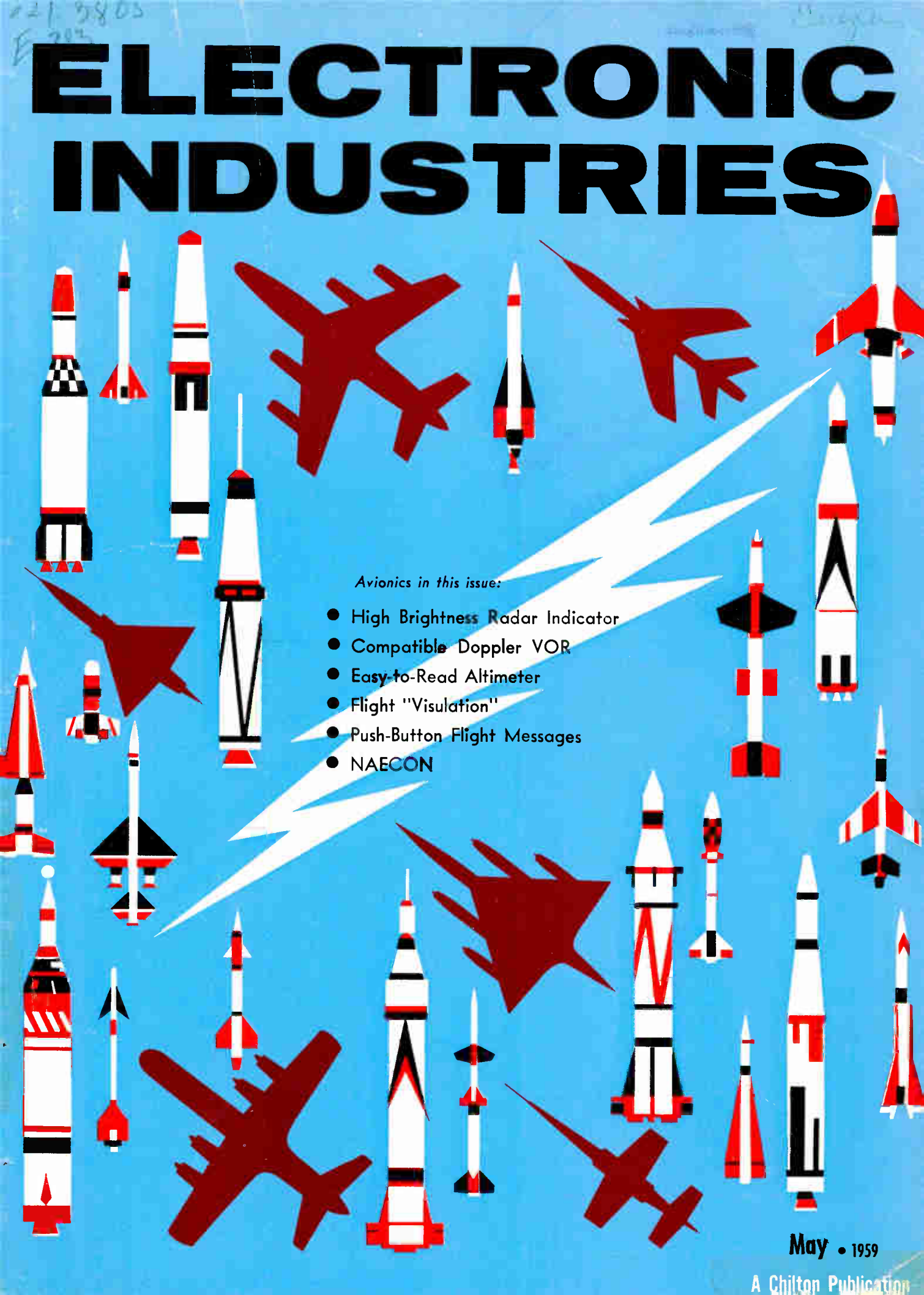
ELECTRONIC INDUSTRIES



Avionics in this issue:

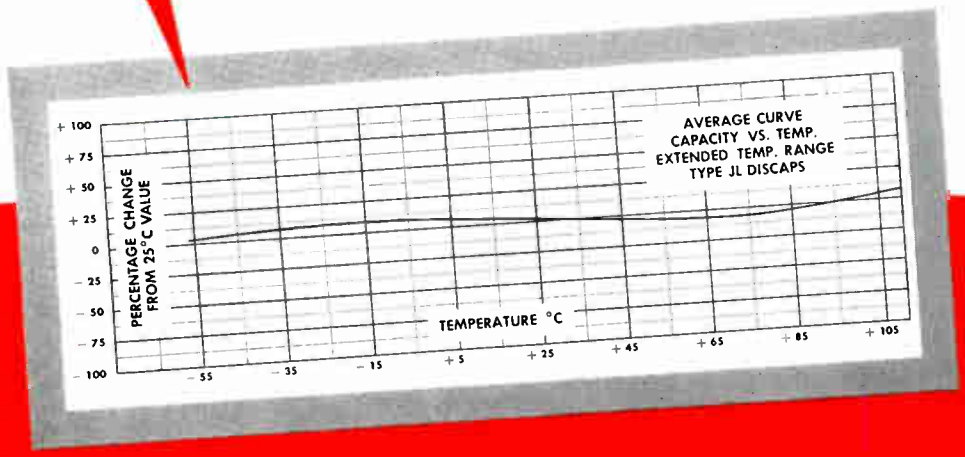
- High Brightness Radar Indicator
- Compatible Doppler VOR
- Easy-to-Read Altimeter
- Flight "Visulation"
- Push-Button Flight Messages
- NAECON

May • 1959

A Chilton Publication

RMC
TEMPERATURE STABLE
DISCAPS

. . . meet your exacting demands for ceramic capacitors



SPECIFICATIONS

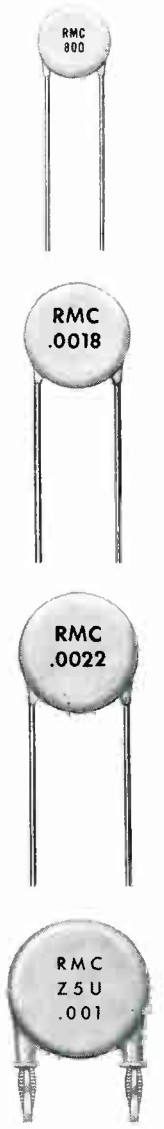
POWER FACTOR: 1.5% Max. @ 1 KC (initial)
POWER FACTOR: 2.5% Max. @ 1 KC (after humidity)
WORKING VOLTAGE: 1000 V.D.C.
TEST VOLTAGE (FLASH): 2000 V.D.C.
LEADS: No. 22 tinned copper (.026 dia.)
INSULATION: Durez phenolic — vacuum waxed
INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms
AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms
CAPACITY TOLERANCE: ±10% ±20% at 25° C

RMC uses the General Radio type 716-C Capacitance Bridge as the standard of capacity and power factor for all Hi K materials. The standard test frequency is 1000 cycles for all capacity and power factor measurements.

RMC Type JL DISCAPS are engineered for applications requiring a minimum of capacity change as temperature varies between –60°C and +110°C. Over this wide range the capacity change of type JL DISCAPS is only ±7.5% of capacity at 25°C. Standard working voltage is 1000 V.D.C.

Type JL DISCAPS offer the advantages of longer life, dependability, and lower initial cost. Their smaller size and greater mechanical strength provide additional economies on the assembly line. These DISCAPS are the ideal cost saving replacement for paper or general purpose mica capacitors.

TYPE JL DISCAPS



. . . also available with Fin-Lock leads

DISCAP CERAMIC CAPACITORS

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RADIO MATERIALS COMPANY
A DIVISION OF P. R. MALLORY & CO., INC.
GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.
Two RMC Plants Devoted Exclusively to Ceramic Capacitors
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Circle 1 on Inquiry Card

ELECTRONIC INDUSTRIES

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

Handle With Care

RECENT newspaper accounts have mentioned that a number of organizations have developed administrative difficulties with their research scientists. We discussed this situation with a senior electronic engineer who had had personal experience on both sides of the fence. We believe the following statement will be of interest to all EI readers.

"When you have been both a research scientist and a research administrator you realize and admit there are several, and often peculiar, administrative problems in company laboratories. These usually stem from 'unorthodox' views concerning rules, regulations and working conditions. The academic background of the scientist, especially if he has been a teacher, naturally differs (usually on the 'soft' side) from that maintained in the commercial laboratory. The administrator, responsible to management for a high yield of progress per company research dollar, knows this and usually makes every effort to keep his men happy. He realizes that new concepts and ideas spring and grow better in a favorable working climate."

1. Tardiness. The Administrator: How can I get my men to report for work on time? The Researcher: It is easier for me if I arrive 30 minutes late for work. Why should I bother with a timeclock when I am thinking about my problem at all hours at home? Suggestion: For the good example it sets for workers, everyone should be on time. If this is not possible, certain valued "thinkers," if they have so proved themselves, should be placed in a definite category with no fixed hours.

2. Sloppy Dress and Habits. The Administration: This means more than tone of my laboratory, especially to visitors and such habits can cause trouble to others and loss to the company. The Researcher: I will wear what I like and do just as I have alway done. Suggestion: On the golf course or at your home tell the sloppy one how you feel about it. If it persists try a direct order. For a later follow-up, if needed, detail the prettiest girl secretary to carry your message.

3. Professional Recognition. The Administration: This means more than money to many men, but we may have to keep research results secret for years. The Researcher: Others publish why can't I? Suggestion: Support and encourage the policy of publication. See that your men get all the "breaks." But when publication is not possible then all you can do is to point out that this is due to management considerations or to the Military.

4. Trips, Leaves of Absence. The Administrator: As a reward for good work or to secure needed information I want my men to attend technical meetings, work for advanced degrees, travel, etc. However, the resulting contacts may lead to them being hired by others or becoming dissatisfied. The Researcher: I need to hear and discuss what others are doing, new ideas, etc. Suggestion: Base a decision on the individual. Have the traveler, upon return, report informally to his coworkers what he has learned.

5. Freedom in Research. The Administrator: Usually the line of research is determined by the management's needs. A researcher interested in this field is selected. Only in pure research laboratories, where older, experienced scientists are involved can we afford completely to give a man his "head." The researcher: My assignment is most uninteresting. Why won't they let me delve into something that will be the basis of an IRE paper? Suggestion: A trained, observant researcher uncovers and reports on many interesting and oftentimes profitable "byways" as he progresses along the main path of his research. If possible, allow him later to follow, or supervise, any research which is initiated along the "byway" he has pointed out. But strong guidance should be exerted, if required, to keep him on the main path until the end is reached.

6. Access to Labs at All Hours. The Administrator: We have to have set hours but the inner urge that prompts a researcher to return at night to his work makes a deep impression on management. The Researcher: When I get interested in a problem hours mean nothing. Why can't I get into the lab.? Suggestion: As far as feasible keep individual labs. open at irregular hours.

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ELECTRONIC INDUSTRIES

Vol. 18, No. 5 May, 1959

MONTHLY NEWS ROUND-UP

NEW PRODUCTS & TECH DATA

DEPARTMENTS

BPA NBP

Highlights

Of This Issue

High Brightness Radar Indicators page 70

Conventional CRT's have been acceptable in radar indicators on shipboard and ground locations where ambient light conditions are controllable. But it's a different story in aircraft cockpits where the pattern must be viewed under conditions of bright sunlight. A new storage tube licks this problem.

Planning Dynamic Reliability page 74

Computing reliability for electronic equipment calls for considerably different methods than might be used in other fields. A simple electronic part may consist of several materials. Material characteristics vary, and the relationship and interaction of materials becomes important.

Designing Transistorized Video Amplifiers page 79

A number of problems still stand in the way of developing a transistorized 1-stage video amplifier with characteristics comparable to those of a vacuum tube equivalent. However, by using drift transistors a 3-stage video amp can be designed that more than fufills the video requirements of a large picture tube.

Thermal Stresses in Klystron Windows page 84

The power output of klystrons is limited by heating of the output cavity windows, but the exact cause has not previously been determined. This new study evaluates the stresses produced by temperature gradients in cylindrical windows caused by dielectric losses and electron bombardment.

Using Unusual Semiconductors page 90

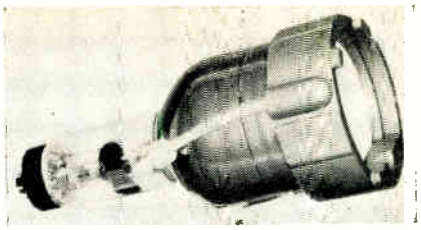
A wide range of materials, other than germanium and silicon, can be expected to exhibit transistor properties. The materials being investigated will offer advantages in higher temperature of operation, higher frequencies, higher power levels, higher voltages and greater ease of fabrication.

Transistorizing a Flip-Flop page 97

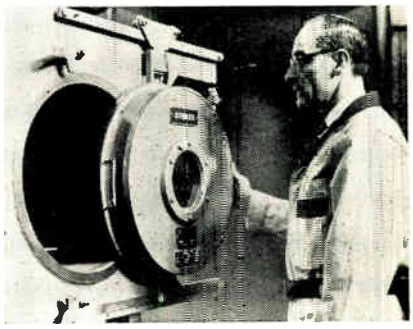
To ease the construction of complex logical equipment, it is to the designer's advantage to use basic building block circuits. One such block is described here—in a flip-flop—where transistors are allowed to switch between saturation, near-zero collector voltage when conducting, and cutoff, a no-current condition.

The Personal Side of "Re-locating" page 190

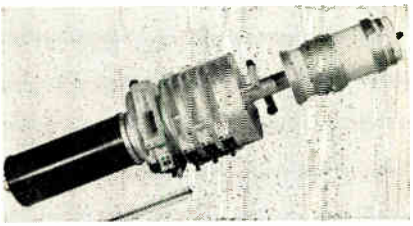
More and more the factor that most influences whether an engineer gets into the upper salary brackets is simply: Is he willing to re-locate? Much is said about the effect that moving has on the family, and on the children; how it upsets the home life, and the psychological effects of "tearing up the roots." But too often we are hearing only from the disgruntled few. Here is how the "average" family takes to moving.



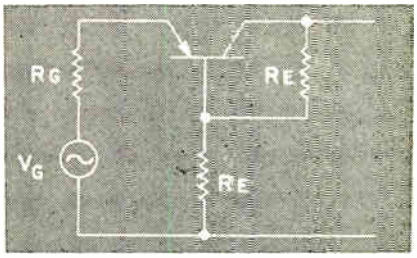
High Brightness Radar



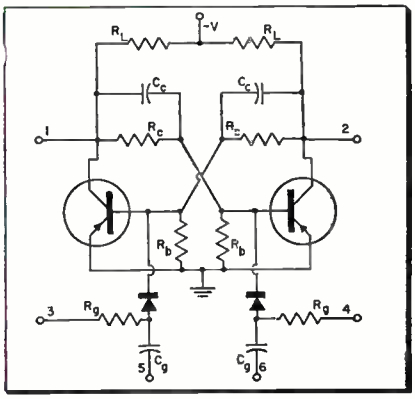
Dynamic Reliability



Stress In Klystron Windows

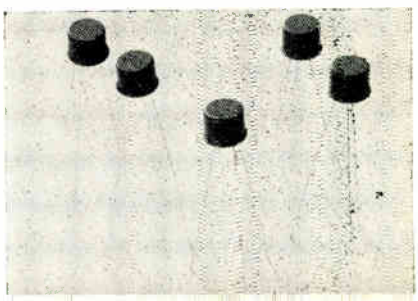


Transistorized Video Amp

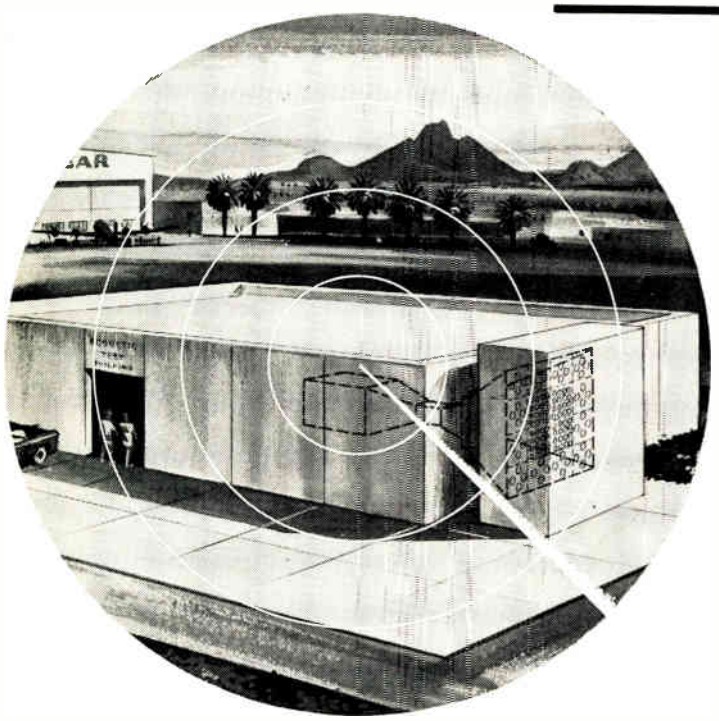


Transistorized Flip-Flop

Unusual Semiconductors



RADARSCOPE



SOUND TEST CHAMBER

This new acoustic test chamber under construction at Goodyear Aircraft Corp., Litchfield Park, Ariz., will be the free world's largest. Sound pressure levels of 150 db in a frequency range of 37.5 to 10,000 cps will be generated. Output for each octave will be independently variable over a range of at least 40 db.

AUTOMATED MEDICINE where a computer would digest data on the patient's symptoms and turn up the diagnosis of his problems, is just around the corner. The computer would have the benefit of medical science's accumulated knowledge correlating symptoms with treatment, providing a much far more efficient service than could be contributed by a single physician.

"EXPLODING WIRE" PHENOMENA is being investigated as a new approach to spacecraft propulsion and possibly to control nuclear fusion. When enormous currents are discharged thru tiny wires, the wires vaporize into plasma 50,000°K. It is believed that this plasma could be directed by an external magnetic field to produce thrust.

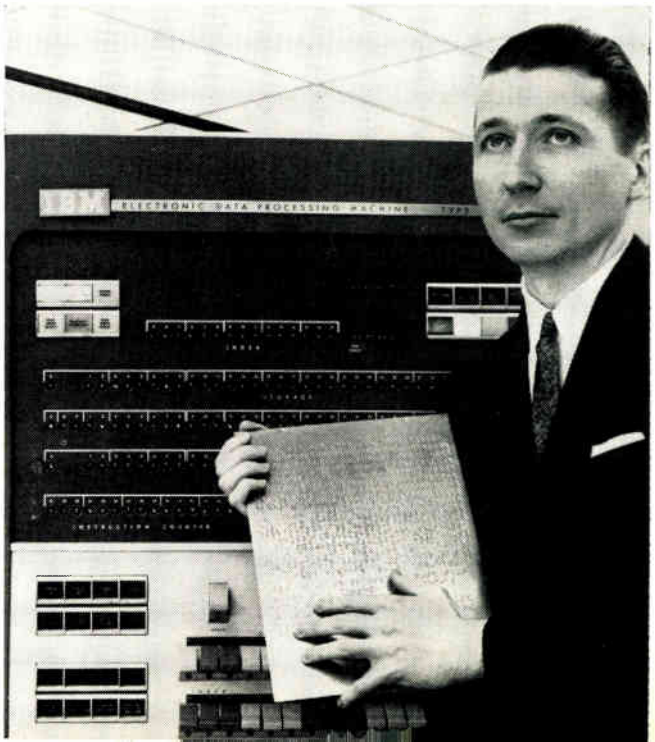
AIR TRAFFIC IN 1980 was crystal-balled by Vernon I. Weihe of General Precision Equipment Corp. at the World Congress of Flight. Among his predictions —transport planes traveling three times the speed of sound; all weather jet cabin scooters and easily maneuvered family planes that would give the automobile the greatest challenge yet. Aircraft telephone that will contact any other subscriber on land, sea or aloft.

HELP WANTED ADVERTISING, riding the crest of the boom, shot up 40% over the same period a year ago. Largest increases are in Los Angeles, San Francisco, Denver, Miami, Chicago, St. Louis, Houston and Milwaukee.

EXPECT STRONG MEASURES to be taken to minimize the pinch being felt by foreign products. Each week brings news of additional quality products either hitting the U. S. market or edging out American products abroad. For over a year now the electrical power generating industry has been up-in-arms over Federal Government purchases of heavy electrical equipment abroad. Industry spokesmen point out that this growing dependence on foreign sources threatens our ability to maintain adequate supply of electric power in time of national emergency. Electronics is now feeling the pinch, too. Just last month a St. Louis TV station accepted delivery of a complete antenna from Siemens Halske in Germany. The semiconductor industry is more than a little concerned over the potential flood of cheap transistors from Japan. None of this would be so serious were American manufacturers able to compete equitably in foreign markets. But with the formation of the European Common Market, it seems apparent that only those American manufacturers with plants overseas will be able to meet the competition from the foreign cheap labor organizations.

AIDING THE BLIND

The Braille printing plate held by Dr. Joseph Flanagan of IBM's Mathematics and Applications Dept. was produced electronically by the 704 in the background. The computer will translate an entire 300-page book in an hour; human translator takes 6 days.



Analyzing current developments and trends throughout the electronic industries that will shape tomorrow's research, manufacturing and operation

RESEARCH AND DEVELOPMENT and procurement are slated to receive $17.1 billion of the $40.8 billion defense appropriations which the President has requested for fiscal 1960. This is nearly $4 billion more than the sum appropriated for R & D and procurement in fiscal 1958.

THE JAPANESE COMPUTER INDUSTRY is poised, ready to swing into high gear, as soon as the problems of licensing can be unraveled. While a good deal of research is going on and a number of sophisticated computers have been designed and built by Japanese engineers, industry-wide development is still hanging on the arrangements that must be made with IBM and Remington Rand Corp. Nearly 400 electronic computers have already been imported into Japan from the U. S. and great pressure is being applied to bring domestic production up to a level that will satisfy the demands. A measure of the potential that is building up is the fact that the Japanese electronic computer manufacturers even at this point are looking to the possibilities of exporting electronic computers.

NEW ARRANGEMENT between International Resistance Co. and Chicago Telephone Supply could set a pattern. IRC, whose distribution channels for replacement parts are among the finest, becomes distributor for CTS potentiometers, gives up its own never-too-profitable pot manufacturing end. CTS, who sold only to new equipment mfrs previously, now gets crack at the big replacement field. And IRC licensees overseas get manufacturing rights to the complete line of CTS quality pots. Both firms greatly expand their potential, but give up no control.

BROADCASTING

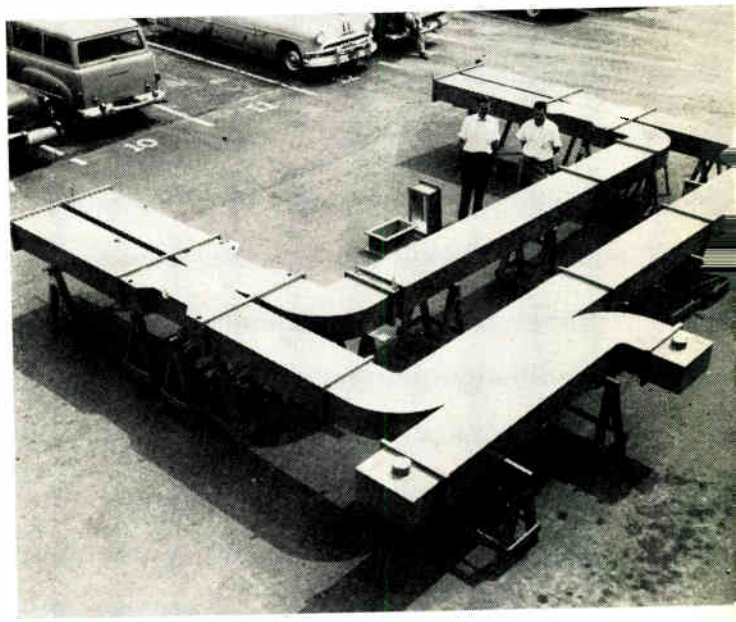
THE FCC has opened the doors to discussion of the problems of FM stereo multiplexing. A raft of problems are being debated back and forth by the FM functional music broadcasters and the stero purists. The functional music group wants the FCC to approve "wide band" FM stereo systems with full frequency range on both main carrier and subcarrier. The purists want two subcarriers—one for the second channel of stereo, the other for functional music —in addition to the main carrier. This arrangement would deprive the stereo subcarrier of some frequency response. One of the interesting sidelights is whether portions of the FM spectrum can be set aside as a "subscription radio" service. A number of functional music broadcasters would like to see stereo FM set up as a subsidiary communications service, to be sold on subscription basis to home listeners.

THE WORLD CONGRESS OF FLIGHT, whatever its success as an air show, was pretty much a waste of time for the 200-odd industrial exhibitors who turned out. Engineers, scientists and production people were conspicuously absent. There was a tacit understanding that this was to be the U. S. counterpart of Britain's Farnborough meet, where industrial exhibits are very much a part of the proceedings, but no audience for this type display showed up. If this affair is to become truly an aviation industry show earnest attempts will have to be made to attract engineers.

A NEW APPLICATION of electronics to education has been devised by Engineering Dept. of Penn State University, under a grant from Westinghouse Electric Corp. The "Motivation and Response Indicator (MARI)," reports whether students' answers are right or wrong and the percentage of students that are answering correctly. The device consists of an instructor's station and small individual stations for each student. The instructor poses a question that has one or two alternative answers, then feeds the correct answer into the system. When the student presses one of two buttons, he learns immediately whether he was right or wrong. At the same time the instructor can tell which students answer the question correctly and the percentage of students answering correctly.

"BIG PIPE"

This huge waveguide complex constructed at Airtron Inc. was so huge it grew out of the shop into the parking lot. Part of an advanced search and track system it is called a "Power Multiplier Resonant Ring." Driven by a high power source it will generate the highest power ever used at this frequency.



