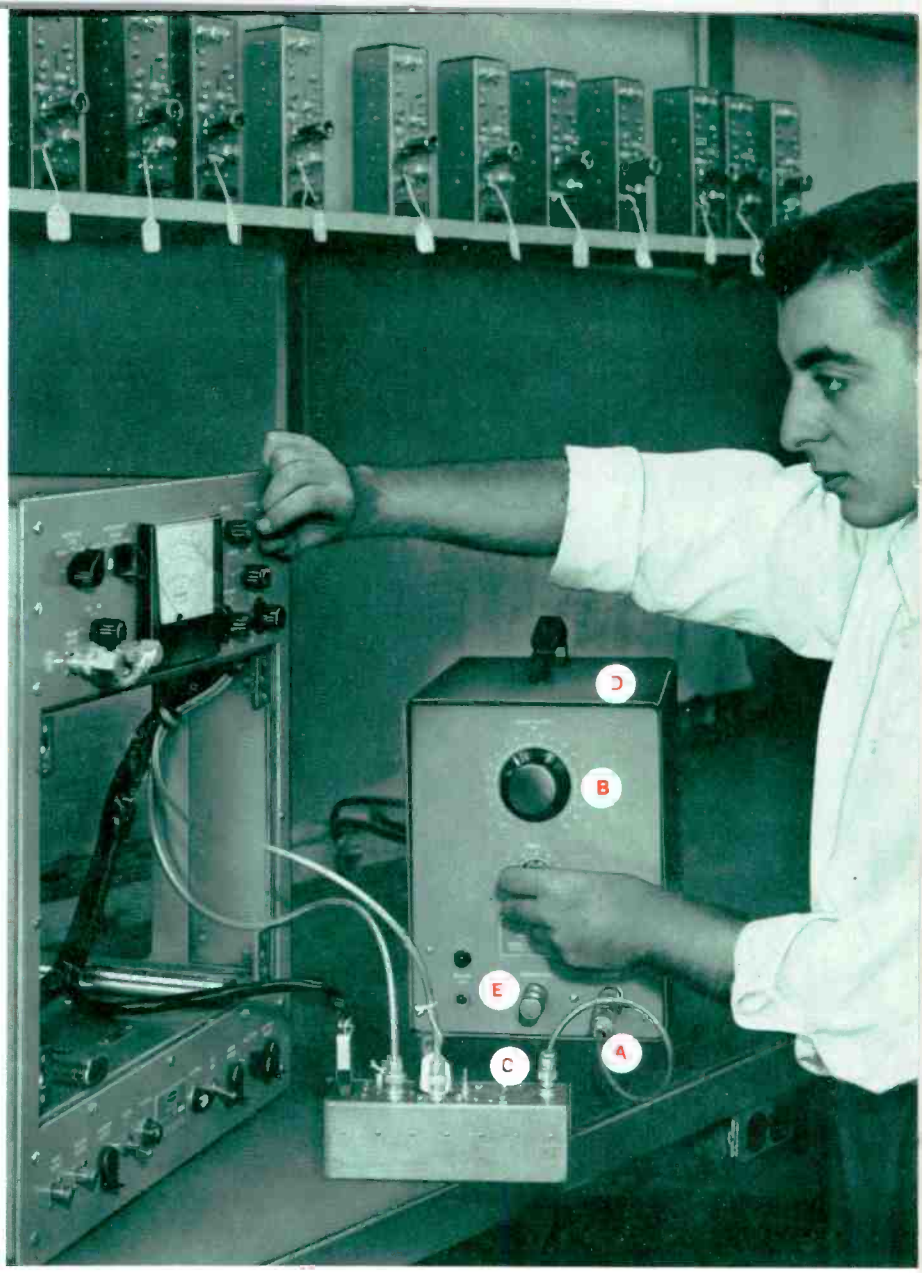
New from Polarad...

PRECISION NOISE GENERATOR

- A 1 kc to 500 mc
- B 1 to 20 db, adjustable
- C 0.25 db output accuracy
- D Long-life, low-maintenance noise tubes
- E Stable output

Noise output constant over entire frequency range. Maintains set level into any terminating impedance, 50 to 10,000 ohms.





Production line noise figure measurements, made rapidly and accurately with Polarad Model N-1.

The Polarad Model N-1 is a small, compact, portable noise generator with easy-to-operate controls. The Model N-1 (Digitized variable output level controls — 0 to 20 db. Calibrated 1 db steps — fine vernier between each step.) is entirely self-contained, including power supplies. Use it for direct noise figure measurements of vacuum tube or transistor amplifiers, receivers and oscillators.

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States.

BUSINESS REPLY CARD
First Class Permit No. 18, Long Island City 1, N.Y.

POLARAD ELECTRONICS CORP
43-20 34th St., Long Island City 1, N. Y.

POLARAD

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

FREE LIFETIME SERVICE ON ALL POLARAD INSTRUMENTS

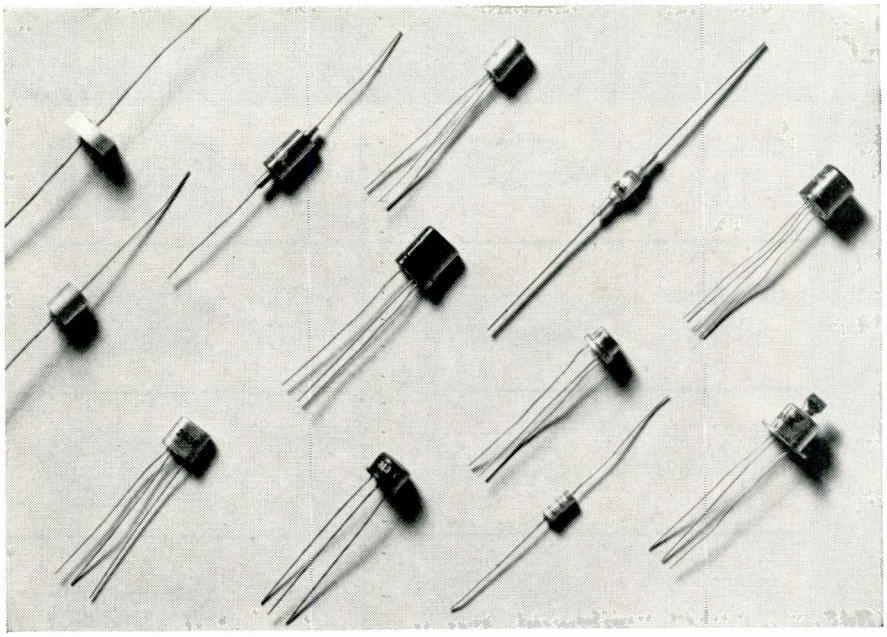
POLARAD ELECTRONICS CORPORATION

43-20 34th Street, Long Island City 1, N. Y.
Representatives in principal cities.

For etching

and washing

semiconductors . . .



B&A® "ELECTRONIC-GRADE" HYDROGEN PEROXIDE

IS THE PUREST AVAILABLE!

Special, new B&A "Electronic-Grade" H_2O_2, 30% and 30% "stabilized"—with its stringent pH specifications—reduces variations in rate of etch . . . cuts down rejects and improves quality control in the production of semiconductors.

To eliminate another variable in the use of hydrogen peroxide for semiconductor production, Baker & Adamson® has now added label specifications for the pH of "Electronic-Grade" H_2O_2, 30% and 30% "stabilized" (see box). The pH for hydrogen peroxide, 30%, is 2.5-3.5 . . . for 30% "stabilized," 3.0-3.5.

These tight specifications provide still better control and uniformity of peroxide than in the past and eliminate variations from lot to lot. This is still another example of B&A's continuing leadership in supplying production chemicals of the highest purity and quality for the electronic industry. B&A "Electronic-Grade" Hydrogen Peroxide, 30%, is readily available in 1 lb. plastic bottles and 30-gallon polyethylene-lined drums. "Electronic-Grade" Hydrogen Peroxide, 30% "stabilized," comes in 1 lb. or 5 lb. glass bottles and in the 30-gallon drums.

Remember . . . for the purest hydrogen peroxide available . . . as well as for the highest quality in other electronic chemicals . . . specify B&A!

Check these stringent specifications

HYDROGEN PEROXIDE, 30% . . . . . CODE 2774
H_2O_2 M.W. 34.02

MEETS A. C. S. SPECIFICATIONS

Assay (H_2O_2)	29.0-32.0%
pH	2.5-3.5

MAXIMUM LIMITS OF IMPURITIES

Residue after Evaporation	0.002%
Free Acid (As H_2SO_4)	0.003%
Chloride (Cl)	0.0005%
Nitrate (NO_3)	0.0005%
Phosphate (PO_4)	0.00025%
Sulfate (SO_4)	0.0005%
Ammonium (NH_4)	0.0005%
Heavy Metals (as Pb)	0.0001%
Iron (Fe)	0.00005%

HYDROGEN PEROXIDE, 30% . . . . . CODE 2775
"STABILIZED"
H_2O_2 M.W. 34.02

Assay (H_2O_2)	29.0-32.0%
pH	3.0-3.5

MAXIMUM LIMITS OF IMPURITIES

Residue after Evaporation	0.03%
Free Acid (as H_2SO_4)	0.005%
Chloride (Cl)	0.0005%
Phosphate (PO_4)	0.020%
Sulfate (SO_4)	0.001%
Heavy Metals (as Pb)	0.0001%
Iron (Fe)	0.00005%

HYDROGEN PEROXIDE, 3% SOLUTION . . . CODE 2773
H_2O_2 M.W. 34.02

Assay (H_2O_2)	3.0-3.5%

MAXIMUM LIMITS OF IMPURITIES

Residue after Evaporation	0.020%
Free Acid (as H_2SO_4)	0.010%
Chloride (Cl)	0.0005%
Nitrogen Compounds (as N)	0.005%
Phosphate (PO_4)	0.003%
Sulfate (SO_4)	0.005%
Arsenic (As)	0.00001%
Heavy Metals (as Pb)	0.0001%
Iron (Fe)	0.00005%
Preservative	0.035%

BAKER & ADAMSON®
"Electronic Grade" Chemicals

Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

AMPHENOL RF CONNECTORS

Quick-Crimp* TNC		SERIES C	
Quick-Crimp* BNC		SERIES BNC	
SUB*Minax*®		SERIES N	
SERIES LT/LC		SERIES HN	

AMPHENOL LEADS IN RF COMPONENTS

1 BROAD AVAILABILITY from a single source. All popular RF Series. In addition to those illustrated above, series UHF, BN, Adapters and Specials are also manufactured by AMPHENOL.

2 SERVICE & ASSISTANCE based on the experience of over twenty years of designing and manufacturing RF connectors.

3 ENGINEERING facilities are the finest of any components manufacturer. AMPHENOL has the know-how and the equipment to assist you in "problem areas" and in special designs.

*PATENT PENDING

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Amphenol-Borg Electronics Corporation

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AMPHENOL RF CONNECTORS

are available from Authorized

AMPHENOL

Distributors -at Factory Prices!

AMPHENOL **DISTRIBUTOR DIVISION**
Amphenol-Borg Electronics Corporation
BROADVIEW, ILLINOIS

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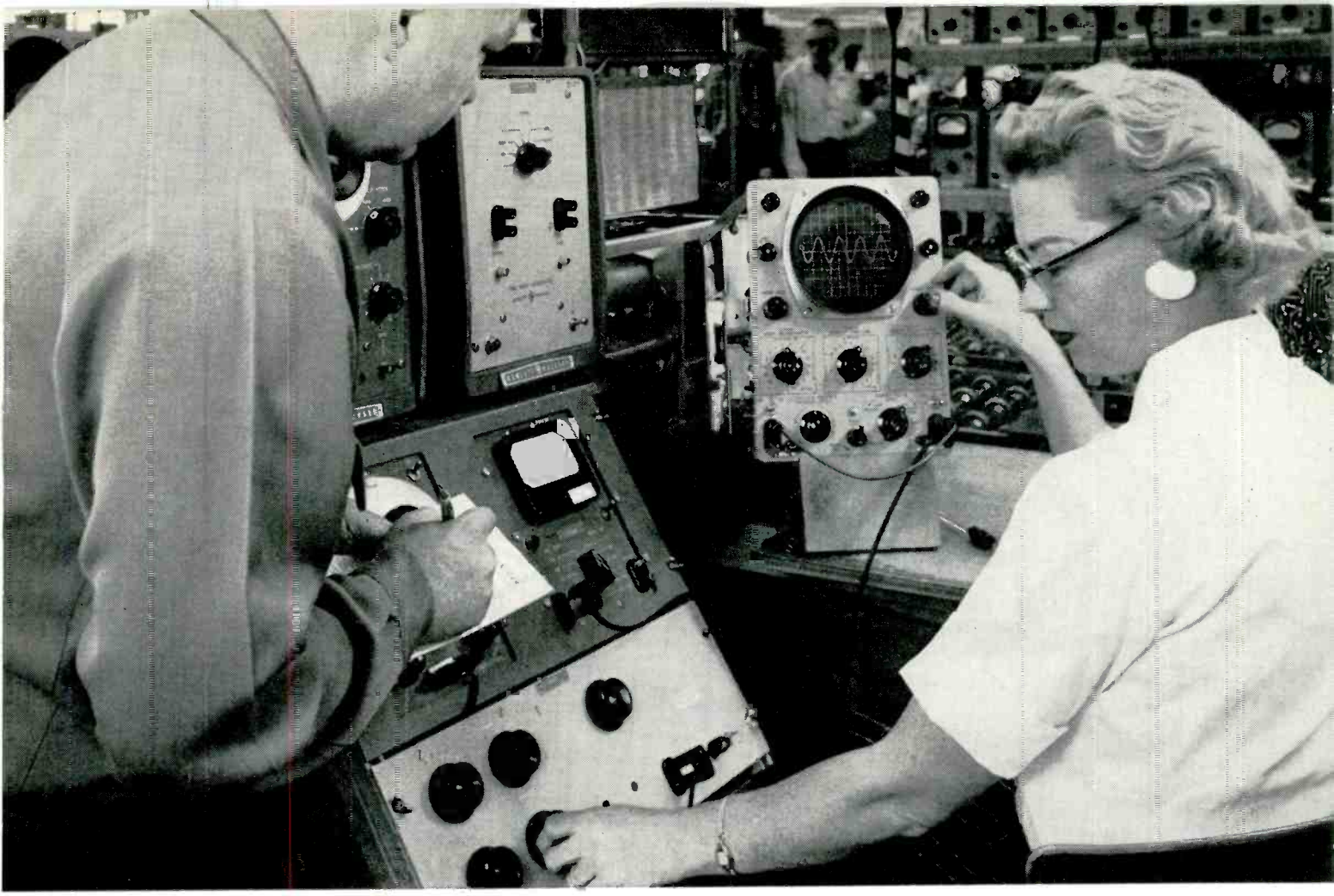

HEWLETT hp PACKARD specifies Tung-Sol tubes for high stability calibration generator

The Hewlett-Packard Voltmeter Calibration Generator calibrates high impedance voltmeters and oscilloscopes with extreme accuracy. An exceptionally stable source for a wide range of precision voltages, the premium instrument speeds up production and maintenance testing.

To assure high stability and low distortion performance, which are listed among the unit's principal advantages Hewlett-Packard selected Tung-Sol 6550's for the 400 cycle power amplifier. As Hewlett-Packard reports: "Tung-Sol's 6550 shows unusual insensitivity to load changes."

What this means, of course, is that under varying loads the 6550 drive, with its tight characteristics, holds to a minimum any change in the unit's already minimal distortion (less than 0.2%). In addition the 6550 helps to provide long-term stability.

Like all Tung-Sol components, the 6550's optimum performance and dependability stems from Tung-Sol's deep-rooted component know-how. Every step in the manufacturing process is carefully disciplined. Stringent quality control guarantees uniformly high performance in any one lot or from lot to lot. And exhaustive life tests under severe overload assures adequate safety margins.

Maybe you're up against some exacting component requirements. If so, you'll be steering a wise course by getting in touch with Tung-Sol applications engineers. They're component experts who will gladly study your design and recommend the units that will do the job . . . precisely. Tung-Sol Electric Inc., Newark 4, New Jersey. TWX: NK193.

For prompt and competent technical consultation on Tung-Sol components call the Tung-Sol Commercial Engineering office near you. SALES OFFICES: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. Canada: Montreal, P. Q.

ts TUNG-SOL®

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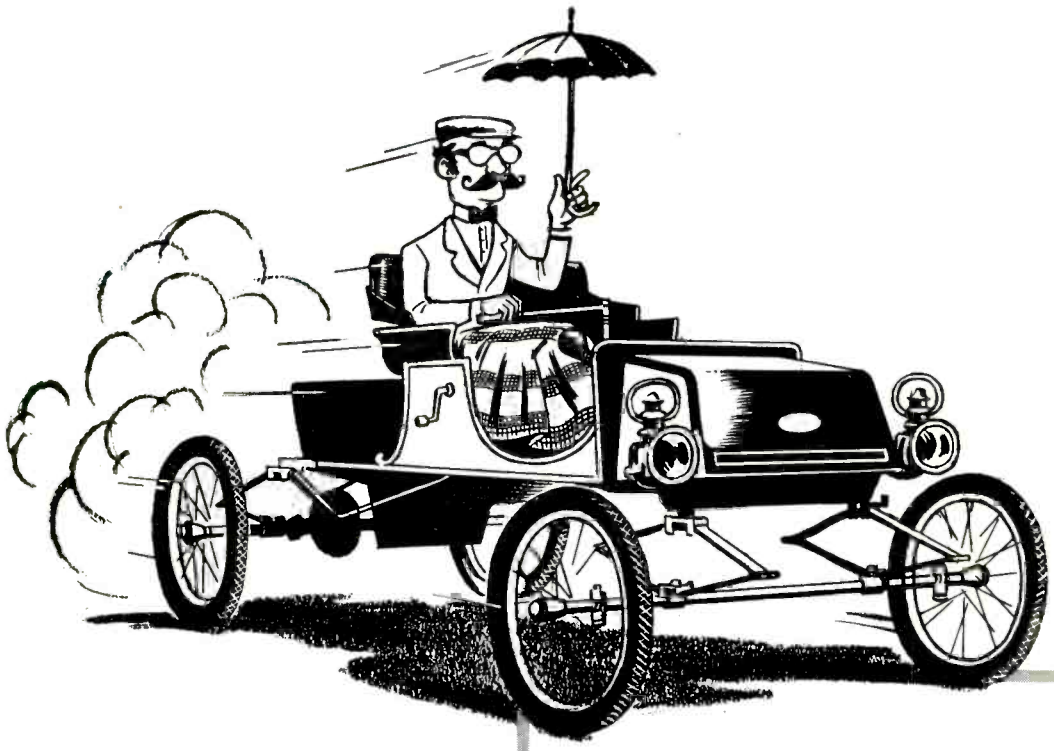
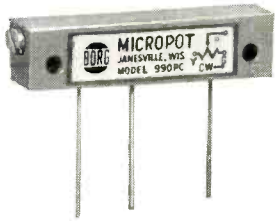


... looking for compact size?

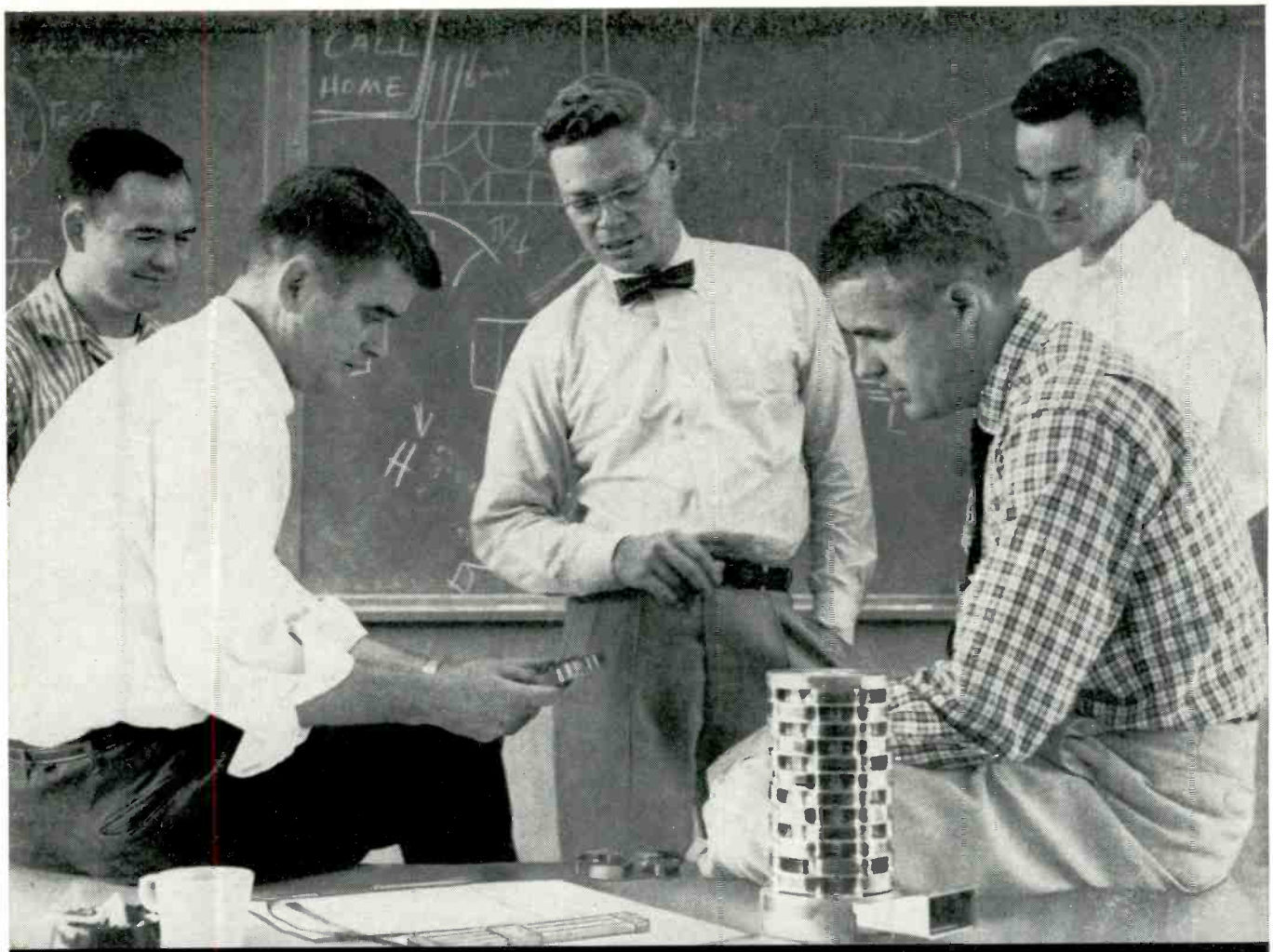


Borg Micropot Trimmers are miniaturized lead-screw actuated potentiometers that match, balance and adjust circuit variables in all sorts of electronic equipment, both commercial and military. Available with either deposited carbon film or wire-wound resistance elements, Borg Trimming Micropots are applicable anywhere accuracy, small size and rugged construction are prime considerations. Can be mounted singly or stacked one upon the other. Terminal types include wire leads, solder and printed circuit terminals.
Get complete data today.

WRITE FOR DATA SHEETS BED-133 AND BED-A134

BORG EQUIPMENT DIVISION
Amphenol-Borg Electronics Corporation
Janesville, Wisconsin

Micropot Potentiometers • Turns-Counting Microdials • Sub-Fractional Horsepower Motors • Frequency and Time Standards



A few of Varian's large research team on wave tubes confer on new design features.

TOP TEAM IN WAVE TUBES

Varian has become the world's leader in the development and production of microwave tubes. With a greatly expanded wave tube team and larger manufacturing facilities, new tubes for advanced applications are being offered at an accelerated pace. From the small X-Band BWO's to the megawatt TWT, there is a Varian wave tube to meet your requirements.

Over 100 Varian Klystrons and Wave Tubes are pictured and described in our new catalog. Write for copy—address Tube Division.

VA-125A, B TWT	2.65 to 3.25 kMc 2 megawatts peak output
VA-161 BWO	8.2 to 12.4 kMc
VA-162 BWO	12.4 to 18.0 kMc
VA-128 TWT	2.6 to 3.4 kMc 1[illegible] kw peak output

VA-125A, B TWT

VA-128 TWT

VA-161
VA-162
BWO's

VARIAN associates
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KLYSTRONS, WAVE TUBES, GAS SWITCHING TUBES, MAGNETRONS, HIGH VACUUM EQUIPMENT, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, NMR & EPR SPECTROMETERS, MAGNETS, MAGNETOMETERS, STALOS, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES

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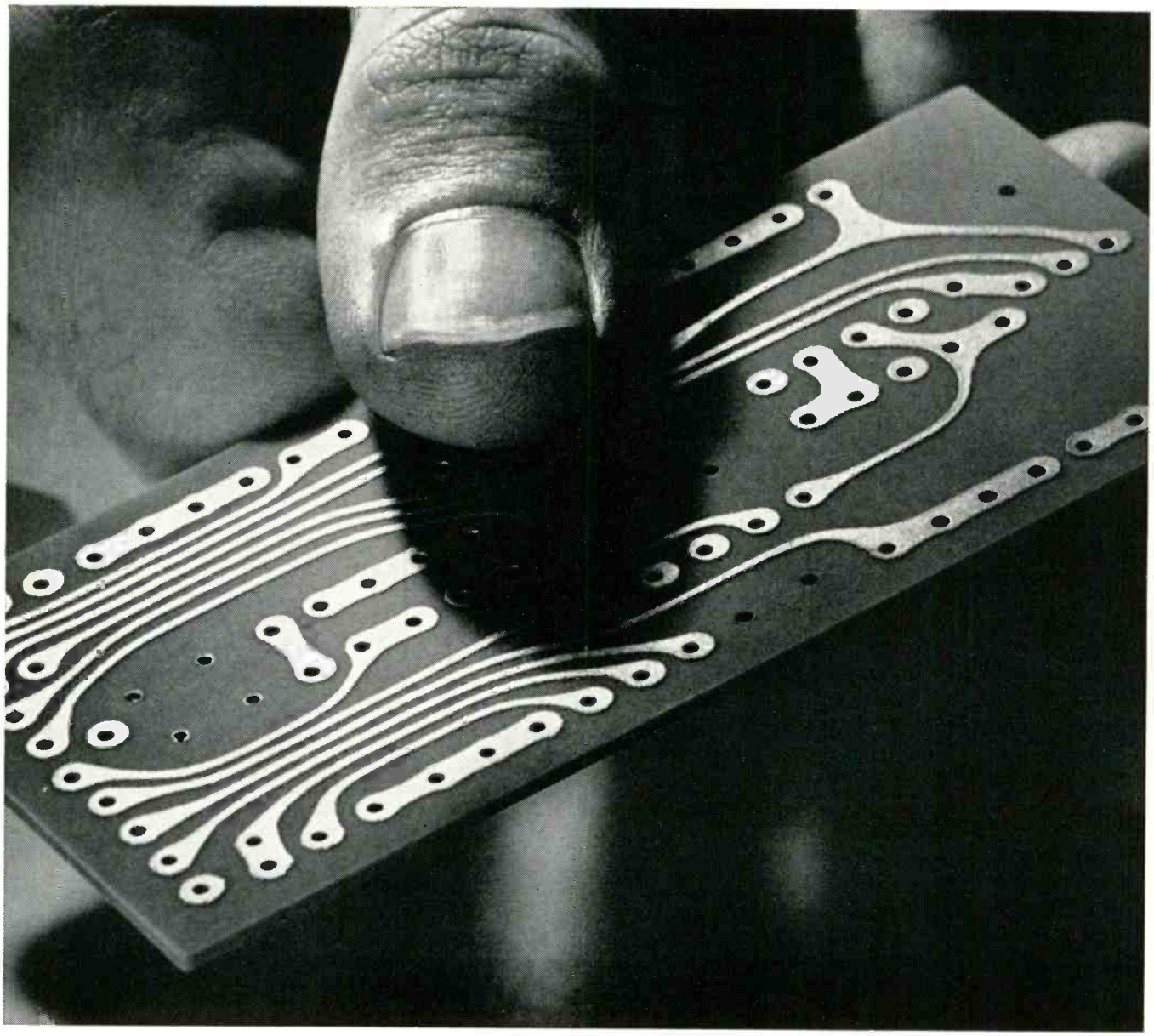


FOTOCERAM circuit board blanks are made using the micro-accuracy of photography. All holes and shapes are produced by simple exposure to light, heat, and an etching operation.

No bending, bowing or delaminating with a FOTOCERAM printed circuit board

Made of one solid piece of Fotoceram material, these printed circuit boards can't delaminate, because there are no laminations—the problem of bending, twisting and warping are eliminated, even under high ambient temperatures.

Dimensional stability is so great you'll want to use them for environmental stress tests.

Through-hole plating presents no problems, either. We plate through the hole uniformly with the same conductor material. Thermal conductivity, as well as electrical conductivity, is exceptionally good. You can even make a solder bridge over a hole with no gap and without a wire.

Resolderability is excellent—we've removed and resoldered components over fifty times on a Fotoceram board without damage to runs or holes.

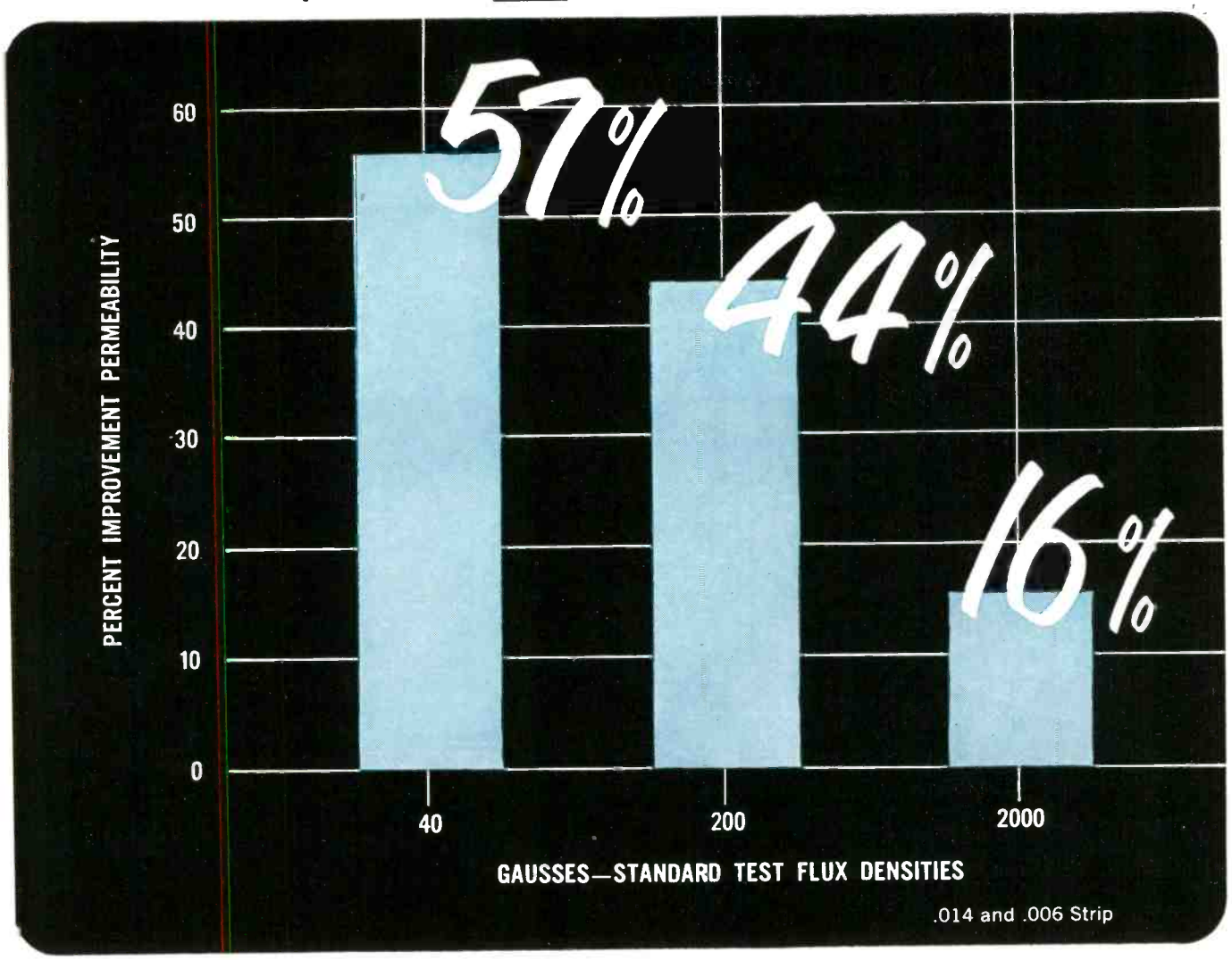
In addition, Fotoceram boards provide good adhesion, exceptional pull strength, zero water absorption. They are non-flammable, never blister.

We are now equipped to produce Fotoceram printed circuit boards in quantity on a mass production basis and at a practical cost.

For more information, write for our data sheet to **Corning Glass Works,** 546 High Street, Bradford, Pa. Or contact our sales offices in New York, Chicago or Los Angeles.

CORNING ELECTRONIC COMPONENTS

Experience**—the added alloy in **A-L Electrical Steels



Greater permeability for Allegheny Ludlum's AL-4750...and it's *guaranteed*

promises more consistency, higher predictability for magnetic cores

AL-4750 nickel-iron strip now has higher *guaranteed* permeability values than ever before. For example, at 40 induction gausses AL-4750 now has 57% higher permeability than in the past, using the standard flux density test.

This greater permeability means better consistency and predictability for magnetic core users . . . and allows careful, high performance design.

This improvement in AL-4750 is the result of Allegheny Ludlum's continuing research on electrical alloys and nickel-bearing steels. Moly Permalloy has been similarly improved in permeability. A-L constantly researches silicon steels, including A-L's well-known grain-oriented silicon, Silectron, and other magnetic alloys.

Complete facilities for the fabrication and heat treatment of laminations are available at Allegheny Ludlum. And A-L's technical know-how guarantees you close gage tolerance, uniformity of gage throughout the coil and minimum spread of gage across the coil-width.

If you have a problem on electrical steels, laminations or magnetic material, call A-L for prompt technical assistance. Write for blue sheet EM-16 for complete data on AL-4750. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa. Address Dept. EI-26.*

7491

ALLEGHENY LUDLUM

STEELMAKERS TO THE ELECTRICAL INDUSTRY

Export distribution, Electrical Materials: AIRCO INTERNATIONAL INC., NYC 17
Export distribution, Laminations: AD. AURIEMA, NYC 4

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Circle 28 on Inquiry Card →

TRIPLETT

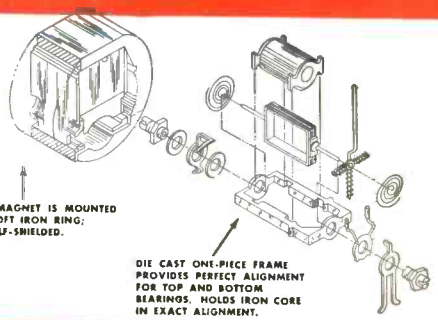
Quality... First to last

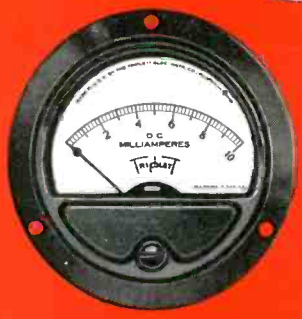
COMPLETE PANEL METER

BURTON BROWNE ADVERTISING

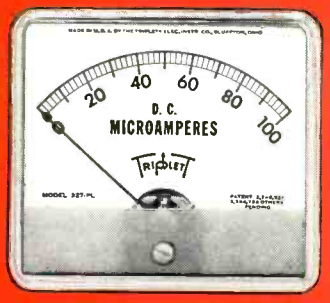
BAR-RING TYPE MOVEMENTS (Exclusively Triplett)

- Self Shielded
- Not affected by magnetic panels or substantially by stray magnetic fields.
- More Torque
- Lower Terminal Resistance
- Faster Response
- Exceedingly Rugged and Accurate
- All Case Sizes



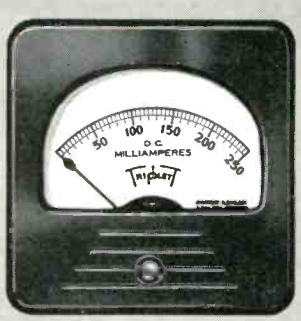


Round Flush Mounting (2 1⁵⁄₁₆")
Model: DC 221-T, AC 231-S, RF 241-T

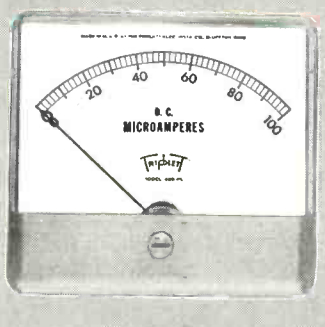


Rectangular Flush Mounting (3 ⅜")
Model: DC 327-PL, AC 337-PL, RF 347-PL

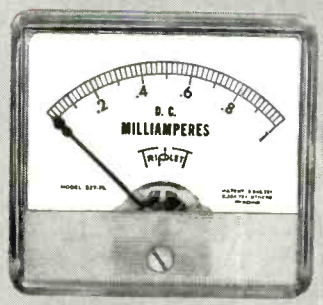
Round Flush Mounting (3½")
Model: DC 321-T, AC 331-S, RF 341-T, Dyn. 361



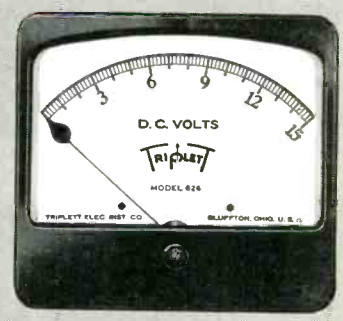
Rectangular Flush Mounting (2⅜")
Model DC 227-T, AC 237-S, RF 247-T



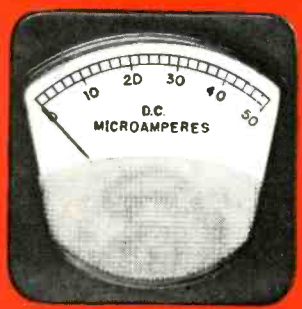
Rectangular Flush Mounting (4⅜")
Model: DC 420-PL, AC 430-PL, RF 440-PL



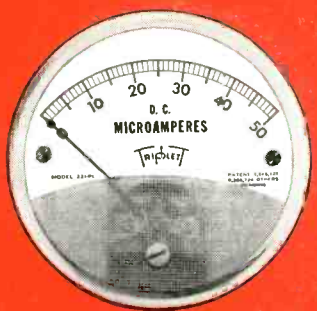
Rectangular Flush Mounting (2 1⁹⁄₃₂")
Model: DC 227-PL, AC 237-PL, RF 247-PL



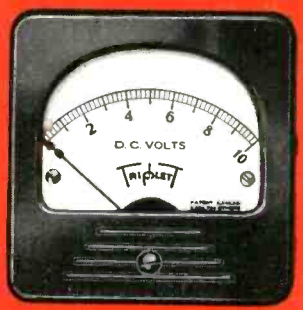
Rectangular Flush Mounting (6")
Model: DC 626, AC 636, RF 646



Ruggedized Instruments— 1½", 2½" and 3½"
In addition to the popular commercial line of panel instruments, Triplett supplies a complete line of ruggedized and sealed instruments designed to meet government specification MIL-M-10304A.



Round Flush Mounting (2 1⁵⁄₁₆")
Model: DC 221-PL, AC 231-PL, RF 241-PL

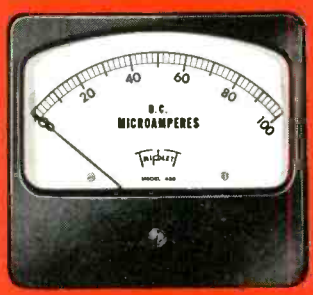


Rectangular Flush Mounting (3")
Model: DC 327-T, AC 337-S, RF 347-T, Dyn. 367-A

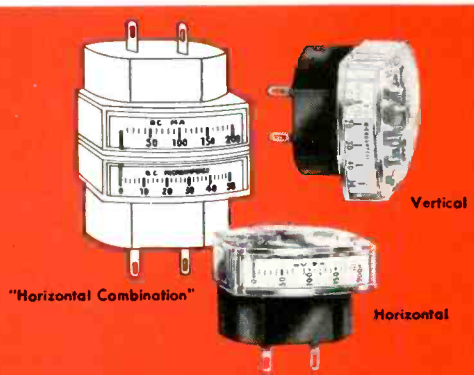
For complete details see your Electronic Parts Distributor, or write

LINE FULLY MEETS YOUR NEEDS

The name TRIPLETT has been on instruments of our manufacture for more than 55 years, and is regarded as a symbol of customer satisfaction to industrials and distributors in all parts of the world. Our instruments can be built to customer specifications or provided from our large stocks of standard ranges in hundreds of sizes and types. We also carry in stock many semi-finished movements which can be converted readily to special customer needs.



Rectangular Flush Mounting (4⅜")
Model: DC 420, AC 430, RF 440

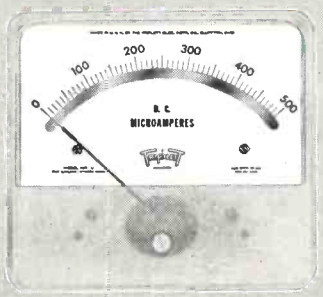


Miniature Edgewise Panel Meters —Model 120

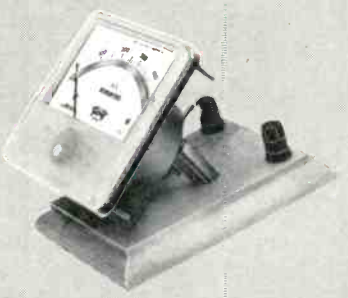
Model 327-U Unimeter 3½" Assembled

Model 354 Relay

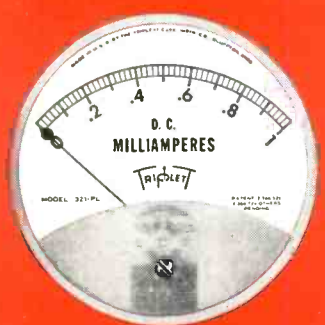
Tilting Case Portable
Model: 325 (DC), 335 (AC)



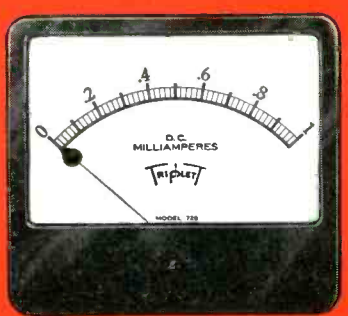
Model 420-U Unimeter 4½"
with mirror scale



Model 234 Unimeter Stand



Round Flush Mounting (3½")
Model: DC 321-PL, AC 331-PL, RF 341-PL



Rectangular Flush Mounting (7⅛")
Model: DC 726, AC 736, RF 746

Model 420 VU Meter
Type A Scale

6" Molded Case 4.7" Scale Portables
Model: 625 (DC), 635 (AC),

TRIPLETT
Quality... First to last

TRIPLETT ELECTRICAL INSTRUMENT COMPANY
BLUFFTON, OHIO

Tele-Tips

(*Continued from Page* 30)

ELECTRONIC THERMOMETER takes the measurement of the temperature of the human body within a second or so of its application to the skin surface. It was developed by Wayne Kerr Laboratories of England. Device uses a temperature sensitive metallic oxide lead which is connected to the sensitive direct d-cb and ridge measuring circuit.

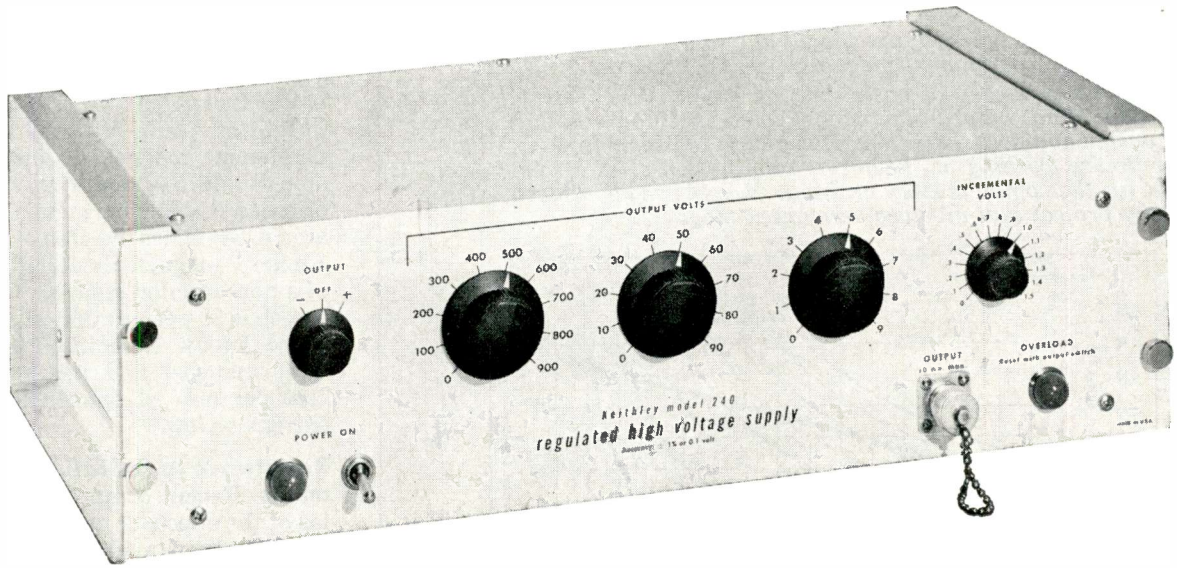
SPACE EXPRESS that would shuttle men and material between earth and orbiting space stations has been designed by Lockheed and Hughes Aircraft. The vehicles will carry up to four astronauts. They combine the features of the space ship, ballistic missile and conventional airplane.

"MICROWAVE MEGAPHONE" being developed by Sperry Rand will allow masters of ships on a collision course to quickly exchange information on intended maneuvers. The microwave voice communication is tied to a radar-scope display. The scope indications will positively identify the target that it is in communication with by means of a narrow beam microwave length.

NEW MARKETING CONCEPTS are needed, says Westinghouse's James H. Jewell. "We must learn to think in terms of 'systems' instead of 'pieces.' The responsibility for designing the system, from end to end, will become the responsibility of the electronic component manufacturers. Computer techniques will be the tool that will enable manufacturers to do this quickly and economically.

POTENTIAL HAZARDS in manufacturing plants, machines or equipment which might crush, cut, electrocute, should be painted a vivid orange, say factory designers. They would paint each item a separate color, to indicate its function. A vivid yellow would indicate tripping or moving equipment. All fire protection and fire fighting equipment would be painted red; electrical controls, elevators, operating levers a precaution blue. RustOleum Corp. is one of the paint companies that has worked with the American Standards Assoc. on the problem.

dial any output from 0-1000V within 1%



KEITHLEY Model 240 High-voltage Supply combines convenience, accuracy, wide range

This convenient supply brings new speed, ease and accuracy to laboratory tests. Typical applications include calibration of meters and dc amplifiers, supplying potentials for photomultiplier tubes and ionization chambers. Other uses include furnishing potentials for high resistance measurements, and for diode and capacitor leakage resistance tests.

The Model 240 output delivers 0 to 1000 volts at up to 10 milliamperes. Three calibrated dials on the front panel select the desired output voltage in one volt steps, with accuracy of 1% or 100 millivolts. Greater accuracy may be obtained with a potentiometer provided for setting the output with an accurate voltmeter.

Polarity is selectable. The switch includes an "OFF" position, facilitating timed measurements. An overload relay cuts off the output at 12 milliamperes within 50 milliseconds. Connectors are provided on front and rear panels.

SPECIFICATIONS

DC OUTPUT VOLTAGE: Positive or negative, 0 to 1000 volts, in one volt steps.

OUTPUT CURRENT: 0 to 10 milliamperes.

ACCURACY: Within 1% above 10 volts, within 100 millivolts below 10 volts.

LOAD REGULATION: 0.02% for 0 to 10 ma.

RIPPLE: Less than 3 mv RMS above 5 cps.

OUTPUT IMPEDANCE: 0.15 ohms at 10 volts, rising linearly to 15 ohms at 1000 volts.

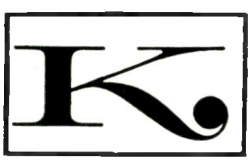
STABILITY: Within 0.02 volts ± 0.02% the first hour, or in subsequent 24-hour periods.

LINE REGULATION: Output change, less than 0.02 volts for a line change of 105 to 125 V.

RACK mounting, shown above with accessory end frames, bench mounting.

PRICE $325.00

SEND TODAY FOR COMPLETE DETAILS



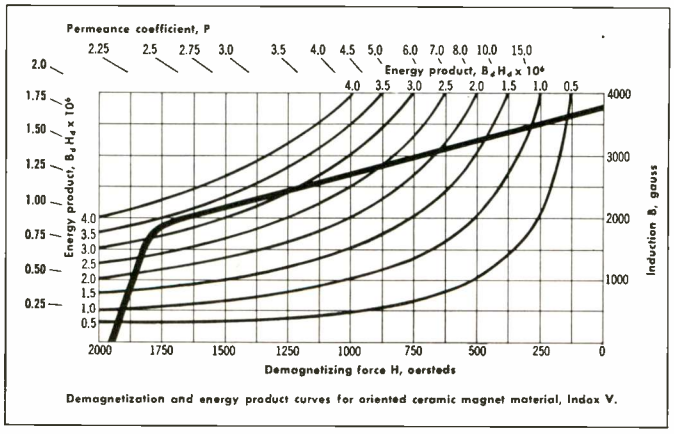
KEITHLEY INSTRUMENTS, INC.
12415 EUCLID AVENUE • CLEVELAND 6, OHIO

Circle 30 on Inquiry Card

INDOX V opens NEW design avenues in permanent magnet applications

Use of Indiana Steel's INDOX V *by design engineers continues to grow by leaps and bounds. So much so that the company has just completed a new plant solely for the production of this remarkable ceramic magnet material. Designers find it the answer where other materials didn't measure up. Today it's in big volume demand by major users of permanent magnets.*

Here's a summary of basic data on INDOX V. *Investigate this material. It has helped others outstrip competition — both in product design and cost reduction. It could do the same for you. Whatever you're working on, keep this information close at hand — or write for the complete story on* INDOX V, *and ask about design help on any project that involves permanent magnets.*



Demagnetization and energy product curves for oriented ceramic magnet material, Indox V.

What Is Indox V?

INDOX V is a *highly oriented* barium ferrite permanent magnet material—the first to be produced in this country on a commercial scale. Like other ceramics, it is a non-conductor, hard, brittle and lightweight—much lighter than metallic alloy magnets. It has an energy product 3½ times that of non-oriented ceramic magnets.

Typical Characteristics of Indox V

Coercive Force (H_c), oersteds	2,000
Residual Induction (B_r), gauss	3,840
Peak Energy Product ($B_d H_d$)	$3.5 \times 10_6$
Reversible Permeability	1.05
Temperature Coefficient of Reversible Flux Change	−0.19%/°C.
Magnetization Field for Saturation, oersteds	10,000
Chemical Composition	$BaFe_{12}O_{19}$
Specific Gravity	5.0 or .181 lb/cu in

INDOX V is made of readily available, non-critical materials — an important design consideration for long-range production plans. In the precisely controlled manufacturing process, magnet shapes are die-formed from powdered material under high pressure, then sintered in a special high-temperature furnace. Standard shapes of INDOX V magnets available from stock include wafers, rings and cylinders in most practical sizes. Special shapes and sizes can be produced for unusual applications.

Special Properties

The unique characteristics of INDOX V often have indicated its use in areas of design where the application of permanent magnets formerly was considered impossible.

High resistance to demagnetization. The high coercive force of INDOX V permits much shorter magnet lengths than is possible with other materials, but larger magnet area is necessary because of lower flux density.

High resistivity. As a non-conductor, INDOX V can be used where other materials would create unwanted current paths. In the presence of high-frequency alternating fields, eddy current losses and associated heating effects are extremely low.

Low incremental permeability. The change in flux that results from a change in demagnetizing influence is lower in INDOX V than in any other magnetic material. Thus, INDOX V maintains a more constant field in the presence of external fields because variations in its flux are small.

High energy per unit volume. On an equivalent weight basis, the energy product of INDOX V is comparable to that of Alnico V — the strongest permanent magnet material available — and 3½ times that of non-oriented ceramic magnets. Optimum area is 5⅓ times the area of an equal Alnico V magnet, about half the area of a non-oriented ceramic. Optimum length is 28 percent that of Alnico V. Since INDOX V requires less magnetic material and less space, the cost per unit of usable energy is extremely low.

Resistance to radiation environments. Recent comprehensive studies of the effects of nuclear radiation on permanent magnet materials indicate that INDOX V meets or exceeds environmental requirements for equipment likely to be used in nuclear-powered aircraft and ballistic missiles.

APPLICATIONS

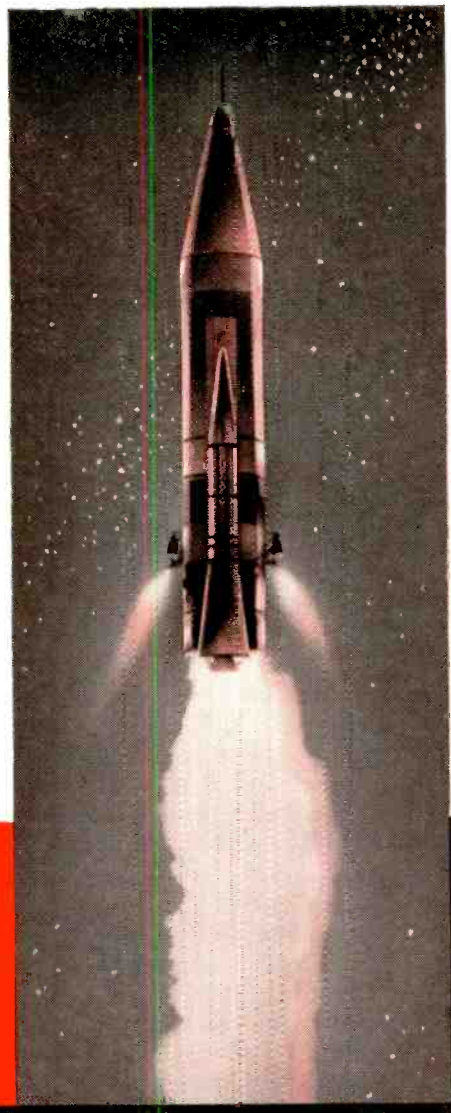
Electronic	Loudspeakers Ion pumps
Holding	Door closers: refrigerators Conveyors and automation Magnetic switches Magnetic chucks
Electro-Mechanical	Synchronous drives: Motors DC fields AC rotors Generators
Miscellaneous	Temperature control Magnetic separation

INDOX V has proved successful on the above applications. If you want to know more about this outstanding material in relation to your product write. Dept. N2.

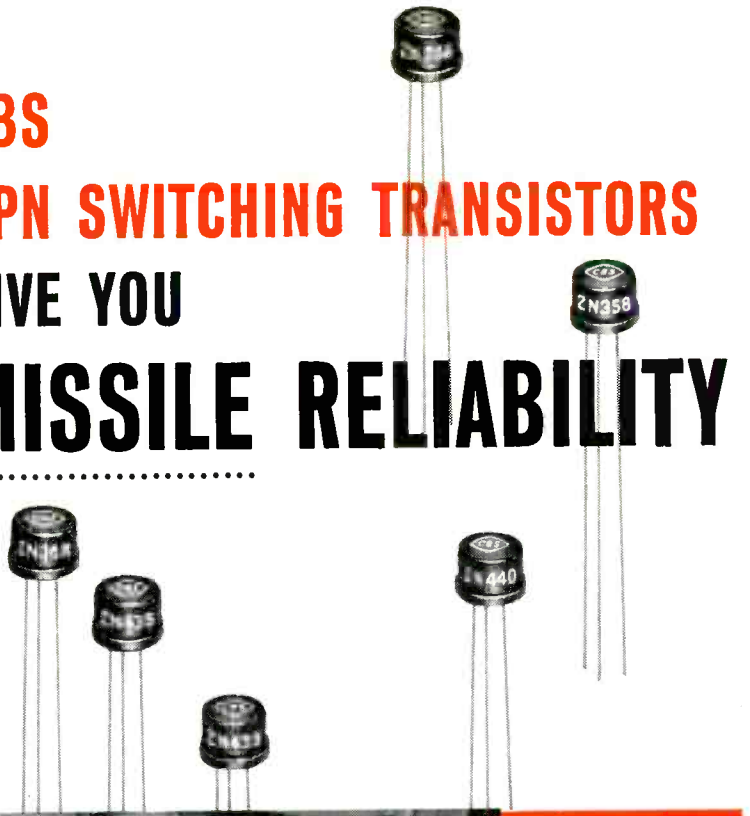
INDIANA STEEL PRODUCTS
Division of
Indiana General Corporation
VALPARAISO, INDIANA

INDIANA PERMANENT MAGNETS

IN CANADA: The Indiana Steel Products Company of Canada Limited, Kitchener, Ontario

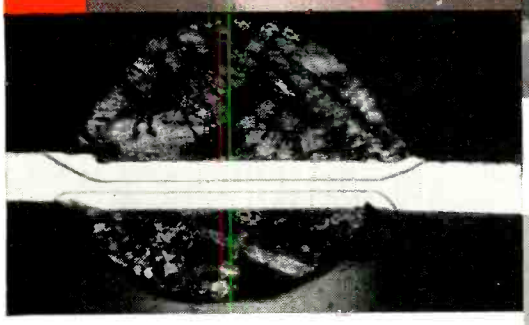


CBS NPN SWITCHING TRANSISTORS GIVE YOU MISSILE RELIABILITY



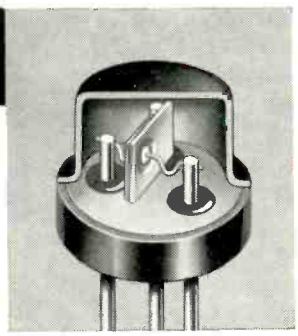
Here Are Some of the Reasons Why . . .

Contamination is eliminated. Baking, surface treatment, electrical testing and package welding are all conducted in dry-boxes at a dewpoint temperature below −90°F.



Flat, even junctions avoid "hotspots." Precise control of time and temperature (±0.03%) of alloying process eliminates localized heating, gives long reliable life. Characteristics are more uniform.

Ruggedness exceeds MIL specification. Severe requirements for shock (1000 g, 1 ms), vibration (10 g, 100-3000 cps) and acceleration (20,000 g) are met by: electronic welding of formed lead wires, horizontal base tab, and welded JEDEC TO-9 case.



CBS NPN switching transistors have proved themselves in flight in many of our important "birds." They have been found to have the advantages of fast switching, high voltage, low cutoff current, and low saturation resistance. All 28 of these CBS transistors exceed the MIL-T-19500A specification.

This same proven reliability under the most adverse environmental conditions is yours for military or industrial core drivers, logic circuits or general switching functions. Write for complete data sheet E-353. Order from your local Manufacturers Warehousing Distributor.

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CBS® semiconductors

Choose From . . .

2N306	2N357	2N388	2N439A	2N445	2N558	2N1000
2N312	2N358	2N438	2N440	2N446	2N634	2N1012
2N356	2N377	2N438A	2N440A	2N447	2N635	2N1090
2N356A	2N385	2N439	2N444	2N556	2N636	2N1091

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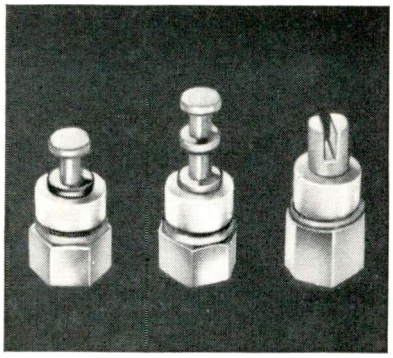
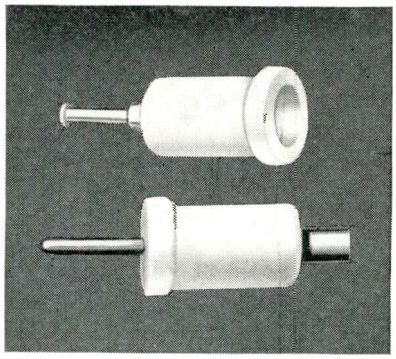
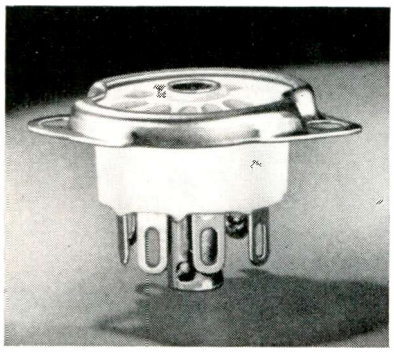
for the Electronics Industry



Chemelec Insulators



Chemelec Connectors



Chemelec Sockets

Plastic Shapes and Parts

RELIABILITY AT ITS ULTIMATE

Garlock electronic components are your assurance of reliable performance in missile guidance, fire control, radar, television . . . electronic systems that operate *only* as well as the smallest component within them. Garlock offers one of the most complete lines of engineered electronic components and materials available from a single source:

Chemelec* Standoff & Feed-Thru Insulators are made of Teflon† because of its exceptional dielectric properties, chemical inertness, resistance to extreme temperatures (−110°F to +500°F). The insulators resist severe shock and are designed for quick and easy installation. They are available in all sizes, designs and colors.

Chemelec Connectors are Teflon-insulated for outstanding high frequency service with plug-in crystal diodes, plug-in coils and forms, test probes. Once installed, they require no further adjustment or hardware. Male and female in .040, .050, .064 pin size, female also in .080 size.

Chemelec Miniature Tube Sockets are specifically designed for use where high or low ambient temperatures or frequency stability are problems. Body insulating material of Teflon and Kel-F**; all metal parts are precision made and plated to JAN specifications. Available in all sizes, types.

Plastic Stock Shapes and Intricate Parts, inserts, thin sections, threaded parts and precision tolerances are available. Excellent facilities and experience in compression and injection molding, extruding, machining of Nylon, Teflon, Delrin†, Kel-F.

Garlock facilities and personnel are also at your disposal for design and development of new electronic products.

GARLOCK

A complete engineering staff keeps abreast of new developments in electronics, reviewing latest techniques and materials thoroughly before introducing them into component products.

Find out more about what Garlock offers. Contact the Garlock Electronic Products representative near you. Call him, or write for Catalog AD-169, Garlock Electronic Products, The Garlock Packing Company, Camden 1, New Jersey.

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complete Gertsch line includes over 500 models featuring:

- **up to 0.0001% accuracy and linearity**
- **high input impedance**
- **low effective series impedance**
- **very low phase shift**

RT-10R

STANDARD RATIO TRANSFORMERS

Sixteen models of these variable, tapped auto-transformers are stocked, differing in mechanical construction, type of switching, number of decades, degree of resolution, max. input voltage, etc. Models available, either case-or rack-mounted.

1001

RATIO STANDARDS

Combining precision RatioTrans with precise resistive dividers, these units offer the ultimate in accuracy (up to .0001%), for calibration and instrument standard labs. Available in 6 combinations of AC & DC sections.

ST-100

SPECIAL-PURPOSE TRANSFORMERS

Gertsch produces many types designed for bridging, isolation, and calibration applications. Many models are available, varying in turns ratio, input impedance, and other specifications.

RRT-1

SHAFT-DRIVEN RATIOTRANS

—precision shaft-angle to AC voltage ratio transducers, with the ratio reading visible through a window in the case. Units are driven by ¼" shafts, and supplied in either 100-turn or 1000-turn models.

PROGRAMMABLE RATIOTRANS

—for automatic checkout equipment and other programmed devices. Gertsch units accept decimal, binary-coded decimal, or straight binary data arriving from punched tape or card readers. Units can be designed to customers applications.

You can set the ratios on these RatioTrans® by almost any method, from simple, manual in-line decade, to coaxial rotary set, proportional shaft position, or remote binary selection. MIL Spec. types available.

CRT-3

COAXIAL SWITCH RATIOTRANS

These small, lightweight instruments, accurate to 0.001%, are available in 2 types—one a 2½"-diameter unit qualified to MIL Specs...the other a 3½"-diameter unit, economically priced.

CRT models are available with up to 6-place resolution, and in a variety of decade arrangements. Gertsch also manufactures a complete line of coaxial-switched resistive dividers.

All types are built to typical Gertsch quality standards...many units available from stock. Requests for specials will be given prompt attention. For complete data, request Cat. #6.

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FOR 50-60 c/s WORKING

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In the standard frame sizes adopted by Bu. Ord. and R.A.E. for 400 c/s types, a range of 60 c/s servomotors and motor tachometers, suitable for 50 c/s operation also, is now in production. These efficient, high torque-inertia ratio motors are useful wherever a mains supply is available.

Size 18, 15 and 11 two phase motors are being produced similar to the Mark 8 Mod. 1, Mark 7 Mod. 1, and Mark 14 Mod. 2 400 c/s counterparts and motor tachometers similar to the Mark 16 Mod. 0 and Mark 12 Mod. 0. A 60 c/s size 11 motor tachometer, without a Bu. Ord. parallel, is also available.

These motors may be operated from a two phase supply or single phase supply split with a capacitor. Windings to suit customers' voltage requirements can be supplied.

60 c/s Information

	Type	*Stalled Torque*	*No load Speed*	*Output Voltage per 1000 r.p.m.*
Motor				
Size 18	18M10B4	3.5 oz. in.	3300	—
Size 15	15M10A4	1.45 „	3300	—
Size 11	11M10A10	0.63 „	3300	—
Motor Tachometer				
Size 18	18M10D6	3.5 oz. in.	3000	1.25
Size 15	15M10B8	1.45 „	3000	1.25
Size 11	11M10E1	0.6 „	3200	0.2

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ENGLAND

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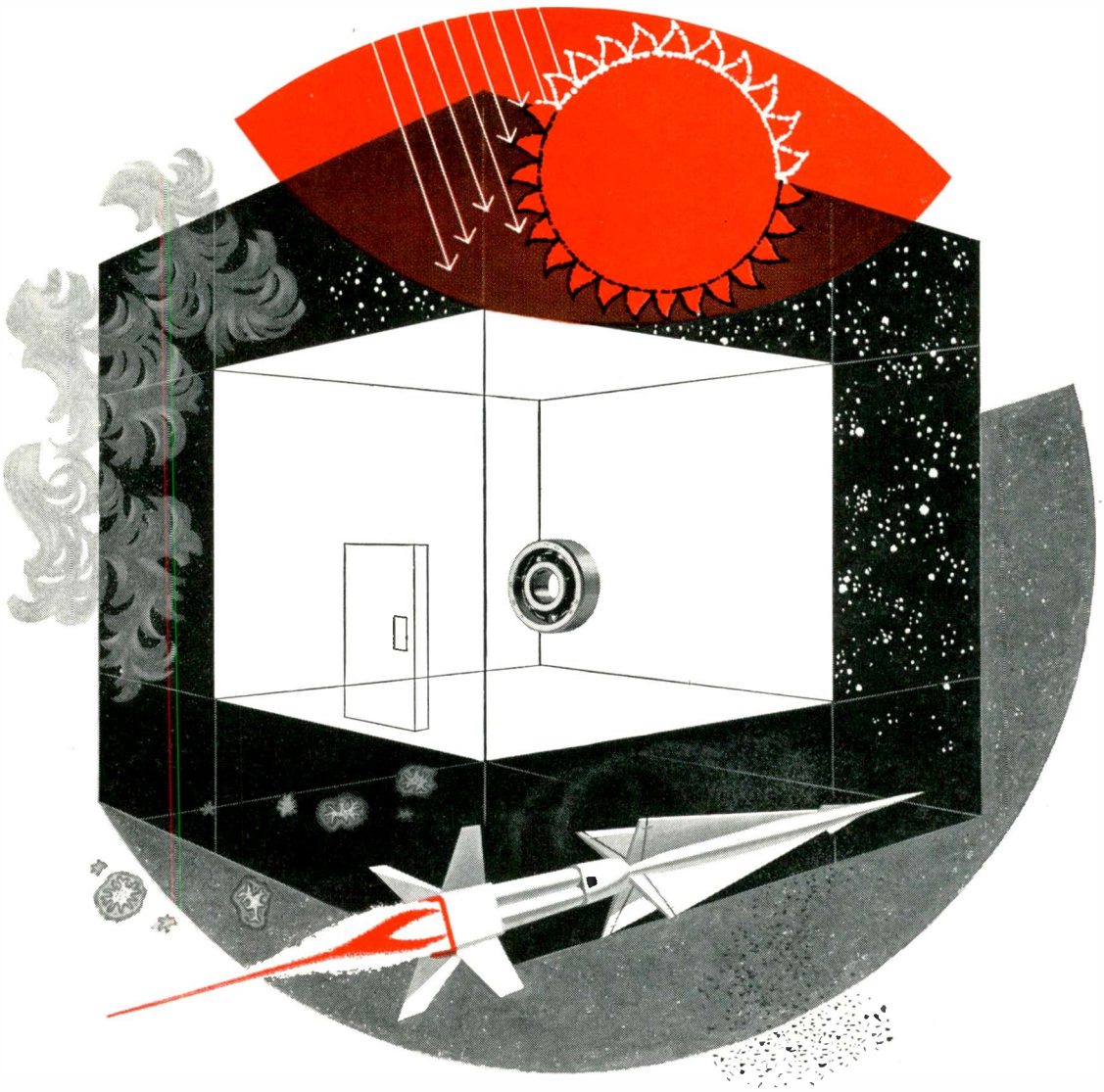

THOR
MACE
TITAN
HAWK
ATLAS
SNARK
NIKE B
BOMARC
NIKE ZEUS
SPARROW I
SPARROW II
SPARROW III
NIKE HERCULES
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REGULUS II
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REDSTONE
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N/D's Unique "White Rooms" Improve Miniature Ball Bearing Reliability!

In these rooms the most infinitesimal air-borne contaminants are scientifically whisked from the air . . . away from superprecision miniature ball bearing parts.

New Departure introduced the White Room nearly twenty years ago. And today, New Departure's concept is a pace-setting standard in miniaturization industries. At N/D, miniature ball bearings are completely assembled in properly humidified, temperature controlled atmospheres that approach fantastic levels of cleanliness. The most advanced air filter systems available are employed. In addition, pressurized access air locks and individual counter-top pressurized chambers are used by N/D's skilled technicians during final assembly and statistical inspections. Air-borne particles rarely ever touch bearing surfaces.

All N/D White Room equipment is of the most recent development and design—incorporating the highest order of today's technological know-how and reliability methods. These are just a few reasons why more and more major missile contractors rely on New Departure Miniature and Instrument ball bearings.

If you are working on a new miniature ball bearing application where reliability is critical, include an N/D Sales Engineer in your design discussions. Call or write Department L.S., New Departure Division, General Motors Corporation, Bristol, Connecticut.

NEW DEPARTURE

MINIATURE & INSTRUMENT BALL BEARINGS

proved reliability you can build around

Books

Encyclopedia on Cathode-Ray Oscilloscope and Their Uses, 2nd Ed.

By John F. Rider and Seymour D. Uslan. Published 1959 by John F. Rider, Publisher, Inc., 116 W. 14th St., New York 11. More than 1350 pages. Price $21.95.

This new edition presents worldwide known art on the application of this extremely valuable device in all areas of research.

The 2nd edition is a greatly expanded version of the extremely popular 1st edition. No known area of application of the cathode-ray oscilloscope is left uncovered. The authors have succeeded in serving the beginner as well as the experienced engineer. Both the elementary and advanced concepts of the tube are treated.

The explanations of the electrical organization of the device are very detailed, but not any less detailed are the many chapters devoted to uses. Such information was gathered from research organizations of all kinds, thus making the contents truly encyclopedic.

Certain chapters contain information not to be found anywhere else. For instance, one chapter deals with square waveform testing of amplifiers. The response curves are described which will produce indicated changes in the shape of the output signal. The amplifier response curve responsible for the change in waveform as well as the resultant waveform is illustrated.

Nature and Properties of Engineering Materials

By Zbigniew D. Jastrzebski. Published 1959 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 571 pages.

This book approaches the fundamental nature of materials from an engineering viewpoint. It provides the reader with a basic knowledge necessary for intelligent selection and use of materials for specific engineering applications and prepares him to solve materials problems of the future. Furthermore, this approach offers a close link between the basic sciences of chemistry, physics, and engineering practice.

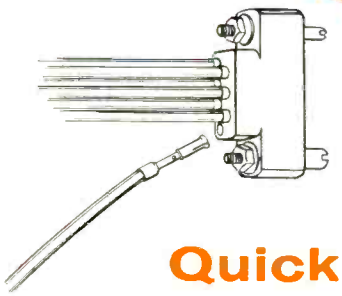
The book begins with a consideration of the basic concepts of interatomic and intermolecular forces and their relationship to the structural characteristics of both crystalline and amorphous materials. This is followed by the discussion of such phenomena as diffusion, crystallization, phase transformation, and phase equilibria. These principles are further developed in the subsequent chapters which consider more specifically the characteristic properties and uses of a wide variety of engineering materials.

SNAP-IN....SNAP-OUT CONTACTS NO TOOLS REQUIRED

REMI®

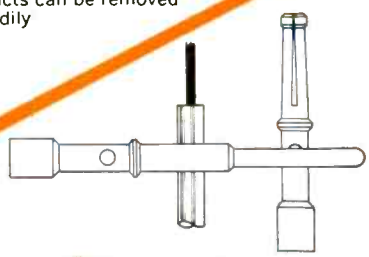
RE-ENTRANCY MINIATURE

REMI means the best in . . . **RE**movability, **RE**liability, **RE**entrancy



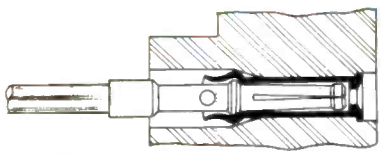
Quick...

Individual contacts can be removed or replaced readily without tools



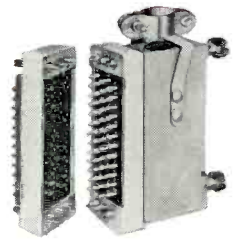
Simple...

Individual contacts are wire-crimped away from connector, facilitating operation.

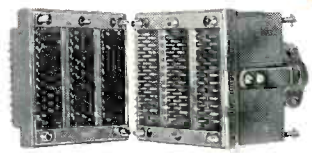


Sure...

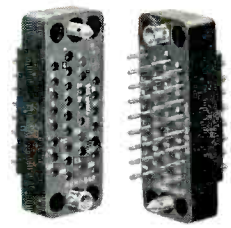
Light hand pressure seats female or male contact firmly in sleeve. Sleeve acts as guide for mating male contact, assuring ease of connector mating and operational stability.



REMI-BSL



REMI-BMSL



REMI

- Mechanical stresses are confined between metallic elements rather than between metal and plastic insulation
- Sleeve, which is part of connector block, allows for interchangeability of male and female contacts on the same connector, at will.
- Additional polarization and keying can be accomplished with ease by use of dummy pins.
- Conforms to Mil Spec MIL-C-25955.
- Contacts are removed from mating or terminal side of connector at your discretion without tools.
- Terminals are designed to meet all types of crimp-on requirements. Terminals can be provided with solder cup, turret, eyelet design.
- All REMI design features combine to offer the ultimate in reliability under extreme environmental conditions.

U.S. COMPONENTS, INC.

Associated with U. S. Tool & Mfg. Co., Inc.

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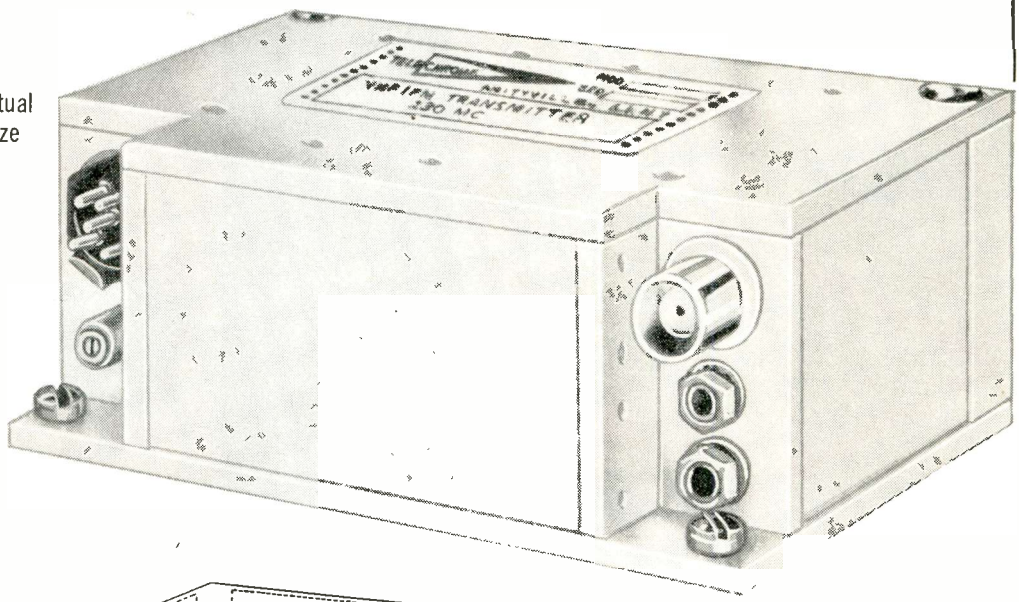
U. S. and Foreign Patents applied for

Circle 17 on Inquiry Card

TELECHROME TRANSMITTER*

actual size

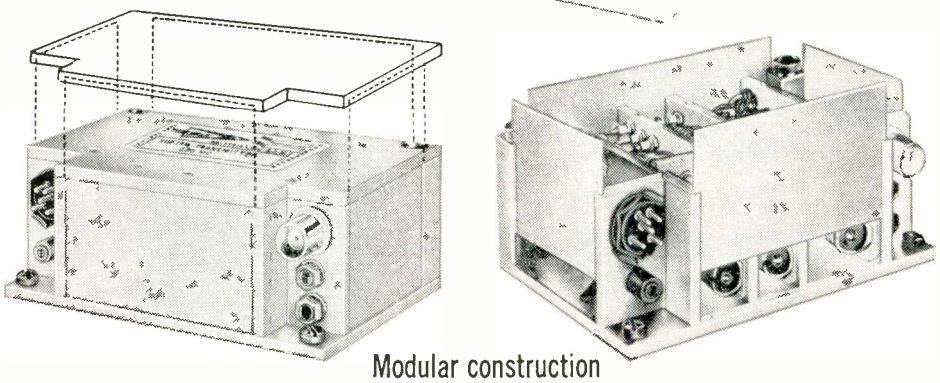


215-260 mc
FM/FM TELEMETERING TRANSMITTER
Model 1483A1

Features:

- Power output 4 to 5 watts.
- AFC Loop crystal controlled for ± .005% carrier stability.
- Modular construction.
- Silicon Transistors for Low Noise and High Efficiency.
- Modulation Distortion Less than 1%.
- Very low spurious emission
- Plug-in tubes
- —40° C to +100° C
- Size 1⅝" x 2¾" x 4".