SPRAGUE® RELIABILITY in these two dependable wirewound resistors

MINIATURE

Blue Jacket®

VITREOUS-ENAMEL POWER RESISTORS

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

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

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

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

NEW SMALLER SIZE

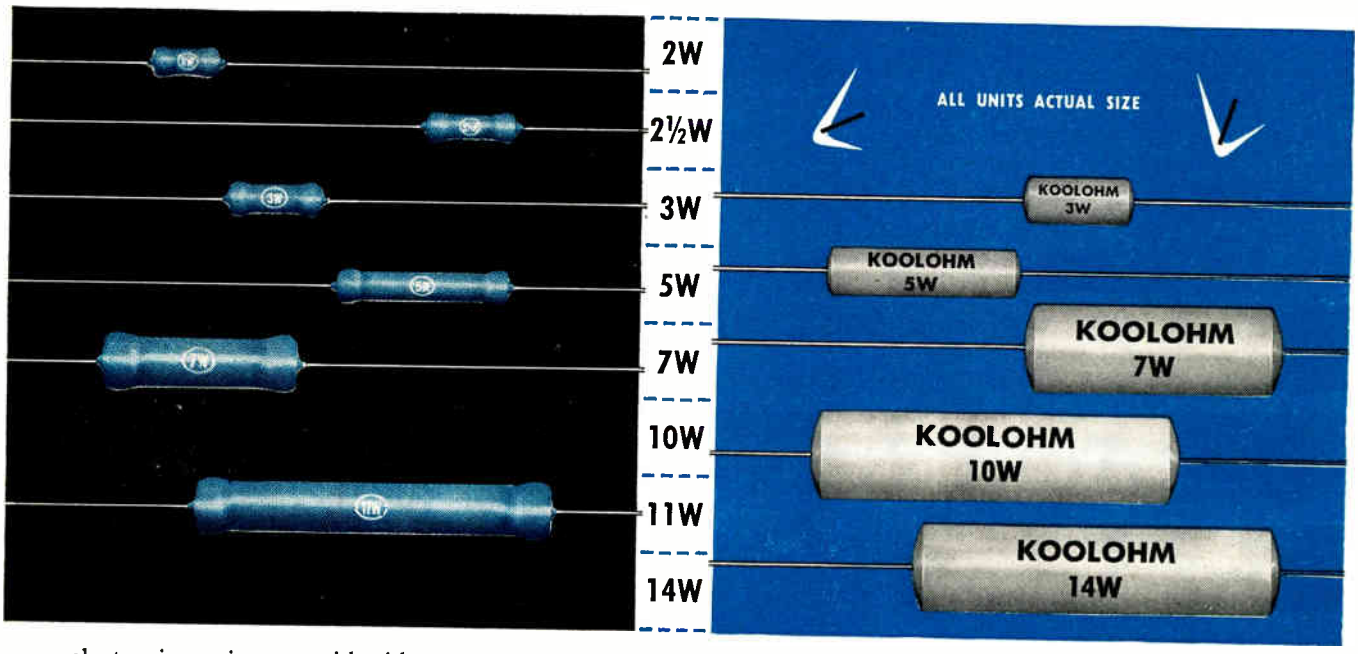
KOOLOHM®

INSULATED-SHELL POWER RESISTORS

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

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

Send for Engineering Bulletin 7300 for complete technical data.



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Circle 3 on Inquiry Card

As We Go To Press...

New Radar Tube Shows Only Moving Targets

A new electronic storage tube for radar virtually eliminates signals from stationary objects such as buildings, mountains, and other ground obstructions has been developed for the Signal Corps by IT & T Corp. in conjunction with USASRDL, Fort Monmouth, N. J.

Only the moving target signal is passed by this "barrier grid storage tube" eliminating the ground clutter within the tube.

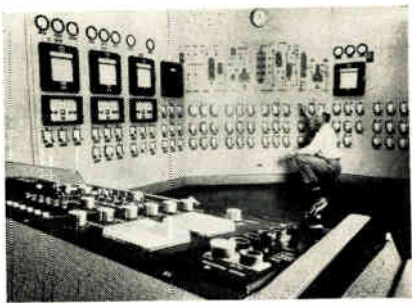
The tube will also strengthen distant or faint target signals by an integrating process that makes them visible above background noise which normally makes a weak signal undetectable.

These capabilities should make the tube useful in infrared detection systems and lead to important advances in missile and aircraft defense systems.

Because the tube can accurately store and read a large amount of information in binary digital form at very high speed, it may be used in automatic telephone switching systems and electronic computers as a temporary store.

The tube's high resolution, permitting a large storage capacity, results from its unique design.

The storage element consists of a curved metal ceramic-coated bowl, the barrier grid being formed into the bowl and fused to the storage surface. The novel tube design permits high resolution with little shading signal over the storage surface. The fuzed structures result in a high degree of ruggedness permitting more widespread application.



Thompson Ramo Wooldridge RW-300 computer, foreground, controls refinery operation.

Computer Takes Over Refinery Operation

The first industrial process ever to be controlled by an electronic brain has just gone on stream at Port Arthur, Texas.

With no more indication than a steady glow of indicator lights and hum of electronic parts, a Thompson Ramo Wooldridge RW-300 digital computer took over control of the processing on a nearly $4-million refining unit at Texaco's huge Port Arthur refinery.

This is the first time in the history of automation that the so-called "loop" of computer control has ever been closed on a full-scale plant operation.

While carrying out its complex control program—gathering information from 110 sources and controlling 16 different streams, pressures, and temperatures in nearly every combination — the computer also checks the accuracy of its information, watches its own performances, types out what it is doing, and sounds an alarm if any part of the system shows signs of impending danger or failure.

Tube Mfrs. Organize Information Council

An Electron Tube Information Council has been formed by eight of the nation's leading receiving tube manufacturers.

Comprising representatives of CBS-Hytron, General Electric Co., Philco Corp., Radio Corporation of America, Raytheon Manufacturing Co., Sylvania Electric Products Inc., Tung-Sol Electric Inc., and Westinghouse Electric Corp., the new ad hoc group has these objectives.

1. "To promote the use of tubes in those electronic applications where they offer superior properties."
2. "To emphasize the engineering factors involved in the selection of alternative electron valve-type devices."
3. "To focus attention on new trends and developments in tube technology."

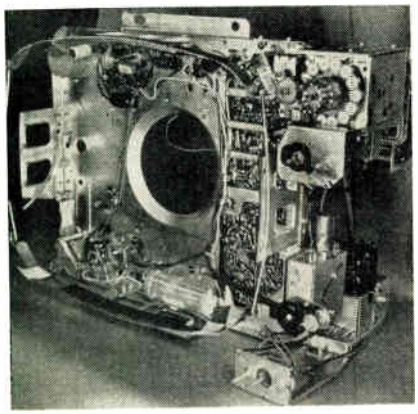
Elliott Named EIA Small Business Chief

Chairman of EIA's newly established Small Business Committee is Joseph B. Elliott, Pres. of Tele-Dynamics, Inc.

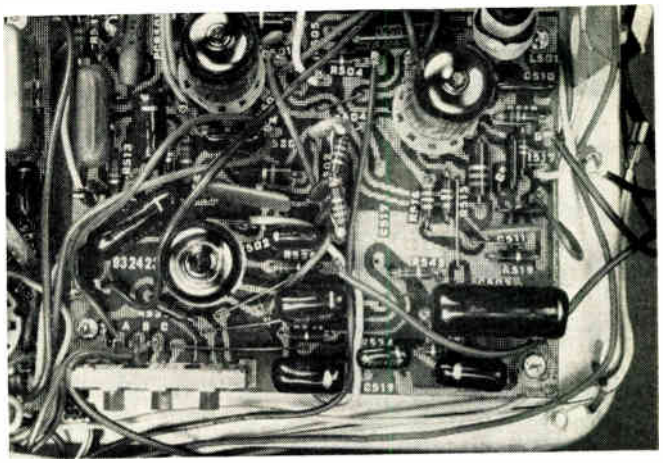
Authorization of the 11-member group was approved last December. The Committee provides a vehicle for small EIA electronic manufacturers to review and act upon "small business" problems, particularly in the military procurement field.

More News
On Page 8

NEW SETS FEATURE SERVICING CONVENIENCE



In RCA's new portable TV sets components are identified by number on one side, and the circuit is printed on the other. The chassis is designed so that work can be done on this side without completely removing the kinescope.



ELECTRONIC SHORTS

▶ **A charter for the newly established Office of the Director of Defense Research and Engineering, transferring to this Office the personnel and functions of the former Office of the Assistant Secretary of Defense (Research and Engineering), has been issued. The transfer also includes the administrative direction of the Weapons System Evaluation Group.**

▶ Dun & Bradstreet, Inc., now has the first coast-to-coast private wire communication system in the United States to carry credit and business information. This wire network, which is leased from the Western Union Telegraph Company, extends for 16,000 miles and connects 79 of the 142 offices of the credit agency.

▶ **The moon will be used to link Washington, D. C. and Pearl Harbor in a new communication system. Over a year ago the Navy demonstrated that such a means of communication is feasible. One reason for considering the moon as a replacement for the ionosphere is that the latter is subject to changing properties from sun spots, whereas the moon's properties are stable.**

▶ A mobile microwave telephone and telegraph communication system which will cost over $3½-million has been ordered from Marconi's Wireless Telegraph Co., Ltd., of Chelmsford, England, by the United States Government. The system will link many of the USAF bases in the United Kingdom. The mobile stations will be self-contained with all the necessary equipment including their own power supply. Mobility will permit the units to be deployed individually or collectively.

▶ **Patent rights to the MASER have been turned over to Research Corp., a non-profit foundation whose total income is distributed among educational institutions for support of fundamental research, by Dr. Charles H. Townes, its developer, Professor of Physics at Columbia. The patent rights cover a variety of existent MASERS as well as those that are proposed or are now being constructed.**

▶ A three positioned toggle switch is the nucleus of a new type of flight control mode selector and display for supersonic and future outer space flight. The selector was designed and developed by GE's Light Military Electronics Equipment Dept. During a stress period, extreme gravitational pull or complete weightlessness, the pilot may change operational modes by simply flicking the switch. The three positions are for off, selection display, and action.

▶ **The Dept. of the Army has developed a radio transmitter the size of a pencil eraser. It is used in ballistic studies. The device determines temperature of an artillery shell while in flight and instantaneously radios the information back to ground receivers. The device, developed by the Diamond Ordnance Fuze Laboratories, received a national award for achievement in the field of miniaturization.**

▶ Ten Ohio University students, directed by Dr. John D. Kraus, are constructing a unique radio telescope which will permit them to map the radio sky at a minimum cost, under a National Science Foundation grant. It consists of a fixed parabolic antenna 360 ft. long by 70 ft. wide, a flat tiltable reflector 360 ft. long by 100 ft. high, and associated radio receiving equipment. The students worked part-time during the school year and full-time in the summer.

▶ **Republic Aviation Corp. reports that more than 50,000 items, from washers to diapers and from aluminum sheet to fire control systems, were purchased from 3,450 firms to support production of the USAF's F-105 fighter-bomber. The diapers are used to polish the cockpit canopies on the big jet. Small businesses, employing less than 500, totaled 2,670.**

▶ Misleading advertising as to the effectiveness and efficiency of mail-order crystal radio sets for use in civil defense alert emergencies have seriously increased recently. These devices, rightfully belonging in the toy class, are heralded as having hi-fi clarity or of utilizing the same electronic and engineering principles employed by the Army and Navy on radar and sonar equipment.

As We Go To Press . . .

NBS Frequencies Are Off—by $3x10^{-9}$

A difference of three ten-billionths in frequencies between two cesium-beam atomic standards, although separated by half a continent, has been detected by the radio broadcast section, Radio Standards Division of Boulder Labs., N. B. S.

The accomplishment is unique in that high frequency radio signals provided the medium by which the error was detected. A. H. Morgan, chief of the section, believes this is the first time such a high degree of accuracy in frequency measurement has been obtained by use of high frequency radio signals. Similar accuracy has been recorded in low frequency ranges, but low frequency signals have considerably greater stability than those in the high frequency range.

Had the difference remained undetected and had each of the two atomic standards, one located at Boulder Laboratories and the other at radio station WWV, Beltsville, Md., been made to operate regular clocks with a variance of three parts in ten billion, they would have registered a time difference of only 3 secs at the end of 300 years.

The trouble was traced to a defective beam tube in the Maryland equipment.

Ridenour Joins EIA Board of Directors

Dr. Louis N. Ridenour, vice president and general manager of Lockheed Aircraft Corp.'s newly formed Electronics and Avionics Division, was elected a member of the EIA Board of Directors.

Also, Major. Gen. W. Preston Corderman (USA-ret), vice president of Litton Industries, was elected to the Association's Military Products Division Executive Committee, succeeding Charles B. Thornton, president of Litton Industries.

At the same time, Norman A. Triplett, vice president, Triplett Electrical Instrument Co., was elected one of EIA's two representatives to the Electronic Industry Show Corp., succeeding Parts Division Chairman William S. Parsons, of Centralab, a division of Globe-Union, Inc., of Milwaukee.

Technological Competition

Continual demands are being made for more effective—and more *complex* electronic weapons systems. These demands have multiplied the problems of reliability to a point where some scientists have resorted to mystical methods to "hex" competitive systems—even to the point of sticking pins in voodoo dolls.

With Hughes systems and components you have no such reliability problems. Hughes "hardware" is backed by the brain power of over 5000 reliability-oriented Hughes engineers and scientists—who have designed and developed well over two billion dollars worth of reliable electronic systems and components. When you specify HUGHES you insure against breakdowns—even under the most severe environmental conditions.

On the three following pages you'll find specific examples of Hughes reliable components — semiconductor devices, TONOTRON* Storage Tubes, and MEMO-SCOPE® recorders.

In addition to these, other Hughes Products devices which offer you this "built-in" reliability include: precision crystal filters for selective tuning ...rotary switches...thermal relays... MEMOTRON® and TYPOTRON® storage tubes...microwave tubes... diodes, transistors and rectifiers...and industrial systems which operate a complete and integrated line of machine tools.

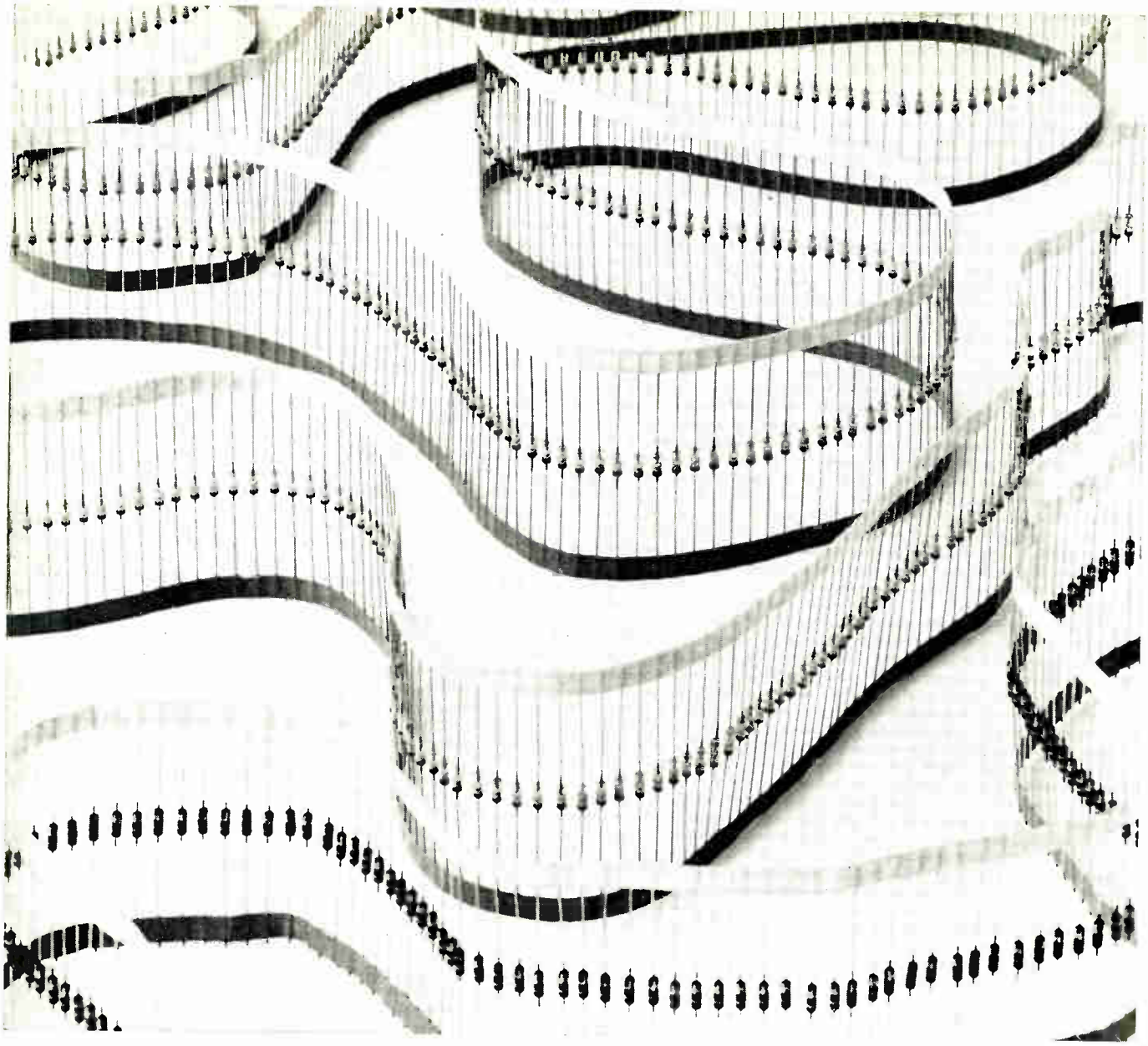
*Trademark of H.A.C.

For additional information regarding any component or system please write: Hughes Products, Marketing Dept., International Airport Station, Los Angeles 45, California.

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

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



ZENER DIODES IN A PROVEN GLASS PACKAGE

Now you can get high-performance voltage-regulator diodes in the famous, hermetically-sealed Hughes glass envelope. These diodes have an outstanding characteristic: sharp regulation of reverse voltage. This means that you can use them—with confidence—in clipping, clamping, coupling, and compensation circuits to obtain *dependable voltage regulation*. In addition, they retain this stability, together with low dynamic resistance, throughout a wide range of operating temperatures.

CHARACTERISTICS

Nominal Voltage: 2 volts to 30 volts

Power Dissipation: 250 milliwatts

Maximum Dynamic Resistance: 10 to 75 ohms

Operating Temperature Range: —65° to 175° C.

Dimensions, Diode Glass Body: Maximum Length: 0.265″ max.
Maximum Diameter: 0.105″ max.

To obtain your copy of specifications covering the family of more than a dozen types of Hughes Silicon Voltage-Regulator Diodes, please write: Hughes Products, Semiconductor Division, Marketing Department, P.O. Box 278, Newport Beach, California.

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

taking "whether" out of the weather

With the Hughes TONOTRON* tube in your airborne weather radar system you can provide smoother, more dependable air miles.

Ideally suited to weather radar, the Hughes TONOTRON tube gives you:

***Full Gray Scale**—Seven different shades of gray.*

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

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

These same characteristics make the Hughes TONOTRON tube equally adaptable to many other military, scientific and commercial applications, such as: sector scanning, ground mapping, "B" scan radar, oscillography, armament control radar, optical projection systems and miniature radar indicators. TONOTRON tubes are available in a range of sizes...from 3 inches to 21 inches in diameter.

You can obtain additional information concerning Hughes Tonotron tubes by simply writing: Hughes Products, Electron Tube Sales, International Airport Station, Los Angeles 45, California.

*TRADE-MARK OF H.A.C.

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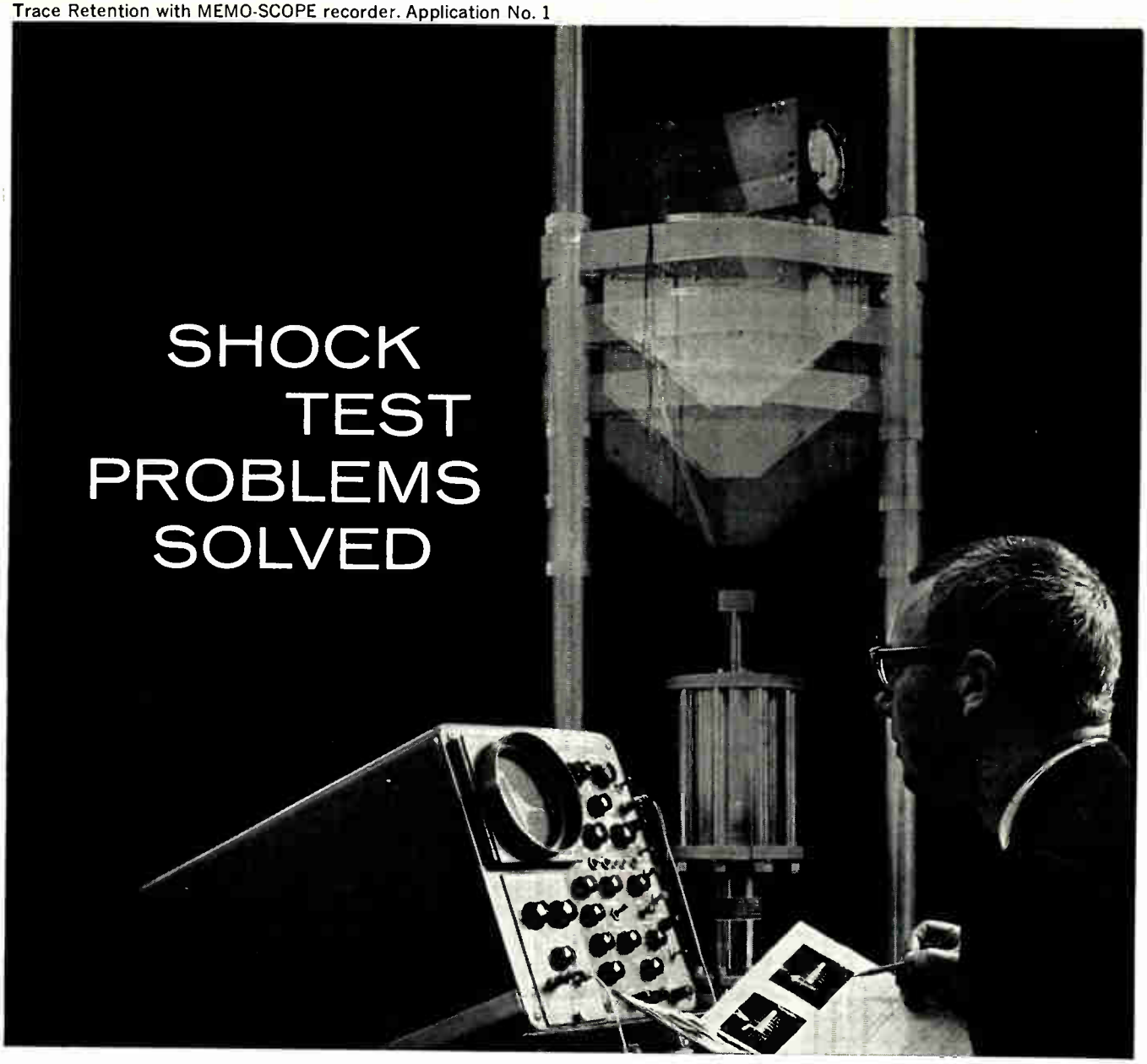
Trace Retention with MEMO-SCOPE recorder. Application No. 1



Now with the Hughes MEMO-SCOPE® oscilloscopic recorder you can instantly freeze wave forms which record shock and other environmental tests. In association with the Hyge Shock Test Unit, manufactured by Consolidated Electrodynamics, you can produce predictable, repeatable acceleration shock thrusts. The information can be stored on the face of the MEMO-SCOPE recorder for hours—or even days if necessary—until intentionally erased. Successive wave forms may be written above, below or directly over the original information. This ability to freeze transients for study saves you time and money in transient analysis.

In addition to physical testing (shock, stress, and strain) the MEMO-SCOPE recorder makes it possible for you to solve problems associated with:

- *Ultrasonic flaw testing*
- *Drift measurements*
- *Ballistics, explosives research*
- *Switch, relay contact studies*
- *Transducer testing*
- XY *plotters*
- *Medical diagnosis problems*
- *Trouble shooting*

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

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

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

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

Coming Events

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

May 3-7: 115th National Meeting, The Electrochemical Society, AFOSR/ Chem. Div.; Sheraton Hotel, Philadelphia, Pa.

May 4-5: Maint. & Plant Engineering Conf., ASME; Edgewater Beach, Chicago, Ill.

May 4-6: Nat'l Aeronautical Electronics Conf. (NAECON), IRE, Dayton Section, IAS; Dayton-Biltmore, Dayton, Ohio.

May 4-7: 5th Annual Flight Test Instrumentation Symp., ISA; Seattle, Wash.

May 4-8: 85th Semiannual Conv. & Intn'l Equipment Exh., SMPTE; Fontainebleau Hotel, Miami Beach, Fla.

May 5-7: 7th Nat'l Conf. on Electromagnetic Relays, National Assoc. of Relay Mfg., Oklahoma State Univ.; Oklahoma State Univ. Campus, Stillwater, Okla.

May 5-7: URSI Spring Meeting, URSI, IRE.

May 6-8: 7th Regional Tech. Conf. & Trade Show, IRE; Univ. of New Mexico, Albuquerque, New Mexico.

May 6-8: Electronic Components Conference, WCEMA, IRE, EIA, AIEE; Benjamin Franklin Hotel, Phila., Pa.

May 7: Plastics in the Metals Industry Conf., Society of Plastics Engineers; Pen-Sheraton Hotel, Pittsburgh, Pa.

May 7: Conference on Corrosion Inhibitors, Armour Research Foundation; Chicago, Ill.

May 11-13: Joint Conf. on Automatic Techniques, IRE, AIEE, ASME; Pick-Congress Hotel, Chicago, Ill.