Write for Data Sheets



Modular construction

All circuitry mounted on rugged bulkheads. Each may be removed individually for servicing or replacement. Spare modules available. Top of case and side panels removable separately for easy access to all parts.

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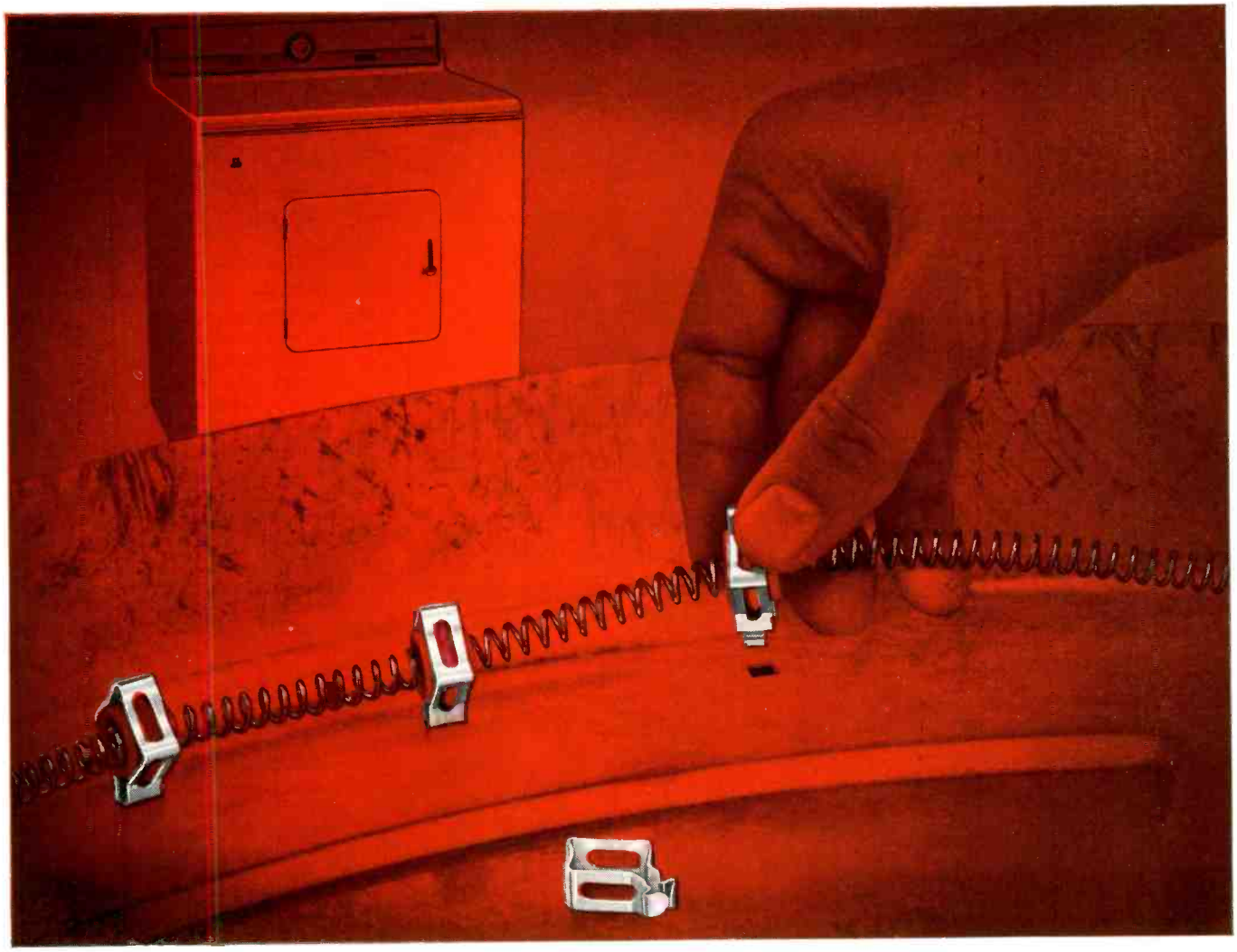
SOUTHWESTERN ENGINEERING DIVISION • 4207 Gaston Ave., Dallas, Tex., TAylor 3-3291

*Even transmits in Russian.



Engineered by Tinnerman . . .

SPEED CLIPS® reduce costs, simplify assembly and servicing on Maytag "Halo of Heat" Dryer

Clothes are dried efficiently in the famous Maytag "Halo of Heat" automatic dryer. And now the quality of the "Halo of Heat" dryer is even better than ever because its unique circular heating element is fastened quickly, securely by 22 special Tinnerman SPEED CLIPS developed by joint efforts of Tinnerman and Maytag designers.

Each one-piece SPEED CLIP eliminates a separate welding operation on the "Halo of Heat" assembly. Various screw-driving operations formerly required on Maytag's assembly line to capture the ceramic insulator and secure the mounting clamp were also eliminated, with equally interesting reductions in cost. Now, the stainless steel, vibration-proof fastener is snapped in place with simple "button-hook" action. No special skills or equipment are required. Assembly and parts costs have been reduced . . . *substantially!* Serviceability in the field has been improved.

A free Tinnerman Fastening Analysis of your own product can show you where similar assembly and cost-saving advantages are possible. Call your Tinnerman representative—he's listed in the Yellow Pages under "Fasteners". Or write to:

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Dept. 12 • P. O. Box 6688 • Cleveland 1, Ohio

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Speed Nuts®

FASTEST THING IN FASTENINGS®

CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessories Ltd., Treforest, Wales. FRANCE: Simmonds S. A., 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Mecano-Bundy GmbH. Heidelberg.

Books

The Theory of Optimum Noise Immunity

By V. A. Kotel'nikov. Translated from the Russian by R. A. Silverman. Published 1959 by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36. 140 pages. Price $7.50.

In 1947 the author, a communications engineer already well-known for his work on sampling theorems for band-limited functions, published a doctoral dissertation that has proved to be one of the most important Soviet contributions to the statistical communications art. Because this work was virtually unknown outside the U.S.S.R. until quite recently, few Western scientists were aware that Dr. Kotel'nikov had developed a statistical analysis of communication problems (using what we now call decision theory techniques), which anticipated by several years much of the work by Western communication experts.

The author's approach is always that of a practical engineer. He invokes only the most elementary notions of probability theory; the steps in his analysis are easy to follow; and his primary intention is to establish the behavior of communications systems at a level that is of practical use to the engineer. The development is also notable for its lack of dependence on advanced mathematics. The reader who is passingly familiar with Fourier series, discrete and continuous probabilities and probability densities (simple, joint, and conditional), and the notion of statistical independence will have no trouble with the material.

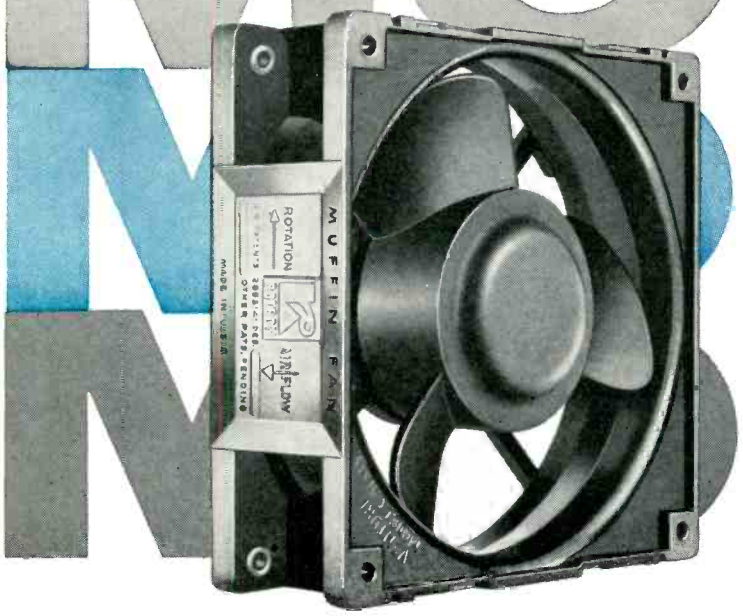
The author made extensive use of geometric models of the signalling and detection process as operations on vectors in multi-dimensional space, an artifice that Shannon introduced later. The reader will find these geometric interpretations very helpful. The subject matter of almost every chapter is reviewed in terms of the geometric model at the end of the chapter.

Economic Control of Interconnected Systems

By Leon K. Kirchmayer. Published 1959 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 207 pages.

This book has as its primary thesis the treatment of mathematical methods, computers, and controllers to obtain the optimum economic operation of interconnected electric utilities systems. The theories and application featured represent pioneering applications of optimalizing computer control in continuous process industry.

MOST MOST MOST



most economical,
most compact, most efficient
cooling fan of its size!

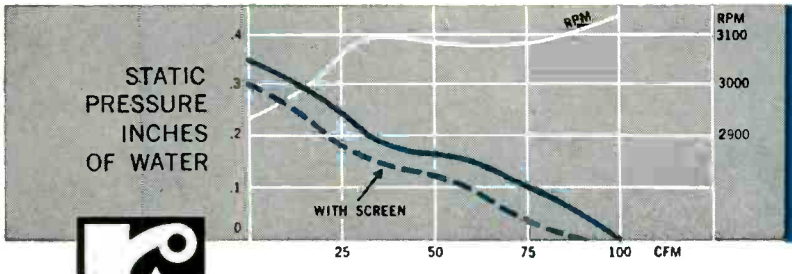
ROTRON **MUFFIN®** FAN

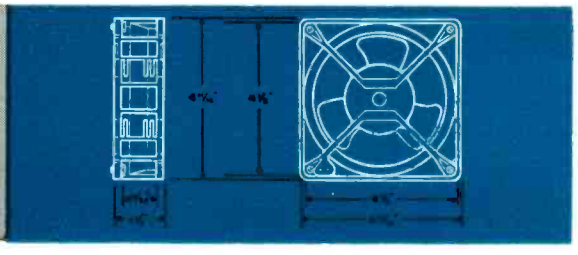
Unlike conventional or phonograph motor assemblies, the MUFFIN FAN boasts a high air performance of 100 CFM free delivery from a basic package only 4-11/16" square and 1½" deep and weighing just 1.2 pounds.

Power requirement is 105 to 120 VAC, 60 cycles, single phase. Electrical connections made to convenient terminal lugs accepting standard 18 gauge lamp cord. Completely original aero-dynamic design permits operation through a dust filter and tightly packed electronic equipment. Airflow instantly reversible by turning fan end-for-end.

The MUFFIN FAN is a completely integrated cooling unit consisting of propellor, stator assembly and venturi block. It is also available in combination with a grille assembly and all-purpose mounting clips to form a **complete** package. Unbelievably thin, the MUFFIN FAN can be installed in seconds in cabinet cutout, imposing practically no space requirement within the enclosure.

Cool economically...the MUFFIN FAN can be supplied at a price less than $8.00 per unit in quantity. The low cost, high performance, compact size and maintenance-free design provide efficient air cooling previously unobtainable. Write for complete details...





ROTRON® **ROTRON mfg. co., inc.**

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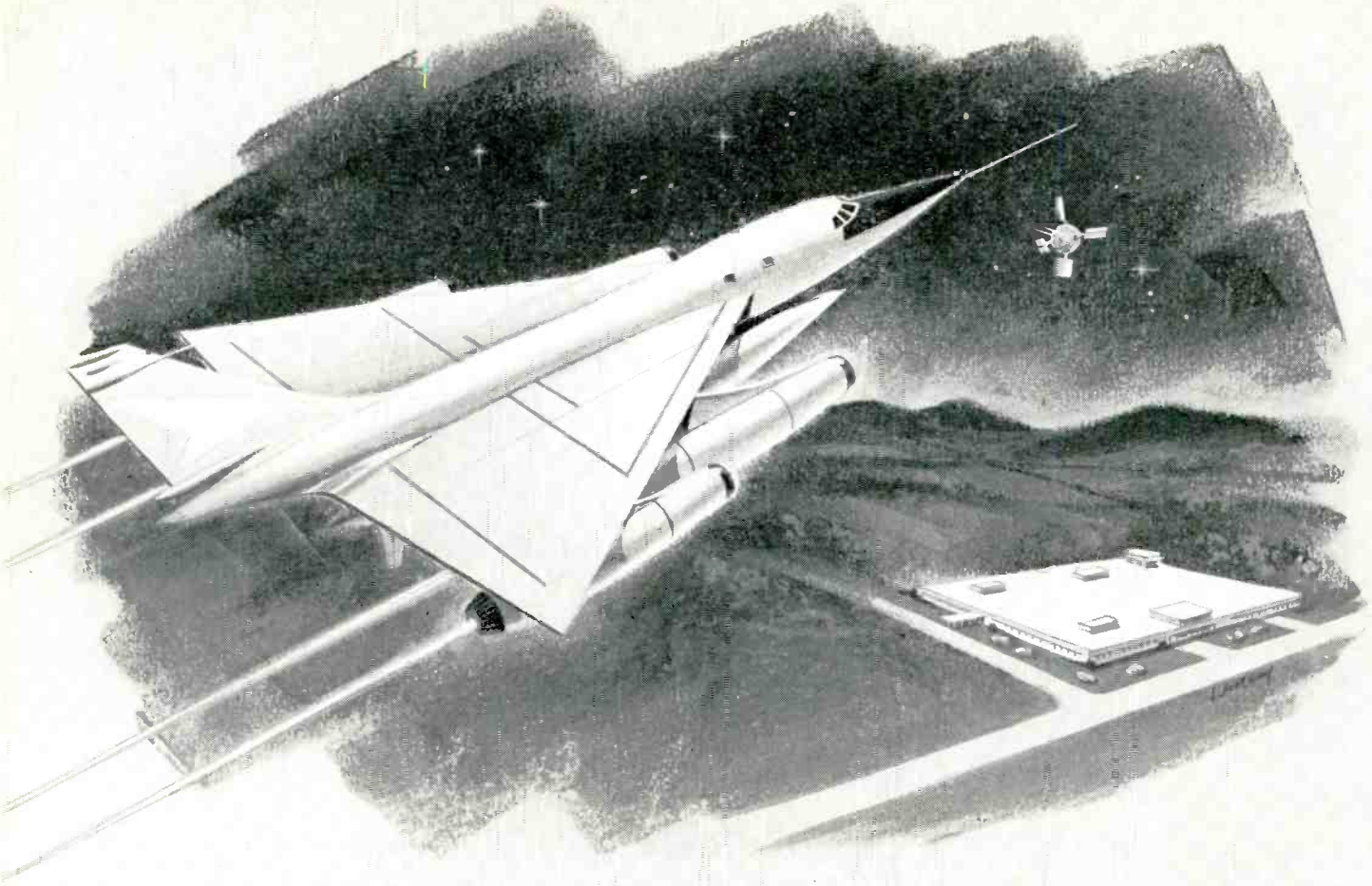


Expanding a capability. . .

Raytheon's Airborne Electronic Subdivision this month occupies a new multi-million dollar research and development laboratory.

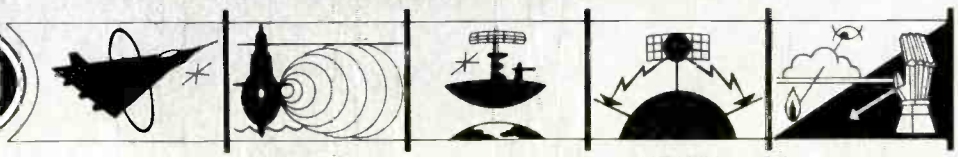
Creative effort within this new facility will be directed at featherweight transistorized Doppler radars; altimetry and terrain clearance techniques; satellite weather radar studies; airborne early warning radars; missile boost, flight and terminal guidance problems; radiometry; and other areas.

Like the B-58's sophisticated search and Doppler radars, the systems, subsystems or equipments developed will find application in manned aircraft, missiles, drones, and a variety of space carriers.

To engineers and scientists with particular interest in this work, the new laboratory offers complete professional satisfaction in an academic environment. For immediate information on select staff appointments, write Mr. Donald H. Sweet, Engineering & Executive Placement, Raytheon, 624 T Worcester Road, Framingham, Mass. (suburban Boston).

AIRBORNE ELECTRONIC
GOVERNMENT EQUIPMENT DIVISION

RAYTHEON
EXCELLENCE IN ELECTRONICS



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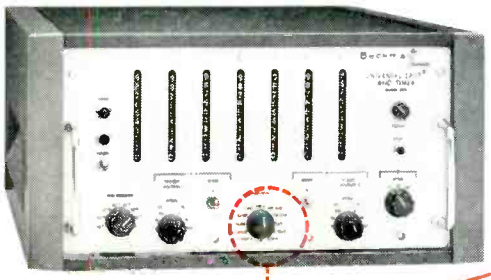
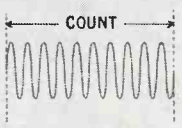
10 Mc COUNTER

does everything without plug-ins

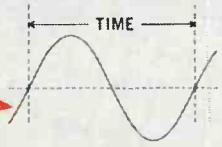


FUNCTION

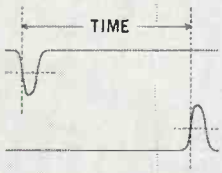
TEST
PER B
PER B×10
E/UT
TIM B-A
SCAN
E/B
E/UT×10
E/B×10
COUNT-E
OFF
E/B-A



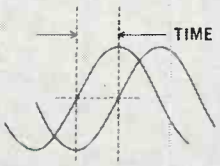
Frequency counting to 10Mc **with 0.1v sensitivity**



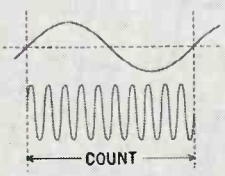
Period measurements in 0. 1μsec units



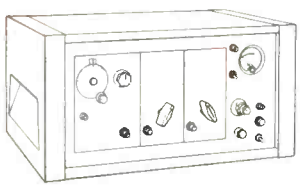
2-channel time interval measurements



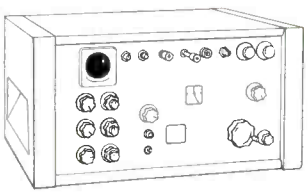
Phase difference measurements



Frequency ratio measurements



Add this heterodyne unit (Model 7570 Series) to measure frequencies up to 1000Mc.



Or add this computing transfer oscillator (Model 7580) to get a counter display of frequencies up to 15,000Mc.

Complete specifications on Models 7370, 7570 and 7580 will be sent on request.

Beckman

Berkeley Division
2200 Wright Avenue, Richmond 3, California
a division of Beckman Instruments, Inc.

T21

Books

Electron Physics

By O. Klemperer, Ph.D. Published 1959 by Academic Press Inc., Publishers, 111 Fifth Ave., New York 3. 248 pages. Price $7.00.

This work is basically an extension of the lecture courses which Dr. Klemperer has delivered for many years to Honours students at Imperial College, University of London. As such it is a text for undergraduate students, though, to make it as comprehensive as possible, some sections have been included which would suit a graduate course. In Part I, the author has added material, carefully selected from his experience in industrial research, which provides the fundamental equipment required in electronic engineering and serves the needs of other disciplines which have a practical bias.

This volume is the physics of the free electron. It includes primarily the subjects of electron dynamics and electron optics and deals with the interaction of free electrons with electromagnetic fields and with matter, including problems of electron emission and of electron collisions with atoms. In a wider sense, electron physics is also concerned with "quasi-free" electrons, such as conduction electron in metals and in semiconductors, which in many respects can be treated like free electrons.

Books Received

Annual Proceedings, JTAC

Published jointly by the Institute of Radio Engineers, 1 E. 79th St., New York and Electronic Industries Assoc. Price $5.00.
This is volume XVI. It covers official correspondence between the FCC and the JTAC and approved minutes with a period July 1, 1958 to June 30, 1959.

Effects of Nuclear Radiation on Men and Materials

By T. C. Helvey. Published 1959 by John F. Rider Publisher Inc., 116 W. 14th St., New York 11. 64 pages, paper bound. Price $1.80.

Low Frequency Amplifier Systems

Edited by Dr. A. Schure. Published 1959 by John F. Rider, Publisher Inc., 116 W. 14th St., New York 11. 80 pages, paper bound. Price $1.80.

R-L-C Components Handbook

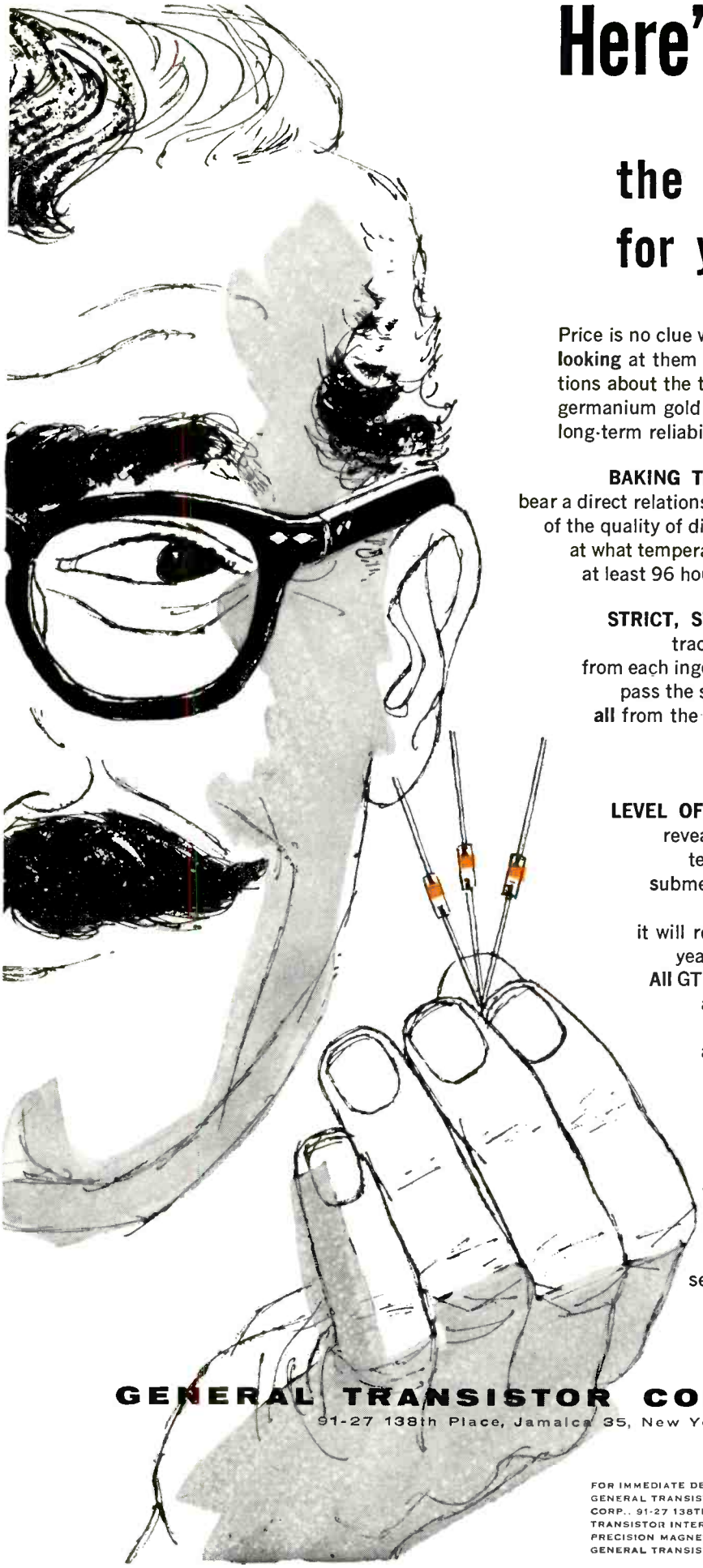
By David Mark. Published 1959 by John F. Rider Publisher Inc., 116 W. 14th St., New York 11. 104 pages, paper back. Price $3.50.

1959 Registry of Common Carrier and Miscellaneous Radio Systems

Published 1959 by Communication Engineering Book Co., Monterey, Mass. 58 pages, paper bound. Price $3.00.

Transistor Manual, 4th Edition

Published 1959 by General Electric Co., Semiconductor Products Dept., Charles Bldg., Liverpool, N. Y. 227 pages, paper back, spiral bound. Price $1.00.



Here's how to pick the best DIODES for your money

Price is no clue when diodes sell for about the same, and just **looking** at them tells nothing. But if you ask the right questions about the three key factors in the production of **quality** germanium gold bonded diodes, you have your clues to more long-term reliability for your money. Here they are:

BAKING TIME AND TEMPERATURE
bear a direct relationship to long-term stability. You get a measure of the quality of diodes by asking: "How long do you bake, and at what temperature?" (**All** GT diodes are baked at 140°C for at least 96 hours—the highest and longest in the industry!)

STRICT, STATISTICAL, HISTORY LOGGING
traces the progress of every single wafer made from each ingot of germanium. At GT, if a few wafers fail to pass the stringent GT quality tests along the way, then **all** from the ingot are suspect and can be identified and pulled out. There are no "stowaways" in a shipment of GT quality diodes.

LEVEL OF TESTING STANDARDS
reveals the level of quality. Ask about "everyday" test standards. (In the GT Seal Test, diodes are submerged in a penetrant-dye solution for 24 hours under 75 psi. This test is so sensitive that it will reveal a leak so small it would take over 300 years for 1 cc of gas to diffuse through the case.) **All** GT quality tests—100% electrical, 100% shock and vibration, and 100% temperature cycling—are at the highest industry level... and as a final mark of quality, the color bands on GT Germanium Gold Bonded Diodes are baked on to stay.

GT is equipped to supply diodes tested to individual customer requirements, such as JAN Qualification Inspection Tests and many others.
To get the full measure of quality in Germanium Gold Bonded Diodes, see your GT representative; or write directly to the company with know-how **NOW.**

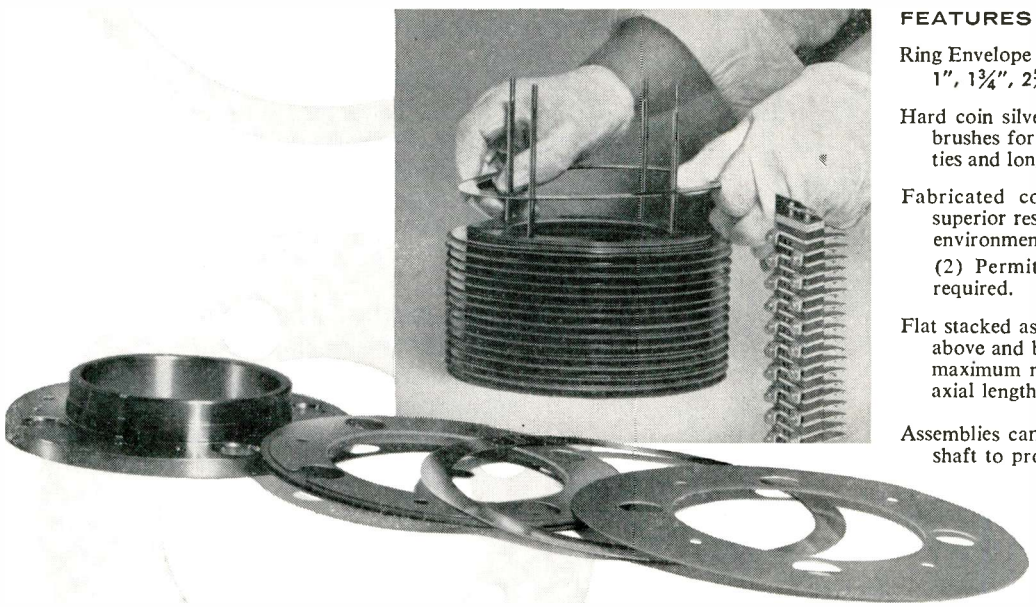
GENERAL TRANSISTOR CORPORATION
91-27 138th Place, Jamaica 35, New York

FOR IMMEDIATE DELIVERY FROM STOCK, CONTACT YOUR NEAREST AUTHORIZED GENERAL TRANSISTOR DISTRIBUTOR OR GENERAL TRANSISTOR DISTRIBUTING CORP., 91-27 138TH PLACE, JAMAICA 35, NEW YORK. FOR EXPORT: GENERAL TRANSISTOR INTERNATIONAL CORP., 91-27 138TH PLACE, JAMAICA 35, NEW YORK. PRECISION MAGNETIC RECORDING HEADS AVAILABLE FROM GENERAL TRANSISTOR WESTERN CORP., 6110 VENICE BLVD., LOS ANGELES, CALIF.

AN ANALYSIS covering over four thousand custom slip ring assemblies designed and produced by Breeze Corporation during the past seventeen years has shown that a substantial number of these requirements have been for assemblies having similar size and operating characteristics.

Now . . . to meet these repetitive requirements more rapidly and at reduced costs, Breeze offers seven standard size slip rings with ring envelope diameters from 1" through 10½".

SEVEN STANDARD SLIP RING SIZES NOW in stock!



FEATURES

Ring Envelope Diameters:
1", 1¾", 2⅝", 4⅞", 9⅝", 10½".

Hard coin silver rings and silver graphite brushes for excellent electrical properties and long life.

Fabricated construction (1) Provides superior resistance to shock, vibration, environmental conditions.
(2) Permits addition of rings when required.

Flat stacked assembly with rings mounted above and below each barrier provides maximum number of rings in shortest axial length for rated capacities.

Assemblies can be stacked on a common shaft to produce a multiple unit.

You'll want a copy of the new Breeze catalog 66 SR which contains complete details on these standard units. Catalog 66 SR also describes a wide range of custom units and incorporates a design guide section. Write for your copy today.

BREEZE MARK

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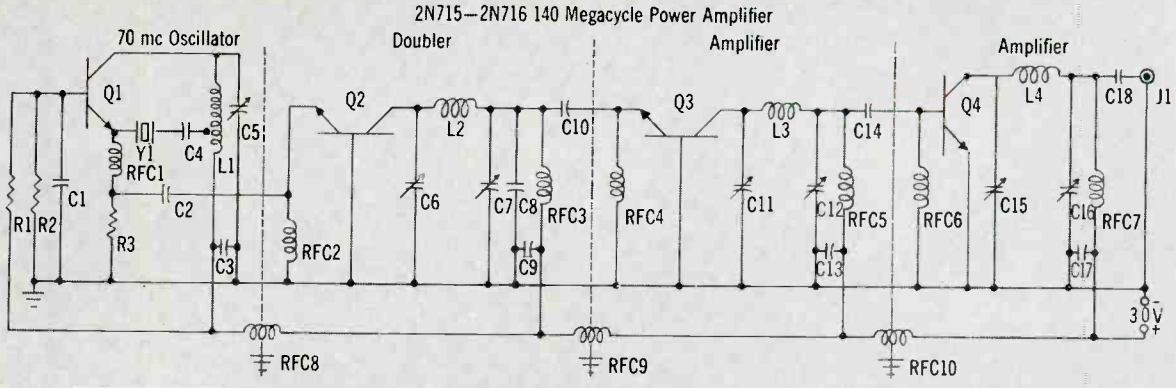
How to design 250 mw at 140 mc transistorized power amplifiers

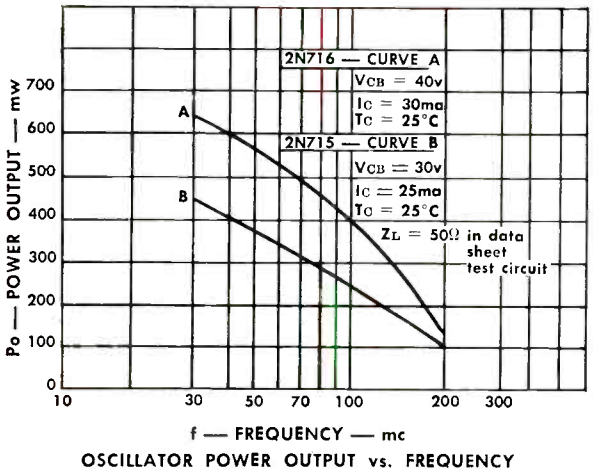


ACTUAL SIZE

C1, C2, C3—.001 μf disc ceramic
C4,—20 μμf tubular ceramic
C5, C6, C7, C11, C15—1.8-13 μμf
C8,—47 μμf silver mica
C9, C10, C13, C14, C17, C18—500 μμf disc ceramic
C12,—7—45 μμf mica trimmer
C16,—3.2—50 μμf
L1,—8 turns #408 Airdux, tapped 2 turns from ground
L2,—4 turns #12 magnet wire, ½" D, ¾" L
L3,—3 turns #12 magnet wire, ½" D, 7/16" L

L4,—3 turns #12 magnet wire ½" D, ⅜" L
Q1, Q2, Q3, Q4,—TI 2N716
R1—5100 ohms, ½ watt
R2—680 ohms, ½ watt
R3—200 ohms, ½ watt
RFC1—.47 μh
RFC2—4.7 μf
RFC3 through RFC10
1.2 μh
Y1—70 mc crystal

...with NEW TI 2N716 silicon mesa transistors



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Now . . . silicon high frequency transistors *specifically* designed for your VHF power circuits . . . another addition to the industry's broadest line of silicon mesa transistors (now 16 TI types!).

TI 2N715 and TI 2N716 *guarantee 500-mw amplifier output at 70 mc* and provide *100-mw typical power output at 200 mc.*

These subminiature (TO-18) silicon units feature . . . 1.2-w dissipation at 25°C case temperature . . . 10-50 beta spread . . . collector reverse voltages of 50 and 70v . . . maximum collector reverse currents of 1.0 μa (25°C) and 100 μa (150°C).

Check the guaranteed specs below and take immediate advantage of advanced performance in your designs. Both units are ready for your orders in every TI distributor's stocks today, and in quantities of 1,000 and up from your nearest TI sales office.

Tentative Specifications 2N715 - 2N716

1 P_C T_C = 25°C watt	Tstg °C	2 V_{CB} v dc	2 V_{EB} v dc	3 V_{CE} v dc
1.2	−65 to + 175	+70 (2N716) +50 (2N715)	+5	+40 (2N716) +35 (2N715)

Parameter	Test Condition	2N715 Min	2N715 Typ	2N715 Max	2N716 Min	2N716 Typ	2N716 Max	Units
**BV_{EBO}	I_{EBO} = 100 μ a I_C = 0	5			5			v dc
***BV_{CBO}	I_{CBO} = 10 μ a dc I_E = 0	50			70			v dc
*h_{FE}	V_{CE} = 10 v dc I_C = 15ma dc	10		50	10		50	
*$V_{CE(sat)}$	I_C = 15ma I_B = 3ma	1.2			1.2			v dc
C_{ob}	V_{CB} = 5 v dc I_E = 0 F = 1 mc		3	6		3	6	μμf
Amplifier Power Output and	(V_{CB} = 40 v dc (I_C = 30 ma dc (P_o (AC) = 500 mw (F = 70 mc				500 4	600 7.5		mw db
Transducer gain	(V_{CB} = 30 v dc (I_C = 25 ma dc (P_o (AC) = 300 mw (F = 70 mc	300 4	400 8					mw db

1 This power rating for 1000 hours expected life at a case temperature of 25°C derated linearly to +175° case temperature at the rate of .125°C per mw.
2 Maximum voltage ratings at an ambient temperature of +25°C.
3 BV_{CEO}: This is the voltage at which h_{FE} approaches one when the emitter-base diode is open circuited. This value may be exceeded in applications where the dc circuit resistance (R_{BE}) between base and emitter is a finite value.
When the emitter-base diode has a reverse voltage applied, peak collector to emitter voltage equal to BV_{CBO} minus V_{EB} may be allowed. Such conditions may be encountered in class B or C amplifiers and oscillators.
*Pulse Measurement
**Specify I_{EBO} on commercial data sheet
***Specify I_{CBO} on commercial data sheet

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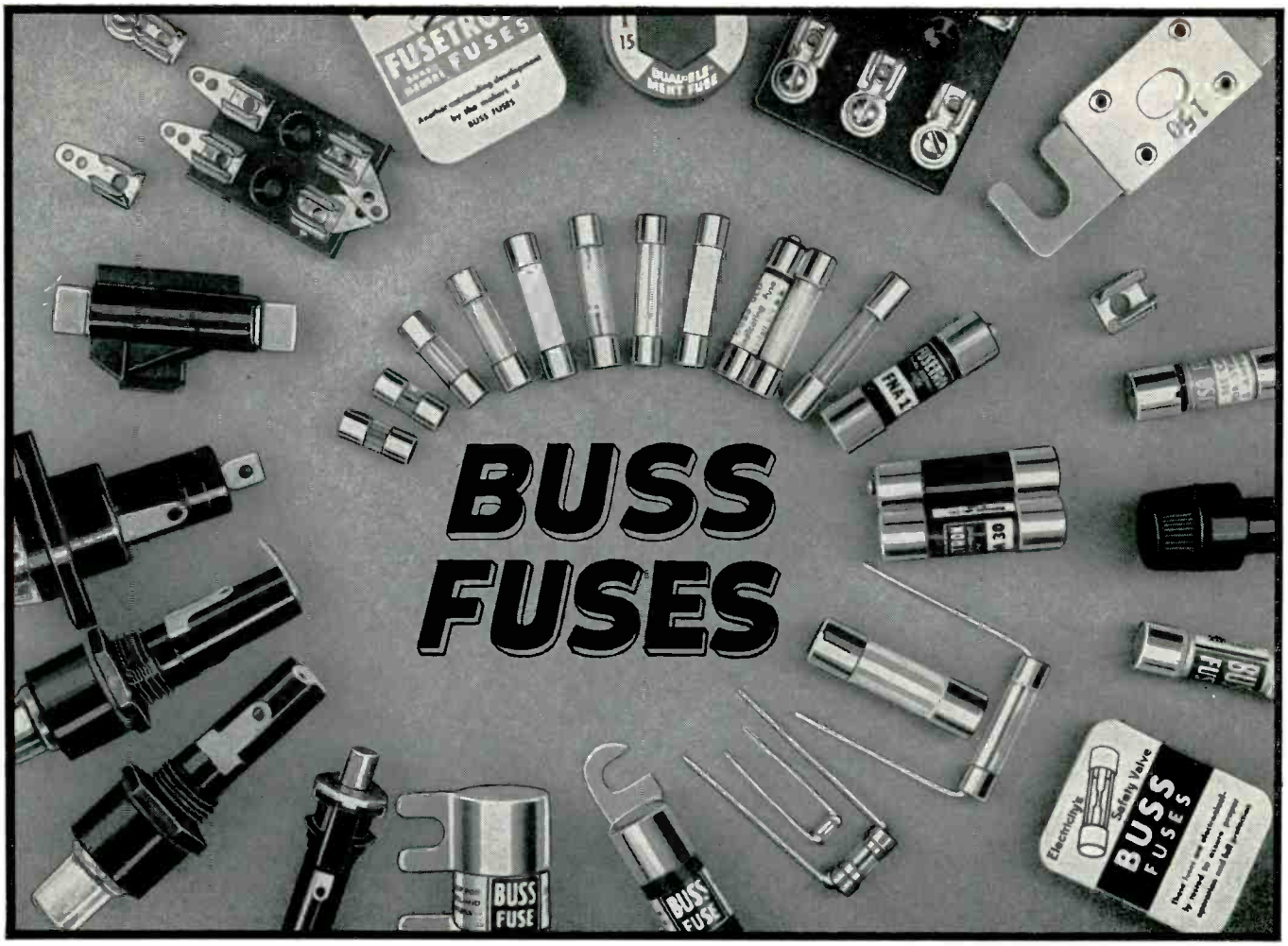

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Dependable BUSS Fuses safeguard both your product . . .

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When you specify BUSS or FUSETRON fuses for the products you manufacture, you not only provide the finest electrical protection possible — but you also help protect your company's reputation for quality products.

Remember: No matter how good your product is, a poor quality fuse that opens needlessly deprives a customer of the use of your device, — or a fuse that does not protect may permit costly damage to occur. In either case you may lose a customer's goodwill and future business.

Why take the risk when you know you can depend on BUSS and FUSETRON fuses?

Every fuse is tested in a sensitive electronic device that automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

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To meet all your fuse needs, the BUSS line is most complete, — including a companion group of fuse clips, blocks and holders.

To help you on special problems in electrical protection . . .

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University at Jefferson, St. Louis 7, Mo.

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Circle 49 on Inquiry Card

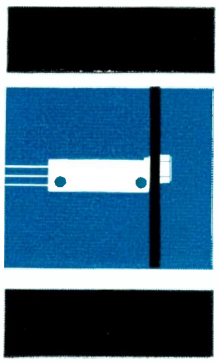
Subminiature ...
Proven Reliability

ACTUAL SIZE

TRIMPOT® MODEL 220

As many as 17 of these compact units can be mounted in a space of just one cubic inch. Designed for printed circuits and modular assemblies, Trimpot Model 220 measures less than 3/16″ x 5/16″ x 1″. Power rating is 1 watt and maximum operating temperature is 175°C. This Potentiometer meets or exceeds Mil-Specs for humidity, salt spray, fungus, sand and dust, as well as acceleration, vibration and shock. Self-locking 15-turn shaft insures sharp, stable settings...exclusive Silverweld® fused-bond termination and ceramic mandrel provide extreme temperature stability. The Model 220 is available in a wide variety of resistance ranges and a choice of two terminal types—gold-plated Copperweld wire or insulated stranded leads.

Stocked by leading electronic distributors across the nation, these units are ready for immediate delivery. **Write for complete technical data and list of stocking distributors.** AVAILABLE AS PANEL MOUNT UNIT (illustrated at right) with same specifications.



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Letters

to the Editor

"Strain Calibrator"

Editor, ELECTRONIC INDUSTRIES:

We are interested in the excellent article, "A Dynamic Strain Calibrator," by Morris Halio which appeared in the December issue. Mr. Halio and your readers may be interested to know that the "new" foil strain gages which he describes have been manufactured and marketed for several years by the Electronics and Instrumentation Division of Baldwin-Lima-Hamilton as a part of their standard strain gage line. They were, as he states, developed in England, and are produced by B-L-H under an exclusive licensing agreement with the British patent holder, Technograph Instruments Company.

Brooks R. Major
Product Supervisor
SR-4® Strain Gage Equipment
Baldwin-Lima-Hamilton Corporation
Electronics and Instrumentation Division
Waltham 54, Mass.

"Coming Events Calendar"

Editor, ELECTRONIC INDUSTRIES:

"Please accept our thanks for the very fine job Electronic Industries did on the '1960 Coming Events Calendar.' I am certain that many in our industry are planning, as we are, to file the article as a handy reference for coming events in 1960. . . ."

V. V. Marchi
Applications Engineer

"June Directory"

Editor, ELECTRONIC INDUSTRIES:

". . . Thank you for an ever-improving magazine. Your June Directory has been a very useful desk-side encyclopedic source of most difficult to assemble 'elsewhere' type of information. The Military agency section could be possibly expanded next year to include the names and code addresses of top level technical personnel as well as procurement personnel."

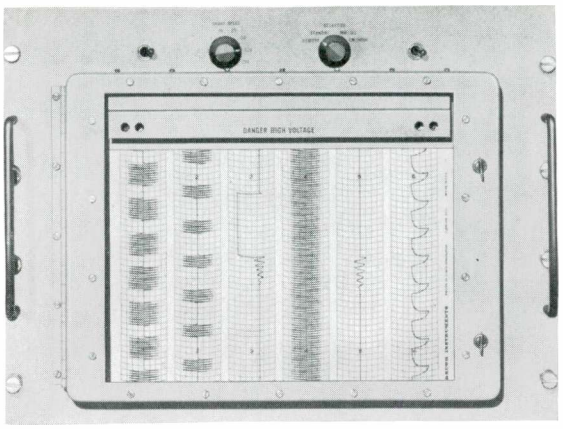
Adolph Warsher, P. E.
Consulting Engineer
Reliability Control Engineering

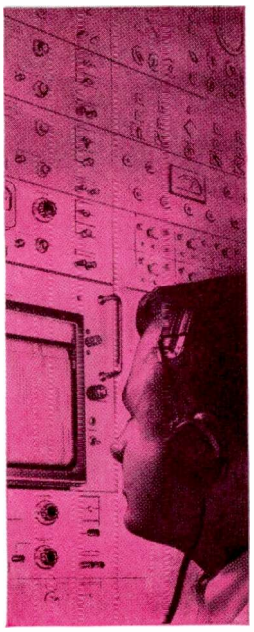
Ed: Thanks for this plug and suggestion. We will consider the possibility of including top technical personnel in our June All-Reference issue.

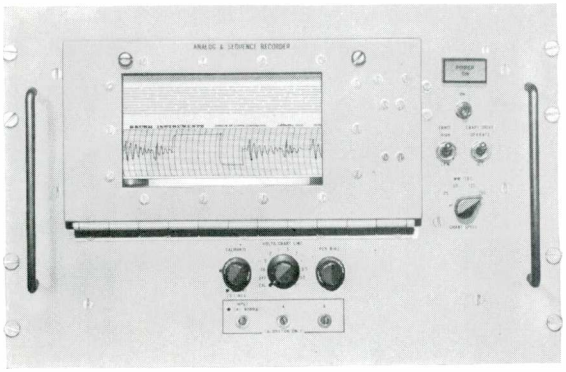
Don't Miss—

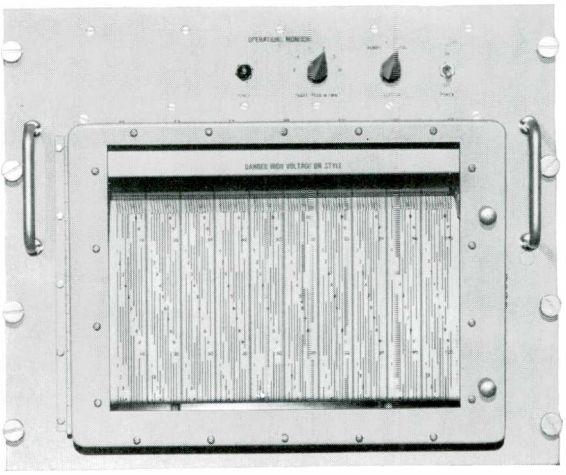
"Computing Systems In Process Control"

beginning on page 70









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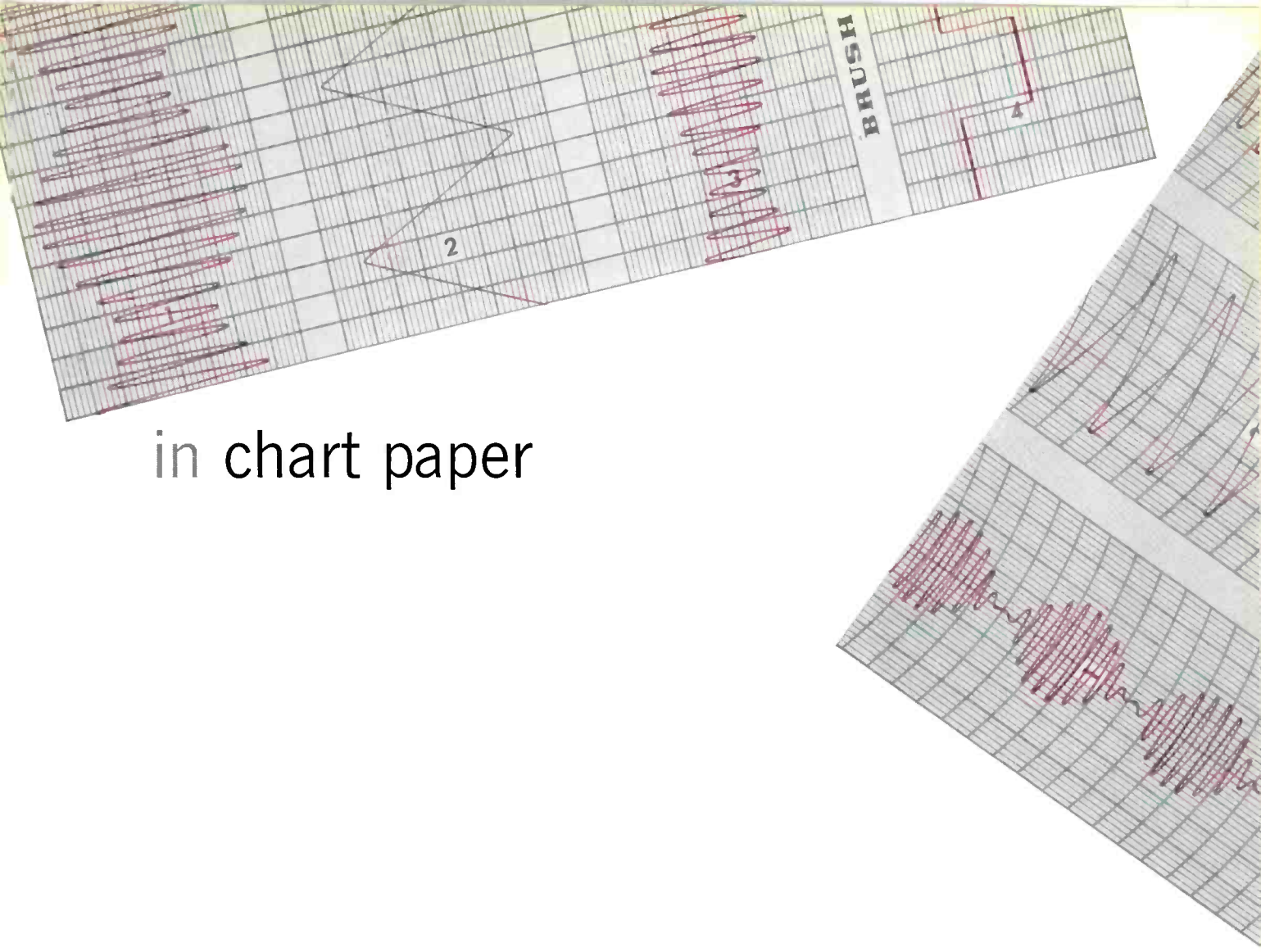

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Next month

SPECIAL PURPOSE CATHODE RAY TUBES

Another in EI's series of Special Staff Reports. The cathode ray tube has found scores of applications beyond those most commonly thought of . . . . oscilloscopes and picture tubes. Here's the story on many new applications and a thorough treatment of the engineering of tubes to meet new technical specifications from the glass and phosphor to the electron gun.

TRANSISTOR INTERCHANGEABILITY CHART—II

A repeat of the very successful chart published last year which went completely out-of-print within sixty days after publication. Updated, this chart uses EIA type numbers as a base, and tells which type numbers are electrically interchangeable and who manufactures them.

TUNNEL DIODE AMPLIFIERS

What are the general considerations that are involved in designing tunnel diode amplifiers? A great deal of new equipment now on the drawing boards will be using these devices. This article discusses circuit characteristics of GE's ZJ-56, developmental tunnel diode.

REVIEW OF THE 1960 ANNUAL RADIO ENGINEERING (IRE) SHOW AND CONVENTION

Summarizing the principal show events, listings of technical papers to be presented, and a review of description of new electronic products being introduced for the first time this year. With so many interesting and important events occuring simultaneously, readers will find this feature a handy reference guide for planning their convention activities.

Plus all our other regular departments

Our regular editorial departments are designed to provide readers with an up-to-the-minute summary of world wide important electronic events. Don't miss Radarscope, As We Go To Press, Electronic Shorts, Coming Events, EI Totals, Snapshots of the Electronic Industries, EI International, News Briefs, Tele-Tips, Books, Rep News, International Electronic Sources, Personals, Industry News, etc.

COMING SOON:

RADIO FREQUENCY INTERFERENCE STUDIES

A new series of articles discussing extremely important areas of this most timely subject. Our editors have arranged with more than ten of the most prominent engineers and scientists for this exclusive series. Study areas in this series include: Transmitters, Antennas, Transmission Lines, Receivers, Propagation, Instrumentation, Man Made RFI, Satellite Interference, The Role of Management, etc. This series running in Electronic Industries throughout 1960 will provide valuable and important reference data. Watch for these articles!

Watch for these coming issues:

***APRIL** — Space Electronic Issue

***AUGUST** — Annual WESCON Issue

***NOVEMBER** — Annual Microwave Issue

***JUNE** • 18th Annual Directory & All-Reference Issue

Nine general-purpose digital computing systems are commercially available for the control of continuous and batch type industrial processes. For quick reference, these computers are compared in a single table. A general discussion of general-purpose digital computers and the characteristics of the nine control computer systems are included.

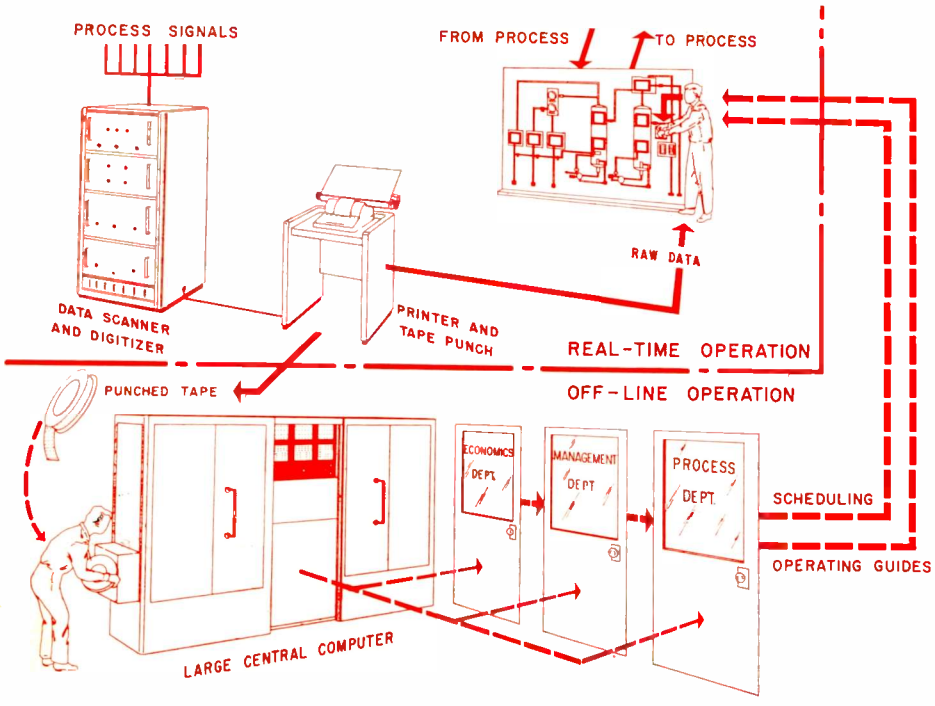
For Process Control . . .

General Purpose

COMPUTERS are being put to work every day in new fields. One of the latest is the application of computers to the control of batch and continuous processes in the petroleum, chemical and power industries. The digital computer shows great promise in this area. A general discussion of digital computers follows, along with a comparison chart of nine commercially available process control computers.

Through common usage, the term "general purpose" or G.P. digital computer has become the generic name for a class of computers which operates on the principle of integral transfer; that is, digital data is processed through the computer based upon the entire numerical value of the quantity. This distinguishes the general purpose computer from the incremental transfer computer (the digital differential analyzer or DDA is an example of an incremental machine). The general purpose computer is therefore defined in terms of its internal logic rather than its general applicability. Its logic permits it to perform all arithmetic functions such as addition, subtraction, multiplication, and division as well as non-arithmetic functions such as shifting numbers, etc. It can compare quantities, make logical decisions based on results of comparisons, vary its sequence of operation as a result of its own decisions, and detect its own failures plus those of other components in a system.

Fig. 1: The flow of information around a process unit with a data logger in the control room is shown for a continuous industrial process. A large central computer is used.



Process Control Computer Applications

In process control applications, the computer must be linked to the process variables such as temperatures, pressures, flows, tank levels, fluid compositions, etc. The process measuring elements or transducers are predominantly analog devices.

This article is based on an article by the author which appeared in the July 1959 issue of the ISA Journal (Instrument Society of America).

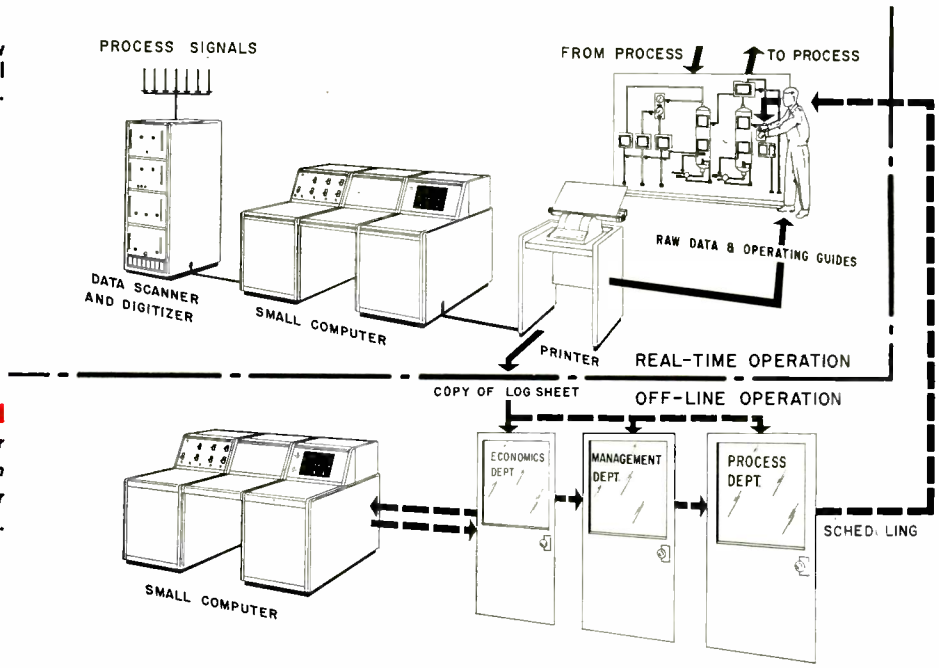


Fig. 2: The information flow when using a small digital computer is illustrated.

By ARTHUR H. FREILICH
Research Engineer
Burroughs Corporation
Research Center
Paoli, Penna.

Digital Computing Systems

To connect the digital computer to the transducers, it is necessary to provide an input switching system which will select the input to be read into the computer. It is also necessary to provide an analog-to-digital conversion system to convert the selected analog transducer signal into a digital value which can be entered into the computer. Therefore, a process control computer system requires input switching and A/D conversion units as well as the computer itself. Similarly, if the output of the computer is to be used to change the settings of the analog controllers which are responsible for holding a single variable, such as a temperature, at a constant value, it is necessary to provide a digital-to-analog converter and an output switching system at the computer output. With such an input and output system, the computer can then measure process conditions and change control setpoints. These setpoint changes would cause the process to operate in a more optimum manner. The particular optimum may vary from process to process or from day to day; it will always, however, involve not only process conditions but the all-important economic criteria of cost, demand, etc.

It is in the area of more optimum (hence more profitable) operation that computer control holds promise. Present analog controllers can maintain stable process operation today. But such operation may not be the most profitable. Seeking-out and maintaining the optimum process operating points is the job of the control computer.

Since the process is essentially an analog system, why use a digital computer at all? Certainly, linking an analog computer to the analog process is far simpler. The answer to this question lies in the scope of the problem to be solved by the computer.

In small processes or small control systems, the analog computer is the better answer. But where the control system requires logical decisions, data reduction, complex calculations and modifications of the computations dependent upon process conditions, then the logical ability of the digital computer becomes important.

The general purpose digital computer is more accurate and more flexible than analog computers but requires a larger outlay of initial capital. Therefore, the analog computer holds an advantage in the smaller installation; the general-purpose digital machine is more powerful and more economical in larger systems.

In terms of control speed, most serial general-purpose digital computers are relatively slow, with a frequency response of less than 5 to 10 cycles per second. However, since it operates on the entire numerical value and can have a completely different program for different inputs, the general-purpose digital computer is well-suited to multiplexed systems in process control where the computer is time-shared among many inputs. Present investigations into sophisticated routines for control may increase the frequency response of G.P. digital computers by a considerable factor.

Table I is a comparison of nine digital computers for on-line computing and process control applications. All these computers are of the general purpose digital type with the exception of the Genesys machine which is a hybrid computer (G.P. logic and incremental

Digital Computers *(Continued)*

logic combined). All of the machines are of the internally stored program type except the Ferranti ARGUS computer. It uses pegboards for the storage of program steps and constants. (Only limited data are available at present on the Ferranti ARGUS.)

In addition to the nine computers in Table 1, there are several other general purpose digital computers being developed for process control:

A. A computing system is being developed jointly by Leeds & Northrup Co. and Philco Corporation, called the LN-3000.

B. Minneapolis - Honeywell, through the Industrial Products Group and the Datamatic Div., is developing the D-290 Computer for process control. The first unit is scheduled for installation at Philadelphia Electric Co. in 1960.

C. RCA and Foxboro are jointly furnishing computer control systems.

About Table 1 . . .

The following discussion clarifies the points of comparison in Table I:

1. Internal Number Base — All the computers listed use the binary system as their internal number system.

2. Operating Mode — A serial computer operates on each digit of a number in sequence, processing the digits in time sequence through the same hardware components. A parallel computer operates on all digits in parallel at the same time, through parallel channels of hardware. A serial computer is slower than the equivalent parallel unit, but is generally smaller and less expensive.

3. Bulk Memory Type — Three types of bulk memory (drum memories, disc memories and core storage) are used for storage of instructions and data in the machines listed. A drum memory consists of a rotating drum with magnetic tracks upon which the data are recorded by means of reading and writing heads. In one drum revolution, all data pass beneath both a read and write head and can be either read or recorded. However, it is necessary to wait until the exact data desired is under the proper head. Up to one complete drum revolution may be required before the desired data can be obtained. The average waiting time, known as average access time, generally runs about 7 milliseconds on the listed computers, assuming one-half drum revolution as average. Access time can represent an appreciable amount of computing time. The computer program should be written to minimize access time as much as possible. Circulating registers can be provided in drum memories for faster access to limited amounts of data which are transferred from main storage to the fast access circulating registers. Drum memories are relatively inexpensive storage media at the present time, compared to core memories. Disc memories are similar to drums but use a flat mag-

TABLE 1

Manufacturer	Thompson-Ramo-Wooldridge Prod., Inc. Los Angeles, Calif.	General Elec. Co. Phoenix, Arizona	G.P.E. Controls Chicago, Illinois	Daystrom Systems La Jolla, Calif.	Panellit, Inc. Skokie, Illinois	Genesys Corp. Los Angeles, Calif. (11)	Autonetics Downey, Calif.	Bendix Corp. Los Angeles, Calif.	Ferranti Electric, Inc. Hempstead, N. Y.
Computer	RW-300	GE-312	Libratrol—500	Complete Daystrom Computer System	Panellit 609	Unit Memory Processor	RECOMP II	G-15	ARGUS
Internal Number Base	Binary	Binary	Binary	Binary	Binary	Binary	Binary	Binary	Binary
Operating Mode	Serial	Serial	Serial	Serial	Serial	Serial in G.P. mode Parallel in incremental	Serial	Serial	—
Bulk Memory Type	Drum	Drum	Drum	Magnetic Core	Magnetic Core	Magnetic Disc	Magnetic Disc	Drum	Cores (15)
Bulk Memory Capacity Minimum	7,936	2,048	4,096	1,024	4,096 (7)	10,000	4,080	2,176	256 (15)
Maximum	7,936	16,384	4,096	16,384	4,096 (7)	30,000	4,080	2,176	256 (15)
Word Length	17 bits + sign	20 bits + sign	30 bits + sign	20 bits + sign	38 bits + sign	19 bits + sign	39 bits + sign	28 bits + sign	9 bits + sign
Logic	Diode	Transistor	Diode	Diode-Transistor	Core-Transistor	Hybrid logic	Diode gating	Diode	—
Active Componehts Cores (in logic)	None	None	None	None	800	157 to 350	None	None	—
vacuum tubes	13	None	171	None	None	None	None	450	—
transistors	approx. 580	approx. 1,600	approx. 250 (4)	approx. 1,800	2,400	212 to 280	1,137	None	—
diodes	approx. 4,000	approx. 2,000	1,850	approx. 5,000	1,000	85 to 125	10,628	3,000	—
Instruction Type	Double address (1+1)	Single or double address (1+1)	Single address	Single address	Single address	Single address (12)	Single address	Modified (1+1) (12)	Single address
Words/Instruction	Two	—	One	One	One	One	—	One	One
No. of Different Inst. Normal	20	>60	16	46	—	20	49	56	—
Maximum	>34	very high	—	85	64	Up to 500	—	1300 W/micro-coding	—
Clock Frequency	153.6 Kc.	250 Kc.	136 Kc.	50 Kc.	167 Kc.	50 to 500 Kc.	151 Kc.	100 Kc.	—
Add Time w/o access	0.78 ms.	0.096 ms.	0.25 ms.	0.44 ms.	0.720 ms. (8)	—	0.54 ms.	0.27 ms.	—
Mult. Time w/o access	2.99 ms.	0.29 to 2.02 ms.	15.0 ms.	9.24 ms.	2.80 ms. (8)	—	10.8 ms.	15.12 ms.	—
Time to Perform Calc. in Fig. 3	42 ms. (1)	30 ms (1) (17)	900 ms. (5)	75 ms.	31.7 ms.	50 ms. (13)	98 ms.	216 ms.	—
Max. Input Switching Speed	3,840 pts./sec. (1,000 pts./sec. typical)	300 pts./sec.	200 pts./sec.	284 pts./sec.	350 pts./sec. (9) 5-10 pts./sec. (10)	300 pts./sec.	Can be tied to commercially available A/D input and D/A output systems.	Can be tied to commercially available A/D input and D/A output systems.	A/D input and D/A output conversion equipment are included in system.
A/D Conversion Input Range	0-10.23 V. (2)	0-10 mv.	0-10V. std.	0-50 mv.	0-60 mv.	0-8V.			
D/A Conversion Output Range	0-15 V. or 0-5 ma.	0-20 V.	as required	as required	as required	as required			
Time to Perform Calc. in Fig. 3a	42 ms. (16)	63 ms. (3)	915 ms. (5)	79.2 ms. (6)	39.7 ms. (19)	100 ms.	105 ms. (typical)	Varies for application.	—
Weight	600 lbs.	3,000 lbs.	1,000 lbs.	2,000 lbs.	2 cabinets	200 lbs.	197 lbs. (computer only)	800 lbs.	—
Size	36" x 56" x 29"	76" x 108" x 24"	30" x 42" x 60"	4 std. racks	66" x 56" x 16"	desk size	23" x 21" x 16.5"	60" x 27" x 32"	48" x 48" x 24"
Power Requirement	500W, 120V, 60 cy.	4KW, 120V, 60 cy.	1500W, 117V, 60 cy.	less than 2KW.	1 KVA.	350 watts	500W, 115V, 60 cy. (14)	3.5 KW, 110V, 60 cy.	—
Price	$98,000 with basic input-output.	Varies depending on application.	$85,000 with A/D input & output logic.	$135,000 and up for complete sys.	$125,000 for complete control sys.	Varies depending on application.	$86,000 for computer only.	$49,500 for (18) computer only.	—

NOTES

(1) Time shown is based on use of optimum coding. Computer routines are available to automatically code programs for minimum access.
(2) Complete input system including amplifiers, filters, electronic switches, etc. can handle input ranges as low as 0-10 mv., floating input for thermocouples.
(3) Assumes settling time of 20 ms. for low level differential amplifier and a 5 ms. settling time for the scanner.
(4) This figure includes transistorized A/D and D/A conversion units.
(5) Based on accuracy of nine decimal digits in square root calculation. Faster on special order.
(6) Assumes 20 ms. stabilization time, concurrent with computation.
(7) Magnetic film back-up storage available as required.
(8) Includes random access time.
(9) Clean, high-level signals.
(10) Process signals, low-level with noise.
(11) The Genesys machine is a hybrid computer, combining the logic of the G. P. computer and the incremental computer.
(12) Micropro gramming available.
(13) In hybrid mode. Calculation time is 150 ms. in G. P. mode.
(14) Includes power for paper-tape reader, paper-tape punch typewriter and console.
(15) Core storage is for data only. Program steps and constants are stored on pegboards (128 constants and up to 4,096 program steps.)
(16) Input switching and conversion system is independent of the arithmetic computer which has immediate access to most recent data.
(17) Based on square root calculation accuracy of 10 bits; for 19 bit square rooting accuracy, time is 34 ms.
(18) $1,485 per month lease including maintenance.
(19) Does not include settling time.

—Reprinted from July 1959 ISA Journal

netic disc as the storage medium.

Core memories consist of a matrix of magnetic cores, wired so that each core can be driven to one of two states of magnetism. One core is used to store each binary bit. Reading and writing with cores are accomplished by various schemes which, for reading, sense the state of the magnetism of the core and for writing, drive the core to the desired state of magnetism. Cores are addressed by energizing wires representing the X, Y and Z coordinates of the core in the matrix. Thus, data can be read out of any core, regardless of location, in the same period of time. The access cycle time (write, read, write) is negligible compared to a drum, being only a few microseconds. This speed of access represents a tremendous saving in computer calculating time. However, core memories are expensive and require fairly large amounts of peripheral read-write equipment.

4. Word Length—The size of the word (one unit of stored digital data) in the computer and memory is not too critical in process control applications since all machines provide between 9 and 39 binary bits. This is equivalent to a precision of 1 part in 500 to approximately 1 part in 10^{11}. Most of the machines can operate with either single or double precision arithmetic, so that even greater accuracy is available.

5. Instruction Type — A digital computer performs its computations in accordance with its program. The program is a series of instructions which tell the computer what it is to do.

For the instruction ADD, for example, it is necessary to tell the computer what numbers to add and what to do with the results. Some of the required logic is built into the computer and some is dependent on the program. In a typical computer, the ADD instruction may sequence the computer through the following sub-steps: (1) obtain one number from a location in memory specified in the instruction. (2) add this number to the number already in the accumulator (The accumulator is a register in the arithmetic section of the computer). (3) put the result of the addition in the accumulator. The programmer must insure that one of the two numbers to be added is already in the accumulator prior to this instruction. He then specifies the memory location for the second number. The result of the addition is in the accumulator at the end of this program step and the programmer must then take this into account in writing the next step of the program.

SAMPLE CALCULATION (1)

(1) READ IN NEW INPUT X (exclusive of input switching time or A/D conversion)

(2) CALCULATE $AX + B = Y$

(3) COMPARE Y TO C TO INSURE THAT $Y < C$

(4) COMPARE Y TO D TO INSURE THAT $Y > D$

(5) CALCULATE $Z = \sqrt{EY}$

(6) CALCULATE $J = \dfrac{[ZF - G]\,K}{H + L}$

(7) STORE J IN BULK MEMORY (use average access time)

(8) STORE Z IN BULK MEMORY (use average access time)

SAMPLE CALCULATION (2)

Same as above except:

(1) Assume input X must be selected by computer, switched into A/D converter and read into computer from converter.

Fig. 3 (top) 3a: Calculations supplied to manufacturers to determine computer speeds.

Various types of instructions are used. The simplest type is the single address instruction where the programmer specifies the function to be performed and a single memory address. Each function (add, divide, shift left, compare, etc.) is assigned a numerical designation which the control section of the computer interprets prior to sequencing the computer through the required steps. A counter in the control unit keeps track of the instructions and supplies the computer with the address of the next instruction. The instructions are normally taken in numerical sequence, based on the memory address in which the instruction is stored.

In a double address machine, the instruction generally specifies the operation, the location in memory of the data to be operated upon and the location of the next instruction. This particular double address instruction format is known as (1+1) and permits locating the next instruction on a drum or disc memory so that access or waiting time between instructions is reduced to a minimum (optimum coding or minimum access program).

6. Number of Different Instructions—The normal number of instructions shown is the number which is available as standard in the machine. The maximum number represents the largest number of instructions which the logic of the machine can handle in terms of available digits in the instruction code, etc. In some machines, computer operations on a level of detail lower than a normal instruction are available to the programmer to permit so-called micro-programming or micro-coding in which the programmer constructs his own instructions from detailed steps.

7. Clock Frequency, Add Time, Multiply Time — These classifications are all related to the arithmetic speed of the computer, as is the memory access time. However, no one of these factors is a suitable index for determining machine speed. The structure and flexibility of the instruction code, the memory access time, the arithmetic speed, and the input-output capabilities all play a part in determining the speed of a computer in a given problem.

8. Time to Perform Calculation in Fig. 3—The calculation shown in Fig. 3 was programmed by the manufacturers of eight of the computers in the table. The results are listed to indicate relative computational speeds of the machines. Note that no input switching, analog-to-digital conversion or readout times are included in this calculation. The sample problem involves memory access, add times, multiply times, etc. It represents typical calculations encountered in scaling a process input, comparing it to

high and low limits for determining abnormal conditions, calculating a flow from a differential pressure reading and calculating a process control guide involving several variables.

Where fast access memories such as circulating registers are available in a drum or disc computer, the calculation time is based on use of the fast access memory. Drum computers which permit optimum coding list the calculation time with an optimum coded program.

9. Input Switching Speed and A/D Conversion Ranges—The maximum input switching speeds shown in Table I are not necessarily attainable with typical low level process inputs. An individual amplifier on each low level input (or an amplifier shared among a few inputs) would be required along with a filter for each input, in order to attain the switching speeds shown as maximum. In most process applications at present, such switching speeds are not required and slower speeds result in less costly input systems. In all cases, amplifiers can be used on low level inputs to make them compatible with A/D converter input ranges.

In the case of the RECOMP-II and G-15, these computers are not normally furnished with integral A/D and D/A input-output converters but are generally tied to commercially available A/D and D/A systems.

10. Time to Perform Calculation in Fig. 3A—The calculation previously shown in Fig. 3 is used, with the added requirement that the computer select an input, convert it from analog form to digital form and read it into the computer prior to computation.

Because of variations in the methods of handling input signals, the calculation times for Fig. 3A should be used only as a general guide. Exact input speeds will generally depend on the type of input signal, the input equipment used in the particular installation and the requirements of the application.

11. Price — Since all computer control systems are tailored to the application, the prices shown are only general figures. In some cases, prices are for basic systems, with a minimum of input-output equipment. In other cases, typical complete process control computer systems are included in the price. In the case of the RECOMP-II and the G-15, the prices shown cover only the computer. In considering pricing for a computer control system, one should also bear in mind the cost of transducers, measuring devices and control elements which might not otherwise be required in the installation. Such additional costs, plus engineering and systems analysis costs, can easily equal the cost of the computer system itself.

General Computer Descriptions

Autonetics RECOMP-II—This is a general purpose digital computer, all transistorized, single address, disc memory machine. It has floating point arithmetic and automatic decimal conversion. It is utilized ordinarily for engineering and scientific calculations. However, with appropriate input-output units, it can be used for process control installations. It has 4,080 word storage capacity, each word containing 39 bits plus sign.

Bendix G-15—A general purpose digital computer with drum memory, modified double address for optimum coding and micro-coding which permits programmer to construct his own commands. A 16-word fast access memory is provided on the drum. The G-15 is a commercial computer, widely used for engineering, business, and scientific data processing. It has also been used in a variety of on-line applications including wind tunnels, navigation, tracking, and processing plants. This computer does not include A/D and D/A input-output units, but most such commercial units may be used under control of the computer for complete on-line computing systems. Beckman Systems is now using a G-15 with their equipment for a computer control package.

Daystrom Computer—This computer is the heart of the Daystrom Operational Information System. It is a solid state digital system using magnetic core memory with single address instructions. Although a relatively slow clock speed (50 kc) is used, the random access core memory permits relatively fast computation speeds without need for optimum programming. The Daystrom A/D input system normally integrates each sampled input for 100 ms. to obtain a high noise rejection rate without use of filters. Where it is practical to filter each input or where no noise is present, input sampling can be performed at 284 points per second. It was specifically designed for process monitoring and control.

Ferranti Argus — The Ferranti Argus is a transistorized process control computer manufactured in England and marketed in the U. S. by Ferranti Electric in Hempstead, N. Y. It is unique among the available computers because it does not have an internal stored program. At 256 word core memory is provided for storage, but program steps and constants are manually stored in pegboards, contained in trays in the computer. In this manner, 512 program steps and 128 constants can be stored in the computer. A unit is available for expansion to 4096 steps. Input A/D and output D/A conversion equipment is an integral part of the Argus system. The computer is designed for closed-loop control.

General Electric GE-312—It is an all solid-state digital computer, using magnetic drum storage for both data and program, specifically designed for process monitoring and control. Computer is available in an upright air conditioned cabinet and uses removable printed circuit cards. Instructions

can be either single address or double address (1 + 1) for optimum coding. Computer itself can be used to code program for minimum access. In addition, routines are available for simulating the 312 on an IBM 704 to assist in programming. An optional feature is circulating registers on the drum to provide 4 to 16 words of fast access memory. Includes A/D and D/A conversion units and input-output switching. The application determines scanning and input-output requirements.

GPE Controls Libratral - 500—Manufactured by Librascope and marketed by GPE Controls (both subsidiaries of GPE). This computer is an adaptation of LGP-30, a commercial digital computer widely used for many engineering, scientific, business, and accounting applications. Over 250 LPG-30 computers are now in use. Libratral-500 uses drum memory with 3 single-word fast access circulating registers for instructions. Specifically designed for process monitoring and control. Basic unit includes scanner, voltage-to-digital converter, and output logic. Computer operation is serial, fixed binary point, with internally stored program using single address instructions. A transistorized model will be released shortly.

Genesys Unit Memory Processor—This is a hybrid unit, combining both general purpose digital and incremental logic. It operates as either or both. It is housed in a desk type enclosure. All functions of the computer are achieved with a magnetic disc memory (10,000 to 30,000 words capacity) and a small magnetic core-transistor sequential network. The general purpose logic is used for decision making, arithmetic, etc. and the incremental logic for integration, etc. This combination uses a minimum of active components, relying heavily on the reliable passive storage elements of the magnetic disc memory. A/D conversion is by an all-electronic feedback encoder. The system is built according to individual applications. Process operation is optimized through adaptive control methods.