Abbreviations

ACM: Association for Computing Machinery
AFOSR: Air Force Office of Scientific Research
AIEE: American Inst. of Electrical Engrs.
AIME: American Institute of Mining & Metallurgical Engineers
ASME: American Society for Mechanical Engineers
ASTM: American Society for Testing Material
CCIR: International Radio Consultative Committee
EIA: Electronic Industries Assoc.
IAS: Institute of Aeronautical Sciences
IRE: Institute of Radio Engineers
ISA: Instrument Society of America
ONR: Office of Naval Research
SAE: Society of Aeronautical Engineers
SMPTE: Society of Motion Picture & TV Engineers
SPI: Society of Plastics Industry
WCEMA: West Coast Electronic Manufacturers Assoc.

May 11-12: Symp. on Radar Return, Naval Ordnance Test Station, China Lake, Calif.; at Univ. of New Mexico, Albuquerque, New Mexico.

May 11-13: PGMTT National Symposium, IRE (PGMTT); Boston, Mass.

May 11-13: Nat'l Power Instrumentation Symp, ISA; Kansas City, Mo.

May 12-14: Production Engineering Conf., ASME; Statler-Hilton Hotel, Detroit, Mich.

May 14-16: Spring Meeting, Acoustical Society of America, Ottawa, Canada.

May 18-20: Electronic Parts Distributors Show, Assoc. of Electronic Parts & Equipment Mfg.; Conrad Hilton Hotel, Chicago, Ill.

May 17-19: 5th Nat'l Symp. on Instrumental Methods of Analysis, ISA; Shamrock-Hilton Hotel, Houston, Texas.

May 19-21: Middle Eastern District Meeting, AIEE; Lord Baltimore Hotel, Baltimore, Md.

May 20-22: Annual Convention, EIA; Sheraton Hotel, Chicago, Ill.

May 21-27: International Conv. on Transistors & Associated Semiconductor Devices, British Institute of Electrical Engineers; Savoy Place, London.

May 22: Plastics in Electrical Insulation Conf., SPE; Fort Wayne, Ind.

May 24-27: 51st Annual Convention, National Assoc. of Electrical Distributors; Hotel Conrad Hilton, Chicago, Ill.

May 25-27: National Telemetering Conf., IAS, ISA, ARS, AIEE; Cosmopolitan Hotel, Denver, Col.

May 25-27: National Space Age Industry Exposition; National Rocket Club, Sheraton-Park Hotel, Washington, D. C.

May 25-27: Meeting, American Rocket Society; Denver, Colo.

May 25-27: 13th Annual Convention, American Society for Quality Control; Hotel Cleveland, Cleveland, Ohio.

May 25-28: Design Engineering Conf., ASME; Convention Hall, Phila., Pa.

May 25-29: Symposium on Neuronal Inhibition, AFOSR / Aeromedical Div., City of Hope Medical Center, Univ. of California; at Duarte, Cal.

May 26-28: Annual Convention, American Public Power Assoc.; Olympic Hotel, Seattle, Wash.

June 3-5: Annual Convention & Exh., Armed Forces Communications & Electronics Assoc.; Sheraton Park Hotel, Washington, D. C.

June 9-11: 8th Annual Convention, National Community TV Assoc.; Mayflower Hotel, Washington, D. C.

June 13-23: Ist International Conf. on Information Processing, UNESCO, U.S. Committee, IRE, AIEE, Assoc. for Computing Machinery; Paris, France.

June 17-20: Annual Meeting, National Society of Professional Engineers; Commodore Hotel, New York, N. Y.

June 20-22: National Convention, American Radio Relay League; Galveston, Texas.

June 21-26: Annual Meeting, American Society for Testing Materials; Chalfonte-Haddon Hall, Atlantic City, N. J.

June 29-July 1: 3rd National Conv. on Military Electronics, IRE; Sheraton Park Hotel, Washington, D. C.

August 3-6: 25th Annual Convention, Associated Police Communications Officers; Shirley Savoy Hotel, Denver, Colo.

August 17: 1st National Ultrasonics Symposium, IRE; Stanford Univ., Stanford, Calif.

August 18-21: WESCON, IRE, West Coast Electronic Manufacturers Assoc.; Cow Palace, San Francisco, Calif.

August 20-24: Annual Convention, National Alliance of TV & Electronic Service Assoc's; Congress Hotel, Chicago, Ill.

SOME HIGHLILGHTS OF 1959

Aug. 18-21: WESCON, West Coast Electronic Mfgs. Assoc. & 7th Region IRE; San Francisco, Calif.

Oct. 12-14: Nat'l Electronics Conf., IRE, AIEE, EIA, SMPTE; Hotel Sherman, Chicago, Ill.

Nov. 9-11: Radio Fall Meeting. IRE, EIA; Syracuse, N. Y.

Nov. 10-12, 1959: 12th Annual Conf. on Electrical Techniques in Medicine & Biology, IRE, AIEE, ISA; Sheraton Hotel, Phila., Pa.

Nov. 16-18: JEDEC General Council; Bellevue - Stratford Hotel, Phila., Penna.

Nov. 30-Dec. 1: Eastern Joint Computer Conf., IRE (PGEC), AIEE, ACM; Hotel Statler, Boston, Mass.

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Clevite offers new types with improved reliability and power handling capacity.

EIA REGISTERED TYPES WITH:

- **Improved seal for long life.**
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- **Average thermal resistance 0.7°C per watt.**
- **Current gain controls: 60-150 at 5 amperes.**
- **100% test for resistance to transient burn out.**
- **Either standard pins or solder lugs.**

TECHNICAL DATA

Typical Electrical Characteristics at 25°C

2N1147 Series has solder lugs 2N1146 Series has standard pins	2N1147 2N1146	2N1147A 2N1146A	2N1147B 2N1146B	2N1147C 2N1146C
Collector to Emitter Voltage Shorted Base (IC = 1 amp)	30V (Min)	40V (Min)	60V (Min)	75V (Min)
Saturation Voltage (IC = 15 amps)	1.0V (Max)	1.0V (Max)	1.0V (Max)	1.0V (Max)
DC Current Gain (IC = 5 amps)	60-150	60-150	60-150	60-150
DC Current Gain (IC = 15 amps)	35	35	35	35
Absolute Maximum Ratings				
Collector Current	15 amps	15 amps	15 amps	15 amps
Collector to Base Voltage	40V	60V	80V	100V
Collector to Emitter Voltage	40V	60V	80V	100V
Power Dissipation at 70°C Case Temperature	25W	25W	25W	25W
Junction Temperature	95°C	95°C	95°C	95°C

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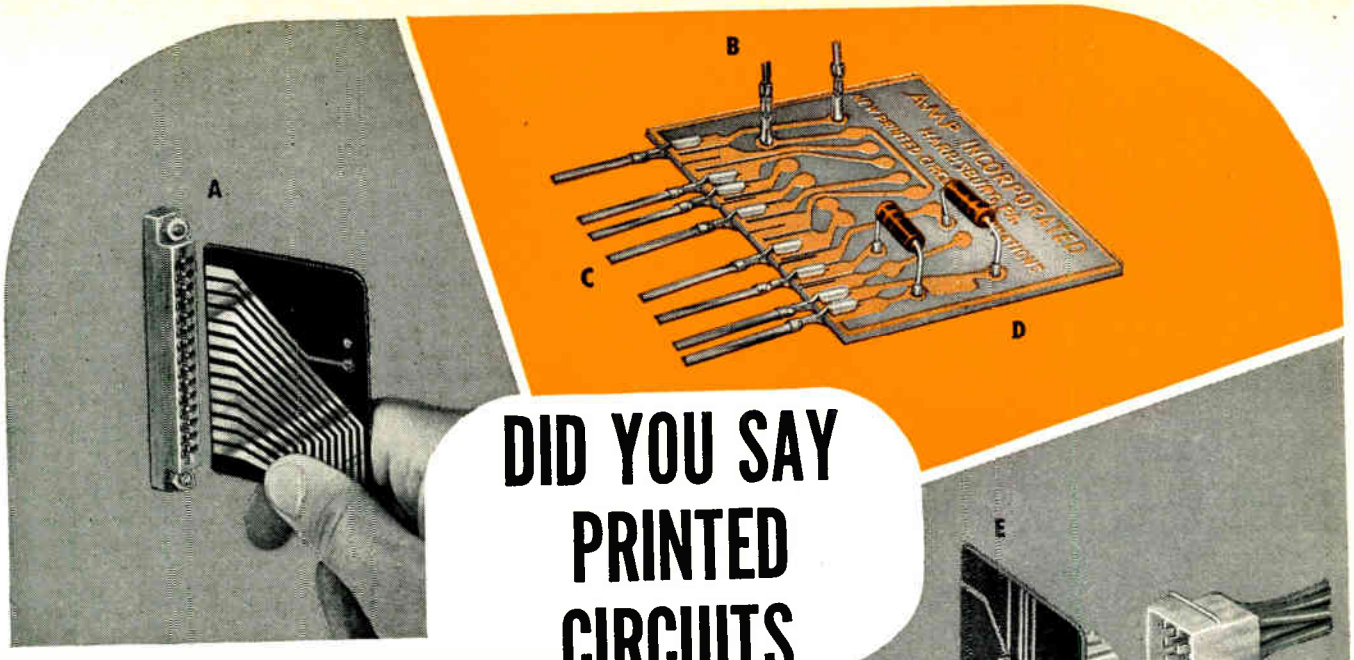

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A—A-MP Molded Edge Connector affords a solderless, reliable multi-circuit connection on printed circuit board edges.

B—AMPin split tip firmly holds pin in board during solder dipping, assures good capillary flow. AMPin attaches to your leads with high speed A-MP tooling.

C—AMP-edge fits edge slotted boards giving high conductivity without scoring paths. Low cost board edge connections.

D—A-MP Component Tips crimp to component leads for firm mounting during solder dip. Permit stacking of units, protect semi-conductor leads from heat.

E—AMP-lok—economical multiple quick connect/disconnect of harness to board.

F—A-MP Printed Circuit Connector, for gruelling aircraft environments, is sealed against moisture and arcing, attaches with right angle pins to circuit board edge. Dual leads for each contact.

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No matter how you approach printed circuit problems—with single or multiple connector units, with board-edge or face attachments, with or without solder dipping, with or without eyeletting—AMP has just the product you'll need for low-cost top reliability.

Production and assembly speeds are miles ahead of most other techniques. Versatility is unbeatable, permitting A-MP products to be used on different applications and in combination with each other.

For complete information on electrical characteristics, application methods and other specifications, send for our new Printed Circuit Applications Catalog.

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Circle 9 on Inquiry Card

NEW!

SMALL!

DELCO POWER TRANSISTOR

Designed for use where space and weight are restricting factors

MAXIMUM RATINGS	2N1172
Collector Diode Voltage	40 volts
Emitter Diode Voltage	20 volts
Collector Current	1.5 Amperes
Junction Temperature	95°C
TYPICAL CHARACTERISTICS (25°C)	
Typ. Collector Diode Current I_{co} V_{cb}=40 volts	50μ
Current Gain (V_{ec}= −2 volts, I_c=100 Ma)	70
Current Gain (V_{ec}= −2 volts, I_c=½A)	30
Saturation Resistance	0.3 ohms
Cutoff Frequency (Common Emitter)	17 kc
Thermal Resistance	12° C/Watt

The 2N1172 is a medium power transistor offering dependable operation in a new range of applications where space and weight have been a problem.

It's a mighty mite with more punch in a smaller package. The 2N1172, excellent for output use or as a driver for a very high power transistor, has already proved especially effective in DC amplifiers, voltage regulators, and as a driver for a high power stage in servo or other amplifiers.

This PNP germanium transistor is housed in a modified version of the JEDEC 30 package with a diamond shaped base for improved thermal conduction. It dissipates up to 2 watts at a mounting base temperature of 70 degrees centigrade. Available now in volume production—write today for complete engineering data.

DELCO RADIO

Division of General Motors
Kokomo, Indiana

BRANCH OFFICES

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Santa Monica, California
726 Santa Monica Boulevard
Tel: Exbrook 3-1465

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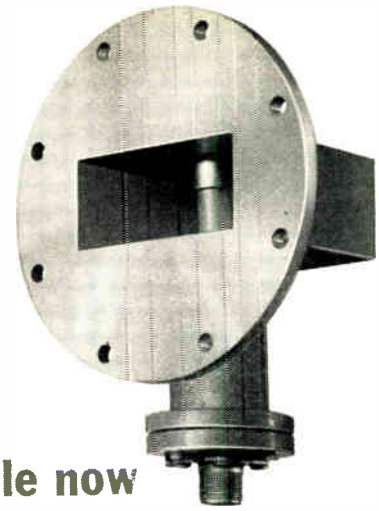
Circle 11 on Inquiry Card →

SMALL APPETITE NOISE SOURCES



service-proved and available now

Until recently signal simulators for monitoring radar receivers or microwave relays were of two types. One was a big and heavy ampere eater with cumbersome auxiliary equipment; and the other was a sensitive though delicate instrument suitable only for the laboratory.

We call your attention now to the Litton 2000 series of miniature gas noise sources. The Litton 2000 for waveguide use is pictured above. It has a first cousin, the Litton 2007 designed for coaxial cable use. We call your attention because most tubes in this series are now in production and we suspect there are frustrated design engineers who will receive this announcement with keen interest.

Our gas noise sources may properly be called miniature. They require only inches of space, smaller, lighter auxiliary equipment, and small voltages and currents. Around 500 volts fires them; 100 milliamperes maintains them. These characteristics, plus others, have caused them to find numerous applications: for in-flight calibration and test of aircraft microwave receivers; as *automatic* watchdogs on airborne radar systems; and in other systems which require various immunities to vibration, shock, humidity, and temperature cycling.

The Litton family of miniature gas noise sources, like all Electron Tube Division products, was designed to solve specific end item functions. We have found that this philosophy contributes to consistent reliability: tubes do their jobs more efficiently, for longer periods of time, and at lower overall cost to the buyer. Other advantages also result. For example, these noise sources require *no* ageing-in and the L-2000 is replaceable in the field without changing the mount.

Specific frequency ranges in L, S, C, X and K bands are covered. If you are concerned with radar transmission, or with microwave data links of any kind, we'll gladly send you more information. Write to Litton Industries Electron Tube Division, Office E13, 960 Industrial Road, San Carlos, Calif.

LITTON INDUSTRIES Electron Tube Division

MAGNETRONS • GAS DISCHARGE TUBES • CARCINOTRONS • TRAVELING WAVE TUBES
KLYSTRONS • BACKWARD WAVE OSCILLATORS • NOISE SOURCES • DISPLAY TUBES

CAPABILITY THAT CAN CHANGE YOUR PLANNING

Electronic Industries International

American Mfrs. Line Up For Moscow Exhibition

Electronic manufacturers are most prominent among the U. S. firms lining up to display their products at the $3,600,000 American National Exhibition schedule to open on July 4 in Sokolniki Park in Moscow.

One of the highlights will be an exhibition by the Institute of High Fidelity Manufacturers of stereophonic high fidelity sound. The exhibit will have its own fan-shaped glass, steel and aluminum pavilion.

Philco will be exhibiting 2 TV receivers, a washer-dryer and a room air conditioner.

RCA will provide a complete TV studio, and 8 hours daily of color TV programming. Show visitors will be invited to see themselves on color TV.

Norway to Join Eurovision

Chelmsford, Essex — Marconi's have been awarded contracts from the Norwegian PTT Administration and the Royal Board of Swedish Communications for a combined multichannel radio-telephone and television link between the Norwegian capital, Oslo and Karlstad (Sweden).

A further section, carrying multichannel radio-telephony only, is to be installed in Sweden between Karlstad and Arvika.

The path carrying the television signals will enable programmes emanating from Oslo to be fed into the Swedish link and so into the Eurovision network; by reversing the path, Oslo can take programmes from Sweden or the Eurovision network.

Foreign Competition Eating Into U.S. Export Markets

U. S. exports dropped to $16.3 billion last year, down more than 16% from the record business of 1957.

The Bureau of Foreign Commerce attributes the decline to the influence of European and Japanese booms, the Suez crisis and the depleted foreign exchange reserves.

Sales to Japan receded in 1958 from boom levels as a mild recession set in there. U. S. demand for Japanese goods continued to rise.

Canada's economy shows signs of picking up, which should bring an end to the decline in U. S. sales there.

U. S. Lends Korea $3,500,000

Korea's telephone and telegraph systems, 80% destroyed by the Communists during the Korean War, and only partly restored, will be modernized through a 3,500,000 loan from the Development Loan Fund.

Of the loan funds, $2,250,000 will be used to defray foreign exchange costs of extending and improving intra-city telephone systems, $850,000 will be similarly used for long-distance telephone systems and $400,000 for telegraph facilities.

SWEDEN

Joins Ericsson Board

Stockholm — Erik Boheman, former Swedish ambassador to the U. S. has been elected a director and vice chairman of the board of the L. M. Ericsson Telephone Co., parent company of the Ericsson Group, worldwide telecommunications firm.

Sealectro Sets Up UK Plant

Surrey, England—A British branch operation with offices and plant in Surrey, 16 miles southwest of London, has been set up by Sealectro Corp. of Mamaroneck, N. Y. manufacturers of Teflon terminals and sub-miniature r-f cable connectors.

The new British plant will permit intensified R&D in fluorocarbons (Teflon) and other plastics, as well as in metals, notably beryllium-copper, for spring-contact members.

The Sealectro British operation is headed by Carl T. Nuttall, formerly of Siemen-Ediswan.

Officers of new Sealectro British operation, Carl T. Nuttall (l) and S. T. Deakin, in charge of R&D discuss problems with William Silberstein, pres of Sealectro.

MOSCOW-BOUND

The message being flashed on the screen reads, "See yourself on TV." It's part of the RCA equipment being shipped to the American National Exhibition which is starting in Moscow this coming July 4th.

FRANCE

New Iron Fireman Rep

The Bureau de Liaison of Paris, France, has been appointed sales representative to Free Europe for Iron Fireman gyros, relays, slip rings and other electronic products.

Though the Electronics Division of Iron Fireman has done some business with European nations, this is the first concentrated sales effort that they have made in that area.

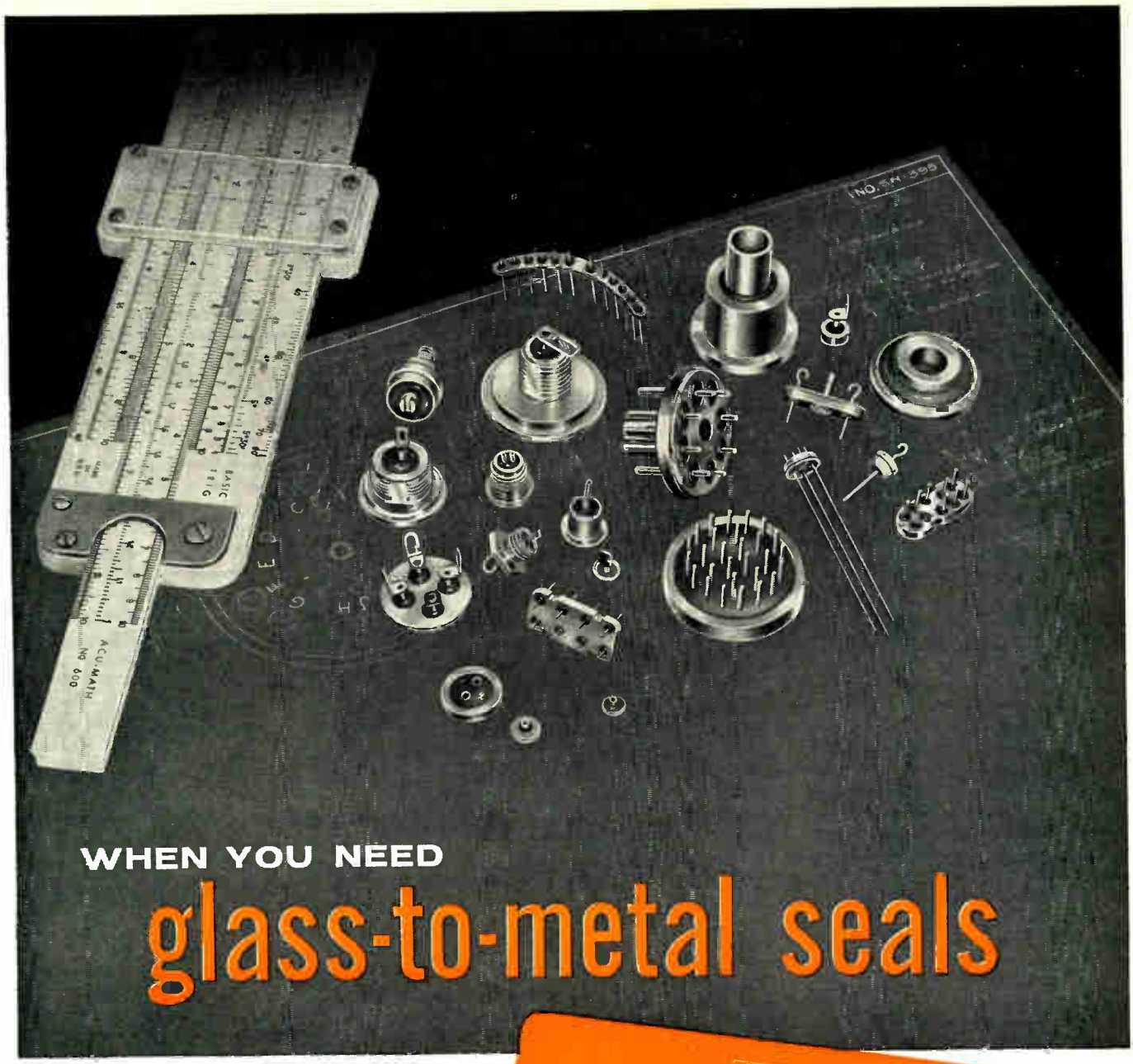
JAPAN

Japanese TV Booming

Tokyo last month opened Japan's first educational TV station, JOAB-TV. At the same time commercial station JOEX-TV began transmissions. Tokyo now has a total of five stations.

The addition of these stations brings the total number of TV stations in Japan to 46, of which 21 are commercially operated and 25 are under the Japan Broadcasting Corp. (NHK).

Closed-circuit TV for educational institutions has also been inaugurated at Tokyo University in Tokyo. Lectures given in the studio are transmitted to classrooms, and the students put questions to the lecturers through an interphone system.



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ELECTRICAL INDUSTRIES

A Division of Philips Electronics, Inc. MURRAY HILL, NEW JERSEY

HIGH-POWER FILTERS TO SUPPRESS HARMONIC AND- BEING DEVELOPED AT GENERAL ELECTRIC MICRO-

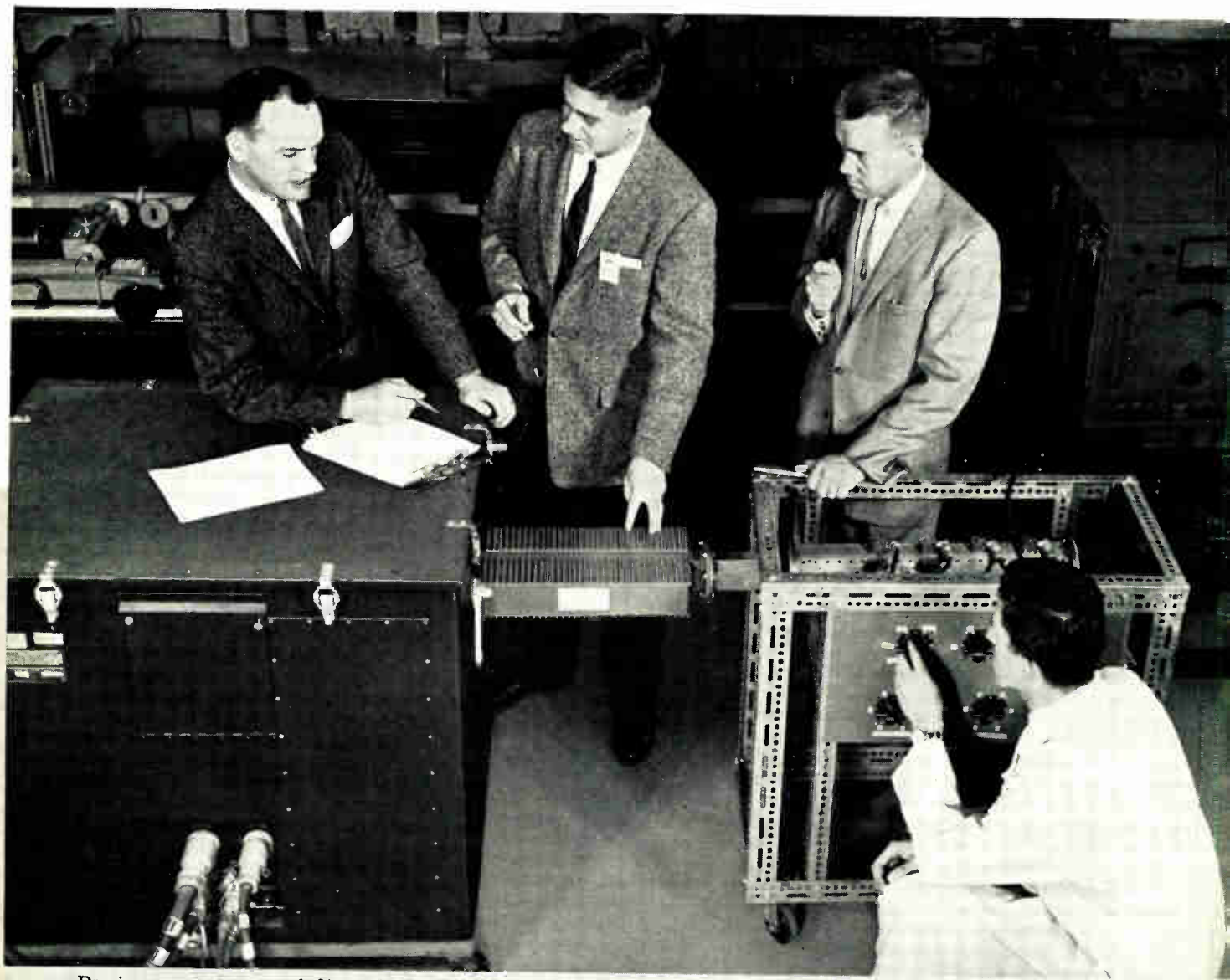
THE equipment designer's requirement for freedom from harmonic and spurious signals in microwave radars is the subject of a continuing, large-scale project at the Microwave Laboratory of the General Electric Power Tube Department.