Panellit 609—This all purpose digital computer uses magnetic cores for both storage and logical operations in the computer. Transistor drivers operate the core logic circuits. It is housed in two upright cabinets. The core memory permits random access to any memory location with relatively high computing speed, and without need for optimum programming. The input-output system contains buffering and fast arithmetic units to permit processing inputs and outputs with a minimum of interference with main computer arithmetic units. The 609 uses one channel for computation and a second channel for on-line data logging. Attachments include a magnetic film memory for 250,000 words on a single reel. A/D and D/A conversion are available as required as a part of the system.

Thompson-Ramo-Wooldridge RW-300—A digital computer using diodes and transistors for logic and magnetic drum storage for both data and program. Available in desk size or upright model. It was specifically designed for on-line process control. Removable printed circuit cards used for internal circuitry and component mounting. Double address instructions (1+1) are used for optimum coding. Computer itself can be used to automatically code program for minimum access. A 16-word circulating register on the drum provides fast access during computation. The A/D conversion and input system operates independently of the arithmetic computer, so that inputs are sampled and converted to digital form and entered directly into the memory without interfering with computation. Thus, most recent input data is used in computation without waiting for selection of an input and receiving of data.

Westinghouse OPCON.—A fully transistorized logic control unit designed to automatically experiment with a process and optimize performance. It contains no numerical computation ability, depending on a small analog computer to calculate optimizing equations. Process equations are not necessary since the control unit uses the process itself as a model. Analog-to-digital conversion range is ±0.5 volts. Digital-to-analog conversion range is 0-5 ma. into 2000 ohm resistance (max.). Weight is 500 lbs.; size, 60 × 22 × 30 in.; power requirements are 260 w, 120 v, 60 cycles. Since OPCON is not a G. P. digital computer, but a special purpose logic device, it is not included in Fig. 3 comparison.

Installations

In the area of computer control of industrial processes such as found in the power, petroleum and chemical industries, there are quite a few general purpose digital computers either presently installed or on order. Among the present installations are those at:

1. Electricite de France, Chinon, France (T-R-W, RW-300).
2. Louisiana Power & Light Co., Sterlington, La. (Daystrom Computer).
3. Standard Oil (N. J.), Baton Rouge, La. (Librascope LGP-30 with Leeds & Northrup input system).
4. Texas Co., Port Arthur, Tex. (T-R-W, RW-300).
5. Universal Products Co., Des Plaines, Ill. (Daystrom Computer).
6. Dow Chemical Co., Midland, Mich. (Westinghouse OPCON Optimizing Logic System).

General-purpose digital computers are on order by the following companies for process control applications:

1. B. F. Goodrich Chemical Co., Calvert City, Md. (T-R-W, RW-300).
2. Carolina Power & Light Co., Darlington Station, (Daystrom Computer).
3. Gulf States Utilities, Louisiana (two units; one Panellit 609, one Daystrom Computer).
4. DuPont Co. (several Panellit 609 Computers).
5. Kansas Gas & Electric Co. (Daystrom Computer).
6. Louisiana Power & Light Co., Little Gypsy Station (Daystrom Computer).
7. Monsanto Chemical Co., St. Louis, Mo. (T-R-W, RW-300).
8. Philadelphia Electric Co., Phila., Pa. (Honeywell D-290).
9. Public Service Co. of Colorado (Libratrol 500).
10. Riverside Cement Co., Oro Grande, Calif. (T-R-W, RW-300).
11. Sun Oil Co., Marcus Hook, Pa. (Westinghouse OPCON Optimizing Logic System; also a Litton Model 80 Digital Differential Analyzer and a Genesys Machine).
12. Jones & Laughlin (G. E. 312).
13. Southern Calif. Edison (G.E. 312, two units).
14. Public Service of New Jersey (L N 3000, Philco-L & N).
15. Phillips Chemical Co. (Recomp II).
16. Standard Oil of Calif. (Recomp II).

"TPR" Recording

New method for recording electrical signals on a thermoplastic film employs electron gun recorder. System has response capabilities to 50MC. Many new military and industrial recording applications envisioned.

FROM GE's Research Laboratory in Schenectady, N. Y. comes word of a new recording system called thermoplastic recording or "TPR." This new system, still in developmental stages, combines the processing speed and much of the versatility of magnetic recording with the storage capacity of photography and offers some advantages over both. According to Dr. Guy Suits, Vice President and Director of Research, "Thermoplastic recording can already concentrate 100 times as much information in a given space as can magnetic recording, and it has the potential for still greater concentration. As an illustration of its extreme storage capacity and speed, TPR could in principle record all 24 volumes of the Encyclopedia Britannica on a reel the size of a spool of thread, taking only a minute to record each volume."

Like photography, TPR possesses the advantage of almost instantaneous recording, and will produce pictures either in color or black-and-white, but it does not require the chemical processing needed by photographic film, and can be erased and reused as desired. Thermoplastic recording was invented by Dr. William E. Glenn, physicist, of the General Electric Research Laboratory.

In describing the operation of a TPR system, Dr. Glenn disclosed that the recording is made in the form of small ripples on the surface of a plastic film. The ripples are formed by means of an electron beam, which scans the surface of the film. The recorder has an electrical input similar to a magnetic

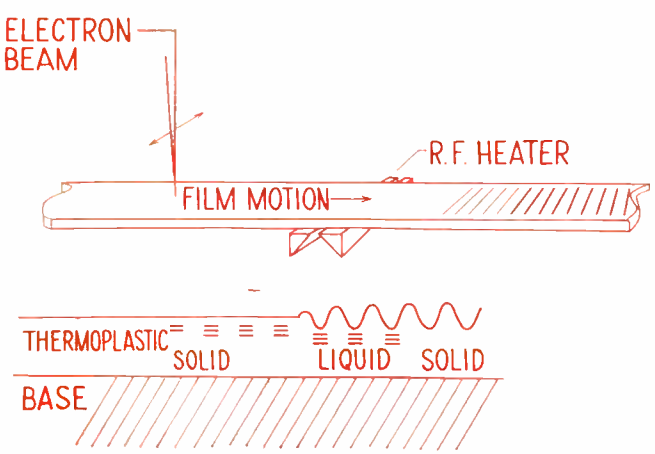


Fig. 1 (left): The melted thermoplastic coating is deformed by the charges. The ripples are then frozen in place.

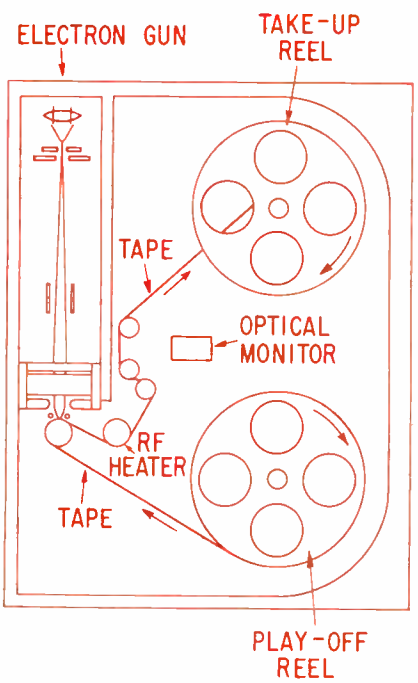


Fig. 2 (right): The film in this TPR machine is handled in a vacuum. Vacuum is obtained in about one minute.

tape recorder, and an image output that is similar to photographic film. The latter can be changed to an electrical output signal by standard techniques.

Fig. 1 shows the recording process and one type of thermoplastic film. The film has a base that is similar to the standard moving picture film base. On top of this is a transparent conducting coating, and on top of the transparent coating there is a thin coating of thermoplastic material. This material will melt if it is raised to a fairly high temperature.

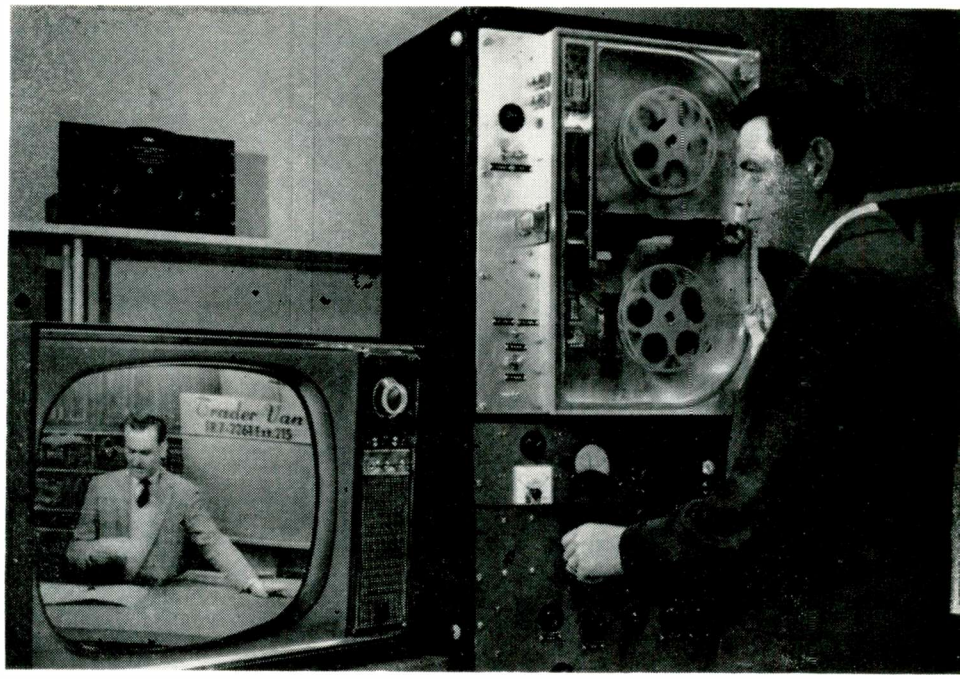
The surface of the thermoplastic is charged with an electron beam in a pattern that corresponds to the pattern of ripples that is to form the image. As the film moves on, a current is induced in the transparent conducting coating, which heats the film so that the thermoplastic coating melts. The charges are attracted to the transparent conducting coating and depress the surface of the thermoplastic. After the surface has been deformed by the charges, the film is then allowed to cool; this freezes the ripple pattern in place.

To erase the information, you simply heat the thermoplastic again to a higher temperature, so that the charges leak away and surface tension smooths the surface back out to its original state. The film is then reusable.

Fig. 2 is a diagram of a recording machine that records on thermoplastic film in this way. The film, of course, must be handled in a vacuum, since the electron gun has to work in a vacuum. This is not nearly as much of a problem these days as one might think. It only takes about one minute to pump the machine down from atmospheric pressure to a vacuum low enough for effective operation.

The signal input, in this particular recorder, is simply the intermediate-frequency signal out of a black-and-white TV set, at about a one-volt level. If the images are to be recorded in color, another signal has to be added to another electrode, also at about a one-volt level.

At first thought, it might seem difficult to use ripples on the surface of the film in order to produce an image. There is, however, a special optical system that can be used to do this. In projecting black and white, this is simply a modification of a Schlierien optical system; in color, it is necessary to use a special optical system.



TPR recorder is demonstrated by inventor Dr. W. E. Glenn of the GE Research Lab.

Fig. 3 shows how a standard projector works. It has a plane light source, a condensing lens, and a projection lens. The light source is imaged on the projection lens by means of a condensing lens, and the projection lens images the slide to be projected on the screen.

If we now modify this (Fig. 4) so that instead of using a plane light source we use line light sources, and image these on a set of bars in front of the projection lens, no light will get through to the screen. If, however, we have *ripples* on the surface of the film at any particular point, these will scatter light through the bar system. Thus, the bar system acts somewhat like a shutter that allows light to pass wherever there is a ripple on the film. Whenever light passes through the projection lens, it images the ripple on the screen as a white spot. You can, for example, take a clear slide that simply has ripples on the surface, put it in the projector, and have it appear as a black-and-white picture on the screen.

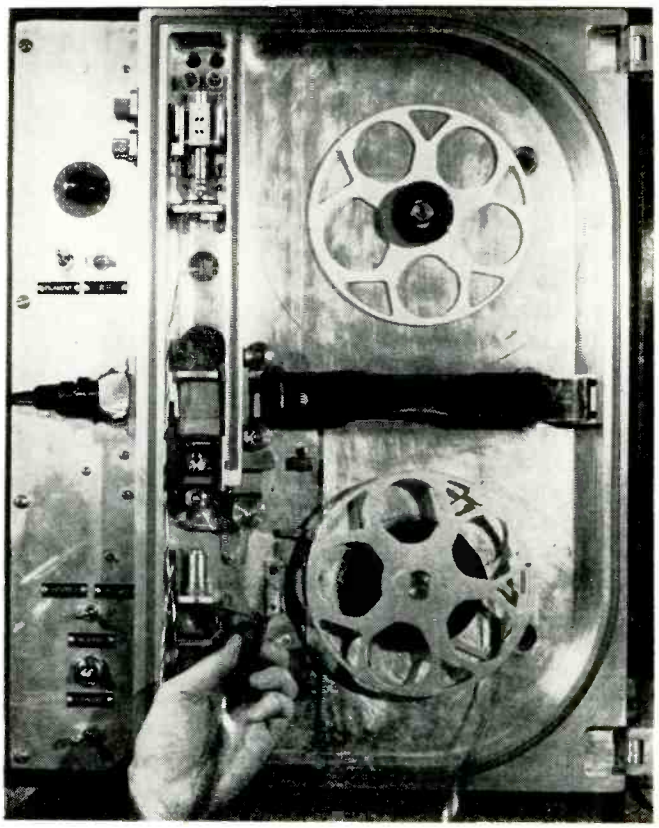
This system can be modified so that it can be used to produce color pictures. Fig. 5 shows how. Each picture element has in it a set of ripples that form a little diffraction grating. The light that is diffracted by this grating forms a spectrum on each side of the central beam. The slots are made small enough so that only one color from the spectrum gets through to the projection lens. Since the projection lens can receive only one color of the spectrum, the spot that appears on the screen will appear in a single color. If you would like the spot to appear in another color, you change the spacing of the grating so that a different part of the spectrum gets through the slot. In order to produce a color that is formed by a superposition of two or more colors, you superimpose the gratings in this spot and you get the superposition of the colors.

The film we use at our present stage of development is the size of standard 16 mm film. Our larger-size recordings use half the width of the film—the images are actu-

Tape playback of TV picture being taken above.

ally 5 mm wide—and the film runs at 10 in./sec. We are also recording with full resolution at half this picture size, so that the width of the track on the film is 0.1 in. wide, with the film running 5 in./sec. In the latter case, this is the width of a half-track of standard audio magnetic tape.

As noted, however, we run at only 5 in./sec. rather than at the 7.5 in./sec used in audio recording tape. This is true, despite the fact that video recording requires approximately 100 to 150 times the density of information that is ordinarily required by audio. We are thus doing more than 100 times the work that an audio tape recorder does.



Thermoplastic recorder: The thermoplastic tape moves from the play-off reel (bottom), past an electron gun, a heating unit, and an optical monitor to the take-up reel (top).

Defense Application

Dr. G. L. Haller, Vice President and General Manager of GE's Defense Electronics Division, in speaking of the defense applications of TPR pointed out that there is a whole gamut of possibilities to be explored. As specific examples he cited:

1. Radar Applications. Thermoplastic recording promises to extend greatly the range and reliability of present and future radar sets. It will greatly enhance the possibility of devising a positive and instantaneous method of identifying radar targets. This technique is called "optical correlation."

A radar set transmits a signal that is subsequently reflected by a target and received back at the radar set. The radar observer must then correctly identify the received signal even though it is now surrounded by random signals commonly called "noise." Optical correlation functions to separate the real signal from the noise background so that the observer can make a positive identification.

A replica of the transmitted radio wave is recorded on thermoplastic. When a reflected radio wave is received by the radar set, it also is recorded on thermoplastic. The two recordings are then optically compared with one another to determine whether or not the received radio wave is the same as the transmitted radio wave. Identification is positive regardless of how weak the received signal is, since the optical comparison is made on the basis of signal character rather than strength. False signals are automatically rejected and the observer views only real objects on his indicator.

2. Radar-Jamming or Countermeasures Applications. It has been impossible to record intercepted radar signals on a continuous basis because of the narrow bandwidth limitations of present recording equipment. TPR will overcome this problem. Use in Ferret-type reconnaissance missions is one obvious application. Ferrett reconnaissance

Fig. 3: Standard projector has a plane light source.

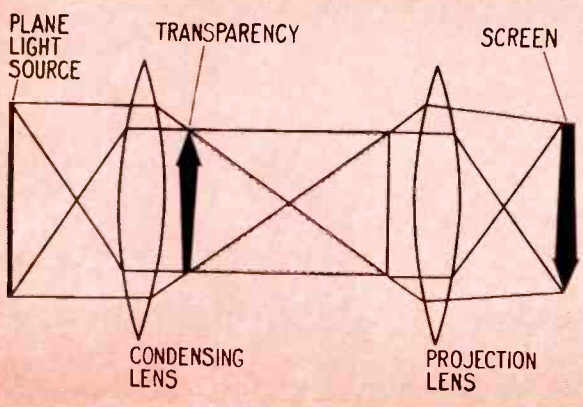
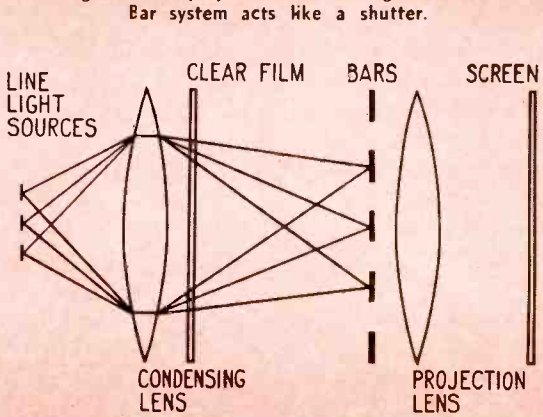


Fig. 4: TPR projector uses line light sources. Bar system acts like a shutter.



is a concept of recording and storing all electromagnetic radiation from the area under surveillance.

3. Radar, Sonar, and Infrared Displays. TPR opens up new possibilities in the large-screen display of radar and sonar images. This type of display is used in radar control centers where large numbers of people must simultaneously view radar information as it is received. In the past, the data has been plotted by hand on large display boards, or photographically copied from the radar screen and presented in the form of a motion picture some time later. Both methods inherently involve delays. With thermoplastic recording, the radar signal is written on tape, developed, and projected on a large screen without a significant loss of quality or detail within a fraction of a second.

TPR will also permit a new technique, similar to that used in time-lapse photography, to extend the range of radar and help distinguish "targets" from random signals that appear as "noise" on the radar screen. This principle, called "time compression," involves speeding up the action on a radar screen by storing the images for a period of time, then playing them back in rapid sequence. The same procedure in time-lapse photography has produced motion pictures of flowers bursting into bloom.

By speeding up the sequence of events taking place, slowly moving and therefore almost indistinct targets would begin to move very rapidly. This rapid and purposeful motion would be enough to enable the observer to make positive identification. Experiments have shown that objects apparently hidden from view can be identified by observing some orderly motion.

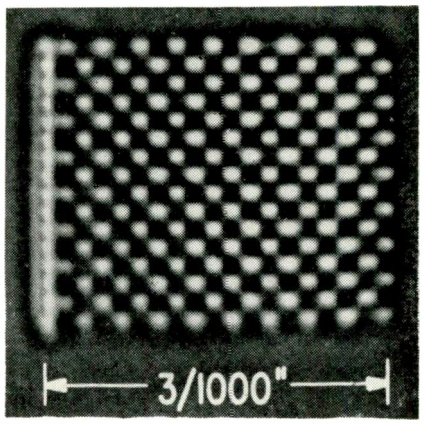
In the development of an integrated display, TPR offers a means of correlating information from a variety of sensing devices, reading it out on a single display screen. This would allow the operator to compare radar, radio, infrared, and optical data simultaneously, or to select whichever gives best results at any given moment. An integrated display would be especially useful in airborne anti-submarine warfare, for example, by allowing the operator to view radar, sonar, infrared, and other submarine detecting and tracking inputs simultaneously on one screen.

4. Missile Guidance. One specific application is that of long-range missile guidance, using map-matching techniques. That is, TPR tape with a pre-programmed mapped path to be used in the missile to correlate its flight path with the programmed path, right up the target area itself.

5. Satellites and Space Vehicles. The usefulness of a satellite is proportional to the amount of information it can gather and transmit to the earth. At present, satellites can be assigned only simple tasks, but with TPR they may be assigned such complex duties as reporting the world's weather or global surveillance to monitor and analyze unfriendly electro-magnetic emissions.

Line-of-sight limitations hamper world-wide communications. Since TPR can be reused many times, it seems feasible to use this technique for recording terrain and other strategic data in any area of the earth, to relay the data to ground sites as the satellite passes overhead, and to re-record new data on the same tape on the next orbit. Here again, the space and weight savings possible with TPR are critical to small space vehicles.

6. Aerial Reconnaissance. TPR is a "natural" for military aerial reconnaissance and recording cameras. The instantaneous monitoring or read-out that TPR can provide is an obvious advantage. It provides on-the-spot evaluation of results so that retakes can be made if necessary. Information so obtained can also be disseminated without processing delays.



Checkerboard pattern is approx. 3/1000 in. in length and width. Forty million "bits" of information per sq. in. may be recorded.

Lloyd C. Herriott of the General Engineering Laboratory reported, "The demonstrations in our laboratories of data storage at a density of 40 million bits per square inch makes it realistic to think of storing entire libraries of business reports, drawings or engineering data in equipment the size of an office desk."

H. A. Strickland Jr., Vice President and General Manager of the Industrial Electronics Division, said, ". . . It should be emphasized that thermoplastic recording will greatly expand the total market for recording devices of all kinds. We believe this its bandwidth (50 megacycles), density, and other capabilities enable us to achieve results not possible with present recording media. To the extent that it might compete with established media such as photographic film and magnetic tape, we would expect both economic and performance considerations to determine its degree of acceptance."

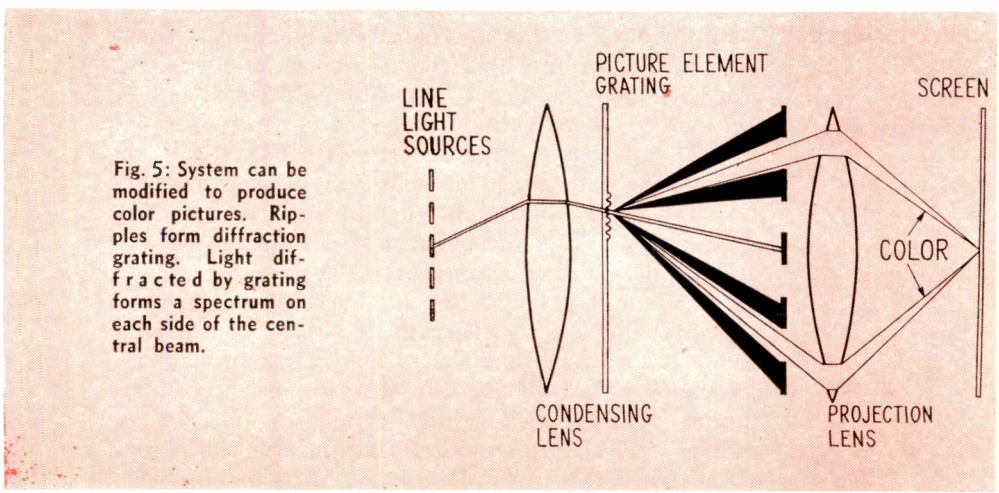


Fig. 5: System can be modified to produce color pictures. Ripples form diffraction grating. Light diffracted by grating forms a spectrum on each side of the central beam.

When re-designing a tube for changed electrical characteristics it is usually necessary to modify the internal tube dimensions. These three monographs make it possible to quickly determine the physical characteristics of the new tube from specs of a tube of the same general class.

Nomographs Simplify Electron Tube Design

By ROBERT D. REICHERT
Engineering Leader
Entertainment Receiving Tube Design
Electron Tube Division
Radio Corp. of America
Harrison, New Jersey

Part Two of Two Parts

In the use of the nomographs, straight lines are drawn intersecting three axes at a time. The axes marked "bend" indicate turning points. In the case of diode problems, it is only necessary to use axes V through XI of nomograph No. 2 (Figs. 2, 3, and 5). It is not always possible to work across from left to right. For some problems, the user has to start at both ends independently; however, a continuous line bent at the "bend" axes should be the final result.

The basic steps in the use of the nomographs are as follows:

1. Enter into the nomographs the known characteristics and dimensions of a tube which is in the same general class as the desired tube.
2. Keeping F and K constant, i.e., passing through the same intersection points on the F and K axes, enter the desired electrical characteristics of the new tube.
3. Read the dimensions of the new tube being careful to obtain practical solutions when more than one solution is possible.

Table 1

Mechanical

cathode coated outer diameter	: 0.051 in.
grid minor outside diameter	: 0.077 in.
grid lateral-wire diameter	: 0.0033 in.
grid turns per inch (TPI)	: 67
plate inside diameter	: 0.121–0.124 in.

Electrical

g_m = 2600 μmhos
I_b = 9 ma.
μ = 20
E_b = 250 v.
E_{cl} = −8 v.

Sample Diode Problem

It is desired to calculate the dimensions of a damper diode which has a plate current of 400 ma. at a plate voltage of 18 v. The 6W4-GT, which has a plate current of 250 ma. at a plate voltage of 21 v., is chosen as the original tube. The pertinent data on the 6W4-GT is as follows:

I_b = 250 ma. @ E_b = 21 v.
Coated cathode outer diameter = 0.103 in.
Plate inner diameter = 0.146 in.

Therefore, the plate-cathode spacing is 0.0215 inch. The first step is the notation of the data of this original tube on the appropriate nomograph. Nomograph 2, shown in Fig. 2 (nomographs 1 and 3 are not used for diode problems) is used, and 21 v. is entered on axis V. From this point, a line is drawn through the 250-ma. point of axis VI to axis VII. From the point thus determined on axis VII, a line is drawn through the 21.5-mil point (0.0215 inch) on axis VIII to axis IX. From the point thus determined on axis IX, a line is drawn through the 100 per cent cathode-area point on axis X to axis XI which determines K for the 6W4-GT. The cathode area of the original tube is always normalized to 100% to eliminate the necessity of calculating the effective area in square units.

The second half of the problem concerns the desired tube. The desired characteristics, 18 v. and 400 ma.,

are entered on axis V and VI, and a line is drawn through these two points to axis VII. From this point, a glance ahead indicates that various solutions are possible. The designer may decide to leave the plate-cathode spacing at 0.0215 inch as it was on the 6W4-GT. In that case, he proceeds from the point just established on axis VII through the 21.5-mil point on axis VIII with a straight line to axis IX. From this point, a line is drawn to the point on axis XI which was established when the 6W4-GT data was entered, i.e., K is kept constant. This line will pass through axis X at a point which will be the required cathode area of the desired tube in terms of percentage of the cathode area of the 6W4-GT. The intersection point on axis X is 200%, which means that the desired tube has to have an effective cathode area twice as large as the 6W4-GT if no changes are made in the plate-cathode spacing.

On the other hand, the designer could choose to leave the cathode area unchanged and modify the cathode-plate spacing, as shown in Fig. 3. As before, 18 v. and 400 ma. are entered on axis V and VI and a straight line is drawn to axis VII. It is now necessary to work back from the right-hand side of the nomograph. The cathode area and K are kept constant, and a line is drawn from axis XI through axis X to axis IX, as shown in Fig. 3. This line retraces our original 6W4-GT line. The point thus established on axis IX then is joined to the point previously established (for the new tube) on axis VII. This line will intersect axis VIII at a point which represents the required plate-cathode spacing of the new tube. The value is 0.015 inch. It is possible, therefore, to make the desired tube by using the 6W4-GT cathode with a plate which has an inside diameter of 0.133 inch—coated-cathode outer dimension plus 2 x 0.015.

Finally, it is possible to use any practical combination of cathode area and plate-cathode spacing provided K is kept constant and the straight lines between the combinations of three axes meet one another properly. Any solution to the above problem which incorporates a change in cathode area naturally requires a corresponding change in heater input power.

Sample Triode Problem

A new twin triode having the following characteristics is required.

g_m = 2000 μmhos
I_b = 15 ma
E_b = 200 v.
E_c = −6 v.
P_b = 4 w./plate

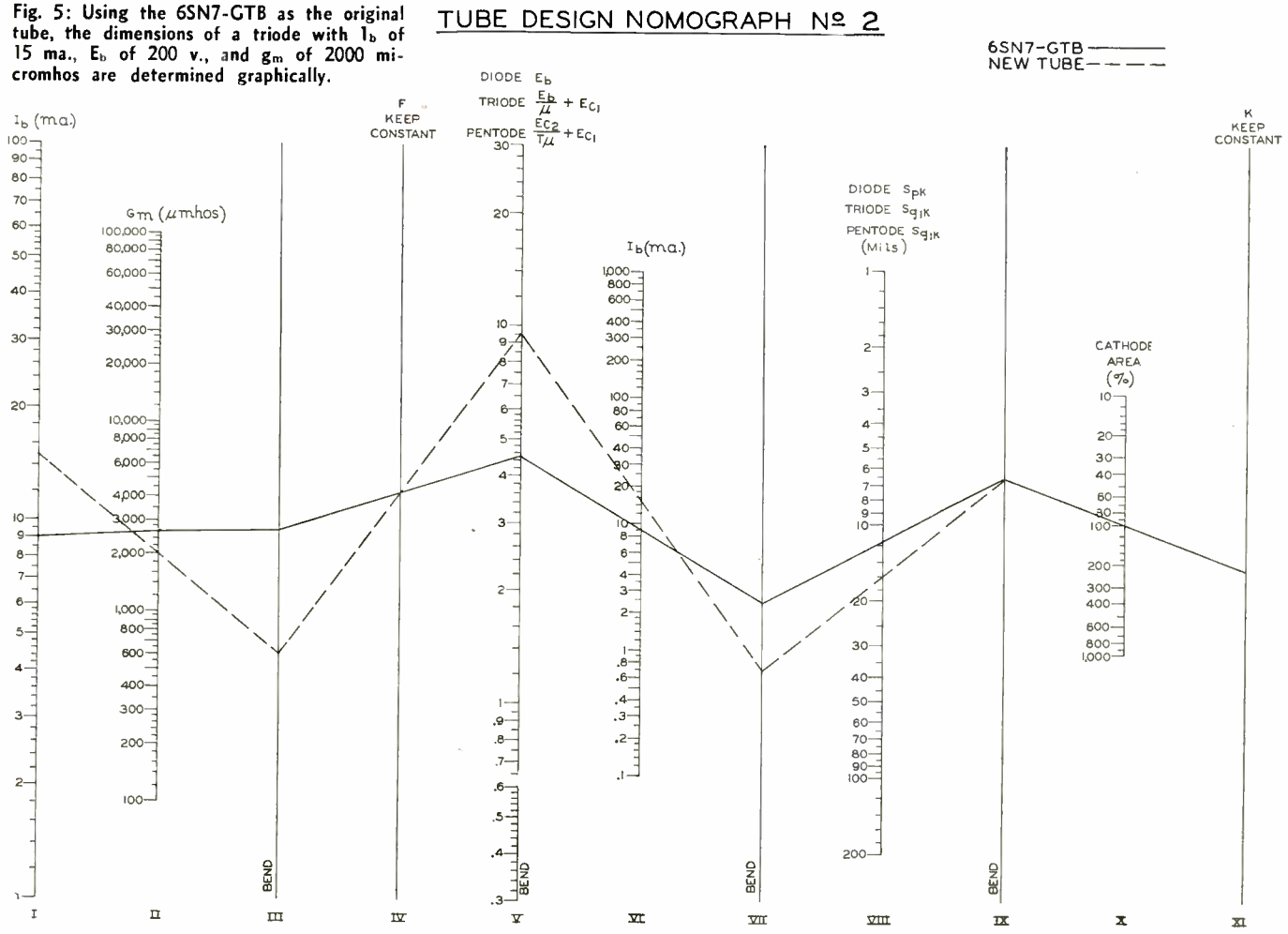


Fig. 5: Using the 6SN7-GTB as the original tube, the dimensions of a triode with I_b of 15 ma., E_b of 200 v., and g_m of 2000 micromhos are determined graphically.

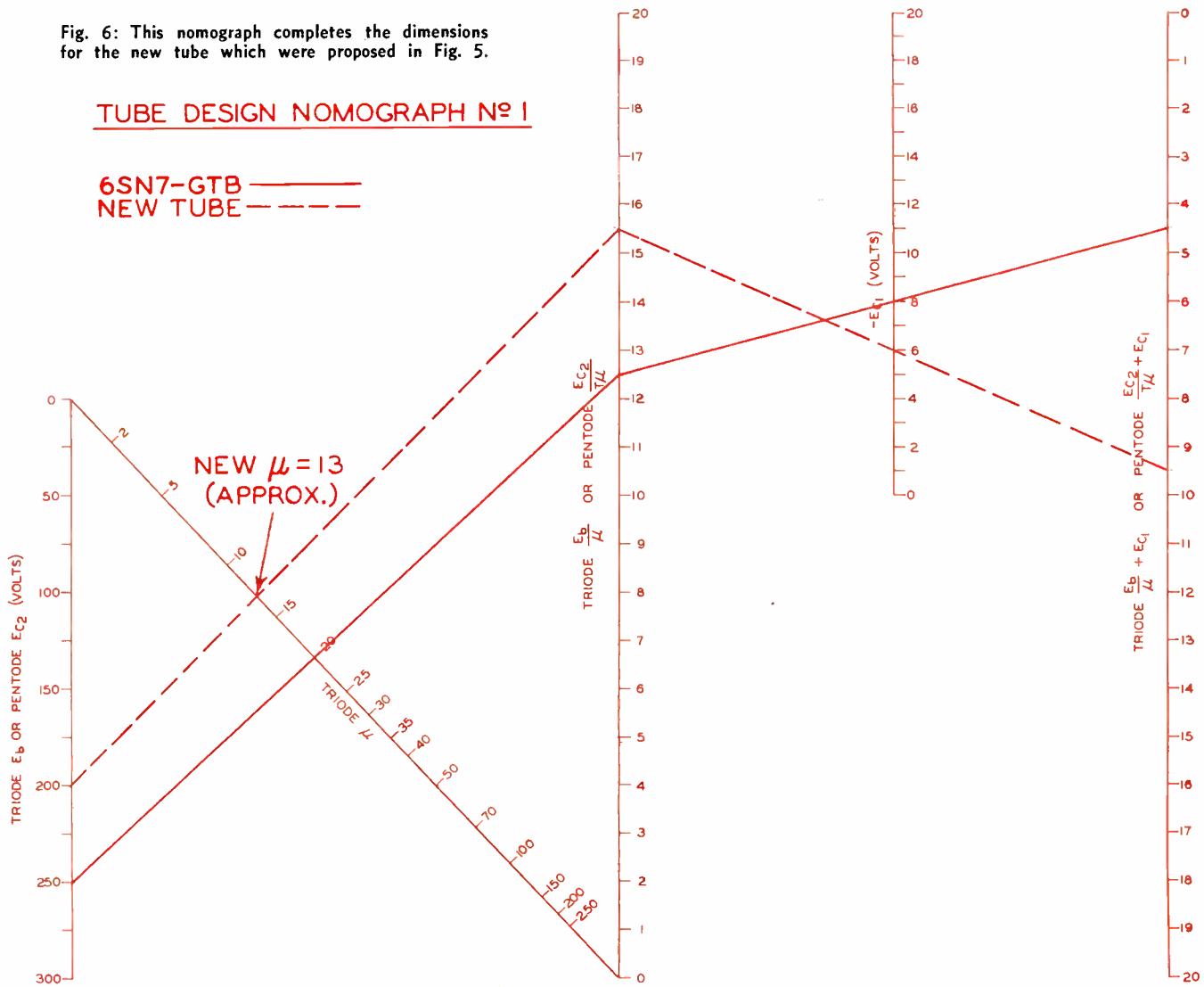
Tube Nomographs *(Continued)*

Although the g_m requirement is fairly low, the plate-current and plate-dissipation requirements suggest a tube of about the same physical size as the 6SN7-GTB. It is decided to use the 6SN7-GTB as the original tube. The pertinent data of the 6SN7-GTB, summarized in Table 1, is illustrated in Fig. 4.

First, the 6SN7-GTB data is entered on nomograph No. 2, as shown in Fig. 5. The plate current of 9 ma. is marked on axis I, and a line is drawn through 2600 μmhos on axis II to axis III. The line for axis III, IV and V cannot be drawn yet because axis IV is blank and the value to be entered into axis V is not known. This value $(E_b/\mu)+E_c$ can be determined rapidly from nomograph No. 1 which is shown in Fig. 6. First, $E_b = 250$ volts and triode $\mu = 20$ are entered on nomograph 1 and a line is drawn to the center axis. From this point, a line is drawn through $-E_{c1} = 8$ v. and the value of $(E_b/\mu)+E_c = 4.5$ is read on the right-hand axis. This value (4.5) is then inserted into axis V of nomograph No. 2, as shown in Fig. 5. A line is then drawn from the point previously established on axis III through axis IV to the 4.5 point on axis V. From the 4.5 point on axis V, a line is drawn through the 9-ma. point of axis VI (a re-entry of the information on axis I) to axis VII. Next, from the point just established on axis VII, a line is drawn through the 11.5-mil point, 0.0115 in. being the nominal spacing between the cathode and the center of the grid-No. 1 lateral wire, on axis VIII to axis IX. From this point on axis IX, a straight line is drawn through the 100% cathode-area point on axis X to axis XI, thereby establishing K.

The designer then enters the desired characteristics of the new tube. From the 15-ma. point on axis I, a line is drawn through the 2000 μmho point on axis II to axis III. From this point on axis III, a line is drawn through the previous intersection on axis IV, which was determined when the 6SN7-GTB data was entered, to axis V, and the value of $(E_b/\mu)+E_c = 9.5$ for the new tube is established. It should be emphasized that F is kept constant, i.e., the point established for the 6SN7-GTB is also used for the new tube. From the 9.5 point on axis V a line is drawn through the $I_b = 15$ ma. point on axis VI to axis VII.

Fig. 6: This nomograph completes the dimensions for the new tube which were proposed in Fig. 5.



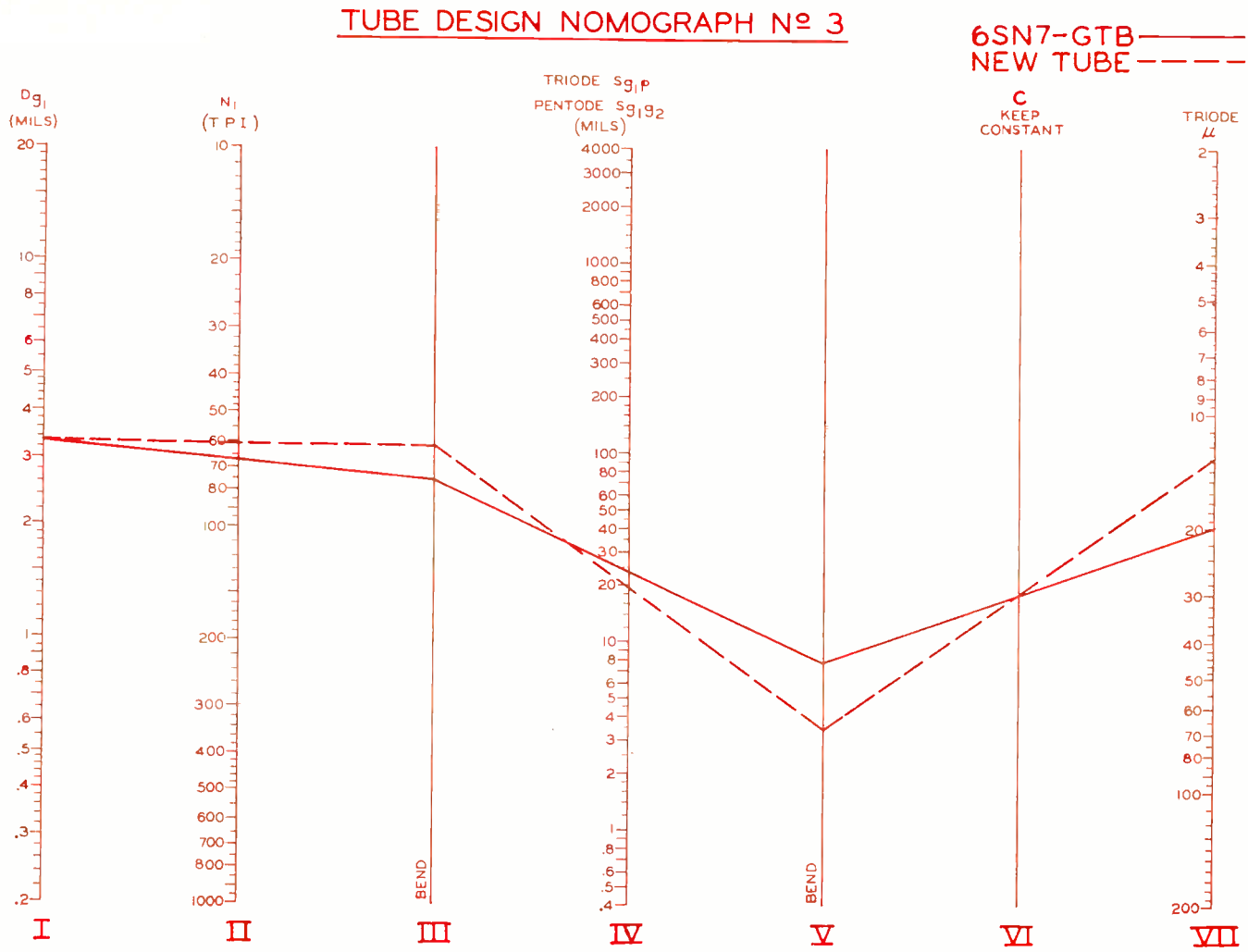


Fig. 7: The parameters of the new tube, which used the 6SN7-GTB as an original, can be determined by working back on this nomograph.

At this point, a look ahead shows the possibility of multiple solutions. If the designer chooses to keep the cathode area constant, a line is drawn from the point on axis XI that was established when the 6SN7-GTB data were entered (K is kept constant) through the 100% cathode area point on axis X to axis IX (a retrace of the line already existing in Fig. 5). The point previously established on axis VII for the new tube is connected with the point established on axis IX, and the intercept point on axis VIII is found to be 16 mils, which means that the grid-cathode spacing of the new tube is 0.016 inch.

The remaining dimensions of the new tube can be calculated by taking the value of $(E_b/\mu)+E_c = 9.5$ for the new tube (axis V of nomograph No. 2 in Fig. 5) and entering this value on the right-hand axis of nomograph No. 1, as shown in Fig. 6. Then a line is drawn from the 9.5 point through $-E_{c1} = 6$ v. to the center axis. From this point a line is drawn to the $E_b = 200$ v. point on the left-hand axis. As shown in Fig. 6, the new triode μ is approximately 13.

Once the μ of the new triode is known, the grid parameters may be calculated from nomograph No. 3, shown in Fig. 7. First, however, the known data of the 6SN7-GTB must be entered on nomograph No. 3. A line is drawn from the 3.3-mil (0.0033 inch) lateral-wire diameter point on axis I through the 67 TPI point on axis II to axis III. From the point thus established on axis III, a straight line is drawn through the 24-mil (0.024 inch) grid-plate spacing point on axis IV to axis V. From this point on axis V, a line is drawn to the triode $\mu = 20$ point on axis VII intersecting axis VI. The entry of 6SN7-GTB data is completed and the constant C on axis VI is established.

The parameters of the new tube now can be determined by working back on nomograph No. 3. The triode $\mu = 13$, which was previously determined from nomograph No. 1 in Fig. 6, is entered on axis VII in Fig. 7, and a line is drawn through the intersection previously established on axis VI (to keep C constant) to axis V. Before the solution can be continued, the grid-plate spacing of the new tube must be determined. It was determined previously that the grid-cathode spacing of the new tube is 0.016 inch (from axis VIII of nomograph No. 2 in Fig. 5). The grid-cathode spacing for the 6SN7-GTB was 0.0115 inch. If the plate in the new tube is to be the same as that used in the 6SN7-GTB, and the grid of the new tube is 0.0045 inch further away from the cathode than the grid in the 6SN7-GTB, the grid-plate spacing of the new tube will be 0.0045 inch less than the grid-plate spacing of the 6SN7-GTB. Thus, the grid-plate spacing of the new tube will be 0.0195 inch. From the point previously established for the new tube on axis V of nomograph No. 3 in Fig. 7, a

Tube Nomographs *(Concluded)*

line is drawn through the 19.5 mil (0.0195 inch) point on axis IV to axis III.

Once again, multiple solutions are possible. The new tube may vary TPI, D_g, or both. If the designer decides to keep the grid lateral wire constant at 0.0033 inch he can draw a line from the point just established on axis III through axis II to the 3.3 mil (0.0033 inch) point on axis I. The resultant intersection on axis II determines the TPI of the new tube. The value is 61. In a similar manner, the designer could have chosen to vary the lateral wire diameter, within limitations, and determine the corresponding TPI.

Thus, all of the critical dimensions of the new tube have been determined. While the explanation of the procedure is lengthy, the actual operations can be performed on the nomographs within a few minutes.

Pentode Problems

Pentode problems are performed in a manner similar to triode problems and, accordingly, a detailed sample problem will not be worked out. The notable differences between the solution of a pentode and a triode problem are as follows:

Nomograph No. 1.

(a) E_{ca} is substituted for E_b

(b) Triode μ is substituted for μ

(c) E_{c2}/μ_T is substituted for E_b/μ

Nomograph No. 2

(a) $E_{c2}/\mu_T + E_{c1}$ is substituted for $E_b/\mu + E_c$

Nomograph No. 3

(a) S_{g1g2} is substituted for S_{g1p}

(b) Triode μ is substituted for μ

Multiplying Factors

Any of the scales on nomographs No. 2 and No. 3 may be multiplied by any factor provided the same factor is used throughout the entire problem. Thus, axis I of nomograph No. 2 which cycles through 1-10-100 ma. may be modified to cycle through 10-100-1000 ma., 0.1-1-10 ma., 3-30-300 ma., and so on. The multiplication of any axis, or combinations of axes, by any factors does not require the correction of other axis.

In the case of nomograph No. 1, however, it is not possible to apply multiplying factors to the various scales. If a particular problem involves values which are beyond the scales of nomograph No. 1, the value of $(E_b/\mu)+E_c$ for triodes or $(E_{c2}/\mu_T)+E_{c1}$ for pentodes can be calculated arithmetically and inserted into nomograph No. 2.

Problem Clinic

—To Measure Semiconductor Wafers

A large Eastern manufacturer is looking for an electronic thickness measuring and indicating device to measure semiconductor wafers.

Following are specifications:

1. Contacting or non-contacting.
2. The area of measurement is a point contact on a wafer about .125 in. square.
3. The points of measurements are on the opposing flat side of wafer and/or at the bottom of .010 in. diameter pits on opposing sides of wafer.
4. Since there are pits on both sider of wafer, two opposing probes are needed.
5. The range of thickness for wafer measurement is from .001 in. to .007 in.

For pit measurement .0001 in. to .002 in. with range switching if necessary.

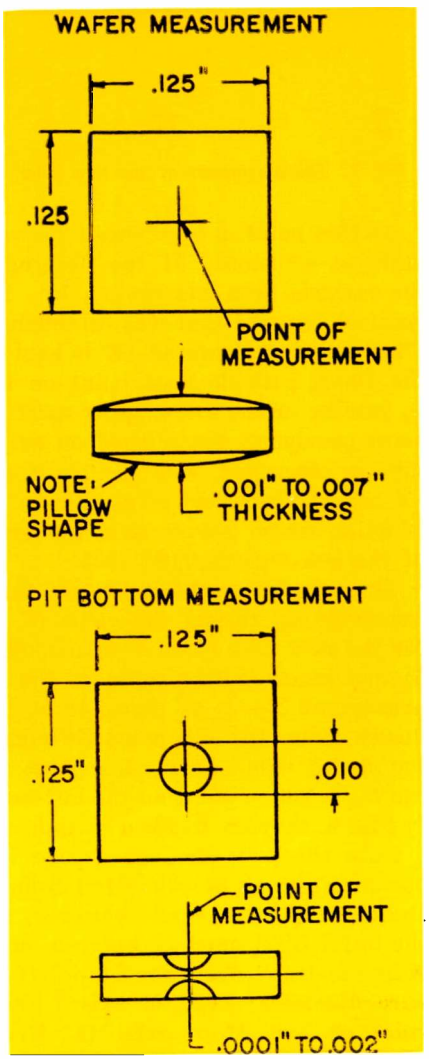
6. The measurements can be either comparative or absolute.
7. The accuracy of measurement should be ± .000005 in.
8. If a contacting device is used, the contact pressure on either side of wafer should be less than 6 grams.

Need includes—gage head, transducer, detector, indicator, and a well filtered DC output voltage which is proportional to thickness (2V/mil).

The wafer handling and jigging devices and gage head mounts will be the manufacturer's own.

* * *

Firms or individuals offering a solution to this problem please contact Editor, Electronic Industries. Correspondence will be forwarded to the Mfr.

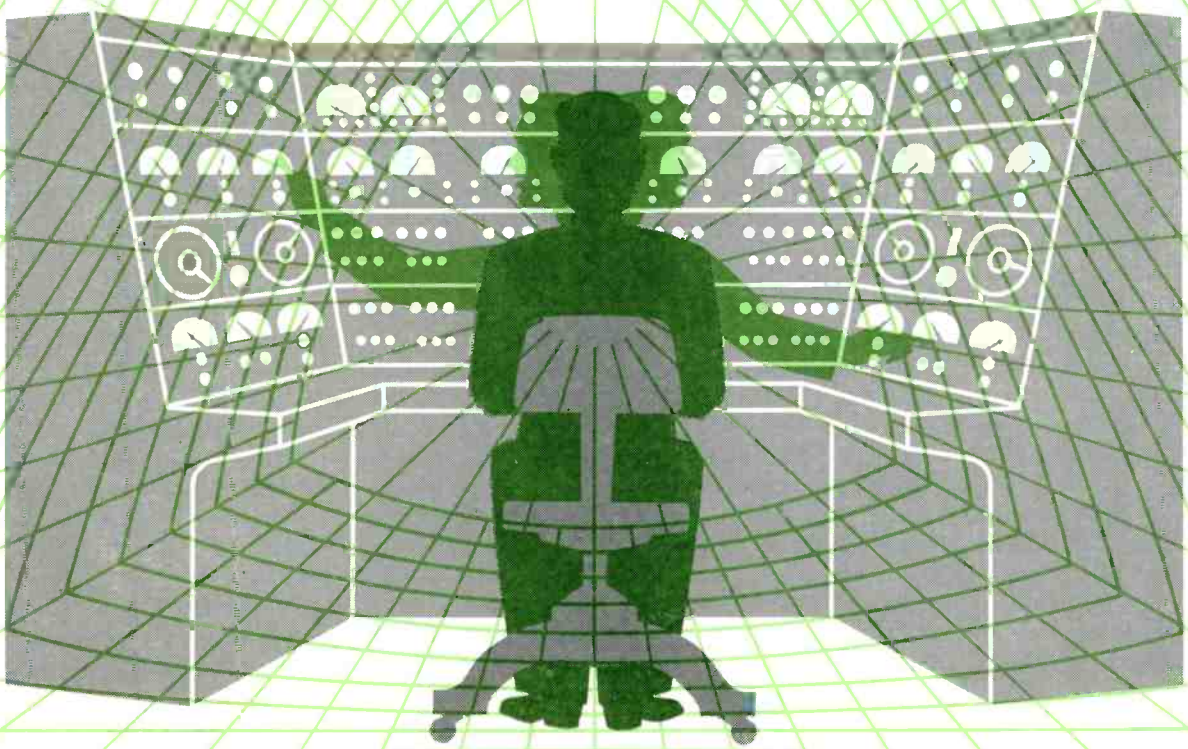


ELECTRONIC INDUSTRIES

A CHILTON PUBLICATION

SPECIAL EDITORIAL STAFF REPORT

"HUMAN FACTORS"—
Newest Engineering Discipline



February
1960

Fig. 1: Dr. Irving Streimer, Boeing Airplane Co., inspects "Sierra Sam", an Air Force dummy rigged for space tests. Instruments will be used to determine how humans react to space travel

"HUMAN FACTORS"—

By **CHRISTOPHER CELENT**
Assistant Editor
Electronic Industries

SOMEWHERE in the design of every piece of electronic equipment, whether it is a relatively simple component or a huge complex, the human factor must be considered.

In the past, the problem of whether the equipment was designed to "fit" the man was either ignored or solved on a common sense basis. Since most people, including design engineers, really know very little about human behavior, the so-called common sense approach often led to costly errors. Until recently, the data available on human behavior was extremely limited, and when extrapolated proved highly inaccurate. As the complexity and sensitivity of equipment has increased, it has become imperative that the old intuitive design criteria be replaced by data on human behavior obtained under scientifically controlled conditions.

The volume of data on human behavior being made available today is tremendous—so tremendous that human engineering has become a "team effort" involving specialists in the behavioral sciences as well as in engineering.

Who Are the Human Engineers?

The men supplying this data and applying it to practical engineering problems are known variously as human engineers, human factors specialists, human factors engineers, and engineering psychologists. In England the term "ergonomics" is used.

They are developing entirely new methods for solving the human factors problems being encountered as man demands more precise control over his environment.

The "team effort" mentioned is well-illustrated by looking at "typical" human engineering staffs. Represented on such staffs are anthropologists, sociologists, physiologists, psychologists (all kinds) mathematicians, electrical engineers, aeronautical engineers, mechanical engineers, computer engineers, systems engineers, and many others.

Much of the experimental data obtained to date has been drawn from research performed by psychologists, physiologists, and anthropologists, but no single discipline has a monopoly on knowledge of human behavior. Any discipline that deals with the questions of why and how a man functions can make important contributions to the human factors field. Human factors work involves a continuous complementary exchange of information between engineers and these other disciplines.

The term "human engineering" is perhaps not well-chosen. What is meant is engineering for human use

Christopher Celent

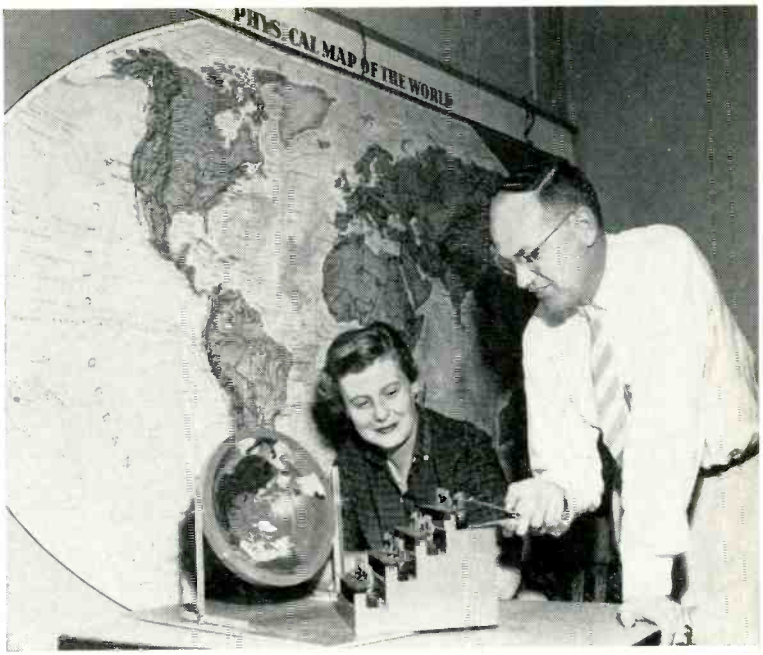


Fig. 2: Concave globe-type map and viewing room, developed by human factors scientists at Battelle Memorial Institute to expedite group discussion of military problems, is an example of how science can be applied to the solution of human factor problems.

Newest Engineering Discipline

The rapid technological advances of the last twenty years have generated problems concerning man-machine compatibility that call for an exhaustive knowledge of human behavior. Human engineering, representing a cross-fertilization between life sciences and engineering, tries to analyze the human as a component in a complex system. The effort ranges from "knob and dial" work to developing complex mathematical models of human behavior.

—not engineering the human. The aim is to make the best use of the abilities that today's human being has—not the creation of superior type individuals.

The term "human engineer" has received widespread acceptance; however, Dr. Launor F. Carter, General Manager, Systems Training, Systems Development Corp. (a large employer of human factor people) makes the following differentiation between human factors and human engineering:

"The human factors area usually includes the specifications of personnel and job assignments, the development of individual and system training, the man-machine aspects of system design, and a narrower field of human engineering which deals with design characteristics of individual components of equipment to assure their compatibility with the human operator. The term human engineering is sometimes used to encompass all of the above."

Why Human Engineering?

There are many examples of the need for human engineering. Many appliances in the home are technically far beyond the comprehension of the "average" housewife. But they are made simple enough that she can be taught to use them. Automobiles for years were plagued with accident producing blind spots.

Fig. 3: Helicopter Flight Simulator Dynamic Platform, developed by Franklin Institute for research under the ANIP. Capable of six degrees of motion, it can give a "pilot" a realistic "feel" of flight. Bell Helicopter Corp. psychologists are using this research tool to study the effect of motion and vibration on the ability of a pilot to control his craft. It is electronically controlled.

Human Factors

(Continued)

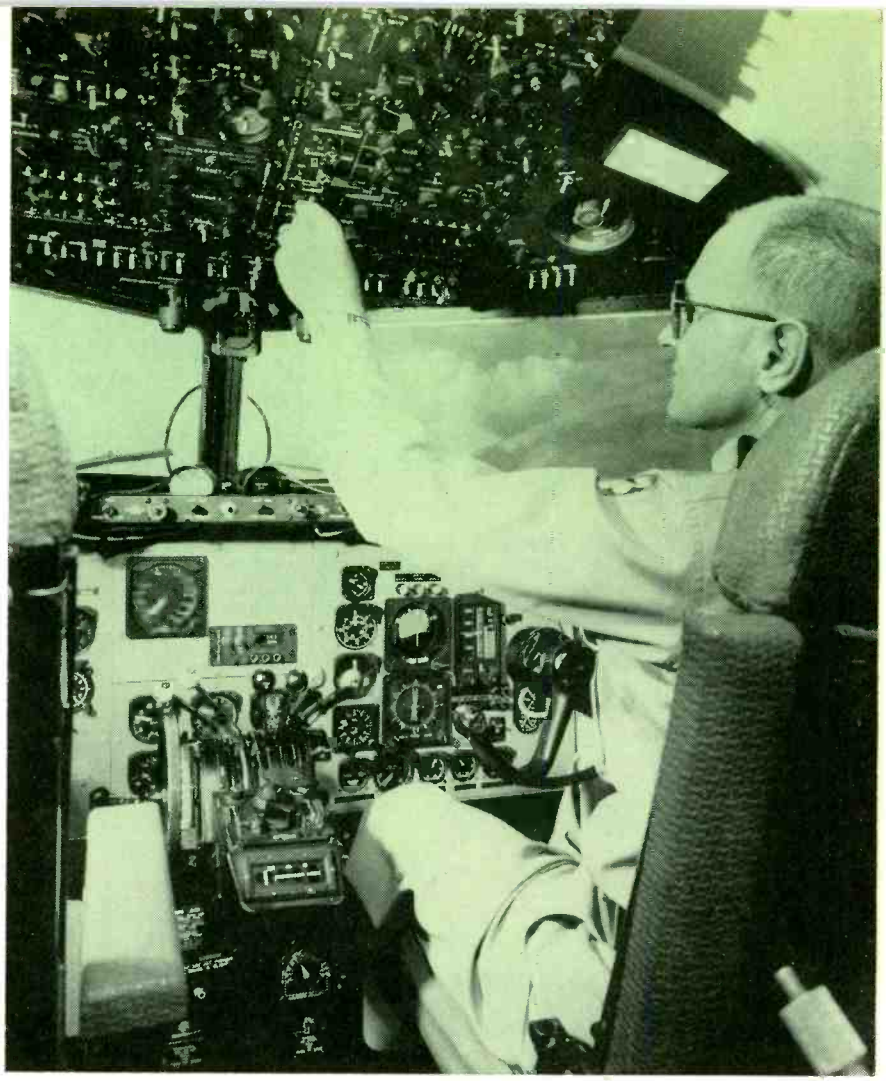


Fig. 4: Some of the original work in human engineering aimed at reducing the complexity and the number of tasks the pilot had to perform. This R4D aircraft has a navigation computer which, after takeoff, will automatically direct him to his destination. System includes special cockpit instruments which enable the pilot to fly a pre-set flight-path without resorting to outside navigational aids. System is being developed by Sperry Gyroscope Co. for the Army.

Now this is being corrected through the use of human engineering data. General Motors Corp., for example, uses analog computers which stimulate road conditions to gain more information on driver limitations and capabilities and so reduce the possibilities of accidents. Many automatic machines used in industry are now doing only a small part of the job they could do. They could be much improved if the human operator were considered.

How do we define "good" human engineering? In its simplest form, we can say that equipment is well designed from a human engineering standpoint when it makes the optimum use of both man and machine capabilities. (The optimum can change with time and circumstance. The Kamikaze bombs of the Japanese, for example, might be considered an optimum use of man, but only if the consideration of survival is minimized. At another time in history, the spearpoint was also considered to be well engineered from a human viewpoint.)

So human engineering is concerned with assigning to each—the man and the machine—the function each performs best, always keeping in mind that the man-machine must be considered an integrated unit.

Human Engineering and Space Travel

A well-developed science of human engineering is an absolute "must" for manned space travel. Man's unique ability to observe, draw logical conclusions, and make decisions, makes manned space flight highly desirable, if not absolutely necessary.

NASA has already announced several long-range plans for putting man into space. These range from putting one man into space for one day (project Mercury) to the establishment of a permanently manned space station (project Nova).

With man in space we want to make the best use of his abilities. Not only must he be equipped with human engineered equipment that will enable him to function to the limit of his abilities in collecting scientific information, but he must also be provided with an environment which will enable him to survive.

The problems and advantages of manned space flight are detailed in, "A Positive Approach to Man's Role in Space," by D. T. McRuer, AFIAS, I. L. Ashkenas, AFIAS, and Ezra S. Krendel, the Franklin Institute. This paper points out that putting a human operator in the space vehicle greatly reduces the reliability requirements of operational and navigational equipment. Also discussed are uses for the power output of man in such things as direct manual control on the orientation of reaction jets, the braking or acceleration of inertia wheels, and the generation of electrical power.

Man-in-space must be protected against high or complex acceleration forces, and the effects of extremes of pressure, temperature, humidity, radiation, noise, and vibration. How "weightlessness" and loss of orientation will affect him must be known. He must be kept physically strong, mentally sound, and emotionally stable. The solutions to these problems are properly within the framework of the human engineering effort.

The Human as a Component

Human engineers see man as a component of a total system, one that should "pay its way" like other components in the system.

He can be a simple amplifier, an integrator, or a differentiator. The complexity of the function assigned to him has been the basis for some disagreement

among human engineers. Some feel that man's actual control assignment should be as simple as possible to reduce the possibility of error and to free him for decision-making functions. Others say that the adaptive abilities of man should be used to the fullest extent.

Man can modify his characteristics to match many control situations. This makes him attractive as a control system component. This quality of adaptation makes it extremely difficult to describe the operator, and one of the aims of human engineering is to set up reasonably simple behavioral models which can fit general situations.

Man, in many ways, is similar to a machine. He receives inputs via sound, sight, touch, smell, taste, and the proprioceptive senses and in turn operates on the inputs with a complex of mechanical, chemical and electrical systems, and delivers a workable output in terms of force or displacement to the system. He is often compared to a servo system. He receives an input signal, feeds back an output signal, and compares the results with the input.

The human engineer wants to know which functions are best assigned to the man, and which to the machine. He wants to know how well a man can do the job assigned to him and what factors influence his performance. He wants to know how many in a given population can do specific tasks and how to discover them. He knows that the reliability of a system is no better than that of the weakest link and his job is to make sure that the weakest link in a man-machine system is not the man.

The human engineer knows that machines are best at making rapid responses and computations, handling simultaneously many complex operations, applying force smoothly and precisely, and performing repetitive tasks reliably. Man excels where inductive reasoning, judgment, imagination, and broad memory are required.

The human engineer faces three important problems in furthering his profession. The first is industry acceptance; the second concerns when the advice of the human engineer is called for, and a third is acceptance by his brother engineers as a useful contributing member of the professional engineering team.

Industry Acceptance

Industry acceptance has been difficult to obtain because the results of the human engineering effort are not easily measured. Quite often the human engineer must spend a good deal of his time convincing management of the need for and value of his services. The results of inadequate human engineering are much more obvious. But this problem is diminishing, largely through the insistence of the Military that human engineering be included in their contract work. Also, a growing number of industrial concerns are adding human engineering people to their engineering organizations, and consulting firms specializing in this type of work are multiplying.

The Aircraft Industry Leads

The leader in human factors work is the aircraft industry, a not too surprising fact since the original work in this field was aimed at improving pilot performance. Engineering psychologists we have talked to estimate that over 75% of applied human engineering work is being done by the aircraft and supporting industries.

A good measure of the importance of human engineering in the aircraft industry can be found in two surveys by J. A. Kraft, Manager, Human Factors Research Dept., Military Operations Research Engineering, Lockheed Aircraft Corporation.[2, 3]

Mr. Kraft outlines the programs, organizational status of human engineers, the size and professional make-up of human factors research groups, and project activities of 32 companies in the airframe and supporting industries. The survey shows that the size of the human engineering groups ranges from 1 to 32 people. They are heavily weighted with engineers and psychologists (57, and 61, out of a total of 166). The engineers on the teams are primarily electrical/electronic, aeronautical, and mechanical.

The activities of these human factors specialists include: audible information display, environmental studies, human factors in maintenance, space flight, remote handling procedures, aural radar, human factors design handbook development, and many others.

Says Mr. Kraft, "Major activities of human factors teams can be categorized principally as consulting, equipment and system design, and applied experimentation with somewhat limited basic experimentation taking place. It is noted, however, that plans for more basic research are being made, and most of the groups have definite plans for expansion of personnel allotments and a greater variety of activities."[2]

Fig. 5: Human Factors engineer Francis J. Conley holds miniaturized transmitter developed by Martin Co.'s Baltimore Div. Continued development could make the transmitter, shown mounted on a pilot's helmet for experimental purposes, suitable for a lunar suit communications system.

Human Factors
(Continued)

A "typical" human engineering team draws from a variety of professional skills. Illustrated at right are the technical specialties and academic degree level of human engineers in 32 aircraft companies.

Table 1

The Make-up of Human Engineering Teams

SPECIALTY	Number of Degrees Within Specialty				
	No Degree	Bachelors	Masters	Doctors	TOTAL
Experimental Psychologist	2	14	31	52	99
Industrial Psychologist	0	0	8	10	18
Social Psychologist	0	0	0	2	2
Physiological Psychologist	0	0	1	0	1
Other Psychologist	0	5	5	3	13
Mechanical Engineer	6	36	6	1	49
Electrical Engineer	5	20	10	1	36
Aeronautical Engineer	2	5	0	0	7
Industrial Engineer	0	1	0	0	1
Other Engineer	3	4	1	0	8
Physician	0	0	0	9	9
Physicist	0	8	6	0	14
Physiologist	0	2	3	7	12
Mathematician	0	5	2	1	8
Statistician	0	3	1	0	4
Anthropologist	0	3	3	0	6
Biophysicist	0	0	2	0	2
Industrial Designer	0	5	1	0	6
Other Profession	0	1	2	1	4
Pilot*	1	6	2	1	10
Engineering Technician*	24	1	0	0	25
Administrative*	13	4	0	1	18
TOTAL	56	123	84	89	352

* No academic specialty given.

From "Human Factors Research in the Aircraft Industry" (See Ref. 2).

The companies place human engineering services at a level sufficiently high to be effective and, in many instances, provide straight line reporting to the Chief Engineer or a high level engineering executive. Human engineers are found in Advanced or Preliminary Design, on Electronics and Control Staffs, in Operations Research, in Staff or Systems Engineering, in Professional Services Groups, in Design Safety, on Technical Specialties Staffs, in Servo-Electronics, in Applied Research, on Reliability Staffs, in Equipment Design, and in Advanced or Long-range Planning.[2]

Table 1, from Mr. Kraft's report, shows the composition of these human engineering groups. (Note that the PhD is rather common among the psychologists; it does not seem to be as necessary in the engineering group.)

Timeliness

The special talents of human engineering should be called for early in the design, development process. If, as does often happen, they are called upon after trouble develops or equipment found faulty, correction can be extremely costly.

The problem of timeliness is also diminishing. In the missile industry, for example, human factors engineers work closely with design engineers in all phases of the operation. Lawrence Pitman, Raytheon Corp., says, regarding the Hawk missile program, that man-machine compatibility was checked at three stages of the missile's development: first in the blueprint stage, second with the first "breadboard" model, and finally with the full-scale engineering models of the missile.

It is significant that at each stage, human engineering dictated modification in design. These changes were relatively easy to make at the time but they would have been costly and time-consuming later in development.

Generally speaking, the human engineer's work begins with a study of system requirements and possible system alternates. He studies the man-machine linkages, and the assignments of functions. With the establishment of human functions he studies the input (visual, auditory, etc.) and the output desired from the human. He studies the integration of machine and human components and analyzes experimental missions ranging from the most routine to the most difficult. He establishes hook-ups between major parts and constructs mock-ups to study the system. Finally he studies the finished product in use for the possibility of improving subsequent models or the advisability of complete redesign.

Early Work in Human Engineering

In the mid-20's only a handful of psychologists were interested in equipments and the emphasis was on placement of controls, dials, error reduction, and color coding for single equipments. In the 30's, concern was still with single equipments, particularly aircraft components. Emphasis was on psychomotor skills and sensory capacities as they affected human capabilities and limitations.

The second World War represented a transition period in engineering psychology and a beginning of engineering psychology as it appears today. The mid-40's brought forth a substantial interest by psychologists and engineers in man as a link in equipment systems. There was a growing awareness of the need to examine entire systems, not just components or subsystems.

The original stimulus came from such problems as the development of complicated manual control devices

for fire control, improving the lay-out and instrumentation of airplane cockpits, air-traffic control, etc. It was found that in many instances equipment design was running ahead of human capabilities. These control systems, which sometimes underloaded the human operator as well as overloaded him, required a more detailed knowledge of human performance than had hitherto existed.

As early as 1942 the Franklin Institute in Philadelphia conducted a human operator study and coordinated a program of engineering research into the operation of lead computing sights used in flexible aerial gunnery. A theory was developed, and the production prototype of a stable man-machine system was designed. Simulation studies showed that the Institute's sight and gun system in the hands of untrained secretaries was more accurate than was the previous system when operated by trained Air Force personnel.

Recognition that improving the operator's functioning was an important research area came first in Great Britain and then in the United States. Research teams, at first consisting mainly of psychologists, were organized. In time the aid of other disciplines was enlisted. Two approaches to the problems stand out.

Industrial psychologists analyzed job requirements and concentrated on the selection and training of people who could best be expected to perform the tasks well. Experimental psychologists studied the complimentary possibilities of training and equipment redesign. The equipment redesign efforts were separated into static, kinetic, and dynamic studies.

Equipment Studies

Kinetic studies deal largely with control-display relationships. Static studies deal with such matters as anthropometry and the placement of controls, knob and handwheel design, reticle design, etc. Several excellent handbooks emphasizing this aspect are available. Included in most handbooks are sections devoted to visual indicators, aural equipments, controls, console design, panel layout, workspace design, illumination, environmental factors like temperature, humidity, body measurements, etc.

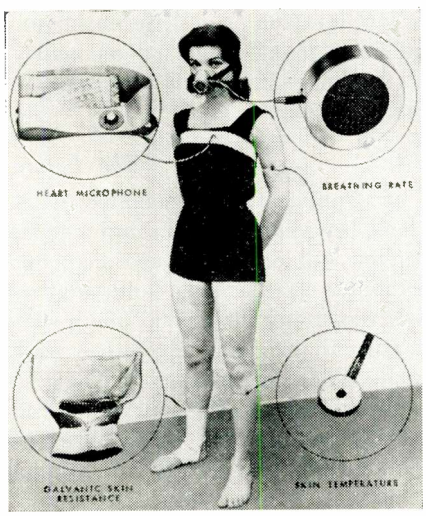


Fig. 6: The well-dressed space pilot will wear many of these medical instruments (designed by Gulton Industries, Inc.). They will measure heart reactions, breathing, temperature, and resistance to shock and stimuli. The breathing rate apparatus, can even tell if he is alive or unconscious.

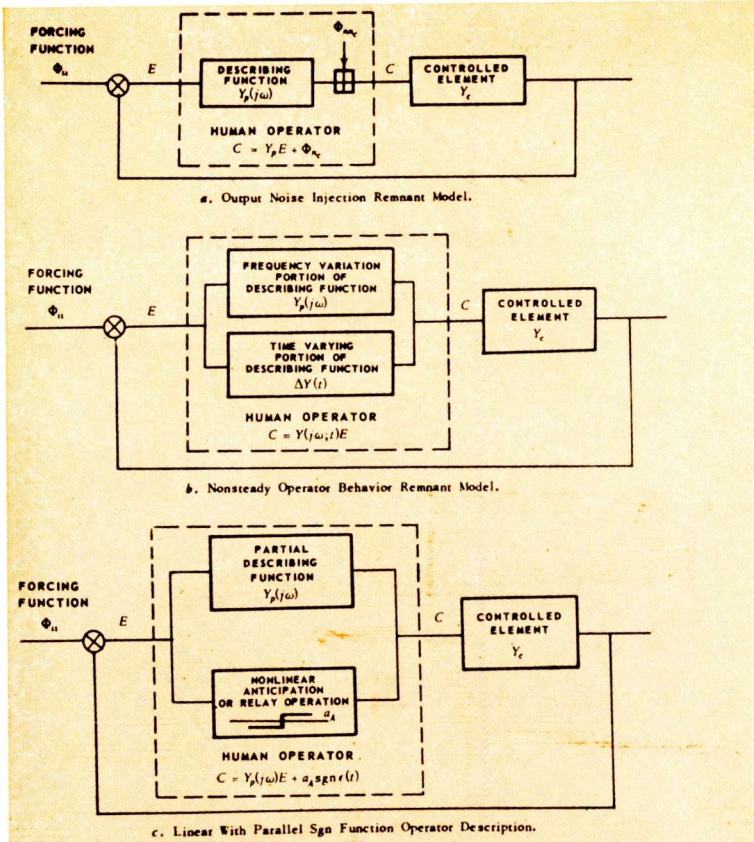


Fig. 7: Human Engineers see man as a "component" in a control system. The non-linear portion of the human's output is as important as the describing function in describing human behavior. From "A Review and Summary of Tracking Research Applied to the Description of Human Dynamic Response." See bibliography.

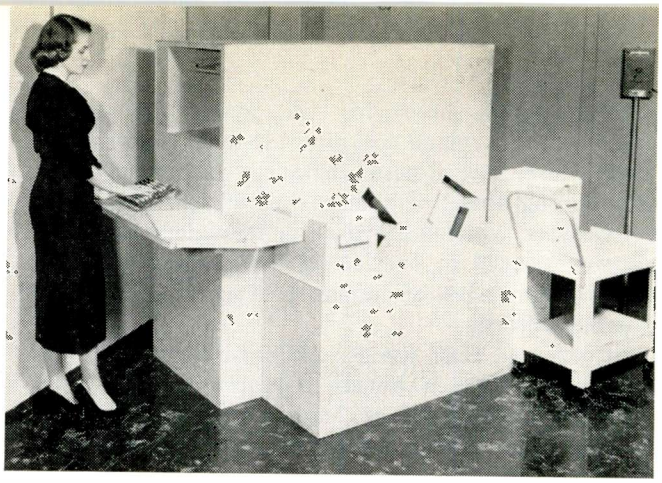
Dynamic Studies

In many control systems, the human acts as an error detector. Dynamic studies are characterized by analytical descriptions of the processes by which the human operator exerts control in closed loop tasks. These dynamic studies have led to the application of the well-developed theory of linear servomechanisms to manual control systems in much the same manner as they are applied to automatic processes. The human is represented as a block in the system with inputs, outputs and feed back loops in much the same manner as the mechanical and electrical components of the system.

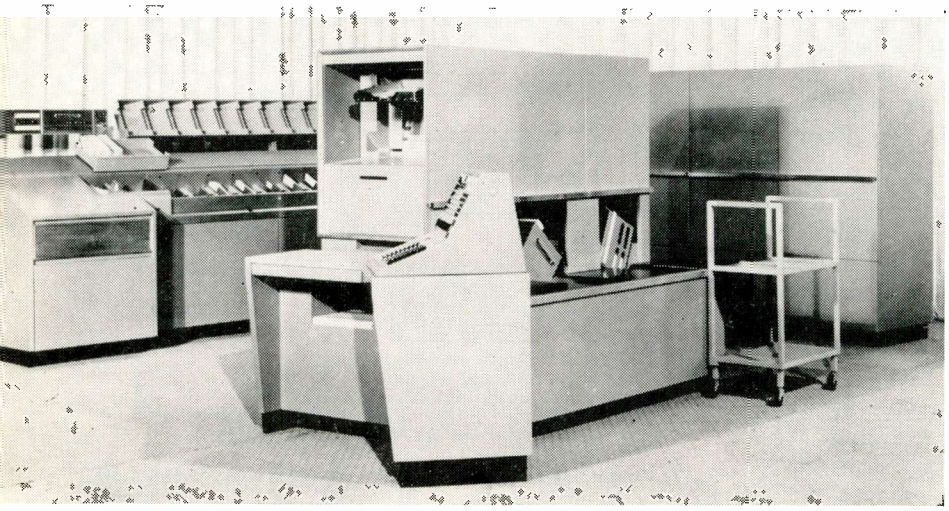
The mathematical expression of man's transfer function is difficult for several reasons. First, man's response is inherently intermittent and involves a time delay in responding to stimuli. Second, he appears to have many transfer functions, and by learning can modify his transfer function to optimize his performance.

Non-linear analysis techniques could be used to describe these functions, but since the results apply only to specific situations, the human engineer would need a huge dictionary of input-response pairs to properly describe the human function. A technique described by Dr. Ezra Krendel of the Franklin Institute Laboratories for Research and Development allows the use of linear differential equations and describes the human component in terms of a weighting function or its transform.[4] An additional quantity called a "remnant" describes that portion of the human

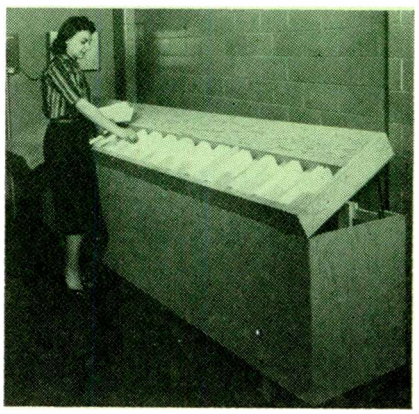
Human Engineers Called in Early



Human engineers at Burroughs Corp., Paoli, Pa. are consulted early in the design-development process. Wooden mock-ups of the system are built with both engineering specifications and human dimensions carefully considered.



From these stages (above and below) is developed an actual artist's concept of the finished product and finally the final machine shown left. This is Burrough's B251 Visible Record Computer, a solid-state electronic data processing system.



behavior not ascribable to this linear operation on the input. See Fig. 7.

This "remnant" may be accounted for in many ways. For instance, a random "noise" may be superimposed on the operator's output; the human operator may behave in a non-steady manner by exhibiting a time variation of his open loop describing function during the course of a run; and there may be a nonlinear anticipation, or relay operation, in parallel with the operator.

Drs. H. P. Birmingham and F. V. Taylor of the Naval Research Laboratory say that, "speaking mathematically, man is best when doing least." They make the fundamental assumption that "the more complex the human task, the less precise and the more variable becomes the man. . . .Human control behavior reaches the optimum when the man becomes the analogue of a simple amplifier."[5]

It should be noted that below some optimum number of events-per-unit-time man's performance may degrade with passage of time. It may be necessary to provide additional motivation to decrease this effect, commonly called the "vigilance" effect. For instance, a loud sound may be used whenever a particular response is not made to an infrequently-occurring signal.

Quickening and Unburdening

Drs. Taylor and Birmingham describe two aids to achieving this optimum in control devices in a report, "A Human Engineering Approach to the Design of Man-Operated Continuous Control Systems." The two principles are "Quickening" and "Unburdening."[5, 6]

Quickening provides the operator with immediate knowledge of the effects of his own responses. Although it modifies what is displayed to the man, it does not change directly what he is called upon to do with the control. It has the effect of simplifying the mental processes involved in the tasks.

"Unburdening" uses mechanical, electrical, or other systems to relieve the operator of the necessity of performing complex integration or differentiation. This method tries to limit man's function as nearly as possible to that of a simple amplifier according to the principles mentioned above.

The Future

Jack W. Dunlap, of Dunlap and Associates, Inc., predicts that in the next ten years human engineering basic research techniques will remain unchanged, but research tools (electronic, mechanical, and mathematical) employed by human engineers will make substantial advances; a formal program of engineering, physiological and anthropological courses leading to advanced degrees in human engineering will be offered —probably in engineering schools; out of the present committees and organizations for study of human factors will come a single, strong interdisciplinary

society (see Table 2); men formally trained in human engineering will be in strong demand; the emphasis in equipment systems will be placed on man as a sensing, monitoring device; and problems of environmental stress induced by ultrasonic speeds, space travel, isolation of individuals, and automation will receive the major attention of human engineers.[7]

We have already mentioned several examples from the wide-range of problems and projects of the human engineers. In the past few years so many human engineering teams have been organized that it would be difficult to list separately the work being done by each. It would be equally difficult to select any single group as "representative" of the many facets of human engineering. We have selected, however, several programs from industry, government, non-profit organizations, and private consulting firms to give a general illustration of the work being done in this field.

Battelle Memorial Institute

Battelle Memorial Institute, Columbus, Ohio, is a not-for-profit organization doing research in most scientific and engineering fields. The organization conducts research for both industry and government.

The human engineering program at Battelle is just over three years old. The human factors group, under Systems Engineering, is organized into three parallel groups: Engineering Psychology, Personnel Psychology, and Sensory Psychology.

The sensory psychologists study the human senses (vision, auditory, taste, smell, motor skills, etc.). The personnel psychologists study such subjects as selection, training, safety, motivation, etc. The engineering psychologists concentrate on man-machine relationships. Nine industrial, experimental, and physiological psychologists staff the department and can draw from the entire technical and professional staff of the Institute for human factors work. Head of the human factors group is Dr. William Hitt.

Typical Battelle human engineering studies include: investigating the effects of degrees of automation on man-machine system performance; development of a system simulator for studying Air Force problems; formulation of a program for research on human problem solving; a study of the effects of electronic countermeasures on defense systems; the development and evaluation of a reading instrument for the blind; and the design and layout of an operator's console for a large radio telescope.

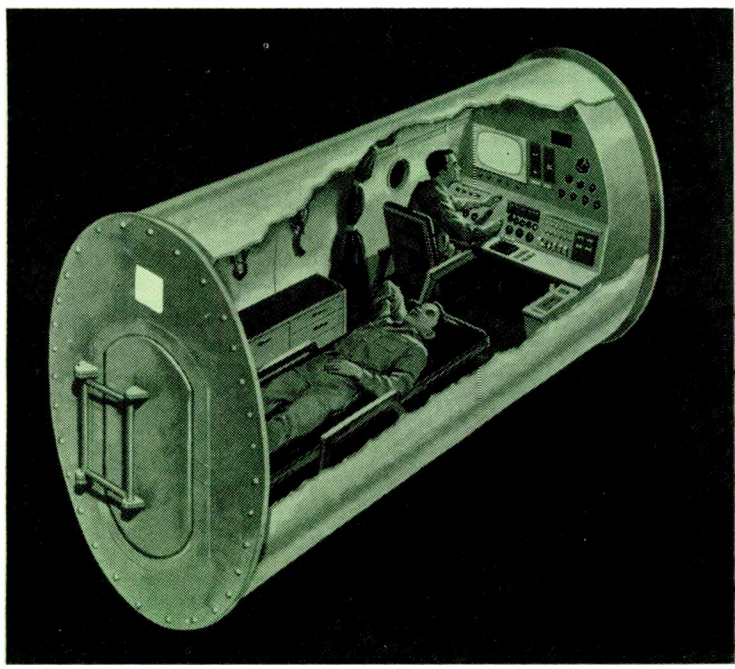
The Aural Reading Device for the Blind (see Fig. 9) is a direct-translating, non-integrating machine sponsored by the Veteran's Administration, Prosthetic & Sensory Aids Service. The device, still in the experimental stage, is moved over a printed page by the blind person. The printed characters trigger photoelectric cells and sounds are emitted which describe the characters. With training, the blind person can interpret the sound and so read the printed material somewhat like reading Morse code. The device uses 11 separate sound channels with frequencies from 400 to 4000 CPS.

Battelle, in cooperation with the Ohio State School for the Blind, has a training program, including group and individual methods, for evaluating the device. Although there is, of course, some variation in ability among the trainees, a reading speed of 10 words per min. has been attained. Compared to the Braille System (approx. 37 wpm) this may not appear particularly startling. However, it must be remembered that these machines are designed to supplement present methods. When fully developed, they will give blind people access to newstand material, daily papers, technical journal articles, personnel correspondence, and other printed media not now available in Braille. Then, too, the 10 wpm is not a machine limited speed. It could be increased depending on the person using it and the degree of his experience.

Battelle's human factors group is doing the design and layout of an operator's console for one of the world's largest radio telescopes. The human factors group is working with a team of electrical and mechanical engineers on this console, the nerve center of the system.

Typical problems relate to the duties to be assigned to the operating personnel; the types, shapes, sizes, and colors of the controls to be used; the layout of indicators and controls on the console according to function, importance, frequency of use, and sequence of use; the organization of sub-systems on the console; and the types of malfunction and acknowledge malfunction cues to be used. Also part of the group's responsibility are designing for reduced maintenance and increasing reliability by increasing operator efficiency.

Fig. 8: Artist's conception of a satellite simulator designed by Minneapolis-Honeywell for the Air Force School of Aviation Medicine. Information obtained from research with this capsule will pave the way for design of living and working accommodations in future extended-trip space vehicles.



To test the results of their study, the human factors group will build a full-scale mock-up of the system.

A third project is a simulation study to evaluate the effects of electronic countermeasures (ECM). In this

study, a combined analog-digital simulation of an air battle between an attacking bomber and a ground-controlled interceptor including the intermediate human radar operator was devised. The measure of effectiveness of ECM was considered to be the probability of survival of the bomber.

The experiment involved 500 trials and consisted of 50 different ECM displays presented to 10 different subjects (operators). The experiment enabled analysis of the functional relationships between performance measures and the errors in the system. These included measures of effectiveness related directly to the performance of the human operator, and the effectiveness of measures derived from the operator's performance after the observed data have been operated on by a complex transformation.

Armour Research Foundation

The human factors section at ARF is under the jurisdiction of the Mechanical Engineering Dept. The area of responsibility includes kinematics and kinetics of body joints and limbs, analysis of protheses and man-machine and man-vehicle coordination studies. Projects usually involve an interdisciplinary approach. The instrumentation section of the Electrical Engineering Dept. has done extensive work in the field of electro-medical research including the development of special recording equipment. The Foundation also provides a testing service for new design electro-medical equipment for the American Medical Association.

Other programs at ARF in which human factors play a significant part include: a program to simulate "g" effects in aircraft flight simulators, which may involve the design of an engineering model to produce the desired effects; and a program to design and develop an integrated system for monitoring the physiological response of experimental subjects undergoing severe whole body vibration.

TABLE 2

Professional Society Information

The professional societies listed below have as their aim the advancement of human factor knowledge and application in systems, equipment, procedures and processes; or have groups or committees specifically concerned with human factor applications to their major areas of interest.

Human Factors Society P. O. Box 263 Arlington 10, Virginia Journal: HUMAN FACTORS	Dr. Paul Cheatham, Secretary
Division 21, Society of Engineering Psychologists American Psychological Association 1333 Sixteenth Street, N. W. Washington 6, D. C.	Dr. Frank V. Taylor, President Naval Research Laboratory Washington 25, D. C.
Ergonomics Research Society Journal: ERGONOMICS	Dr. K. F. H. Murrell, Secretary Department of Psychology 22 Berkeley Square Bristol 8, England
Professional Group on Human Factors in Electronics Institute of Radio Engineers, Inc. One East 79th Street New York, New York	Mr. H. P. Birmingham, Chairman Naval Research Laboratory Washington 25, D. C.
Human Factors Group American Society of Mechanical Engineers 29 West 39th Street New York 18, New York	Mr. Arthur H. Schroeder, Chairman International Business Machines Corporation Box 390 Poughkeepsie, New York
Man-Machine Integration Sub-Committee Technical Operations Department American Institute of Electrical Engineers 33 West 39th Street New York 18, New York	Mr. W. H. MacWilliams, Jr. Bell Laboratories Whippany, New Jersey
Seventh Technical (Human Factors) Division American Rocket Society 20th and Northampton Streets Easton, Pennsylvania	Major Stanley White, Chairman NASA, Langley Research Center Langley Field, Virginia
Psychological and Sociological Factors Committee American Institute of Industrial Engineers 145 North High Street Columbus 15, Ohio	

Courtesy of Dunlap & Associates, Stamford, Conn.

Applied Psychology Corporation

Applied Psychology Corp., Arlington, Va. is making a study of "Design Standards for Man-machine Tasks in Signal Corps Systems." They are aiming to reduce the number of kinds of tasks an operator will have to perform in future systems. The overall purpose of the study is to provide a method by which the engineer can determine the functions of the human in the early design stages of systems or equipment development.

To do this, they are developing criteria by which functions can be analyzed, identifying human functions in present developmental systems, and developing an analysis procedure. A survey will be made to classify functions presently found. A catalog of tasks and equipments indicating the processes performed in each case will be made. A design engineer could turn to the catalog of tasks, locate the task in which he is interested and notice both the human processes involved and the equipment components used in previous systems.

APS feels that the human processes associated with each separate piece of equipment will not be the same even though the task being performed is the same. Having information on the most efficient processes, the engineer will be able to select more intelligently the component design which optimizes human efficiency.

Initial work has been done on developing a methodology for analyzing these human processes. A preliminary list of human functions in Signal Corps systems has been developed. Certain functions are indicated as "basic" in the sense that it seems possible to define all complex human activities with relatively few terms. The first stage in an attempt to discover these basic terms has been carried out. Further work on delimiting and defining the basic process or function is planned.

Systems Development Corporation

Systems Development Corp., a non-profit organization which was formerly the System Development Div. of Rand Corp., is probably the largest single em-

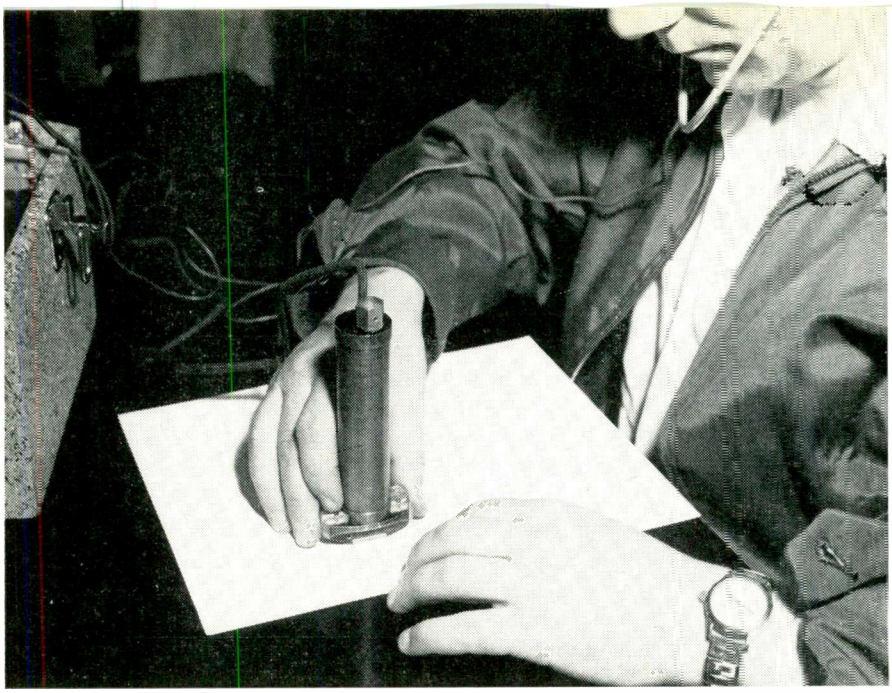


Fig. 9: This Aural Reading Device for the Blind, designed by Battelle's Engineering Psychologists will give blind people access to ordinary printed material. The device has 11 frequency channels and is "read" somewhat like reading code.

ployer of human factors personnel in the world. The main emphasis has been on system training. The corporation has developed a system training program for both the manual air defense system and the SAGE air defense system. They are currently doing the human factors work, including system design, for the new SAC control system.

Human factors is one of four major professional specialties of the corporation's technical staff. The others, Data Processing, Engineering, and Management Research are closely connected with human factors work.

The human factors scientists study the human elements of control systems. They study system environment, and develop training programs that help men to perform effectively in these environments. The corporation carries on a long-range research program into all aspects of man-machine relationships. Specialists collect the detailed information required for realistic simulation of a system's actual or potential environment, and design training exercises that will stress critical functions of all or parts of the system. After the training design phase, consultation is provided during the actual operation of a training program. As new training techniques are developed, they are tested in SDC's simulation laboratories or in the field.

The Air Defense Command's System Training Program (STP) began as an experimental study of the human factors affecting the performance of man-machine systems. STP exercises simulate conditions of emergency situations—such as air attack—with which a control system must deal. These exercises are planned, controlled and closely observed. They make possible evaluations of human performance under stress conditions.

STP materials—hundreds of aids such as charts, maps, film, magnetic tape, and scripts—are largely machine-produced by SDC computing equipment. More than a billion calculations are performed annually to maintain a steady output of varied and increasingly complex training exercises.

Defense Agencies

The defense agencies, besides specifying human factors work in contracts, are doing other work in human engineering. As a matter of fact, almost all military agencies have at least one human factors group. The Aeromedical Laboratory at Wright Field, a pioneering organization in human factors, is one of the largest. The Army at the Aberdeen Proving Grounds has a large human engineering staff about evenly divided between engineers and psychologists, and we have already mentioned the well known work of Drs. Taylor and Birmingham at the ONR. Many military groups serve as monitors of the human factors work being done by private industry on government contracts.

The Navy has prepared a survey of work in the field of bio-electronics to aid in the use of these techniques in human engineering. This technology permits measurements of electrical changes associated with body functions. The survey, by A. Ford of the Navy Electronics Lab., is preliminary to the NEL's use of bioelectrical techniques in investigating human behavior in job settings. Included are chapters on: "The Viewpoint in Human Engineering," "Amplitude and Frequency of Bioelectric Signals," "Amplifiers and Recorders," "The Human Transmission System," "Applications to Human Engineering" and others.

The School of Aviation Medicine at Randolf Air Force Base has studied the effect on humans of short

Fig. 10: Dr. P. Robert Knaff, Scientist, Human Factors, at General Electric Co.'s Missile & Space Vehicle Dept., Phila., sets up analog computer in the company's Human factors lab. Computer can simulate control situations encountered in manned space vehicle re-entry.

Human Factors *(Continued)*

term zero gravity conditions. The Holloman Aero Medical Field Laboratory has investigated the stresses and hazards of upper atmosphere flight and human tolerance to G forces. Operation HIDEOUT, conducted by the Navy, and Operation LONGSHOT, conducted by the Aero Medical Laboratory, Wright Air Development Center, have studied some of the effects produced by long-term confinement and isolation. The American Institute for Research has conducted research on behavior impairment due to stress.[8]

The Flight Control Laboratory and the Aeromedical Laboratory of the Wright Air Development Center have sponsored work directed toward learning more about human transfer functions in tasks most likely to be found in aircraft. Some of the measurements were made at Franklin Institute, some at Princeton, and a great deal of the work was coordinated by personnel of Systems Technology Inc., as well as by project officers at Wright Field.

Some of their findings: The human operator is an adaptive, optimalizing control device, within the limits of the linearized model, although there are many non-linear aspects of human behavior. However, in many tasks of considerable value, the linear model is close enough to the facts to be pertinent.

Army-Navy Instrumentation Program

Human factors engineering is playing a primary role in the joint Army Navy, BuAir, Long-range instrumentation program (ANIP). A basic objective of ANIP is to provide instrumentation, displays, and controls that make a maximum use of man under all environmental conditions. The long-range program aims to relieve the human pilot of tasks which prevent him from using his full capabilities in carrying out his mission.

Two other programs similar to ANIP are the Submarine Integrated Control Program (SUBIC) and the Surface Integrated Control Program (SURIC). Coordination responsibility of ANIP is with the Electronics Dept. of Bell Helicopter Corp., and Douglas Aircraft Co. Electric Boat Div., General Dynamics Corp., coordinates SUBIC and Sperry Gyroscope Co., Div. of Sperry Rand Corp. the SURIC program.

One human factors study for ANIP will determine how objects sensed by other than visual means can be best encoded and displayed. The study considers the textural elements and edge contours of images essential to their recognition and will permit a quantitative expression of required image properties.

Many advances in techniques, design and theory have been developed as a result of these programs. General Electric Co.'s Light Military Electronic Dept.'s Advanced Electronic Center at Cornell Univ. has developed an instrument which shows the pilot an electronic "picture" of the earth below. The technique, "Contact Analog Display," was developed from specifications advanced by engineering psychologists at GE and Dunlap and Associates (Consultants in Human Factors) for the information a pilot needs

Fig. 11: Chart shows general Army Navy Instrumentation Program philosophy and information flow. Human engineers study the pilot's information requirements and how best to present them to him.

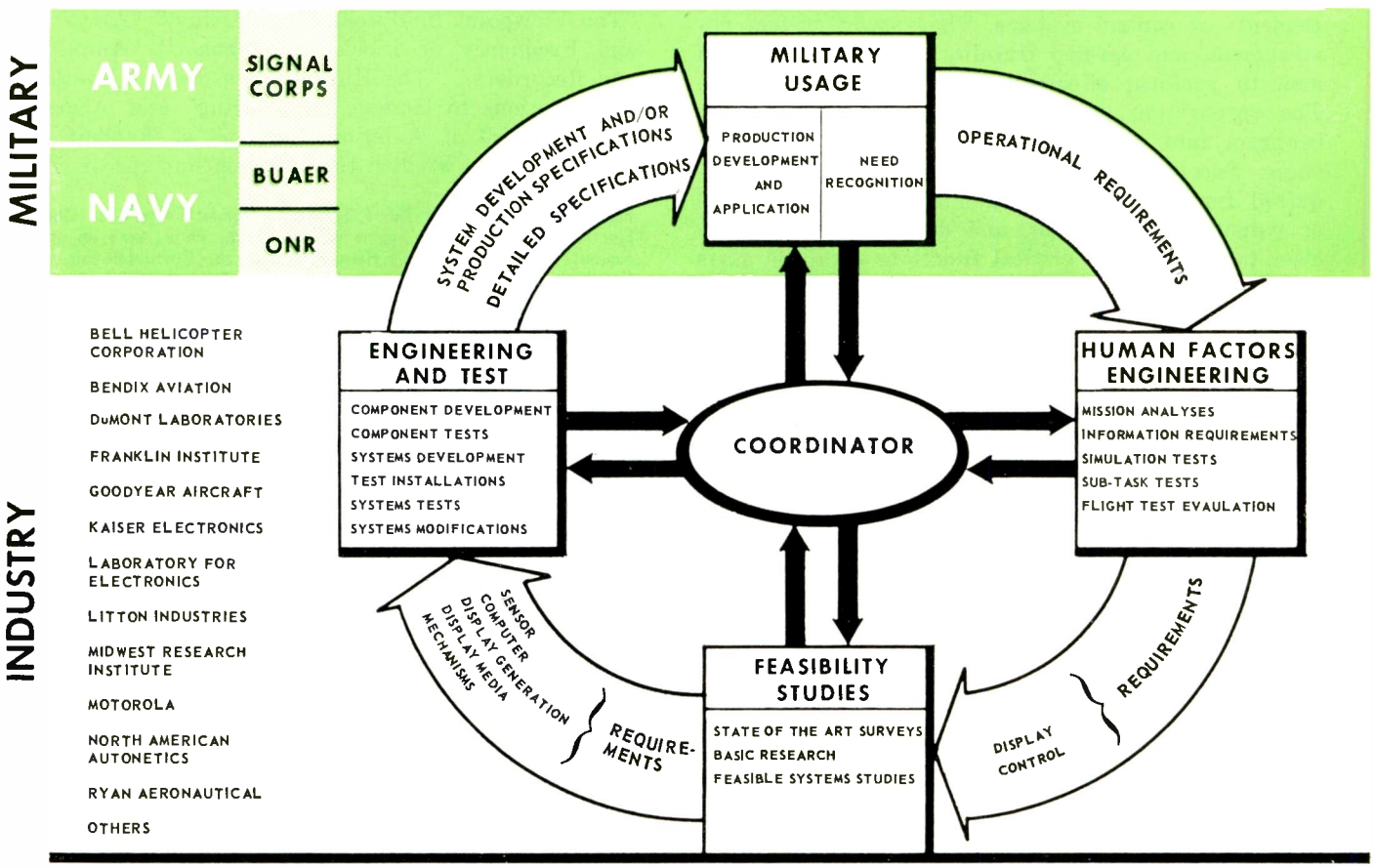
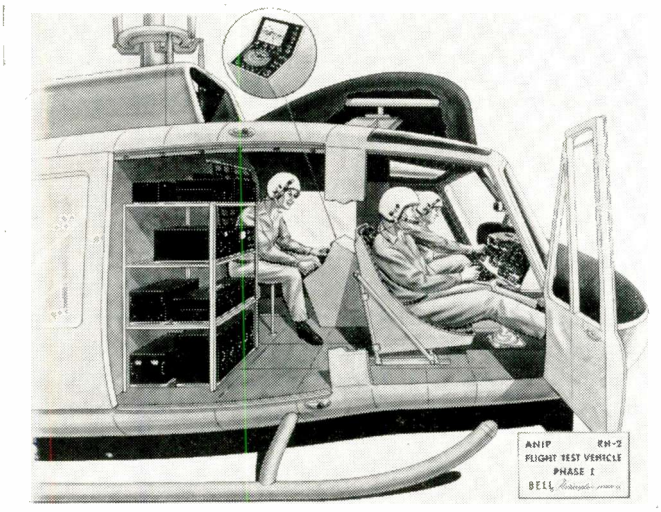


Fig. 12: Research helicopter (above) is a flying laboratory for human engineers and electronic engineers in ANIP program. (Below) Radar mapping information is on bottom half and forward looking obstacle information on top half of console. (Right) Pilot-subject sits at left.



for safe instrument flying. Fig. 13 shows what the pilot would see on the windshield of his plane when using the instrument.

John Senders, research scientist at Minneapolis-Honeywell Corp., says that both men and aircraft have been simulated on digital and analog computers by Minneapolis-Honeywell in studies for ANIP to determine human ability to control everything from a single pushbotton to a complete space ship. The effect of variation in both human and machine parameters was measured.

Avion Div., ACF Industries, Inc., has devoloped a "Horizontal Navigation Situation Display" which correlates information fed into it by computers and instruments and presents a TV picture in the form of a map of the terrain below the plane. A plane image, corresponding to its actual position, is projected on the display.

Bell, and Franklin Institute have built a helicopter flight simulator which will be used primarily for human factors studies under ANIP. The simulator can reproduce the motion, sound, vibration, and general cockpit arrangement of most existing helicopters. See Fig. 3.

The pilot flies the machine as though he were actually flying the real helicopter under blind flight conditions. A computer accepts the control movements from the pilot and then calculates the response of the helicopter. The machine can simulate pitch, roll, yaw, rise 8 feet, and move sideways, fore, and aft. A display generator is driven by the computed responses and presents visual information about attitude, velocity and altitude to the pilot.

Two groups of Bell engineers establish the criteria for these R & D programs. They are the electronics engineers, directed by Owen Q. Niehaus, who develop the equipment, and the human factors coordinators, headed by Dr. W. G. Mathery, who establish the criteria for the need of the equipment and the design of such displays and controls as will be used by the human operator. RH-2, Fig. 12 is a helicopter used only for research purposes of the ANIP program. Its equipment includes: a side-arm cyclic control, an electronic control system with various modes of stabilization; an airborne radar (built by Bendix) which will present radar mapping information, and foreward looking obstacle information which will be displayed through a scan converter (built by DuMont). Additional equipment to be installed includes: an airborne central control computer (by Litton Industries) to provide information to various display components within the cockpit, primarily to the navigation display.

Human engineers working at the Goodyear Aircraft Corp. are studying data from which may be designed and built visual electronic displays for the ANIP program. The program is outlined in two steps; the development of mathematical transfer functions for human perception under certain conditions of action, and reduction to a minimum the amount of information required by a human to identify a given object as being that object in reality. A theoretical-experimental model of the electronic

display mechanism is being formulated which will provide a two-dimensional image. In addition, symbols are being established which would convey to the pilot obstacle information picked up by sensors. All this is being tied in with the determination of a human's ability to perceive and react to such a system of object recognition.

Documentation Incorporated, 2521 Connecticut Ave. N.W., Washington, D.C., is operating a man-machine information center which collects and disseminates the tremendous amount of human engineering data used in these programs. The aim is to provide a high level of information capability for scientists and engineers working in the ANIP, SUBIC, and SURIC programs.

Avco Crosley

Human factors engineering at Avco Crosley Corp., headed by Dr. Vladimir Sklodowski, has both long and short-range goals. The short-term objectives serve to apply existent knowledge to the design of present systems. The long-range goals are those of research. Human factors engineering is channelized into three activities: the improvement, or prediction of improvement, in the design of non-specific systems; developmental human engineering applied to the design and construction of specialized display and control equipment; and improvement, or prediction of improvement, in the design of specific systems.

The section had responsibility for locating controls, prescribing panel layouts, specifying cabinet dimensions, and making recommendations for various defense projects like: Radar System AN/MPS-16, Receiver-transmitter, AN/VRC-12, and Polaris Adaption Kit Test Equipment. The group contributed to the study and development of the re-entry vehicle and the group support equipment for the TITAN ICBM, operational and habitability evaluation of DEW line installations, and many other projects in cooperation with the Air Force Ballistic Missile Division.

Fig. 13: This is what the pilot sees on the contact analog display when his plane is banked right. The information is much the same as he would get when looking through the windshield on a clear day. A more advanced version will also show man-made obstacles.

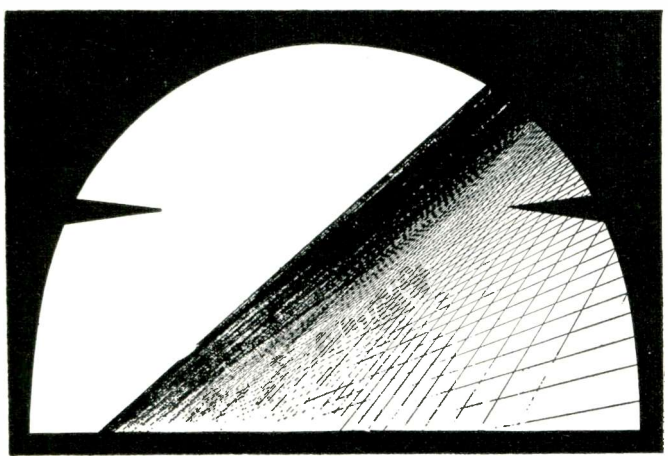


Fig. 14: Battelle Memorial Institute built this booth for conducting experiments to determine the relation between physical characteristics of odorants and their subjective odor properties. They are studying this and others as possible alternate inputs to the man-machine system.

Dunlap and Associates

The emphasis being placed on human engineering is marked by the many consulting firms specializing in this and closely related fields. Typical of these firms is Dunlap and Associates, Stamford, Conn. The company's work has already been mentioned in connection with the "Contact Analog Display" for ANIP.

The major efforts of the firm are indentified with human engineering, Operations Research, Personnel Research, and Motivation Research. The professional training of the staff falls into two broad categories: the physical sciences (engineering, chemistry, physics, mathematics, etc.) and the behavioral sciences (psychology, economics, sociology, etc.).

Three types of studies typify the company's work in human engineering: the "Human Engineer This Entire Product For Me" study where the company performs the entire human engineering work on a product; the "Solve This Problem For Me" study where the company's human engineering specialists are called on to work out a specific problem; and the "Teach Us How" study; where Dunlap & Associates train a company's staff in human engineering techniques and practices.

The company has done human engineering work for the Armed Forces in developing a human engineering guide for equipment designers; establishing requirements in design and layout of operations centers in connection with the defense of the North American Continent; for the Air Force, developing system requirements and design specs for checkout and control consoles in major missile systems; and for private and military groups in preparation and orientation of advanced seminars in human engineering, operations research, and training and development for management and technical staff personnel.

Minneapolis-Honeywell Corp.

The human engineering program at M-H was organized in 1954. The first project was an analysis of cockpit instruments in terms of navigational inertial information, attitude, and range. Much work has also been done on altitude indicators and LABS

indicators, and experimental work has been done on simulator and production instruments.

H-H has developed several procedures for human factors analyses. One technique is the Second-by-Second Operational Analysis. Essentially this procedure is a series of time-sequenced statements of the particular events within a given mission or operation. These events are sensory inputs to, and motor outputs from the human operator. After considering these events in terms of information theory, they can be quanticized in terms of the specific requirements of the desired goal, or mission objective. The resultant data provide a quantitative statement of the workload on the human operator expressed as a

Fig. 15: George H. Balding, Kaiser Aircraft & Electronics, operates the company's Contact Analog Display System. The system will show the pilot at a glance the basic information needed for flight control.

percentage of his total capability for information processing. Then, re-examination of the earlier steps in this sequence of analyses permits an appropriate adjustment of the allocation of functions to the man. In this manner, a quantitative appraisal of the man-machine relationship can be achieved.

M-H initiated a basic research procedure in 1959 aimed at refining these analytic methods, the major problem being to keep pace with the ever increasing demands of manned aircraft and space vehicles. For example, a study was done at M-H to evaluate empirically the present state-of-the-art in human tranfer function data.

M-H has developed simulation methods for studying the reactions of the human operator and providing controls that optimize overall system efficiency. The space cabin simulator, Fig. 8 is a device of this sort used to provide a highly controlled environment and to display certain flight conditions, via instruments, to the pilot and from this to determine the optimum control-display relationships for given vehicle dynamics.

Another method used by M-H is the Workload Analysis Technique. This can be used to determine the exact time duration of one specific problem solution in terms of information processing. This is a technique for determining the information processing rate of the pilot in order to predict mission success probability.

Among the work done by M-H which involved human factors analyses is work on Project Mercury and Dynasoar, Human Engineering Man-Machine Study of Weapons Systems, work on eliminating parallax on flight director needles, curve fitting analyses applied to a learning experiment, work on electrol minescesne, analyses of the human operator as a servo mechanism, and proposals for a human engineering handbook.

General Electric Company

The human factors group at GE's Missile and Space Vehicle Dept. in Phila., under the direction of Dr. P. Robert Knaff, is doing a manned re-entry study for the Air Force. The study involves determining the ability of humans to affect re-entry, a study of aerodynamic control systems, how pilot control can affect the problems of overheating, too many g's, stresses on the craft, etc.

The engineering psychology lab (see fig. 16) is designed for flexibility so that a wide range of human factors problems can be studied. The lab includes a large simulator area and a large observation-computer-programmer area. The simulator room provides sound attenuation of at least 30 db at 125 cycles for the acoustical isolation of subjects.

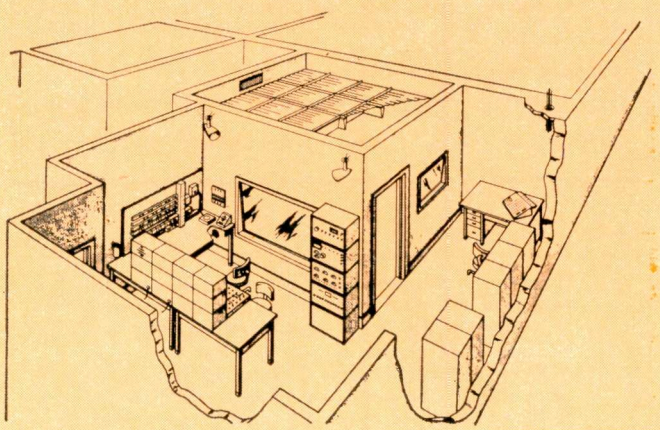
The observation-computer-programmer area has its own analog computer facility (a 30-amplifier analog computer) and is directly connected to the company's main analog computer facility. It is also equipped with function generators, function multipliers, etc. and a special low-drift oscilloscope modified to operate either as a four-independent beam oscilloscope or as a two-beam x-y oscilloscope.

Lockheed Aircraft Corp.

The Lockheed Human Factors Research Laboratory in Marietta, Georgia under the direction of Dr. J. A. Kraft has a mock-up simulating a space restricted flight station. In this experimental environment, determination will be made of the performance capabilities and psycho-physiological characteristics of operators performing tasks representative of future flight situations. Project leader is Dr. Oscar Adams.

Performance tasks measured are representative of

Fig. 16: GE's Human Factors Lab in Phila. is used for the study of space vehicle management and control.



Human Factors *(Concluded)*

basic flight skills. They include: compensatory tracking, arithmetic computation, pattern discrimination, scale position monitoring, probability monitoring, warning light monitoring, auditory vigilance etc.

A key part of the laboratory facility is the automatic instrumentation for the programing, recording, and scoring of the measures, and which permits instantaneous viewing of some of the autonomic responses on an oscilloscope. The entire mock-up interior can be viewed through a closed circuit TV system.[8]

TABLE 3

Military Specifications Dealing with Human Factors

A. Military Specifications

1. Control Configuration and Markings (For Plastic Lighting Plates, Control Panels, and Placards). MIL-C-18012A (ASG).
2. Colors, Aeronautical Lights and Lighting Equipment, General Requirements for. 29 October 1954, MIL-C-25050 (ASG).

B. Military Specifications: Air Force

1. Data for Guided Missile Weapon Systems. 20 November 1957, MIL-D-9310A (USAF).
2. Data for Fixed Wing Aircraft Weapon Systems. MIL-D-25876.
3. Data, Personnel Information for Weapon Systems. 19 November 1957, MIL-D-26239 (USAF).
4. Ground Support Equipment for Weapon Systems, Support Systems, Sub-systems, and Equipment; Engineering and Procurement Data for. MIL-G-9412.
5. Handbooks: Organizational (Flight Line); Maintenance Instructions (Aircraft). 7 March 1955, MIL-H-25098 (USAF).
6. Human Factors Data for Guided Missile Weapon Systems. MIL-H-26207.
7. Human Factors Data for Manned Aircraft Weapon Systems. 26 November 1957, MIL-H-25946 (USAF).
8. Specifications; Air Weapon Systems, Requirements for Preparation of. MIL-S-8048.
9. Specifications: Detail, Guided Missile, Requirements for Preparation of. MIL-S-8169.
10. Training Equipment, Weapon Systems, Specifications and Engineering Test Outlines, Instructions and Requirements for Preparation of. MIL-T-4857.
11. Trainers, Operational Procedure, General Requirements for. 1 October 1958, MIL-T-4860C (USAF).
12. Weapon Systems; Air, General Specifications for. MIL-W-9411.
13. Handbook of Instructions for Aircraft Designers. Volume I, HIAD ARDC Manual 80-1.
14. Handbook of Instructions for Aircraft Designers (Guided Missiles). Volume II, HIAD ARDC Manual 80-1.
15. Handbook of Instructions for Ground Equipment Designers. 1 May 1957, HIGED ARDC Manual 80-5.
16. Handbook of Instructions for Aircraft Ground Support Equipment Designers. HIAGSED ARDC Manual 80-6.
17. Human Engineering Design Standards for Missile System Equipment. (and supplements) 1 November 1958, Air Force Ballistic Missile Division Exhibit 57-8A.

C. Military Specifications: Navy

1. Control Configuration and Markings; (For Plastic Lighting Plates, Control Panels and Placards). MIL-C-18012 (AER).
2. Electronic Equipment, Naval Ship and Shore: General Specification. 15 March 1955, MIL-E-16400A (SHIPS).
3. Interior Communication Equipment; Basic Design Requirements for. MIL-I-983A (SHIPS).
4. Illumination of Consoles and Instruments; Basic Design Requirements for. MIL-I-19823 (SHIPS).
5. Plate, Plastic, Cockpit and Interior Controls Lighting. MIL-P-7788A.

D. Signal Corps Technical Requirement

1. Human Factors Engineering for Signal Corps Systems and Equipment. 3 April 1958, SCL-1787.

Courtesy of Dunlap & Associates, Stamford, Conn.

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For a wide variety of jobs, the trigger circuit described offers correct, reliable output information at low cost. It is virtually independent of input rise time, can handle large variations in input amplitude and dc level, and rejects noise.

Designing Input Trigger Circuits

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AN essential part of any electronic device for counting or timing events is an input circuit which will create sharp pulses at the precise time the events occur. Such a circuit presents appreciable design problems. The electrical signal it receives may have any of widely varying characteristics; whereas the pulses it generates should be uniform and precisely timed. The electrical signal itself may be the event of interest or, being the output of a transducer, it may simply correspond to some other physical event. We will first point out salient characteristics of possible input signals and second consider the design of a vacuum tube circuit which will accommodate such signals satisfactorily.

We will consider a voltage sensitive device only, because vacuum tube circuits are most naturally and economically operated in this way. For the same reason, we will treat the input signal as a varying electrical potential. A part of this signal, a voltage excursion, will be taken to represent the event of interest, and the precise time of the event will be defined as the moment the excursion reaches a certain instantaneous potential.

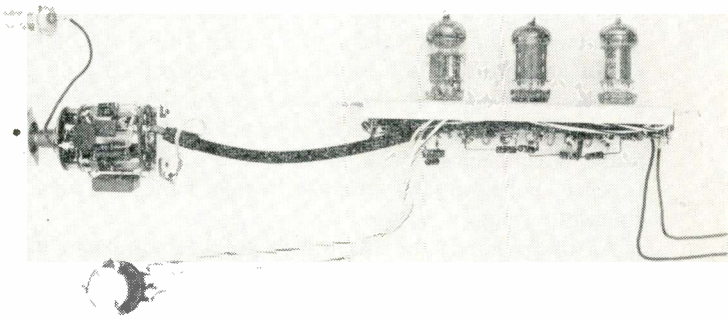
Characteristics of Input Signals

The wider the range of input signals the circuit will accommodate, the better. Fortunately, some types of signal are far more common than others; therefore, balancing expense against versatility, we have aimed for a comparatively simple device which will meet nearly all needs. The vast majority of signals will fall within the following limits:

1. The voltage excursion representing the event of interest will range in amplitude from ½ v. to 100 v. In some cases the ½ v. change must be sufficient to trigger a pulse; in other cases it may be necessary to ignore variations as great as 10 or 20 volts and to generate a pulse only when a more massive change occurs. We will use the term "noise" to designate all excursions which should be ignored, and "signal" to designate excursions which should generate pulses.

2. The rate at which a voltage excursion approaches the critical value will range from 1 v/sec to 100 v/microsec (a 1 x 10^8 to one ratio). Varying rates must not appreciably affect the time at which a pulse is generated nor the shape of the pulse.

Fig. 1: Input pulse-forming circuitry used in electronic counters. Potentiometer adjusts dc level. Switch is for input attenuation.



Trigger Circuits *(Continued)*

3. The instantenous voltage marking the time of the event may lie anywhere between —100v and 100v.

4. The source impedance of the input signal may be very high.

A Circuit for Essential Requirements

High noise levels and extreme variations in rate of change present the most difficult design problems. These features tend to dictate the basic type of pulse-forming circuit chosen; the other input characteristics can be accommodated by conventional techniques of amplification and attenuation.

One circuit that possesses the necessary properties is a voltage discriminator known as a Schmitt trigger circuit. Such a circuit assumes one of two stable states depending upon whether its input potential is above or below a critical voltage level. An input excursion through the critical level will cause it to switch states rapidly, generating a sharp pulse. Later on we will show how the timing and shape of the output pulse can be made virtually independent of the slope of the input excursion; but first, let us see how such a circuit can discriminate against noise.

Noise Rejection

If we examine an input signal closely, we may find it contains high frequency noise superimposed upon the slower voltage excursion which represents the event of interest. Notice in Fig. 2 that such noise may cause several intersections with the critical value. To prevent several pulses from being generated, we must suppress or ignore the additional intersections. One method is to use a trigger circuit which responds so slowly that it will not react to fast noise. This is not a satisfactory solution. Slowing the trigger action sufficiently to time slow waveforms will result in a large time error or complete failure to trigger on fast input signals.

Another possible solution, filtering frequency components higher than those present in the signal excursion, is not practicable because the filtered frequency must be adjustable for each input frequency. The best solution is to utilize the natural hysteresis of the trigger circuit to discriminate against noise below a certain peak-to-peak amplitude. This means that there will be two critical voltages instead of one. The circuit action might be diagramed as in Fig. 3. While the input is above the "on" trigger level the circuit will assume the "on" stable state; below the "off" level the circuit will be in the "off" state. In the region in between the "on" and "off" levels, the state of the circuit depends solely on its past history. It will be in whatever state it was in before the input entered the indeterminate region. Under these conditions noise with peak-to-peak amplitude less than the difference between the trigger levels cannot cause a complete trigger cycle.

As diagramed, the circuit is initially in the "off" state. The first time the input voltage crosses the "on" trigger level, it switches to the "on" state. Now, the several intersections with the "on" trigger voltage occurring immediately after entering the "on" region

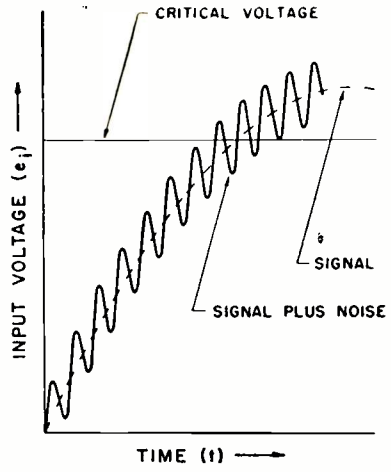


Fig. 2: Noise may cause input voltage to intersect critical value more often than a pure signal would

are ineffective. The circuit cannot switch to the "off" state until the input voltage falls to the "off" level. The "on" and "off" levels should, therefore, be separated by more than the peak-to-peak noise but less than the peak-to-peak signal. For this reason the hysteresis should be adjustable to accommodate various signal and noise amplitudes. We will find that the best way to modify the effective hysteresis is by amplifying or attenuating the input signal.

Timing Error

Referring again to Fig. 3 notice that, although noise variations do not cause the circuit to trigger more often than it should, the noise still causes the circuit to trigger a little earlier or later than the pure signal would. This produces an irremediable timing error which should be considered in determining how fast the trigger should act. There will be another time error because the circuit will never trigger instantaneously and will trigger slightly later on a slowly rising waveform than on a sharp pulse. However, it would be futile to design a trigger circuit whose switching error was appreciably less than the error due to inescapable noise.

Noise can be analyzed as a peak-to-peak voltage variation (e_n) superimposed on an ideal input signal. Its source may be the input transducer, the trigger circuit or an amplifier preceding the trigger circuit. The maximum possible time error may be calculated from the formula.

$$t_z = e_n / R \qquad (1)$$

where t_z = maximum possible error in seconds

R = slope of ideal signal at the trigger level in volts/sec

e_n = peak-to-peak noise in volts

In the case of a sine wave triggering at its zero cross-over value,

$$R = \frac{1}{2}\omega E_{pp}$$

where ω is the signal frequency in radians/sec and E_{pp} is the peak-to-peak value of the signal in volts, and

$$t_z = e_n / \frac{1}{2}\omega E_{pp} \qquad (2)$$

From this formula we learn that a 1CPS signal with a signal-to-noise ratio of 100,000 to 1 would produce a possible noise error of 3.3 μsec. Since it is virtually

impossible to obtain a signal with a lower noise content than this (noise 100 db down) a trigger circuit with a maximum switching time error of one μsec. is quite adequate.

The Switching Action

The trigger circuit may be considered as a dc coupled amplifier with positive feedback and a single time constant as shown in Fig. 4.
In Fig. 4:

e_i = input voltage

e_o = output voltage with respect to output voltage in the "off" state

$e_s = e_o + e_i$

μ = open-loop dc gain of amplifier

α = amplifier time constant

$(\alpha = 1/RC)$

The transfer characteristic of the amplifier is a non-linear function. (Fig. 5.) In the "off" state e_o is zero, so $e_s = e_i$. When e_i rises until e_s reaches point A, feedback forces e_s to increase until the operating point is at B. In this state, $e_s = e_m + e_i$, and e_i must decrease far enough to force e_s to point C, where reverse regenerative action occurs, placing the point of operation at D. The distance from D to A or from B to C is the hysteresis (e_h).

As an input excursion intersects a trigger level, the output voltage changes state in two phases. At first it rises (or falls) exponentially at a rate determined by the slope of the input excursion and the gain of the circuit. This phase is the switching time. When the output reaches a certain value, the input signal loses all effect and the output rises (or falls) quickly but at a decreasing rate. This phase is the output rise time.

The two phases emerge clearly when we consider what happens when the input voltage is raised to a point minutely above the trigger level and held constant. At first the response is governed by the transfer function

$$e_o = e_i \, \mu \, \alpha \, / \, s\text{-}\alpha \, (\mu\text{-}1) \qquad (3)$$

So that in relation to time

$$e_o = e_i \frac{\mu}{\mu\text{-}1} \, \epsilon^{\alpha(\mu-1)t_1} \qquad (4)$$

Where t_1 = time elapsed since e_i was applied.

Plotting this relationship creates the first part of the curve shown in Fig. 6. When the output reaches e_m/μ the feedback voltage alone is sufficient to saturate the amplifier. At this point the transfer function, now independent of the input, becomes

$$e_o = e_m \, \alpha \, / \, s + \alpha \qquad (5)$$

or, in relation to time

$$e_o = e_m \, (1 - \epsilon^{-\alpha t_2}). \qquad (6)$$

This relationship is illustrated by the last part of the curve in Fig. 6.

Since the response after the output reaches e_m/μ is fast and independent of input rise time this point may be defined as the time of triggering. The time elapsed from the moment the input crosses the trigger level until the output reaches e_m/μ will be the switching time error. We can see that for input voltages barely above the trigger level, an appreciable switching time error will occur.

A similar time error will occur if the input is a slowly rising excursion with slope R. The time equation then becomes

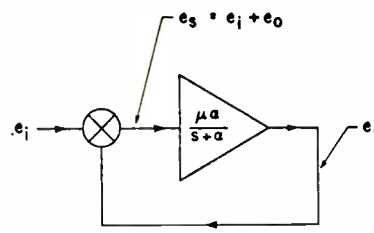


Fig. 4: Block diagram of trigger circuit

$$e_o = \frac{R}{\alpha \, (\mu\text{-}1)} \left[\frac{\mu}{\mu\text{-}1} \, \epsilon^{\alpha(\mu-1)t - \alpha \, (\mu-1) \, t\text{-}1} \right] \qquad (7)$$

or since the last two terms are insignificant within the range of values which concern us, simply

$$e_o = \frac{R}{\alpha \, (\mu\text{-}1)} \cdot \frac{\mu}{\mu\text{-}1} \, \epsilon^{\alpha(\mu-1)t_1} \qquad (8)$$

Where t_1 = time elapsed since e_i crossed the trigger level.

In the desired circuit e_o should reach e_m/μ within one μsec, even though the input rises at a rate (R) as slow as one volt/sec. This means that α and μ should be as large as possible, whereas e_m/μ should be small. Factors α and μ are interdependent, because for any given tube the gain-bandwidth product ($\alpha\mu$) is fixed. To maximize these factors, we will need a tube with a high gain band-width product. If the tube is to be driven from cut-off to saturation and the output is to be the total voltage swing thus developed across a purely resistive plate load, the term e_m/μ will be nearly equal to the grid base of

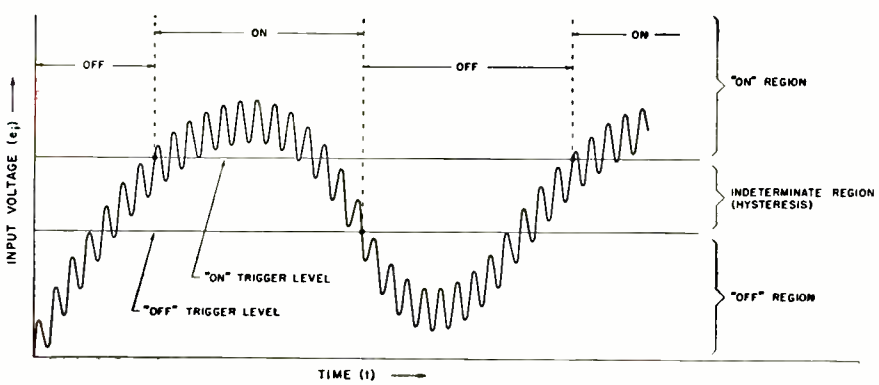


Fig. 3: Diagram showing how hysteresis of trigger circuit discriminates against noise.

Trigger Circuits *(Concluded)*

the tube. For this reason, the tube should also have small grid base.

Using a Pentode

A tube meeting these requirements well is the pentode part of a type 6U8. Operated in the region with which we are concerned, a 6U8 pentode has an $\alpha\mu$ of about 10^8. Unfortunately, the entire gain cannot be realized. In order to procure a low impedance feedback signal, a cathode follower stage must be inserted in the feedback path. The voltage-dividing action of direct-coupling and the loss in driving a low-impedance load reduces the over-all gain to about one-half the pentode gain; thus yielding an $\alpha\mu$ of about 5×10^7 which can be fully utilized.

Using a 6U8 pentode, a circuit can be built with the following characteristics:

$$\alpha = \frac{1}{10^{-7}\ \text{secs}} = 10^7$$

$$\mu = 4$$

$$e_o = e_m/\mu = 2\ \text{volts}$$

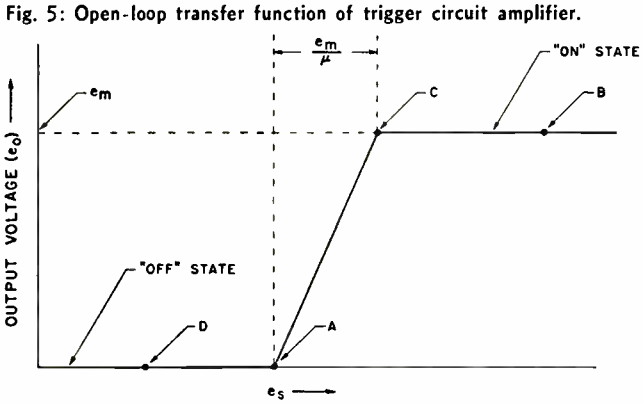
Inserting these values in equation (8), we find that with $R = 1$ v/sec, t_l becomes approximately 0.6 μsec. This means that the switching time error will be less than 1 μsec. This is the least time error that can be procured with the selected tube. Increasing μ will produce a compensating decrease in α, leaving t_l substantially the same. Moreover, α should be large in comparison with μ so that the output rise time, as defined by Eq. 6, will be short.

Let us see how the selected gain affects the hysteresis. The hysteresis (e_h) is governed by the following formula:

$$e_h = \frac{e_m}{\mu}(\mu\text{-}1) \qquad (9)$$

It can be seen that with a μ of 4, e_h is substantially the same as the output voltage swing e_m. Since e_m/μ is a constant approximately equal to the grid base of the tube, the only way to narrow the hysteresis is to reduce μ. This is undesirable for two reasons. One is that the switching speed falls, considerably if μ-1 in Eq. 8 becomes appreciably less than μ. Another reason is that e_m/μ becomes a large fraction of the total output swing. This means that a large part of the output rise would occur during the first phase ($e_o = 0$ to $e_o = e_m/\mu$) when the output is dependent on the input voltage and, consequently, that output pulses would not be the same shape for all input waveforms. For these reasons the hysteresis (which is equivalent to the peak-to-peak sensitivity of the trigger circuit) must be 6v or more.

Fig. 5: Open-loop transfer function of trigger circuit amplifier.



Factors Not Accounted For

The circuit we have analyzed is an idealization which differs from the actual circuit used in Beckman/Berkeley equipment in several important respects. First, constant gain from cut-off to saturation cannot be found in a real circuit. Rather, as the circuit switches, there is a gradual increase in gain from less than one to a maximum, then a gradual decrease to less than one again. This means that the trigger points are less sharply defined and that slowly rising excursions may take longer to saturate the amplifier than we calculated. Nevertheless, if the value of μ is understood to be an average during the switching time, the calculated response is not appreciably different from the actual.

Second, the idealization falls short of reality by assuming only one time constant. In the actual circuit diagramed in Fig. 7, there are two stages; hence, two time constants. However, because one time constant is usually many times larger than the other, the equations still hold.

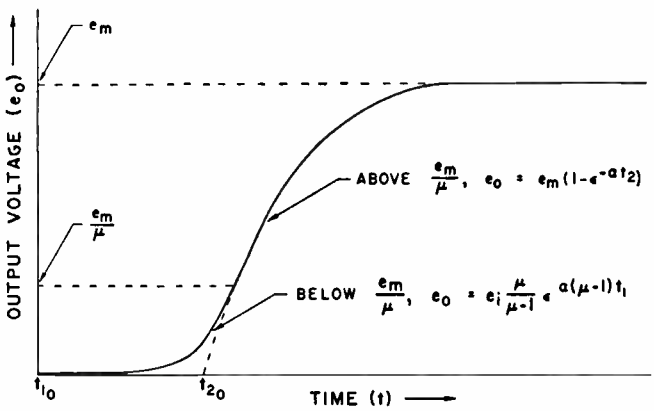


Fig. 6: Curve shows switching action of trigger circuit when input voltage is raised to a point infinitesimally above the trigger level at time t'_0 and held constant.

Third, we failed to include the effect of mixing the input and feedback signals in our analysis. In the actual circuit the input is applied to the grid and the feedback signal to the cathode of the same pentode. In switching the cathode changes potential rapidly and this transient is coupled to the grid through the grid-to-cathode capacitance. Unfortunately, the signal which reaches the grid has a polarity which opposes the input voltage excursion and, therefore, tends to inhibit the triggering action. In fact, if the time constant of the amplifier is large enough to cause a sufficient time gap between input and feedback signals, this transient may actually switch the circuit back from the state to which the input excursion has flipped it. Under these conditions, the second switching action will produce another feedback transient which triggers the circuit

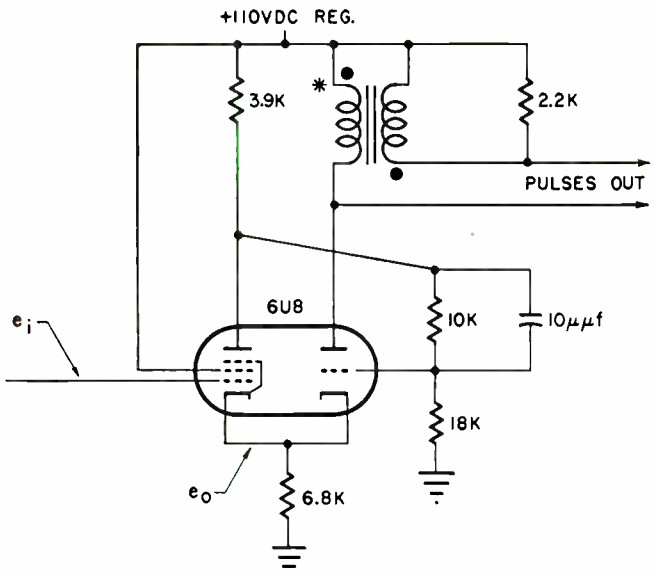


Fig. 7: Actual Schmitt Trigger circuit used in "7000 Series". Amplification occurs in the pentode circuit. The second stage (triode) operates as a cathode follower to provide a low-impedance feedback signal which is direct-coupled to cathode of the pentode. A pulse transformer in the plate circuit of the triode differentiates plate current changes to create output pulses.

once again, and in this way sustained oscillations may ensue.

To forestall these effects we must do three things: *one,* keep the hysteresis large so that the amplitude of the feedback transient will be insufficient to retrigger the circuit; *two,* drive the input from a low impedance source in order to reduce the effect of the capacitively-coupled signal; and *three,* minimize capacitive coupling by careful lay-out and by using a low-capacity tube.

The Input Amplifier

The trigger circuit we have described requires an input amplifier in order to accommodate the wide variety of likely input signals. The amplifier adds many desirable features:

1. It extends the input sensitivity from 6v peak-to-peak to 0.3v peak-to-peak.
2. Combined with an input attenuator, it makes it possible to expand or contract the input signal so that peak-to-peak noise will be less than the hysteresis of the trigger circuit at the same time that the signal excursion exceeds the hysteresis. The attenuator provides, in effect, a method of adjusting the hysteresis. So equipped, the circuit can accommodate signal-to-noise ratios as extreme as 2 to 1.
3. The amplifier can present a high impedance to the input signal, while it generates a suitable low impedance signal for the trigger circuit.
4. By using a differential amplifier, we can add or subtract a dc voltage from the input signal. This enables us to shift the instantaneous voltage at which the input signal will trigger a pulse.

Output Circuitry

The output of the trigger circuit must be differentiated to produce sharp pulses. When the trigger circuit switches, the plate current of the cathode follower changes rapidly from cut-off to saturation or vice versa. Differentiated, this rapid current change produces a sharp voltage pulse at the time of triggering. In the Beckman/Berkeley circuit, differentiation is accomplished by the primary winding of a pulse transformer. This makes it possible to obtain pulses of either desired polarity; one polarity at the primary winding; the opposite polarity at the secondary winding.

The input circuit described will produce an output pulse closely synchronized with an input voltage excursion. Over a wide range it is virtually independent of input rise time, can accommodate considerable variation in amplitude and dc level, and can reject noise. For a wide variety of jobs, this circuit offers correct, reliable output information at minimum cost.

PERFORMANCE OF 1MCS INPUT TRIGGER CIRCUIT

Input Frequency Range
DC Coupling: dc to 1.1Mcs.
AC Coupling: 5 cps to 1.1Mcs.

Input Impedance
10 megohms in parallel with 40 μμf.

Input Coupling
AC or DC.

Input Attenuation
Input voltage may be attenuated by a factor of 10 or 100.

Input Sensitivity (Effective Hysteresis)
Without attenuation: 0.3v peak-to-peak.
Attenuated by factor of 10: 3v peak-to-peak.
Attenuated by factor of 100: 30v peak-to-peak.
(Noise below input sensitivity will not trigger a pulse.)

Trigger Voltage Level
Instantaneous voltage which input signal must reach to trigger a pulse may be varied continuously between the limits noted below:
Without attenuation: 1v to +1v.
Attenuated by factor of 10: −10v to +10v.
Attenuated by factor of 100: −100v to +100v.

Trigger Slope
Output pulse of desired polarity can be triggered by either positive-going or negative-going input voltage excursions.

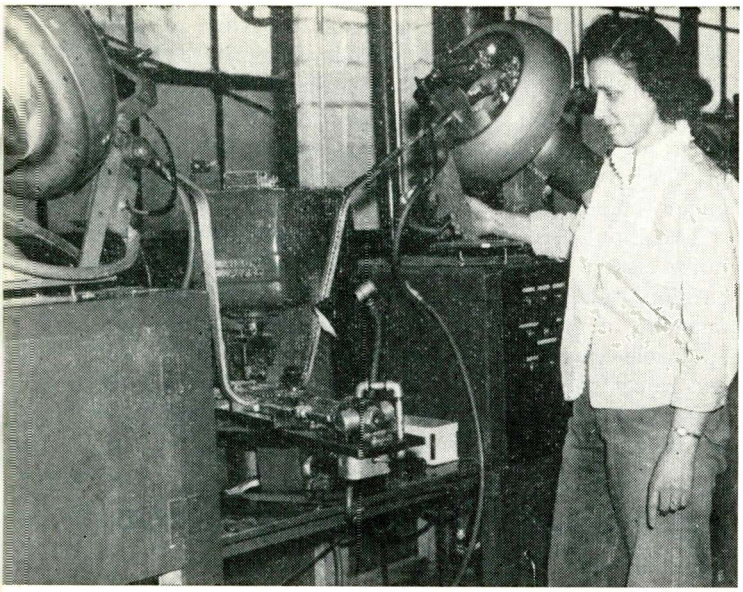
Switching Time Error
Less than one microsecond.

Internal Noise
Less than 300 microvolts referred to input signal after attenuation.

Input trigger circuits accommodating frequencies up to 2 and 10Mcs are also used in 7000 Series equipment.

What's New . . .

Automation Improves Components



Multipress method using hopper feeds to handle and position component parts for assembly of terminal posts.

A PRODUCTION combination of standard component feeding devices and hydraulic operated presses can often solve difficult assembly problems encountered in electronic part manufacture. Radio Condenser, Co., Watseka, Ill., in their assembly of miniature components, has employed this production combination.

To meet the problem of uniform, economical production, a completely automatic operation has been developed for an unusually low tooling cost by use of a hydraulic press built by the Denison Engineering Div., American Brake Shoe Co., Columbus, Ohio. With a Model "A" 1-ton capacity hydraulic press as prime method for staking, auxiliary feeding devices built by Detroit Screwdriver Co. were integrated to handle and place component parts into position for assembly by pressing.

The terminal post is one type of assembly produced with the Multipress method. The basic bakelite component is fed from the hopper shown at the extreme left of the production photo. Prestamped metal lugs are similarly fed from hoppers at the rear and at the right.

A sliding fixture on the press platen receives the three parts in proper position and slides the positioned components beneath the ram of the hydraulic press. The ram of the press then automatically descends to contact the work and fold the lugs around the bakelite.

The basic functions of the hopper feeds, slide fixture and hydraulic ram stroke are, of course, integrated into a preset time cycle. Consequently, the operator has only to supervise the functioning of the production cycle and load additional component parts into the hoppers as the production cycle demands.

Assembled component parts are ejected from the fixture by a jet air stream after assembly.

With hydraulic operation, scrap is virtually eliminated. This is a result of the pressure reversal principle on which the hydraulic press ram operates. In other words, the ram will not reverse or back away from the work until a pressure preset on the ram has been reached.

Books via Teletype

Librarian in reading room, upstairs, orders books from stacks, in basement, by teletype.

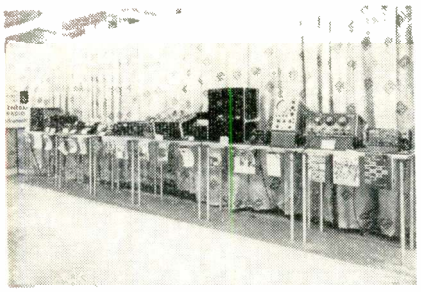
TELETYPEWRITERS are usually tools of business offices, newspapers, wire services, brokerage firms, and the military. Now, they contribute to culture and learning.

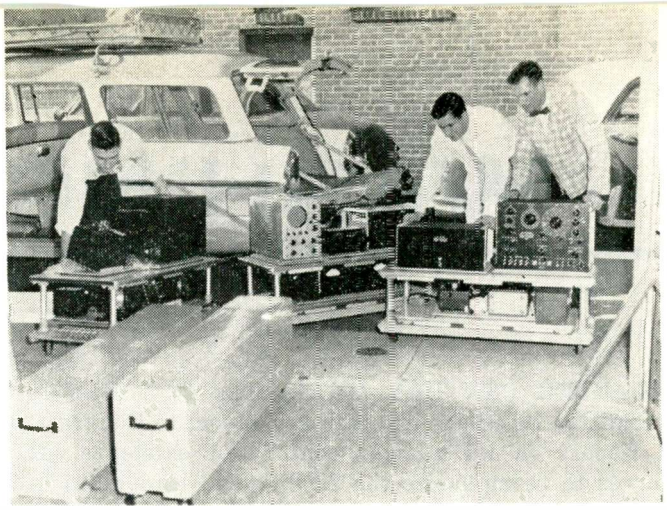
In Philadelphia's beautiful, fully stocked Free Library, Kleinschmidt teletypewriters help speed the flow of books from the stacks to the reading public and back again. They are used with belt conveyors, book lifts, and electrical signalling devices.

All large libraries want to reduce the time readers must wait for books which are stored in the stacks. In Philadelphia, the problem was especially acute. Contributing factors were the size of the building (60,000 sq. ft.), the distances between the 2nd floor reading rooms and the underground stacks, and the fact that the library is so well patronized. About 20% of the population of Philadelphia are registered borrowers.

Here is how the system works. When a reader presents his order, the librarian types it out on the teletypewriter. This reproduces it as page copy both on the second floor sending unit and in the nerve center of the basement stack area. The order is acknowledged. The page then gets the books off the stacks, places them on a conveyor belt or book lift and signals the librarian. A page on the second floor picks up the order and delivers it to the reader. Normal elapsed time: 8 to 12 minutes.

Library officials point to the speed, clarity, and accuracy. The order is transmitted and received simultaneously in original typed





All the equipment and literature, plus the six tables on which they are displayed (left), can be packed on three dollies and in two boxes. These five pieces are then transported in the station wagon (right).

Traveling Exhibit

AN innovation in exhibits—a traveling instrument display-demonstration vehicle—is now operated by the General Radio Co., West Concord, Mass.

Developed to bring a full complement of the latest developments in electronic measuring equipment directly to local government agencies, laboratories, industry and educational institutions, the car—a modified station wagon—carries over 600 pounds of instruments mounted on six collapsible tables. The display can be set up in an hour by a three-man team of engineers.

The wide assortment of test apparatus—six operational displays—is packed into the car by collapsing the tables onto three moving dollies, and fitting bundles of literature, signs and miscellaneous accessories into a two-decker rolling box.

Based on an idea conceived by George G. Ross, manager of G-R's New York office, and W. R. Thurston at the plant, the show serves not only as an exhibit of equipment, but as a technical-information center on measurement problems.

* * *

form, with no possibility of being misunderstood.

There are other advantages. If the stock room pages are all busy getting books off the shelves, the orders are there waiting for them when they return to the nerve center of the storage area. Instead of jangling, unanswered telephones, there is a continuous flow of typed orders coming in over the teletypewriters.

Altogether, 150 to 175 orders are processed on a normal weekday via the teletypewriter network. On Saturdays the average is higher—from 200 to 225. The busiest time, however, is during the Sunday library hours of 2 to 6 P.M. During this 4-hour stretch the teletypewriters—and the pages in the storage area—are really kept "hopping" with an average of 175 orders.

Coating Machines

A NEW machine accurately coats coaxial lead components at a rate of 4000 per hour. Conforming Matrix Corp., 474 Factories Bldg., Toledo 2, Ohio, is the manufacturer.

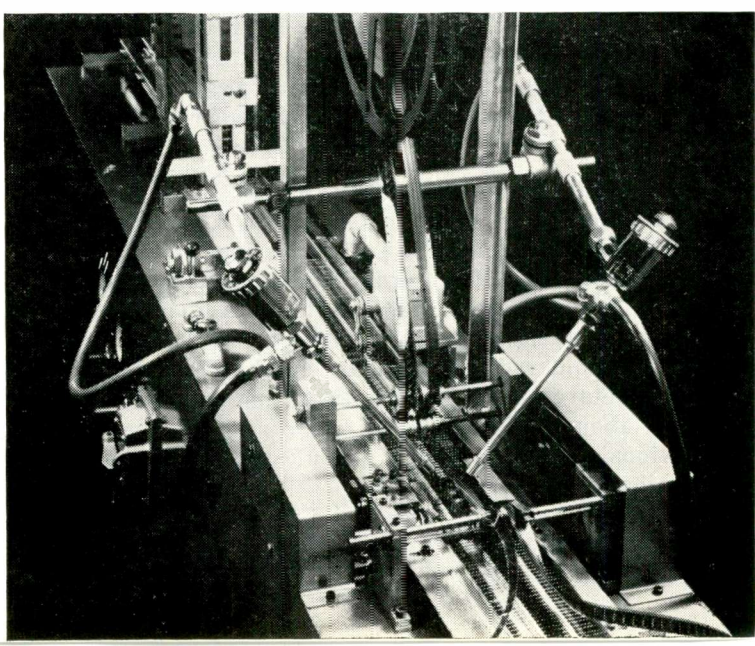
A resinous composition can completely form a light-tight seal for selenium diodes. Other coaxial lead components can similarly be provided a baked heat and abrasion-resistant clear coating.

The coating is confined by two accurately spaced traveling strips, while racks, loaded with diodes, move continuously through the spray station. The diodes are spun to assure application of an even coating. The lead wires are not sprayed. This prevents coating cracks if the wires are bent for printed circuit insertion. There is no excess coating. The units remain in the racks for both spraying and baking.

The spray coating is completely automatic. Racks carrying the diodes move through the machine and emerge evenly coated without the need for a handling operator.

Automation is possible, inasmuch as the coating material is confined by remote masking and not mechanical means. Spray masks, registering devices, and mask cleaning operations are eliminated.

The machine may be adjusted to accommodate coaxial lead components of varying lengths.



Bodies of 4000 coaxial components can be coated accurately every hour with this machine.

WASHINGTON News Letter

QUARTER CENTURY MARK—The FCC recently submitted its Silver Anniversary report to Congress, a Report on its quarter century of existence. It serves to reemphasize the U. S. world leadership in radio and telecommunication. Radio authorizations have practically multiplied by that number of years —from slightly more than 100,000 at the close of the Commission's first year to nearly 2.5 million today. Radio stations of all kinds have increased from 51,000 to more than 507,000, currently representing the use of about 1.8 million transmitters. Almost two-thirds of the world's total of broadcast and TV receivers are in the United States, with more than 200 million in this country.

SAFETY AND SPECIAL—There are more than 40 categories of safety and special radio services, the FCC reported. Most of them did not exist 25 years ago, nor were they even in the experimental stage. Over half a million licensees now operate more than 1.7 million fixed, mobile and portable transmitters. And no leveling in the demand for these facilities is foreseen for many years to come. The FCC is seeking more effective ways of utilizing the spectrum space available for these services as well as handling the increasing volume of applications.

USEFUL RADIO SPACE TRIPLED — The useful radio spectrum space covered by international agreement has been increased three times over its present amount in recognition of most recent developments in radio usage. This was determined by the International Radio Administrative Conference at Geneva, Switzerland. The allocations were extended to 40,000 MC. as contrasted with the previous international radio conference's limit of 10,500 MC. A report of the conference's accomplishments was presented to the State Department in Washington by FCC Commissioner T. A. M. Craven. He was chairman of the United States delegation at the Geneva deliberations which began August 17 and lasted until the end of December.

AMERICAN HEADS ITU—Gerald C. Gross, former FCC assistant chief engineer and a World War II Naval Reserve captain, has become the Secretary General of the International Telecommunications Union—the first American to hold that post. He is an outstanding authority on frequency allocations and radio operations. He has been Assistant Secretary General since 1946 and has participated in about 30 international radio and telecommunications conferences and consultative committee sessions.

ASTRONOMY AND EARTH SPACE — The ITU radio conference allocations delineated ample protection from interference by other radio services for radio astronomy. The six bands assigned to that service are protected with standard frequency guard bands. Space and earth-space radio services received the international allocations at the Geneva conference which was sought by the U. S. delegation.

SPECIAL SPACE PARLEY — The International Telecommunications Union has planned a special world radio conference in 1963. They will cover the problems of space communications with a goal towards peaceful use of outer space. This was a highlight of the final decisions of the recent International Radio Conference. FCC Commissioner T. A. M. Craven, chairman of the U. S. delegation at the conference, said the committee is to continue its research into space and earth-space radio communications.

National Press Building
Washington 4

ROLAND C. DAVIES

STOP BICKERING—Chairman Overton Brooks (D., La.) of the House Committee on Science and Astronautics urged the Administration to eliminate interservice bickering over the development of missiles and space systems. Brooks declared that if this is not done, there is danger that "we will find our defenses cut to an irreparable factor which will set the United States in a position for attack from any strong aggressor nation."

PROJECT ICEF—Scientists from 14 nations are expected to participate in the high energy cosmic ray investigations of Marcel Schein of the University of Chicago. Project ICEF (International Cooperative Emulsion Flights), will send up giant stacks of photographic emulsion sheets in high altitude Navy balloons to record primary cosmic ray particles. The balloons will be launched from the USS Valley Forge.

MUST HAVE RADAR — The Federal Aviation Agency ruled that most of the nation's airliners must be equipped with airborne weather radar. The new Special Civil Air Regulation provides a timetable which required all pure jet and turbo-prop airplanes used in passenger service to be equipped with the radar by July 1, 1960. The Douglas DC-6 and DC-7 series and the Lockheed Constellation 1049 and 1649 series must be equipped by January 1, 1961. All other affected transport category airplanes must be equipped by January 1, 1962.

"STANDARD"

In the more than a quarter of a century of experience in the manufacture of electronic components, CINCH parts by specification and application have earned recognition as "Standard in the Industry."

D SUB-MINIATURE CONNECTORS ☆

D Sub-Miniature plugs and sockets with printed circuit pin and socket inserts are also available for immediate delivery.

Send for illustrated catalog No. 100-Cinch Connectors, D Sub-Miniature, DPX and DPA Types.

CINCH MANUFACTURING COMPANY
1026 South Homan Ave., Chicago 24, Illinois
Division of United-Carr Fastener Corporation, Boston, Mass.

Centrally located plants at Chicago, Illinois; Shelbyville, Indiana; La Puente, California; St. Louis, Missouri.

Manufactured by agreement with Cannon Electric Company.

DB 25 P

DB 25 S

PHYSICAL SPECIFICATIONS

SHELL MATERIAL INCLUDING FLANGE—D- steel or brass, finish, cadmium plate & irridite. DH- steel, finish, electro-tin over cadmium.

CONTACT MATERIAL—D- copper base alloy gold plate finish, DH- steel, electro-tin over cadmium finish.

INSERT ARRANGEMENTS—5 (plus coaxials)

NUMBER OF CONTACTS—9, 15, 25, 37, 50

INSULATION MATERIAL—D- Zytel 101, DH- Glass, C7- Diall (Type MDG Mil. M-14), C13- Melamine (Type MME Mil. M-14), C26- Glass Diall (Type GDI-30 Mil. M-19833), F114- Diall solder pot side, Nylon pin engaging side.

POLARIZATION—keystone cornered shell

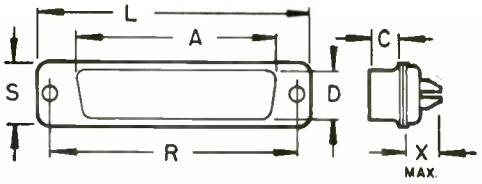
COUPLING MEANS—friction-locking accessory

WIRE ACCOMMODATION—#20 AWG, B&S stranded

OPERATING TEMPERATURE—D + 310°F, —67°F, DH + 350°F max. —67°F, varies with finish: TIN PLATE — 350° max. CAD. PLATE — 500°F max., TIN over CAD. — 350°F max. GOLD PLATE — 600°F max.

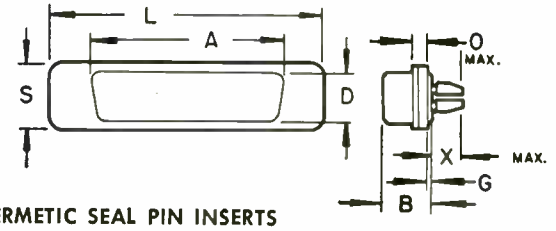
Circle 54 on Inquiry Card

D SUB-MINIATURES:
STANDARD PIN AND SOCKET INSERTS.



size	A	C	D	L	R	S	X	weight
DA-15P	1 1/64	15/64	23/64	1 17/32	1.312	31/64	5/16	.013
DA-15S	31/32	15/64	5/16	1 17/32	1.312	31/64	5/16	.014
DB-25P	1 9/16	15/64	23/64	2 5/64	1.852	31/64	5/16	.023
DB-25S	1 33/64	15/64	5/16	2 5/64	1.852	31/64	5/16	.031
DC-37P	2 13/64	15/64	23/64	2 23/32	2.500	31/64	5/16	.035
DC-37S	2 11/64	15/64	5/16	2 23/32	2.500	31/64	5/16	.035
DD-50P	2 7/64	15/64	15/32	2 5/8	2.406	39/64	5/16	.035
DD-50S	2 5/64	15/64	27/64	2 5/8	2.406	39/64	5/16	.040
DE-9P	45/64	15/64	23/64	1 13/64	.984	31/64	5/16	.011
DE-9S	41/64	15/64	5/16	1 13/64	.984	31/64	5/16	.012

FRACTIONS ±1/64 Tolerance DECIMALS ±0.005 Tolerance



HERMETIC SEAL PIN INSERTS

size	A	B	O	D	G	L	S	X max.	weight
DAH-15P-001	1 1/64	23/64	3/32	23/64	1/32	1 35/64	1/2	5/32	0.021
DAH-15P-002	1 1/64	23/64	3/32	23/64	1/32	1 35/64	1/2	15/64	0.021
DBH-25P-001	1 9/16	23/64	3/32	23/64	1/32	2 3/32	1/2	5/32	0.027
DBH-25P-002	1 9/16	23/64	3/32	23/64	1/32	2 3/32	1/2	15/64	0.027
DCH-37P-001	2 13/64	23/64	3/32	23/64	1/32	2 47/64	1/2	5/32	0.037
DCH-37P-002	2 13/64	23/64	3/32	23/64	1/32	2 47/64	1/2	15/64	0.037
DDH-50P-001	2 7/64	23/64	3/32	15/32	1/32	2 41/64	39/64	5/32	0.041
DDH-50P-002	2 7/64	23/64	3/32	15/32	1/32	2 41/64	39/64	15/64	0.041

Variation in final dash number indicates type of contact terminal. —001 = eyelet type; —002 = solder pot type.