Result of this work is significant progress toward development of a line of microwave filters suitable for eliminating such signals from high-power magnetrons, klystrons and traveling-wave tubes. These filters are intended for use in the waveguide line between tube and antenna. Low insertion loss in the pass band and high attenuation in the stop band of these filters assure efficient systems operation. Low VSWR over both the pass band and the stop band allows these filters to be used without danger of tube damage.

Filter development is only one of a broad range of activities now being conducted at the G-E Microwave Laboratory. Applied research, advanced development, and prototype design are conducted in all areas of microwave tubes and microwave techniques (see list on opposite page). Technical inquiries pertaining to advanced microwave development are invited. *Power Tube Department, General Electric Company, Schenectady, New York.*

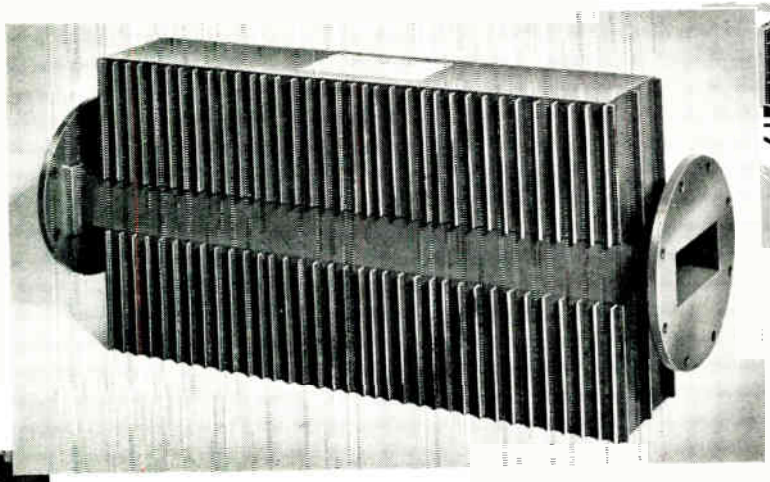
* * *

Professional opportunities available for electron tube production, engineering, and scientific personnel. Inquiries are invited.



Precise measurement of filter characteristics being made with special harmonic probe section developed at the General Electric Microwave Laboratory. *Left to Right:* Project Engineer Vernon G. Price, John P. Rooney, Richard H. Stone, Robert N. Spong (foreground).

SPURIOUS SIGNALS WAVE LABORATORY



▲ Typical of a family of high-power harmonic suppression filters under development is this unit which has an insertion loss in excess of 25 db for all signals from 5400 mc to 10,000 mc. It is capable of power levels up to 5 megawatts and has an insertion loss below 0.2 db throughout the pass band from 2700 to 3100 mc. The VSWR across both pass and stop bands is less than 1.8. Two or more filters can be joined in cascade to increase harmonic rejection. Other developmental filters operating in the L and S bands have been designed to meet specific operating conditions. All filters of this family are of rugged construction to meet performance standards of military applications.

▲ The General Electric Power Tube Microwave Laboratory is located at Stanford Industrial Park, Palo Alto, California where it was one of the Park's pioneer installations. Its scientists and engineers have the advantage of technical exchange with the faculty and research staff of Stanford University, as well as extensive opportunities for graduate training. Constant technical liaison is also maintained with General Electric's own Research and General Engineering Laboratories, Schenectady, New York.

The extensive program of the General Electric Microwave Laboratory on advanced microwave components and techniques includes the following:

- CW Klystron Amplifiers
- Super-Power Klystrons
- Voltage-Tunable Oscillators
- High-Power Duplexers
- Microwave Filters
- Pulse Klystron Power Amplifiers
- High-Power Pulsed TWT Amplifiers
- Low- and Medium-Power CW TWT Amplifiers
- Low-Noise, Broad-Band TWT Amplifiers
- Frequency Multiplier TWT Amplifiers

Progress Is Our Most Important Product

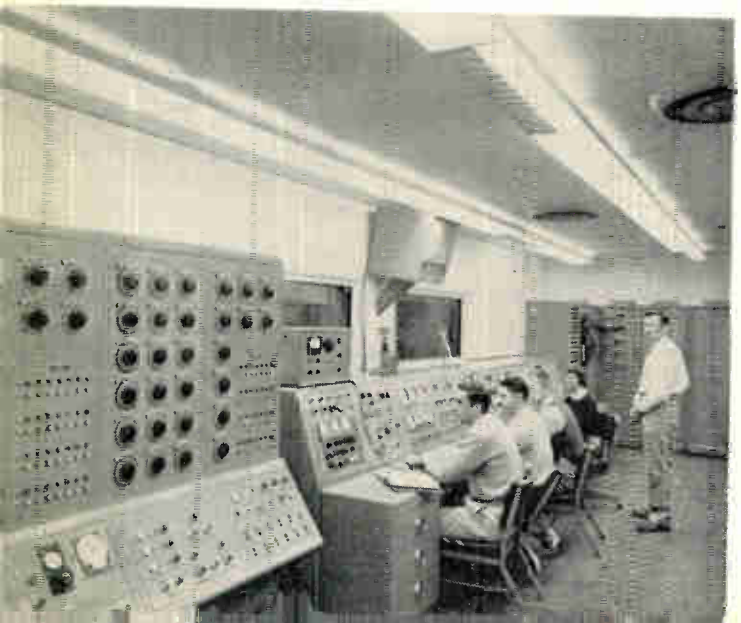
GENERAL ELECTRIC

9545-8481-20

TRANSISTOR TESTER-SORTER

At Raytheon's Semiconductor Division Plant, Brighton, Mass., this specially designed transistor tester detects up to 1200 different levels of performance within similar-appearing transistors

Snapshots . . . of the Electronic Industries

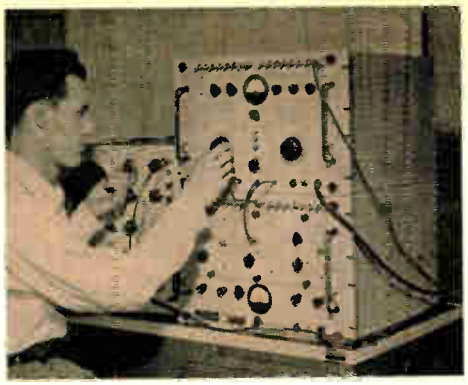


WIND TUNNEL

(l) Chance Vought's new wind tunnel is controlled by this bank of equipment. Cabinetry is by EMCOR

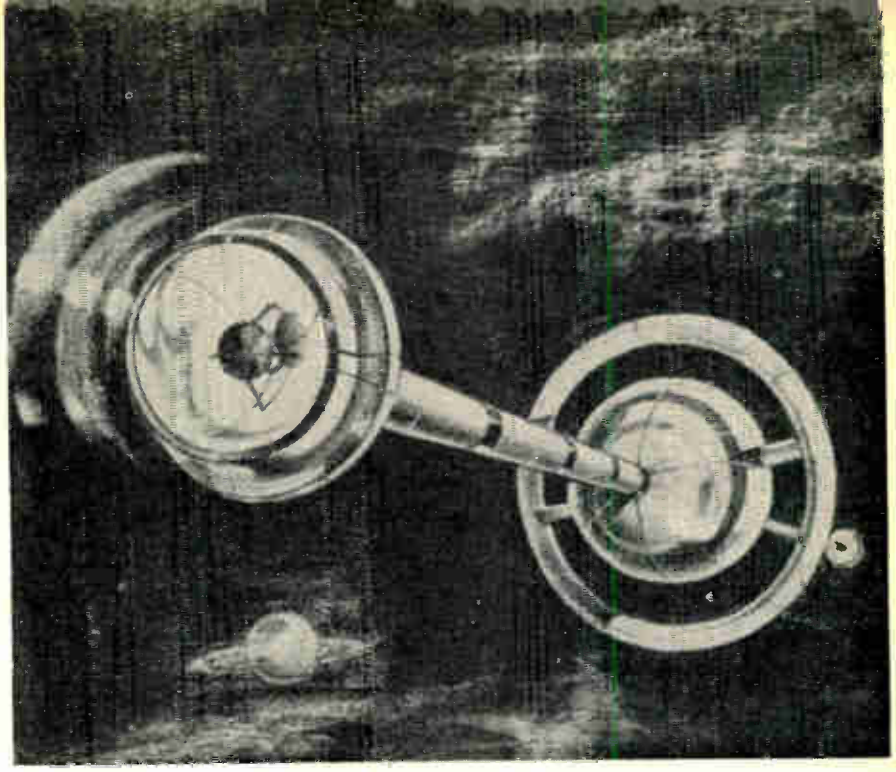
PUBLIC WORKS COMPUTER

(r) Officials of Chicago's sewer and public works departments look on with Bendix's R. C. Whiting (rear) as their new Bendix G-15 is put to work on a sewer hydraulics problem



DUAL RADAR TEST SET

The "first dual purpose radar test," model PG-1091, being introduced by Divco-Wayne, tests MTI radar sets for cancellation ratio and sub-clutter visibility ratio.



PHOTON-POWERED SHIP

This forward-looking space ship would whisk passengers to distant space at almost the speed of light. It was one of the winning designs in Mars Outstanding Design Contest

"BLISTER" TECHNIQUE

To eliminate the chance of contamination and resulting deterioration of precision instrument ball bearings the Eclipse-Pioneer Div. of Bendix seals bearings in a transparent blister.

MISSILE BUSINESS

Charles F. Adams, pres. of Raytheon Mfg. Co. (r), demonstrates attack of an Army Hawk Missile to Edward A. Pierce, vice-pres. of Merrill Lynch, Pierce Fenner & Smith, at Grand Central Sta., NYC.

EMISSION TEST

At Westinghouse tubes are operated with heater volts 20% over normal to check whether cathode coating is migrating to grid

NOISE CHECK

Noise of 122 db level is blasting A. Culver of Stromberg-Carlson's Electroacoustics Dept. as he tries to recognize information transmitted to receivers embedded in his ear defenders.

As We Go To Press . . .

U. S., Russian Computer Men Exchange Visits

A group of eight Russian computer experts and mathematicians last month took a two-week tour of U. S. industrial and educational data processing facilities. They were here to see how American commercial and scientific computers are manufactured and used, and to meet with American computer scientists.

The Russians' visit was arranged by the National Joint Computer Committee as part of a cultural exchange program under the auspices of the State Department. A group of American computer scientists representing the National Joint Computer Committee makes a reciprocal visit to the Soviet Union beginning May 17.

The Russians' tour included IBM's research facilities at Poughkeepsie, N. Y., M.I.T., Harvard University, Philco and N.B.S.

Satellite Tracking Stations Network

A "fence" has been constructed across the southern United States to detect and track all earth satellite vehicle and high-flying objects which pass over this country. The detection line extends from Ft. Stewart, Ga., to San Diego, Calif.

ARPA assigned construction and operation of minitrack stations on the Eastern and Western section of this line to NRL; and construction and operation of a CW-Doppler complex called "DOPLOC" in the center to the U. S. Army Ballistic Research Laboratories, Aberdeen, Maryland.

One of ARPA's major purposes in this program is to ensure that "passive" or "silent" satellites will not be able to orbit unnoticed over the United States. The network also will be capable of obtaining certain types of scientific data from such "silent" satellites as may be in orbit.

The position of the line was selected to take advantage of two minitrack tracking sites which were already in existence — Ft. Stewart, and Brown Field, near San Diego.

Each portion under Naval responsibility consists of three stations—Jordan Lake, Ala.; Ft. Stewart, Ga.; and Silver Lake, Miss. in the East; and Gila River, Ariz.; Elephant Butte, N. M. and Brown Field, Calif. in the West.

The Army complex consists of three stations across the central part of the country—Forrest City, Ark.; Fort Sill, Okla. and White Sands Missile Range, N. M.

The center station, in each portion—is a transmitter; the other two, receivers. The transmitters emit a continuous thin fan-shaped "spray" of radio frequency energy into the sky along the line of tracking stations. These emissions overlap to provide a detection fence across the continent.

A satellite passing through the fence is detected by the energy reflected from the body of the satellite and picked up by sensitive receiving antennas and the information is transmitted to computing centers for orbital determination.

The data from the Navy-operated portions are relayed instantaneously to the Proving Ground, Dahlgren, Va. and NRL, and from the Army complex to the Ballistic Research Laboratories at Aberdeen Proving Ground, Md. for analysis and evaluation.

MEDICAL RESEARCH

Sensing elements, manufactured by Gulton Industries, are providing an electronic physical examination of this model. Units can measure heart reactions, breathing temperature and resistance to shock and stimuli.

To Avoid Chipping Plastics—Cut Backwards

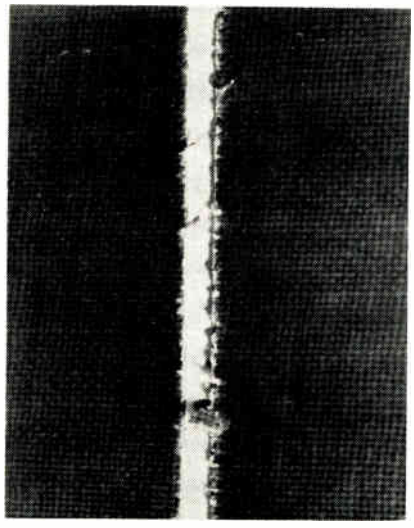
A simple way to increase productivity more than 30% while improving quality of the work when sawing and finishing thin nylon-base or paper-base plastic laminate is to mount the circular saw blade backward.

Backward sawing, in which the blunt backs of the teeth do the cutting, eliminates the stringers and chipping caused in the normal operation. This in turn makes separate hand filing of edges unnecessary.

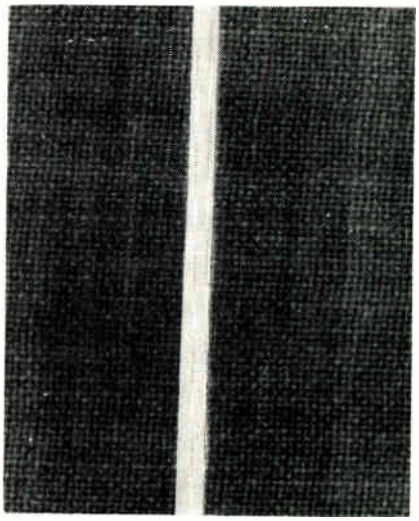
Taylor Fibre Co., Norristown, Pa., recommends backward sawing for sheet laminate 3/16 of an inch or less in thickness, and for thin wall tubing of wall thickness 1/32 in. and under.

To saw and file an 8 by 10 inch panel of paper-base stock 3/16 of an inch thick requires 68 seconds —48 seconds for sawing and 20 seconds for filing. Elimination of the 20 seconds filing time thus increases production 30%.

Wrong way

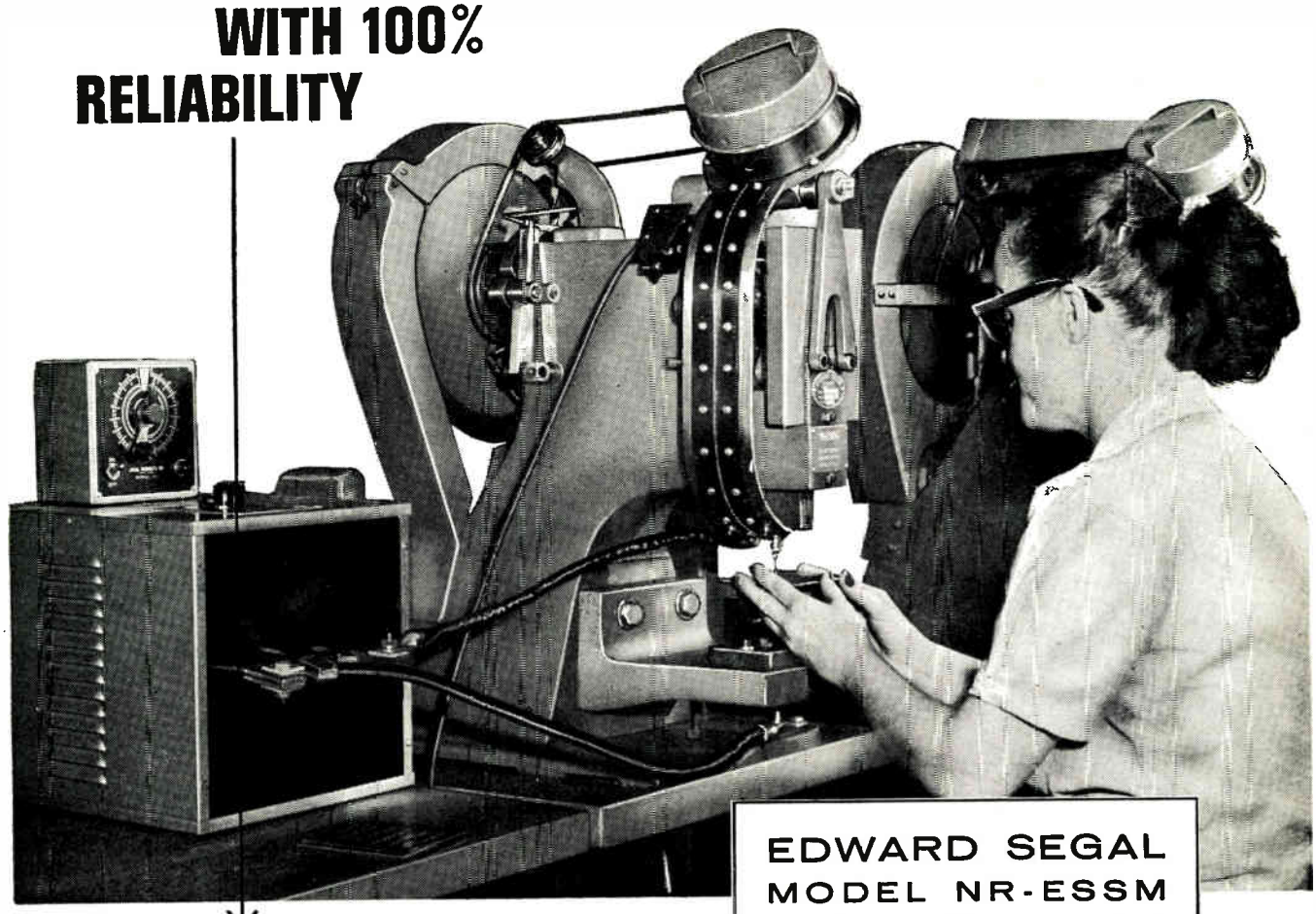


Right way



Feeds, stakes and fuses Eyelets in PRINTED CIRCUIT Boards

WITH 100% RELIABILITY



in every environmental test!

EDWARD SEGAL
MODEL NR-ESSM
automatic eyelet attaching machine

*** Some of the plants using Edward Segal Model NR-ESSM eyeleting machines—in many cases, batteries of them, include:**

Bendix Aviation Co., Kansas City, Mo.
Federal Telephone & Radio Division of I.T.T., Clifton, N. J.
Bell Telephone Laboratories, Whippany, N. J.
Laboratory of Electronics, Boston, Mass.
Melpar, Inc., Arlington, Va.
Sandia Corp., Albuquerque, New Mexico
Western Electric Co., Greensboro, N. C.
. . . and many others.

Economical, too. They frequently pay for themselves in a few months or less.

This revolutionary development in printed circuit board production is obsoleting manual eyelet attaching and soldering. Many of the leading manufacturers in America* find that Segal's new Model NR-ESSM is a completely dependable automatic method of making continuous electrical circuits of the printed elements on opposite sides of a board – or a single side if desired.

This unique machine stakes and solders simultaneously, sets up to 30 eyelets a minute, top and bottom, with never a reject.

Model NR-ESSM is just one of many efficient Edward Segal machines. There's Model NRLT for example, for cold staking flat and funnel type eyelets, and Model LSD that automatically feeds and stakes tube pins and turret terminals with equal reliability. For full details on these or any other machine to improve *your* eyelet attaching production, write Section EI-5.

Edward Segal engineers can recommend and supply you with eyelets for every phase of printed circuit work.

Edward Segal

MANUFACTURERS OF EYELETING MACHINERY, SPECIAL HOPPERS AND FEEDING DEVICES
132 Lafayette Street, New York 13, N. Y. Telephone: WOrth 6-3935
Chicago 22: A. J. Horne, Inc., 1958 West North Avenue
California: Dolliver & Bro., 5108 East Washington Blvd., Los Angeles 22; 619 Mission Street, San Francisco 5

Electronic Industries' News Briefs

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

EAST

SYLVANIA ELECTRONIC SYSTEMS is the recipient of a contract, amount unspecified, from the Rome Air Development Center. The award is for a study of various methods of classifying and tracking targets detected in an ICBM "defensive environment."

WILTEC ELECTRONICS, INC., recently organized, at 53 Water St., South Norwalk, Conn., is currently producing tubes for use in industrial and military devices.

MID-EASTERN ELECTRONICS, INC., will lease equipment, at only 10% of the normal purchase price, to customers with an option to buy after a year. Manufacturer will keep the unit in repair during the initial period (1 year) of the lease.

SPERRY GYROSCOPE CO. acquired a 52,000 sq. ft. building at 7 Aerial Way, Syosset, N. Y., for its Marine Div. The plant expansion was needed to meet the firm's expanding role in the Polaris program.

TRACERLAB KELEKET is opening a new sales office in Columbus, Ohio and Atlanta, Ga. Complete addresses are not yet known.

ASTRIONICS DIV., FAIRCHILD ENGINE & AIRPLANE CORP., is investigating a new concept of underwater detection for the USN Office of Naval Research.

JAMES R. KEARNEY CORP., of St. Louis, and **ELECTRICAL INDUSTRIES, INC.,** an affiliate of The Dyson Corp., have received approval in principle by the Directors of both companies for a merger. Kearney is a leading manufacturer of switchgear, protective devices, and related products.

STAVID ENGINEERING is negotiating with **BOSTICK LABORATORY, INC.,** Tyngsboro, Mass., for the purpose of acquiring business assets of the latter. Bostick is engaged in the design, development and manufacture of specialized pulse transformers and charging reactors.

REPUBLIC AVIATION CORP. is constructing a $14-million Research and Development Center at Farmingdale, N. Y. The 120,000 sq. ft. center is scheduled for completion early in 1960.

EMERSON & CUMING, INC., have introduced Eccosorb SC, a series of thin sheet materials of controlled surface resistivity, dielectric constant, and dissipation factor. It is used in a variety of microwave applications.

MICROWAVE ASSOCIATES, INC., manufactured the type MA-460D Silicon Varacter which was used in the Pioneer IV's parametric amplifier.

MELPAR, INC. opened its new 60,000 sq. ft. plant located in the Shirley Industrial Area, south of Washington, D. C. The new plant will provide facilities for the Simulation and Training Systems Engineering Dept.

WESTINGHOUSE ELECTRIC CORP. cut the prices on its silicon power transistors by amounts up to 30%.

RAYTHEON MFG. CO. received a $64.6-million follow-on production contract from USN's Bureau of Aeronautics for Sparrow III guided missiles. About $38-million will be awarded by Raytheon to more than 550 direct sub-contractors.

HERMETIC SEAL CORP. is now using localized radio frequency heat for sealing transmitters, diodes, relays and crystals.

A. B. DuMONT LABORATORIES, INC. has completed development on a device which converts radar signals into TV-like displays and allows pilots to perceive depth of surrounding space outside an aircraft.

SYLVANIA-CORNING NUCLEAR CORP. announces the completion of production and delivery of 120 nuclear fuel elements for 4 research reactors.

BENDIX RADIO DIV. received an order from USN's Bureau of Aeronautics for more than $350,000 worth of VHF Communications Systems.

AUGAT BROS. INC. now have available a longer-life, heat-dissipating resilient thermal conductive elastomer called Elastaclamp. This is specifically designed to provide complete contact between heat transfer medium and glass envelope while protecting tubes from severe shock and vibration.

STROMBERG-CARLSON now has a new sales force with exclusive responsibility for the sale of SCATE (Self-Checking Automatic Test Equipment).

SPRAGUE ELECTRIC CO. is now working on a contract awarded by Convair for engineering assistance in connection with electromagnetic interference control on the entire B-58 Hustler supersonic bomber.

KEARFOTT CO., INC. leased new quarters at 75 Lakeview Ave., Clifton, N. J. for its Engineering Div. The acquisition adds approximately 33,000 sq. ft.

MID-WEST

DIAMOND POWER SPECIALTY CORP. is supplying an underwater television system to the Humphreys Salvage Co. of Denver, Colo., for use during a six month program of exploration and salvage work in the Mediterranean Sea.

DAGE TELEVISION DIV., THOMPSON RAMO WOOLDRIDGE, INC. received a contract in excess of $200,000 for 6 closed-circuit TV systems to be delivered to Nortronics Div. of Northrop Corp. The systems will be used for proficiency training of countdown procedures for guided missile handling personnel.

C. P. CLARKE & CO. reduced prices from 7½% to 10% on mercury-wetted contact relays Types HG, HGP, AND HGS.

AMPHENOL-BORG ELECTRONICS CORP. is the new name for the Equipment Div. of The George W. Borg Corp.

TINERMAN PRODUCTS, INC., has developed a new speed clip to secure small-diameter armored control cables on equipment.

TEXAS INSTRUMENTS INCORPORATED now has immediately available a complete line of heavy-duty diffused silicon stud-mounted rectifiers, rated at 50 and 30 amps at a stud temperature of 150°C.

PHILIPS ELECTRONICS, INC., through its Instruments Div. will hold the 33rd session of the Norelco X-ray Diffraction and Spectrographic School at the Edgewater Beach Hotel, Chicago, during the week of June 1-5, 1959.

MALLORY BATTERY CO., Cleveland, a div. of P. R. Mallory & Co., Inc., manufactured the mercury batteries which were used to power all of the data-reporting instruments in the Explorer IV satellite.