FRACTIONS ±1/64 Tolerance DECIMALS ±0.005 Tolerance

New Tech Data for Engineers

Space Calendar

"Space calendar," lists all U. S. and foreign space shots and supplies a log for similar activities in 1960. The inside front cover of the booklet lists all space shots since the first Sputnik, October 4, 1957. The inside back cover is a launch log for shots during Space Year IV (1960). A page is devoted to each month and is marked off with memo space provided for each day. Avion Div., ACF Industries, Inc., 11 Park Place, Paramus, N. J.

Circle 167 on Inquiry Card

Control Devices

General Purpose Control Catalog, GEC-1260D, 72-page publication contains information on the complete line of control devices manufactured by the General Electric Company's General Purpose Control Dept., Schenectady 5, N. Y. Horsepower selection charts are listed for motors from one-fourth through 200 hp. It includes product description of motor starters (manual and magnetic) contactors, relays, solenoids, limit switches, push buttons, static control and pilot devices. Wiring diagrams, dimensions and application information for each device are included.

Circle 168 on Inquiry Card

Tellurium Copper

Tech data sheet from Bridgeport Brass Co., Bridgeport 2, Conn., discusses physical, mechanical and fabrication properties of tellurium copper. Tellurium copper's primary use is in rod form for screw machine work where high heat and electrical conductivity are required. Other uses are connector parts in electrical switches, transformers, wire connectors, circuit breakers, and simple screws and rivets carrying electric current.

Circle 169 on Inquiry Card

Printed Circuits

Technical Bulletin P-5a "Miniaturized Printed Circuits," is available from Photocircuits Corp., Dept. P-1539, 31 Sea Cliff Ave., Glen Cove, N. Y. It contains information on how the elimination of lands or pads around plated-thru holes permits substantial size reduction of printed circuit boards and greater component densities. It describes how the barrels of the holes are used for solder joints without sacrifice of reliability, repairability, pull strength or insulation resistance.

Circle 170 on Inquiry Card

! MORE !

The literature mentioned here has been selected for contribution to or advancement of the electronic industries. These items are combed from several hundred bulletins, catalogs, and data sheet announcements received during the past month by ELECTRONIC INDUSTRIES. To keep interested readers informed of all new developments, a summary record is kept of ALL new products and tech data announcements received. For a copy of this month's list, please send your request on company letterhead to Readers' Service Dept., Electronic Industries, 56th & Chestnut Sts., Phila., Penna. or Circle No. 161 on Inquiry Card.

Resins, Bonding Agents

Bulletin 121 contains Selector Charts for potting compounds, coatings, foams and bonding agents. Definitions are provided for such terms as casting, encapsulation impregnation, and coating. The charts offer hard, semi-rigid and flexible formulations for each of these processing applications. A similar breakdown is given for foams. Plastic Associates, 185 Mountain Rd., Laguna Beach, Calif.

Circle 171 on Inquiry Card

Fixed Resistors

Bulletin 5000E, 8-pages, provides power nomographs for predicting the long-term performance of A-B composition fixed resistors. The nomographs are arranged so that resistor performance can be predicted over periods from 100 hrs. to 100 years under various operating conditions. A table gives the relation between the resistor temp. rise and the heat sink temp. under 50% and under 100% rated load for atmospheric pressures of 760 mm H_g and 0.2 mm H_g. Four typical examples are included. Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 4, Wis.

Circle 172 on Inquiry Card

Insulation

"When You Need a Material With Extra Advantages," a folder from Rogers Corp., Rogers, Conn., summarizes design and application data on the company's materials for high temp., electrical and electronic insulation, and gasketing and sealing requirements.

Circle 173 on Inquiry Card

Laminated Plastics

Basic application information and engineering data on laminated plastics and vulcanized fibre is given in a condensed catalog from Taylor Fibre Co., Norristown, Pa. Data is provided to aid engineers in selecting and applying these basic materials for electrical, electronic, and mechanical components. A two-page spread lists general data and engineering data for 21 of the most common grades of Taylor Fibre's laminated plastics including NEMA grades, mil specs., color, sizes, and forms.

Circle 174 on Inquiry Card

Instruments

1960 Catalog describes and illustrates instruments for electronic, biological and chemical measurement and control. Specs and performance data, schematic diagrams and application circuits, as well as basic information on electrometers and micro-microammeters are included. Keithley Instruments, Inc., 12415 Euclid Ave., Cleveland 6, Ohio.

Circle 175 on Inquiry Card

Electric Plants

A 12-page "Electric Plant Folder E-344," illustrates a line of standard electric plants. Sizes range from 500 w to 100,000 w. Kohler Co., Kohler, Wis.

Circle 176 on Inquiry Card

Video Tape

Proper handling and storage of video tape are discussed in "Video Talk" Bulletin No. 1, from Minnesota Mining and Mfg. Co. (3M), Magnetic Products Advertising, 900 Bush Ave., St. Paul 6, Minn. The bulletin, first of a monthly series, is accompanied by a folder for permanent file purposes.

Circle 177 on Inquiry Card

Pulse Transformers

Description of Miniature Pulse Transformers for blocking oscillator pulse coupling, inverting and impedance matching is outlined in Bulletin PT 160. The pulse width, rise time, pulse inductance, dc resistance, impedance ratio and 4 types of packaging (molded, tubular, plug-in and chassis mounting) are explained. Valor Instruments Inc., 13214 Crenshaw Blvd., Gardena, Calif.

Circle 178 on Inquiry Card

OUTSTANDING IN PERFORMANCE

type D

RESIN-COATED SILVERED MICA CAPACITORS

Sangamo Type D mica capacitors combine the excellent electrical performance characteristics of silvered mica with a multi-layer, protective case of high moisture-resistant thermo-setting resins.

temperature range — The Type D is designed to operate over the temperature range of —55°C to +125°C at rated working voltage without derating.

tolerances — Available in capacitance tolerance values of ±20%, ±10%, ±5%, ±2%, ±1% (or ±1 mmfd, whichever is greater).

insulation resistance — The insulation resistance of these capacitors will exceed 3,000 megohms at 125°C.

moisture resistance — Insulation resistance shall be greater than 1000 megohms as measured in accordance with paragraph 2.6.2 of EIA specification RS-186-A, Method 2. Paragraphs 2.4 and 2.6.1 do not apply. The test shall continue for 10 cycles, as described in paragraph 2.5.

thermal and immersion cycling — Insulation resistance shall be greater than 3000 megohms after being subjected to temperature cycling between —55°C and +125°C, as outlined in Method 102-A, Test Condition D, and followed by Method 104-A, Test Condition A, of MIL-STD 202A.

Write for Bulletin TSC-118C

TYPE	DC WORKING VOLTAGE - VOLTS.	CAPACITANCE RANGE - MMF.
D-15	500	5-400
	300	5-800
D-20	500	100-2000
	300	100-4000
D-30	500	1000-10000
	300	1000-20000

SANGAMO ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

SC-59-10

New Tech Data for Engineers

Servo Design

"The Second Order Linear Servo," Giannini Technical Notes, from Giannini Controls Corp., 918 E. Green St., Pasadena, Calif., presents a history of servo terminology and how it developed; offers practical working formulae and values not commonly found in formal servo texts; and includes vellum chart sheets of factors conveniently used for servo design which may be removed from the pamphlet for ozalid reproduction.

Circle 179 on Inquiry Card

Switches

Hamlin, Inc., Lake & Grove Sts., Lake Mills, Wis. has a new 1960 catalog on their line of switches, relays and gravity sensing potentiometers. Applications and diagrams are included.

Circle 180 on Inquiry Card

Telemetry Components

Tele-Dynamics Inc., 5000 Parkside Ave., Phila. 31, Pa., has released a 24-page, 2-color brochure, No. 936, which describes a line of airborne FM/FM telemetry components. Transistorized voltage-controlled subcarrier oscillators for conventional signal voltage ranges, fractional volt ranges and millivolt ranges are completely described. It includes electrical, environmental, and physical characteristics plus outline drawings.

Circle 181 on Inquiry Card

Atomic Instruments

Atomic Catalog A-4 is a compilation of current technical data and specs on a line of laboratory, analytical scintillation and special medical systems and other instruments such as scalers, analyzers, detectors, rate and survey meters, timers, amplifiers and power supplies. It includes cable and compatibility charts, optimum counts charts and listings of radioisotopes for medical therapy, clinical and therapeutic use. Baird-Atomic, Inc., 33 University Rd., Cambridge 38, Mass.

Circle 182 on Inquiry Card

BW Oscillators

"PRD Reports," Vol. 6, No. 4, is entitled "Power Supply Requirements of BWO Tubes" and discusses the voltage and modulation requirements needed to power backward wave oscillators. It describes the theory and operation of both M and O type tubes. The relationship between power output, frequency shift, and delay line current stability is graphically presented as a function of various electrode voltages. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y.

Circle 183 on Inquiry Card

Zener Diodes

Eight-page quarterly, Rectifier News, RN-1159, published by International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif., contains articles on referencing and instrumentation with zener diodes, and output regulation utilizing the switching action of zener diodes. Included are detailed circuits and performance curves covering the specific components used.

Circle 184 on Inquiry Card

V-Band Components

A line of millimeter-wave components and antennas is illustrated in catalog No. 160A from T. R. G., Inc., Microwave Component and Antenna Dept., 9 Union Sq., Somerville 43, Mass. Specs included on ferrite components such as isolators, attenuators, circulators, and switches, as well as Hybrid ring mixers and millimeter-wave antennas. Additional millimeter-wave components listed allow for complete systems design in the 60-75 KMC V-Band.

Circle 185 on Inquiry Card

Pulse Transformers

A 24-page catalogue, "Pulse Transformers" contains tables, charts, and schematics, and a brief history of low-level pulse transformers, their measurements, specifications, applications, interchangeability, dielectric ratings, manufacturing, and other data. Also included is information on some of PCA's 2,000 standard design transformers, case types and specifications data. PCA Electronics, Inc., 16799 Schoenborn St., Sepulveda, Calif.

Circle 186 on Inquiry Card

Gears-Reducers

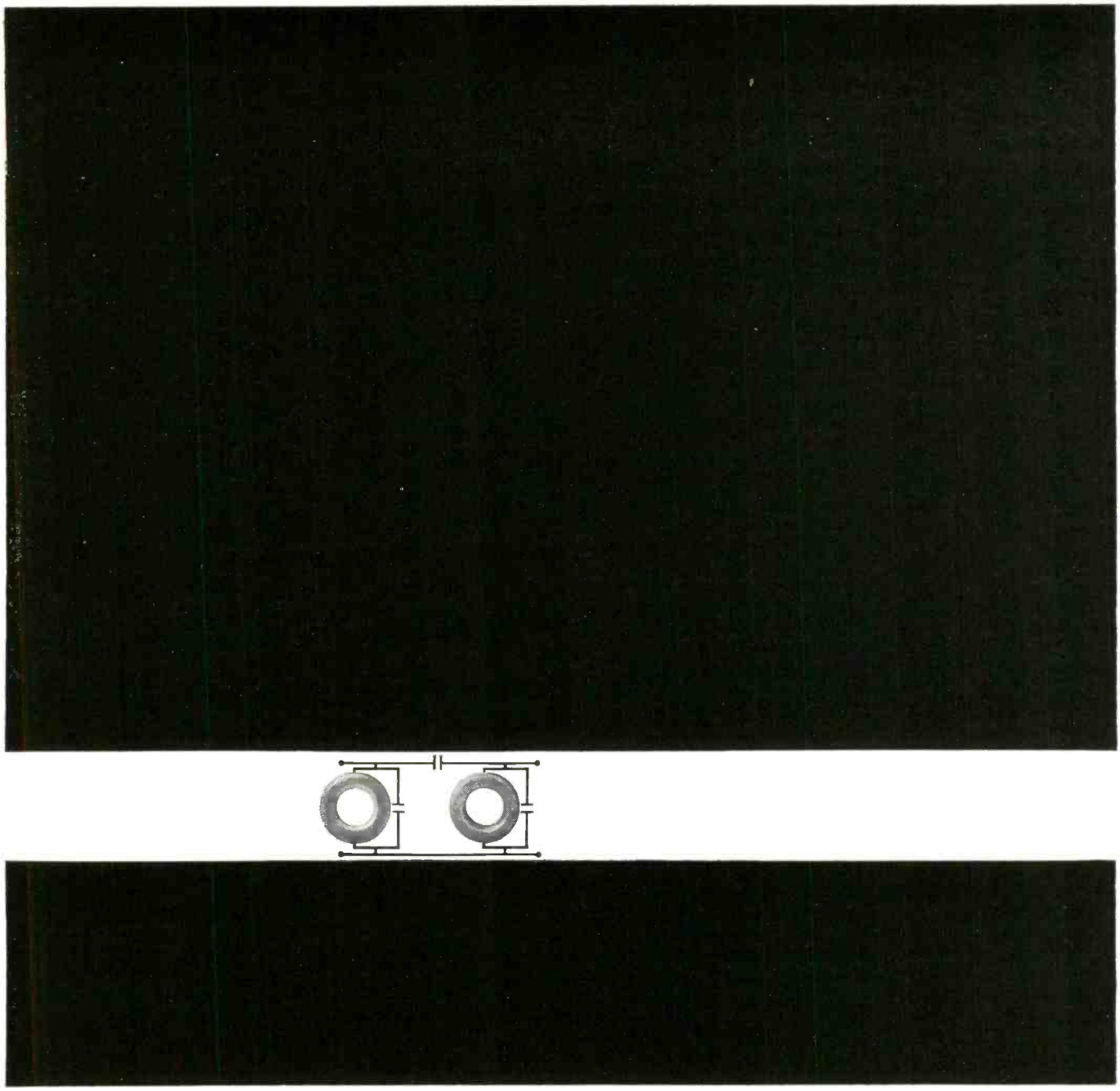
PIC Design Corp., 477 Atlantic Ave., E. Rockaway, L. I., N. Y., is offering their new 416-page 1960 Master Catalog #21 on precision instrument components. The pocket-size catalog contains technical details, MIL specs and complete drawings of over 12,000 stock items, such as: precision gears, shafts, speed reducers, magnetic clutches, differentials, and other associated components.

Circle 187 on Inquiry Card

Transistors

Data sheets on improved 2N1031, A, B, C, and 2N1032, A, B, C, power transistors, a series of eight 25 a peak current transistors capable of switching up to 1000 w. are available from Bendix Aviation Corp., Red Bank Div., 201 Westwood Ave., Long Branch, New Jersey.

Circle 188 on Inquiry Card



Smaller filters ease the squeeze!

Filter designers! First 160-mu moly-permalloy powder cores pack high performance into smaller space

Filter and inductor designers specify our 160-mu moly-permalloy powder cores for low frequency applications. Where space is precious, such as in carrier equipment and telemetering filters, the high permeability of these 160-mu cores eases the squeeze.

In many cases, 160-mu cores offer designers the choice of a smaller core. In others, because inductance is 28 percent higher than that of 125-mu cores, at least 10 percent fewer turns are needed to yield a given inductance.

If Q is the major factor, 160-mu cores permit the use of heavier wire with a resultant decrease in d-c resistance.

Like all of our moly-permalloy powder cores, the 160's come with a *guaranteed* inductance. We can ship eight sizes from stock, with a choice of three finishes—standard enamel, guaranteed 1,000-volt breakdown finish, or high temperature finish. Further information awaits your inquiry. *Magnetics Inc., Dept. EI-78, Butler, Pa*

MAGNETICS inc.

Circle 57 on Inquiry Card

Tech Data

for Engineers

Silicon Diodes

Semiconductor applications report, "Applying Thermal Characteristics of Silicon Diodes," is available from the Semiconductor Div., Hoffman Electronics Corp., 1001 Arden Drive, El Monte, Calif. The 4-page brochure discusses thermal characteristics of forward biased diodes as low voltage reference devices, temp. compensated (voltage reference) diodes, and thermal resistance and thermal time constants in forward and Zener diodes.

Circle 189 on Inquiry Card

Frequency Meters

Bulletin 32-85 from the James G. Biddle Co., 1316 Arch St., Phila., Pa., describes the Frahm "Precision" Frequency Meters, with accuracies of ±0.1% of calibrated frequency. The meters in miniature, switchboard, and portable types are available in various ranges between 10 and 1700 CPS and signal voltages from mv upwards.

Circle 190 on Inquiry Card

Transmitter Adapter

Four-page illustrated brochure from Kahn Research Laboratories, Inc., 81 South Bergen Place, Freeport, N. Y., describes production model SSB-58-1A Adapter systems—a technique to convert existing AM communications transmitters to SSB operation without engineering modifications. It is based on a completely different sideband generation and amplification concept.

Circle 191 on Inquiry Card

Tape Recorder

Details of Type 5-702 airborne and mobile magnetic tape recorder are presented in an illustrated bulletin offered by the DataTape Div., Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. In 7- or 14-track models, it is for high-altitude operation and a temp. range from −54 to +71°C. Specs and operating description included.

Circle 192 on Inquiry Card

Games for Computers

"Games for Electronic Computers" describes 12 games for matching the machine against the human operator. Adaptation of these games to various computers including the company's SEXIAC Electronic Digital Computer Kit is also explained. 12 pages. Willis G. McCormick Co., 15733 Septo St., Sepulveda, Calif.

Circle 193 on Inquiry Card

Circle 58 on Inquiry Card

Circle 59 on Inquiry Card →

UTC NEW EXPANDED DO-T AND DI-T SERIES

Revolutionary transistor transformers hermetically sealed to MIL-T-27A Specifications.

UTC DO-T and DI-T transistor transformers provide unprecedented power handling capacity and reliability coupled with extremely small size. Comparative performance with other available products of similar size are shown in the curves (based on setting output power at 1 KC, then maintaining same input level over frequency range). The new expanded series of units cover virtually every transistor application.

DO-T

ACTUAL SIZE

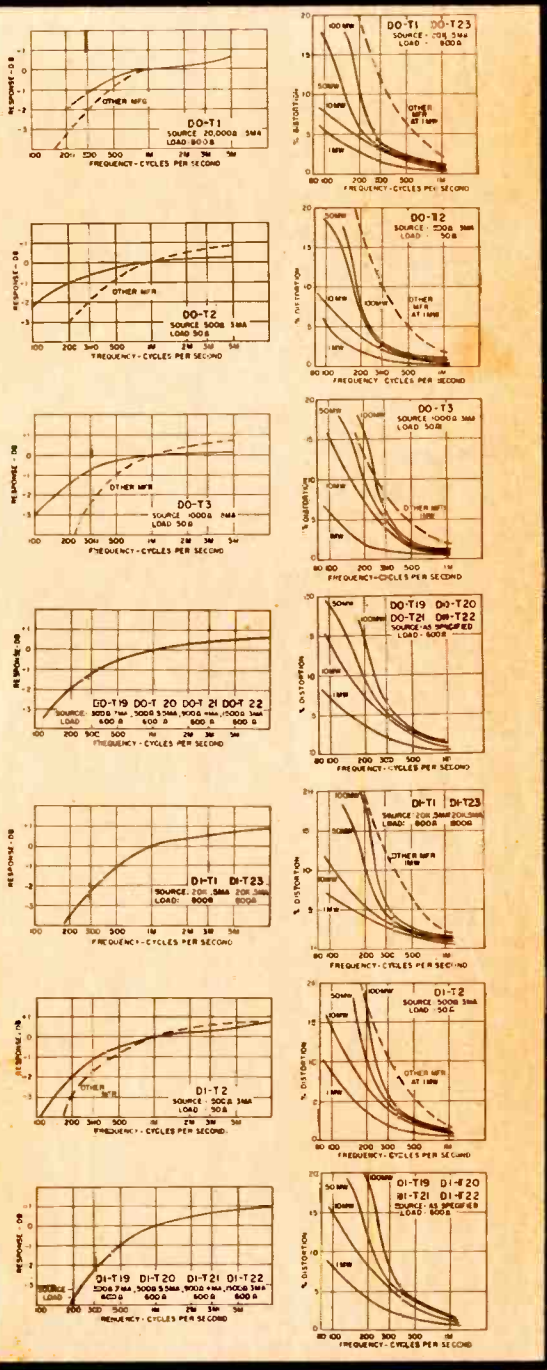
5/16 Dia. x 13/32, 1/10 Oz.

- High Power Rating . . . up to 100 times greater.
- Excellent Response . . . twice as good at low end.
- Low Distortion . . . reduced 80%.
- High Efficiency . . . up to 30% better.
- Moisture Proof . . . hermetically sealed to MIL-T-27A.
- Rugged . . . completely cased.
- Anchored Leads . . . withstand 10 pound pull test.
- Printed Circuit Use . . . plastic insulated leads.

DI-T

ACTUAL SIZE

5/16 Dia. x 1/4, 1/20 Oz.



DO-T No.	MIL Type	Application	Pri. Imp.	D.C. Ma.‡ in Pri.	Sec. Imp.	Pri. Res. DO-T	Pri. Res. DI-T	Level Mw.	DI-T No.
DO-T1	TF4RX13YY	Interstage	20,000 30,000	.5 .5	800 1200	850	815	50	DI-T1
DO-T2	TF4RX17YY	Output	500 600	3 3	50 60	60	65	100	DI-T2
DO-T3	TF4RX13YY	Output	1000 1200	3 3	50 60	115	110	100	DI-T3
DO-T4	TF4RX17YY	Output	600	3	3.2	60		100	
DO-T5	TF4RX13YY	Output	1200	2	3.2	115	110	100	DI-T5
DO-T6	TF4RX13YY	Output	10,000	1	3.2	790		100	
DO-T7	TF4RX16YY	Input	200,000	0	1000	8500		25	
DO-T8	TF4RX20YY	Reactor 3.5 Hys. @ 2 Ma. DC, 1 Hy. @ 5 Ma. DC				630			
	TF4RX20YY	Reactor 2.5 Hys. @ 2 Ma. DC, .9 Hy. @ 4 Ma. DC					630		DI-T8
DO-T9	TF4RX13YY	Output or driver	10,000 12,000	1 1	500 CT 600 CT	800	870	100	DI-T9
DO-T10	TF4RX13YY	Driver	10,000 12,000	1 1	1200 CT 1500 CT	800	870	100	DI-T10
DO-T11	TF4RX13YY	Driver	10,000 12,000	1 1	2000 CT 2500 CT	800	870	100	DI-T11
DO-T12	TF4RX17YY	Single or PP output	150 CT 200 CT	10 10	12 16	11		500	
DO-T13	TF4RX17YY	Single or PP output	300 CT 400 CT	7 7	12 16	20		500	
DO-T14	TF4RX17YY	Single or PP output	600 CT 800 CT	5 5	12 16	43		500	
DO-T15	TF4RX17YY	Single or PP output	800 CT 1070 CT	4 4	12 16	51		500	
DO-T16	TF4RX13YY	Single or PP output	1000 CT 1330 CT	3.5 3.5	12 16	71		500	
DO-T17	TF4RX13YY	Single or PP output	1500 CT 2000 CT	3 3	12 16	108		500	
DO-T18	TF4RX13YY	Single or PP output	7500 CT 10,000 CT	1 1	12 16	505		500	
DO-T19	TF4RX17YY	Output to line	300 CT	7	600	19	20	500	DI-T19
DO-T20	TF4RX17YY	Output or line to line	500 CT	5.5	600	31	32	500	DI-T20
DO-T21	TF4RX17YY	Output to line	900 CT	4	600	53	53	500	DI-T21
DO-T22	TF4RX13YY	Output to line	1500 CT	3	600	86	87	500	DI-T22
DO-T23	TF4RX13YY	Interstage	20,000 CT 30,000 CT	.5 .5	800 CT 1200 CT	850	815	100	DI-T23
DO-T24	TF4RX16YY	Input (usable for chopper service)	200,000 CT	0	1000 CT	8500		25	
DO-T25	TF4RX13YY	Interstage	10,000 CT 12,000 CT	1 1	1500 CT 1800 CT	800	870	100	DI-T25
DO-T26	TF4RX20YY	Reactor 6 Hy. @ 2 Ma. DC, 1.5 Hy. @ 5 Ma. DC				2100			
	TF4RX20YY	Reactor 4.5 Hy. @ 2 Ma. DC, 1.2 Hy. @ 4 Ma. DC					2300		DI-T26
DO-T27	TF4RX20YY	Reactor 1.25 Hy. @ 2 Ma. DC, .5 Hy. @ 11 Ma. DC				100			
	TF4RX20YY	Reactor .9 Hy. @ 2 Ma. DC, .5 Hy. @ 6 Ma. DC					105		DI-T27
DO-T28	TF4RX20YY	Reactor .3 Hy. @ 4 Ma. DC, .15 Hy. @ 20 Ma. DC				25			
	TF4RX20YY	Reactor .1 Hy. @ 4 Ma. DC, .08 Hy. @ 10 Ma. DC					25		DI-T28
DO-T29	TF4RX17YY	Single or PP output	120 CT 150 CT	10 10	3.2 4	10		500	
DO-T30	TF4RX17YY	Single or PP output	320 CT 400 CT	7 7	3.2 4	20		500	
DO-T31	TF4RX17YY	Single or PP output	640 CT 800 CT	5 5	3.2 4	43		500	
DO-T32	TF4RX17YY	Single or PP output	800 CT 1,000 CT	4 4	3.2 4	51		500	
DO-T33	TF4RX13YY	Single or PP output	1,060 CT 1,330 CT	3.5 3.5	3.2 4	71		500	
DO-T34	TF4RX13YY	Single or PP output	1,600 CT 2,000 CT	3 3	3.2 4	109		500	
DO-T35	TF4RX13YY	Single or PP output	8,000 CT 10,000 CT	1 1	3.2 4	505		500	
DO-T36	TF4RX13YY	Isol. or Interstage	10,000 CT	1	10000 CT	950	970	500	DI-T36

DO-TSH Drawn Hipermalloy shield and cover for DO-T's, provides 25 to 30 db shielding, for DI-T's **DI-TSH**

‡DCMA shown is for single ended useage (under 5% distortion—100MW—1KC) . . . for push pull, DCMA can be any balanced value taken by .5W transistors (under 5% distortion—500MW—1KC)

*DO-T units have been designed for transistor application only . . . not for vacuum tube service. Pats. Pend.

And Special Units to Your Specifications

UNITED TRANSFORMER CORPORATION

150 Varick Street, New York 13, N. Y.

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EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y. CABLES: "ARLAB"

Tech Data
for Engineers

Electrical Insulation

A 4-page bulletin, No. 33 from Inmanco Div., Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill. covers precision-slit electrical insulation. Tables list 10 popular slit plastic films, papers, and combinations as well as thicknesses, widths, tolerances, and coil and core sizes in which each is supplied. Conversion tables are included for translating area to lineal ft. per lb.

Circle 194 on Inquiry Card

Stable Platform

A 4-page illustrated data sheet provides specs for a 4-gimbal inertial platform. It uses 3-floated integrating gyroscopes and 3 linear force balance accelerometers. Specs include erection cycle, attitude, input data, output data, and environment. Inertial Guidance Dept., Sperry Gyroscope Co., Great Neck, N. Y.

Circle 195 on Inquiry Card

Diodes

New 10-page brochure GD-40 describes the company's line of germanium gold bonded diodes. It describes the mechanical, electrical, and hermetic seal tests and includes complete specs. Characteristics forward and reverse cirves are included. General Transistor Corp., 91-27 138th Place, Jamaica 35, N. Y.

Circle 196 on Inquiry Card

PC Resin Fluxes

Bulletin from London Chemical Co., Inc., Dept. ES-2, 1535 N. 31st Ave., Melrose Park, Ill., describes and illustrates results of a U. S. Signal Corps Mirror Test for corrosiveness of printed circuit resin fluxes. The test was run in accordance with MIL-F-14256 by the Inland Testing Div. of Cook Research, Morton Grove, Ill.

Circle 197 on Inquiry Card

BW Oscillators

Carcinotron catalog has been published by Litton Industries Electron Tube Div., 960 Industrial Rd., San Carlos, Calif., for its two full-spectrum series of these M-type backward-wave oscillators. The 6-page catalog, No. T891, contains full specs on one of the tubes. The two carcinotron series are characterized by interchangeability, small size, and light weight.

Circle 198 on Inquiry Card

Circle 61 on Inquiry Card →

ABSOLUTE MAXIMUM RATINGS AT 25°C

Forward Current	I_f	50 mA
Minimum Breakover Voltage	V_{bo}	{ TSW-30 30V { TSW-60 60V
Reverse Breakdown Voltage	V_r	{ TSW-30 30V { TSW-60 60V
Storage Temperature		−65°C to 150°C
Ambient Temperature Range		−55°C to +125°C

SPECIFICATIONS AND TYPICAL CHARACTERISTICS

(At 25°C Unless Otherwise Stated)

		Typical	Max.	Test Conditions	
Saturation Voltage	V_S	1.0	1.5	Volts	I_c = 50 mA
Forward Leakage Current	I_B	0.1	10	μA	V_c = 30V
Reverse Leakage Current	I_B	0.1	10	μA	V_c = −30V
Forward Leakage Current	I_B	20.	50.	μA	at 125°C
Reverse Leakage Current	I_E	20.	50.	μA	at 125°C
Gate Voltage to Switch "ON"	V_g On	0.7	1.0	Volts	R_L = 1K
Gate Current to Switch "ON"	I_g On	0.1	1.0	mA	R_L = 1K
Gate Voltage to Switch "OFF"	V_g Off	1.2	4.0	Volts	I_c = 50 mA
Gate Current to Switch "OFF"	I_g Off	7.0	10.	mA	I_c = 50 mA
Holding Current	I_E	2.0	5.0	mA	R_L = 1K

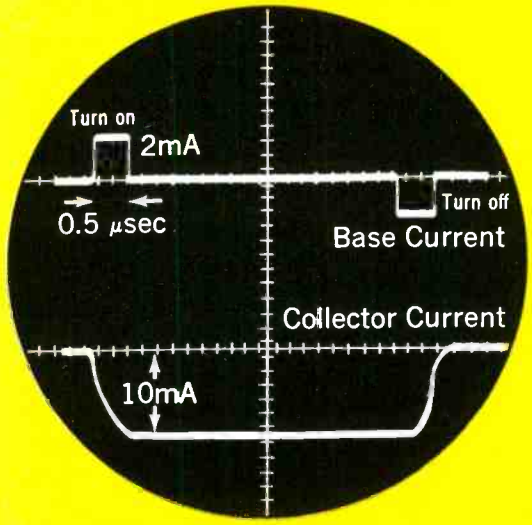
SPECIALLY DESIGNED FOR:

- Miniaturized Memory Circuits
- Ring Counters
- Shift Registers
- Controlled Rectifier Driver
- Flip-Flop Equivalent
- Simplified Information Storage
- 0.3 m second Switching

Transitron

announces a NEW computer element for: Greater Reliability • Circuit Simplicity

THE TRANSWITCH



The TRANSWITCH is a new bistable silicon device that can be TURNED OFF with gate current.

This PNPN latching device "remembers" its last gate signal. High current gain, both turn-on and turn-off, leads to greater circuit simplicity and inherent reliability. Excellent linearity of electrical parameters over a wide current range fulfills both low logic level and medium power needs.

Here is a unique device that replaces TWO transistors plus resistors in most bistable circuits and permits increased component density.

Furthermore, the transwitch is FAST . . . requiring only 0.3 microseconds to turn ON or OFF!

The TRANSWITCH is now available from TRANSITRON in the popular JEDEC TO-5 package, ready to solve your switch-on-switch-off requirements.

For further information, write for Bulletin TE-1357A

Transitron

electronic corporation • wakefield, massachusetts

"Leadership in Semiconductors" SEE YOUR LOCAL AUTHORIZED TRANSITRON DISTRIBUTOR FOR QUANTITIES FROM 1-999.

Tech Data

for Engineers

! MORE !

The literature mentioned here has been selected for contribution to or advancement of the electronic industries. These items are combed from several hundred bulletins, catalogs, and data sheet announcements received during the past month by ELECTRONIC INDUSTRIES. To keep interested readers informed of all new developments, a summary record is kept of ALL new products and tech data announcements received. For a copy of this month's list, please send your request on company letterhead to Readers' Service Dept., Electronic Industries, 56th & Chestnut Sts., Phila., Penna. or Circle No. 161 on Inquiry Card.

Multiplex System

Bulletin 3-543 from the Raytheon Co., Equipment & Systems Div., Waltham 54, Mass., describes the B-640A, a 48-channel frequency-division multiplex system providing moderate-cost channelizing of microwave r-f carrier in a fully integrated communications package.

Circle 199 on Inquiry Card

Switches-Relays

Switches and relays available from Acro Div., Robertshaw-Fulton Controls Co., P.O. Box 449, Columbus 16, Ohio, are described in an illustrated 4-page brochure. Included are miniature, sub-miniature, appliance, open blade, general purpose, metal clad, machine tool, and Acro-Lite switches. Several types of relays also are described.

Circle 200 on Inquiry Card

Vibration Meter

SIE Model T-1A Vibration Meter, designed for accurate measurement of the velocity, displacement amplitude and acceleration of vibration, is described and illustrated in a bulletin from Southwestern Industrial Electronics Co., a Div. of Dresser Industries, Inc., 10201 Westheimer, P.O. Box 22187, Houston 27, Tex.

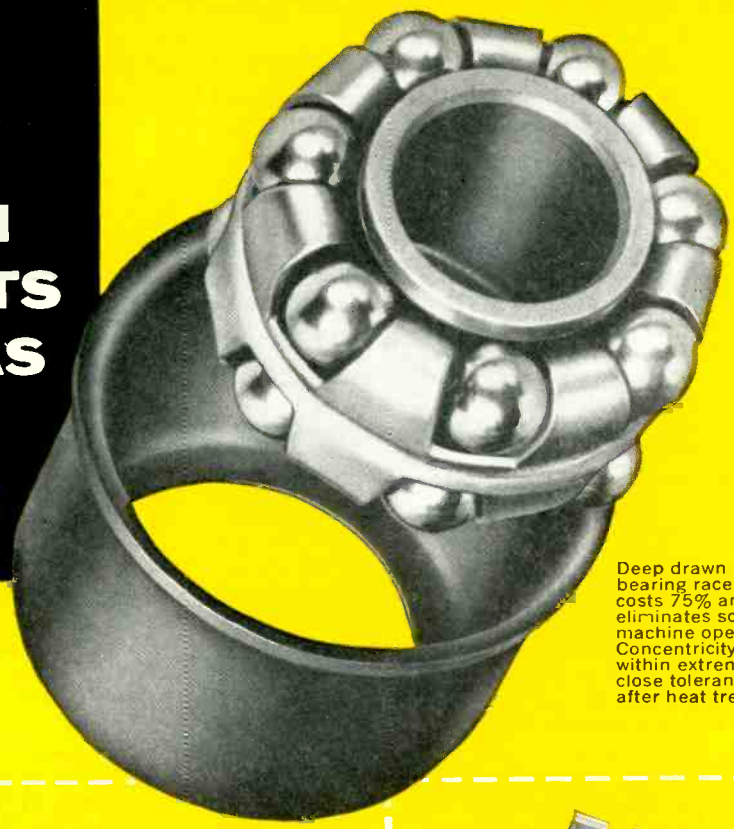
Circle 201 on Inquiry Card

Directional Couplers

Six-page tech. brochure describes Microwave Directional Coupler design and operation. From Waveline, Inc., Caldwell, N. J., it features 30 types of couplers and their design and electrical performance data.

Circle 202 on Inquiry Card

CUT PRECISION PARTS COSTS AS MUCH AS 75%



Deep drawn ball bearing race cuts costs 75% and eliminates screw machine operation. Concentricity held within extremely close tolerance even after heat treating.

Transistor dome has .018 weld flange made from .013 stock, without showing any indentation on reverse side.

Full stock thickness at top of draw on .018 brass case improved watch quality and saved assembly time.

Spring for razor blade dispenser feeds automatically in high-speed assembly machine. Spring steel properties are held during heat treating. Parts are produced free of burrs, without finishing.

- **Improve quality at lower cost**
- **Increase production and speed assembly**
- **Eliminate screw machine costs**

Now a ball bearing race is being made for a textile machine by deep drawing 1050CR steel to .843 within tolerances previously believed impossible. Savings of 75% are reported and the 25% reject rate experienced when this part was made on screw machines was eliminated.

This is only one of a host of examples where United's specialized skill in metal forming provides production economies on made-to-order eyelet-like and other metal specialties for many industries.

Special conveyor-type austempering furnaces are used when required to produce uniform toughness, with specified hardness. Parts are clean, free of quench cracks, and have minimum distortion. Call or write today for analysis and quotation on your most challenging problem.

United

UNITED SHOE MACHINERY CORPORATION

INDUSTRIAL SALES DIVISION

140 Federal St., Boston, Massachusetts

LIberty 2-9100

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Circle 63 on Inquiry Card

How a 150 watt triode 25 years ago led to super power klystrons today

In 1934, two radio amateurs, unhappy with existing final amplifier tubes, formed a company to make their own. Their first tube, the Eimac 150T, established a new standard of electron tube performance and reliability.

Other important Eimac tube developments were:

150T—The first Eimac tube in 1934, was designed primarily for the amateur and established Eimac tube characteristics for the future—clean, hard vacuums, simplified design, lower driving power, high mutual conductance and superior overload capability.

450T—Only two years later practically every major airline was using Eimac tubes. The 450T fulfilled the critical needs of aviation and was first choice in ground-to-air communications.

3X2500A3—By the time Major Armstrong had won his battle for FM, Eimac internal anode triodes were in nearly every experimental FM broadcast station. In 1945 the external anode triode 3X2500A3 was introduced and used in the world's most powerful FM transmitter.

304T—In 1940 Eimac introduced multi-unit triodes—which operate efficiently up to 200mc, and as high as 10 times rated voltage. The 304T, four triodes in one, is still acclaimed as a top linear amplifier tube.

VT 127—In 1939, Eimac 100T triodes powered the first Navy radar, prototype of the first radar to see action in the Pacific. Eimac's 15E met the higher frequency operation needs of airborne radar and made possible 26,000 Navy radar sets. Many of the renowned VT series tubes were other Eimac contributions.

4-125A Family (5 tubes)—In 1945 Eimac introduced the 4-125A, first radial-beam tetrode. Today, Eimac's five internal anode tetrodes are famous for low driving power requirements, low grid emission, low gridplate capacitances, minimized neutralization requirements and dependable VHF performance.

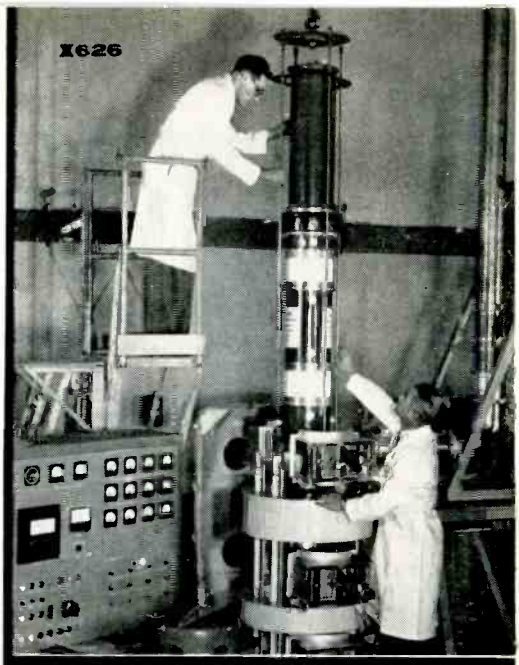
4X150A—Compact, rugged external anode radial-beam tetrodes were introduced by Eimac in 1946. The 4X500A and 4X150A led to smaller, high power, high frequency equipment and coaxial cable circuits.

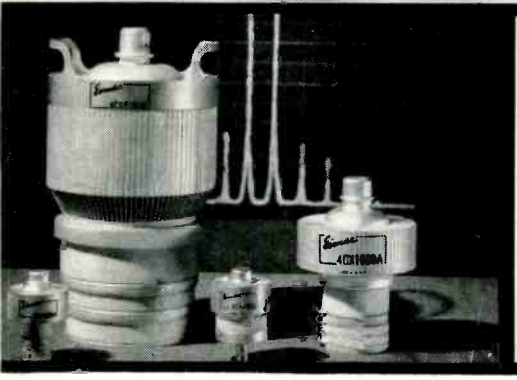
Amplifier Klystron—Eimac saw the shortcomings of grid tubes for UHF in 1948, started developing amplifier klystrons. Today Eimac klystrons are the most widely used tubes in tropospheric communications.

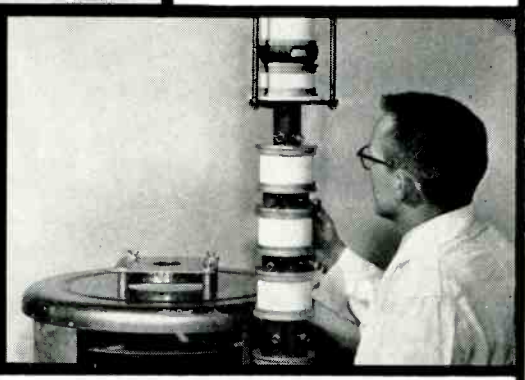
4CX300A, 4CX250B, 4CX1000A, 4CX5000A—Today, over 40 Eimac tubes feature ceramic envelopes. More compact than glass, these advanced tubes can withstand thermal and physical shock never before possible.

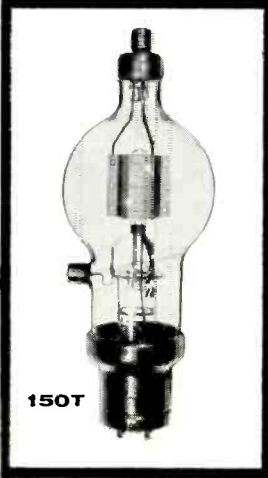
X626—Super power, 1.25 megawatts of long-pulse power, at UHF is now available with the Eimac X626. This tube powered the record 56,000,000 mile radar contact with Venus.

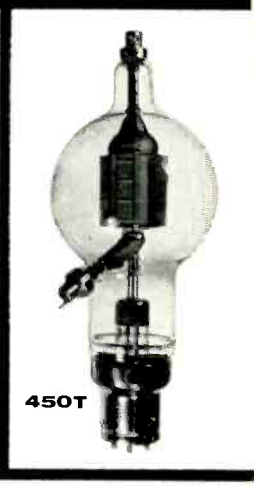
TWT—Now, microwave in the form of ceramic traveling wave tubes and reflex klystrons. Eimac is engaged in the development and manufacture of new electron devices to propagate the uncrowded spectrum at Super High Frequencies and above.

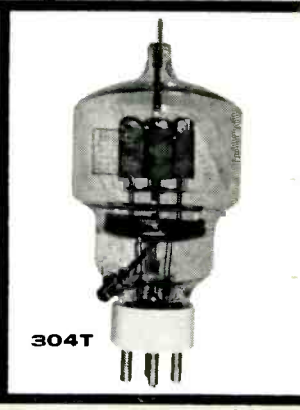


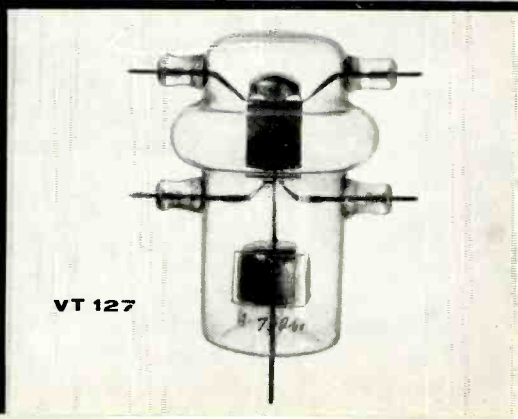












The dependable tubes of yesteryear have not been forgotten. They are constantly improved. Most of the oldtimers on review here are still available and many are replacements for originals that have finally given in after years and years of service.

Eimac **EITEL-McCULLOUGH, INC.,** San Carlos, California

Circle 64 on Inquiry Card

International Electronic Sources

Up-to-the-minute abstracts of articles appearing in the leading foreign electronic engineering journals

ANTENNAS, PROPAGATION

The Reflected Ray on Radio Links over Sea or over Smooth Plane Earth, V. Montevecchi. "Alta Freq." Aug. 1959. 15 pps. On the basis of continuous propagation recordings carried out on the radio link operating in the T.I.M.O. zone and subsequent analysis, a study has been made to evaluate the influence of a reflected ray on the receiver field strength, on all the paths either over sea or over smooth plane earth which are most affected by its presence. A procedure is developed, to be followed both in the design stage of new radio links and when verifying the propagation condition of existing installations, which takes into account a reflected ray as determining factor for the continuity of operation around the "optimum" condition. (Italy.)

Propagation in the Frequency Ranges of 460-470, 585-685, 6660-6700 MHz, in the Gulf of Naples, A. Bruno. "Alta Freq." Aug. 1959. 16 pps. From original records made during some years and from the statistic data worked out from them on the propagation between Naples-Sorrento, Naples-Capri, Capri-Ischia, results in agreement with those already known have been obtained. Propagation proceeding shows well determined characteristics with limited fluctuations in winter months and more frequent ones in summer time. Records on the same frequency but on different heights have been collected on Naples-Capri hop, and interesting comparative elements derived which appear to justify the anomalous propagation in the Gulf already mentioned by other experts. (Italy.)

Multiple Paths in Radio Links with Passive Repeaters, F. Fabbri. "Alta Freq." Aug. 1959. 16 pps. Distortion through multiple paths and fadings are the most limitative factors in radio links with a large number of channels. Echos in practice can be divided in two types: 1—with intensity comparable to the main ray but with a short delay, due to dedoubling in the atmosphere: 2—with weak intensity, but long delay; these, besides the reasons already known, such as mismatching in the feeders, reflection from nearby buildings, etc., can be due, in links with passive relays, to rays which, in spite of the obstacles interposed between the two terminals, reach the receiver through diffraction along the shortest path. Careful study will avoid such interferences, while the first ones may be reduced with the use of very directive antennas. (Italy.)

Radio Link Using Tropospheric Diffraction, A. Favilli. "Alta Freq." Aug. 1959. 14 pps. In the latest years a growing interest has been devoted to a new type of electromagnetic propagation, which differs from the classical systems used in the past in the radio communication field and which is based on a diffraction phenomenon. This system, which after long research work has found only recently practical application, is known as "scatter propagation." Of the two types of "scatter" normally used (ionospheric and tropospheric scatter) the latter is examined, after pointing out briefly the characteristics of the former. (Italy.)

Statistical Analysis of Fading on Short-Wave Transmissions, K. K. Aggarwal. "J. ITE." September 1959. 8 pps. In the present investigation on fading of radio signals in tropical countries, a statistical analysis is presented of the fading records taken on oblique incidence continuous wave modulated transmissions as well as on pulsed transmissions at vertical incidence. The amplitude distributions of some of the random fading curves have been worked out and are shown in this paper. It is observed that the probability distributions of the amplitude in such fading curves are the conventional Rayleigh, Gaussian and log normal type. (India, in English.)

Development of Highly Directive Aerials in Radio Astronomy, W. N. Christiansen. "Proc. AIRE." Sept. 1959. 10 pps. Structural considerations indicate that the design of highly directive aerials should change with size. For diameters up to a few hundred feet, steerable paraboloids have many advantages, but for larger sizes, fixed structure which can be supported from the earth at many points are necessary. For extremely large aerials the new types developed by radio astromoners provide high directivity in a very economical way. The feature of these new aerials is that they are "skeleton" aerials, since they provide a directivity which corresponds to a much greater surface area than they possess. (Australia.)

An Improved Missile Aerial Stabilization System, D. Peat. "Brit. C.&E." December 1959. 2 pps. A single large gyroscope is often used as the stabilizing element to maintain a directional aerial pointing at a target, irrespective of the movement of the vehicle carrying the aerial. A smaller two-gyroscope system is described which would overcome most of the disadvantages of the single gyroscope system. (England.)

CIRCUITS

Compensation Instrument to Transform Power to Direct Current, M. Duma, M. Syrbu. "Avto. i Tel." Nov. 1959. 5 pps. There is described a compensation instrument developed in Research Institute of Electrical Engineering of the Ministry of Heavy Industry of RPR to transform power to direct current. The instrument is based on the standard 3-stage meter circuit. (U.S.S.R.)

Narrow Band Amplification with Transistors, H. Beneking. "Nach. Z." November 1959. A difference should be made between resistive matching and reactive matching in the tuned circuit coupling between amplifier stages having finite complex impedances which depend on the operating point. Resistive matching results in an optimum power transfer to a given bandwidth. Reactive matching gives an optimum power transfer for a predetermined maximum detuning. The relevant formulae

REGULARLY REVIEWED

AUSTRALIA

AWA Tech. Rev. AWA Technical Review
Proc. AIRE. Proceedings of the Institute of Radio Engineers

CANADA

Can. Elec. Eng. Canadian Electronics Engineering
El. & Comm. Electronics and Communications

ENGLAND

ATE J. ATE Journal
BBC Mono. BBC Engineering Monographs
Brit. C&E. British Communications & Electronics
E. & R. Eng. Electronic & Radio Engineer
El. Energy. Electrical Energy
GEC J. General Electrical Co. Journal
J. BIRE. Journal of the British Institution of Radio Engineers
Proc. BIEE. Proceedings of Institute of Electrical Engineers
Tech. Comm. Technical Communications

FRANCE

Ann. de Radio. Annales de Radioelectricite
Bull. Fr. El. Bulletin de la Societe Francaise des Electriciens
Cab. & Trans. Cables & Transmission
Comp. Rend. Comptes Rendus Hebdomadaires des Seances
Onde. L'Onde Electrique
Rev. Tech. Revue Technique
Telonde. Telonde
Toute R. Toute la Radio
Vide. Le Vide

GERMANY

AEG Prog. AEG Progress
Arc. El Uber. Archiv der Elektrischen Uebertragung
El Rund. Electronische Rundschau
Freq. Frequenz
Hochfreq. Hochfrequenz-technik und Electroakustik
NTF. Nachrichtentechnische Fachberichte
Nach. Z. Nachrichtentechnische Zeitschrift
Rundfunk. Rundfunktechnische Mitteilungen
Vak. Tech. Vakuum-Technik

POLAND

Arch. Auto. i Tel. Archiwum Automatyki i Telemechaniki
Prace ITR. Prace Instytutu Tele-I Radiotechnicznego
Roz. Elek. Rozprawy Electrotechniczne

USSR

Avto. i Tel. Avtomatika i Telemakhanika
Radio. Radio
Radiotek. Radiotekhnika
Rad. i Elek. Radiotekhnika i Elektronika
Iz. Acad. Bulletin of Academy of Sciences, USSR

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are discussed and are graphically shown in a normalized form in order to facilitate the design of an optimum circuit for each case. (Germany.)

The Effective Accessibility of Output Groups Following Intermediate Line Circuits, N. Bininda & A. Wendt. "Nach. Z." November 1959. 7 pps. For link arrangements with internal congestion, an effective accessibility is defined for repeated-attempt systems which corresponds to the accessibility of single-stage switching arrangements equivalent from the point of view of traffic theory. (Germany.)

Transistor D.C. Converters for Fluorescent-Lamp Power Supplies, T. Hehenkamp and J. J. Wilting. "Phil. Tech." Nov. 12, 1959. 5 pps. Description of experimental transistor converters which convert dc into ac with output powers up to about 20 w. The particular application concerned here is to furnish an ac supply for fluorescent lamps in circumstances where efficient lighting is desired but where the only source of electricity available is a low-voltage accumulator of limited capacity. (Netherlands, in English.)

Modulators and Demodulators for High Capacity Radio Links, E. Dalla Volta. "Alta Freq." Aug. 1959. 12 pps. Among the various units composing a radio link terminal, the one which mostly affects its quality is the modulator-demodulator assembly. The author examines the influence of this assembly on the overall performance of the radio link, concerning mainly distortion, cross modulation, etc. The modulation problem is investigated in its development, a comparison being made between direct modulation at S.H.F. and modulation at frequencies lower than the output frequency. (Italy.)

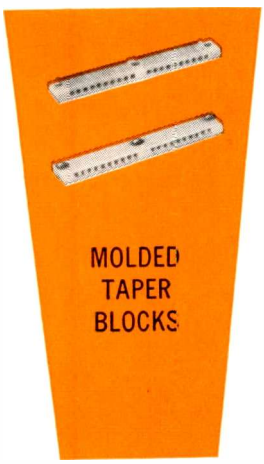
Design and Realization of Microwave Filters, I. Caroli and U. Cucina. "Alta Freq." Aug. 1959. 22 pps. The authors briefly review the fundamental works published on microwave band-pass and band-stop filters and recall design formulas for filters in the cases of maximally flat amplitude response (Butterworth approximation), constant amplitude ripple over the pass-band (Cebiceff approximation) and tuned circuits all identical among themselves. From the above mentioned formulas, graphs have been drawn of easy application for dimensioning two-, three- and four-resonator filters, and rules are given for the choice of the response curve most suited to meet different requirements. (Italy.)

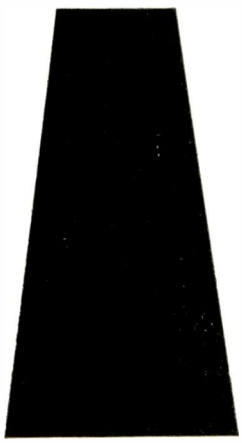
The Realization of Switches for both Current Directions with Junction Transistors, W. Hilberg. "El. Rund." Dec. 1959. 3 pps. A family of transistor circuits is considered by which current is switched in both directions. Starting from the switching properties of the single transistor it is shown that one has to use circuits of diodes and transistors to achieve better results concerning velocity, power control, and switching conditions. (Germany.)

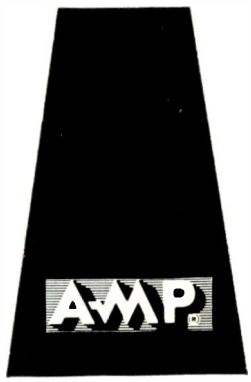
Analysis of Active Networks by Admittance Matrices, M. N. Srikantaswamy & K. K. Nair. "J. ITE." Sept. 1959. 8 pps. In this paper a new method of analyzing active networks by means of admittance matrices is presented. The admittance matrices of vacuum tubes and transistors are derived and examples of the application are given. The concept of the indefinite admittance matrix as defined by Shekel is introduced. The indefinite admittance matrices are then derived for the vacuum tubes and transistors and it is shown how one can derive the admittance matrices of the various tube and transistor configurations from their respective indefinite admittance matrices. (India, in English.)

Design of Transistor I-F Amplifier Detector Stages with Stabilized Band-Pass Characteristics, M. V. Josh. "J. ITE." September 1959. 7 pps. An earlier paper discussed the design of an Ie-controlled i-f amplifier stage employing partial neutralization. The inherent variation in the band-pass characteristics of such a transistor amplifier stage was demonstrated. In this paper, data are presented regarding a transistor i-f amplifier stage employing partial

FOR A TIGHT FIT IN A TIGHT SPOT...







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1N255	400	400	–	–	0.15*	Stud	990B
1N256	600	200	–	–	0.25*	Stud	991B
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1N540	400	–	750	250	0.350†	Axial Lead	1085A
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—International ELECTRONIC SOURCES

neutralization and operating at low collector voltages. The gain of such a stage can be controlled by varying the collector voltages. A transistor collector detector stage can also provide, besides the demodulated audio frequency signal, the control voltage necessary to secure A.G.C. for the preceding high-frequency stages. (India, in English.)

Parallel-Connected Magnetic Amplifier, K. J. Srivastava. "J. ITE." September 1959. 7 pps. A mathematical analysis of parallel-connected magnetic amplifiers with an inductive and capacitive load is presented. The analysis is based on the representation of the normal magnetization curve of the core material by polynomials of third and fifth degree respectively. (India, in English.)

An Adjustable Impedance Circuit, C. T. Murray. "Proc. AIRE." Aug. 1959. 2 pps. In some applications circuit performance may be greatly improved by the use of an impedance having an infinite or negative value. Particular examples are high accuracy cathode followers using a negative cathode resistor and difference amplifiers with an infinite or negative common cathode impedance. The circuit described here is one method of obtaining such a controllable impedance. (Australia.)

Cathode-Coupled Push-Pull Output Stage, K. R. Sturley & J. P. Bennett. "E. & R. Eng." November 1959. 6 pps. A theoretical investigation of the linear operation of the cathode-coupled push-pull output stage shows that, as the common cathode resistance R_K is increased, the ratio of the signal currents in each valve approaches unity and the output voltage is almost independent of R_K. (England.)

COMMUNICATIONS

The PAM Method in Stereophonic Broadcasting, G. Janus. "El. Rund." Dec. 1959. 3 pps. With pulse-amplitude modulation (PAM) both the signals delivered by the stereophonic LF power pack modulate alternatingly the pulses of a scanning generator. An ultra-short wave transmitter is frequency modulated by the resultant signal. In the receiver the signal is divided by electronic switches synchronized by scanning frequency and the two stereophonic signals are fed to both the LF channels. (Germany.)

A New Method for Stereophonic Broadcasting with Frequency Modulated Signals and Amplitude Modulated Subcarrier, F. L. H. M. Stumpers and R. Schutte. "El. Rund." Dec. 1959. 2 pps. The principle of a new method for stereophonic broadcasting with frequency modulated signals and amplitude modulated subcarrier with the following advantages is discussed: 1) small expenditure on the receiving side, 2) low subcarrier frequency and thereby small band width, 3) small additional expenditure on receiver renders possible a second program. Loss in signal/noise ratio with compatible signal is the mentioned disadvantage and the necessity of 55 μV/s at the receiver's input to obtain 50 dB stereophonic signal/noise ratio is considered. (Germany.)

The Cross-Talk in Screened Cables for Exchanges, W. Vogl & A. Ziegler. "Nach. Z." Nov. 1959. 5 pps. Cross-talk attenuation values of 17 N are required for the wiring in repeater stations. These high values can be achieved by means of special screen designs. The physical processes of cross-talk in coaxial and balanced line types are mentioned and the effect of single ended and double ended grounding of cable screen is described. (Germany.)

A Bridged T Network in Action, V. A. Krishnaswamy. "J. ITE." Sept. 1959. 4 pps. Frequently, a bridged T network is employed to combine the outputs of the two transmitters and the article explains in simple terms how several functions are carried out by the bridged T arrangement. It is hoped that the article will be of interest to students and professional radiomen alike. (India, in English.)

Panoramic Systems of Measurements on Equipment for Multichannel FM Radio Link, F. Pollastrello. "Alto Freq." Aug. 1959. 12 pps. Factory test methods on receivers, transmitters and modulator-demodulator units for multichannel frequency-modulated radio links are described. Sweep-methods adjustments of i-f and r-f circuits are treated in some details, as well as transmission quality tests, which aim to the observation of thermal noise and cross modulation noise. Factory test results on the Rome-Pescara radio link (operating band 4000 MHz) are briefly recalled. (Italy.)

Test Results of Multichannel Radio Link Equipments, A. Cardarelli. "Alta Freq." Aug. 1959. 17 pps. The main electrical features of radio link equipments are discussed, as actually ascertained in the factory acceptance tests carried out on different lots of equipment designed for medium and high traffic capacity. The main parameters of the equipments are investigated from the point of view of production uniformity and of the correspondence of the results obtainable in current production with those resulting from theoretical computations or measured on laboratory prototypes. (Italy.)

Group-Delay Equalization of the TV Radio Link Milan-Palermo, A. Luna. "Alta Freq." Aug. 1959. 13 pps. After stating the fundamental ideas on which the problem of the group-delay equalization of each relay station of the Milan-Palermo radio link has been based, the design of the equalizing circuit and the method of calculation of its component are given. (Italy.)

Measure of Cross Modulation Noise in FM Radio Links, O. Fabbri. "Alta Freq." Aug. 1959. 15 pps. In accordance with the modern methods of measuring the cross modulation noise in multi-channel radio links, a specialized instrument has been developed which simulates the operating conditions to the effect of the cross modulation and makes it possible to measure the cross modulation in a certain number of preset gates of the modulation band. (Italy.)

Interferences between Radio Links at Frequency Modulation, M. Federici. "Alta Freq." Aug. 1959. 11 pps. The author examines theoretically the interference produced on a FM receiver by a modulated or unmodulated carrier frequency of small amplitude and shows that the interference depends only on the relative amplitude of the wanted and unwanted signals and is not reduced by reference to an amplitude modulated receiver. The results of experiments carried out are related. (Italy.)

Choice of the Working Frequency in Radio Links, G. Pivetta. "Alta Freq." Aug. 1959. 13 pps. The various frequency bands devoted to the radio links and the corresponding properties of the propagation are mentioned. The factors affecting the choice of working frequencies are then examined, namely: locations to be linked, band-width required by the desired number of channels, fading probability, local level of parasitics, features of the various equipments, aerial size, interfering signals. (Italy.)

Radio Links Using Traveling Wave Tubes, L. Barbaglio. "Alta Freq." Aug. 1959. 27 pps. The simplifications and improvements obtainable by the use of traveling wave tubes in the radio links technique are considered both from the realization and from the performance points of view. Particular mention is made of the circuitry in relation with traveling wave tubes. The second part of the article contains detailed description of the new Marconi radio link operating at 2000 MHz; block schematics of terminal and relay stations are shown together with pictures. A newer version of this equipment operating at higher frequency is briefly outlined. For the 2000 MHz version mentioned above are described also the auxiliary circuits, and alarm devices best suited to the service. (Italy.)

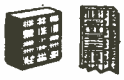
International ELECTRONIC SOURCES——

Application of Compandor Circuits in Radio Links, P. Chiesa. "Alta Freq." Aug. 1959. 9 pps. A brief review is made of the progress of compandor circuits in radio links, particular attention being paid to their applications in the field of telephony. Their theory is also recalled, pointing out the use of semiconductors as non-linear elements for the realization of variable attenuators. After a critical comparison of the available compandor circuits, the possibilities of applications, especially in the field of communications by radio link systems, are described. (Italy.)

Electronically Stabilized Power Supply of Klystrons for Radio Link Application, M. Saba. "Alta Freq." Aug. 1959. 15 pps. After an introductive remark concerning the factors which might affect the frequency stability of klystron oscillators, a distinction is made between the factors which can be directly controlled (supply voltage) and those the effects of which must or can be neutralized indirectly (temperature, tube aging, etc.). Mention is also made on the opportunity of visualizing the electronic controls within the general theory of negative feed-back amplifiers. (Italy.)

Reference Cavities for Automatic Frequency Control, B. Basini. "Alta Freq." Aug. 1959. 8 pps. A hint is made on the frequency stability requisites normally requested for microwave radio links and a short description is given of the stabilizing systems employing as discriminating element one or more tuned cavities. Then the problems on tuned cavities dimensioning and coupling systems depending on the Q .and insertion losses are examined (Italy.)

The South-Lanchashire Radiophone Service, L. T. Arman. "Brit. C.&E." December 1959. 4 pps. The South-Lancashire Radiophone Service is a VHF mobile-radio service providing communications between land mobile stations and the public telephone network. Calls between the mobile service user and both local and distant subscribers on the telephone network are possible, the calls in the latter case being routed via the trunk network. (England.)



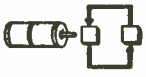
COMPUTERS

Shift Registers with Logic Feedback and Their Application as Computers and Code Devices, A. N. Radchenko, V. I. Phillipov. "Avto. i Tel." Nov. 1959. 8 pp. The article deals with the methods of efficiency of computers and codes based on shift registers. The main property of these devices is that the shift register is fed back by a logical circuit, the action of which is the function of a code in the register. The article describes the methods of designing feedback circuits for counters and codes of any capacity as well as the methods of reading information. (U.S.S.R.)

Punched Card Synthesis of Sequential Switching Systems of Multi-Position Relays, V. I. Shestakov. "Avto. i Tel." Nov. 1959. 11 pp. The paper deals with vector-algebraic synthesis of sequential switching systems of r-position relays by using special punched cards. This method of synthesis is a generalization of punched card synthesis of switching systems of 2-position relays and is available as well both for autonomous and non-autonomous relay systems. (U.S.S.R.)

Pneumatic Switching Circuits, T. K. Berends and A. A. Tal. "Avto. i Tel." Nov. 1959. 13 pp. Pneumatic units used in designing pneumatic switching circuits are described. There are shown means of realizing elementary logic functions and one-pulse delay with the pneumatic devices. It is shown also that using means of the pneumatic automation one can design any finite automation. (U.S.S.R.)

On the Optimum Design of Magnetic Drum Store, D. Dutta Majumdar. "J. ITE." September 1959. 12 pp. An exhaustive review on the design of magnetic drum store has been made in the light of the investigation carried out by the author on this topic. It is attempted to develop the existing ideas with respect to possibilities and limitations of magnetic drum store and on how far the design can be optimized for different types of computer. A technical discussion on the choice of coating material coating thickness, magnetic head design and areodynamic effects at high speed has been made. A very brief description of a new track switching circuit using a magnetic gating transformer, designed to operate with a high speed serial drum memory, has also been included. (India, in English.)



CONTROLS

Pontrjagin Maximum Principle in the Theory of Optimum Systems, L. I. Rozonoer. "Avto. i Tel." Nov. 1959. 18 pp. Most important problems of automatic control are expounded which are connected with proofing and using "Pontrjagin maximum principle in the theory of optimum systems. The paper yields some new results. The problem of optimalizing in the case of free right branch of the trajectory is considered in the first part of the paper. In the second part the maximum principle is formulated for the boundary conditions of more general type. In the third part there is ascertained connection of the dynamic programming method with the maximum principle, proposed the way of solving optimalizing problems in discrete linear systems and some ideas are described about using the maximum principle when solving problems of a certain class which are connected with theory of dynamic accuracy of automatic control systems. (U.S.S.R.)

Approximate Determination of Self-Oscillation Parameters in Delayed Feedback Relay Systems, N. A. Korolev. "Avto. i Tel." Nov. 1959. 5 pp. An approximate method for determining self-oscillation parameters of relay systems of a certain class which is based on modification of the harmonic balance method is proposed. (U.S.S.R.)

Digital Servosystem Used to Control Reversible Rolling Mill Screw-Down, V. M. Ozernoy, G. S. Rozenberg. "Avto. i Tel." Nov. 1959. 9 pp. There is described the digital servosystem used to control the screw-down of the hot sheet reversible rolling mill. Circuits of some blocks and formulae for the main logic units are given. (U.S.S.R.)

Static Sequencing and Positional Control Systems, S. A. G. Emms, et al. "GEC J." Vol. 23, No. 6. 4 pp. As automation technique progresses there is an increasing requirement in industry for the storage, selection and implementing of operation programmes, which often include one or more positional sequences. Typical examples are machine punch and press tools, which have to perform a series of punching or bending operations upon each work piece, and reversing rolling mills, which have to effect a number of passes each requiring a re-positioning of rolls and manipulators associated with speed and direction controls of the main and auxiliary drives. (English.)

GENERAL

Some Technical Applications of Powerful Ultra Sonic, H. J. Gollmick. "El Rund." Dec. 1959. 3 pp. The present article discusses some technical applications of ultra sonic with

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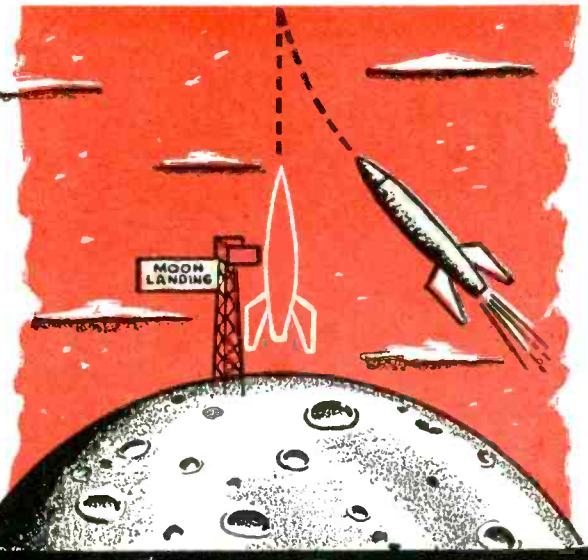

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- **INSULATION RESISTANCE AT 100°C:** For .05MFD or less, 1400 megohms minimum. Greater than .05MFD, 70 megohm-microfarads.
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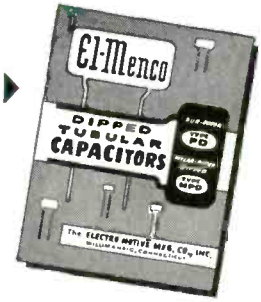

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acoustical overall performances of approximately 50 w and more, but not ultrasonic measuring methods operating with much smaller ultrasonic performances as there are nondestructive testing of materials or thickness measurement by ultra sonic. (Germany.)

The Use of Thermistors in the Ebullioscopic Determination of Molecular Weights, J. G. van Pelt. "Phil. Tech." No. 12, 1959. 5 pp. Brief description of an apparatus for the ebullioscopic determination of molecular weights, the boiling-point elevation being measured with a thermistor resistance thermometer. (Netherlands, in English.)

Vacuum in the Saclay Proton-Synchrotron, F. Prevot R. Le Quinio. "Vide." No. 82, 1959. 17 pp. The 3 GeV Proton Synchrotron built in Saclay gives an example of the application of vacuum technique to nuclear physics which it has appeared to us interesting to describe here because of its unusual characteristics. (France, in English.)

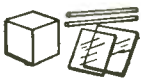
Description of a Gauge for Ultra-High Vacua and Remarks about Ultra-High Vacua Techniques for All-Metal Mountings, Dr. K. G. Muller. "Vide." No. 82, 1959. 10 pp. Almost all the measurements of vacua below 10^{-7} torr are done by means of ionization gauge. In order to avoid the disturbing effect of X-rays it is necessary to use the Bayard and Alpert gauge which is the only one suitable for ultra-high vacua. In the United States such gauges have been already in production for some time, whereas in Europe they are just being introduced. Gauges allowing industrial measurements of pressures below 10^{-7} torr exist also now in Europe; one of them will be described here. (France, in English.)

Discussing Ultrahigh Vacuum, J. Schweitzer. "Vide." No. 82, 1959. 18 pp. The need for large machines capable of running at pressures below 10^{-8} mmHg leads us to consider how complex mechanical units can be produced. A review of limiting factors shows the preponderant influence of surface phenomena. These are examined in the particular case of gas influx and evolution. (France, in English.)

Photon-Spin Pumping, Quantum. "E. & R. Eng." Nov. 1959. 4 pp. The term "optical pumping" simply means raising atoms into an excited state by exposing them to visible or near-visible, radiation. The resonance experiments of R. W. Wood and of Horton and Davies were early examples. And, of course, it happens every time an optical absorption spectrum is produced. But in the present context it means exciting them by this means so that they can emit microwave or radio-frequency radiation. (England.)

Analytical Geometry and Impedance Calculations, Computer. "E. & R. Eng." Nov. 1959. 2 pp. (England.)

Simulation of Nerve Cells by Electro-Chemical Methods, R. J. Rice. "Brit. C. & E." Dec. 1959. 3 pp. The general requirements for a model neuron for use in simulated nerve nets are stated briefly. The operation and some applications of an electro-chemical model neuron for use in cybernetic and automata models are then described. (England.)



MATERIALS

Topotactically Crystal-Oriented Ferromagnetics, F. K. Lotgering. "Phil. Tech." No. 12, 1959. 3 pp. The article describes a new method of crystal orientation in ceramic ferromagnetics. The method is based on the phenomenon that in a chemical reaction between solids the crystal orientation of the reaction product is sometimes correlataed with that of one of the initial substances. (Netherlands, in English.)

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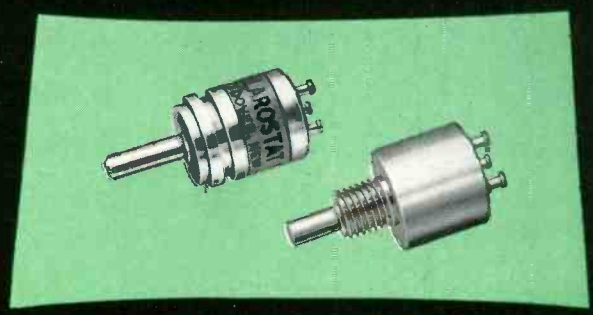

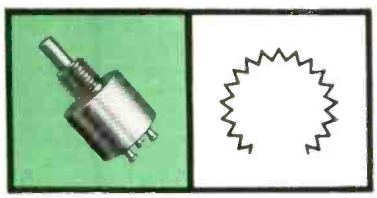

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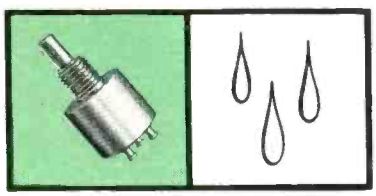

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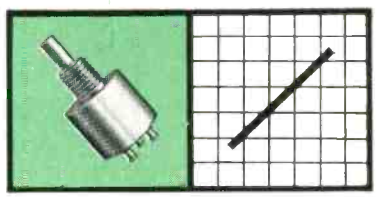

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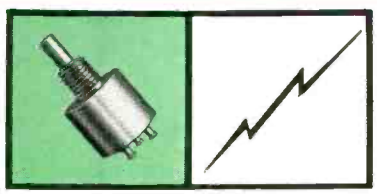

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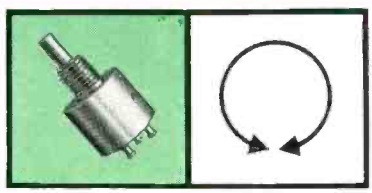

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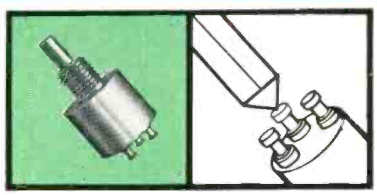

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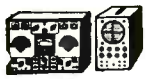


MEASURE & TESTING

Multichannel Automatic Optimizer to Solve Variational Problems, R. I. Stakhovsky. "Avto. i Tel." Nov. 1959. 13 pp. Block-diagrams and some circuits of separate blocks of a 12-channel optimizer of electronic type are described. There are given the results of the test of the optimizer as an automatic approximator of the given time-function. The search method when the system has false extremums of the ridge or saddle type is considered. (U.S.S.R.)

On Symmetric Periodic Motion of Multi-Cascade Relay Systems, I. Neimark, L. P. Shilnkov. "Avto. i Tel." Nov. 1959. 8 pp. The problem of finding and investigating the simplest symmetric motion stability of a multi-cascade relay system is solved. (U.S.S.R.)

On the Need for Revision of Noise Grades for India, B. B. Ghosh & S. N. Mitra. "J. ITE." Sept. 1959. 6 pp. Measurement of atmospheric noise in the frequency range 2.5-9.5 MC/s has been in progress at the Research Dept. of All India Radio, New Delhi, since November 1955. The measured data have been compared with the predicted ones for Delhi from C.C.I.R. Report No. 65. It is observed that the predicted values are invariably low and the difference between the two has, at times, exceeded 40 db. It is concluded that the noise grades predicted in the C.C.I.R. report do not represent condition prevailing in India and there are sufficient justifications to warrant their revision. (India, in English.)

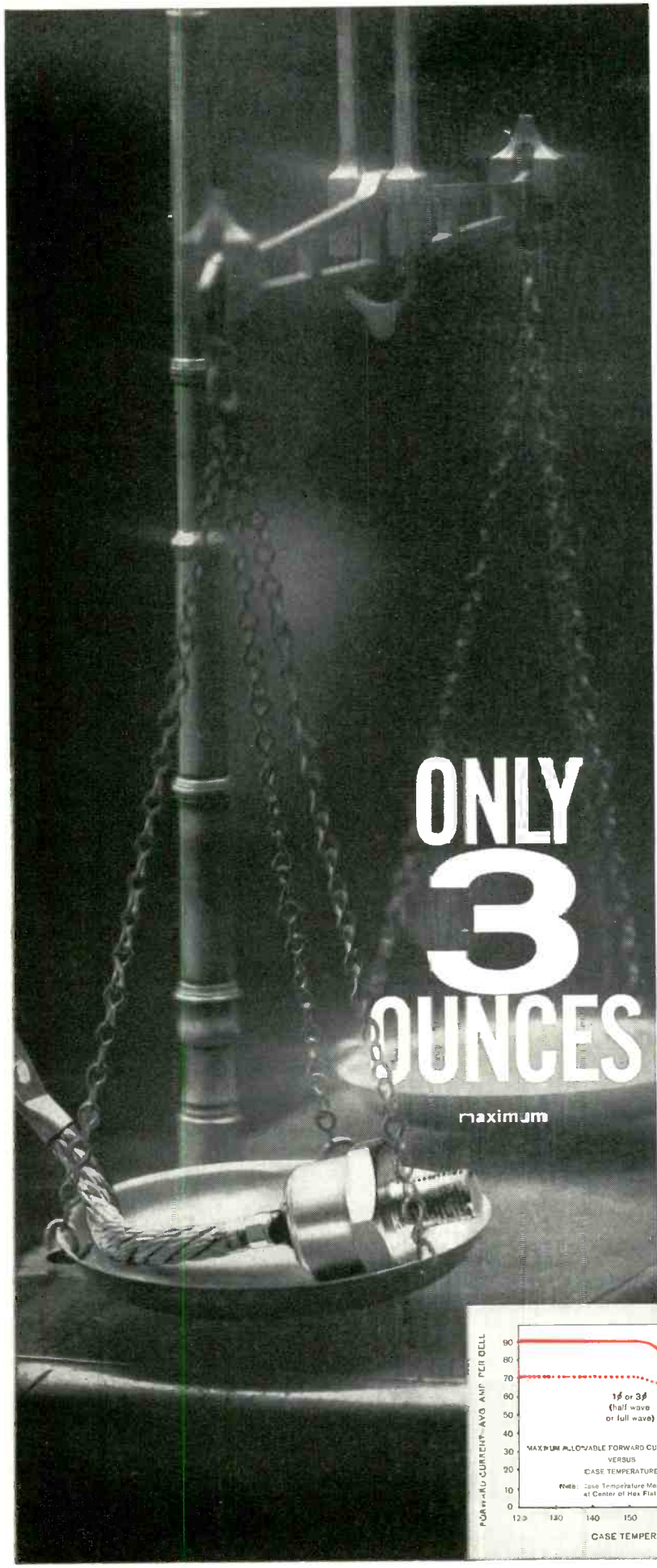
A Survey of Low-Frequency Signal Generators and Oscillators, R. Brown. "Brit. C. & E." Dec. 1959. 6 pp. (England.)