WEST

LENKURT ELECTRIC CO. graduated its 1,000th customer-trainee from its carrier and radio school recently at the telecommunications firm's San Carlos, Calif., headquarters and factory. The 1,000th student was Milton C. Johnson, of Everett, Wash.

ROYAL INDUSTRIES, INC., Los Angeles, was awarded a $445,000 contract by Boeing Airplane Co. to manufacture stabilizer drive mechanisms for use on the B-52.

CUBIC CORP. has delivered over a half million dollars' worth of range safety electronic equipment to Vandenberg AFB. The equipment used in conjunction with missile flights includes angle measuring equipment, correlation tracking, and ranging (AME-COTAR) Systems.

BABCOCK RADIO ENGINEERING, INC., has increased its facilities in Costa Mesa with the addition of a 25,000 sq. ft. Production Building. In less than two years, the firm has quadrupled its employees and doubled its plant area.

KAISER AIRCRAFT & ELECTRONICS DIV. formed a new product research and development organization with headquarters at 2222 Peoria Ave., Phoenix, Ariz. James W. Schartz has been appointed Director of the new activity.

TECHLINE DIV., WHEELABRATOR CORP., has improved service to West Coast users of precision finishing equipment and processes by providing a new warehouse and processing laboratories at 2602 E. Foothill Blvd., Pasadena, Calif.

RYAN AERONAUTICAL CO. has been awarded a contract in excess of $2-million for additional AN/APN-97 helicopter hovering devices, plus spares, by the Sikorsky Aircraft Div. of United Aircraft Corp.

ULTRONIX, INC., San Mateo, moved into a new $100,000 plant located at 111 E. 20th St. The new building offers 10,000 sq. ft. of manufacturing area.

MINCOM DIV., MINNESOTA MINING & MFG. CO., has been forced to increase its production staff fourfold since the first of the year to meet demands for new precision tape recording equipment. Sales backlog for the equipment has grown to $575,000.

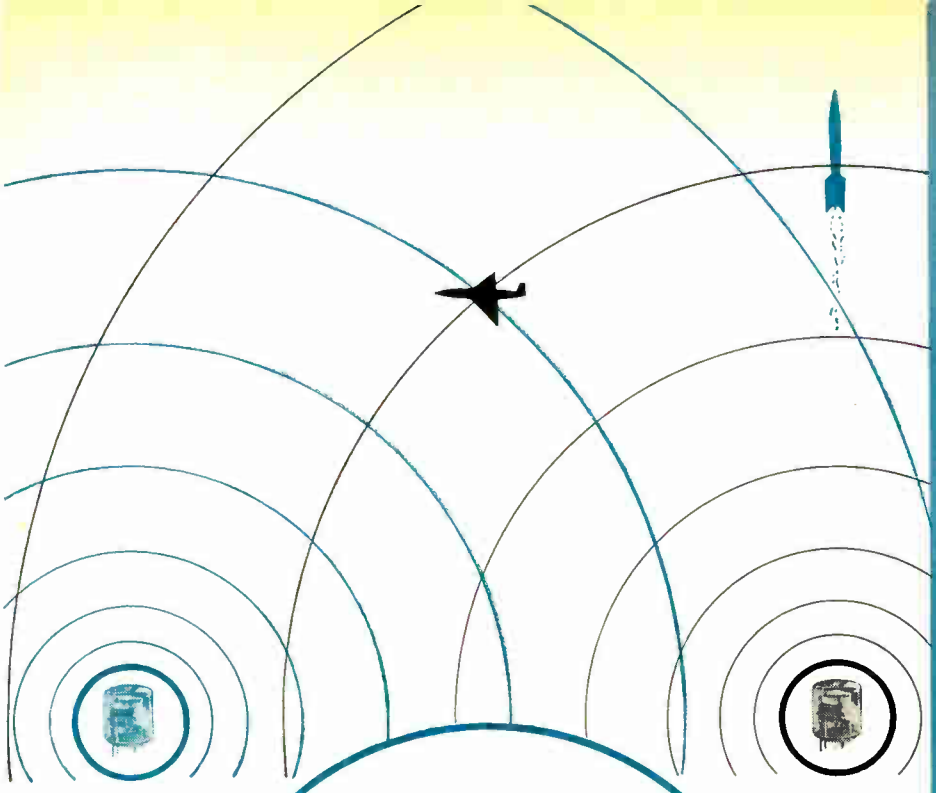
PACIFIC SEMICONDUCTORS, INC., is working on the second increment of its $10-million advanced engineering, production and administrative center near the Los Angeles International Airport.

ACME ELECTRIC CORP. opened its new plant at 12822 Yukon Ave., Hawthorne, Calif. Ray McWaters and Ken Burton head up the engineering and sales staffs, respectively.

THE MICA CORP. completed the expansion of its production and pre-production facilities at 4031 Elenda St., Culver City, Calif.

HOFFMAN SEMICONDUCTOR DIV. is constructing a $1.5-million Los Angeles plant which will double its semiconductor production capacity. The Evanston, Ill., plant will continue its solar cell production and will also expand production of diodes and rectifiers.

BECKMAN INSTRUMENTS, INC., is going into regular commercial production of its IR-7 prism-grating infrared spectrophotometer. The IR-7 is a true prism-grating instrument with grating operation throughout the 2.5-16.6 micron region.



A TUBE WITH A FUTURE

THE NEW **Amperex®**
UHF TWIN-TETRODE
TYPE 7377

The need has long existed for stable tubes in the 500-1000 Mc. range. Now, with the availability of the Type 7377, the UHF equipment designer is provided with a uniquely constructed, uniquely efficient twin-tetrode capable of stable operation up to 1000 Mc.

Circle 15 on Inquiry Card

THE UNIQUE CONSTRUCTION OF THE NEW AMPEREX TYPE 7377....

- The plate lead structure and pins are isolated from the main socket, thereby making the anode pins an integral part of the external circuit.
- Plate lead structure, plus a tuning stub (which extends downwards through a cutout in the socket) permits exceptionally compact equipment packaging.
- Frame grid structure provides optimum reliability.
- Getter structure, and hence getter film, isolated from cage structure.

PLUS THE COMBINED EXCELLENCE OF THESE IMPRESSIVE FEATURES...

- Delivers 5.5 watts output (ICAS) at 960 Mc.
- Extremely low plate output impedance and capacitance. (Plate output cap: 0.82 $\mu\mu$f for both sections in push-pull operation.)
- Internally neutralized plate-to-grid capacitance (0.145 $\mu\mu$f for each section.)
- High transconductance (10,500 micromhos)
- High gain and high figure of merit

IS YOUR GUARANTEE OF UNIQUE SUITABILITY AS AN RF AMPLIFIER OR FREQUENCY MULTIPLIER FOR:

- Telemetering
- TV link communications
- Mobile and small transmitters
- Broadband amplifiers

TYPICAL OPERATION, CLASS C AMPLIFIER

	ICAS
Frequency	960 Mc/s
Plate Voltage	250 volts
Grid No. 2 Voltage	170 volts
Negative Grid No. 1 Voltage	15 volts
Plate Current	2 x 40 mA
Grid No. 2 Current	15 mA
Grid No. 1 Current	2 x 0.75 mA
Drive Power	1.4 watts
Plate Input Power	2 x 10 watts
Plate Dissipation	2 x 5.4 watts
Plate Power Output	8 watts
Load Power Output	5 watts

ask Amperex
about tubes for RF, VHF, and UHF applications

AMPEREX ELECTRONIC CORPORATION
230 Duffy Avenue, Hicksville, Long Island, N.Y.
In Canada: Rogers Electronic Tubes & Components, 116 Vanderhoof Avenue, Toronto, Ontario

How Indiana Steel's engineers help you solve micro-wave magnetic problems

Engineers at The Indiana Steel Products Company are in constant contact with leading manufacturers of micro-wave equipment on problems involving permanent magnets. Consultations with Indiana's magnet specialists have resulted in time and cost savings — often eliminating expensive redesign.

CASE IN POINT:

A leading micro-wave component manufacturer. *Problem:* Produce a special load isolator magnet to fit smaller space contour in a new radar unit. Also, deliver the new magnet to the customer in 12 days.

Solution: Indiana engineers turned to their previous design files, selected an existing magnet and modified it to meet the new size specifications. Gauss tests showed that the new design met the customer's specified magnetic field range. The magnet was delivered within the time specified.

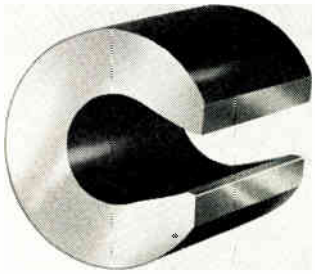
This is just one of many hundreds of cases where Indiana permanent magnet specialists have applied their unequaled experience to solve a magnet problem *ahead* of a customer's deadline. Indiana not only has the engineering know-how, but also manufacturing equipment from previously designed magnets which may be quickly adapted to meet special requirements.

THREE BASIC DESIGNS FOR LOAD ISOLATOR APPLICATIONS

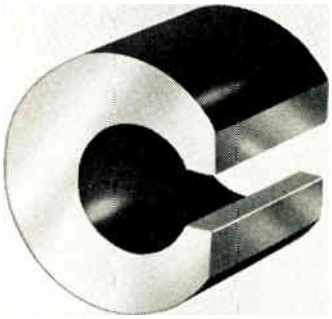
Permanent magnet specialists at Indiana Steel utilize three basic magnet designs for load isolator applications. These are, two variations of the C magnet, and the U magnet. All three of these designs can be varied to meet specific customer requirements. Actual size and shape of any individual magnet is dependent upon size limitation of the load isolator, and the magnetic field strength needed.

WIDE EXPERIENCE IN MICRO-WAVE APPLICATIONS

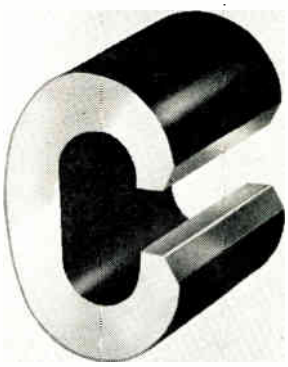
Magnet specialists at Indiana have designed and produced permanent magnets for a wide range of micro-wave applications including pm-focus traveling wave tubes, load isolators, radar magnetrons, backward wave oscillators. And, you can be sure the material selected is *best* for your particular application because Indiana Steel produces *all* permanent magnet materials. Our engineers will give prompt attention to your micro-wave problems or any other permanent magnet applications. Call your Indiana man or write us direct. Ask for Catalog No. 20, "Alnico V Load Isolator Magnets." Dept. N-5.



U Magnet



C Magnet



Flat C Magnet

Sales Offices in:
Boston, Chicago, Cleveland, Los Angeles, New York, Philadelphia, Rochester

THE INDIANA STEEL PRODUCTS COMPANY
VALPARAISO, INDIANA

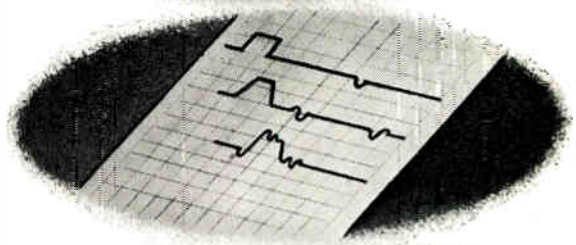
WORLD'S LARGEST MANUFACTURER OF PERMANENT MAGNETS

INDIANA PERMANENT MAGNETS

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

SIGNED.....

SOLVED ...



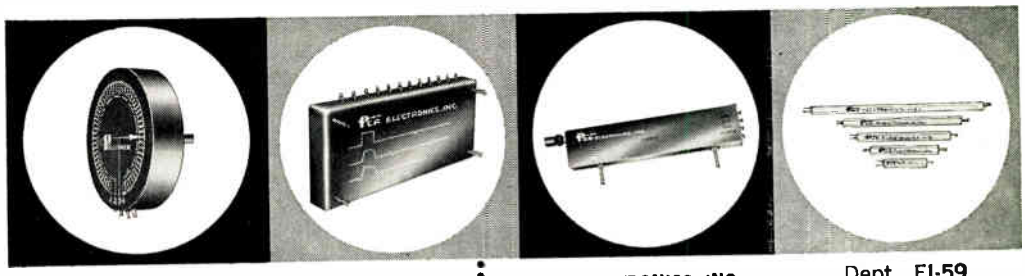
DELIVERED ....

TIME DELAY TOLERANCES AS TIGHT AS 1/10th OF 1%

with DELAY LINES BY PCA

Time Delay: 40 ±.04 microseconds @ 25°C.
Temperature coefficient of delay: <20 P.P.M./°C.
Attenuation: 4 db.
Rise time: 0.4 microseconds (10% to 90%).
Size: 50 cubic inches.

PCA design engineers are specialists in the research and development of delay lines custom built to meet the most exacting military specifications. The above example is only one of hundreds of difficult delay line problems cracked by PCA engineers. When stability, low attenuation, minimum size, and high ratio of delay to rise time are critical requirements for *your* delay line—let PCA engineers give you technical data and specifications.



PCA ELECTRONICS, INC.

16799 Schoenborn Street Sepulveda, California, U.S.A.

PCA Electronics, Inc. is also a leading manufacturer of pulse transformers

Dept. EI-59

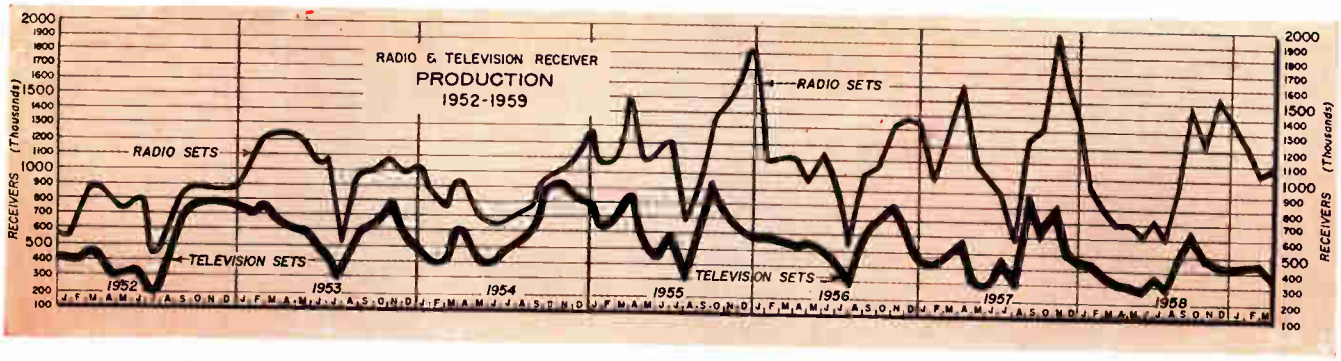
To: **PCA ELECTRONICS, INC.**
16799 Schoenborn Street
Sepulveda California, U.S.A.

Please send data on Delay Lines:
_____Complete Catalogue.
_____Specification sheet on which we will indicate our special requirements.

Name_____
Company_____
Street_____
City_____ State_____

Circle 17 on Inquiry Card

ELECTRONIC INDUSTRIES TOTALS



GOVERNMENT ELECTRONIC CONTRACT AWARDS

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

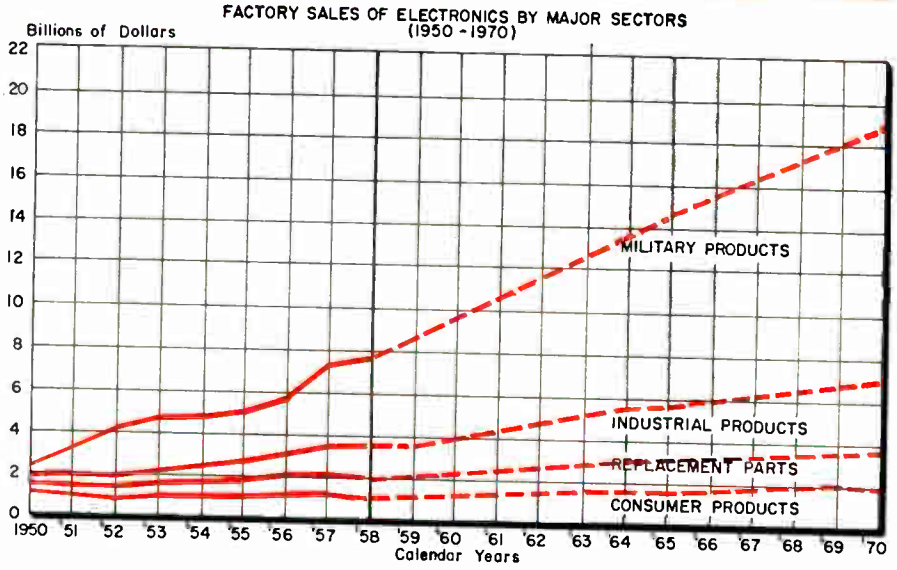
Accelerometers	27,900
Amplifiers	131,220
Antennas	369,833
Batteries, dry	187,687
Beacon, radar	181,305
Beacon, radio	162,379
Cable assemblies	68,366
Cable, telephone	587,692
Calibrator set, frequency	72,850
Capacitors	55,186
Cavity assemblies	25,772
Cells, photoelectric	26,845
Chargers, battery	26,112
Circuit breakers	59,532
Computers, digital	50,708
Computers	228,459
Connectors	489,558
Controls, radio	36,410
Couplers	65,618
Crystal units	67,284
Decoders, audio	335,293
Delay lines	269,489
Detector, infrared	41,850
Diodes, semiconductor	61,128
Filter, band pass	57,866
Fuses	411,870
Generators, pulse	169,740
Gyros	32,176
Headsets	28,950
Indicator, coupler, antenna	147,796
Limiter, fuse	221,810
Meters, various	999,019
Meters, volt	98,400
Microphones	382,800
Modulators	98,700
Monitor, coordinate data	568,470
Oscillators	27,330
Paper, recording, electrosensitive	30,880
Potentiometers	182,092
Power Supplies	399,020
Radomes	2,229,790
Radar sets, accessories	18,721,028
Radiac sets	928,288
Radio sets	823,667
Receivers, radio	5,943,164
Receiver/transmitters	449,460
Recorders/reproducers, accessories	112,229
Receptacle, connector	207,522
Relay, armature	346,192
Relay assemblies	216,758

NUMBER OF ENTERTAINMENT SETS IN USE

(Add 000,000)

End of Year	Television	Radio (except auto)	Auto Radio	Phonographs
1950	10.6	81	18	16.8
1951	15.8	84	21	18.0
1952	21.2	87	23	19.5
1953	27.3	88	25	20.8
1954	31.8	89	27	22.4
1955	37.5	91	29	24.0
1956	42.5	93	32	25.6
1957	46.1	95	35	27.1
1958	49.7	96	47	29.9

—*EIA 1959 "Fact Book"*



Relays, solenoid	28,939
Resistors	542,836
Scanners	69,000
SSB equipment	238,985
Switches	151,298
Switches, rotary	29,041
Switches, toggle	34,317
Systems, control	38,846
Systems, telemetry	99,193
Synchros	56,700
Synchronizer, buffer	99,516
Tape, magnetic	133,672
Teletypewriter	3,722,798
Terminal lugs	121,977
Test equipment, various	459,700
Trainer, code	255,098
Transformers	25,875
Transformers, pulse	27,080
Transistors	45,383
Transmitters, radio	332,928
Transmitter, pulse	38,660
Tube, electron	5,421,675
Tube, klystron	569,271
Tube, magnetron	3,733,225
Tube, thyratron	223,720
Waveguide assemblies	73,488
Wire & cable	57,410

From Transistor Center, U.S.A....

PHILCO®

announces a new family of LOW COST Medium Power Alloy Junction Transistors

Introducing a completely new family of PNP germanium transistors, especially designed to meet rigid military and industrial specifications . . . at lowest possible prices.

These transistors are available in production quantities, for use in teletypewriters, control amplifiers, ignition systems, mobile radios and desk calculators (2N1124); servo amplifiers, voltage regulators and pulse amplifiers (2N1125, 2N1126, 2N1127); medium power audio and switching applications (2N1128, 2N1129, 2N1130).

Also available in quantities 1-99 from your local Philco Industrial Semiconductor Distributor.

Make Philco your prime source of information for all transistor applications. Write to Lansdale Tube Company, Division of Philco Corporation, Lansdale, Pa., Dept. EI 359.

	TYPE	V_{CB} Max. (Volts)	V_{CES} Max. (Volts)	Peak I_C (Amps)	P Max. (Watts)	$F_{\alpha b}$ (MC)	Beta	Applications	PRICE
	2N1124	40	35	0.5	0.3	0.4 Min	h_{fe} 40 Min	For high voltage general purpose use in amplifier and switching. Small signal beta controlled.	$ 1.30
	2N1125	40	40	0.5	0.3	1.0 Min	h_{fe} 50-150 @ 0.5 amp	For high voltage, higher frequency industrial amplifier and switching systems. Large signal beta controlled.	$1.90
	2N1126	40	35	0.5	1.0	0.4 Min	h_{fe} 40 Min	1 watt version of 2N1124 for servo amplifiers and relay actuators. Small signal beta controlled.	$1.80
	2N1127	40	40	0.5	1.0	1.0 Min	h_{FE} 50-150 @ 0.5 amp	1 watt version of 2N1125 for servo amplifiers and control systems. DC beta controlled.	$2.40
	2N1128	25	18	0.5	0.15	1.0	h_{fe} 70-150	For low distortion, high level driver and output application. Small signal beta controlled.	$ .95
	2N1129	25	25	0.5	0.15	0.75	h_{FE} 100-200 @ 0.1 amp	For high gain general purpose amplifier and switching. Typical DC beta 165.	$1.10
	2N1130	30		0.5	0.15	0.75	h_{FE} 50-165 @ 0.1 amp	For higher voltage, higher level amplifier and switching applications. Typical DC beta 125.	$ .95

Available in Production Quantities—Also Available from Local Distributors

PHILCO CORPORATION

LANSDALE TUBE COMPANY DIVISION

LANSDALE, PENNSYLVANIA

TRANSISTOR CENTER U.S.A.

Circle 18 on Inquiry Card

FREQUENCY STANDARDS

*3⅛" high
400 - 1000 cy.

PRECISION FORK UNIT
TYPE 50

Size 1" dia. x 3¾" H. Wght., 4 oz.*

Frequencies: 240 to 1000 cycles
Accuracies:—
Type 50 (±.02% at —65° to 85°C)
Type R50 (±.002% at 15° to 35°C)
Double triode and 5 pigtail parts required
Input, Tube heater voltage and B voltage
Output, approx. 5V into 200,000 ohms

FREQUENCY STANDARD
TYPE 50L

Size 3¾" x 4½" x 5½" High
Weight, 2 lbs.

Frequencies: 50, 60, 75 or 100 cycles
Accuracies:—
Type 50L (±.02% at —65° to 85°C)
Type R50L (±.002% at 15° to 35°C)
Output, 3V into 200,000 ohms
Input, 150 to 300V, B (6V at .6 amps.)

*3½" high
400 to 500 cy.
optional

PRECISION FORK UNIT
TYPE 2003

Size 1½" dia. x 4½" H. Wght. 8 oz.*

Frequencies: 200 to 4000 cycles
Accuracies:—
Type 2003 (±.02% at —65° to 85°C)
Type R2003 (±.002% at 15° to 35°C)
Type W2003 (±.005% at —65° to 85°C)
Double triode and 5 pigtail parts required
Input and output same as Type 50, above

FREQUENCY STANDARD
TYPE 2005

Size, 8" x 8" x 7¼" High
Weight, 14 lbs.

Frequencies: 50 to 400 cycles (Specify)
Accuracy: ±.001% from 20° to 30°C
Output, 10 Watts at 115 Volts
Input, 115V. (50 to 400 cycles)

FREQUENCY STANDARD *NEW*
TYPE 2007-6
TRANSISTORIZED, Silicon Type
Size 1½" dia. x 3½" H. Wght. 7 ozs.
Frequencies: 400 — 500 or 1000 cycles
Accuracies:
2007-6 (± .02% at —50° to +85°C)
R2007-6 (±.002% at +15° to +35°C)
W2007-6 (±.005% at —65° to +125°C)
Input: 10 to 30 Volts, D. C., at 6 ma.
Output: Multitap, 75 to 100,000 ohms

FREQUENCY STANDARD
TYPE 2121A

Size
8¾" x 19" panel
Weight, 25 lbs.
Output: 115V
60 cycles, 10 Watt
Accuracy:
±.001% from 20° to 30°C
Input, 115V (50 to 400 cycles)

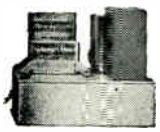
FREQUENCY STANDARD
TYPE 2001-2

Size 3¾" x 4½" x 6" H., Wght. 26 oz.

Frequencies: 200 to 3000 cycles
Accuracy: ±.001% at 20° to 30°C
Output: 5V. at 250,000 ohms
Input: Heater voltage, 6.3 - 12 - 28
B voltage, 100 to 300 V., at 5 to 10 ma.

FREQUENCY STANDARD
TYPE 2111C

Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8¾" H.
Weight, 25 lbs.
Frequencies: 50 to 1000 cycles
Accuracy: (±.002% at 15° to 35°C)
Output: 115V, 75W. Input: 115V, 50 to 75 cycles.



ACCESSORY UNITS
for TYPE 2001-2

L—For low frequencies multi-vibrator type, 40-200 cy.
D—For low frequencies counter type, 40-200 cy.
H—For high freqs, up to 20 KC.
M—Power Amplifier, 2W output.
P—Power supply.

This organization makes frequency standards within a range of 30 to 30,000 cycles. They are used extensively by aviation, industry, government departments, armed forces—where maximum accuracy and durability are required.

WHEN REQUESTING INFORMATION
PLEASE SPECIFY TYPE NUMBER

American Time Products, Inc.

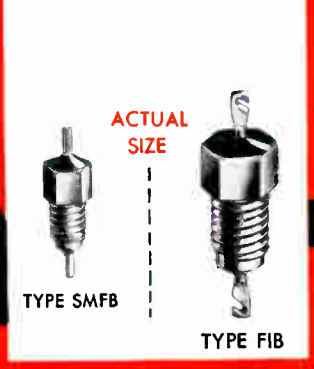
Watch Master
Timing Systems

Telephone: PLaza 7-1430

580 Fifth Ave., New York 36, N. Y.

Circle 19 on Inquiry Card

Circle 20 on Inquiry Card →

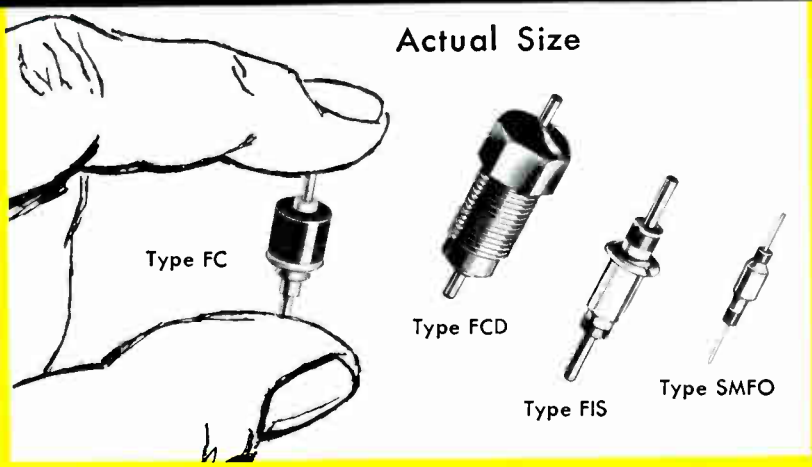


A-B QUALITY

Broad Band

High Frequency Filters

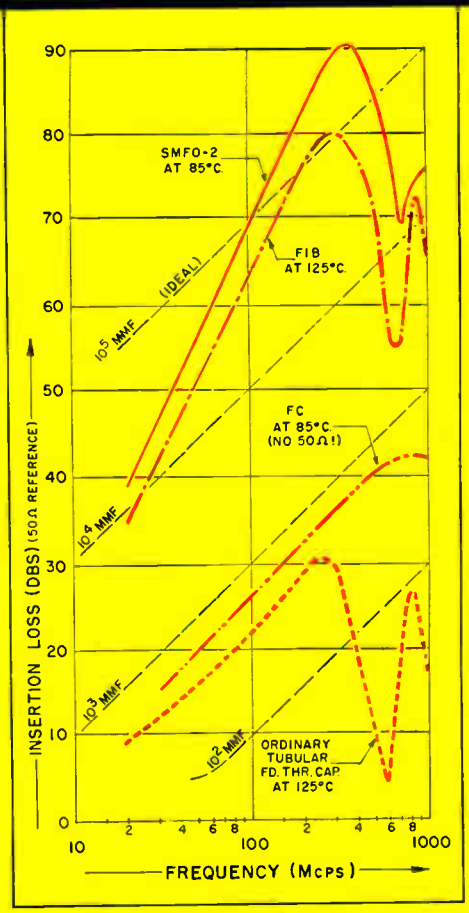
Allen-Bradley cascaded ceramic feed-thru filters provide effective filtering up to and beyond 5,000 MCS



Here's an entirely new concept in ultra-high frequency filtering—Allen-Bradley's new ceramic feed-thru filters. Their high insertion loss—up to 60 db—effectively prevents feedback and radiation from low power circuits operating in the frequency range from 50 mcs to 5000 mcs.

Astounding in performance, these new A-B filters are actually superior to the theoretical *ideal* capacitor over a wide frequency range. Note, in the graph at right, their effective filtering increases with frequency—and they have none of the undesirable resonance characteristics of standard tubular capacitors. In addition, A-B filter elements provide far greater effective capacitance values than practical with conventional capacitor designs. Filters are available in voltage ratings up to 500 v DC at 125°C. Send for Technical Bulletin 5410.

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

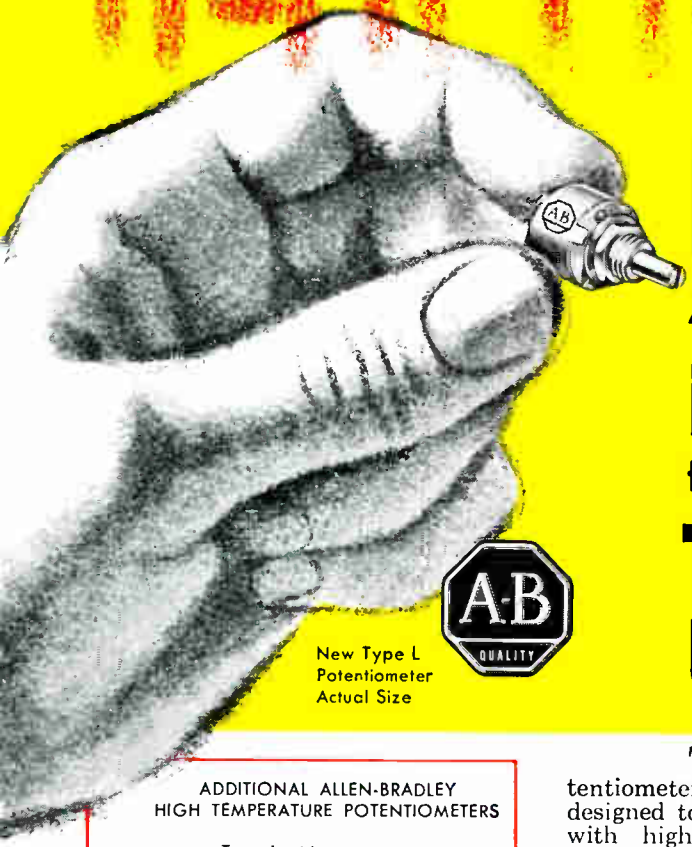


3-59-E

ALLEN-BRADLEY

Quality
ELECTRONIC
COMPONENTS

HEAT PROBLEMS?



New Type L Potentiometer Actual Size

NEW

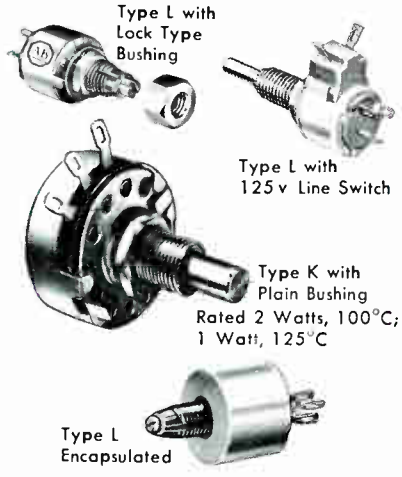
Allen-Bradley

POTENTIOMETERS

for use in

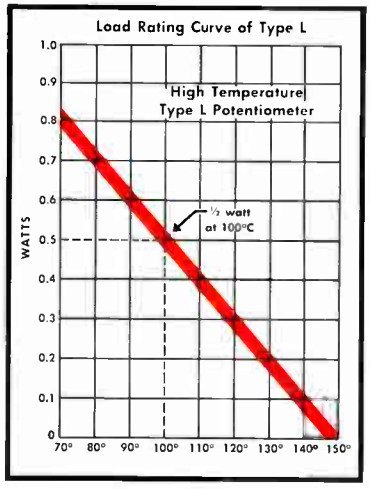
TEMPERATURES UP TO 150°C!

ADDITIONAL ALLEN-BRADLEY HIGH TEMPERATURE POTENTIOMETERS



This new Allen-Bradley potentiometer—the Type L—is especially designed to solve problems associated with high ambient temperatures—*and* space conservation. Although extremely compact—0.5 inch in diameter—the Type L control has a conservative rating of 0.5 watt when operating in an ambient temperature of 100°C. And, it provides reliable performance when operated at a temperature of 150°C—under "no load" conditions. (See graph at right.)

The new Type **L** control features the same solid, *hot molded* resistance element that has proved unequaled for long life, smooth operation, and low "noise" characteristic in Allen-Bradley's popular Type J, Type K, and Type G potentiometers. When temperature and space problems in your designs plague you, this new A-B "high temperature" potentiometer is a reliable answer. Please send for complete information, today.



AMBIENT TEMPERATURE °C.

Load Capabilities of Type L below the Critical Resistance Value. Type L Far Exceeds the Requirements of MIL-R-94B.

ALLEN-BRADLEY

Quality Electronic Components

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

3-59-E

Two New oscilloscopes each with 3.5-millimicrosecond risetime

TYPE 581

The new Tektronix Type 581 is a general-purpose oscilloscope with excellent transient response and high-speed sweeps. Risetime is 3.5 mμsec and sweep time is calibrated to 0.01 μsec/cm. Passband is dc to approximately 100 mc.

The vertical deflection system is designed for plug-in preamplifiers. A low-capacitance probe is an integral part of the Type 80 Plug-In Preamplifier, which provides a calibrated deflection factor of 0.1 v/cm. Sufficient signal delay is included in the main vertical amplifier to permit displaying the leading edge of the waveform under observation.

The wide sweep range of the Type 581 includes calibrated sweeps fast enough to take advantage of its risetime capabilities. Calibrated sweeps from 0.05 μsec/cm to 2 sec/cm are available in 24 steps, and a 5-x magnifier increases the calibrated range to 0.01 μsec/cm. Sweep time is continuously adjustable from 0.01 μsec/cm to 5 sec/cm. Versatile triggering includes amplitude-level control, and preset stability for operating convenience. Lockout-reset circuitry provides for one-shot sweep operation.

A new Tektronix cathode-ray tube with distributed-type vertical-deflection plates is used in the Type 581. 10-kv accelerating potential assures a bright trace, even at low sweep-repetition rates. An amplitude calibrator is also incorporated in the Type 581, with square-wave output from 0.2 mv to 100 v in 18 steps.

TYPE 585

The Tektronix Type 585 has, in addition to the identical general specifications of the Type 581, a second time base generator. This time-base generator, designated TIME BASE B, acts as a delay generator, providing a wide range of calibrated sweep delay. Two modes of sweep delay are available—triggered (delayed sweep is started after the delay period by the signal under observation), and conventional (delayed sweep is started at the end of the delay period by the delayed trigger). Calibrated sweep delay is continuously variable over the range of 1 μsec to 10 sec. Color-correlated controls eliminate confusion, making this new high-performance oscilloscope easy to operate.

PRICES

TYPE 581, without plug-in units **$1375**
TYPE 585, without plug-in units **$1675**
TYPE 80 Plug-In Preamplifier, with Probe **$ 150**

(Other plug-in preamplifiers are currently in development.)

Prices f.o.b. factory.

Tektronix, Inc.

P. O. Box 831 • Portland 7, Oregon
Phone CYpress 2-2611 • TWX-PD 311 • Cable: TEKTRONIX

TEKTRONIX FIELD OFFICES: Albertson, L. I., N.Y. • Albuquerque • Atlanta, Ga. • Bronxville, N.Y. • Buffalo • Cleveland • Dallas • Dayton • Elmwood Park, Ill. • Endwell, N.Y. • Houston Lathrup Village, Mich. • East Los Angeles • West Los Angeles • Minneapolis • Mission, Kansas Newtonville, Mass. • Orlando, Fla. • Palo Alto, Calif. • Philadelphia • Phoenix • San Diego St. Petersburg, Fla. • Syracuse • Towson, Md. • Union, N.J. • Washington, D.C. • Willowdale, Ont.

TEKTRONIX ENGINEERING REPRESENTATIVES: Hawthorne Electronics, Portland, Oregon., Seattle, Wash.; Hytronic Measurements, Denver, Colo., Salt Lake City, Utah.

Tektronix is represented in 20 overseas countries by qualified engineering organizations.

Letters

to the Editor

"KDKA's First Transmitter"

Editor, ELECTRONIC INDUSTRIES:

I don't often write to an Editor of a magazine, but while thumbing through your latest ELECTRONICS INDUSTRIES periodical, namely, Vol. 18, No. 3, of March, 1959, I read with interest, Pages 22, 23, entitled "Snapshots of the Electronic Industries" and especially, with interest read the small cut on page 23, lower, titled "Old-Timer," which showed a picture of KDKA's Chief Engineer, in front of, and examining a replica of early KDKA No. 1, which broadcast the results of the Harding-Cox election in 1920.

With nostalgic tear in eye I gazed at the photo on this page, but, was somewhat disturbed to read that the equipment shown was called the original control board of KDKA, and that the "Board" is being delivered to Smithsonian Institution to repose in all its glory for future generations of engineers to view with awed wonder. To set the record straight, and the minds of future neophtye genius, this is not the control board, but rather, the actual radio transmitter, which consisted of the modulated oscillator, and modulator and speech amplifier. Note the left and right hand variable tuning controls for the oscillator under the R.F. ammeter. The receiver to the extreme left is an early Westinghouse regenerative detector and two stage amplifier, and I believe one of the first commercially built receivers for public consumption after WWI. I happen to have one. However, the patent dates state the earliest patent to be 1921, so I'm a bit puzzled as to circa.

J. F. Geilenkirchen
Engineer
WFAS, WFAS-FM
White Plains, N. Y.

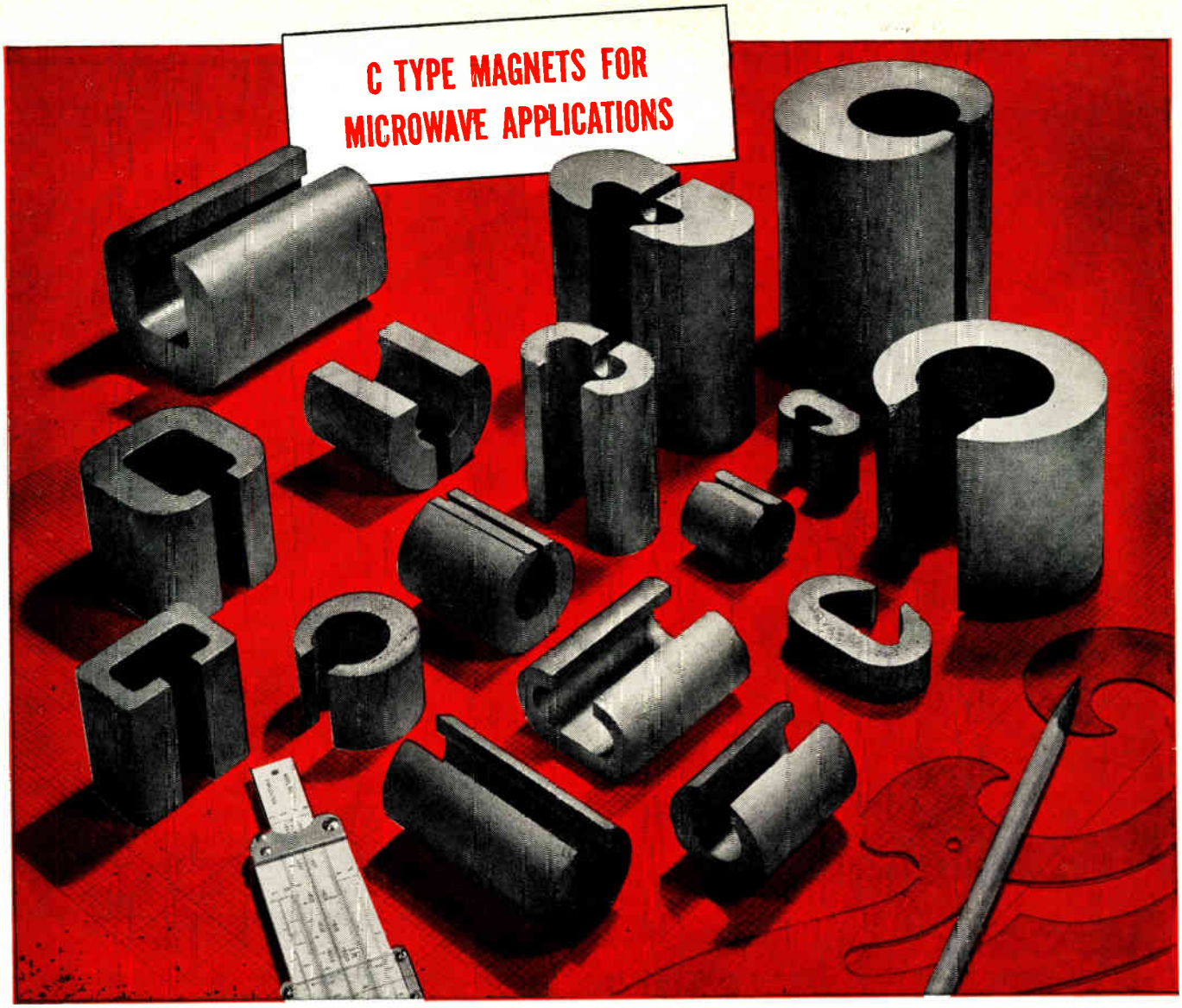
Ed: Reader Geilenkirchen is half right. The gear shown is, as he says, a complete transmitter, but it is not the original KDKA No. 1. Some years back the first KDKA unit was converted into a telegraph transmitter and given to the Pennsylvania State Police for use at their barracks in Butler. The equipment shown in the picture is a replica put together by Westinghouse for the museum. As to Mr. Geilenkirchen's question about the patent date, perhaps one of our "oldtimers" can explain the discrepancy.

"Reprints of Articles"

Editor, ELECTRONIC INDUSTRIES:

I feel very thankful to you for the

(*Continued on page* 41)



C TYPE MAGNETS in a wide range of sizes to meet your design needs in ★ Transverse Field Isolators ★ Differential Phase Shifters ★ Duplexers

Arnold C-type Alnico Magnets are available in a wide selection of gap densities ranging from 1,000 to over 7,500 gausses. There are six different basic configurations with a wide range of stock sizes in each group.

The over-all size and gap density requirements of many prototype designs can be met with stock sizes of Arnold C Magnets, or readily supplied in production quantities.

When used in transverse field isolators, Arnold C Magnets supply the magnetizing field to bias the ferrite into the region of resonance, thus preventing interaction between microwave networks and isolating the receiver from the transmitter. These magnets are also used in differential phase shifters and duplexers, and Arnold is prepared to design and supply tubular magnets to provide axial fields in circular wave guides.

A feature of all Arnold C Magnets is the excellent field uniformity along the length of the magnet. Versatility in design may be realized by using multiple lengths of the same size magnet stacked to accomplish the needs of your magnetic structure.

Let us work with you on any requirement for permanent magnets, tape cores or powder cores. ● For information on Arnold C Magnets, write for Bulletin PM-115. Address *The Arnold Engineering Company, Main Offices and Plant, Marengo, Illinois.* WSW 7428 A

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ELECTRONIC INDUSTRIES • May 1959 Circle 25 on Inquiry Card 37

Inside ESC: Number Three

ESC ENGINEER-REPS know their business . . . and yours!

The men who represent ESC in the field are all top-flight technical people in their own right. Each is thoroughly conversant with the very latest developments in the fast-moving delay line field and each stands ready to apply the combined knowledge of the entire ESC organization to your particular problems. Whether you want advice on a standard delay line application, or something special from ESC's modern research laboratory, you can be sure of receiving top engineering talent, prompt delivery, and expert, local service. There's an ESC engineer-rep very close to you, wherever you are. Why not discuss your current delay line problem with him now.

COMPONENTS SALES CORPORATION 218 East Hartsdale Avenue Hartsdale, New York SCarsdale 5-1050 New York State, New Jersey except Camden and Moorestown, Westchester County 44 Brattle Street Cambridge 38, Massachusetts UNiversity 4-1727 New England	KAY SALES COMPANY 2600 Grand Avenue Kansas City 8, Missouri BAltimore 1-3800 7603 Forsyth, Suite 206 Clayton 5, Missouri PArkview 7-3414 Kansas, Nebraska, Missouri, Oklahoma, Arkansas, Albuquerque, N. M. and the following counties in Illinois: Monroe, Calhoun, Jersey, Madison and St. Clair	MAGNUSON ASSOCIATES 3347 West Irving Park Road Chicago 18, Illinois KEystone 9-7555 Teletype CG 913 Illinois (except Monroe, Calhoun, Jersey, Madison and St. Clair counties), Indiana, Iowa and S. Wisconsin 1359 West Maynard Drive St. Paul 16, Minnesota Minnesota and N. Wisconsin	HARRY J. WHITE COMPANY 121 Covered Bridge Road Haddonfield, New Jersey HAzel 8-2304 Camden and Moorestown, New Jersey; Eastern Pennsylvania and Delaware Mr. Richard Trainor 115 Greenbrier Road Towson 4, Maryland VAlley 3-6184 Maryland, Virginia as far south as Alexandria, and Washington, D.C.
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Distributed constant delay lines • Lumped-constant delay lines • Variable delay networks • Continuously variable delay lines • Pushbutton decade delay lines • Shift registers • Pulse transformers • Medium and low-power transformers • Filters of all types • Pulse-forming networks • Miniature plug-in encapsulated circuit assemblies

Letters

to the Editor

(*Continued from page* 36)

excellent service rendered by your Reader Service Dept. for some time past. I am regularly availing myself of this service. Please accept my thanks for this service, which makes it possible to get latest information for negligible effort and cost on my part. I am much pleased and hope to use it regularly.

As I get my Reader Service card from our library, it sometimes happens that all the cards are already used up by other persons. In such cases, may I know whether I can get the service by writing the numbers in a separate letter to you? I hope you will allow me to avail myself of this service, if I write a separate letter. Please let me know.

I have received some reprints in the past for which I thank you. I am sure this reprint service is unique and I know of no other comparable magazine which has this service. Please keep it up.

V. S. Godhi
Atomic Energy Establishment
Electronics Div.
(H.I.I. Bombay)
Apollo Pier Road
Bombay 1, India

Ed: Strictly speaking, the Inquiry Card should be used only for inquiries about New Products or New Technical Data (company bulletins, etc.), not for reprints of feature articles. Requests for reprints of articles should be written on company letterhead. If the Inquiry Card is missing, requests for information on products can be written on company letterhead.

"Tear-Out Pages"

Editor, ELECTRONIC INDUSTRIES:

The idea of tear out pages on design and engineering articles is a very good idea but it seems to me you have defeated its purpose of convenience in two respects.

One; run-over on articles are put into back sections which do not contain "tear out" sheets. This makes a messy dissection job.

Two; article endings and beginnings are placed back to back so that they are impossible to separate for individual filing.

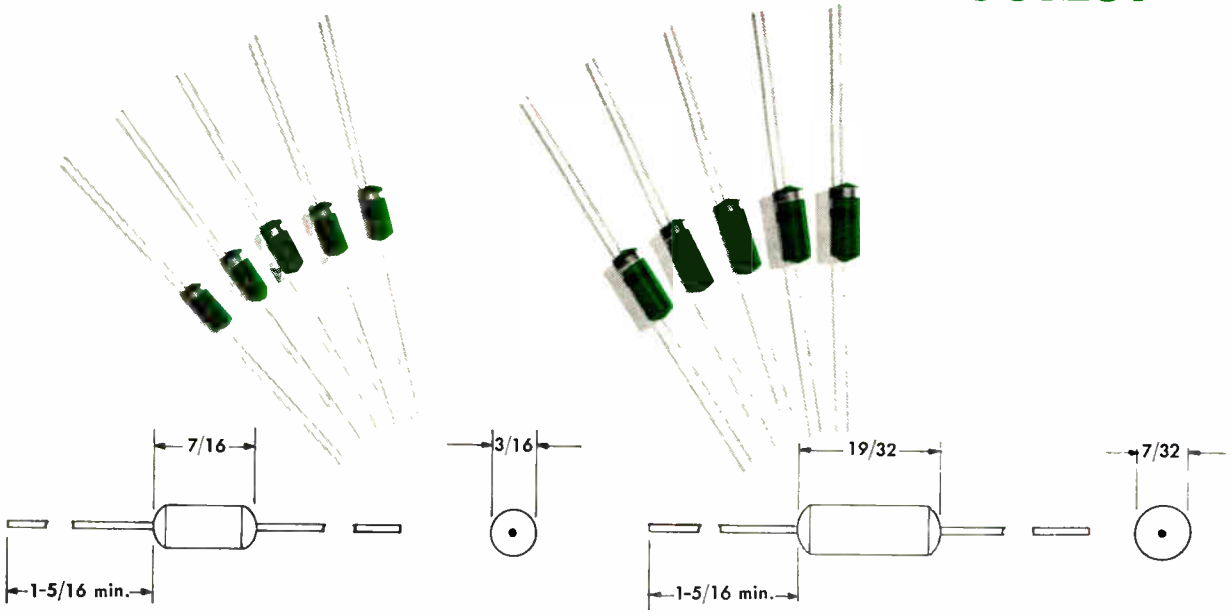
The above can of course be overcome and hope it is planned to do so.

Your issues generally though have what I think good design information and detailed analysis articles. I find them helpful enough so that a high percentage are filed in a permanent design file.

A. O. Kuhnel,
Framingham, Mass.

Proved in design... construction... and performance

JEFFERS MOLDED COILS!