Magnetic Measurements with Bridged-T Network, J. K. Choudhury, et al. "E. & R. Eng." Nov. 1959. 4 pp. The bridged-T network has been hitherto mainly used as a frequency-selective network. Its applications in harmonic analizers, frequency selective amplifiers and as a circuit for use in the measurement of high resistance at radio frequencies are well known. In a recent article the authors have described how the bridged-T network can be very usefully employed for the measurement of magnetic loss and ac permeability under different conditions of excitations in the core. (England.)

RADAR, NAVIGATION

The Port of Rotterdam Radar System, B. H. G. Prins and J. M. G. Seppen. "Phil. Tech." No. 12, 1959. 5 pp. Shipping on the Nieuwe Waterweg, which connects the Hook of Holland and the port of Rotterdam, is assisted in conditions of bad visibility by a chain of 7 radar stations working on wavelengths in the 3 cm band. Ships proceeding along the Waterweg or inside the harbor area can be supplied with accurate information about their positions in a matter of seconds. (Netherlands, in English.)

Radio Astronomy and the Development of Receivers with Greatly Increased Sensitivity, J. L. Pawsley and F. F. Gardner. "Proc. AIRE." Sept. 1959. 7 pp. The "signals" from the Sun, Milky Way, and other bodies in the heavens which radio astronomers observe are usually exceedingly weak. The current development of radio astronomy has only been possible because means have been found, using tedious averaging procedures, which permit the measurement of "signals" down to 1/1000 of the accompanying "noise." Exciting new inventions, masers and parametric



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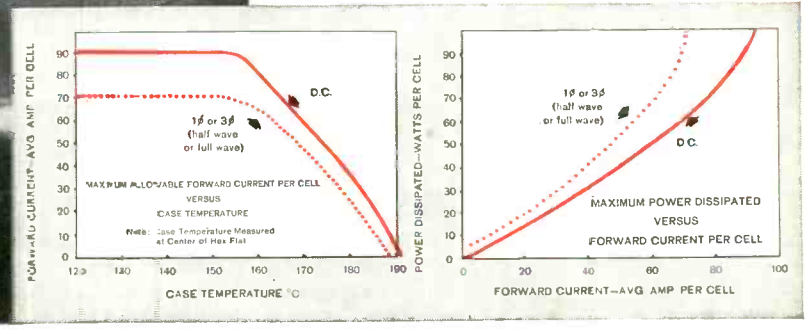

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amplifiers, now promise a hundred-fold increase in sensitivity applicable equally to scientific and engineering purposes. The physical principles involved are outlined and the prospects for practical realization discussed. (Australia.)

SEMICONDUCTORS

Application of Transistors in Radio Link Equipments, C. Tamburello. "Alta Freq." Aug. 1959. 29 pp. The rapid progress in the field of the semiconductors has opened wide possibilities of applications of transistors in electronics. At the present stage of the development there are still two main limiting factors to its application: the upper limit of the operating frequency, which in the most recent types attains 100 MHz and the upper limit of the output power, which for the high frequency types is of the order of one miliwatt. (Italy.)

TELEVISION

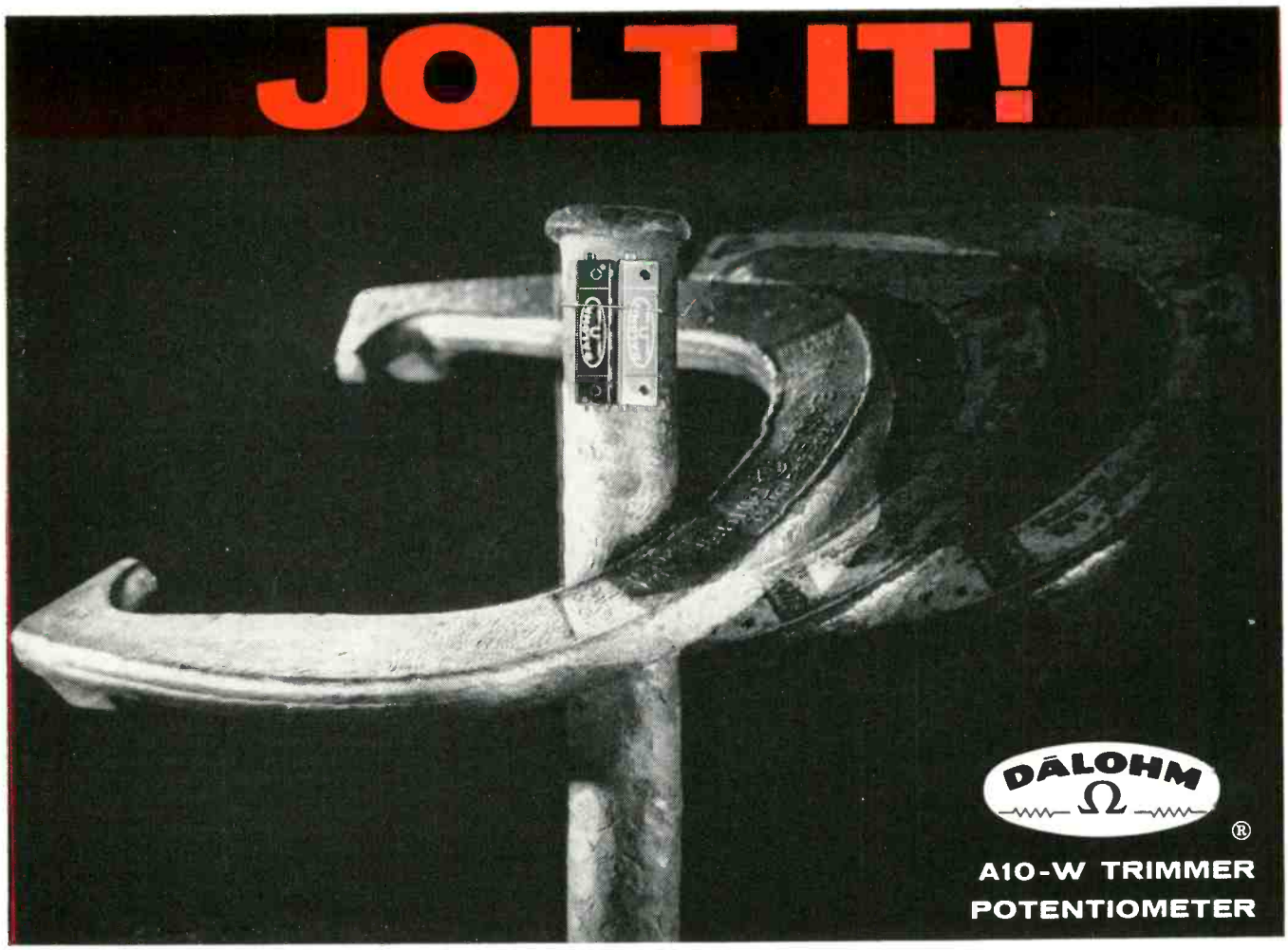
Does Dr. Edwin H. Land's Theory of Color Vision Form the Basis for a New Color TV System?, P. Neidhardt. "El. Rund." Dec. 1959. 7 pp. The developmental basis of color television is the additive mixture of three primary impulses, red, green, and blue. Dr. H. Land's invention has made itself known insofar as the wave lengths of the luminosity beams do not play the decisive part for color vision which according to Land derives from the combination of shorter and longer waves noticed simultaneously by the human eye. (Germany.)

Automatic Room Light Matching of Contrast and Brightness in TV Sets, R. Suhrmann. "El. Rund." Dec. 1959. 4 pp. With the aim at simplifying the handling of a TV set for the viewer, various automatic adjustments of TV receivers have been in use for some time. The automatic matching of the contrast and the brightness of the screen with the illumination increase of the surrounding area are important contributions to the realization of this aim. Circuits are described which perform the necessary controls in the desired manner, whereby the contrast is increased proportionally to room light intensity. The brightness increases either proportionally to the room lighting or it is raised only above a certain threshold value. (Germany.)

Planing Principles for TV Networks in the Broadcasting Bands IV/V. "Nach. Z." Nov. 1959. 7 pp. Modern knowledge and recent investigations have resulted in new aspects in planing work for the bands IV/V and these are compared with known principles for the bands I and III. The question of height-gain characteristics, the radiation power required at transmitters and frequency converters as well as the transmitter spacing for the bands IV/V are discussed in details. (Germany.)

N.T.S.C. Colour-Television Signals, Evaluation of Measurements, J. Davidse. "E. & R. Eng." Nov. 1959. 4 pp. (England.)

A Precision Colour Television Signal Source for Research Purposes, J. E. Benson, "Proc. AIRE." Aug. 1959. 15 pp. After an introductory statement on the present status of color television in America and England, some of the problems of producing a precise color television signal for research purposes are discussed in relation to a new color slide scanner and monitor, manufactured by Rank Cintel. This equipment, which is capable of producing color video signals with sufficient precision and stability to serve as a reference



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standard for research and test purposes, is described in tbe concluding section. (Australia.)

TRANSMISSION

Long Distance Transmission in the Frequency Range 40-52 Mc/s by Means of the F_2-layer, H. Wisbar. "Nach. Z." Nov. 1959. 7 pp. The propagation characteristics reported in the previous year in connection with the radio path USA-Europe has been investigated for suitability. A radio-weather forecast for a maximum of 5 hrs. is a possibility. The application of this characteristic also permits the drawing of conclusions with respect to the statistical distribution of field-strength values which can be expected and facilitates the location of exceptional interferences on the transmission path. (Germany.)

Directional Couplers on Coaxial Line, I. Bucci. "Alta Freq." Aug. 1959. 17 pp. After explaining the theories of directional couplers and determining some parameters an elementary theory is given, in a general sense, considering a directional coupler as an octopole coupling two radio frequency lines. It is shown that a certain internal structure of the octopole may give a directive coupling for a certain nature and dimensions of the impedances realizing the octopole: directivity conditions and formulas for the coupling and input impedance are given. Results in accordance with the elementary theory are then found by direct analysis of the coaxial line directional coupler. In this particular case some particular considerations are made concerning the coupling. From what exposed above, criteria can be obtained for the design of the coaxial line directional coupler. (Italy.)

TUBES

The Drive Range of Grid Controlled Valves, R. Wolfram. "Nach. Z." Nov. 1959. 6 pp. The ac drive range of triodes and multi-grid valves should not be considered to be equal to the bias voltage difference between the operating point and the point where grid current starts. The complicated relationship between these quantities, which also complicated relationship between these quantities, which also includes the impedances of the layer and intermediate layer on the cathode, can approximately be illustrated in a lucid form. (Germany.)

Pumping of Electron Tubes with the Titanium Pump, H. Huber, et al. "Vide." No. 82, 1959. 12 pp. One year ago, at the International Congress on Vacuum Technology at Namur, three models of a getter-ion pump were presented (laboratory models 2006, 2003 and 401), with pumping speeds between 2 and 12 L/s. Their purpose was the maintenance of vacuum in high power microwave tubes. It will be noted that the choice of the pumping speed was directed by the available values of the conductance in these tubes. (France, in English.)

Life of Electronic Tubes and Service Reliahility, A. Ingignoli, et al. "Alta Freq." Aug. 1959. 16 pp. The life of electronic tubes is characterized by some probabilistic functions, that are the result of experimental determinations and are successively elaborated. It is possible to express these functions by means of mathematical expressions and consequently it is possible to make some type of abridged life tests. At last for a system, in which the electron tubes are being substituted just as they are inefficient it is necessary to establish the modalities and the periodicity of the tests on the tubes. (Italy.)

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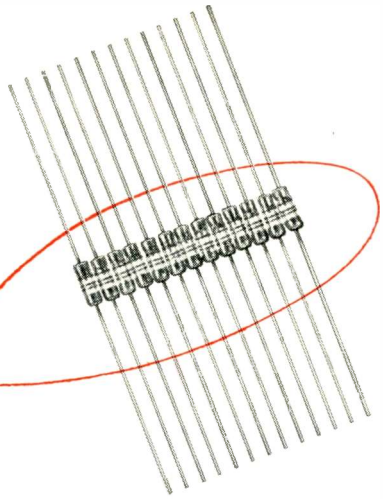

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Absolute Maximum Ratings*		Typical Operating Conditions*	
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Fwd. Curr.	50 mA	Fwd. Curr.	2.0 μA
Back Volt	20 V	Rev. Recovery	2.5 mμs
Pwr. Diss.	80 mW		

†at 10 mA *at 20° C.

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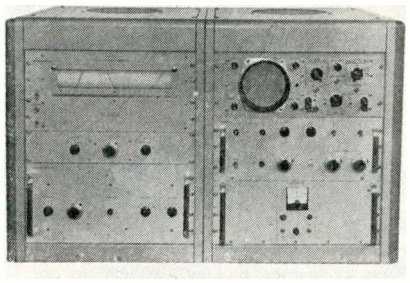

aperture, the far fields of arrays from the magnitude and phase of the currents in the elements, the frequency spectra of voltage pulses, and other physical problems. Integration can be observed on a dc oscilloscope for interpretation or visual readout. Scientific-Atlanta, Inc., 2162 Piedmont Road, N. E., Atlanta 9, Georgia.

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DIGITAL VOLTMETER

Digital voltmeter with full 4-digit resolution, the V64, is designed for a wide range of dc measuring and with accessories, ac and low-level dc measurements. It features full 4-digit

(0.01%) resolution, high input impedance and an average measuring time of 0.75 sec. per reading. It is 5¼ in. high by 15¼ in. deep for mounting in a standard 19-in. rack. Its range without accessories is 500 vdc in steps of ±9.999/99.99/500. Non-Linear Systems, Inc., Del Mar, Calif.

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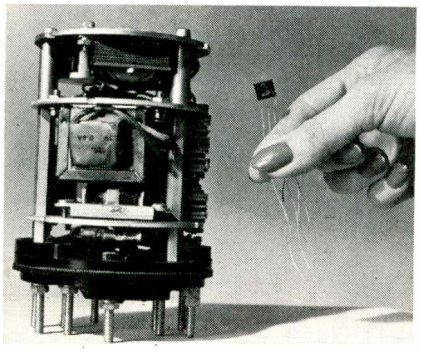
TRANSDUCERS

The Hall multiplier, a watt-measuring device, serves as a watt transducer, where it converts ac to dc mv signal. Watt transducers supply a signal, proportional to measured watts, for application to a control device, or to a telemetering transmitter. It has a speed of response in μsec. as compared to a time constant of about 1 sec. for a thermal converter. Two



versions have been designed: one produces an unfiltered dc current output in the ma range; the other a filtered dc mv output. Westinghouse Electric Corp., Box 2278, Pittsburgh 30, Pa.

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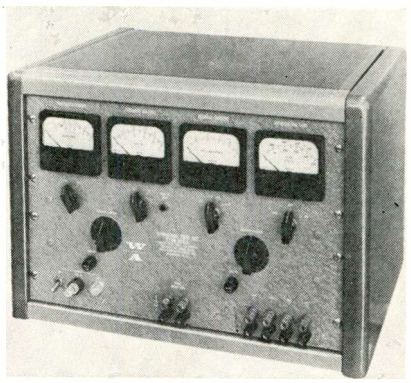
! MORE !

The New Products mentioned here have been selected for contribution to or advancement of the electronic industries. These items are combed from several hundred new product releases received during the past month by ELECTRONIC INDUSTRIES. To keep interested readers informed of all new developments, a summary record is kept of ALL new products received. For a copy of this month's list, please send your request on company letterhead to Readers' Service Dept., Electronic Industries, 56th & Chestnut Sts., Phila., Penna. or Circle No. 161 on Inquiry Card.

RECTIFIER ANALYZER

Dynamic rectifier test set, Model 138A, is for incoming inspection, on-line testing and laboratory use. Forward current and reverse voltage controls are independently adjustable. Forward current range is 0-1 and 0-5 adc average, reverse voltage peak is 0-1000. It measures a forward drop range of 0-1/5 v. and a reverse current range of 0, 0.05, 0.5, 5, 50 ma



average. Specs include: power input, 120 v., 60 CPS, 250 w; size, 21¼ x 16 x 16 in.; weight, 60 lbs. Wallson Associates, Inc., 912-914 Westfield Ave., Elizabeth, N. J.

Circle 166 on Inquiry Card

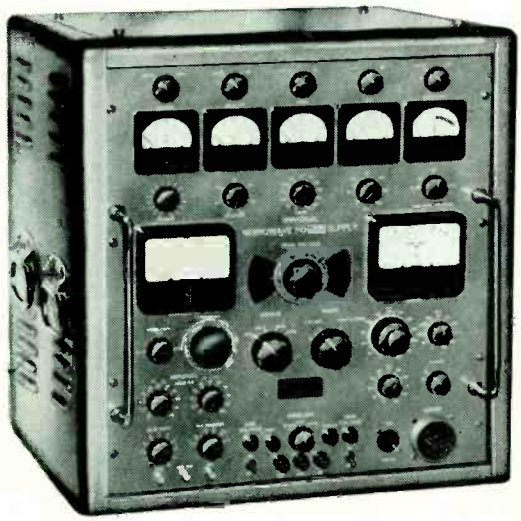
it has everything...

VERSATILITY

RELIABILITY

STABILITY

BACKWARD WAVE OSCILLATOR • KLYSTRONS • TRAVELING WAVE TUBES • MAGNETRONS • VOLTAGE-TUNABLE



FXR'S Model Z817A, UNIVERSAL MICROWAVE POWER SUPPLY

is a **single** *power source for microwave tubes.*

- Six individual floating power supplies can be interconnected in many combinations.
- Regulation is outstanding.
- Ripple is negligible.
- Voltages and frequencies can be preset with extreme accuracy.

WOULD YOU LIKE THE DETAILS?

FXR, Inc.

Design · Development · Manufacture

26-12 Borough Place
Woodside 77, N. Y.

Precision Microwave Equipment · High-Power Pulse Modulators · High-Voltage Power Supplies · Electronic Test Equipment

product of the pioneer

DU MONT

425

the most significant advancement in the state-of-the-art since DU MONT introduced the first commercial oscilloscope

the new DU MONT 425

Only the very latest concepts known in the art of cathode-ray oscillography have been incorporated in the Du Mont 425 High-Frequency Oscilloscope. This new scope will outperform any commercial oscilloscope in its class—now, yet its entire design concept is based on the future—the 425 will always be a modern scope.

By ease of operation, and elimination of chances of human error in making measurements, the 425 becomes simplified enough for a non-technical person to use. At the same time, with the extreme versatility provided by a series of plug-ins, and replaceable module construction, the 425 will satisfy every laboratory or scientific need within its range.

Such features as: simultaneous use of two plug-ins; digital ReadOut of measurement parameters; joystick control of traces; a unique, highly-accurate "two-dot" measurement system; replaceable, modular construction; a new "tailored" cathode-ray tube; output facilities to feed information to external recorders or systems—all of these features and more help establish the fact that the 425 will always be the most advanced, versatile oscilloscope commercially available.

Write for technical details

the result of 44,000 engineering hours!

a DC to 35 mc oscilloscope with digital and printed ReadOut— versatility exceeding all other scopes.

DU MONT 425

Within its range, every job requiring an oscilloscope can be accomplished with the 425. Each electronic circuit and mechanical facet has been designed for versatility—for present and future needs. From production line go-no-go gauging and external statistical recording of production records, to the most complicated laboratory or hospital investigation—the 425 Oscilloscope is the answer—for today and tomorrow.

- Digital ReadOut on two axes
- Simultaneous use of two of a selection of plug-ins
- Electronic switches on X, Y, and Z axes
- Accurately repeatable two-dot measurement system
- No selected tubes
- Joystick control of traces

SPECIFICATIONS

Rise Time—10 millimicroseconds

High Resolution Vertical Scan—5 cm

Main Time Base—
Max Sweep rate—10 millimicrosecond/cm
Max Sweep time—1 minute full scan

Delaying Sweep—
Min delay—0.5 μsec
Max delay—10 sec.

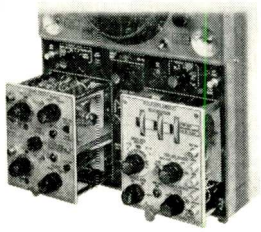
Digital Readout Repeatability—0.5%

Accelerating Voltage—12 KV

24 Calibrated Sweep Speeds

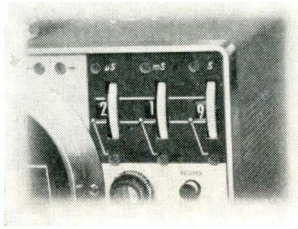
Digital Contact Closure Output and 100 mv

Analog ReadOut Output

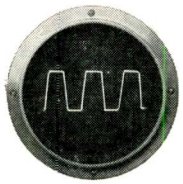


A selection of plug-in circuits now—new ones coming.

Joystick manipulations of waveforms—establishing freedom for many other physical operations.



Direct, digital ReadOut of measurement parameters — reducing errors due to interpolations.

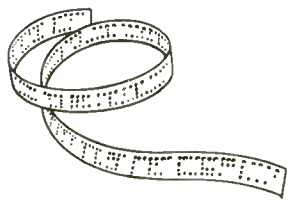


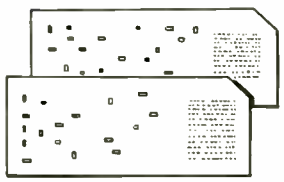
Unique, two-dot system of establishing waveform parameters to be measured — makes possible accurately repeatable readings.

Plug-in modular construction — mechanically arranged for easy access or replacement.

Entirely new cathode-ray tube—"tailor-made" to the requirements of the 425.

FOR STATISTICAL RECORDINGS





Output facilities on the 425 establish it as an analog to digital converter, or as a source of parameters for statistical recording of measurements on many types of external recording devices and systems.

DU MONT®

WRITE for complete details

precision electronics is our business

ELECTRONIC TUBES/INDUSTRIAL TV/MILITARY ELECTRONICS/MOBILE COMMUNICATIONS/SCIENTIFIC INSTRUMENTS/AUTOMOTIVE TEST EQUIPMENT

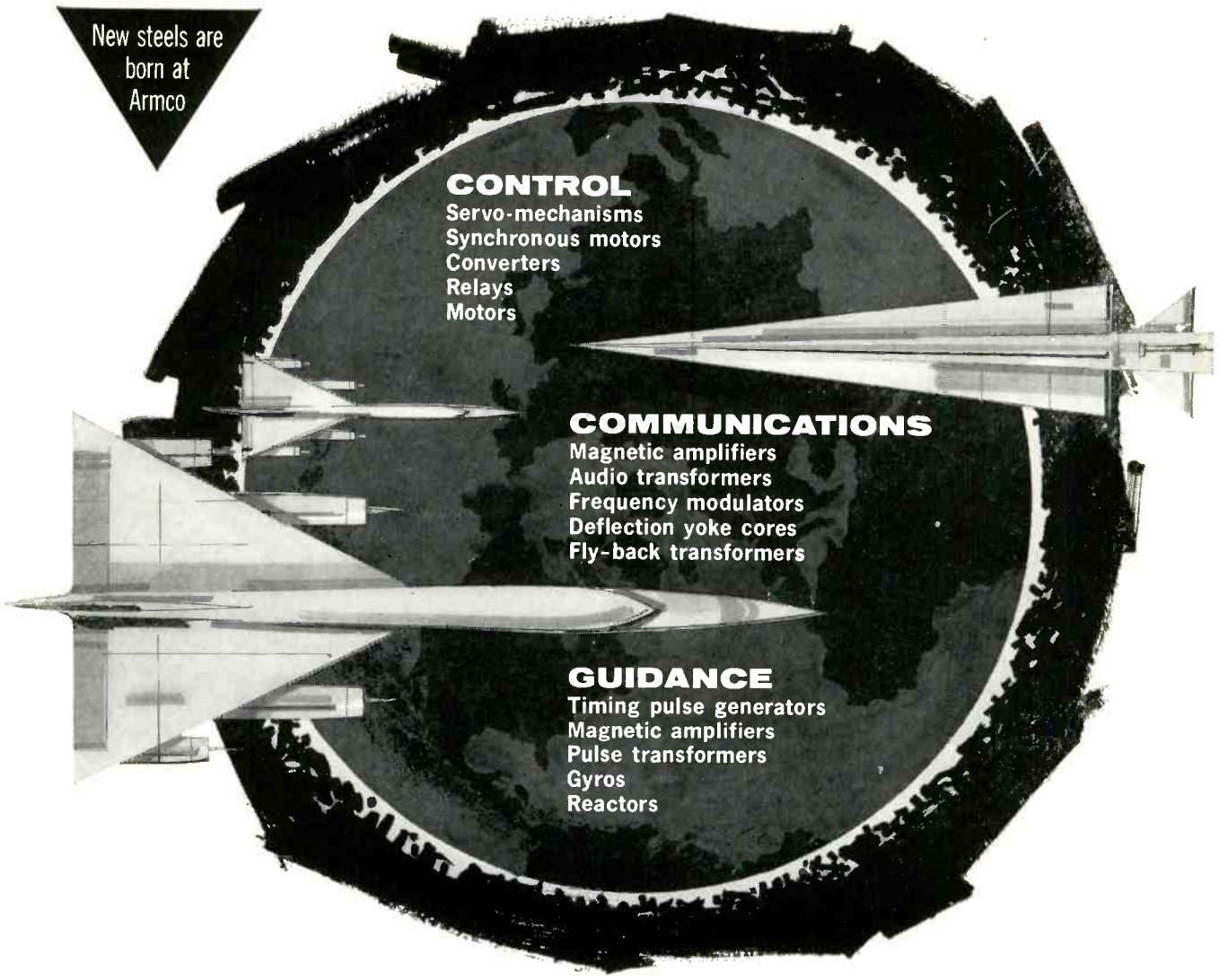
Engineers interested in employment opportunities at Du Mont, contact the Industrial Relations Department.

Allen B. Du Mont

ALLEN B. DU MONT LABORATORIES, INC., CLIFTON, N. J., U. S. A.

INTERNATIONAL DIVISION • 515 MADISON AVENUE, NEW YORK 22, N. Y. • CABLES: ALBEEDU, NEW YORK

Circle 79 on Inquiry Card



HOW TO IMPROVE EFFICIENCY, CUT COST OF AIRBORNE MOTORS, CONVERTERS AND TRANSFORMERS

Armco Thin Electrical Steels and Nickel-Iron Magnetic Alloys provide properties that facilitate design of light-weight, high quality, reliable components for control, communications and guidance units.

Armco Thin Electrical Steels—Three different grades—Armco TRAN COR® T, Oriented T, and Oriented TS—in thicknesses from 1 to 7 mils have exceptionally high permeability and low hysteresis loss. Advantageous for 400-cycle and higher equipment such as servo-mechanisms, specialty transformers, motors and magnetic amplifiers.

Armco Nickel-Iron Magnetic Alloys—Armco 48 Ni combines very high permeability at low to moderate inductions with extremely low coercive force and hysteresis loss. It is produced in 2 to 14-mil strip specially processed for laminations or wound cores.

Armco 48 ORTHONIK® offers the advantages of a rectangular hysteresis loop combined with very low coercive force. A highly oriented material, produced in thicknesses from ¼ to 6 mils, 48 ORTHONIK has proved highly useful for components of computer and control circuits.

Applications for these special Armco magnetic alloys include magnetic amplifiers, reactors, bi-stable elements, audio and pulse transformers, gyro and synchronous motors and other specialty, high quality devices.

Give the airborne electronic or electrical equipment *you* make the advantages obtained with Armco's Thin Electrical Steels and Nickel-Iron Magnetic Alloys. Write us for complete information and design data. Armco Steel Corporation, 3379 Curtis Street, Middletown, Ohio.

ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation

Circle 80 on Inquiry Card

Circle 81 on Inquiry Card →

Electron Tube News ...from SYLVANIA

Sylvania introduces new tube outline!

9-T9

straight-sided bantam envelope with 9-pin miniature pin circle

Sylvania continues to advance the development of new concepts in electronic tubes. 9-T9 is another example! The new "outline" lifts restrictions imposed upon engineers who design equipment to be produced by printed circuit techniques. Now it becomes possible to employ tube assemblies capable of high plate dissipation in printed circuit boards. This can be done with conventional 9-pin sockets widely used in printed circuits. The 9-T9 concept of tube design offers unusual promises of compactness.

9-T9 increases volumetric efficiency of the chassis by eliminating the relatively large octal base of the T9 outline.

9-T9 enables the use of large tube-assemblies in those stages where higher power-dissipation capabilities of the tube are a design necessity to include reliability.

9-T9 maintains compactness of the equipment formerly afforded by tubes fitted with T6-½ header.

NEW SYLVANIA TUBE-TYPES IN 9-T9 DESIGNS!

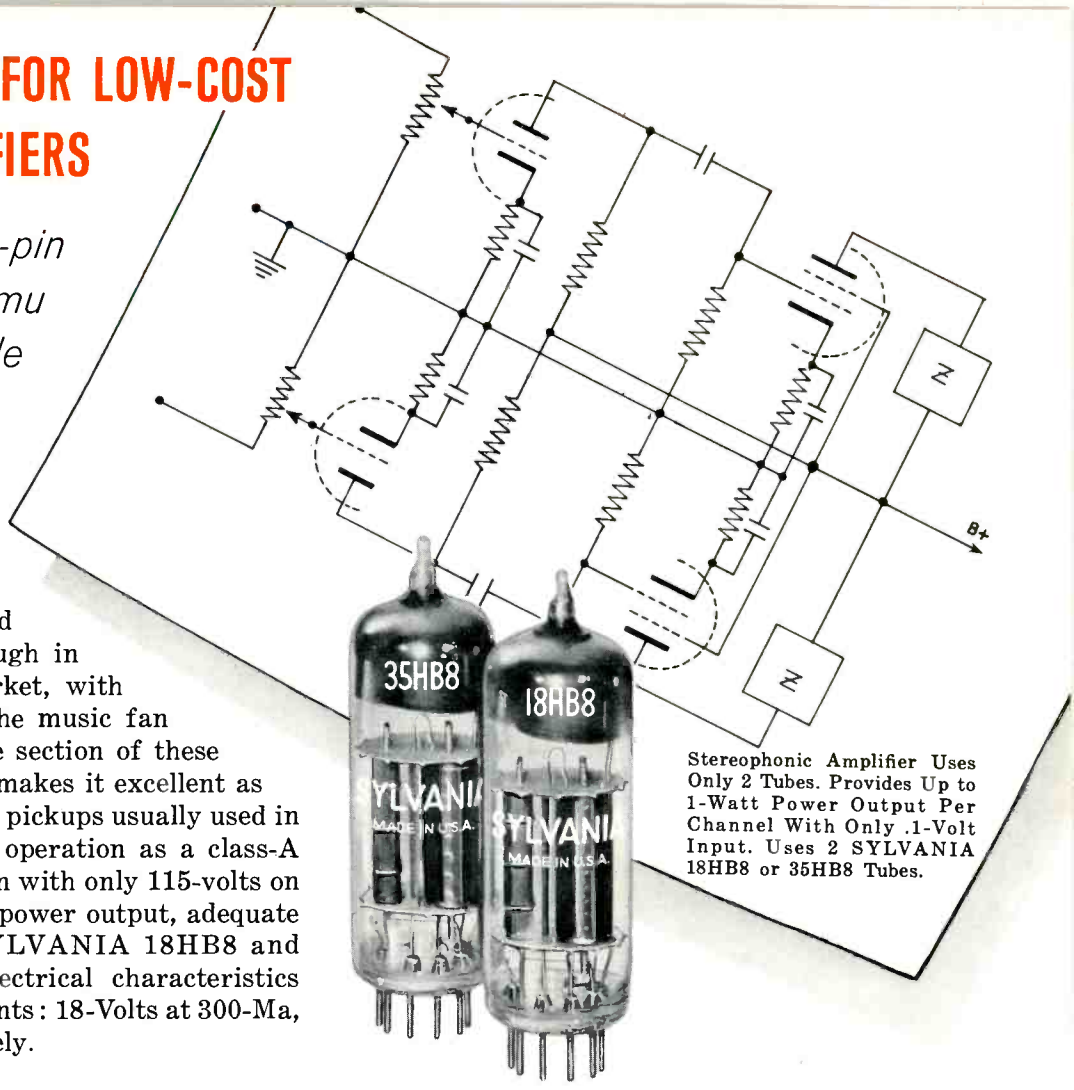
6EW7... double-triode... triode #1 will be intended for service as a vertical deflection oscillator, triode #2 as a vertical deflection amplifier in TV receivers. Note especially the high plate-power dissipation capabilities of triode #2 in this new tube-type as compared to a conventional 9-pin miniature tube. 10EW7 ... identical to 6EW7 in electrical characteristics except for heater power requirements.

New 9-T9 SYLVANIA designs include a beam-power pentode with approximately 5-watts power output in audio amplifier service; a medium-mu triode, beam-power pentode for audio amplifier service in low-cost equipment where power outputs of 1 to 2 watts are required; a medium-mu triode, high perveance beam-power pentode for vertical deflection circuits in TV equipment.

NEW SYLVANIA TUBES FOR LOW-COST STEREOPHONIC AMPLIFIERS

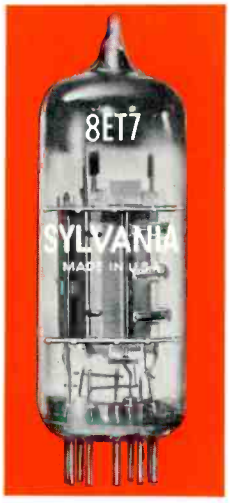
18HB8 and 35HB8 . . . 9-pin miniatures feature high-mu triode and power-pentode in one envelope!

Looking for sales-building record players you can quantity-produce and market? Here are 2 new tube-types that will help you design stereophonic and monophonic amplifiers small enough in cost to reach the "popular" market, with enough power output to please the music fan with a "tight" budget. The triode section of these new tubes has a mu of 100. That makes it excellent as a voltage amplifier for the types of pickups usually used in low-cost phonographs. In typical operation as a class-A audio amplifier, the pentode section with only 115-volts on the plate can deliver up to 1-watt power output, adequate for a small-speaker system. SYLVANIA 18HB8 and 35HB8 are identical in their electrical characteristics except for heater power requirements: 18-Volts at 300-Ma, and 35-Volts at 150-Ma, respectively.

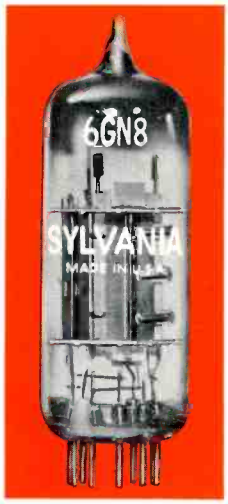


Stereophonic Amplifier Uses Only 2 Tubes. Provides Up to 1-Watt Power Output Per Channel With Only .1-Volt Input. Uses 2 SYLVANIA 18HB8 or 35HB8 Tubes.

NEW SYLVANIA TUBES ANNOUNCED FOR IMPROVED TV-RECEIVER DESIGNS



8ET7 . . . this 9-pin miniature features *duo-diodes* for discriminator or video-detector service and a *pentode section* for video-output service.



6GN8 . . . a 9-pin miniature with a *triode section* for general-purpose use as a voltage amplifier or for service as a sync-separator, and a pentode section for video-output service. The *pentode* section is equipped with a cathode especially designed to provide "cool" operation with resultant extended life and reliability.

8GN8 . . . 9-pin miniature with electrical characteristics identical to SYLVANIA 6GN8 except for heater power requirements.

For further information, contact the Sylvania Field Office nearest you. Sylvania Electronic Tubes, a division of Sylvania Electric Products Inc., 1740 Broadway, New York 19, New York.

SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

BENDIX SR RACK AND PANEL CONNECTOR

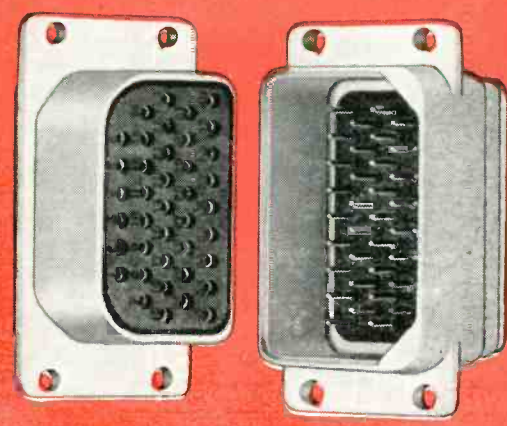
with outstanding resistance to vibration

The Bendix type SR rack and panel electrical connector provides exceptional resistance to vibration. The low engagement force gives it a decided advantage over existing connectors of this type.

Adding to the efficiency of this rack and panel connector is the performance-proven Bendix "clip-type" closed entry socket. Insert patterns are available to mate with existing equipment in the field.

Available in general duty, pressurized or potted types, each with temperature range of −67°F to +257°F.

Here, indeed, is another outstanding Bendix product that should be your first choice in rack and panel connectors.



FEATURES:

Resilient Insert • Solid Shell Construction • Low Engagement Forces • Closed Entry Sockets • Positive Contact Alignment Contacts—heavily gold plated Cadmium Plate—clear irridite finish • Easily Pressurized to latest MIL Specifications.

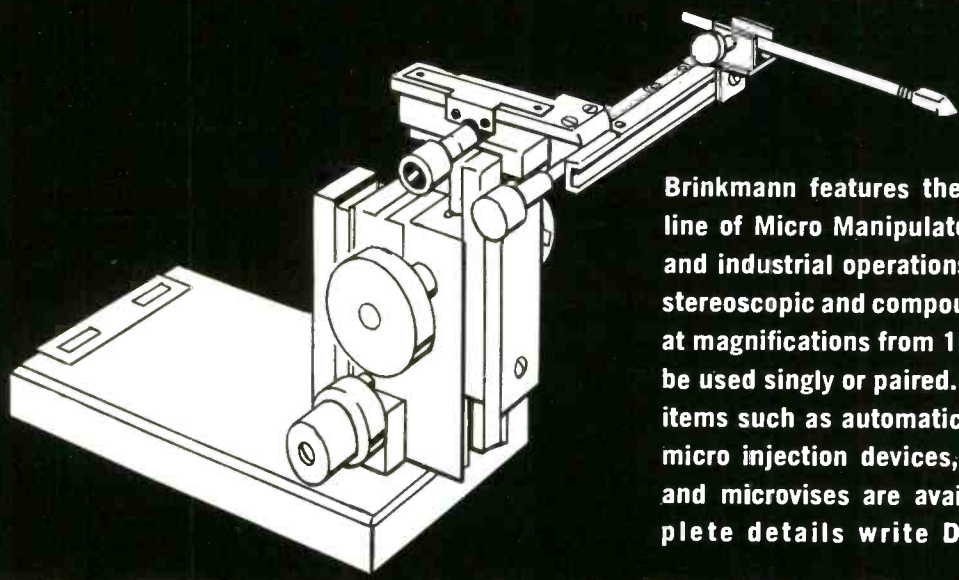
SCINTILLA DIVISION
SIDNEY, NEW YORK

Bendix AVIATION CORPORATION

Export Sales and Service: Bendix International Div., 205 E. 42nd St., New York 17, N. Y.
Canadian Affiliates: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec.
Factory Branch Offices: Burbank, Calif.; Orlando, Florida; Chicago, Illinois; Teaneck, New Jersey; Dallas, Texas; Seattle, Washington; Washington, D. C.

Circle 83 on Inquiry Card

MICRO MANIPULATORS



Brinkmann features the most complete line of Micro Manipulators for scientific and industrial operations. Available with stereoscopic and compound microscopes at magnifications from 10 to 1000 x. Can be used singly or paired. Many accessory items such as automatic pipette pullers, micro injection devices, pipette holders and microvises are available. For complete details write Department M.

BRINKMANN

INSTRUMENTS INC., 115 CUTTER MILL ROAD, GREAT NECK, NEW YORK

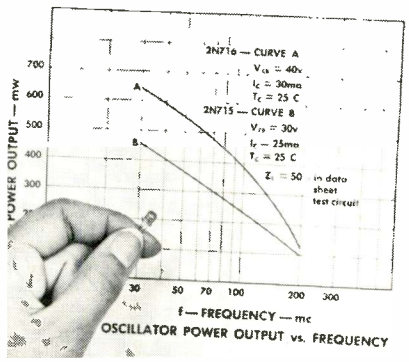
← Circle 82 on Inquiry Card

Circle 84 on Inquiry Card

New Products

MESA TRANSISTORS

Two new silicon mesa transistors feature high power with high frequency. The 2N715 and 2N716 have a min. power output of 50 mw at 70 MC. They will deliver approx. 50 mw at 200 MC. Both are packaged in the subminiature JEDEC-outline TO-18 case. Guaranteed beta spread is 10 to 50 and collector reverse voltage is 50 and 70 v. Collector reverse

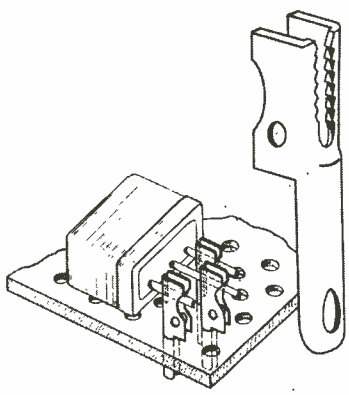


current at 25°C is 0.5 μa max. and 50 μa max. at 150°C. Temperature limits are at −65°C and 175°C. Texas Instruments Incorporated, P.O. Box 312, Dallas, Tex.

Circle 203 on Inquiry Card

TERMINAL

Small push-in terminal, T28, for 1/16 in. round holes has serrations in the main slot which grip small component leads. Ideal for experimental breadboarding, it is also suited for printed circuits. It holds firmly when pushed in by hand and need not be



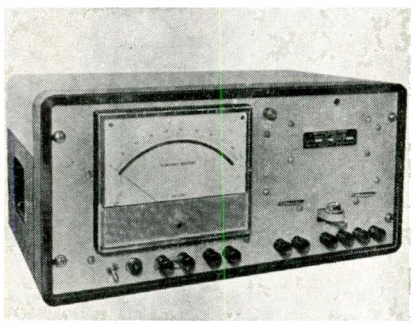
staked. Six leads may be connected in the 3 possible directions. It is built of heat treated beryllium copper with a fused tin finish. Vector Electronic Co., 1100 Flower St., Glendale, Calif.

Circle 204 on Inquiry Card

New Products

WATTMETER

Wattmeter, Model 1483, for accurate measurements and resolution to 0.01% of rated input. Output is low impedance dc. True temp. compensation is effected by making the air gap increase with increasing

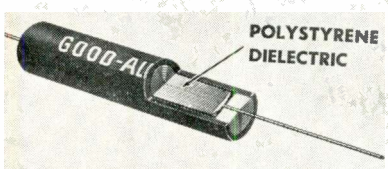


temp. to compensate for decreased current in the moving coil. Coils can be overloaded 400% without degrading accuracy due to heating effects. Ranges are 250/500/1000 w. Input (current) is 5 a nor. and 10 a max.; (potential) 50/100/200 v. nor. and 75/150/300 v. max., and outputs of 1 ma in a max. output burden of 5000 ohms (5 v). Frequencies are 40 to 1000 CPS. Daystrom-Weston Sales Div., Daystrom, Inc., 614 Frelinghuysen Ave., Newark 12, N. J.

Circle 205 on Inquiry Card

CAPACITORS

Type 820-UB polystyrene dielectric, capacitors have low capacitance change with temp. — with a T. C. of less than 125 ppm per °C. The case is a specially cured phenolic molding with endfill of moisture tight epoxy compound. Capacitors are for use in



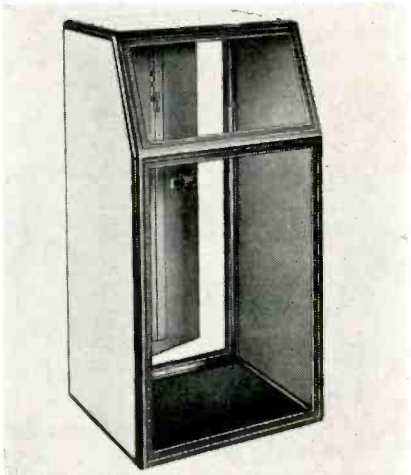
computer and timing circuits, electronic organs, and precision test equipment. Available from 0.001 to 0.68 mfds. and in 100, 200, 400 and 600 v. Good-All Electric Mfg. Co., Ogallala, Nebraska.

Circle 206 on Inquiry Card

New Products

CONSOLE

Inclined Panel Console's structural members are aluminum extrusions, joints are ball cornered aluminum castings while sides, top and bottom are ⅛ in. aluminum alloy. Inclined

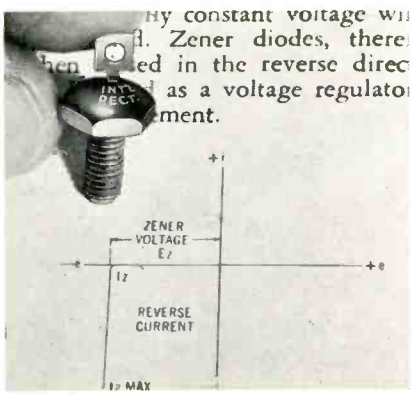


panel is set at 22½° angle for comfortable viewing. Top, front and panel are drilled and tapped to accept standard rack panels. Reinforced rear door will support heavy components. It is available in 4 sizes. Bud Radio, Inc., 2118 East 55th Street, Cleveland 3, Ohio.

Circle 207 on Inquiry Card

ZENER DIODES

10-w rated "Tri-Sealed" silicon zener diodes feature a three-layer seal providing high resistance to temperature extremes, humidity and shock, while assuring low diode cost. Designed for commercial equipment applications, these diodes demonstrate low zener impedance values and sharp

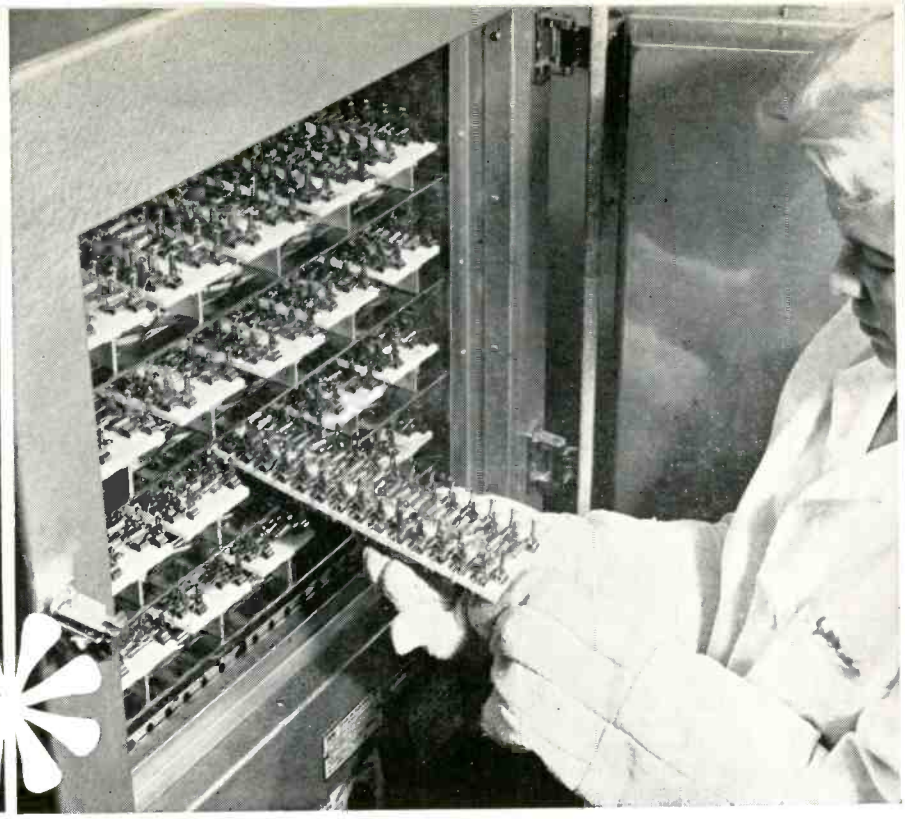


zener "knees." All series are available in standard RETMA 10% voltage steps from 5.6 to 27 volts. International Rectifier Corp., 1521 E. Grand Avenue, El Segundo, Calif.

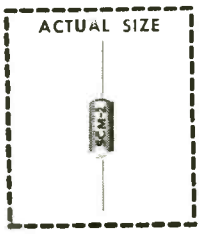
Circle 208 on Inquiry Card

tan-TI-*cap* †

CAPACITOR STABILITY ASSURED BY 250-HOUR PERFORMANCE LOAD TEST



...expanded TI line of type SCM solid tantalum capacitors meets MIL specs

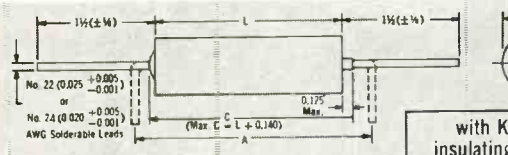


Another assurance to you of Texas Instruments capacitor reliability — 250-hour performance load test on a sample basis of *all* lots of the Type SCM series.

Your margin of design safety is greater with *tan*-TI-*cap* capacitors. Type SCM capacitors are *100% tested* for capacity, dc leakage and dissipation factor, and are aged under load at elevated temperature. SCM units in all 203 standard ratings (6 - 35 volts, 1 - 330 μfd.) meet and exceed the electrical and mechanical requirements of MIL-C-55057 (Sig. C) and/or MIL-C-21720A (NAVY) specifications for solid tantalum capacitors.

Contact your nearest authorized TI distributor or TI sales office today for your immediate and future delivery requirements.

† trademark of Texas Instruments Incorporated



						with KEL-F insulating sleeve			with Mylar insulating sleeve**		
case size	D +0.010 −0.005	L ±0.031	*A ±0.031	wire size AWG	avg. wt. gms.	D +0.020 −0.010	L ±0.062	avg. wt. gms.	D ±0.010	L ±0.031	avg. wt. gms.
F	0.125	0.250	0.482	24	0.4	0.162	0.337	0.5	0.135	0.322	0.4
B	0.175	0.438	0.688	24	1.1	0.210	0.525	1.3	0.185	0.510	1.2
G	0.279	0.650	0.888	22	2.7	0.315	0.735	3.1	0.289	0.722	2.8
H	0.341	0.750	0.988	22	3.3	0.377	0.835	3.9	0.351	0.822	3.4

* Dimension "A" determined by suspending a one-pound weight from one lead and rotating the case from the vertical position to the horizontal position, and then repeating the procedure for the other lead.

** Meets all requirements of MIL-C-55057 and MIL-C-21720A, including dimensions.

All lots of Type SCM *tan*-TI-*cap* capacitors are tested for performance stability at rated temperature and voltage prior to release for shipment. Performed on a lot-sample basis, the test is run for 250 hours or until performance stability is established by successive time interval measurements of the principal parameters of each test capacitor.

Write to your nearest TI sales office on your company letterhead for Bulletin DL-C 1173 which gives detailed specifications on the complete SCM series.

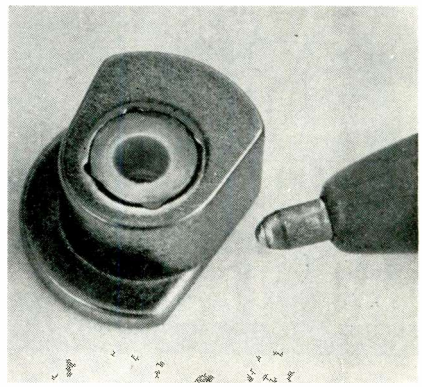
TEXAS INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
13500 N. CENTRAL EXPRESSWAY
POST OFFICE BOX 312 · DALLAS, TEXAS

Circle 89 on Inquiry Card

New Products

SELF-ALIGNING CLAMPS

Self-aligning stainless steel clamp, Synclamps, permit secure fastening of components with base flanges or grooves. Available in 8 different sizes with the same O.D. of 0.390 max. For hard-to-reach places, they are self-

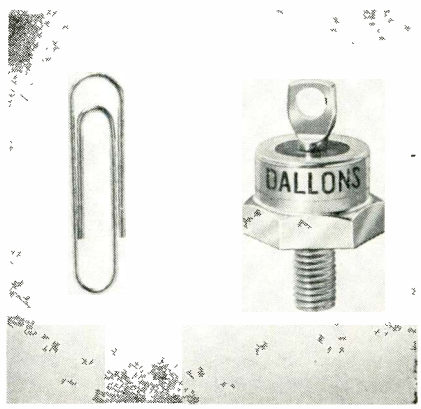


aligning, self-locking and withstand extreme environmental conditions. Self-alignment is quickly and easily accomplished because of a nylon insert. When the screw is tightened, the nylon insert is stripped which allows the clamp to self-align perfectly. The more the screw is turned the tighter the clamp seats. Timber-Top, Inc., 36 Brooklyn Ave., Freeport 8, L. I., N. Y.

Circle 209 on Inquiry Card

SILICON RECTIFIERS

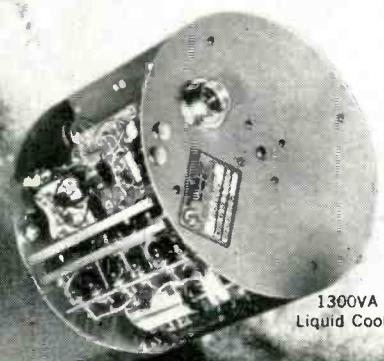
20-35 Amp, 60-600 P.I.V. silicon rectifiers exhibit stable characteristics at high temp. Units contain solders which have a melting point in excess of 600°C. The 11/16 in. stud construction houses a pure silver, heavy spring lead anode assuring ruggedness and high resistance to shock and vibration. Electrical specifications show that these units have less



than 5 ma reverse current and the max. forward drop voltage at a test temp. of 25°C at 20 adc is 0.65 v. Dallons Semiconductors Div., Dallons Laboratories, Inc., 5066 Santa Monica Blvd., Los Angeles 29, Calif.

Circle 210 on Inquiry Card

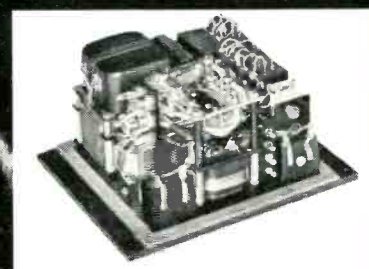
STATIC INVERTERS



1300VA Exotic Solid to Liquid Cooling (Reversible)

for every missile system

30 & 50VA Precision Frequency



80VA Wide Range Stabilization

250 & 500VA 3ø Short Circuit Protected

750 & 1KVA 3ø Phase Locked Circuitry

60VA 3ø High Temperature, Reverse Voltage Protected

STANDARD LINE . . . DC-AC INVERTERS 28 VDC input -55°C to + 71°C Mil specs

MODEL	POWER RATING	OUTPUT VOLTAGE	OUTPUT FREQUENCY	SPECIAL FEATURES
SS-40311 series SS-40511 series	30 VA 1ø 50 VA 1ø	115 VAC adjustable ± 10%	400 cps ± .01 to ± .05%	Precision frequency, excellent waveform, voltage regulated, ± 1% for line, ± 2% load.
SS-408042 series	80 VA 1ø	115 VAC ± 5 V	400 cps ± 1%	Wide range stabilization, input 18-30 VDC, Voltage regulated ± 1½% no load to full load.
SIS-410042 series SIS-425041 series	100 VA 1ø 250 VA 1ø	115 VAC ± 5%	400 cps ± 1% LC. osc. tuning fork	Magnetic Amplifier voltage regulated. Rapid on-off switching no transients high efficiency.
SIS-3-425042 series SIS-3-450022 series	250 VA 3ø 500 VA 3ø	115 VAC ± 2%	400 cps ± 2% ± 1%	Regulates to ± 2% with simultaneous variation of zero to full load, and line 25 volts to 29 volts.
SIS-3-47512 series	750 VA 3ø	208/115 V or 115/65.5 volts Adj. ± 5%	400 cps ± .002%	Extreme frequency accuracy. Phase lock circuitry. Magnetic voltage regulator.
SIS-3-40613 series	60 VA 3ø	26 VAC Adj. ± 5%	400 cps ± .01%	Short circuit protected, reverse voltage protection, high temp., + 100°C. Voltage regulated.

DESIGN NOTE: any of the special features described may be combined in a single unit to meet your special requirements.

Engineering conferences at your or our facilities. Write—call—or wire (TWX 2931)

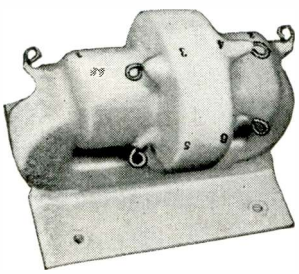
MAGNETIC AMPLIFIERS, INC.

632 TINTON AVENUE
NEW YORK 55, N. Y.
CYPRESS 2-6610

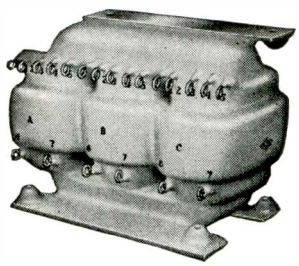
136-140 KANSAS STREET
EL SEGUNDO, CALIFORNIA
OREGON 8-2665

TRANSFORMERS for APPLICATIONS UP TO 350°C

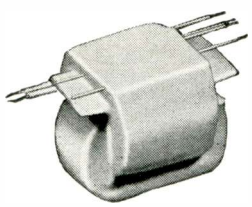
Engineering "know how" and manufacturing facilities are available at Acme Electric to produce prototypes or production runs of transformers that must function with operating temperatures up to 350°C.



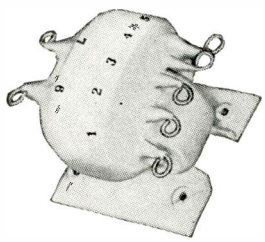
T-36127
Weight: 14 ounces. VA: 47.8
50°C rise, 125°C ambient
12 KV test @ 30,000 feet



T-34671
Weight: 4¼ lbs. VA: 705
165°C rise, 125°C ambient
12 KV test @ 30,000 feet



T-34894
Weight: 260 grams VA: 26.4
30°C rise, 125°C ambient
6.2 KV test @ 30,000 feet



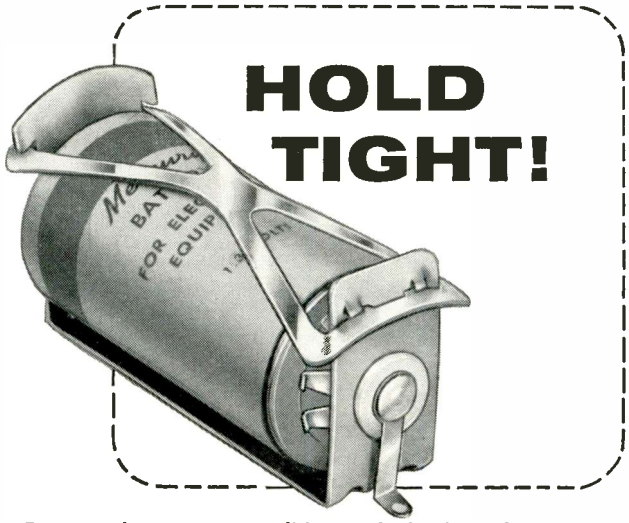
T-36196
Weight: 235 grams. VA: 32
31°C rise, 125°C ambient
5.2 KV test @ 30,000 feet

ACME ELECTRIC CORPORATION
892 WATER STREET • CUBA, NEW YORK
West Coast Plant: 12822 YUKON AVE., HAWTHORNE, CALIF.
PO 3254

Acme ACME Electric
TRANSFORMERS

Circle 92 on Inquiry Card

HOLD TIGHT!

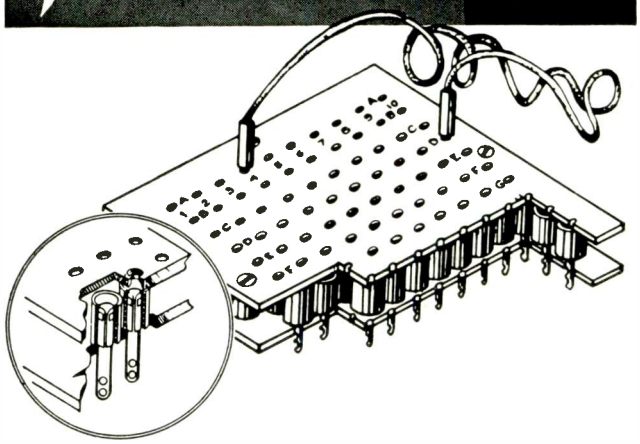


Even under severe conditions of shock and vibration, CAMBION® Vibration-Proof Battery Holders hold tight. Unique "locking strap" keeps "D" size mercury battery securely in place. Suitable for use in all types of circuits, the holders are available in two models. No. 2570 is insulated at one end only. No. 2870 is insulated at both ends to permit "floating" of the voltage supply, and is ideal for transistorized circuits and other low-voltage applications. Both holders are designed so that leads can be easily brought up to terminals even though unit is flush-mounted. Write Cambridge Thermionic Corporation, 504 Concord Avenue, Cambridge 38, Mass., for full details on these and other products in the wide line of

CAMBION®
The guaranteed electronic components
Circle 93 on Inquiry Card

Vector PATCH BOARDS

FOR RELIABLE CONNECTIONS WHERE SMALL SIZE AND ECONOMY COUNT



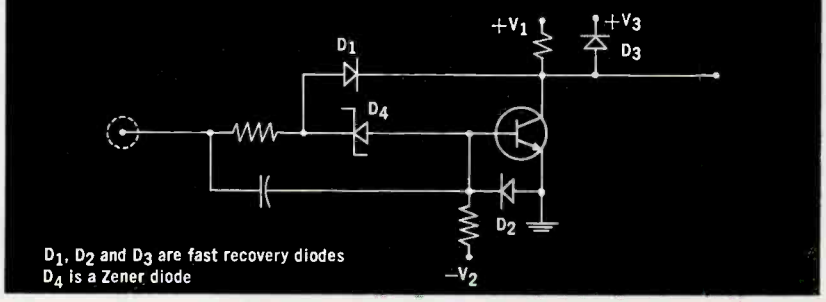
Vector Patch-Boards provide simple, economical units for multiple-connection, single conductor patching. Useful for low cost computers, test boards and a multitude of connecting applications. Receptacles are 0.265" on centers and take .087-.091 diameter plugs. Patch cords also available. Standard boards available or readily made to size required.

Write for information:

VECTOR ELECTRONIC COMPANY
1100 FLOWER STREET • GLENDALE 1, CALIFORNIA
CHAPMAN 5-1076
Circle 94 on Inquiry Card

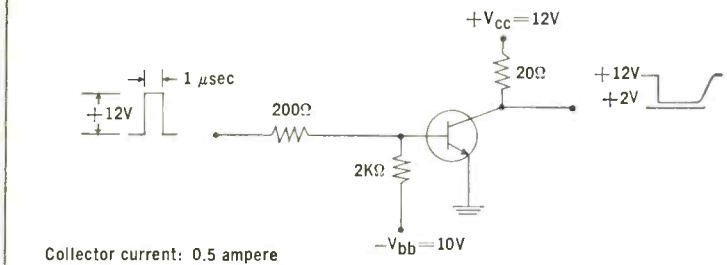
RELIABLE SILICON TRANSISTOR SWITCHING

NON-SATURATED SWITCH WITH LONG-STORAGE-TIME TRANSISTOR



9 COMPONENTS REPLACED BY 4

SATURATED SWITCH WITH 2N1252 TRANSISTOR



HOW? – By using Fairchild's 2N1252 or 2N1253 **lowstorage** silicon mesa transistors. The guaranteed low storage characteristic permits a simple saturating circuit to achieve switching speeds that previously required complex non-saturating circuits.

WHY? – Improved reliability and reduced cost – one semiconductor instead of five and fewer soldered connections. Power dissipation is only 1/3rd to 1/5th as great, making possible much higher component densities in packaging. Cost and reliability are improved all the way from development through volume production.

WHERE? – Switching circuits in general. The 2N1252 and 2N1253 are ideally suited to high-speed high-current switching applications such as magnetic-core drivers, drum and tape write drivers, high-current pulse generators and clock amplifiers. In addition, the transistors are applicable to medium-speed saturated logic circuits.

FAIRCHILD 2N1252 and 2N1253

Symbol	Characteristic	Rating	Min	Typ	Max	Test Conditions
h_{FE}	D.C. pulse current gain 2N1252		15	35	45	I_C=150mA V_C=10V
	2N1253		30	45	90	
P_C	Total dissipation at 25°C case temperature	2 watts				
$V_{BE\ SAT.}$	Base saturation voltage			0.9V	1.3V	I_C=150mA I_B=15mA
$V_{CE\ SAT.}$	Collector saturation voltage			0.6V	1.5V	I_C=150mA I_B=15mA
h_{fe}	Small signal current gain at f=20mc 2N1252		2	4		I_C=50mA V_C=10V
	2N1253		2.5	5.5		
I_{CBO}	Collector cutoff current			0.1μA	10μA	V_C=20V T=25°C
				100μA	600μA	V_C=20V T=150°C
t_s+t_f	Turn off time			75mμs	150mμs	I_C=150mA I_{B1}=15mA
						I_{B2}=5mA R_L=40Ω
						Pulse width=10ms

For full specifications, write Dept. J-2

FAIRCHILD
SEMICONDUCTOR CORPORATION

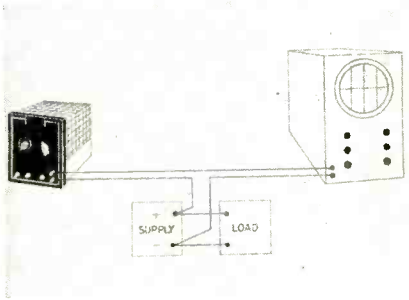
545 WHISMAN ROAD • MOUNTAIN VIEW, CALIFORNIA • YORKSHIRE 8-8161 • TWX: MOUNTAIN VIEW CAL 122

New York Area: Pioneer 1-4770 • Syracuse: GRanite 2-3391 • Philadelphia Area: TUrner 6-6623
Washington D.C.: NAtional 8-7770 • Chicago: BRowning 9-5680 • Los Angeles: OLeander 5-6058

New Products

OSCILLOSCOPE ACCESSORY

For coupling to an oscilloscope, this instrument, Scope-O-Trol, has an input of 115 v., 60 CPS, with an output of 0-300 vdc. It was developed to observe the regulation, ripple, transient response, and other characteristics of dc power supplies by removing the dc component and utilizing the scope to its max. capabilities. Voltage adjustment is in 75 v. steps for coarse adjustment, with fine adjustment potentiometer 0.25 v./degree; ripple is less than 1 mv RMS. The unit has current limiting and short circuit protection. Acme Electric Corp., Cuba, N. Y.



Circle 213 on Inquiry Card

PRESSURE TRANSDUCER

Model 304 Gage Pressure Transducer is an integrated pressure instrument incorporating a bourdon tube as the pressure sensing element. Gage pressures are converted into an electrical output through a pivot linkage system, moving the wiper contact linearly across a precision wire-wound potentiometer. Unit operates with a high level ac or dc signal. Specs are: range, 0-100 to 0-5000 psig; resistances, 1K to 10K ohms; resolution, 0.3 to 0.5%; linearity, ± 1.0%; hysteresis, as low as 0.5%; power rating, 1.2 w at 50°C; weight, approx. 2.2 oz. Bourns, Inc., 6135 Magnolia Ave., Riverside, Calif.

Circle 214 on Inquiry Card

LITTLE INSTRUMENTS BY DeJUR PERFORM BIG PRECISION FUNCTIONS

Potentiometers

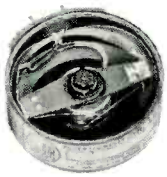
Small but Accurate—unique design and production techniques assure exceptional functional accuracy.

SERIES C-050

½". Sealed, sub-miniature type with one-piece metal case and bearing. Completely enclosed. Solid terminals, integrally cored with molded covers. Rotation: 320° electrical, 325° mechanical, 360° continuous.

SERIES C-078

⅞". Weight only ½ ounce. Independent linearity: ±1% of total resistance is standard. Linear or non-linear windings on flat card. Fully enclosed. Tolerance: ±5% standard, ±1% on order.



SERIES C-178

1⅞". Sine-cosine units with peak-to-peak accuracies to 0.25%. Independent brush contacts on common shaft, 90° apart. Ganged types available. Also 2" and 3" diameters.

Panel Instruments

Ruggedized . . . round or square—miniature high precision units meet reduced size and weight requirements of aircraft and electronic applications

SERIES 100

1". Accuracy ±3% at full scale. Non-magnetic calibration. Scale length, 0.738". Background markings black or white, lance pointer, sealed solder lug terminals, aluminum housing. Watertight to meet MIL-M-3823 specs.

SERIES SC-031

½". Rugged, micro-miniature sealed unit. Includes external pivot D'Arsonval movement and high flux density Alnico magnet. Optional mounting, face plate and hex nut.

SERIES 131

1½". Ruggedized to withstand shock, vibration or thermal extremes. Meets MIL-M-10304 specs. Positive watertight seal of meter and terminal studs.

Write for detailed literature on complete lines.

You're always sure with

DeJUR

ELECTRONIC COMPONENTS

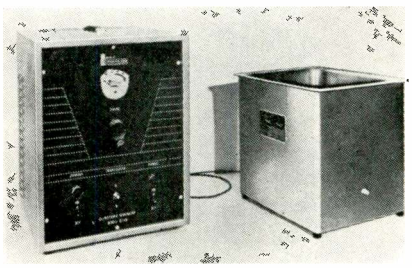
Manufacturers of Precision Electronic Components for Over 35 Years

ELECTRONICS DIVISION, DeJUR-AMSCO CORPORATION, 45-01 NORTHERN BOULEVARD, LONG ISLAND CITY, N. Y.

New Products

ULTRASONIC CLEANER

Ultrasonic cleaner, Model 140, is for use where average ultrasonic energy is required. Featured is a 7-gal. heavy gauge, polished, stainless steel tank 14¾ x 11¾ x 10 in. 27.5% of the bottom is covered with

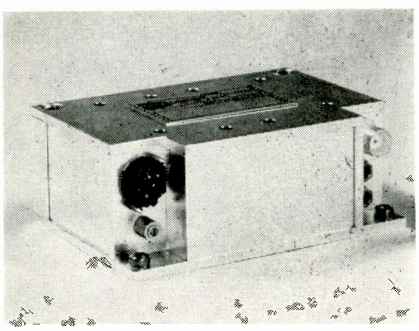


crystals. Actual radiating surface is 48 sq. in. Designed for continuous operation, it delivers an average power output of 250 w and produces peaks of 1000 w. Features include 1-tube oscillator, front panel switching, forced air cooling and 3-wire ground protection. National Ultrasonic Corp., 111 Montgomery Ave., Irvington, N. J.

Circle 215 on Inquiry Card

TRANSMITTER

Model 1483-A1 true FM Telemetering Transmitter is a completely modularized missile transmitter. All circuits are mounted on individual bulkheads which may be separately removed and replaced from spare parts. Output is 2 to 6 w at 215 to 260 MC. It measures 1.64 x 2.75 x 4 in. and features AFC loop crystal control for ± 0.005% carrier stability, and silicon transistors for low noise



and high efficiency. It will withstand extreme environmental missile conditions including vibration and heat beyond 100°C. Telechrome Mfg. Corp., 28 Ranick Drive, Amityville, L. I., N. Y.

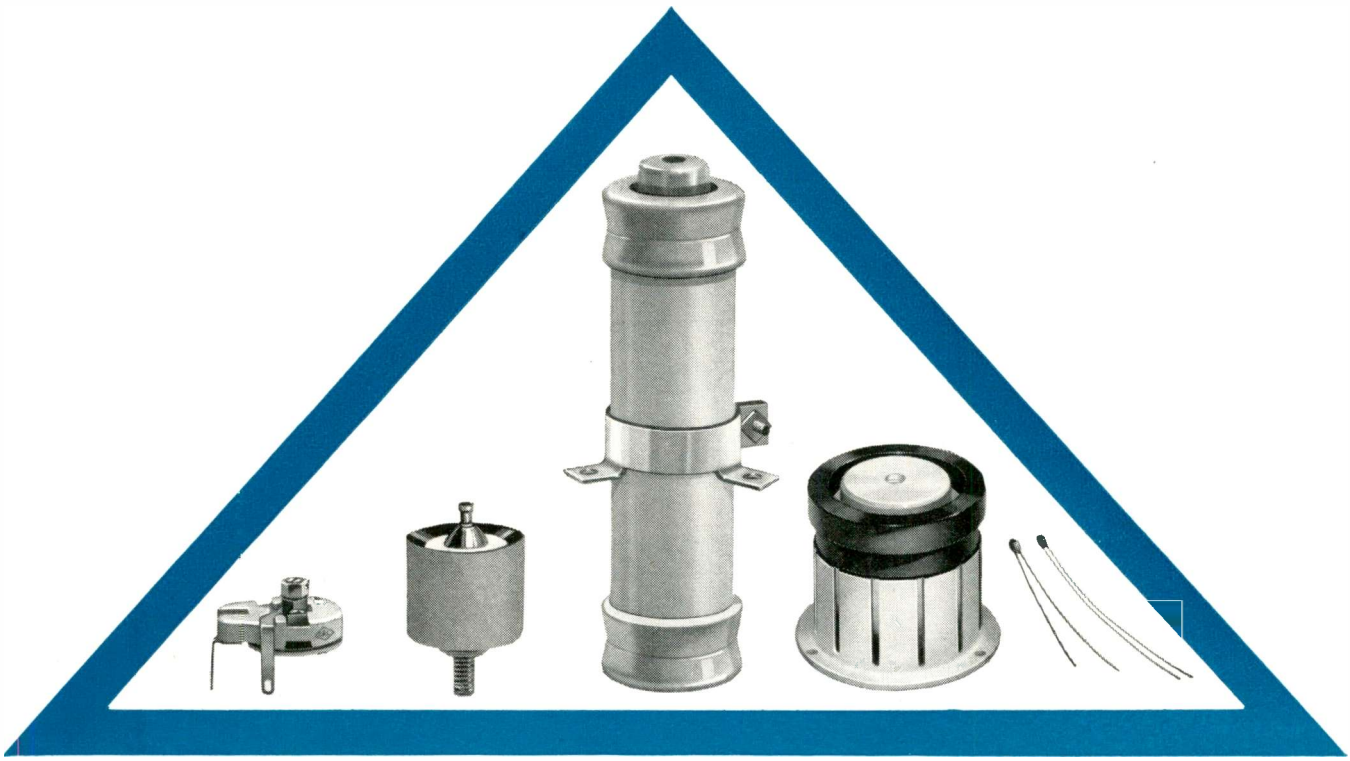
Circle 216 on Inquiry Card

Developing capacitors for unusual situations your job...and Centralab's

Centralab CERAMIC CAPACITORS for difficult applications

Ceramic capacitors have almost unlimited capabilities . . . but utilizing their full potential demands expert knowledge *not bound to conventional approaches*. Creative engineering, involving new concepts and new techniques, can broaden your design horizons.

That kind of creative engineering is a CENTRALAB specialty. As specialists in *ceramic* capacitors, CENTRALAB engineers have developed units to meet an enormous variety of difficult size and rating requirements beyond the scope of oil, mica or vacuum capacitors. The unusual designs illustrated here are typical of CENTRALAB's answers to the problems no-one else could solve. A representative group of additional specialized units are described in Bulletin #42-719. Request your free copy of this bulletin today; it will stimulate your thinking towards making full use of the design potential of ceramic capacitors.



Variable Capacitors
600VDCW, capacity ranges to 250 mmf. Compact construction, 13/16" wide, 1 5/16" long, 1 1/16" deep overall. Temperature compensating units NPO, N650 are standard. Other temperature characteristics available on special order.

Precision Temperature Compensating Capacitors
Hermetically sealed, T.C. ± 10 PPM, capacity tolerance ± 1%. Outer shell grounded. Available in 50-3500 mmf range in NPO. Other T.C. ratings proportional.

High Voltage Capacitor
12KVDCW, 2000 mmf; 30 amps at 30 mc. Unit is 6" long, 2" O.D. Extremely flexible design—can be made to a wide range of dimensions and ratings. Units that operate at 125°C. without derating can be designed.

DC Blocking Capacitor
10KVDCW, 1700 mmf ± 10%; 12 amps at 4 mc, 80 amps at 30 mc. Measures only 4" high and 4" O.D. at base. Ideal for restricted space, high reliability applications. Can be used in parallel to handle large loads.

Ultra-Miniature Capacitor
3VDCW, .01 mmf G.M.V. Capacity change +10° to +85°C.; 25% maximum. Approximately 1/8" diameter. For transistor, coupling, by-pass, cathode and other low voltage, high capacity applications.

Centralab
D-5947

ELECTRONICS DIVISION OF GLOBE-UNION INC.
938B E. KEEFE AVE. • MILWAUKEE 1, WIS.
In Canada: 669 Bayview Ave., Toronto 17, Ont.

VARIABLE RESISTORS • ELECTRONIC SWITCHES • PACKAGED ELECTRONIC CIRCUITS • CERAMIC CAPACITORS • ENGINEERED CERAMICS

New Products

POWER SUPPLY

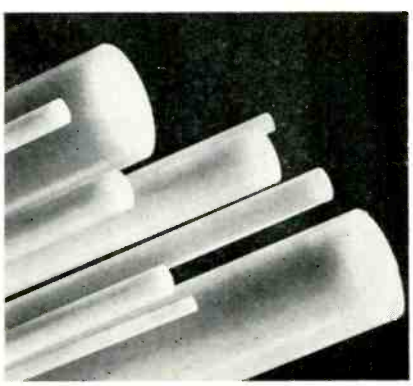
Voltage regulated power supply, Spec 7197. Input is 15 vac ±10%, 60 CPS ± 1 CPS, 1 ø; output adjustable from 2.5 to 13.0 vdc; load current is 0 to 10 a, continuous duty. Dynamic regulation: with ±90% load change

and a step function of ±5% line change; slow regulation: no load to full load and a ±10% line change; total regulation: slow, dynamic and ripple will not exceed ±1%; ripple voltage: will not exceed 10 mv max. Power supply is short circuit protected and will meet electrical specs to 35°C. Dc output voltage floating from chassis, with external voltage sensing available. The Daven Co., Livingston, N. J.