TYPE NO. 101

PART NUMBER	L-Micro-henries	L-Tol. Plus or Minus	Approx. Fr Mc	Min. Q	at MC	R dc Max. 25°C	Max. I dc. MA
10100-20	0.15	20%	540	45	25	0.03	3650
" -22	0.22	"	450	45	25	0.04	3160
" -24	0.33	"	385	45	25	0.07	2400
" -26	0.47	"	335	45	25	0.08	2230
" -28	0.68	"	285	40	15	0.15	1630
" -30	1.00	"	230	30	10	0.30	1150
" -32	1.50	"	190	30	10	0.50	900
" -34	2.20	"	155	30	8.0	1.10	600
" -36	2.70	10%	140	30	7.0	1.20	570
10102-20	3.30	"	80	25	6.0	0.15	1630
" -22	3.90	"	75	25	6.0	0.16	1580
" -24	4.70	"	70	25	5.5	0.22	1350
" -26	5.60	"	62	30	5.0	0.30	1150
" -28	6.80	"	55	30	4.5	0.40	1000
" -30	8.20	"	53	30	4.5	0.45	940
" -32	10.0	"	47	30	4.0	0.60	810
" -34	12.0	"	42	45	3.5	1.00	620
" -36	15.0	"	38	45	3.0	1.20	575

TYPE NO. 102

PART NUMBER	L-Micro-henries	L-Tol. Plus or Minus	Approx. Fr Mc	Min. Q	at MC	R dc Max. 25°C	Max. I dc. MA
10200-20	0.47	20%	335	50	15	0.06	3160
" -22	0.68	"	280	50	14	0.10	2400
" -24	1.00	"	230	45	10	0.15	2000
" -26	1.50	"	190	45	10	0.28	1450
" -28	2.20	"	155	40	8.0	0.50	1100
" -30	2.7	10%	140	40	8.0	0.70	920
" -32	3.3	"	120	35	6.0	1.40	650
" -34	3.9	"	112	35	6.0	1.50	630
" -36	4.7	"	110	35	5.0	1.80	575
10203-20	5.6	"	60	35	5.0	0.15	2000
" -22	6.8	"	54	35	4.0	0.20	1730
" -24	8.2	"	50	35	4.0	0.25	1550
" -26	10.0	"	49	35	3.5	0.30	1400
" -28	12.0	"	40	40	3.0	0.50	1100
" -30	15.0	"	37	40	2.5	0.60	1000
" -32	18.0	"	34	50	2.5	0.80	860
" -34	22.0	"	29	60	2.5	1.20	700
" -36	27.0	"	27	65	2.0	1.40	650
" -38	33.0	"	24	70	2.0	1.90	560
" -40	39.0	"	23	70	2.0	2.00	550

Jeffers Coils are designed to give circuit engineers a standardized inductor line on which they can rely. The millions of Jeffers Coils made and sold every year are proof that they give just what's promised: longer, *more useful* service life!

Jeffers Molded Coils are engineered for dependability by virtue of their rugged mechanical construction and through the use of time-proven materials and manufacturing techniques. Only three physical sizes are required to cover a wide inductance range. Small size and close dimensional tolerances of the Jeffers Molded Coils make them ideal for automatic insertion.

JEFFERS MOLDED COILS

proved in extended life-performance tests!

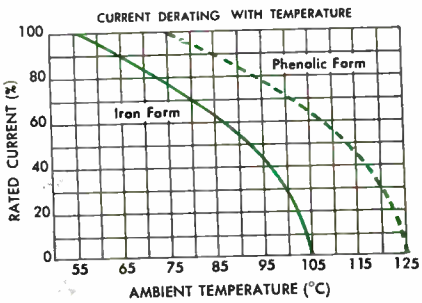
Jeffers Molded Coils are engineered to provide stabilized electrical characteristics for many thousands of hours of useful life under a variety of operating conditions.

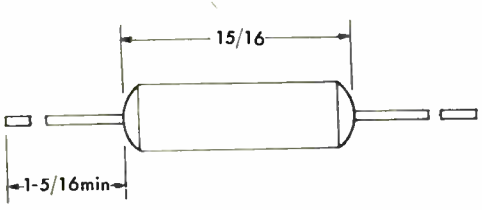
TYPICAL CHARACTERISTICS FOR TYPE 101 COILS.*

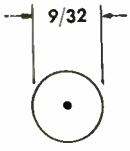
Moisture Resistance (MIL-STD-202, Method 106)

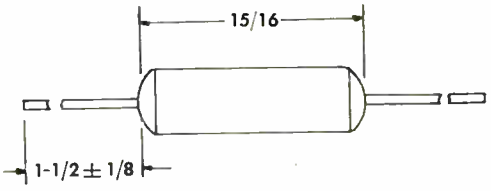
Change in: Inductance . . . . . Less than 2%
Change in: Resistance . . . . . Less than 2%
Change in: Resonant Frequency . . Less than 4%
Change in: Q Value . . . . . Less than 10%
Life Expectancy . . 20,000 hours plus at maximum operating temperature

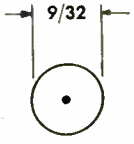
*(Data for other types available on request.)











TYPE NO. 104

PART NUMBER	L-Micro-henries	L-Tol. Plus or Minus	Approx. Fr Mc	Min. Q	at MC	R dc Max. 25°C	Max. I dc. MA
10402-20	1.2	20%	200	60	10	0.09	2980
" -22	1.5	"	180	65	10	0.12	2580
" -24	2.2	"	145	65	10	0.20	2000
" -26	2.7	10%	130	55	8.0	0.28	1700
" -28	3.3	"	125	50	6.0	0.32	1580
" -30	3.9	"	110	45	5.0	0.50	1260
" -32	4.7	"	100	45	5.0	0.60	1150
" -34	5.6	"	90	45	5.0	0.95	920
" -36	6.8	"	85	40	4.0	1.10	850
" -38	8.2	"	80	40	4.0	1.20	810
" -40	10.0	"	70	40	3.5	1.80	670
" -42	12.0	"	60	40	3.0	2.70	545
" -44	15.0	"	57	40	3.0	3.00	510
" -46	18.0	"	53	35	2.5	4.80	410
10404-20	**22.0**	"	**27**	**40**	**2.5**	**0.30**	**1630**
" -22	27.0	"	25	40	2.0	0.36	1500
" -24	33.0	"	22	45	2.0	0.60	1150
" -26	39.0	"	20	45	1.8	0.80	1000
" -28	47.0	"	18	70	1.5	1.20	820
" -30	56.0	"	17	70	1.5	1.30	780
" -40	68.0	"	15	75	1.5	1.90	650
" -32	82.0	"	14	85	1.2	2.20	600
" -34	100.0	"	13	85	1.0	2.80	530
" -36	120.0	"	11	85	1.0	4.00	450

TYPE NO. 404

JEFFERS PART No.	Mil Type Designation	Inductance UH	Q Min.	Meas. Freq. MC	Self Res. Freq. MC	DC Res. Max. Ohms	DC Current Rated MA
40402-1	LT8K001	1.1 ±20%	60	10.0	200 ±10%	.09	2800
40402-2	LT8K002	2.2 ±20%	65	10.0	165 ±10%	.20	1800
40402-3	LT8K003	3.3 ±10%	50	6.0	130 ±10%	.32	1500
40402-4	LT8K004	4.7 ±10%	45	5.0	100 ±10%	.60	1100
40402-5	LT8K005	6.8 ±10%	40	4.0	90 ±10%	1.10	800
40402-6	LT8K006	10.0 ±10%	40	3.5	70 ±10%	1.80	600
40402-7	LT8K007	15.0 ±10%	40	3.0	55 ±10%	3.00	500
40402-8	**LT8K008**	**22.0 ±10%**	**30**	**2.5**	**27 ±10%**	**.30**	**1500**
40402-9	**LT8K009**	**33.0 ±10%**	**45**	**2.0**	**21 ±10%**	**.60**	**1100**
40402-10	**LT8K010**	**47.0 ±10%**	**70**	**1.5**	**16 ±10%**	**1.20**	**700**
40402-11	**LT8K011**	**82.0 ±10%**	**85**	**1.2**	**14 ±10%**	**2.20**	**600**
40402-12	**LT8K012**	**100.0 ±10%**	**85**	**1.0**	**14 ±10%**	**2.80**	**500**
40402-13	**LT8K013**	**120.0 ±10%**	**85**	**1.0**	**13 ±10%**	**4.00**	**400**

AND DON'T FORGET JEFFERS TECHNICAL SERVICE! You're invited to submit your inductor design problems for evaluation and solution at no cost or obligation. You can be sure you're getting the *right* answer from Jeffers.

Light face type denotes coils on phenolic coil forms.
Bold face type denotes coils on powdered iron forms.

*Per MIL-C-15305A, MS 91189 (15 December 1953)

JEFFERS ELECTRONICS DIVISION
Speer Carbon Company,
Du Bois, Pennsylvania

JEFFERS ELECTRONICS

Circle 28 on Inquiry Card

Personals

Harvey W. Hess has been named Sales Engineer of the midwest for the Special Products Div. of Stromberg-Carlson.

Paul Mariotti has joined Polytechnic Research & Development Co., Inc., as Applications Engineer. He continues to teach in the evening division of Polytechnic Institute of Brooklyn.

James M. Hall has been named Chief Engineer of the Semiconductor Dept. of P. R. Mallory & Co., Inc.

J. M. Hall

G. P. Walker

George P. Walker, formerly with Magnavox Research Lab., has joined Ampex Corp. as Senior Staff Engineer in the Instrumentation Div.

Larry McFarren has been appointed Chief Engineer of the Burlington Iowa Plant of International Resistance Co.

James R. Juncker has joined Texas Instruments, Inc., as Military Relations Engineer in the Semiconductor Components Div. He will service agencies in the New York, New Jersey area.

Joseph Statsinger has joined Servo Corp. of America as Director of Engineering.

J. Statsinger

D. R. Greenberg

David R. Greenberg is now Chief Development Engineer at Control Instrument Co., Brooklyn, N. Y.

Norman R. Wild was appointed Chief Engineer for Equipment Design at Sanders Associates, Inc. Thomas E. Woodruff was named Chief Engineer for Preliminary Design.

(*Continued on page* 46)

New MUIRHEAD D-890-A OSCILLATOR

This is the latest, wide-range general purpose oscillator to be designed by Muirhead & Co. Limited. With a frequency range of 1c/s-110kc/s, it incorporates many design improvements and operational advantages over the widely accepted D-650 Oscillator which it supersedes. Chief among the operational features is the inclusion of a crystal-check facility: using a panel-mounted 1-inch cathode ray tube, the oscillator output frequency can be set against the highly accurate crystal over practically the entire range. Write for publication No. 136.

MUIRHEAD

377/3

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TECHNIQUE

A Journal of Instrument Engineering for Scientists, Engineers, Technicians, Research Workers

MUIRHEAD & CO. LIMITED
BECKENHAM · KENT
ENGLAND

Personals

(*Continued from page* 44)

Cleafe A. Best has joined the Technical Staff of Denver Laboratories of Ramo Wooldridge, Div. of Thompson Ramo-Wooldridge Inc. Best was formerly with Sparton Automotive Div. as Chief Development Engineer.

John Isabeau has been named Senior Project Engineer at R/S Electronic Corp., subsidiary of Regan Industries, Inc.

Stanley E. Jacke has joined Acoustica Associates, Inc., Eastern Div., as Chief Engineer of the Special Ultrasonic Cleaning Systems.

William L. Warner has joined Granger Associates, a Palo Alto Electronic Systems firm as Supervisory Engineer.

Walter A. Liebermann has just been appointed Chief Engineer of Metrolog Corp., Pasadena, Calif.

W. A. Liebermann

Dr. H. L. Garbarino

Dr. Harold L. Garbarino has joined Magnaflux Corp. as Chief Engineer-Electronics. He was formerly with Armour Research Foundation as Assistant Manager of Electrical Engineering Research.

Stanley F. Molner has been appointed Senior Application Engineer at Epsco-West, specializing in Applications Engineering of special purpose digital computers.

Harry J. Lewenstein has been promoted to Applications Engineering Manager in the Commercial Products Div. of Lenkurt Electric Co.

John A. Buzby has been appointed Project Engineer at General Devices Inc., Princeton, N. J.

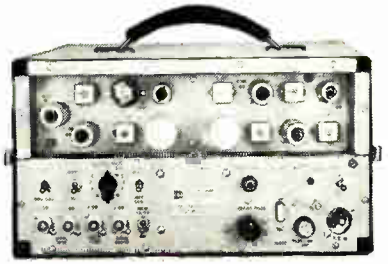
Basil V. Deltour has been appointed Senior Field Engineer at Laboratory for Electronics, Inc., with headquarters in Los Angeles, Calif.

Paul Hufnagel has been promoted to Operations Manager in the Transducer Div. of G. M. Giannini & Co. Other appointments: **Charles Court** to Assembly Superintendent and **Joseph Garza** to Engineering Products Manager for the Accelerometer Group.

(*Continued on page* 49)

1003-C VIDEO TRANSMISSION TEST SIGNAL GENERATOR

Produces multi-frequency burst, stairstep, modulated stairstep, white window, composite sync. Variable duty cycle. Regulated power supply.



1004-B VIDEO TRANSMISSION TEST SIGNAL RECEIVER

Very rapid and accurate measurements of differential phase and differential gain characteristics of video facilities. Responds to standard stairstep test signal modulated with 3.58mc, or any differential phase or gain test signal.

VIDEO TRANSMISSION TEST EQUIPMENT

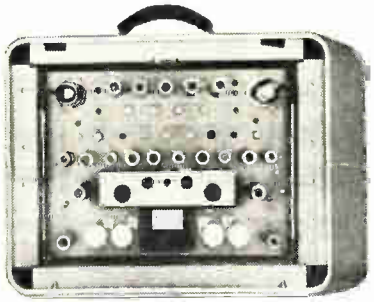
In Daily Use by All Major Networks, Stations and Telephone Co. Coaxial Cable, Microwave, and Intercity Facilities.

ALL CARRYING CASE UNITS IMMEDIATELY ADAPTABLE TO STANDARD RACK MOUNTING

1005-A VIDEO TRANSMISSION TEST SET

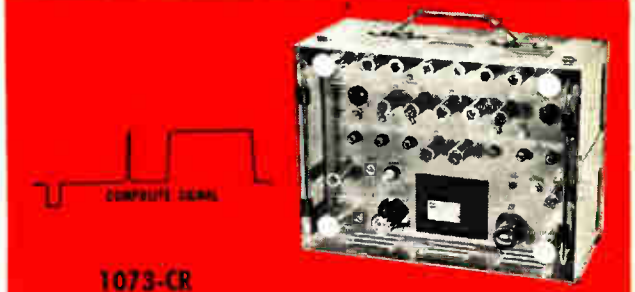
1005-A1 — Produces composite television waveforms suitable for measuring amplitude vs. frequency; differential gain vs. amplitude; dynamic linearity; differential phase vs. amplitude; high frequency transient response; low frequency transient response; low frequency phase or streaking; smears; mismatches; and other video characteristics.

1005-A2 — Supplies composite EIA Sync, blanking, horizontal and vertical drive signals and regulated B + power for 1005-A1. Features magnetic core binary counters.



1008-A VERTICAL INTERVAL KEYER

Permits test and control signals to be transmitted simultaneously with program material, between frames of TV picture. Any test signal (multiburst, stairstep, color bar, etc.) may be added to the composite program signal. Test signals are always present for checking transmission conditions without impairing picture quality. The home viewer is not aware of their presence.



1073-CR

SINE SQUARED (SIN²)—SQUARE WAVE GENERATOR

Produces new waveform for testing TV or other pulse unit or system for amplitude and phase characteristics. Sin²—Square Wave pulse is equivalent to TV camera signal and is more sensitive than a Square Wave in indicating ringing. Video test signal adjustable for 1.0 volts or 2.4 volts peak to peak. Now in use by major TV networks and telephone companies.

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Midwest Engineering Division—106 W. St. Charles Rd., Lombard, Ill., MAyfair 7-6026 Western Engineering Division—13635 Victory Blvd., Van Nuys, Calif., State 2-7479

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in easy-to-use packages.

Aircraft and Auto Radio Wire	Magnet Wire
Antenna Rotor Cables	Microphone Cables
Broadcast Audio Cables	Mil-Spec Hook-Up Wires
Bus Bar Wire	RG/U Cables
Community TV Cables	Shielded Power Cables
Cords	Shielding
Hi-Fi and Phono Cables	Sound and PA Cables
Hook-Up Wires	Strain Gauge Cables
Intercom Cables	Transmission Line Cables

TV Camera Cables

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One Wire Source for Everything
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CHICAGO

Magnet Wire • Lead Wire • Power Supply Cords,
Cord Sets and Portable Cord • Aircraft Wires
Electrical Household Cords • Electronic Wires
Welding Cable • Automotive Wire and Cable

08A03J8

Circle 33 on Inquiry Card

Personals

(*Continued from page* 46)

William G. Sterns has been promoted to Chief Engineer at Meridian Metal Craft, microwave equipment manufacturers.

Walter Schumann has been named Application Engineer for Automated Check-out Systems at Nortronics Div., of Northrop Aircraft. **Burl H Ervin** has been appointed Head of Market Research Operations.

Arch T. Colwell has been named for the newly created position of Vice President-Engineering, Research & Development at the Corporate Staff Level of Thompson Ramo-Wooldridge Inc.

Marion A. Condie has joined Dalmo Victor's Electronic Systems Div. as Head, Advanced Systems Planning.

Paul V. Brown has been appointed Manager-Manufacturing of the La-Verne, Calif. plant of Taylor Fibre Co.

Tore N. Anderson, Vice President of Airtron, Inc., was recently appointed a Consultant to the Secretary of Defense, serving under working group and transmission line of the Advisory Group on electronic parts.

Books

Semiconductors

Edited by N. B. Hannay. Published 1959 by Reinhold Publishing Corp., 430 Park Ave., New York 22. 767 pages. Price $15.00.

Here is an unrivaled, indispensable reference on the physical chemistry and fundamental physics of semiconductors, with detailed analysis of important semiconductor materials. The emphasis throughout is on basic principles and phenomena. The chemical aspects and the physics of semiconductor behavior are exhaustibly treated.

Semiconducting materials are treated individually, the amount of attention given each material being in direct relation to the degree of understanding of that material which exists.

Each chapter, whether it be on principles, crystal growing, or specific materials is preceded by an introduction placing that chapter in perspective with semiconducting as a whole.

The contributors are all leaders in semiconductor research, and are well-known in the particular area in which they write. There are discussions of, or references to, most of the recent literature.

By virtue of its organization, thoroughness and authorship, this mono-

(*Continued on page* 52)

12MA1 Actuator

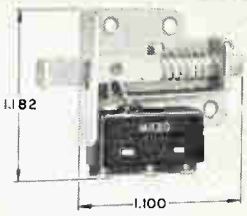
12MA5 Actuator

Pushbutton actuators are versatile, low cost

These actuators accept three families of basic pin plunger switches permitting their use in a wide range of applications. Two button sizes—½" and 1"—and choice of red, green or black buttons give panel distinctiveness. Switch and actuator mounting hole arrangement permits use in panels from .060" to .312" thick, and simplifies button travel adjustment. Data Sheet 155.

New subminiature "TM" toggle switch uses minimum panel space

The 2TM1-T offers considerable reductions in space and weight in manual control of compact equipment. Weight—4½ grams. Only ½" square at the base. Dependable operation from −65° to +200°F. Low circuit resistance. Rating: 7 amps. resistive, 28 vdc. DPDT. Data Sheet 158.



New subminiature safety door interlock

The 17AC1-T cuts off power in equipment cabinets when a service door is opened. Manually pulling the rod actuator to maintained contact position closes circuit for checking. When door is next closed, switch returns to normal . . . resets itself to safety position. Dependable in temperatures from −65° to +250° F. SPDT. Data Sheet 159.

ACTUAL SIZE

Sub-subminiature series switches

These remarkable switches combine smallest available size with "regular size" electrical capacity, operate dependably in temperatures from −65° to +250°F. Weight—1/28 oz. Qualifies as Military Standard Part Number MS24547-1. Rating: 5 amps., 230 vac; 7 amps. resistive, 28 vdc. Data Sheet 148.

LEAF ACTUATOR

ROLLER LEAF ACTUATOR

Auxiliary actuators add to the versatility of application. Two are shown. Others are pivoted lever and pivoted roller lever. All are stainless steel.

"One-Shot" switches simplify circuit development

Time-consuming custom development of circuits is made unnecessary by "1PB600" Series "One-Shot" pushbutton switches. These switches produce one square wave pulse per operation. Pulse widths from 0.1 to 10.0 microseconds. Applications include computer and radar consoles, electronic test equipment, setting and resetting flip-flops, and reflected pulse systems. Data Sheet 150.

Selections from a line large enough to solve almost any switching problem

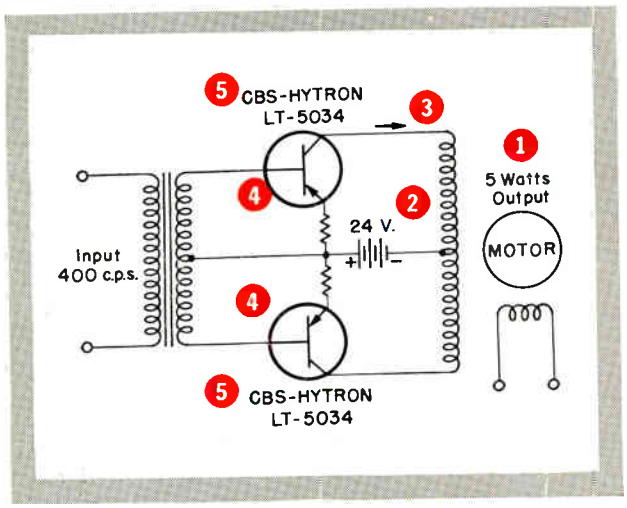
MICRO SWITCH makes many hundreds of switches and switch devices especially useful to the electronic designer. Here are a few of them, in a considerable range of sizes, electrical capacities, and functions. MICRO SWITCH development engineers are constantly widening the choice with new switches and devices to meet new requirements. The designer can go ahead with a switching arrangement he has in mind with confidence that MICRO SWITCH can supply his need.

Engineering assistance in switch applications is available without obligation from MICRO SWITCH branch offices. Consult the Yellow Pages.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls Limited, Toronto 17, Ontario

Honeywell
MICRO SWITCH Precision Switches

Selection of the Right Power Transistor made easy



FOR EXAMPLE:

Need a transistor for an airborne servo amplifier?

Here's how easy it is to select the transistor with optimized characteristics at minimized cost:

1. You may need 5 watts output — 2.5 watts per transistor. At 70°C maximum base mounting temperature, this equals a 10-watt rating at 25°C standard. Pick "20-Watt Group."
2. Source voltage, 24 volts. With inductive load, peak-to-peak volts approximate 48. Choose "Minimum Breakdown Voltage" of 60.
3. Input signal current, 7 ma. Power output of 5 watts divided by .707 times 24 source volts gives 300-ma. collector current. "Current Gain" of 43 is required . . . use 60.
4. For a convenient, plug-in standard package, you may want the "Diamond" version.
5. That is it . . . you have picked the CBS-Hytron LT-5034.

Use these same convenient tables in selecting the exact PNP germanium power transistors you need from CBS-Hytron's most comprehensive line: 3 power groups . . . 6 packages . . . over 100 EIA, military and special types.

And for complete data on the types you choose, write for Bulletin E-288. Ask our Applications Engineering Department for any special assistance you may want.

20-WATT GROUP
Types Available

Current Gain‡	30V	60V	100V	120V	Packages#
60	LT-5028	LT-5034	LT-5042	LT-5051	Diamond
	LT-5027	LT-5033	LT-5041	LT-5050	Male
	LT-5026	LT-5032	LT-5040	LT-5049	Female
40	LT-5025	LT-5031	LT-5039	LT-5048	Diamond
	LT-5024	LT-5030	LT-5038	LT-5047	Male
	LT-5023	LT-5029	LT-5037	LT-5046	Female
20	LT-5022	2N157	2N157A	LT-5045	Diamond
	LT-5021	LT-55	LT-5036	LT-5044	Male
	LT-5152	LT-5153	LT-5035	LT-5043	Female

Minimum Breakdown Voltage†

30-WATT GROUP
Types Available

Current Gain‡	30V	60V	80V	100V	Packages#
100	LT-5060	LT-5069	LT-5078	LT-5087	Diamond
	LT-5059	LT-5068	LT-5077	LT-5086	Male
	LT-5058	LT-5067	LT-5076	LT-5085	Female
60	LT-5057	LT-5066	LT-5075	LT-5084	Diamond
	LT-5056	LT-5065	LT-5074	LT-5083	Male
	LT-5055	LT-5064	LT-5073	LT-5082	Female
30	LT-5054	LT-5063	LT-5072	LT-5081	Diamond
	LT-5053	LT-5062	LT-5071	LT-5080	Male
	LT-5052	LT-5061	LT-5070	LT-5079	Female

Minimum Breakdown Voltage†

40-WATT GROUP
Types Available

Current Gain‡	30V	60V	80V	100V	Packages#
160	LT-5096	LT-5105	LT-5114	LT-5123	Diamond
	LT-5095	LT-5104	LT-5113	LT-5122	Male
	LT-5094	LT-5103	LT-5112	LT-5121	Female
80	LT-5093	LT-5102	LT-5111	LT-5120	Diamond
	LT-5092	LT-5101	LT-5110	LT-5119	Male
	LT-5091	LT-5100	LT-5109	LT-5118	Female
40	LT-5090	LT-5099	LT-5108	LT-5117	Diamond
	LT-5089	LT-5098	LT-5107	LT-5116	Male
	LT-5088	LT-5097	LT-5106	LT-5115	Female

Minimum Breakdown Voltage†

‡Minimum large-signal current gain: 40-watt group at 1.0 A, 30-watt group at 0.75 A, 20-watt group at 0.50 A.
†Minimum breakdown voltage, collector to base with emitter open.
#Five packages: diamond, female industrial with solder lugs or flying leads, and male industrial with solder lugs or flying leads.

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Circle 36 on Inquiry Card

Books

(*Continued from page* 49)

graph will stand for many years to come as a standard work on semiconductors. It is of outstanding importance to physical chemists, solid-state physicists, inorganic chemists and metallurgists, electrical engineers, electro-chemists, electronic and chemical industries.

Electrical Safety

By H. W. Swann. Published 1959 by Philosophical Library, 15 E. 40th St., New York 16. 292 pages. Price $15.00.

Safety in the use of electricity is a matter of great importance not only to engineers and technicians but to the general public. The universal use of electricity in our public buildings, factories, streets and homes for power, lighting and heating as well as in hospitals and clinics for physical application indicate the consideration that must have been given to the subject of electrical safety in all these varied conditions.

The author of this work was until recently the Senior Electrical Inspector with the British Home Office and has a very wide experience of accidents that have occurred, and clear judgment as to the safety precautions to be taken.

Static electrification may occur under unexpected conditions and the author writes entertainingly of some of the cases with which he has had to deal.