Circle 217 on Inquiry Card

THERMOPLASTIC

Delrin acetal resin, a new thermoplastic material developed by du Pont is available in extruded rods up to 3 in. in dia. The new material has outstanding tensile strength, rigidity, fatigue life and resistance to creep and solvents at both room and elevated temperatures. These properties are combined with excellent dimensional stability, and good electrical and frictional properties. The rods

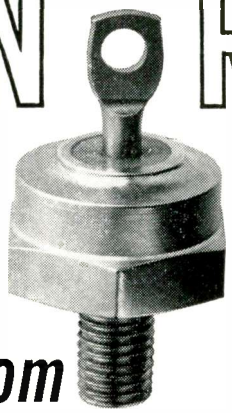


have a hard glossy surface with a very low coefficient of friction. The rods have a hard glossy surface with a very low coefficient of friction. The Garlock Packing Co., 441 Main Street, Palmyra, New York.

Circle 218 on Inquiry Card

Announcing...

SILICON RECTIFIERS

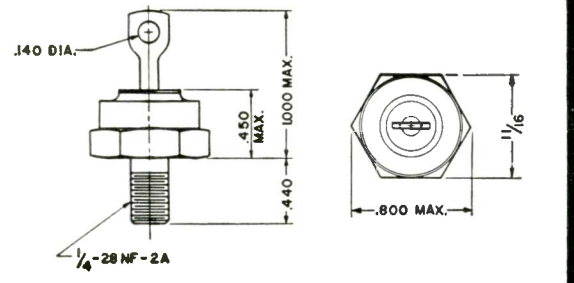


from DELCO RADIO

High Quality
High Performance
Extreme Reliability

From the leading manufacturer of power transistors, new Silicon Power Rectifiers to meet your most exacting requirements. Even under conditions of extreme temperatures, humidity and mechanical shock, these diffused junction rectifiers continue to function at maximum capacity! Thoroughly dependable, completely reliable—new Delco Rectifiers are an important addition to Delco Radio's high quality semiconductor line.

Conservatively rated at 40 and 22 amperes for continuous duty up to case temperatures of 150°C.



TYPE	AVG. DC CURRENT	PIV	NORMAL MAX. TEMP.	MAX. FORWARD DROP	MAX. REVERSE CURRENT
1N1191A	22A	50V	150°C	1.2V at 60 amps.	5.0 MA
1N1192A	22A	100V	150°C	1.2V at 60 amps.	5.0 MA
1N1193A	22A	150V	150°C	1.2V at 60 amps.	5.0 MA
1N1194A	22A	200V	150°C	1.2V at 60 amps.	5.0 MA
1N1183A	40A	50V	150°C	1.1V at 100 amps.	5.0 MA
1N1184A	40A	100V	150°C	1.1V at 100 amps.	5.0 MA
1N1185A	40A	150V	150°C	1.1V at 100 amps.	5.0 MA
1N1186A	40A	200V	150°C	1.1V at 100 amps.	5.0 MA at 150° C case temperature and rated PIV

For full information and applications assistance, contact your Delco Radio representative.

Newark, New Jersey
1180 Raymond Boulevard
Tel: Mitchell 2-6165

Chicago, Illinois
5750 West 51st Street
Tel: Portsmouth 7-3500

Santa Monica, California
726 Santa Monica Boulevard
Tel: Exbrook 3-1465

Division of General Motors • Kokomo, Indiana

DELCO RADIO
DEPENDABILITY

Circle 103 on Inquiry Card

WHAT IS THE RECORD BEHIND HOFFMAN TRANSISTORS?

1 ■ MORE EXPERIENCE IN SILICON TECHNOLOGY.

For seven years—practically the full span of semiconductor history—Hoffman Semiconductor Division has worked exclusively with silicon devices. Company achievements include the world's first commercial silicon diodes, zener diodes and solar cells. Hoffman makes the most extensive line of silicon devices in the industry.

2 ■ MORE EXPERIENCE IN DIFFUSED-JUNCTION DEVICES.

The diffused-junction concept, one of the most important in transistor technology, was adapted by Hoffman as early as 1955. To date, the company has produced over five million diffused-junction devices—more than any other company in the electronics industry.

3 ■ NEW CONCEPT IN QUALITY CONTROL.

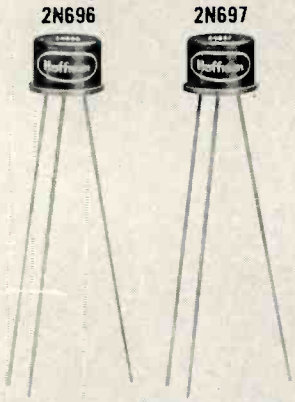
Hoffman has developed a completely new quality assurance and quality control concept which will enable the company to ship devices that meet the most stringent military and commercial requirements.

4 ■ RELIABILITY BACKED BY NUMBERS.

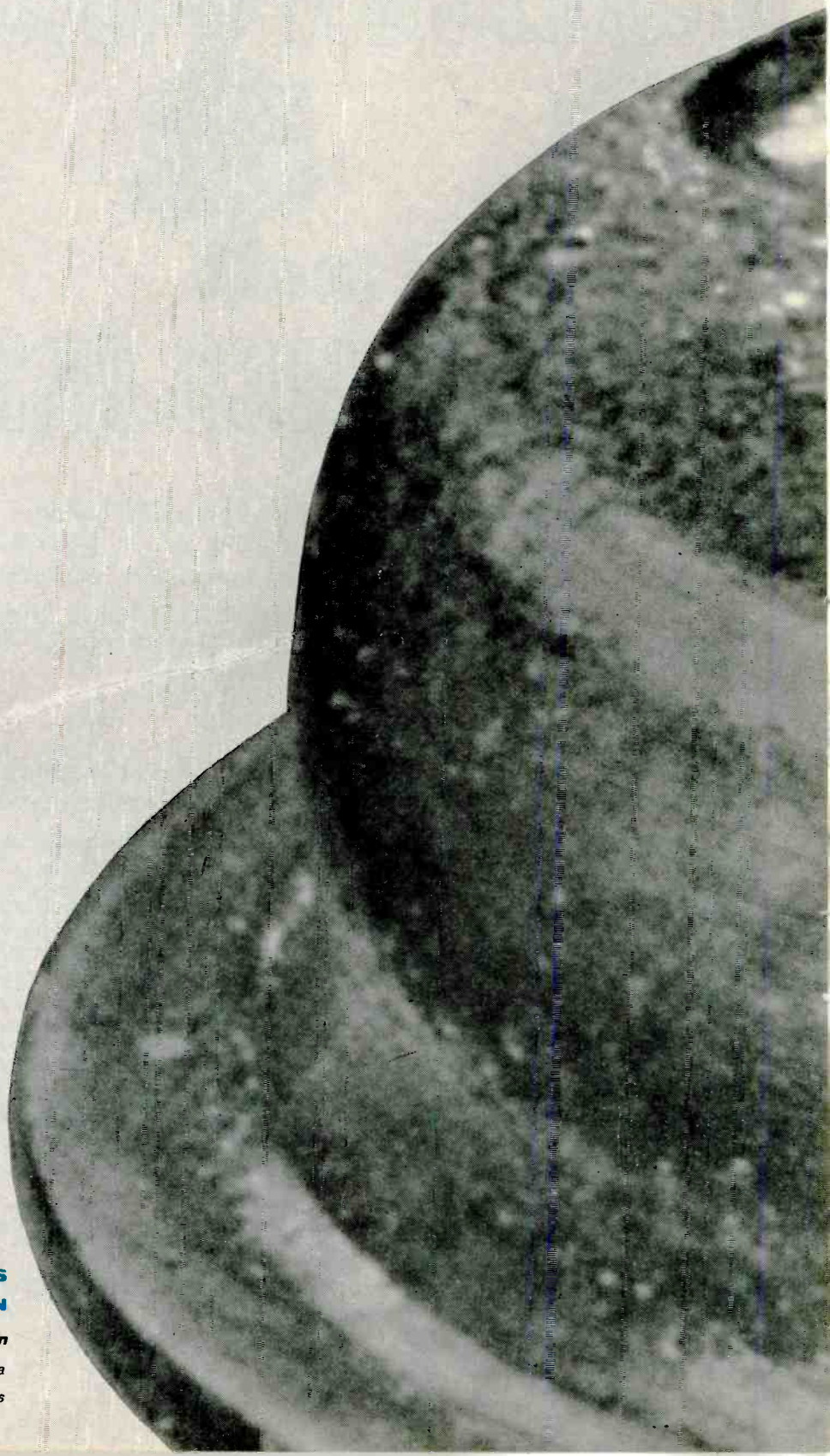
Hoffman has made and shipped more than ten million silicon semiconductor devices.

5 ■ A FACILITY DESIGNED ESPECIALLY FOR TRANSISTORS.

Hoffman's new 109,000-square-foot facility was designed especially for the development, production and testing of transistors. It houses extremely advanced equipment, much of it Hoffman-developed.



For further information and complete technical specifications, contact the factory or your area Hoffman sales engineer.



Hoffman

Hoffman / ELECTRONICS CORPORATION

Semiconductor Division

1001 Arden Drive, El Monte, California

Plants: El Monte, California and Evanston, Illinois

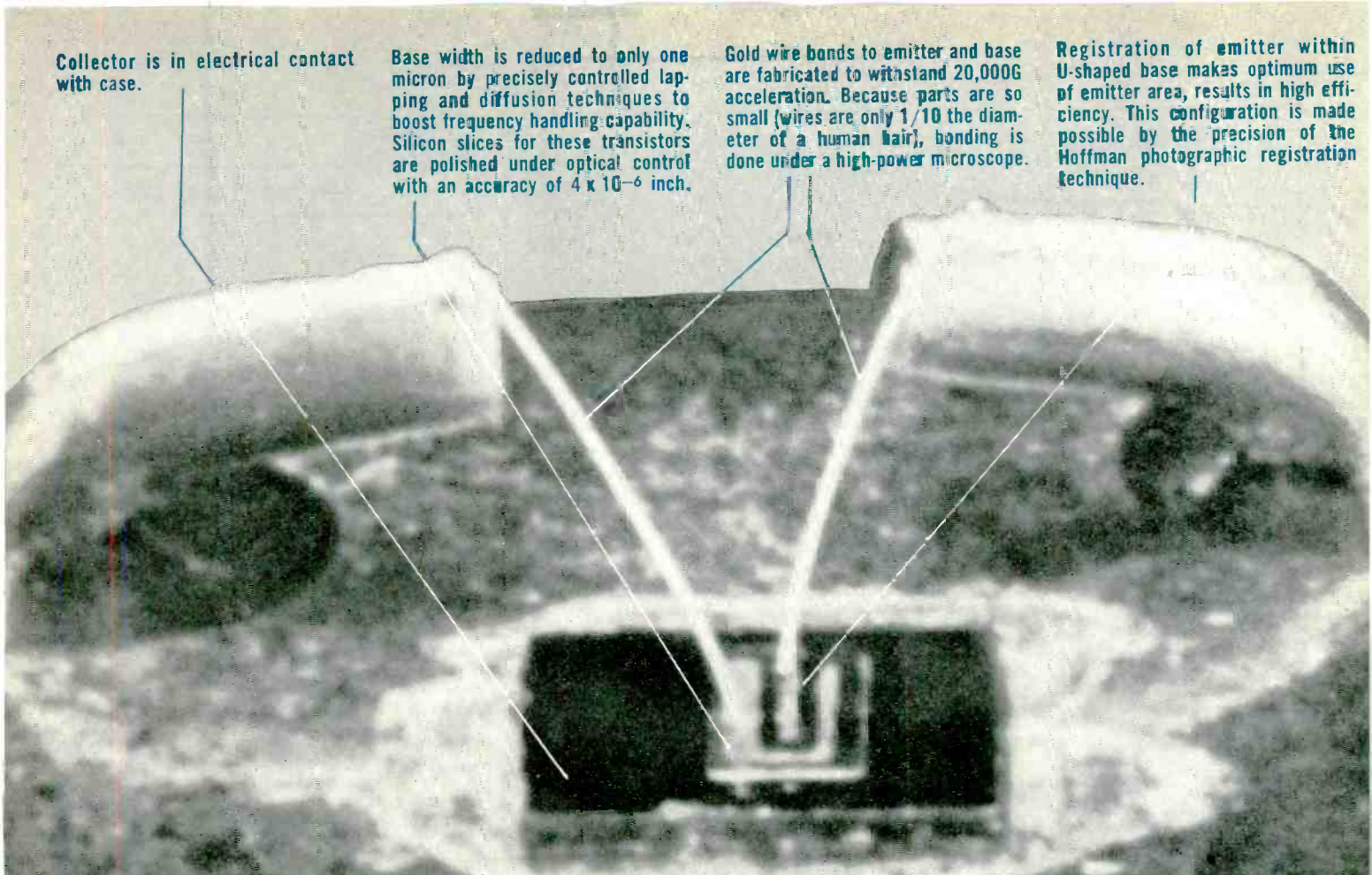
Circle 104 on Inquiry Card

Collector is in electrical contact with case.

Base width is reduced to only one micron by precisely controlled lapping and diffusion techniques to boost frequency handling capability. Silicon slices for these transistors are polished under optical control with an accuracy of 4×10^{-6} inch.

Gold wire bonds to emitter and base are fabricated to withstand 20,000G acceleration. Because parts are so small (wires are only 1/10 the diameter of a human hair), bonding is done under a high-power microscope.

Registration of emitter within U-shaped base makes optimum use of emitter area, results in high efficiency. This configuration is made possible by the precision of the Hoffman photographic registration technique.



NOW...HOFFMAN RELIABILITY IN TRANSISTORS

ANNOUNCING THE HOFFMAN 2N696 AND 2N697 NPN DIFFUSED-JUNCTION DRIFT-FIELD SILICON MESA TRANSISTORS

WITH THREE TIMES THE HIGH-FREQUENCY POWER GAIN OF SIMILAR DEVICES

By increasing the usefulness of the emitter area, Hoffman engineers have boosted the minimum high-frequency gain at large currents to 6 at 20 mc ($I_C = 50$ma, $V_C = 10$V)—more than three times the industry standard. Hoffman's unique base-emitter configuration, coupled with a photographic fabrication technique that offers control accuracy of the order of light wavelengths, has also lifted current and frequency characteristics well above industry specifications. Reasonable current gains at 40mc have been measured. Since the photo process is far more controllable than mechanical fabrication, these transistors have exceptionally uniform characteristics. Stability, too, is outstanding, because Hoffman pre-ages every transistor at 300°C and seals it hermetically in an inert-gas atmosphere.

A wide range of useful current gain and operating frequencies makes these units ideal for computer, radar and many other applications. You can count on them in your most important circuit. Reliability is built into every unit.

ABSOLUTE MAXIMUM RATINGS (25°C)

V_{CBO} Collector-to-base voltage	60V
Total dissipation at case temperature 25°C	2W
Storage temperature range	−65°C to +175°C

ELECTRICAL CHARACTERISTICS (25°C)

SYMBOL	CHARACTERISTIC	MIN.	MAX.	TEST CONDITIONS
h_{FE}	D.C. pulse current gain (2N696)	20	60	$I_c = 150$ma $V_c = 10$V
	(2N697)	40	120	$I_c = 150$ma $V_c = 10$V
V_{BE} (sat)	Base saturation voltage		1.3V	$I_c = 150$ma $I_B = 15$ma
V_{CE} (sat)	Collector saturation voltage		1.5V	$I_c = 150$ma $I_B = 15$ma
h_{fe}	Small signal current gain at f = 20mc	6	9	$I_c = 50$ma $V_c = 10$V
C_{ob}	Collector capacitance		35puf	$I_E = 0$ma $V_c = 10$V
I_{CBO}	Collector cutoff current		1.0ua	$V_c = 30$V T = 25°C
			100ua	$V_c = 30$V T = 150°C

Physical dimensions in accordance with JEDEC 30 (TO-5). Manufactured to meet MIL-S-19500B requirements.

New Products

AUDIO TUBE

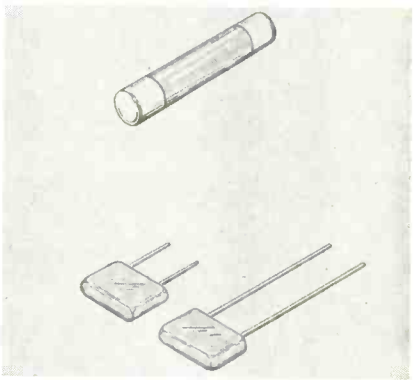
The 7581, a 30-w beam-power pentode for high quality audio power output—but with low-loss mica-filled base provides good r-f performance. Interchangeable with 5881, 6L6, and KT-66, the type 7581 features: A

rounded-top envelope for "rattle control" which reduces microphonic action under vibration. Zero-bias characteristics: plate, 70 v.; screen, 300 v.; control grid voltage, zero; plate current, 210 ma.; and screen, 25 ma. Max. ratings: 500 v plate, 450 v screen, 30 w plate dissipation, and 5 w screen dissipation. General Electric Co., Receiving Tube Dept., Owensboro, Ky.

Circle 219 on Inquiry Card

CURRENT LIMITER

Solid state current limiter for use in all types of electronic circuits, especially where the ultimate in protection is required. The current limiter is a 1-shot device which will fire in less than 1 msec. at 316% rated value or 1/10 sec. at 150%



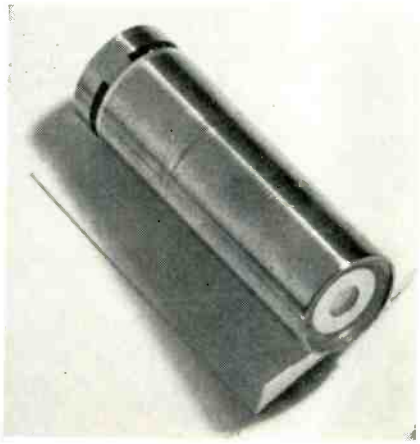
rated value. It is available in ratings from 1/32 a to 5 a in 2 configurations: Model 100, ¼ x 1 in. to fit a standard fuse holder; Model 200, ¼ x ⅛ x 1/16 in.—pigtail type for printed circuits. Microletron, Inc., P.O. Box 24174, Los Angeles 24, Calif.

Circle 220 on Inquiry Card

New Products

INFRARED DETECTOR

The QK748, a sensitive p-type gold doped germanium infrared detector. Characteristics include: Operating Temp., liquid nitrogen (78°K); spectral sensitivity range, the detector proper is sensitive from about 2-9



microns; detector area, 3.5 x 3.5 mm.; impedance, 50,000 ohms to 1 megohm; acceptance angle, approx. 100°; response, measured with a blackbody at 500°K at 800 CPS and referred to 1 cycle bandwidth. NEP = 7×10^{-10} to 7×10^{-11} w; D* = 5×10^{8} to 5×10^{9} cm/w; time constant, less than 1 microsecond. Applications Engineering Dept., Raytheon Co., Waltham, Mass.

Circle 221 on Inquiry Card

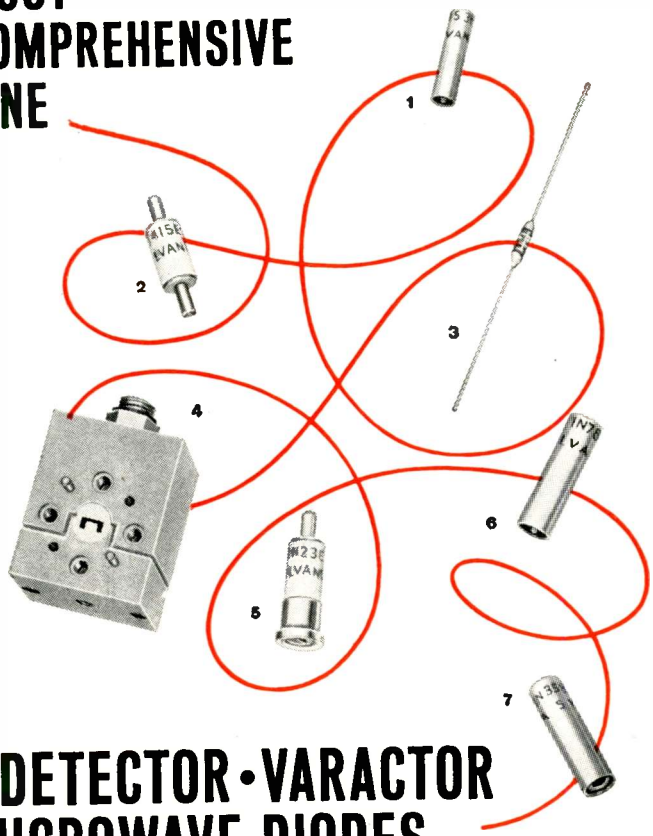
TAPE DEGAUSSER

Bulk tape demagnetizer, Model HD-11, reduces residual sound level of typical fresh virgin unrecorded tape by 3 to 15 db, dependent on previous exposure to stray magnetic fields in transit. It provides a 75 db min. erasure of saturated magnetic tape. Spindle mounting of reel permits

rapid, thorough coverage without missed spots. May be used with reels from 5 through 10½ in. dia. Adapter hub for NARTB wheels available. Microtran Co., Inc., 145 E. Mineola Ave., Valley Stream, N. Y.

Circle 222 on Inquiry Card

SYLVANIA OFFERS THE INDUSTRY'S MOST COMPREHENSIVE LINE



MIXER • DETECTOR • VARACTOR MICROWAVE DIODES

for operation from

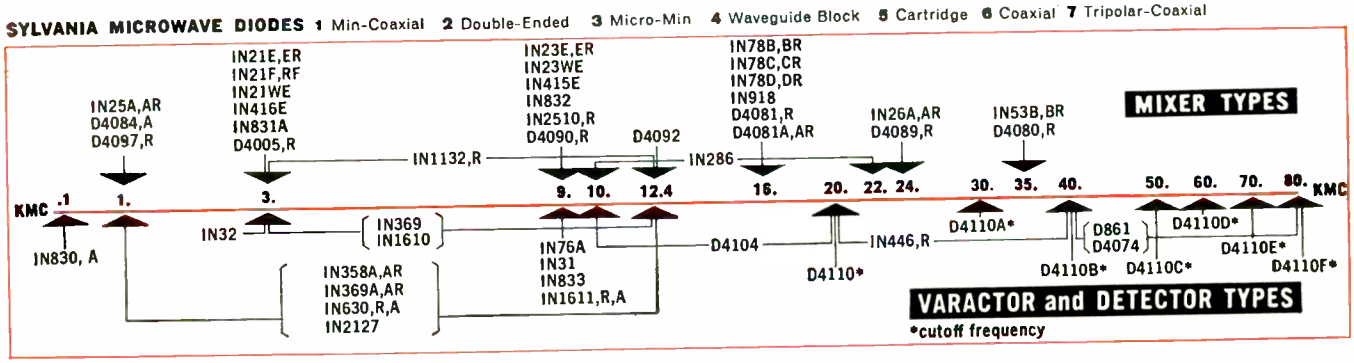
100 MC TO 80,000 MC!

SYLVANIA MICROWAVE DIODES utilize the point-contact structure in those units specifically for MIXER and DETECTOR service, and the MESA structure in the VARACTOR types. Advanced processes and techniques developed by SYLVANIA assure MICROWAVE DIODES capable of withstanding the most severe environmental conditions of shock, vibration, and temperature. Extraordinary quality-controls assure low-noise figures, high sensitivity and high Q in units where those characteristics are essential to equipment design.

If you are designing radar, countermeasure, missile control, TV or telephone relay, test or special-purpose equipment operating at microwave frequencies, send now for your copy of *"SYLVANIA MICROWAVE CHARACTERISTICS AND REPLACEMENT GUIDE."* This valuable new booklet contains data for more than 125 Sylvania Microwave Diodes, the most comprehensive line in the industry. You are certain to find here the right unit for your design. Write to Sylvania Semiconductor Division, Dept. 19-2, Woburn, Mass.

For sales information on any Sylvania Semiconductor Device, contact your local Sylvania Field Office or your local Sylvania Semiconductor Distributor.

SYLVANIA MICROWAVE DIODES 1 Min-Coaxial 2 Double-Ended 3 Micro-Min 4 Waveguide Block 5 Cartridge 6 Coaxial 7 Tripolar-Coaxial



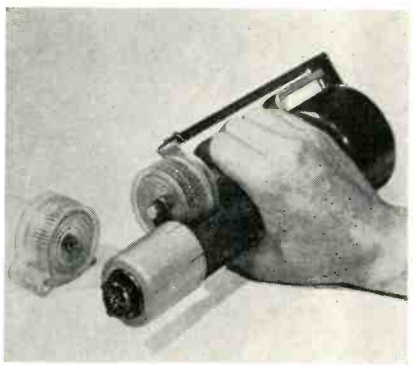
SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

New Products

CRIMPING TOOL

High speed, pneumatic crimping tool for hand or bench operation provides a crimp with strength exceeding that of the wire (sizes AN #18 or smaller). Tool handles both pins and sockets in the Deutsch DC series

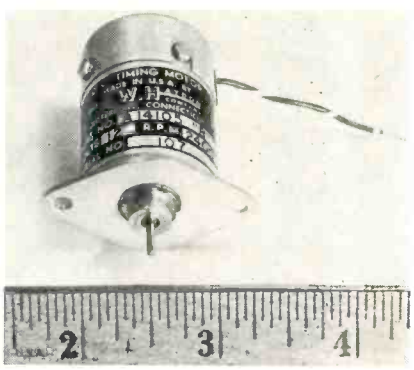


miniatures. Contacts are in disposable plastic cartridges. Crimping action is that of the Deutsch manual crimping tool, providing 2 series of 4 indents. Locking action is built in. In case of air failure or intermittent pressure, the tool will jam. The Deutsch Co., Electronic Components Div., Municipal Airport, Banning, Calif.

Circle 223 on Inquiry Card

DC MOTORS

Line of sub-miniature, reversible dc motors (series 14100) may also be used as low voltage generators. Speed tolerance of ±10% can be maintained at rated voltage. Standard units available for voltages from 4.5 v to 30 vdc, and special windings can be supplied. Furnished with an integral, hardened stainless steel pinion (10 tooth, 96 D. P.) or with a 1/8 in. dia. output shaft. Life expectancy is 1000 hrs. min. (continuous or inter-



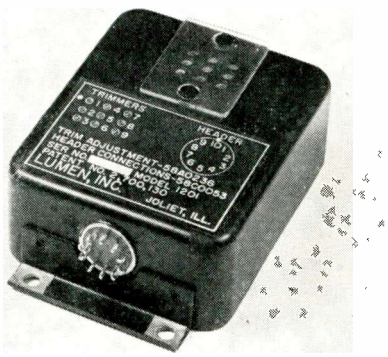
mittent), from −54°C to +85°C. Rotor inertia is 5 gm-cm²; dielectric strength is 500 VRMS at 60 CPS for 1 min. The A. W. Haydon Co., 232 N. Elm St., Waterbury, Conn.

Circle 224 on Inquiry Card

New Products

SIGNAL AMPLIFIER

Model 1201 Amplifier incorporates an adjustable network to adapt it to a range of sensor voltages and impedances. For all sensors, the output of the amplifier is 0-5.0 vdc. Powered from 28 vdc ±5%, characteristics

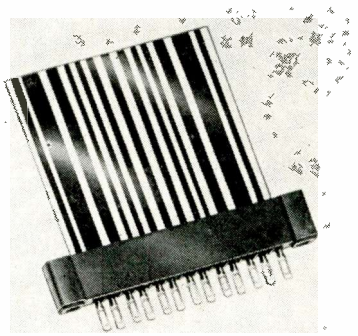


are: amplifier output impedance, 1000 ohms (max.); amplifier output signal, 0-5.0 v.; amplifier output linearity, ±1% of full scale (±50 mv); amplifier zero shift, ±1% of full scale (±50 mv); amplifier frequency response, approx. 2 CPS; excitation voltage, 28 vdc ±5%; amplifier input impedance, 100 ohms per 1 mv input signal. Lumen, Inc., Moen Ave., P.O. Box 905, Joliet, Ill.

Circle 225 on Inquiry Card

P C CONNECTORS

Miniature printed circuit connectors for printed tape cable or printed circuit board applications, the 600-4PCSC-13 for the 13-contact unit and 600-7-1 for the 18-contact unit, have current ratings of 3 a. Molding in glass reinforced Diallyl Phthalate per MIL-M-19833, Type GDI-30. Contact material is spring temper phosphor bronze, gold plate over silver plate.



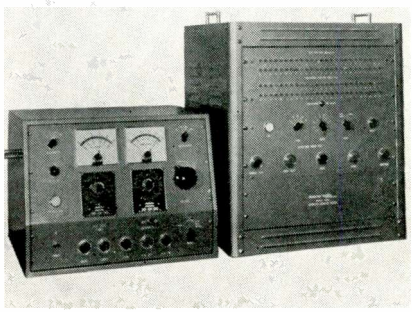
Series 600-4PCSC-13 accepts 1/32 in. board or cable and Series 600-7-1 3/64 in. board or cable. Electronics Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle 226 on Inquiry Card

New Products

LIFE TESTER

Individual components or circuits connected to the Model 8515 Insulation Life Tester are automatically tested in sequence, at the pre-set potential. A dc test potential may be set for any value to 20 kv with the

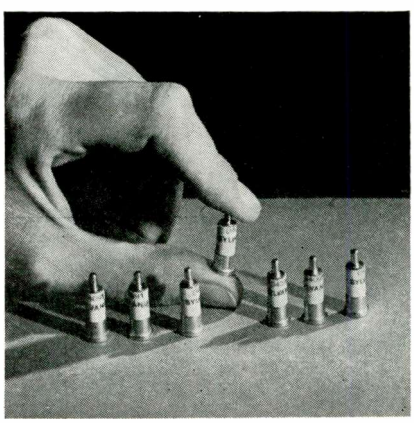


Model 8514 HYPOT[R] high voltage test set used with the tester. The rate of rise for this test potential and the length of time it is applied to each unit (up to 15 min.) is adjustable. All units, when not under test, are short circuited. Leakage current metering circuits have ranges of 0-10/25/100/250 ma. Automatic reject controls are adjustable from a min. of 0.5 μa to a max. of 250 ma. Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill.

Circle 227 on Inquiry Card

MICROWAVE MIXER DIODE

L-band silicon microwave diode is designed for microwave mixer applications in the UHF range to 1500 MC. Designated the D-4097, it is a point contact type. It exhibits a maximum conversion loss of 5.5 db with a maximum output noise ratio as low as 1.5 times. This is the equivalent of a 2



db improvement in noise figure for a receiver whose i-f amplifier noise figure would be 1.5 db, or a 13% increase in range. Sylvania Electric Products, Inc., 730 Third Ave., New York 17, N. Y.

Circle 228 on Inquiry Card

New Products

TANTALUM CAPACITOR

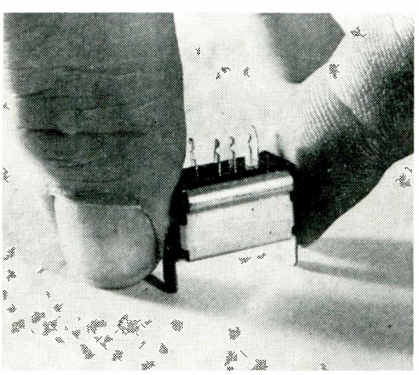
Style "SUB," Series TS, wet electrolytic, tantalum slug capacitors, feature a straight cylindrical form. Range is 1.75 to 30 μf and up to 125 working volts. Operating temp. is −55°C to +85°C. Tantalum slug

capacitors provide low leakage current, low power factor (or equivalent series resistance) and good temp. coefficient characteristics. They can be supplied in close tolerances. Their stability in performance or in storage is unexcelled and they are designed to withstand extraordinary conditions of high frequency vibration, shock and acceleration. Ohmite Mfg. Co., 3667 W. Howard St., Skokie, Ill.

Circle 211 on Inquiry Card

SELENIUM RECTIFIER

Miniature selenium rectifier bridge assembly, designed to operate directly off line voltage, and rated 155 VRMS max. at 90 ma dc, combines 4 selenium elements in 13/16 x ⅞ x 15/32 in. A twist-on locating or mounting lug makes for solid and simple mounting. The tiny rectifier "flat" uses selenium cells which have no artificial barrier layer, eliminating aging and



high voltage drop. It is for use in test equipment, electronic instruments, radio, phonograph and hi-fi sets, etc. Radio Receptor Co., Inc., Selenium Div., 240 Wythe Ave., Brooklyn, N. Y.

Circle 212 on Inquiry Card

New Products

TWO-WAY RADIO

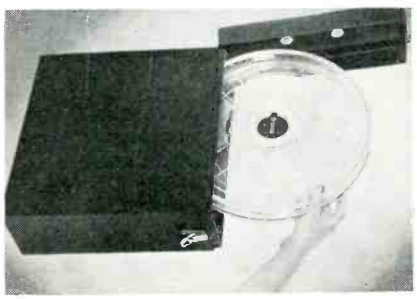
Light weight, portable 2-way FM radio receiver is for use by contractors, field engineers, survey crews, forestry men, and others with need for instant 2-way communication while on foot. It weighs 8 lbs. and is

less than 12 in. in length. It includes a handset, FM receiver, 1 or 2 channel FM transmitter, demountable whip antenna, battery pack, and carrying strap. Available with loudspeaker and palm microphone and for use on the 25-54 MC frequencies or 144-174 MC band. Power output in excess of 1 w on lower frequencies. Allen B. Du Mont Laboratories, Inc., Clifton, N. J.

Circle 229 on Inquiry Card

TAPE SHIELDS

Line of Netic Co-Netic magnetically shielded containers for recording tapes supplied in square or round plastic reel cases. Tapes are protected against erasure or distortion caused by extraneous magnetic fields. Containers available in single or multiple



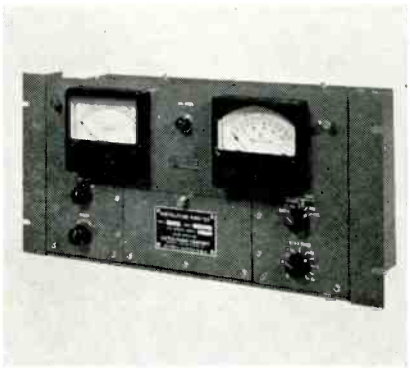
reel capacities. Alloys are non-shock sensitive, non-retentive and do not require periodic annealing to maintain shielding effectiveness. Magnetic Shield Div., Perfection Mica Co., 1322 N. Elston Ave., Chicago 22, Ill.

Circle 230 on Inquiry Card

New Products

MODULATION MONITOR

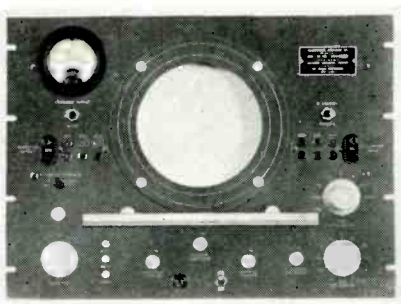
Broadcast Modulation Monitor, Model 5693, will read true values of + and − peaks regardless of the presence of carrier shift. It will give correct peak indications on single program pulses as short as approximately 50 msec and will measure the true peak amplitude of program or tone regardless of the wave forms. It can be located at the transmitter and operated by remote control, with compensating adjustments in the monitor for imperfect telephone lines. Gates Radio Co., Quincy, Ill.



Circle 231 on Inquiry Card

TEST SET

Test set, Model TMS-0100, checks characteristics of transmission lines and other voice-band equipment. It uses swept-band techniques to reduce time needed to check-out a transmission network. A swept-frequency generator provides a sinusoidal wave of adjustable constant amplitude at all frequencies in the voice-band, a measuring system to compare network input and output regardless of the absolute power level, and a cathode ray tube to display in visual form, the information necessary to evaluate network characteristics. Hallamore Electronics Co., 714 N. Brookhurst Ave., Anaheim, Calif.

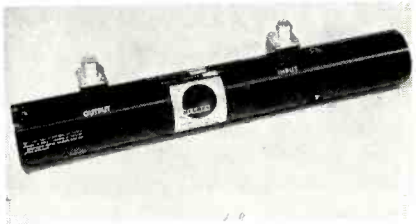


Circle 232 on Inquiry Card

New Products

GRIDDED TW TUBE

A 1 kw traveling wave tube, the MAS-1E, combines a periodic focused permanent magnet (PPM) with a gridded gun. The tube operates in the S-band from 2.0 to 4.0 KMC. A control grid, enables operation with



a very fast response time with low power consumption and simple modulation problems. A primary use is as a final output tube. It can be used to drive other high powered traveling wave tubes or klystrons. Peak output is in excess of 1 kw at 0.5 w input. By cascading 2 tubes, an output of 1 kw can be obtained with less than 0.5 mw of drive. Hughes Products, Electron Tube Div., International Airport Sta., Los Angeles 45, Calif.

Circle 233 on Inquiry Card

Bridge-to-Bridge Radio for Tankers

A ship-to-ship radiotelephone was tested successfully aboard the newest and largest tanker based in the Port of Philadelphia.

The new equipment, installed on Sun Oil Company's 50,000-ton supertanker S. S. Pennsylvania Sun, permits continuous, instantaneous communication between the bridges of ships. This will help to eliminate collisions between ships.

The telephone system, which has an effective range of 10 miles, is said to be the first single-channel bridge-to-bridge telephone system installed on any ship. The company is installing 18 such units on its fleet of ocean-going tankers.

Data Printer Uses Low Power Input

A miniature data printer, smaller than a pack of cigarettes and weighing only a few ounces, has been developed by New York University's research division. The new unit can replace one of the bulkiest components of data systems, the electric typewriter.

Printing is accomplished by energizing elements of an array of stainless steel printing segments. The steel electroplates onto sensitized paper. As many as 20 digits can be printed simultaneously. The printer uses little power and can record directly from the outputs of most electronic devices, thus eliminating the usual isolation and driver stages.

FAA Says Decca Mark X Has Limited Value

The Federal Aviation Agency, in a report, "Helicopter Operations Program, Phase 1," scheduled for publication in the near future, lists some major shortcomings of the British Decca Mark X navigational equipment.

The FAA evaluated the system to check its suitability as an international system of navigation.

The International Civil Aviation Organization (ICAO) last February adopted the U. S.'s VOR-D-MET as the international standard over the protest of the British.

FAA found that on 61% of the test routes flown the pilots reported failure of the Decca equipment to provide the necessary navigation intelligence to use the system continuously as a primary IFR navigational aid.

NEW FACILITY

This "White Room" lab is part of the new West Coast headquarters of Miniature Precision Bearings, Inc. It is located at 8621 Bellanca Ave., Los Angeles, Calif. Engineer Robert Pierson is lubricating a miniature precision bearing.

Freon-14 Used in Satellite Jets

DuPont's "Freon-14" (tetrafluoromethane), originally developed as a refrigerant, is being used in guidance systems on the Discoverer satellite. Freon-14 boils at —198°F. In the guidance system, it spurts out of reaction jet nozzles to provide thrust for regulating attitude.

The entire pneumatic attitude control system weighs about 70 pounds, including torque motors, thrust nozzles, pressure regulator, propellent lines, manifolds, and metal "bottle" containing the supply of nitrogen and Freon.

Data Processor Speeds Spares

The new IBM 705 III electronic data processing system being used by the U. S. Army Transportation Material Command in St. Louis, Mo., communicates via wire and radio circuits with military installations all over the U. S. and on four other continents.

The computer reduces time from requisition to delivery from fifteen days to seventy-two hours.

Brig. Gen. William B. Bunker, Commanding General, says, "The ability to handle orders faster, work with smaller inventories, and reduce losses due to obsolescence is expected to save at least $6,000,000 annually for the next three years."

Lt. Col. W. R. Elliott and Brig. Gen. W. B. Bunker inspect console of TMC's new data processing system.

All the information on 300,000 separate items in TMC's inventory is contained in 45 reels of magnetic tape. The computer processes about 10,000 transactions each 24 hours.

Magnet for Microwave Research Has 3 Poles

Magnets with three poles are almost as scarce as men on the moon. But not quite. The University of Michigan has one, believed to be unique.

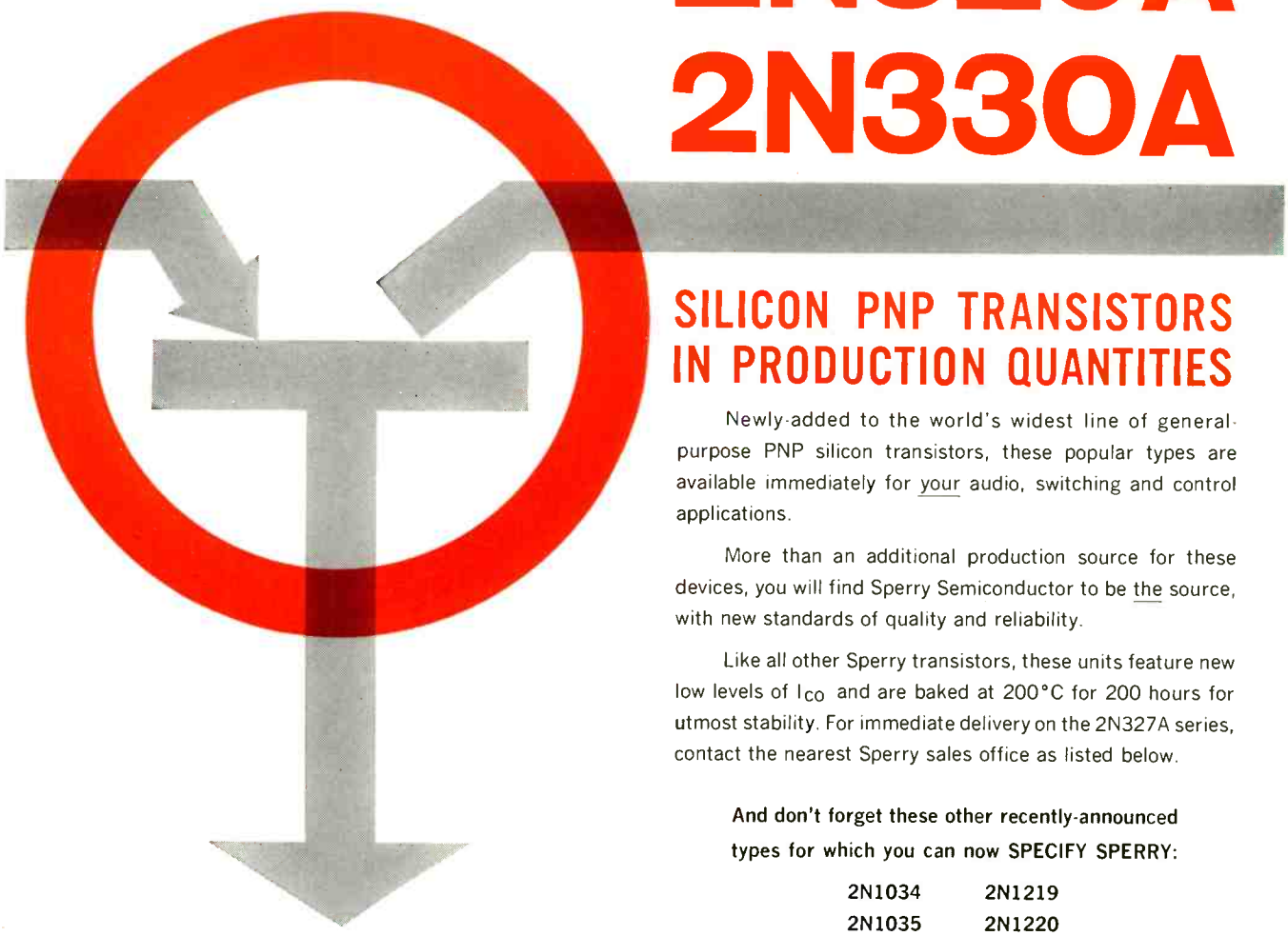
One of a pair of new magnets on the campus being used for research for the armed services, it's designed for basic research on how magnetism affects magnetic materials which in turn affect microwaves.

The research is part of a project undertaken by Assoc. Prof. Dale M. Grimes (Ph.D.), of the Electrical Engineering Dept., under the direction of the U-M Research Institute (UMRI).

The three-pole magnet is being applied particularly to lining up crystals of magnetic materials used as microwave circuit elements. (These are ceramic materials like those used in telephone equipment, and in radio and television sets.)

The three-pole magnet is about the size of a ten-pound wheel of cheese, about a 1½ ft. in diameter.

NOW YOU CAN SPECIFY SPERRY FOR 2N327A 2N328A 2N329A 2N330A



SILICON PNP TRANSISTORS IN PRODUCTION QUANTITIES

Newly-added to the world's widest line of general-purpose PNP silicon transistors, these popular types are available immediately for your audio, switching and control applications.

More than an additional production source for these devices, you will find Sperry Semiconductor to be the source, with new standards of quality and reliability.

Like all other Sperry transistors, these units feature new low levels of I_{CO} and are baked at 200°C for 200 hours for utmost stability. For immediate delivery on the 2N327A series, contact the nearest Sperry sales office as listed below.

And don't forget these other recently-announced types for which you can now SPECIFY SPERRY:

2N1034	2N1219
2N1035	2N1220
2N1036	2N1221
2N1037	2N1222
2N1275	2N1223

SPERRY

SPERRY SEMICONDUCTOR DIVISION, SPERRY RAND CORPORATION, SOUTH NORWALK, CONNECTICUT
Call or write: Sperry Semiconductor, Wilson Avenue, SOUTH NORWALK, Conn., VOlunteer 6-1641; in NEW YORK PLaza 2-0885; 3555 W. Peterson Ave., CHICAGO 45, Ill., KEystone 9-1776; 2200 East Imperial Highway, EL SEGUNDO, Calif., ORegon 8-6226.

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
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YOUR NAME ..... TITLE .....

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ALPHABETICAL LISTING OF

CIRCLE THE NUMBERS OPPOSITE THE NAMES OF THE

A

92 Acme Electric Corporation — Transformers
121 Alden Products Co.—Insulated tube cap connectors
96 Alford Manufacturing Company — Slotted lines
27 Allegheny Ludlum Steel Corporation—Nickel-Iron strip, electrical steels
12 Allen-Bradley Co.—Ceramic disc capacitors
20 Allied Chemical Corp., General Chemical Div. — "Electronic-grade" hydrogen peroxide
87 Allied Radio Corp.—1960 Electronic catalog
66 AMP Incorporated—Taper pins and terminal blocks
29 Amphenol-Borg Electronics Corp., Cable & Wire Div.—Cables of all types
21 Amphenol-Borg Electronics Corp., Connector Div.—RF connectors
22 Amphenol-Borg Electronics Corp., Distributor Div.—RF connectors
68 Arco Electronics—ELMENCO capacitors for distribution
80 Armco Steel Corporation—Thin electrical steels, Nickel-Iron magnetic alloys

B

37 Babcock Relays, Inc.—Miniature relay
43 Beckman/Berkeley Division, Beckman Instruments, Inc.—Counter
140 Bendix Aviation Corporation, Red Bank Division—Power transistors
113 Birtcher Corporation, The—Diode radiators
137 Bliley Electric Company — Oscillator, crystal and ovens
90 Bogart Manufacturing Corp.—Coaxial dry dummy loads, switch, and balanced bar hybrid
152 Bomac Laboratories, Inc. — Microwave tubes and components
24 Borg Equipment Div., Amphenol-Borg Electronics Corp.—Miniature trimmer potentiometers
49 Bourns, Inc., Trimpot Division—Miniature trimmer potentiometer
46 Breeze Corporations, Inc.—Slip rings
84 Brinkmann Instruments, Inc.—Manipulators for scientific and industrial operations
123 Bruno-New York Industries Corp.—"Pig-tailoring" machine
51 Brush Instruments Division of Clevite Corp.—Direct writing recording systems
52 Brush Instruments Division of Clevite Corp.—Chart paper
7 Burnell & Co., Inc.—Bandpass filters
48 Bussmann Mfg. Division, McGraw-Edison Co.—Fuses and fuseholders

C

93 Cambridge Thermionic Corporation — Vibration-proof battery holders
10 Cannon Electric Company—Terminals with self-fastening insulator
32 CBS Electronics, Semiconductor Operations—NPN switching transistors
100 Centralab Electronics Division of Globe-Union, Inc.—Ceramic capacitors
54 Cinch Manufacturing Company — Subminiature connectors
143 Cincinnati Sub-Zero Products—Sub-zero environmental chambers
109 Clare & Co., C. P.—Relays, relay test
71 Clarostat Mfg. Co., Inc.—Miniature precision potentiometers
44 Cleveland Container Co., The—Phenolic tubing
132 Clevite Transistor A Division of Clevite Corporation—Switching transistor with space-saving mounting
150 Columbian Carbon Company, Mapico Iron Oxides Unit—Iron oxides for ferrites
139 Communication Accessories Co.—Delay lines
125 Communication Accessories Co.—Transformers and reactors
26 Corning Glass Works—Ceramic printed circuit board
99 Curtiss Wright Corporation, Electronics Division—Time delay relay

D

75 Dale Products, Inc.—Miniature trimmer potentiometer
98 DeJur-Amsco Corporation, Electronics Division — Potentiometers and panel instruments
103 Delco Radio Division of General Motors —Transistors
41 Deutsch Company, The—Snap-in type connectors
116 Dialight Corporation—Neon pilot-lights with built-in resistor
79 DuMont Laboratories, Inc., Allen B.—High-frequency oscilloscope

E

105 Eisler Engineering Co., Inc.—Welders and welding accessories
64 Eitel-McCullough, Inc.—Power klystrons
148 Electronic Tube Co., Inc., EICO—Electronics catalog
108 Elastic Stop Nut Corporation of America, AGA Division—Miniature time delay relays
69 Electro Motive Mfg. Co., Inc., The—MYLAR-paper dipped capacitors
16 Elgin-Advance Relays, Elgin National Watch Company—Miniature relays
6 Engineered Electronics Company—Breadboard kit and plastic circuit cards

F

95 Fairchild Semiconductor Corporation—Silicon mesa transistors
128 Film Capacitors, Inc.—Power supplies
146 Freed Transformer Co., Inc.—Toroidal inductors
15 Fusite Corporation, The—Glass-to-metal seals
78 FXR, Inc.—Microwave power supply

G

138 Gamewell Company, The—Precision rotary switch
33 Garlock Electronic Products, The Garlock Packing Company — Engineered electronic components
8 General Electric Co., Receiving Tube Department — Subminiature tubes with heat-resistant glass
67 General Instrument Corporation, Semiconductor Division—Silicon rectifiers
144 General Products Corporation—Aircraft type terminal boards
45 General Transistor Corporation—Diodes
34 Gertsch Products, Inc.—AC or DC voltage dividers
147 Graphic Systems—Visual control board
76 Gulton Industries, Inc. — Sealed nickel cadmium button cell battery

H

5 Hi-Q Division, Aerovox Corporation—Rolled ceramic capacitors
104 Hoffman Electronics Corporation, Semiconductor Division—Silicon mesa transistors
129 Hoffman & Co., Inc., H. L.—Multiplier phototubes

Postcard valid 8 weeks only. After that use own letterhead describing item wanted. **FEB. 1960**

Please send me further information on the items I have circled below. 2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
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YOUR NAME ..... TITLE .....

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FIRST CLASS
PERMIT NO. 36
PHILA., PA.

BUSINESS REPLY CARD
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ELECTRONIC INDUSTRIES
c/o University of Pennsylvania
The Computer Center
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Philadelphia 4, Pennsylvania

ADVERTISERS IN THIS ISSUE

ADVERTISERS FROM WHOM YOU DESIRE FURTHER INFORMATION

3 Hughes Aircraft Company, Semiconductor Division—Silicon diodes
4 Hughes Aircraft Company, Vacuum Tube Products Div.—Flat-face storage tubes

I

149 Ideal Precision Meter Co., Inc.—Panel meters
101 Illinois Condenser Company—Miniature electrolytic capacitors
126 Illumitronic Engineering — Plastic rod, tubing and sheet
102 Industrial Test Equipment Co. — AC electronic generator
11 Institute of Radio Engineers — 1960 Radio Engineering Show & IRE National Convention
60 Instruments for Industry, Inc. — Preamplifier

J

65 Jennings Radio Manufacturing Corporation — Vacuum components catalog summary
117 Johnson Co., E. F.—Plastic sockets
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PROFESSIONAL ENGINEERING OPPORTUNITIES

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511 Garrett Corporation, The
509 Garrett Corporation, The
508 General Electric, Communication Products Dept.
504 General Electric, Light Military Electronics Dept.
502 General Electric, Missile & Space Vehicle Dept.
505 Melpar, Inc.
506 Motorola, Inc.
507 Magnavox Co., Government & Industrial Div.
503 National Cash Register Company, The
501 Raytheon Company, Government Equipment Div.
512 Remington Rand Univac Division of Sperry Rand Corporation

K

80 Keithley Instruments, Inc.—High voltage supply
70 Klein & Sons, Mathias—Pliers
18 Knapic Electro-Physics, Inc.—Silicon for infrared domes and lenses
112 Kulka Electric Corp.—Miniature taper-pin terminal blocks

L

145 Lifschultz Fast Freight—Coast to coast freight forwarding

M

91 Magnetic Amplifiers, Inc. — Static inverters
57 Magnetics, Inc.—Powder cores
106 Marconi Instruments—Q Meter

Employment—Use the handy card below to get more information on the engineering positions described in the "Professional Opportunities" Section which begins on page 193 of this issue.

Postcard valid 8 weeks only. After that use own letterhead describing item wanted. **FEB. 1960**

PROFESSIONAL ENGINEERING OPPORTUNITIES

Please send me further information on the engineering position I have circled below.

501	506	511	516	521
502	507	512	517	522
503	508	513	518	523
504	509	514	519	524
505	510	515	520	525

YOUR NAME .....TITLE.....

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FEB. 1960

NEW Subscription Order

Please enter a new complimentary subscription to ELECTRONIC INDUSTRIES

Company Name: .....

Name: ..... Position .....

Company Address: .....

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

Specific Products Manufactured .....

Advertisers, February, '60—(Continued)

P

122 Panoramic Radio Products, Inc.—Spectrum analyzer
9 Philco Corporation, Lansdale Division—Ultra high-speed switching transistor
18 Polarad Electronics Corporation—Calibrated Microwave field intensity receiver system
19 Polarad Electronics Corporation—Precision noise generator

R

1 Radio Materials Corporation—Subminiature disc capacitors
124 Rahm Instruments — Pressure transducers
53 Raytheon Company, Industrial Components Division—Gas diode tubes
58 Revere Corporation of America—Molded harnesses
141 Rohn Manufacturing Co., Inc.—Communications towers
42 Rotron Mfg. Co., Inc.—Integrated cooling fan

S

55 Sangamo Electric Company — Silvered mica capacitors
74 Sarkes Tarzian Inc., Semiconductor Division—Silicon rectifier
83 Scintilla Division, Bendix Aviation Corporation—Connectors
115 Segal, Edward—Eyelet machine
133 Shure Brothers, Incorporated—Communications microphone
97 Sifco Metachemical, Inc.—Selective plating for printed circuits
130 Spectrol Electronics Corporation—Transistorized power converters and inverters
131 Sperry Semiconductor Division, Sperry Rand Corporation—Silicon PNP transistors
2 Sprague Electric Company—Resistors
14 Sprague Electric Company—Tantalex capacitors
62 Stackpole Carbon Co.—Switches
120 Stanpat Co.—Adhesive backed drafting aid
118 Stromberg Carlson Division of General Dynamics—Twin-contact relays
50 Struthers-Dunn, Inc.—Relays
111 Sylvania Subsidiary of General Telephone & Electronics—Mixer, detector, varactor Microwave diodes
77 Sylvania Subsidiary of General Telephone & Electronics — Germanium switching diode
81 Sylvania Subsidiary of General Telephone & Electronics—Electron Tubes
82 Sylvania Subsidiary of General Telephone & Electronics—Tubes for Stereophonic amplifiers, TV receivers

T

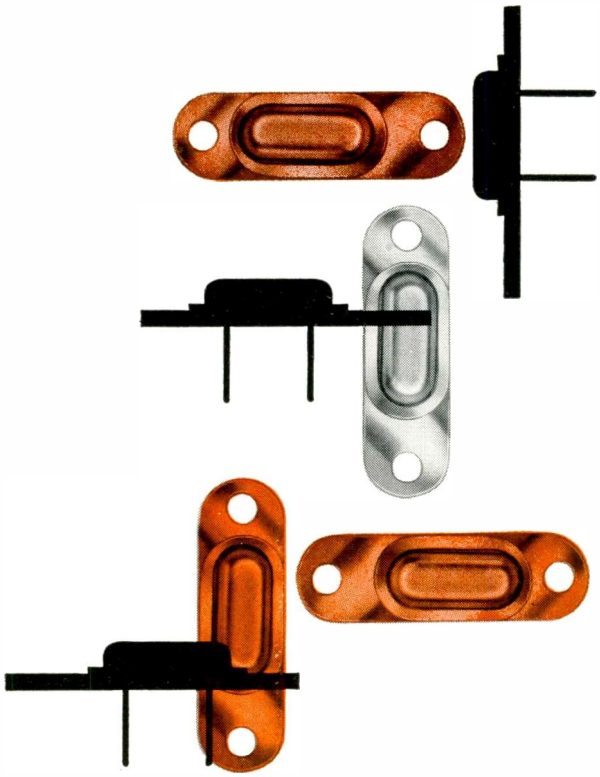
39 Telechrome Manufacturing Corp.—FM/FM telemetering transmitter
89 Texas Instruments Incorporated—Solid tantalum capacitors
47 Texas Instruments Incorporated—Silicon mesa transistors
40 Tinnerman Products, Inc. — Stainless steel vibration proof fasteners
61 Transitron Electronic Corporation—Silicon switching device
28 Triplett Electrical Instrument Company —Panel meters
23 Tung-Sol Electric, Inc.—Tubes

U

136 Ultrasonic Industries, Inc.—Ultrasonic cleaner
63 United Shoe Machinery Corporation—Metal forming and engineering service
59 United Transformer Corporation—Transistor transformers
17 U. S. Components, Inc.—Solderless connectors

V

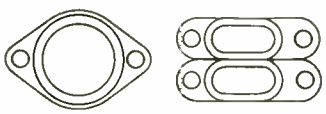
88 Varflex Sales, Co., Inc.—Silicone tubing and sleeving
25 Varian Associates, Tube Division—Micromave tubes
94 Vector Electronic Company — Patchboards
110 Victoreen—Corona type voltage regulator tubes



CLEVITE'S NEW

SPACESAVER

TRANSISTOR



½ actual size

THREE AMPERE SWITCHING TYPES

TEST	CTP 1728	CTP 1735	CTP 1729	CTP 1730	CTP 1731	CTP 1736	CTP 1737	CTP 1733
Min BVcbo @ 2 ma (volts)	40	60	80	100	40	60	80	100
Min BVceo @ 500 ma (volts)	25	40	55	65	25	40	55	65
Min BVces @ 300 ma (volts)	35	50	65	75	35	50	65	75
Max Icbo @ 90°C @ Max Vcb (ma)	10	10	10	10	10	10	10	10
Max Icbo @ 2 V (μa)	50	50	50	50	50	50	50	50
D. C. Current Gain @ 0.5A	30-75	30-75	30-75	30-75	60-150	60-150	60-150	60-150
Max Veb @ 3.0 A (volts)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Max Vce (sat) @ 3.0A, 300 ma (volts)	1.0	1.0	1.0	1.0	0.8	0.8	0.8	0.8
Min fae @ 3.0 A (kc)	20	20	20	20	15	15	15	15
Max Thermal Resistance (°c/w)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

Compared with present power transistors of similar ratings, the new Clevite ***Spacesaver*** gives you important new advantages.

Better Switching — Its low base resistance gives lower input impedance for the same power gain and lower saturation resistance, resulting in lower "switched on" voltage drop. Its lower cut off current means better temperature stability in direct coupled circuits (such as regulated power supplies) and a higher "switched off" impedance.

Better Amplifying — Improved frequency response leads to higher audio fidelity, faster switching and improved performance in regulated power supply applications.

Better Mounting — The ***Spacesaver's*** simple rectangular configuration and low silhouette make it adaptable to a wide variety of mounting requirements where space is at a premium. In aircraft and missile applications, its low mass (half present type) improves shock and vibration resistance of lightweight assemblies.

A DIVISION OF
CLEVITE CORPORATION

Phone for data and prices.

CLEVITE TRANSISTOR

254 Crescent Street Waltham 54, Mass. Tel: TWinbrook 4-9330

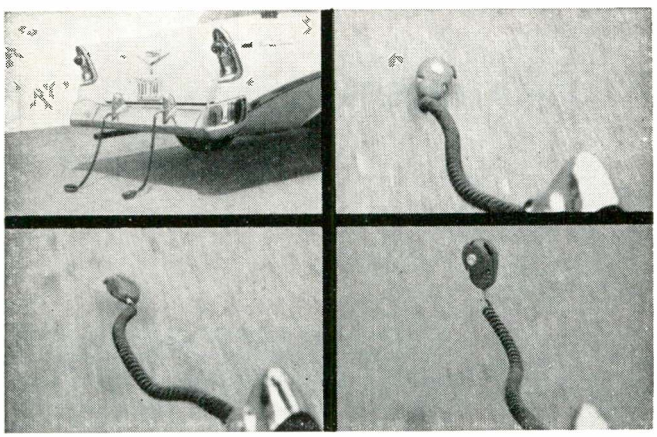
35,000 SMASHING, BATTERING IMPACTS—

and still working perfectly!

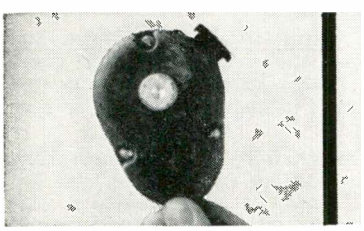
SHURE "TEN-FOUR"

COMMUNICATIONS MICROPHONE

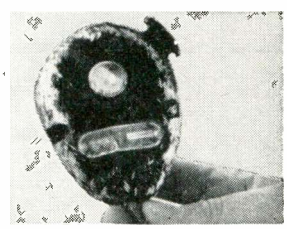
proves its incredible durability in this gruelling destruction test!



New SHURE "TEN-FOUR" MICROPHONE, with exclusive Armo-Dur housing, and another microphone with standard die-cast metal housing were dragged for miles on a test drive over all kinds of pavements at speeds to 30 mph. In a matter of minutes, it was subjected to greater punishment than a lifetime of severest mishandling *and here's the result:*



Ten-Four with Armo-Dur Housing virtually unmarked—*still performed perfectly!*



Standard microphone with die-cast metal housing — cracked, broken, abraded—microphone inoperable.

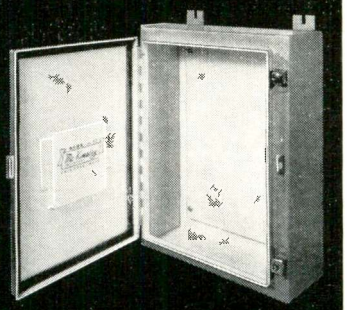
For the microphone that stands up under severe operating conditions with no loss of high speech intelligibility, be sure to specify the Shure "Ten-Four" when you order your new communications equipment or replacements.

Available only to Manufacturers of Communications Equipment.
(Can be furnished with "Controlled Magnetic" or carbon cartridge.)

SHURE BROTHERS, INCORPORATED
222 Hartrey Avenue, Evanston, Illinois, Dept. 33-B

HIGHEST QUALITY MICROPHONES—FIXED-STATION AND MOBILE
Circle 133 on Inquiry Card

Get more for your electrical dollar with McKINSTRY NEMA Type 12 Panel Enclosures



Splash proof — oil and dust tight • Zinc coated to resist corrosion • Baked-on, white enamel interior • Grey zinc chromate exterior • Flanged box opening for extra strength • Made from bonderized sheet • Continuous welded seam • Continuous hinge • Panel mounted on studs for maximum open panel area.

Write Dept. 70 for catalog and price list showing complete line of McKinstry Electrical Boxes, Panel Boards, Wireways and Fittings.

McKinstry Metal Works, Inc.
285 McKinstry Avenue
CHICOPEE, MASSACHUSETTS

Circle 134 on Inquiry Card

GROW WITH AIRESEARCH IN ELECTRONICS

AiResearch expansion in electronics and electromechanical activity is creating outstanding positions at all levels for qualified engineers.

FLIGHT SYSTEMS RESEARCH

General problems in motivation and navigation in air and space; required background in astronomy, physics, engineering.

Openings also exist in the following areas: Data Systems Research... Controls Analysis... Flight Data Components... Electromagnetic Development... Instrument Design... Airborne Instrumentation Analysis and Design.

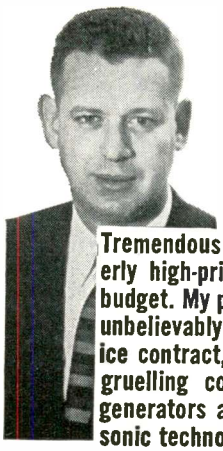
Send resume to: Mr. R. H. Horst

THE GARRETT CORPORATION

AiResearch Manufacturing Division

9851 So. Sepulveda Blvd., Los Angeles 45, Calif.

Circle 511 on "Opportunities" Inquiry Card



My name is Paul M. Platzman,

I pioneered the ultrasonic industry. Two well known ultrasonic companies were founded by me. Now, I have created a new organization, Ultrasonic Industries, Inc., based on a revolutionary approach to mass producing and selling ultrasonic equipment. No middleman's profit in this factory — direct-to-you deal.

Tremendous savings are passed on to you the customer bringing formerly high-priced ultrasonic cleaners within the range of everybody's budget. My products stand out because of their distinctive appearance, unbelievably low money-back-guaranteed prices—free five year service contract, and consistent trouble free performance under the most gruelling conditions. This is possible because my DiSONtegrator generators and transducers incorporate the latest advances in ultrasonic technology.

DiSONTEGRATOR®
SYSTEM FORTY
ULTRASONIC CLEANER

$99.95

Including tank, connecting cable and instruction manual (export model: 220V — 50 cycles $7.50 extra)

The lowest priced ultrasonic cleaner ever sold! **Buy ONE or 100 and Save!**

The DiSONtegrator System Forty ULTRASONIC CLEANER is attractively styled, ruggedly-built, and work-tested to give a lifetime of trouble-free service.

The DiSONtegrator Features:

Simplified one knob control for easy operation. High Frequency sound waves disintegrate harmful soils and contaminants in seconds.
Saves time and labor, boosts production rate, improves product. You can replace hazardous chemicals with safe solvents and even water.

The DiSONtegrator works FAST

In **SECONDS** you can disintegrate soils on: radioactive lab apparatus; glassware; medical instruments; test tubes, syringes, hypodermic needles; dental instruments, drills, burrs, false teeth, bridges; fossils and fossil foraminifera; electronic components, semi-conductors, crystals, switches, precision potentiometers; optical parts, lenses, plastic contact lenses, eyeglasses; timing mechanisms; small gear trains; miniature printed circuit boards; and hundreds of other items.

In seconds you can remove:

rust, oxides, shop dirt, dust, lint, preservatives, finger prints, machining chips, extrusion lubricants, paraffin, wax, paint, varnish, lacquer, plastic residue, resists, silicones, greases, cooked food residue, blood, plaster of paris, lapping compounds, carbon, radioactive particles, polishing compounds, shale, diatomite, volcanic tuffs, clay and sand, graphite, starches, cutting oils, heat treat scale, color stains, foundry sand, abrasives, quenching oil, salts, pitch, asphalt, tar, inks, adhesives, jewelers rouge, tripoli, resin flux, acid flux, many others.

The DiSONtegrator is VERSATILE

In addition to super speed, surgical precision cleaning it can be used to: brighten, quench, degrease, impregnate, decontaminate, pickle, etch, dip coat, emulsify, degas liquids, anodize, dye, mix, accelerate reactions.

Ultrasonic cleaners are widely used

in production lines, maintenance departments and laboratories. You should have at least one DiSONtegrator if your field is Electronic, Optical, Glass, Clinical, Biological, Textile, Oil, Food, Paper, Dental, Plastic, Drug, Rubber, Wood, Chemical, Isotope, Geological, Agronomical, Metallurgical, Anthropological, Paleontological, Petrochemical, Ceramics, Dairy, Brewery, Beverage, Confectionery, Laboratories, Photographic, Paint, Bottling, Cosmetic, Pharmaceutical, Metal Working, Metal Finishing, Die-Casting, Foundry, Plating, Metal Treating, Automotive, Aircraft, Horological, Jewelry, Medical, Marine, Mining, Utilities, Power Plants, Instrumentation.

ultrasonic industries
INC.
141 ALBERTSON AVENUE · ALBERTSON, L. I., N. Y.
Pioneer 1-4333

INTRODUCTORY OFFER

Money Refunded (less shipping charges) if not completely satisfied.

Guarantee

The DiSONtegrator you have just received is the finest ultrasonic machine made. It has passed a rigid inspection and found to be in perfect condition. Read your instruction manual carefully. Properly handled, this equipment will exceed your expectations and render long service.
A free 5 year service policy is included with this purchase. No charge for replacement parts first two years. Tubes carry 90 day guarantee. Service and parts required after the expiration of the guarantee will be furnished at prevailing factory prices.

5-DAY TRIAL

We will pay all shipping charges to any point within the continental limits of the United States (not including Alaska and Hawaii), if you enclose check with order.

UNPRECEDENTED FREE 5 YEAR SERVICE CONTRACT

The DiSONtegrator — System Forty is available from stock for immediate delivery in unlimited quantities.

SPECIFICATIONS

GENERATOR INPUT: 117 V, 60 cycle—GENERATOR OUTPUT: 40 W, 90 KC
DIMENSIONS: GENERATOR: 10" L x 7" W x 5¾" H
Tank (overall): 6¼" L x 7" W x 6½" H
Tank (inside): 5¼" L x 5¾" W x 4" D
Tank (capacity): 0.5 gal.

FOR THE FIRST TIME — you have a choice of 6 beautiful decorator colors to harmonize with your office or laboratory decor: Ivory, Wheat yellow, Turquoise, Desert sand, Pale green and Soft gray. Please specify color when ordering.

ORDER NOW

TO: Ultrasonic Industries, Inc., Dept. 1-EI-2
141 Albertson Avenue, Albertson, L. I., N. Y.

Gentlemen: Please ship _____ DiSONtegrator® System Forty
Unit(s) @ $99.95 ea.: ☐ Ivory ☐ Wheat yellow ☐ Turquoise ☐ Desert sand ☐ Pale green ☐ Soft gray

to: _____

_____

_____

I understand that my money will be refunded if not completely satisfied after 5 day trial.

☐ check enclosed (freight prepaid) ☐ C.O.D.
☐ bill me (rated firms only) ☐ Please put us on your mailing list

GOVERNMENT ELECTRONIC CONTRACT AWARDS

This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in November, 1959.

Amplifiers	126,557
Amplifiers, a-f	104,846
Amplifiers, magnetic	65,876
Amplifiers, r-f	38,150
Amplifiers, synchro signal	107,356
Antennas & accessories	1,003,917
Batteries, dry	225,556
Cable assemblies	48,808
Cable, electronic	31,000
Cable, telephone	91,089
Computers, special purpose	82,916
Computers, indicator radiac	170,647
Connectors	181,094
Console assemblies	27,531
Consoles, situation display	382,989
Control, intercom	180,000
Counters	31,080
Cryostat units	27,305
Crystal units	75,000
Duplexers	45,049
Filters	45,238
Fuses	66,935
Galvanometers	161,577
Handsets	145,787
Insulators, feedthrough	59,432
Meters	70,170
Meters, ohm	79,440
Meters, volt	28,300
Monitors, r-f	86,810
Oscilloscopes	365,950
Oscillographs	122,563
Paper, recording	120,000
Potentiometers	79,126
Radar sets	150,000
Radiacsets	997,322
Radio sets	3,434,214
Reactors	39,729
Receivers, radio	4,808,332
Receiver/transmitters	1,568,545
Recorders/reproducers	147,043
Regulators, voltage	40,467
Relay, armature	465,329
Relay assemblies	348,542
Relays, solenoid	30,631
Resistors	36,662
Semiconductor devices	40,870
Simulators, antenna position	40,921
Switchboard equipment	31,792
Switches	200,415
Switches, pressure	190,676
Switches, rotary	56,818
Tape, magnetic	80,350
Tape, simulator	38,799
Teletypewriters	906,047
Test sets, radio	163,357
Test equipment	1,521,648
Transformers	194,304
Transistors	68,926
Transponders	25,463
Tubes, electron	2,365,283
Tubes, klystron	152,193
Tuning units	44,265

Advanced Research Group Formed

Douglas Aircraft Co. has established a new advanced research organization in Santa Monica, Calif. The staff will be composed of top-flight specialists to be drawn both from within and outside the company.

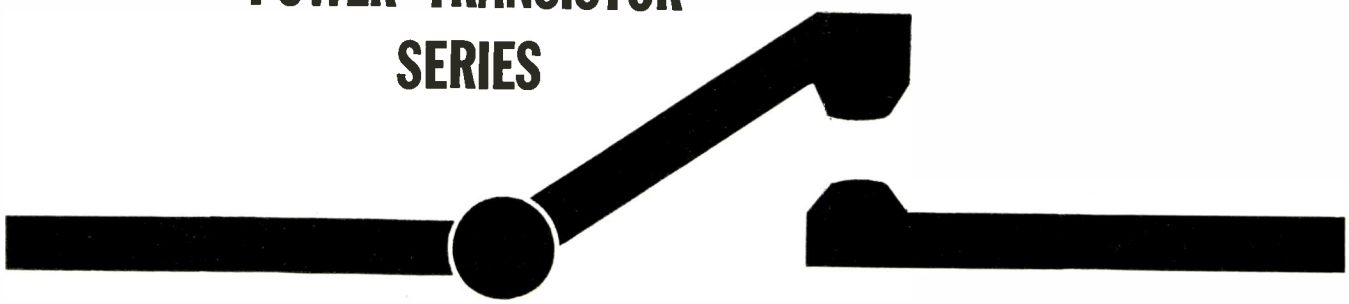
The newly centralized group will be under the overall direction of A. E. Raymond, Sr. Vice President of Engineering.

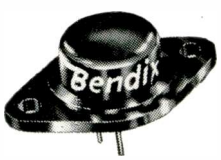
NOW!

Bendix

25-AMP

POWER TRANSISTOR SERIES





Now in production by Bendix* are eight 25-ampere peak current power transistors capable of switching up to 1000 watts—and you can get immediate delivery on all eight types.

Newly improved in design, the transistors have a higher gain and flatter beta curve. The series is categorized in gain and voltage breakdown to provide optimum matching and to eliminate burn-out.

Current Gain hFE at Ic = 10 Adc	Maximum Voltage Rating			
	50 Vcb	60 Vcb	90 Vcb	100 Vcb
	30 Vce	40 Vce	70 Vce	80 Vce
20—60	2N1031	2N1031A	2N1031B	2N1031C
50—100	2N1032	2N1032A	2N1032B	2N1032C

Ask for complete details on this newly improved Bendix transistor series . . . and on the entire Bendix line of power transistors and power rectifiers. Write SEMICONDUCTOR PRODUCTS, BENDIX AVIATION CORPORATION, LONG BRANCH, NEW JERSEY, or the nearest sales office. *TRADEMARK

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LONG BRANCH, N. J.

Bendix
AVIATION CORPORATION

Circle 140 on Inquiry Card

Tele-Tech's
ELECTRONIC OPERATIONS

The Systems Engineering Section of ELECTRONIC INDUSTRIES · FEBRUARY 1960

SYSTEMS—WISE . . .

▸ Packard Bell Computer Corp. has a contract for an analog-to-digital conversion system to be used in the automatic air traffic control system under development for the Federal Aeronautics Administration. The first system will be installed at Atlantic City, N. J., airport for use as an aid in air traffic control in the New York area and as a training set-up for installation at other airports.

▸ **Patent-searching using electronic computer techniques is being tested at the U. S. Patent Office. Officials say it may accomplish in about half-an-hour a job that formerly took a skilled researcher up to a full day. A Bendix G-15 digital computer is being used to search for patent information by a serial scanning technique. Over 1,000 patents are being issued each week.**

▸ A complete radioactivity detection and control system will be designed and built for the AEC's nuclear power plant near Hallam, Neb., by Victoreen Instrument Co. under contract to Atomics International, div. of North American Aviation, Inc. Instruments will measure radiation levels of vapor vents, gasses before being released to the stack, and also check the gasses before they leave the stack.

3-AXIS TELEMETRY ANTENNA

World's largest 3-axis antenna, built by Philco Western Development Labs, Palo Alto, Calif., will be used to receive telemetered information and data from satellites. It is 80 ft. high, weighs over 130 tons, and has a 60 ft. dia. reflector weighing 15 tons.

▸ **Arkansas is installing a modern communications system to help the state's forestry Commission in fire-fighting operations. Seventy-nine radio base stations will be located in various parts of the state, many of them in fire spotting towers. Each station will be able to talk directly with a central control location in Little Rock. General Electric Co.'s Communication Products Dept., Lynchburg, Va., is supplying the equipment.**

NEW TELEX SERVICE

Tosh Nakahiro, staff engineer, communications systems, Cannon Electric Co., and Ralph D. Saylor, Pacific Div. General Mgr., Western Union Telegraph Co., at ceremonies inaugurating two-way direct Telex service in Los Angeles, Calif.

▸ **The Navy's first fully transistorized shipboard fire-control system will be installed aboard the USS George Washington, the Polaris-carrying nuclear powered submarine. The system has more than 15,000 transistors. It also has 1054 digital boards, 18,000 diodes, 40,000 circuits, and 70,000 terminations. It will continuously provide information to the missile guidance system under all sea conditions.**

▸ The Goodyear Aircraft Corp.'s new blimp, the ZPG-3W, built for the Navy and designed strictly for air borne early warning missions, has one of the largest complexes of modern radar and electronic equipment to be operational in a single aircraft. The blimps are 400-ft, 1.5 million cubic ft non-rigid airships scheduled by the Navy for AEW patrol as part of the North American Defense Command. Two have been delivered and two are being built.

▸ **The General Electric Company's Heavy Military Electronics Dept., in Syracuse has a $3,600,000 contract to develop a lightweight air search radar for the U. S. Navy. The air search radar, the AN/SPS-45, is being designed for installation aboard ships of the destroyer class.**

▸ RCA Communications, Inc., has asked the FCC for permission to supplement its global radio communications network with transatlantic coaxial cable channels. RCA would operate the western end of the cables and British, French, and German Post Office agencies the other ends.

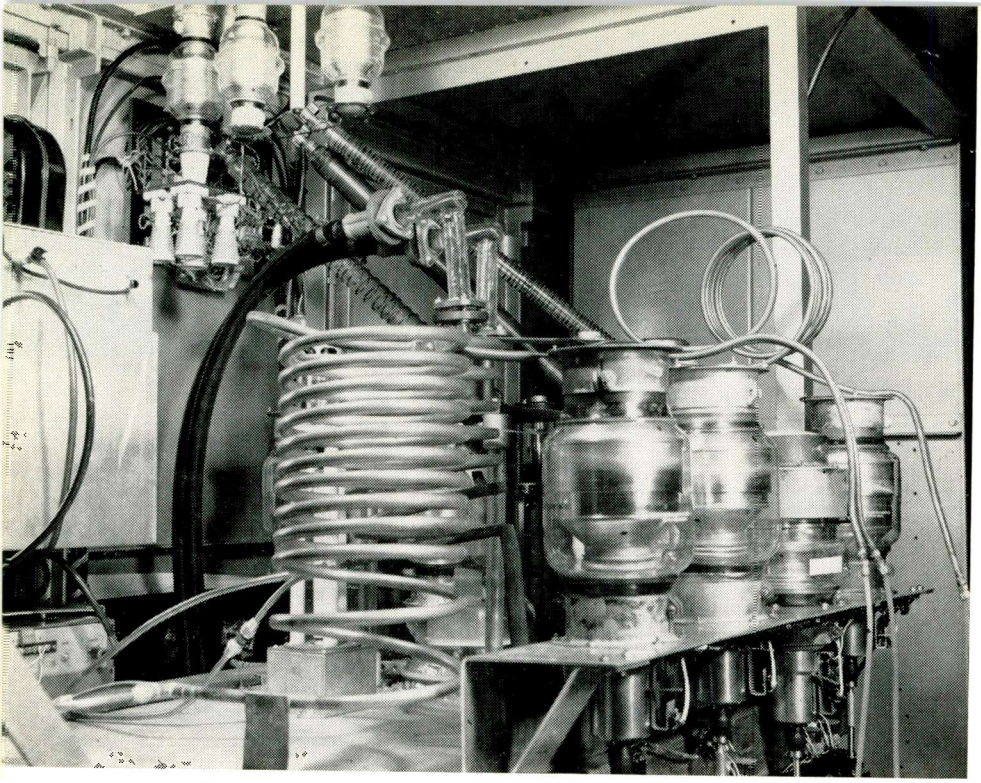


Fig. 1: Final amplifier plate circuits and r-f chokes utilizing motor operated vacuum variable capacitors are shown.

By JO EMMETT JENNINGS
President
Jennings Radio Mfg. Corp.
P. O. Box 1278
970 McLaughlin Ave.
San Jose 8, Calif.

100 KW Transmitter

THE trend in transmitter design has been to employ a combination of inductance and capacitance change to produce the desired frequency. When decreasing inductance it was necessary to physically remove the coil and replace it with one having less inductance, or to short-out the unused portion. The slider system has a high degree of flexibility but there are the disadvantages of physical size as well as contact erosion due to prolonged operation on one frequency. Mechanical linkages or servo operation only ease the physical labor. They have not removed the problems of frequency shift in the transmitter. With the application of vacuum capacitors in tank circuits, wide minimum to maximum capacity shifts are practical, thereby reducing one of the problems in frequency shifting.

The R-F Testing Lab at Jennings Radio Mfg. Corp. is continuously testing vacuum capacitors and vacuum switches to produce realistic data by operating a group of each type of capacitors and switches. Beginning in the 2 to 3 MC range, and going up to 20 or 30 MC., measurements of voltage, current, frequency, and temperature are made. Repetitive testing calls for readjustment in frequency as well as the output circuits for each test. A program of this nature requires almost as much time for set-up as is for testing. Recognizing the mounting labor costs, it was decided to embark on a program of frequency changing from a new concept.

At the outset of this program it was deemed advisable to produce experimental models in the 1 to 2½ kw range. True, the 2½ kw amplifier presented no voltage or current problem, yet there were certain design factors which must be ideal to insure stable operation. A tuned tank circuit for each band was the first step in producing a multi-band amplifier.

To assure success of the new system, several different models were fabricated and put into operation to begin the evaluation process of components, efficiency and adaptability. It was determined early, and verified continuously, that vacuum capacitors and vacuum switches were important in the design of an efficient band switching amplifier.

A prime consideration in setting up an amplifier from 2 to 30 MC. was the h-f resonance in unused tank circuits. The effect of the contact capacity, resistance and inductance in the group of switches, plus the problem of distributing the r-f energy from the particular tank circuit to a load were examined. All of these factors caused us to evaluate single pole vs. multiple pole vacuum switches for long life and stable operation. Needless to say, various models went through an evaluation program and have finally been crystallized in the

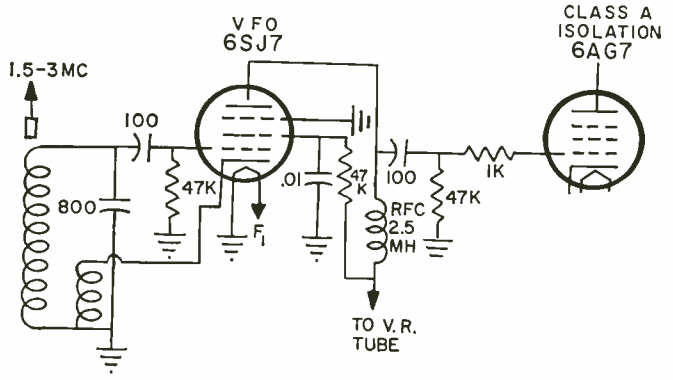
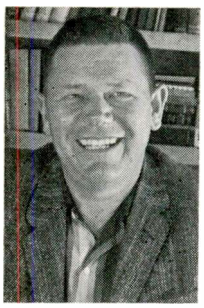


Fig. 2: A stable VFO was chosen instead of a crystal control oscillator because of the need for many different operating frequencies.



J. E. JENNINGS

The new design ideas used in this h-f wide-range transmitter are unique. They can be incorporated in other transmitter designs. Accurate, stable switching is obtained by using vacuum relays and vacuum capacitors in the tank circuits. Over a wide frequency range, r-f chokes can be a problem. A fresh approach to this problem is clearly described.

Has New Design Ideas

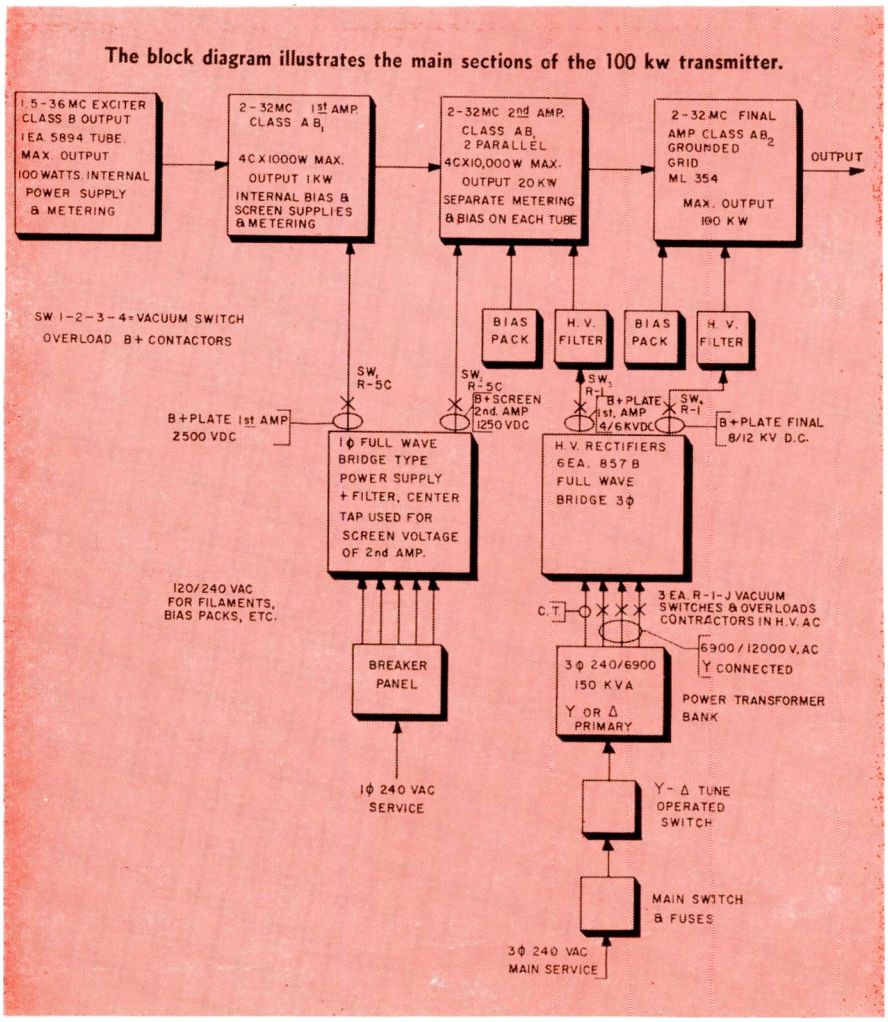
transmitter to be described. The model is now in daily use.

The first and most important part of any transmitter is the signal generator. We chose a stable oscillator (Fig. 2) in preference to a crystal frequency generator since frequency changes in our particular operation were necessary. From the signal generator the harmonic frequencies are produced by a series of frequency doublers, the output of which is switched into tuned input circuits to the first buffer stage, which is followed by the 5-band, 1 kw amplifier operated in Class AB.

First Power Amplifier

As can be seen in (Fig. 3), pi net circuits were employed to match the plate impedance of the buffer to the grid impedance of the first power amplifier. We used a Model RB3 dpdt vacuum switch for each tank circuit (Fig. 4), the solenoids of which are energized from the master band switch. All of the solenoid relays are operated at 24 vdc. to eliminate hum, shock, and simplify wiring. The input of the first power amplifier incorporates a circuit with tetrode power tubes. By resistive loading the in-

The block diagram illustrates the main sections of the 100 kw transmitter.



Transmitter Design *(Continued)*

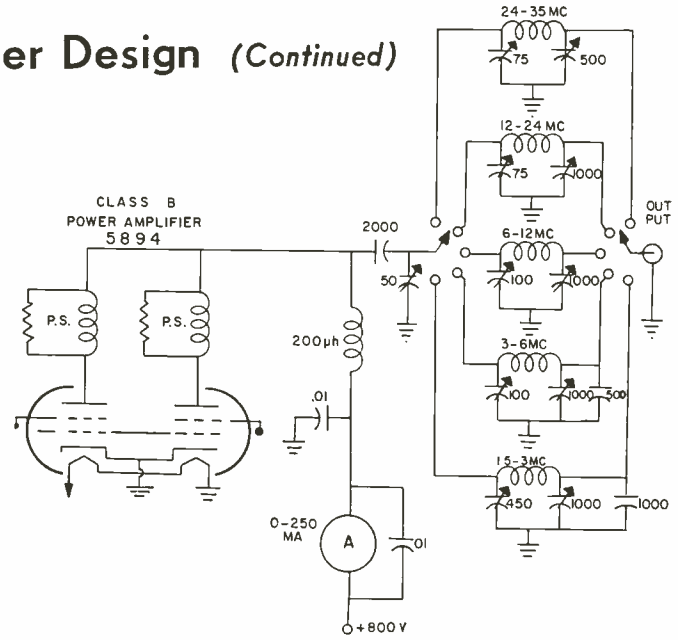


Fig. 3: Pi networks were used to match buffer output to grid of first P.A.

put circuit and dissipating a given amount of energy, we simultaneously reflect a low impedance at the grid itself. This assures stable operation and reduces the tendency towards non-linearity should we use this for AM or SSB linear amplifier service.

The output of the 1 kw amplifier tube is fed into a group of dpdt vacuum switches. One section switches the plate from the tube to the tank circuit. The other section switches the output from the tank circuit to the next power amplifier grid. When not in operation all tank circuits are grounded as well as isolated from the operating circuit. The low contact resistance and low inductance of a vacuum switch, combined with its small space requirements, make it ideal for this application. As can be seen in (Fig. 4), a pi net output is not employed since conductive coupling gives very good results. A pi net could have been used, but this circuit was found to perform satisfactorily without the additional components.

Resistance stabilization of the grid proved highly desirable for the 4CX10,000W tubes as no neutralization was necessary. When operating the second P.A., much thought was given to r-f potentials and the type of switches capable of handling the tank current as well as r-f voltage. Successful operation was attained with an R5C spst vacuum switch actuated by its accompanying insulated solenoid. Provision for metering the screen current of each tube, plus a vacuum circuit breaker gave ample protection for the screens. Normally a failure of plate potential without interrupting the screen potential would damage the tube, so the application of this miniature vacuum overload in the screen circuit was a necessary protection.

A fresh approach to r-f chokes can be seen in the plate of the 20 kw P. A. (Fig. 5). A group of r-f chokes are connected in series for each tube, accompanied by vacuum switches which short-out unused portions. The reason for this is quite obvious since a 30 MC r-f choke is completely inadequate on 2 MC, and a 2 MC r-f choke operating on 30 MC results in internal resonances. By shorting out portions of the choke as the frequency is increased, undesirable resonances are eliminated in a very simple manner. The output from the second amplifier, as switched by the series of R5C vacuum relays is used to excite a Machlett 354 power amplifier.

The 100 kw final stage operates in a conventional grounded grid configuration. As to the method of coupling, we were fortunate in having high current, high capacity, low inductance, fixed capacitors to by-pass the grid. For a high frequency operation, low capacity ceramics were mounted radially (Fig. 6) from grid to ground in a configuration resembling the

spokes of a wheel. Connected in parallel were four .002 μf vacuum capacitors for operation on the lower frequencies. Also two .002 μf capacitors of the same type were used to couple the r-f from the coax to the filament of the 354.

Switching final tank circuits with Type R1 vacuum relays proved to be a good choice as the potentials of 10 to 13 kv dc on the plate give parallel r-f potentials on the switches and vacuum capacitors. See Fig. 7.

For operation on the lower frequencies the residual capacity of the tube did not present a problem. From 20 to 30 MC the residual capacity presented a "Q" problem. It was solved by using a series resonant circuit. The output load was approximately 50 ohm and conductive coupling was used, although a pi net could have been incorporated in the design. A bank of five RC10's, 3⅛ in. coax vacuum switches were used to couple each output circuit to the load termination.

As the schematic shows we have built up a different arrangement of the r-f choke assembly in the final. Perhaps other systems could have been equally effective, but this method is practically fool-proof. Any radio frequency choke can be selected by the vacuum switch assembly. Proper indexing of these switches is accomplished by the master switch on the control panel. Actually, three solenoid type chokes were connected in series with vacuum switches which could short-out progressively as the frequency is increased. To further protect the final amplifier tube, a vacuum overload has been incorporated to interrupt high voltage fault current in about 10 msec. Since all of the amplifiers are operating in the AB region, excellent harmonic suppression is achieved. An oscilloscope monitors the signals at all times, displaying a sine wave. This is essential for establishing calculated current ratings compared to laboratory results.

Water cooling was necessary in the 20 kw driver tank circuit and the tank coils of the final amplifier. Actually, liquid cooling of the coils is accomplished in a unique fashion. The correct O.D. of straight tubing is selected for the current

ESTIMATED CURRENT FLOW IN SWITCHING RELAYS

Band		Amps
No. 1	2 - 3.5 MC	17½
No. 2	3.5- 6 MC	28
No. 3	6 -10 MC	56
No. 4	10 -18 MC	93
No. 5	18 -32 MC	150

Allowable frequency shift:

Without retuning when circuit is loaded 100 KC:

±50 KC unloaded:

Loaded band		
	No. 1	±100 KC
	No. 2	±150 KC
	No. 3	±200 KC
	No. 4	±300 KC
	No. 5	±400 KC

R-F CHOKE ARRANGEMENT

Band 1 & 2—2 to 3.5 MC—1st RFC; 3.5 to 6 MC

Band 3-4—6 to 10 MC—2nd RFC; 10 to 18 MC

Band 5—18 to 32 MC—3rd RFC

2 to 6 MC 14 turns per in.—27 in. long.

6 to 18 MC 3 turns per in.—27 in. long.

18 to 32 MC 1 turn per in.—27 in. long.

1½ in. dia. for high frequency.

2 in. dia. for low frequency.

All wound on hard glass tubing.

Fig. 4: Vacuum switches were used in the output of first P.A.

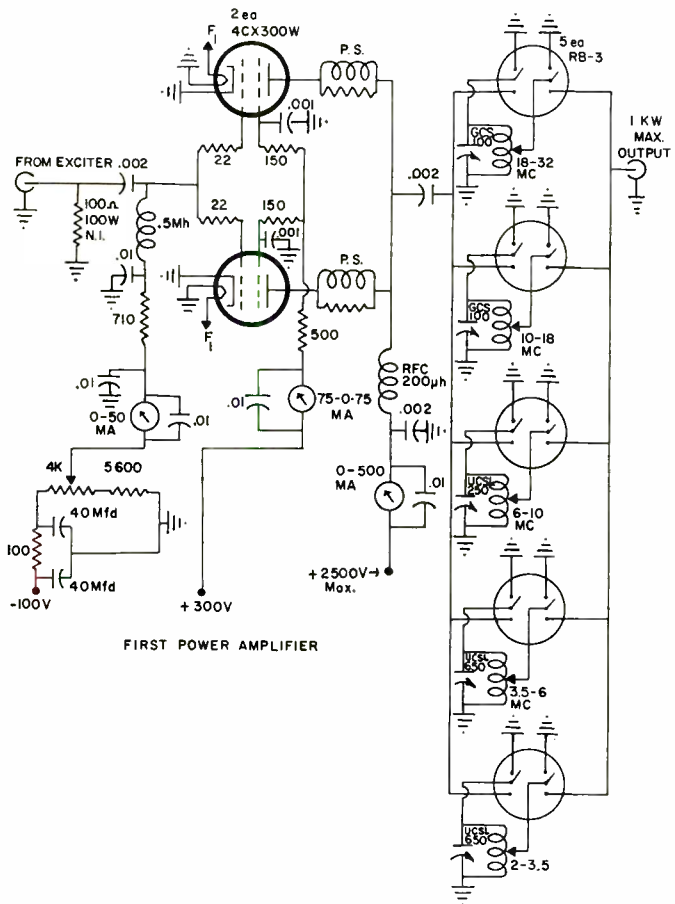
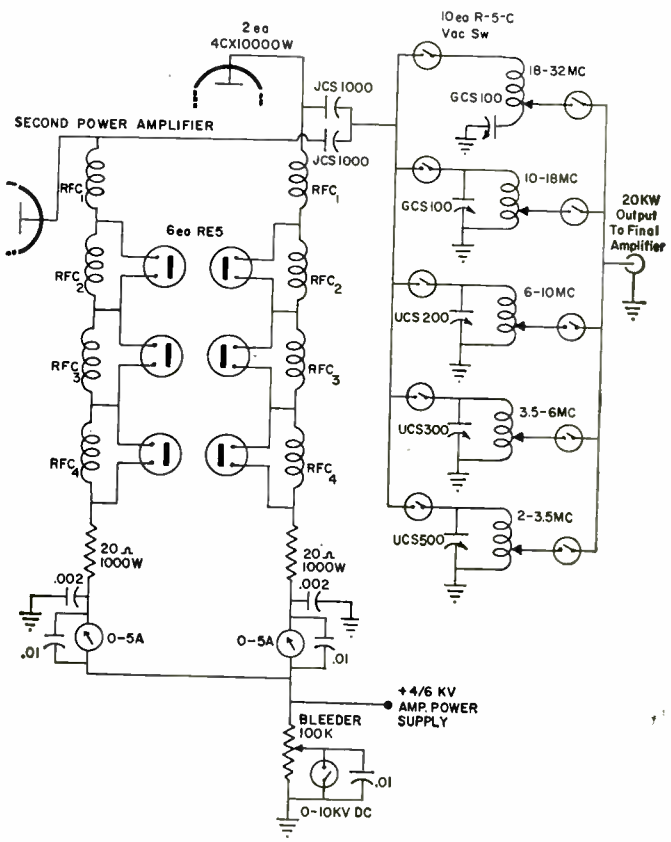


Fig. 5: A fresh approach to r-f chokes can be seen in 2nd P.A.



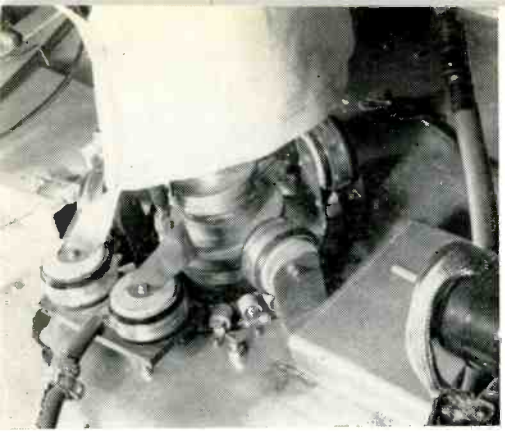


Fig. 6 (left): Final P.A. tube is shown with radially mounted ceramic capacitors. Cloth over tube is air duct.

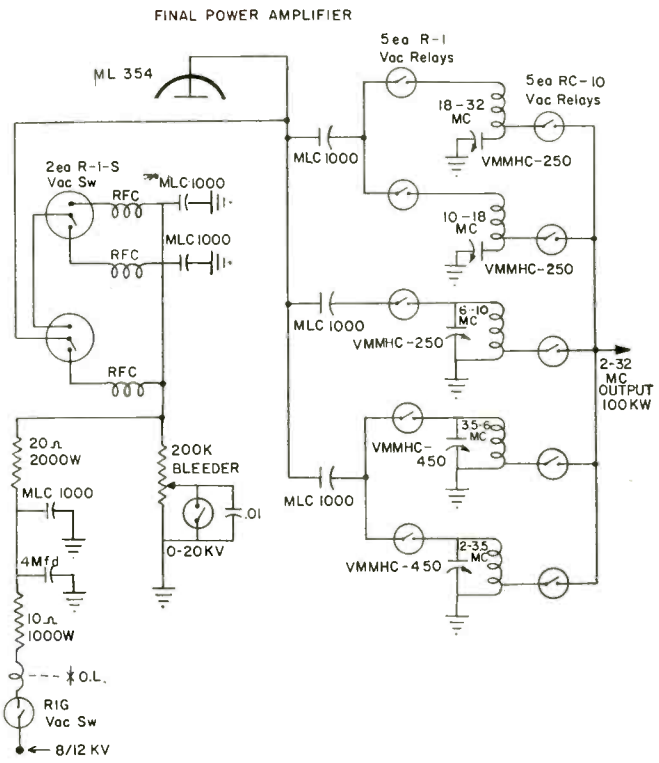


Fig. 7: Final tank circuits are switched into use by vacuum switches. Note r-f choke arrangement.

Transmitter Design

capability and correct inductance. A smaller diameter length of tubing is slipped inside of the larger copper conductor after which the coil is fabricated into a correct physical dimension. The water then flows through the tube and back through the other in a concentric fashion. Cooling water is supplied to the tank coils at r-f ground potential on the first three low frequency bands. When using series resonance on the two higher frequency bands, r-f isolation is part of the cooling system.

Normal operating conditions for the final amplifier tube are as follows: plateloading is 1666 ohms with a capacitive reactance. The highest frequency is 175 ohms and the lowest frequency is 300 ohms. This is for 3 kv dc at 8 amps. The loaded "Q" is approximately 5.

Power Supply

The power supply to accompany the 100 kw transmitter is novel too. Many digressions from the custom construction are incorporated in the new design. A compact walk-in cubicle houses the power supplies and relay assemblies.

All units are adequately protected within themselves and designed for rapid operation and service. First, the power transformers for the high voltage are oil immersed, outdoor type and installed on an outdoor pad. The input is 240 volt 3-phase energized by a 3-wire conventional enclosed, fused, disconnect switch. Incorporated in the primary buss is a 3 pdt manually operated switch to change from Delta to Wye operation. When connected in Wye, operation is for low power or tune-up. The Delta connection is for operating under full power. The secondaries are connected in Wye and are brought into the power cabinet through conduit. Three vacuum circuit breakers are set to trip under overload or fault conditions to protect the electrical system.

As mentioned previously, a vacuum overload is incorporated in the dc 12 kv to interrupt the high voltage for the final amplifier. Another overload is used to interrupt the 6 kv of the 20 kw driver. With these fast operating vacuum dc circuit breakers, it is possible to drop a circuit before any serious difficulty could take place due to fault conditions.

As for the small supplies, they are of a conventional nature and further discussion of their function would be repetitious. Although the partial schematics do not show the complete wiring and monitoring circuits, we have remote reset buttons and indicater lights which show when a circuit is inoperative. This gives greater flexibility and pinpoints for the operator, the defective circuit. This type of power supply design is a radial departure from conventional methods because of the extensive use of vacuum overloads and contactors. Life tests have been conducted to guarantee long life under normal operation or for conditions up to a 500 per cent overload.

Conclusion

Due to the many experimental models previously designed and built before this final transmitter was started, we were able to produce a design that was generally considered impossible. All of the stages performed as designed without being debugged or converted for stable operation. In the entire transmitter, the only problems experienced were with r-f chokes. It took some time to work out the actual r-f choke values for optimum operation on all frequencies. No parasitics were encountered in any stage and the transmitter has been in operation since the original tune-up. All circuits were carefully checked with a grid dip meter prior to applying power, insuring excellent electrical characteristics. Any tank circuit can be shifted and operation established in case of electrical or mechanical failures.

SENIOR ENGINEERS & SCIENTISTS

General Electric's Missile & Space Vehicle Dept. Building New $14,000,000 Space Research Center

17 miles from Philadelphia, Near Valley Forge Park

Back in 1956 this General Electric organization outgrew its quarters in Schenectady, N. Y. and moved to Philadelphia. Since then its research and development staff has increased 5-fold. A new move is fast becoming imperative and will be met by the $14,000,000 Space Research Center now under construction on a 132 acres site near Valley Forge Park. This construction will feature unique facilities, to be utilized in a long-term program, to expand the activities in the realm of space research and the development of space vehicles and systems—areas in which MSVD has already contributed so many notable advances:

- the FIRST re-entry at ICBM range with both heatsink and ablation methods
- the FIRST recovery of payload from space
- the FIRST movies of earth from space
- the FIRST flight demonstration of effective space vehicle stabilization control and navigation (control systems of interplanetary capacity)
- the FIRST measurements in space of earth's magnetic field and infrared radiation
- the FIRST meteorological information from space
- the FIRST organic plastic ablation material for nose cone re-entry protection capable of withstanding temperatures from 5,000 to 13,000°F

Currently a broad diversity of programs are under way at MSVD, offering assignments of exceptional interest to engineers and scientists qualified to work with a research-oriented organization. Your inquiries are invited regarding the following areas: SYSTEMS ENGINEERING • AERODYNAMICS • THERMODYNAMICS • GUIDANCE & CONTROL • INSTRUMENTATION & COMMUNICATION • PLASMA PHYSICS • GAS DYNAMICS • AERO-MEDICAL DESIGN ENGINEERING • ANTENNA & MICROWAVE DESIGN • SPACE MECHANICS • STRUCTURAL DESIGN • ENERGY CONVERSION • HUMAN FACTORS • ADVANCED POWER SYSTEMS • RELIABILITY ENGINEERING • PRODUCIBILITY ENGINEERING • ARMING AND FUZING SYSTEMS • APPLIED MATHEMATICS & COMPUTER PROGRAMMING

Write in confidence to: Mr. Thomas H. Sebring, Div. 24 MB

Missile & Space Vehicle Department

GENERAL ELECTRIC

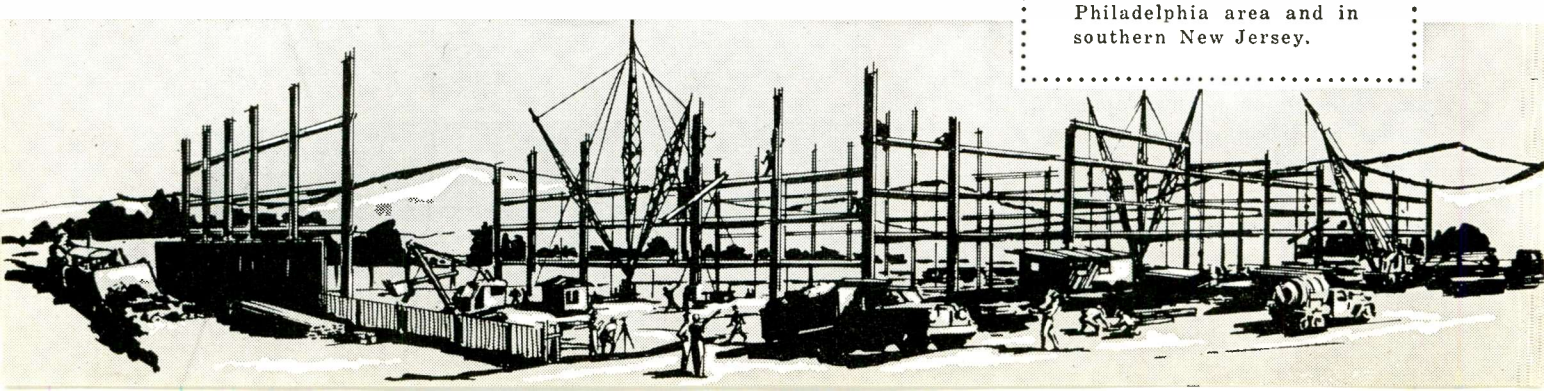
3198 Chestnut St., Philadelphia 4, Pa.

DIVERSITY OF ADVANCED PROGRAMS NOW UNDER WAY AT MSVD INCLUDE:

- Follow-on contracts for 2nd generation nose cones
- NERV (Nuclear Emulsion Recovery Vehicles) for NASA to study the Lower Van Allen radiation belts at altitudes from 200 to 1800 miles
- STEER—a communications satellite to provide global military radio communications.
- Satellite Aero-Medical Recovery Vehicle (SARV) for Discoverer
- Study programs in the area of accessory space power for a variety of missions, including chemical, nuclear and solar energy sources, electrolytic fuel cells and thermoelectric and thermionic converters
- Studies for three of the nation's space agencies to develop more accurate "space maps" than have hitherto existed to guide rockets and manned flights to the moon and planets.

A well qualified scientist or engineer is likely to find advanced work going on at MSVD on almost any field of space research of special interest to him.

A campus-like setting is planned for the new Space Research Center which General Electric's Missile and Space Vehicle Department is building close to historic Valley Forge Park. Situated at the junction of the Schuykill Expressway and Pennsylvania Turnpike, the Center will be easily reached by engineers and scientists living in the Philadelphia area and in southern New Jersey.



PROFESSIONAL OPPORTUNITIES

Reporting late developments affecting the employment picture in the Electronic Industries

Design Engineers • Development Engineers • Administrative Engineers • Engineering Writers
Physicists • Mathematicians • Electronic Instructors • Field Engineers • Production Engineers

"Engineers Need Recognition"—Barthel

"Recognition of the research scientist and engineer as an individual is the first task of management in the effective utilization of its personnel," says Dr. Christopher E. Barthel, Jr., assistant director, Armour Research Foundation.

Barthel, speaking before a panel session at the recent Conference on Efficient Utilization of Engineers and Scientists, pointed out that the necessity of integrating the scientist into a team places a heavy responsibility on management to develop its policies to maintain the dignity and productivity of the individual yet establish objectives, plans, and rules of operation which will stimulate the team effort.

Test Equipment Market to Rise

Steady growth of between 15 and 20 percent will raise annual volume of the electronic test instrument industry to at least $350 million in 1960 says Albert F. Craig, president of Technical Information Corp., 41 Union Square, N. Y., N. Y.

Terming his estimates "on the conservative side," he predicted that a fifth of the test instrument industry's growth would be in the area of power supplies, "reflecting the continued growth of transistors." The power supply market, he said, "should increase from $60 million in 1959 to at least $70 million in 1960. Two other instrument fields slated for rapid growth were high-speed oscilloscopes and pulse generators.

EE Grads Regain Lead

Electrical Engineering students, who last year were second in demand behind Engineering Physicist graduates, regained their lead this year. Everett A. Teal, Director of

OFFER STOCK

Dr. Leslie K. Gulton (left), President of Gulton Industries, Inc., receives check for $1,110,000 from Herman Kahn of Lehman Brothers following the first public sale of 60,000 shares of Gulton common stock.

placement, Lehigh University, says that "the demand never has been as heavy for top students in engineering physics, electrical and mechanical engineering, and those interested in R & D."

Starting salary offers are ranging from $550 to $600. Last year the range was from $490 to $525. Job offers in the non-critical areas carry about the same salary as in 1959. Companies that were below the national average last year have hiked starting salaries to the average starting figure.

Foreign Students Rank At Top of Their Class

The six top men in the graduating class of the RCA Institutes included two men from Latin America. The other four were from New York City. Included among the graduates were students from Chile, Ecuador, Israel, Iran, Peru, Indonesia, Germany, Italy, The Philippines, The Bahamas, and Jamaica, British West Indies.

FOR MORE INFORMATION . . . on positions described in this section fill out the convenient inquiry card, page 177.

Success Formula? Be Mildly Frustrated

A study by David Sirota, Univ. of Michigan Research Center, based on questionnaires given to over 2,000 employees of an electronics manufacturing firm, revealed that employees who were moderately frustrated with promotional chances had a better understanding of company attitudes toward job stability, new product development, expansion, and supervisory activities.

Those who were highly frustrated with promotional chances had the least information about the company, while those who were well satisfied had a medium amount.

The study noted that different types of frustration have different effects. If frustration concerns higher wages rather than promotions, for example, it may result in a strike.

5,000 Hughes Graduates

The technical training program operated by Hughes Aircraft Company, Culver City, Calif., has now graduated over 5000 men in 240 different courses. Over 2,000 of these were military students. The average length of each course is 13 weeks.

The program is designed to familiarize military personnel, airframe contractor personnel, and Hughes' field service and support engineers with the company's electronic armament control systems and Falcon air-to-air guided missiles used in all-weather interceptor airplanes.

The technical training staff numbers about 160 and includes 67 engineers holding bachelor of science and master's degrees and averaging six years of industrial experience. These men serve as classroom instructors in all phases of electronic systems including: communications, navigation, radar, guided missiles, automatic flight controls, and digital and analog computers.

- *Is a personnel philosophy necessary for the R & D organization?*
- *How about recruiting?*
- *Salary administration?*
- *Educational advancement?*
- *A noted administrator makes some thought provoking suggestions.*

The R&D Personnel Administrator—

AT PRESENT, most R&D organizations have come into being in two ways. They are either a young and fairly recent corporate unit, chartered specifically for conceiving and engineering new products; or, a part of an older, larger corporation seeking to exploit new markets.

Little, if any, tradition, precedent, and practice has been established in the former. The newness of the corporation precludes the years of experience required to build a depth of any administrative force or habit.

In the latter, the scientists, engineers, and administrators have inherited traditions and practices which may have worked very well for production and marketing, but are quite inappropriate for the research and development environment.

If the R&D unit is to survive and flourish, it must address itself to the general scheme of any social and economic unit—namely, the creation and satisfaction of a customer. This customer must consider the idea, product, or service rendered him has a value which he is ready to buy.

To satisfy a customer, the unit should have the means for undertaking and resolving technical problems. While technical brainpower may generate the thought which goes into the product, the administrative brainpower brings into being the facilities, material, money, and people who will give substance to the thought.

What's Ahead?

A decade or two from now, the most efficient R&D organizations will probably be as superior in their efforts as the major productive units in industry are today. These organizations will overcome the lack of administrative depth, or the stultifying effects of past production and marketing practices. They will fashion a new philosophy capable of recognizing and reflecting the impact of intellect and thought on the corporate unit and society. These organizations will be creating and satisfying customers at a pace and magnitude not dreamed possible today. And a portion of this philosophy will be engendered by personnel administrators.

By the nature of his work, the Personnel Administrator can key the growth of a philosophy. For he solely concerns himself with people and their industrial and economic environment. He can stimulate the conception and growth of the ideas for a force which can resolve the ever-increasing complex technical and administrative problems of today and the future.

For the Future

The philosophy should be built upon the individual and integrity. For in R&D work, though the individual may work as a part of a team, he can contribute in a greater degree to the end-product than in the mass productive and marketing processes. Also, technical problems must be solved honestly. There is no way to contravene physical law. Integrity of purpose and practice should be the byword for the personnel administrator.

Giving substance to a philosophy can be difficult, yet it can yield tremendous returns. For practical applications, four areas lend themselves very well within the personnel framework. They are recruiting, salary administration, personnel studies, and education. Each area though separate, can be integrated around the individual and integrity, and can yield any company

Editor's Note: For further reading on the subject of education for R & D Personnel, see page 256, ELECTRONIC INDUSTRIES, November 1959.

By E. B. GILROY
Employee Relations Manager
Space Technology Laboratories, Inc.
P. O. Box 95001, Los Angeles 45, Calif.

What's His Role?

more than the time, effort, expense, and staff necessary to accomplish each function.

Recruiting

Take recruiting. This area is one of obvious importance, and will continue to be so. How much of the present recruiting work is geared to attract the individual and how honest are the efforts?

A cursory review of such operations indicates that climate, location, salary, and working conditions all have been combined. They show that advantages for one section of the country or company obviously are superior to another. "Engineers Come West" or "Scientists Return East" are slogans for consumption.

Forgotten is the professional work—which may or may not be challenging, worthwhile, or even fairly long-term in nature. Would it not be better to explain the projects, in brief, and provide for expanding this information through correspondence, literature and personal interviews?

Salary Administration

Then, there's the area of salary administration. How many companies have attempted to measure the productivity of the creative technical mind? Granted, the problem is difficult, but is it not increasingly evident that salary surveys, ranges, reviews and increases are not in themselves providing the hoped for effect of attracting and retaining competent personnel. This suggests the need for studying the problem honestly. Perhaps in company with the Technical Administrator.

One facet of this problem might be to communicate at length the salary program of the company. For, truly, there is no area of greater mystery to the individual scientist and engineer than this one.

I suggest the approach of attempting to direct payroll funds so the greatest contributors receive the greatest return. And further, that deferred or indirect income could well be the vehicle for so doing. Whether this income be in bonus, stock, retirement, insurance, time-off, or company car, it should be considered. I would not suggest neglecting the salary for the individual. Rather, this could be the cake and the other the frosting.

Personnel Studies

Of course, if one is to approach these problems he should do so on the basis of facts. There should be the means to measure progress of the individual, trends of the group, and economic implications salary-wise, tax-wise, and cost-wise for the individual and the company. How many corporate units have attempted to operate from a posture of data wisely chosen, carefully checked, and painstakingly assembled for planning their personnel moves? Whether these moves be for salary increases, promotions, transfers or any other personnel action? The application of data processing is suggested as one approach.

But whether data processing or hand calculating is the method for recording, reporting and analyzing facts and figures, the process should be a continuous one. From these facts can come the glimmers for the ideas which will permit the administrator to plan and execute programs on the basis of evidence rather than hunches.

This type of function, incidentally, lends itself very well to being understood by the engineer and scientist. For he is oriented in this direction. He understands figures, trend-lines, graphs and charts. Data is a good foundation for establishing a common ground between the administrator and the engineer.

Education

Finally, there is education, or training if this is preferred. This area can have a tremendous impact for the companies fortunate to be near, or have available, the academic capacity for increased intellectual exercise. The continued exposure of professional scientific and engineering minds to new concepts and theories means continued professional growth. Particularly, if opportunities are present for the application of these new concepts and theories.

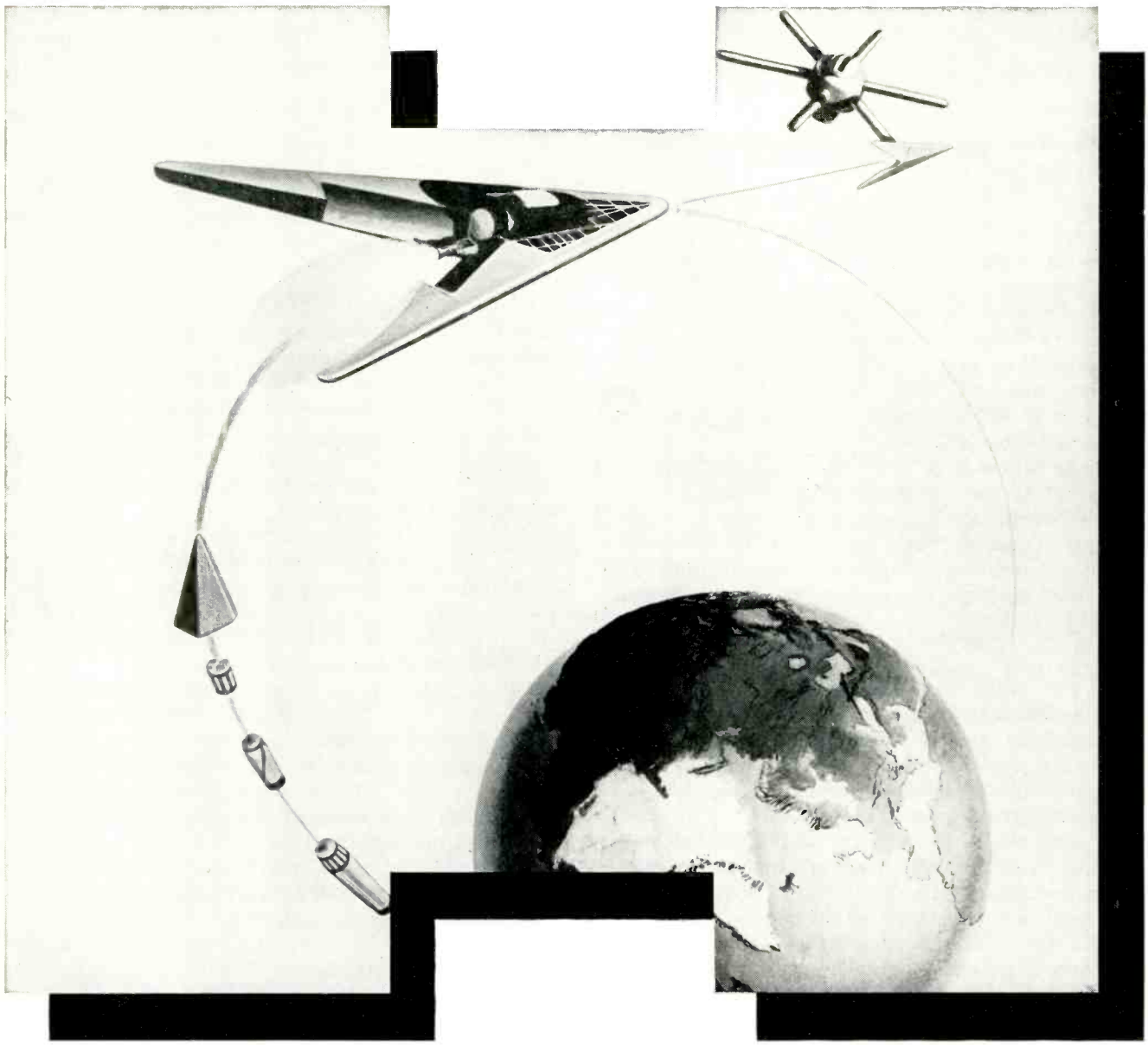
There are, of course, many methods for effecting such a program whether it be by importing the teaching talent or by exporting the individual to the school. Indeed, there may be reasons for doing both. But, it should be done on the basis that knowledge and the quest for knowledge is good in itself.

I suspect there is a self-regulating mechanism in the application of a liberal policy to encourage study. There probably are few scientists who would presume on a company's finances by taking wholly inappropriate studies. In fact, perhaps the most directive practice which could be established is one of non-direction, at least from the company's point-of-view.

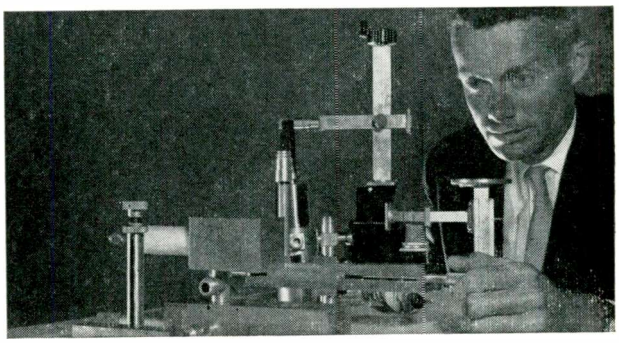
The writer hopes the ideas presented have provoked some thought concerning the philosophies and programs which might be appropriate for a R&D organization. At least from a personnel orientation. The ideas are offered as "Spring-Boards" to more detailed practices and procedures.

* * *

Earth-to-space ferry



"Paramp" *(parametric amplifier) developed by Hughes research engineers and scientists, can double effective range of today's radar units.*



for Astronauts

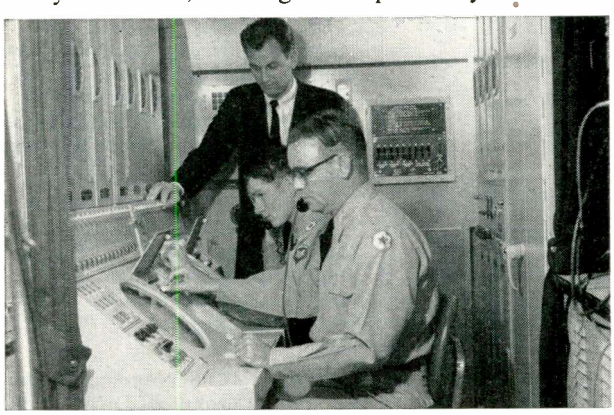
Combining the features of a space ship, guided missile and a conventional airplane, the new Space Ferry was designed by Hughes-Lockheed Project teams to shuttle men and materials between earth and outer space.

The Space Ferry would carry a pilot and 3 commuters. Payload would be about 14,000 pounds; cargo could vary from flight to flight.

Taking off from earth the Space Ferry would orbit at 300 to 500 miles, rendezvous with other space craft, transfer passengers and cargo, and return to earth... all on a routine schedule.

The Hughes-designed Navigation and Guidance System would utilize an inertial platform and a digital computer. It would automatically control boost to orbit, bringing the Ferry to within 20 to 50 miles of its destination.

The Hughes Attitude and Flight Path Control System would incorporate several novel features: A space attitude and translation control system, based on velocity feedbacks, would give the pilot easy control for rendezvous and final soft contact with the platform. For re-entry and flight in atmosphere, the system would use structural temperature as a signal for automatic control during the critical heating phase. The resulting maneuver eliminates the characteristic skipping oscillations of uncontrolled re-entries. Either pitch or bank (or both) maneuvers would be selected with elevons as primary controls.



"Vest Pocket Air Defense System"—*Hughes mobile digital computer and display unit, linked to a Hughes 3-D scanning radar antenna, assigns enemy targets to missile batteries.*

The new Space Ferry reflects the many stimulating outlets available to Hughes engineers. Other projects include nuclear electronics, spatial communications systems, advanced airborne electronics systems, three-dimensional radar systems, new semiconductor materials, electron storage tubes...and many others.

A diversity of advanced projects, a history of continued growth, technically oriented company philosphy — these factors make Hughes the ideal environment for engineers interested in building a rewarding future.

Newly instituted programs at Hughes have created immediate openings for engineers experienced in the following areas:

Electroluminescence	Equipment Engineering
Infra-red	Microwave & Storage Tubes
Plasma Physics	Communications Systems
Digital Computers	Micro Electronics
Reliability & Quality Assurance	Engineering Writing
Systems Design & Analysis	Circuit Design & Evaluation

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Hughes General Offices, Bldg. 6-C2, Culver City, Calif.

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HUGHES

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Tucson, Arizona

Personals

Loren A. Bailey, formerly with the Long Lines Dept. of the American Telephone & Telegraph Co., has joined Page Communications Engineers, Inc., as a Sr. Staff Engineer.

Dr. George Wertwijn, former Division Chief of the Semiconductor Development Group of the Zenith Radio Corp., has been named chief Engineer of U. S. Transistor Corp.

Donald A. Ashford has been appointed Chief Engineer at the Raleigh, N. C., plant of Kellogg Switchboard and Supply Co., Communications Div. of International Telephone and Telegraph Corp.

C. P. Clare Transistor Corp., has elected Amos Kaminski, former Chief Research Scientist of General Transistor Corp., as President. The new company is a subsidiary of C. P. Clare & Co.


A. Kaminski


H. F. Schoemehl

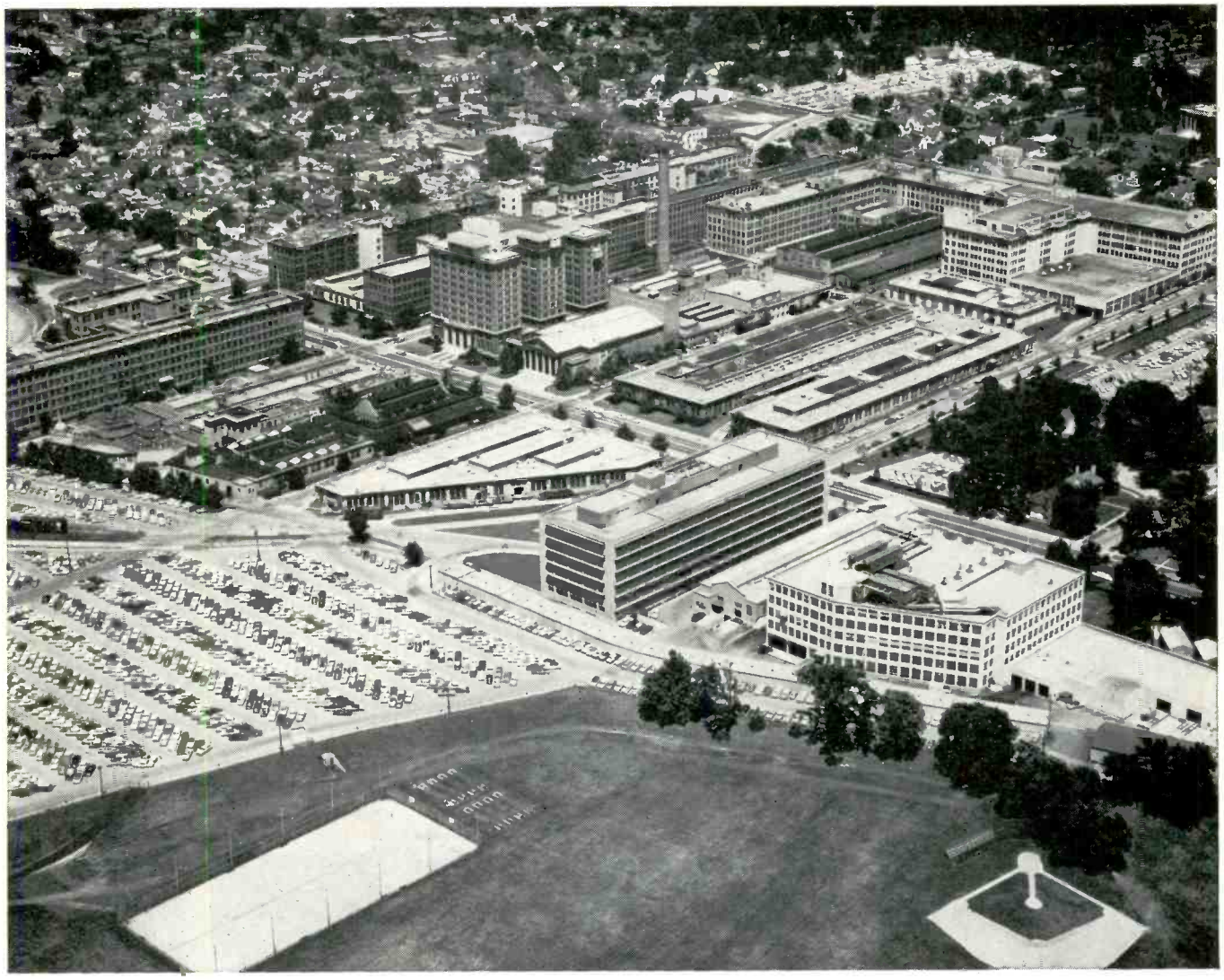
Henry F. Schoemehl has been appointed Director of Engineering of Hoffman Electronics Corp.'s semiconductor plant in Evanston, Ill.

Donald C. Beem has been named Sr. Design Engineer in charge of design and development of solid state power supplies of the Special Products Group of Spectrol Electronics Corp.

Dr. Norman A. Baily, has joined Hughes Aircraft Co.'s nuclear electronics laboratory as a Sr. Staff Physicist. He had been Chief Scientist for the dept. of radiation therapy at the Roswell Park Memorial Institute.

Dr. Adolf D. May, Jr., has joined the Technical Staff of Ramo-Wooldridge, div. of Thompson Ramo Wooldridge Inc., as a member of the Intellectronics Labs.

Reuben O. Schlegelmilch has been appointed Technical Director of Westinghouse Electric Corp.'s defense products group. He was formerly Director of Research and Development at the Air Force's Rome Air Development Center.



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Industry News

Bela J. Losmandy has been named Chief Electronics Engineer of Micro Gee Products, Inc.

Three Hughes Aircraft Co. executives have been appointed to Managerial positions. They are: **David A. Hill**, Manager of the Semiconductor Div., Hughes Products Group; **Lloyd H. Scott**, Manager of Santa Barbara Research Center; and **L. James Levisee**, Director of Materiel, general office.

Daniel D. Kirschner has been appointed to the newly created position of Director of Industrial Relations by FXR, Inc. He was formerly Sales Engineer of Microwave Test Equipment and High-Power Pulse Modulators.

Dr. Maurice Nelles has joined American Electronics, Inc. to fill the newly created post of Vice President, Engineering. He was formerly Vice President, Research and Development and Chairman of the Corporate Product Planning Committee of Crane Co.

M. Nelles

V. Alessi

Vincent Alessi has been appointed General Manager of Dallons Semiconductors, a division of Dallons Laboratories, Inc.

Dr. Charles L. Register, Manager, Great Valley Labs, Burroughs Research Center, has been named Program Manager to head the recently awarded ALRI (Airborne Long Ranger Input) contract to extend the range of the SAGE system.

Rex Welch is now Manager of Sales for Electronic Systems Development Corp., a subsidiary of Solar Aircraft Co. He had been Sales Manager for the Industrial Systems Div., Hughes Aircraft.

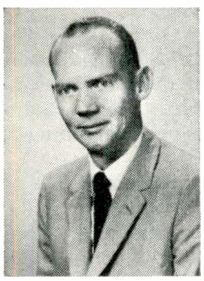
Adolph Warsher, formerly Manager of Reliability Control Engineering at Bendix Aviation's Eclipse - Pioneer Div. has opened Consulting Engineering offices in Ridgewood, N. J.

Industry News

Russell C. Taylor is now President and James F. Clark is Chairman of the Executive Committee of ACF Industries, Inc.

International Telephone and Telegraph Corp. has announced the election of James F. Lillis as Vice President and Comptroller.

Wayne A. Brown has been named Manager of the Pacific Components Div., Hermetic Seal Transformer Co.



W. Brown

F. Scott

Fred Scott, formerly of Kearfott Mfg. Co., has been appointed to the newly created position of General Plant Manager, Astron Corp.

Raymond G. Johnson has become a Vice President of General Precision Laboratory Inc. He will continue to serve as Controller and Assistant Treasurer.

Walter J. Kruel is Executive Vice President of the Hallamore Electronics Div., The Siegler Corp. He succeeds John J. Burke, who was recently elected a Vice President of The Siegler Corp.

Carl Pilnick has been named Vice President and Director of Research and Development at Consolidated Avionics Corp.

Haskel A. Blair is now President of University Loudspeakers, Inc., a subsidiary of Ling Altec Electronics, Inc.

The election of Charles D. Manhart as Vice President of Daystrom, Inc., has been announced.

Frederick J. Bell is now Vice President—Washington, D. C. Office—for General Telephone & Electronics Corp.

Lt. Gen. C. S. Irvine, (Ret.), former United States Air Force Deputy Chief of Staff for Materiel, will become a Member of the Board of Directors of Houston Fearless Corp. early this year.

Industry News

Curtis A. Haines has been named Vice President, Facilities and Manufacturing Planning of Sylvania Electronic Systems, div. of Sylvania Electric Products Inc.

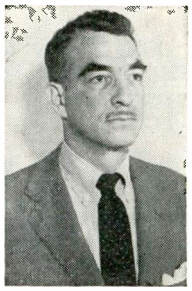
Roy H. Isaacs has been named Vice President in Charge of Government Relations for the Bendix Aviation Corp.

International Business Machines Corp. has elected Arthur K. Watson as Corporate Vice President and Group Executive, and a Member of the Board of Directors.

Appointment of Ewen C. Anderson to the newly created position of Executive Vice President, Staff, Radio Corp. of America, has been announced.

Myron G. Domsitz has joined Weinschel Engineering as Executive Vice President. He was previously Vice President, Engineering, of Simmonds Aerocessories.

M. G. Domsitz



R. S. Mandelkorn

Rear Adm. Richard S. Mandelkorn (USN, Ret.), has joined General Instrument Corp. as Executive Vice President of its Harris Transducer Corp. subsidiary. He had been Operations Manager and Director of Planning for Philco Corp.'s Lansdale Tube Div.

James J. Kelly has been appointed Assistant to the Vice President-Manufacturing, Taylor Fibre Co.

Kenneth M. Lord has been appointed Vice President and General Manager of the Electronics Div., Stromberg-Carlson.

William M. Semple, has been named Director of Manufacturing for U. S. Semiconductor Products. He was formerly with Beckman/Helipot Corp., Div. of Beckman Instruments, Inc.

B. I. Belasco is now Manager, Advertising and Sales Promotion, for the Semiconductor Div., Raytheon Co.

Thomas C. Deane has been appointed to the Board of Directors of Packard Bell Electronics Corp.

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BUT, MR. ENGINEER, DID YOU KNOW...

... that people are talking up Magnavox in the military and industrial fields as well? That we not only make the world's finest stereophonic high fidelity, radio phonographs and television instruments, but do vital work for some of the principal names in government and industry both here and abroad? We are, in fact, currently engaged in advanced electronic activity covering the broad areas of communications, airborne radar, missiles, anti-submarine warfare systems and data processing equipment. And the growing demand for our services in every one of these fields has made it necessary to put in a call for more creative talent. If you're an engineer with a yen for challenge ... if you like to work with interesting, capable people ... and if you very definitely DON'T intend getting lost in the crowd ... look into Magnavox. There's a promising future ahead.

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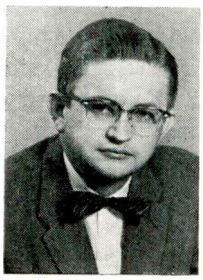
Industry News

William T. Hack has been elected President of Audio Devices Inc., and **William C. Speed**, former President has been elected Chairman of the Board.

Indiana General Corp. has appointed **Frank A. Saikley**, Assistant Treasurer and Assistance Secretary and **Portus M. Wheeler**, Vice President, Sales, for the Indiana Steel Products Div.

Richard A. Campbell has been elected Vice President in Charge of Operations of Pacific Semiconductors, Inc., a subsidiary of Thompson Ramo Wooldridge, Inc.



R. A. Campbell

D. F. Sanders

D. F. Sanders is now President of Lockheed Electronics Co., the new subsidiary of Lockheed Corp. The company will include the Newport Div. (formerly Lockheed Electronics and Avionics Div.) and the Stavid Div. (formerly Stavid Engineering, Inc.).

Jack J. Bromberg has been appointed Program Manager for the Douglas Aircraft Company's Nike Zeus activities.

Edward J. Garrett has been elected Vice President of Loral Electronics Corp. He will continue as General Manager.

Harold T. Summers, is now Manager of Manufacturing for Boonton Radio Corp.

The election of **Ross D. Siragusa, Jr.**, and **Harris Hesketh** as Vice Presidents of Admiral Corp. has been announced.

Lear, Inc., has elected **T. Kenneth Greenlee** and **William P. Lear, Jr.** as Vice Presidents.

The appointment of **Edward S. Weyl** to the newly created position of Director of Business Planning for International Resistance Co. has been announced.

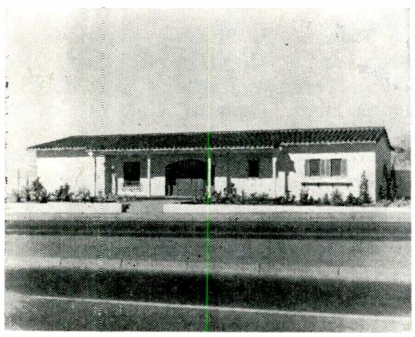
News of Reps

REPS WANTED

Manufacturer of Magnetic components, including tape wound cores, bobbin cores, and transformer laminations, desires Engineering Reps in the following areas: northern California, Arizona, Colorado, Texas, Ohio, Michigan, Indiana, Missouri, Minnesota, Virginia, Wisconsin, Florida, Alabama, Mississippi, Georgia, North and South Carolina, and Kansas. (Box R2-1, Editor, Electronic Industries.)

Essex Electronics, Div. of Nytronics, Inc., has appointed Engineering Services Co., Kansas City, Missouri, as rep in Nebraska, Kansas, Missouri, Iowa, and southern Illinois.

New Office



Neely Enterprises has opened this new 3,000 sq. ft. office building and expanded service dept. at 6501 Lomas Blvd., N.E., Albuquerque, New Mexico.

The **Dan Greene Organization, Inc.**, Cambridge, Mass., is now sales reps for Howell Instrument Co. in Maine, Massachusetts, Rhode Island, Vermont, New Hampshire, and Connecticut.

Three new members of the Buckeye Chapter of the Electronic Representatives Assoc. are: **J. R. Dannemiller**, J. R. Dannemiller Associates, Cleveland, Ohio (full membership); **Bernard C. Newman** of F. A. Daugherty Co., Cleveland, Ohio and **Todd Hart** of H. H. Seay Co., Columbus, Ohio (associate members).

Alfred Electronics has appointed **Rush S. Drake Associates**, Seattle, Wash., rep in Oregon, Washington, Idaho, and British Columbia.

Computer - Measurements Co. has appointed two reps in metropolitan New York and the Pacific Northwest. They are: **G. Curtis Engel and Associates, Inc.**, Ridgewood, N. J. and **Comptronics, Inc.**, Seattle, Wash.

Appointment of two manufacturer's reps by Lear, Inc., has been announced. Named were **Berndt Associates**, Glencoe, Ill., and **Electro-Mation Assoc.**, Warren, Mich.

News of Reps

Acton Labs., Inc., a subsidiary of Technology Instrument Corp., has appointed **Lowry Dietrich Co.** as rep in Ohio, Kentucky, West Virginia, and Western Pennsylvania.

Ballentine Labs., Inc., has appointed reps in 3 areas. They are: **Bayly Engineering, Ltd.,** Ajax (Toronto), Ont., Canada, rep for Ontario and provinces of Eastern Canada; **Ohio Instrument Co.,** Dayton, Ohio, rep for Ohio and Pittsburgh area of Pennsylvania; and **Gaine Engineering Co.,** Detroit, Mich., rep for the Michigan area.

Miratel, Inc., has appointed Ken Wyborny as sales rep for Arkansas, Louisiana, Oklahoma, and Texas, excepting El Paso County.

Thomas S. Moroney is now sales rep for the Cleveland District (Michigan Territory) of the Silicone Products Dept., General Electric Co.

New sales rep appointed by Technology Instrument Corp. are: **Kinrick Co.,** St. Louis, Mo., for Missouri and Kansas, and **Jim Morrow Sales,** Highland Park, Mich. for Michigan.

The newly formed rep firm, **J. P. Dearie Co.,** Boonton, N. J., headed by John P. Dearie., has acquired the Industrial Div. of the Art Cerf Co.

J. P. Dearie

H. Brown

The Irv Brown Co., Inc., manufacturers rep, Brooklyn, N. Y., has added **Harry Brown** to their field sales staff.

Engineering Services Co., St. Louis, Mo., has been named rep for Missouri, Kansas and Nebraska by the DeJur-Amsco Corp. **Roy H. Cooley & Assoc.,** Seattle, Wash., is rep in Washington and Oregon.

Essex Electronics, Div. of Nytronics, Inc., has appointed **Malcolm Ross & Co.,** Los Angeles, Calif., rep in Southern California, Nevada and Arizona. **George W. Meeker** is rep in Washington and Oregon.

The **C. H. Mitchell Co.,** Electronic rep firm, is now located at 13804 Ventura Blvd., Sherman Oaks, Calif.

High Temperature Material Available

Raytheon has announced the development of a process for producing oriented graphite in commercial quantities. Called "Pyrographite," the high-temperature material offers characteristics which promise to solve many space-age problems. Thermal and electrical conductivity material is strongly anisotropic—higher in a plane parallel to the surface than at right angles to it. Other valuable properties are high density and impermeability to gases.

Oriented graphite has been produced in the laboratory for many years in minute quantities—for example, as a thin coating on a hot filament—and its properties have long been investigated on a theoretical basis.

Pyrographite has the strength-to-weight ratio along the planes higher than series 310 stainless steel at low temperatures. Above 2000°C, where normal graphite has one of the highest strength-to-weight ratios known, Pyrographite has a ratio five times as great.

ELECTRONIC INDUSTRIES Advertisers — February 1960

This index is published as a convenience. No liability is assumed for errors or omissions.

CUES for Broadcasters

Automatic Two Cycle Carrier Restorer

NORMAN BOWMAN, Ch. Eng.
KBTM, Jonesboro, Arkansas

The station here at KBTM operates from remote control. We needed a device which would put the transmitter back on the air when momentary overloads, such as overmodulation, knocked the carrier off.

This unit cuts the "off-air" time to five or ten seconds. It also relieves the strain on engineers.

Here at KBTM a Schaeffer remote control unit is used, but this system will work with any remote.

The operation is as follows: Spare contacts on the transmitter-on relay, which is operated by the remote control unit, applies power to relay #1. Relay #1 closes its contacts, turning the transmitter on. The bottom contacts of relay #1 hold this relay on until the normal sign-off. The top contacts make power available to a contact on relay #2. If the carrier goes off, relay #2 will open supplying power to Amperite relay #3. After 5 seconds delay relay #3 will close and actuate relay #5.

Now, while relay #5 was not actuated, capacitor C1 was charging to line voltage through the selenium rectifier. When relay #5 is actuated it places C1 across relay coil #7. C1 discharges through the relay coil, actuating it for a short time. Relay #7 has a set of its contacts in parallel with the transmitter-on contacts. These contacts turn the transmitter back on.

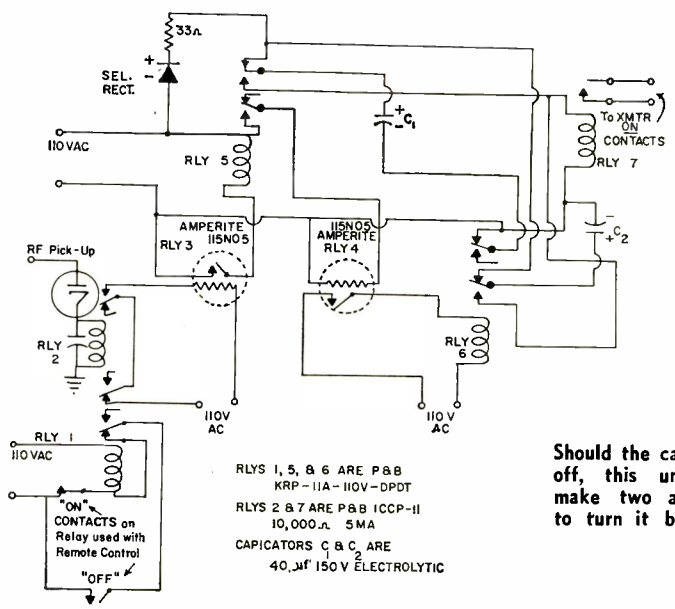
If the transmitter fails to go on, Amperite relay #4 will operate in 5 seconds, actuating relay #6. Relay #6 disconnects C1 from relay coil #7 and connects C2 (which is charged) in its place. This capacitor again causes relay #7 to actuate and turn transmitter on.

When the transmitter is back on the air, relay #2 is actuated. This relay then removes power from relay #3, placing system back into a standby status.

Should the transmitter fail to operate after both cycles of this unit, an engineer will have to clear the trouble in the transmitter. Unit will not affect normal operation such as Conelrad tests or regular sign-off.

$$$ for Your Ideas

Readers are invited to contribute their own suggestions which should be short and include photographs or rough sketches. Typewritten, double-spaced text is requested. Our usual rate will be paid for material used.



Should the carrier go off, this unit will make two attempts to turn it back on.

RADAR AND REVOLUTION

One sweltering July afternoon in 1789, a tattered raggedy mob appeared outside the gates of the Bastille, the formidable prison of Paris, and demanded entrance.

"Go away," the guard shouted, "or we'll have to arrest you."

"That's exactly the idea!" a voice came back. "We're starving to death. All we want is a little of that moldy bread and canal water you feed your prisoners!"

Word was passed to the prison commandant, one Maurice Antoinette. "If they want their just desserts," he smiled, "let them eat cake!"

It was this remark that sparked the Revolution. The mob grew ugly. "Force the gate!" shouted a sickle-wielding daughter of France named Brigitte Sourdough. A radar controlled battering ram, appropriated from the local armory, swung into play. In moments, the Bastille gate had been hammered into shambles, and the unfortunate Maurice Antoinette was at the mercy of the mob.

"Observe the instrument of your defeat!" sneered Brigitte Sourdough, pointing at the radar.

"Pfui," the commandant replied, calm and disdainful. "No Beaumac (French for Bomac) tubes."*

Brigitte was furious. "The commandant wants 'Beaumac'? He shall have Beaumac!"

With that, Antoinette was led to a second instrument of the people — a device consisting of a heavy blade, poised between grooved uprights. It had no tubes at all.

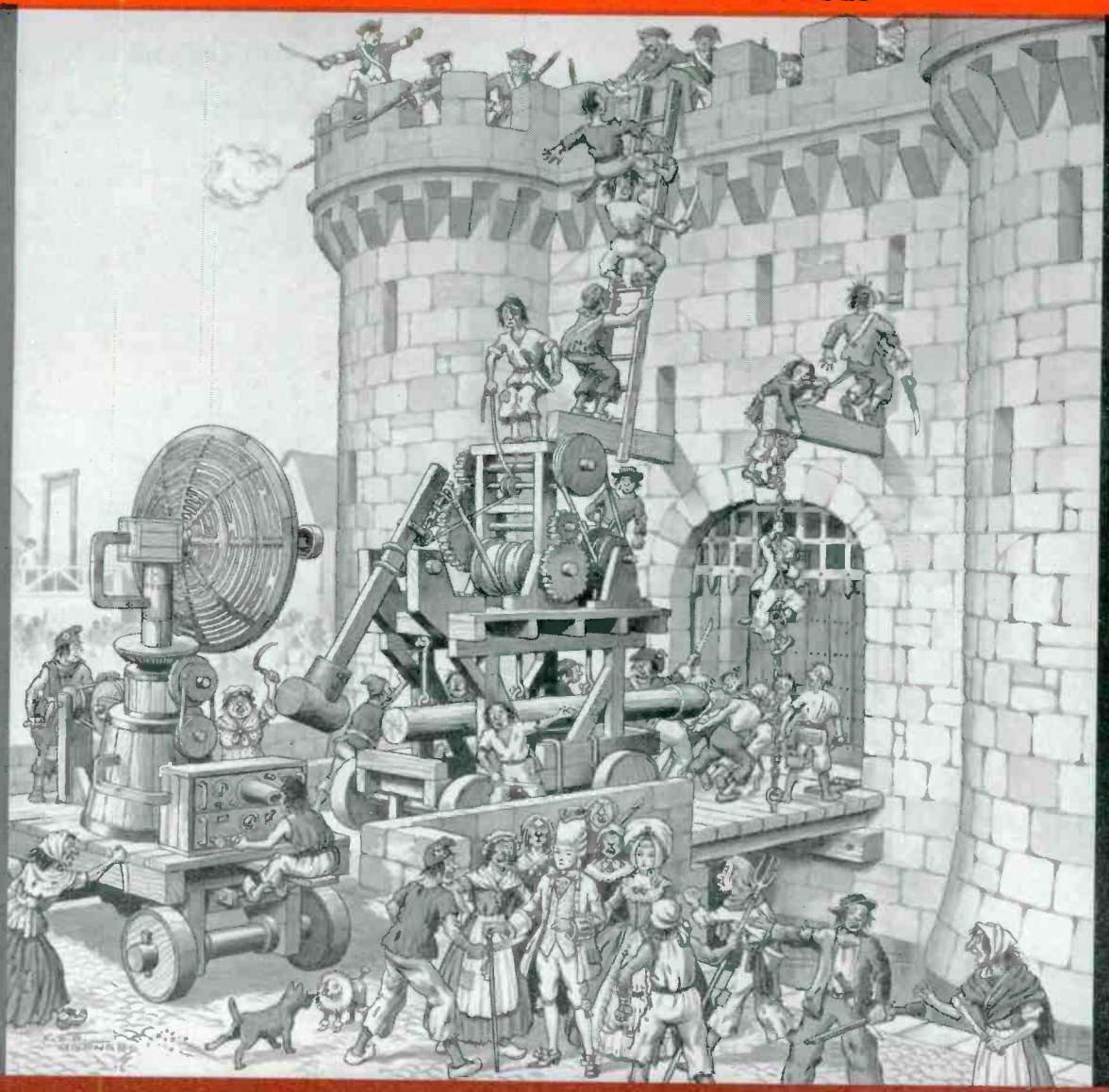
"This is your Beaumac?" the commandant asked.

"Oui, monsieur," Brigitte Sourdough leered. "This is Beau Mac — the knife!"

No sooner had Maurice Antoinette heard these words than his icy calm vanished.

Matter of fact, he lost his head completely.

No. 18 of a series . . . BOMAC LOOKS AT RADAR THROUGH THE AGES



* *Bomac makes the finest microwave tubes and components since the storming of the Bastille.*

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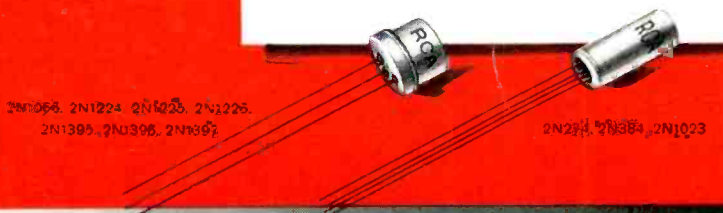
RCA's new family of ten INDUSTRIAL DRIFT FIELD TRANSISTORS

specifically matched to your design requirements... for superior high frequency performance—up to 50 Mc and above as rf amplifiers ...up to 125 Mc and above as oscillators.

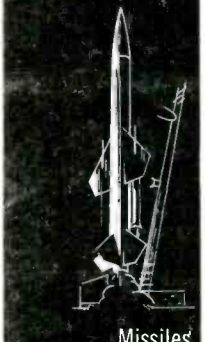
RCA now offers a comprehensive group of industrial drift field transistors specifically designed for industrial and military high-frequency communications, instrumentation, controls, navigation and mobile equipment.

These application-tailored types capable of operating up to 50 Mc and above in rf amplifier service and 125 Mc and above in oscillator service will permit a large safety factor in your equipment designs and assure long-term operating reliability. They feature a maximum junction temperature rating of 100°C; a maximum transistor dissipation rating of 120 Mw in free air at 25°C, and higher ratings with heat sink; and maximum collector-to-base voltage rating of −40v, except for the 2N1226 which has a −60v rating and is intended for those critical military and industrial applications requiring such a high voltage. Millions of RCA drift field transistors now in use are your proof that RCA drift field types are today's number one answer to the designer requiring top performance and reliability at low cost.

Call your RCA Field Representative now and ask him about RCA Industrial Drift Field Transistors with performance specifications tailored to your specific needs. For additional technical data, write RCA Commercial Engineering, Section, B-50-NN, Somerville, N. J.



1.5 MC 12.5 MC 30 MC 50 MC



HIGH FREQUENCY AMPLIFIER PERFORMANCE

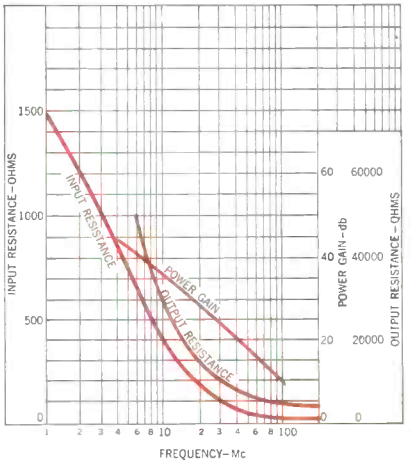
RCA TYPE NUMBERS

	2N1023			2N384			2N274		
h_{fe} 20 to 175 (JEDEC TO-44)									
h_{fe} 20 to 175 (JEDEC TO-33)	2N1066			2N1225			2N1224		
h_{fe} 50 to 175 (JEDEC TO-33)	2N1397			2N1396			2N1395		
50 Megacycles (sig. freq.)	Min.	Type	Max.	Min.	Type	Max.	Min.	Type	Max.
Common Base Circuit									
Power Gain (db)	18	21	24	15	18	21	—	—	—
Input Resistance (ohms)	—	25	—	—	30	—	—	—	—
Output Resistance (ohms)	—	8,000	—	—	5,000	—	—	—	—
30 Megacycles									
Common Emitter Circuit									
Power Gain (db)	20	23	26	16	20	24	—	—	—
Input Resistance (ohms)	—	100	—	—	50	—	—	—	—
Output Resistance (ohms)	—	8,000	—	—	5,000	—	—	—	—
12.5 Megacycles									
Common Emitter Circuit									
Power Gain (db)	—	—	—	24	28	32	17	22	27
Input Resistance (ohms)	—	—	—	—	250	—	—	150	—
Output Resistance (ohms)	—	—	—	—	16,000	—	—	4,000	—
1.5 Megacycles									
Common Emitter Circuit									
Power Gain (db)	—	—	—	—	—	—	40	45	50
Input Resistance (ohms)	—	—	—	—	—	—	—	1,350	—
Output Resistance (ohms)	—	—	—	—	—	—	—	70,000	—

2N1226—High Voltage Transistor for Video Amplifier and General Instrumentation Service is identical to 2N1224 except maximum collector-to-base and punch-through voltage rating 60v.

RCA Drift Field Transistors can be supplied to meet MIL-S-19500B specifications

Common-Emitter Circuit, Base Input.
Ambient Temperature = 25°C
DC Collector-to-Emitter Volts = −12.
DC Emitter Milliamperes = 1.5.



Performance Characteristics for Types 2N1023, 2N1066, 2N1397

ANOTHER WAY RCA SERVES YOU THROUGH ELECTRONICS

RADIO CORPORATION OF AMERICA

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Available through your Authorized RCA Distributor