Design of Transistorized Circuits for Digital Computers

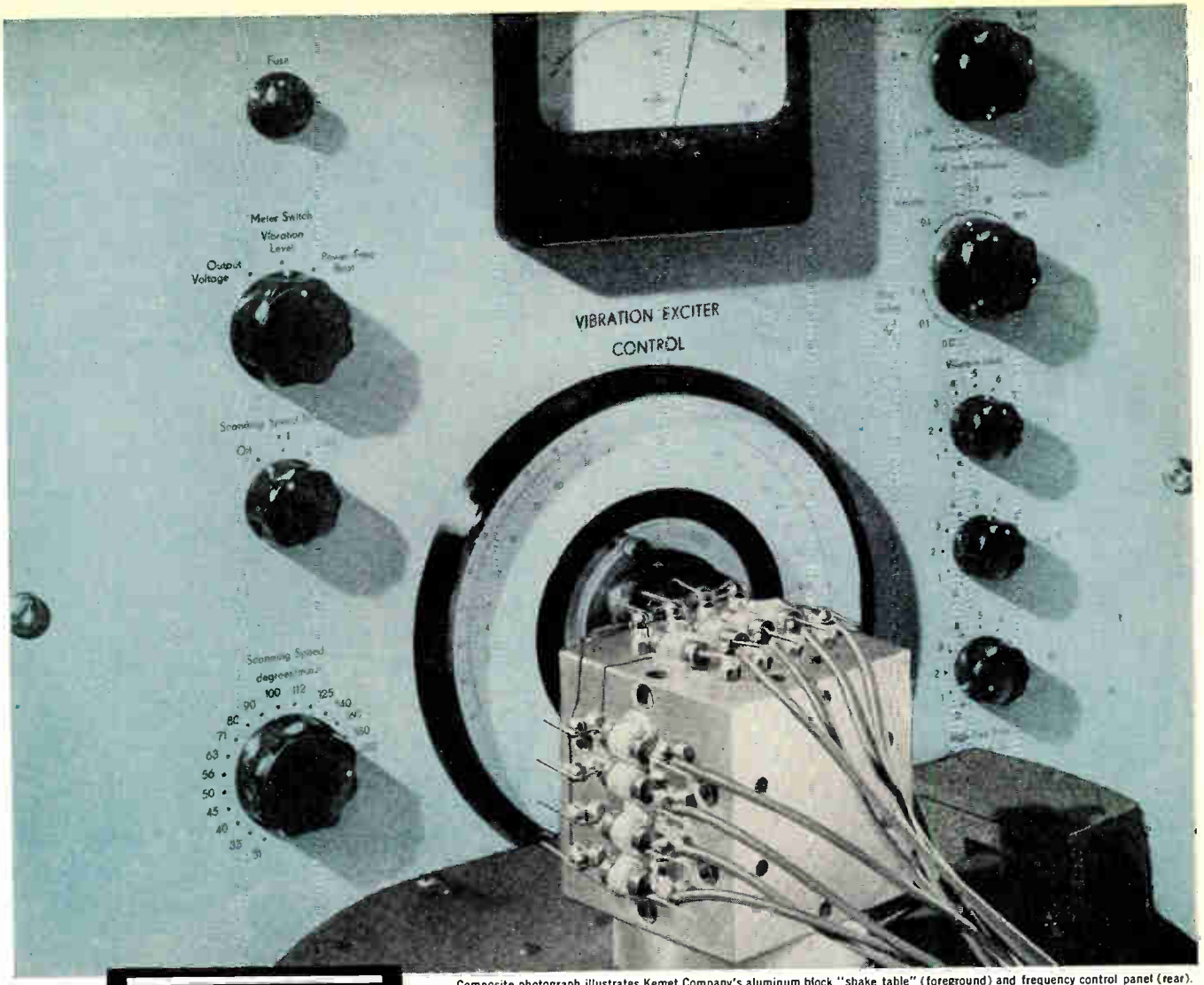
By Abraham I. Pressman. Published 1959 by John F. Ryder, Publisher, Inc., 116 W. 14th St., New York 11. 324 pages. Price $9.95.

Digital circuits are usually fabricated by interconnecting repetitively used standard building blocks. The design of these building blocks using transistors is the subject matter of this book. It is written from the circuit designer's point of view, and emphasizes worst-case design techniques.

Worst-case designing permits circuits to work when all supply voltages, resistors, passive components, and all transistor and diode parameters are simultaneously off their nominal values by the maximum expected tolerances. Such worst-case designing is absolutely essential for digital-type circuits as these are of the nature of all or noncircuits, and single errors even over long periods of time cannot be tolerated.

The circuit designer must decide on the tolerance limits of his components, taking into account the initial production spread, deterioration due to aging, temperature and other deleteri-

(*Continued on page* 54)



Composite photograph illustrates Kemet Company's aluminum block "shake table" (foreground) and frequency control panel (rear).

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CAPACITORS WITHSTAND SEVERE VIBRATION TESTS WITHOUT FAILURE!

In addition to severe tests involving low and high temperatures, high humidity, electrical overload and salt spray, "Kemet" solid tantalum capacitors are regularly subjected to rigid vibration tests on a routine sampling basis.

During these tests, which are a part of MIL-C-3965B, the frequency is automatically scanned from 10 to 2000 cycles and back in twenty minutes and the capacitors are subjected to twenty-four such cycles; twelve in each of two perpendicular planes. Acceleration and displacement are automatically controlled during each portion of the test. The electrical leads shown in the photograph provide continuous automatic monitoring for open, short and intermittent circuits in the capacitors on test.

In addition to excellent performance on the standard 15g test, "Kemet" solid tantalum capacitors have withstood 45g acceleration on similar vibration tests.

Kemet Company — supplier of a complete line of solid tantalum capacitors — is not dependent on other suppliers for the mining or processing of tantalum. Kemet Company maintains a complete environmental laboratory which includes vibration testing equipment.

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This four-page folder provides performance curves, operating characteristics and specifications.

KEMET COMPANY

DIVISION OF UNION CARBIDE CORPORATION

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Books

(*Continued from page* 52)

ous effects. With these tolerance limits fixed, the designer must analyze his circuit and make it work for all supply voltages, and passive and active components simultaneously being at those extremes of their tolerance limits which would most tend to make the circuit inoperative. If a circuit cannot be "worst-cased" in this manner, it is not useable in digital equipment.

In addition to the detailed analysis of the major schemes of performing transistorized computer logic, a review and analysis of most other schemes appearing in the literature in the past few years is also given.

Further, a discussion of Boolean algebra and its applications to the design of optimum switching circuits is included. This section also shows typical interconnections of the basic logical building blocks, so that the reader with no previous computer experience can gain an appreciation of how the blocks designed later in the book are used and what may be achieved with them.

International Radio Tube Encyclopedia, 3rd Edition, 1958-1959

By Bernard B. Babani. Published 1958 by Bernards (Publishers) Ltd. Available from Joseph Plasencia, Inc., 401 Broadway, New York 13. 769 pages. Price $15.00.

Since 1954, the year of the 2nd edition of this work, research in the radio tube industry has gone on unceasingly throughout the world as some further 9,000 types of radio tubes have been produced. This present edition contains data on more than 27,500 tube types.

One major reason for the vast increase in new tube types is the rapid development in the field of microwave reception and transmission for industrial and defense purposes. In addition, TV and VHF domestic programs all over the world have made necessary the production of many new types of receiving tubes of greater efficiency and capable of working at UHF. In turn, this has helped to increase the scope of this edition.

Data is provided covering some 10,000 more tubes than will be found in any other comparable work published.

The scope of this encyclopedia covers all receiving tubes including diodes, triodes, tetrodes, pentodes, heptodes, hexodes, tuning indicators, regulators, thyratrons, rectifiers, subminiature tubes, TV cathode ray tubes, industrial and military type transmitting triodes, tetrodes, pentodes, cathode ray tubes, klystrons, magnetrons, TR tubes, ATR tubes, coaxial velocity modulators, traveling wave tubes,

(*Continued on page* 58)

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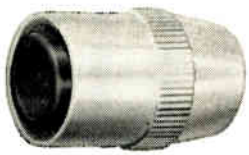

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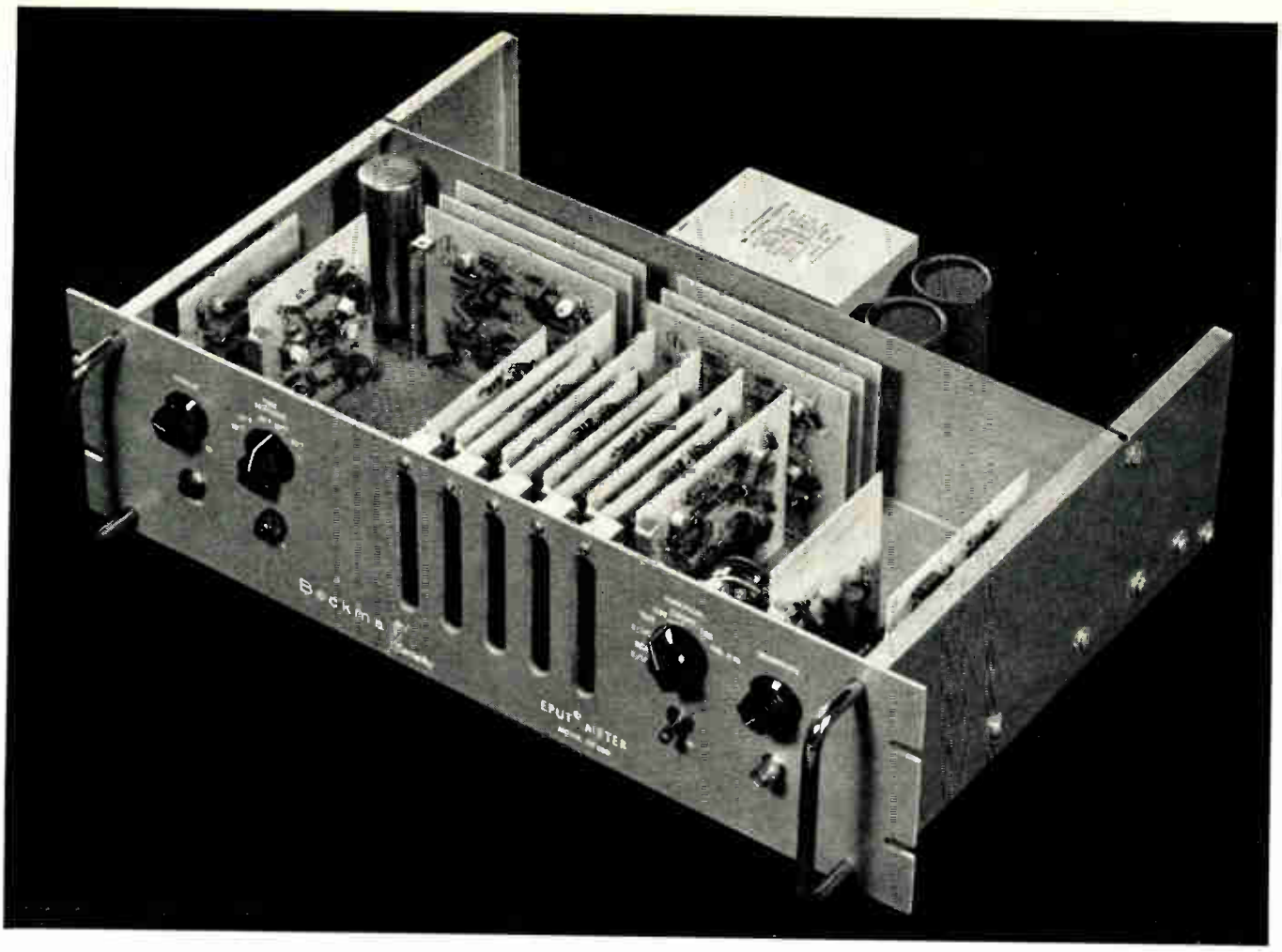

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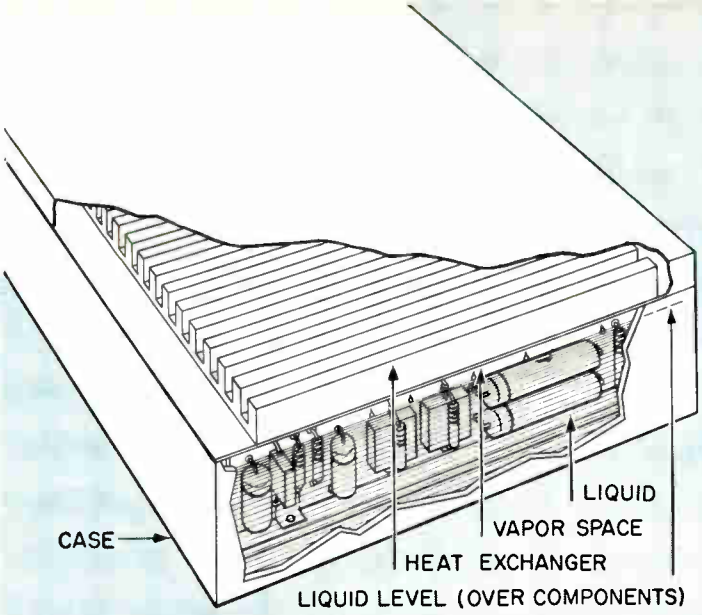

In Raytheon's "EV-GRAV" system, liquid refrigerant boils off the surfaces of the individual electronic components, rises as vapor, condenses on the heat exchanger, and drops as liquid to repeat the cycle.

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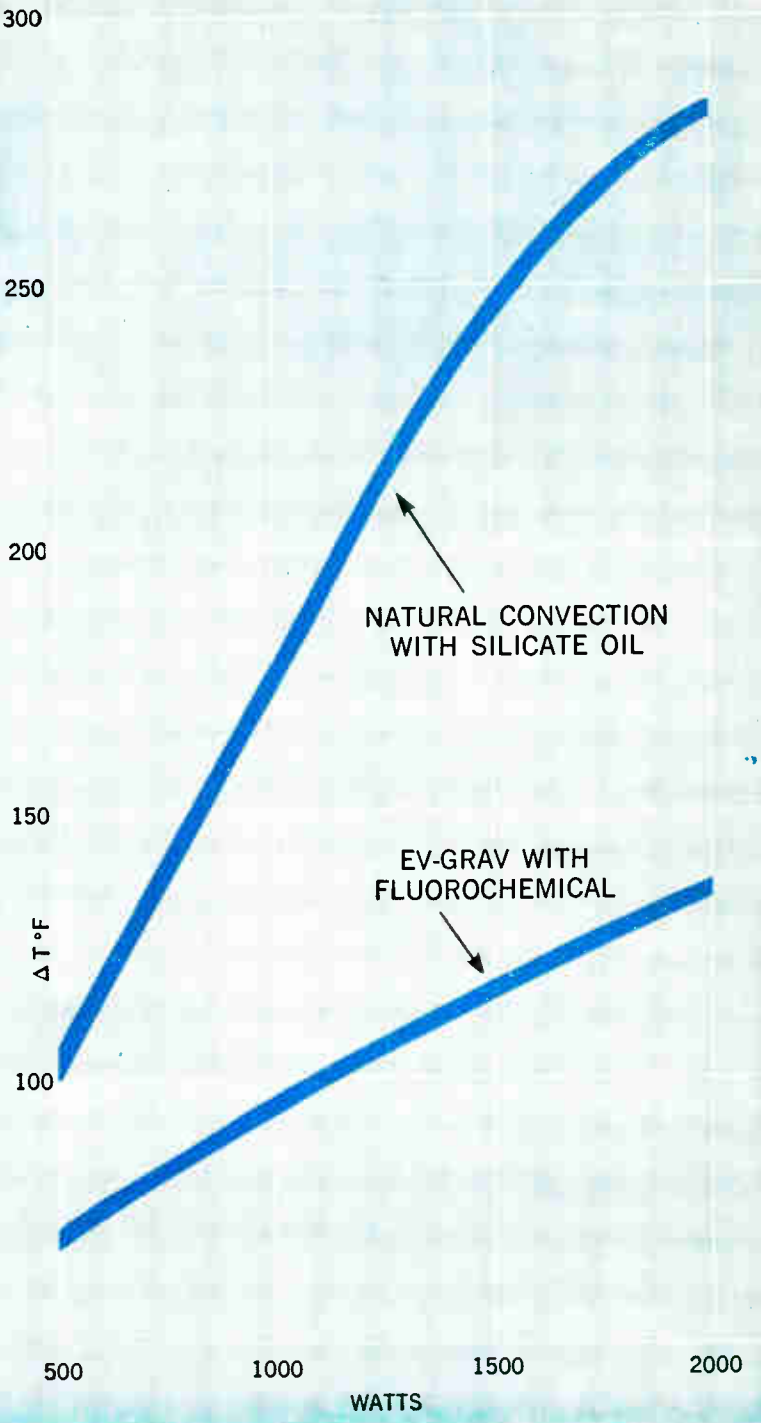
The use of fluorochemical refrigerants in an "evaporative-gravity" cooling system is a novel method of removing heat from electronic components. The refrigerant boils at the surfaces of submerged heat-dissipating components and condenses on the surface of a heat exchanger at the top of the package.

This technique has proved more efficient than free convection in oil dielectrics or forced convection with gas dielectrics. The high dielectric strength of the fluorochemicals permits the achievement of higher density packaging.

Contributions such as this are typical of the Heat Transfer Group in Raytheon's Government Equipment Division . . . assisting design engineers in developing the complex weapons systems of tomorrow.



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Qualified engineers and physical scientists with BS or advanced degrees interested in systems, development, design or manufacturing engineering of complex electronic equipments are invited to write Donald H. Sweet, Government Equipment Division, Raytheon Manufacturing Company, Wayland, Massachusetts.

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Books

(Continued from page 54)

pulse-gas switching tubes, noise sources, microwave oscillators, reflex velocity oscillators, cavity tubes, pre TR tubes, counter tubes, forward wave amplifiers, magnet focused amplifiers, continuous wave amplifiers, frequency multipliers, etc.

All receiving tubes are classified according to electrostructure and for the purpose for which they are used, thereby simplifying the designer or service engineer's need for data in any one section.

Kaiser Aluminum Foil

Published 1958 by Kaiser Aluminum & Chemical Sales, Inc., 919 N. Michigan Ave., Chicago 11, Ill. 244 pages. Available without cost if requested on company letterhead, $12.50 for each personal copy.

Aluminum foil converting processes are described in detail, and many end uses are reviewed.

The new book is designed to suggest to management and sales staffs new foil products, as well as efficient production methods for traditional foil items. Included are more than 350 photographs and drawings, an index, many cross references, a complete table of contents and glossary.

Servo Calculators

Published 1958 by Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55. Available to design engineers free when requested on company letterhead.

Vacuum Tube Characteristics

Edited by A. Schure. Published 1959 by John F. Rider, Inc., 116 West 14th St., New York 11. 96 pages. Price $1.80.

Physical Laws and Effects

By C. F. Hix, Jr., & R. P. Alley. Published 1958 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16 291 pages. Price $7.95.

Transistor Physics and Circuits

By Robelt L. Riddle and Marlin P. Ristenbatt. Published 1958 by Prentice-Hall, Inc., 70 Fifth Ave., New York 11. 428 pages. Price $10.00.

Sideband Handbook

By Don Stoner, WSTNS. Published 1958 by Cowan Publishing Corp., 300 West 43rd St., New York 36, 224 pages. Price $3.00.

Proceeding 5th National Symposium on Reliability & Quality Control

Published by the Editorial Dept., Institute of Radio Engineers, Inc., 1 East 79th St., New York 21. Price $5.00.

It Doesn't Just Seem That Way—It Is!

In our post-Sputnik era one in every four Americans is a science enthusiast. A recent Univ. of Michigan study turned up that fact. Also that 3 of 4 adults recall at least 1 specific science news item.

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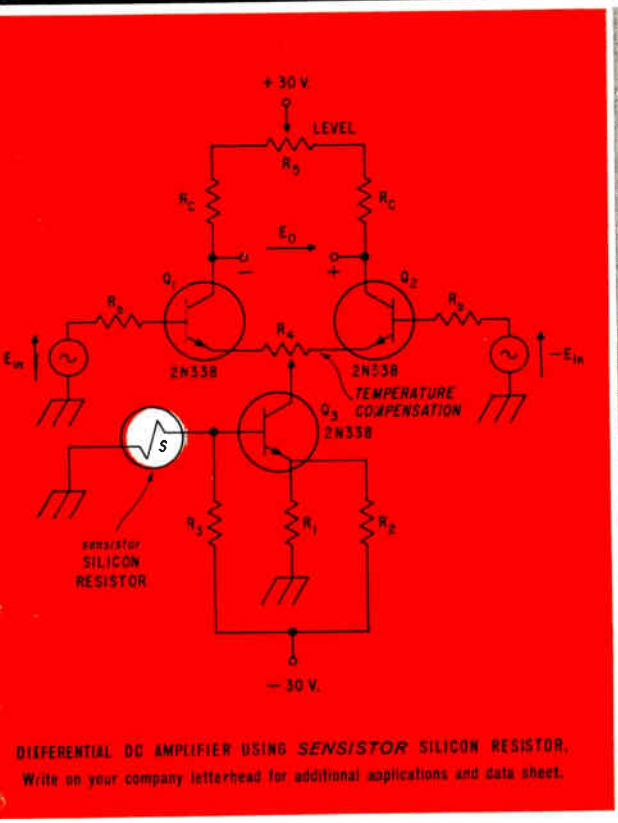
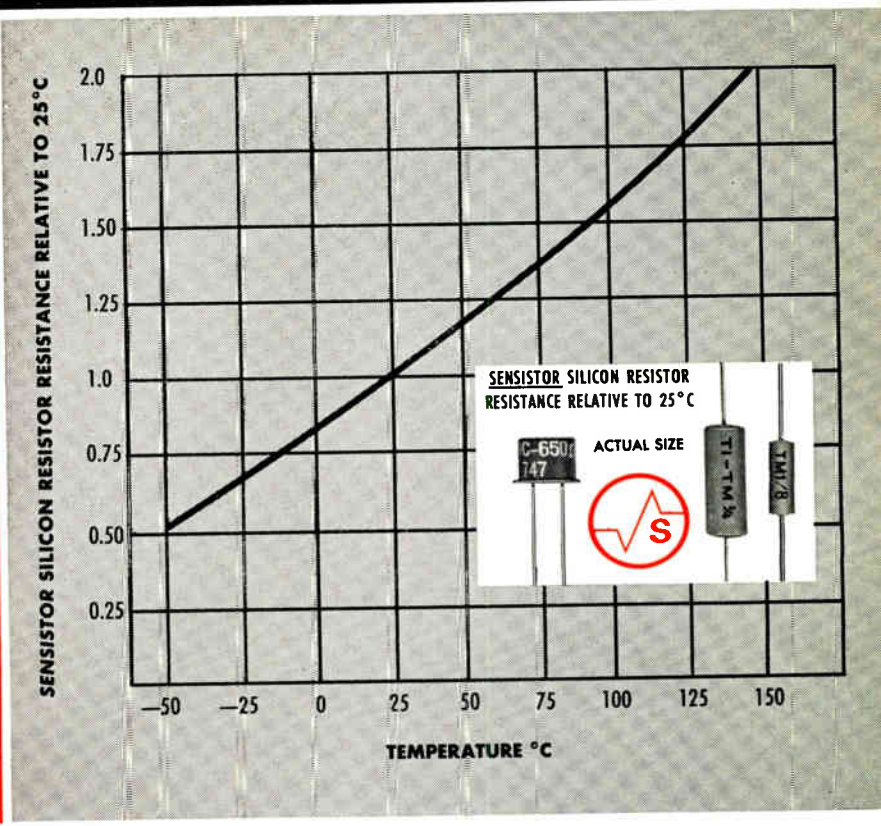
TI APPLICATION NOTE



DIFFERENTIAL DC AMPLIFIER USING *SENSISTOR* SILICON RESISTOR.
Write on your company letterhead for additional applications and data sheet.



HOW TO INCREASE DIFFERENTIAL DC AMPLIFIER STABILITY WITH *sensistor** SILICON RESISTORS

Low drift transistor amplifier circuit using *sensistor* silicon resistor gives drift performance superior to vacuum tube amplifiers for low source impedance applications.

The sensistor silicon resistor has a unique positive temperature coefficient of +0.7%/°C plus a constant rate of change as shown in the graph to the right. Over a 15°C temperature range, the *sensistor* silicon resistor's temperature-resistance curve approaches linearity to an extent that allows its use as a compensating component in a differential D-C amplifier.

This low drift amplifier finds a wide range of low source impedance applications in airborne telemetry where the performance of other types of D-C amplifiers is limited by weight requirements, acceleration, shock, and vibration. It is particularly useful with low level transducers such as thermocouples, strain gages and accelerometers.

DESIGN CONSIDERATIONS

TI 2N338 silicon transistor provides excellent performance as a low drift DC amplifier when used in circuits such as the one shown above.

For optimum performance keep $(2R_b + R_4)$ as small as possible, preferably less than 2000Ω, and the collector currents of Q_1 and Q_2 should remain below 100 μA.

Drift cancellation featured in an uncompensated differential configuration provides an amplifier with an equivalent input drift of 400 μV/°C or less with standard production transistors.

Drifts as low as 6μV/°C will result if the compensating circuit composed of Q_3, sensistor resistor S and their biasing resistors is used with a matched pair of transistors.

CIRCUIT OPERATION

Sensistor resistor S and its biasing resistor R_3 serve as a voltage source which has an output linearly related to temperature . . . level potentiometer R_5 adjusts output voltage E_o to zero when E_{in} is zero . . . potentiometer R_4 adjusts for minimum output drift due to ambient temperature changes.

As temperature increases, the resistance value of S also increases causing the base of Q_3 to go more negative, thereby reducing the collector current of Q_3. This temperature-dependent current is fed into the differential amplifier through R_4.

Depending on the wiper position of R_4, the correcting signal may be positive, negative or zero. When the wiper is centered, zero correction results. As temperature increases, output voltage E_o tends to go more positive if the R_4 wiper is placed nearer the Q_2 emitter and negative if the wiper is placed nearer Q_1. The optimum setting for R_4 can be determined by cycling over the desired temperature range to give a minimum drift for changes in ambient temperature.

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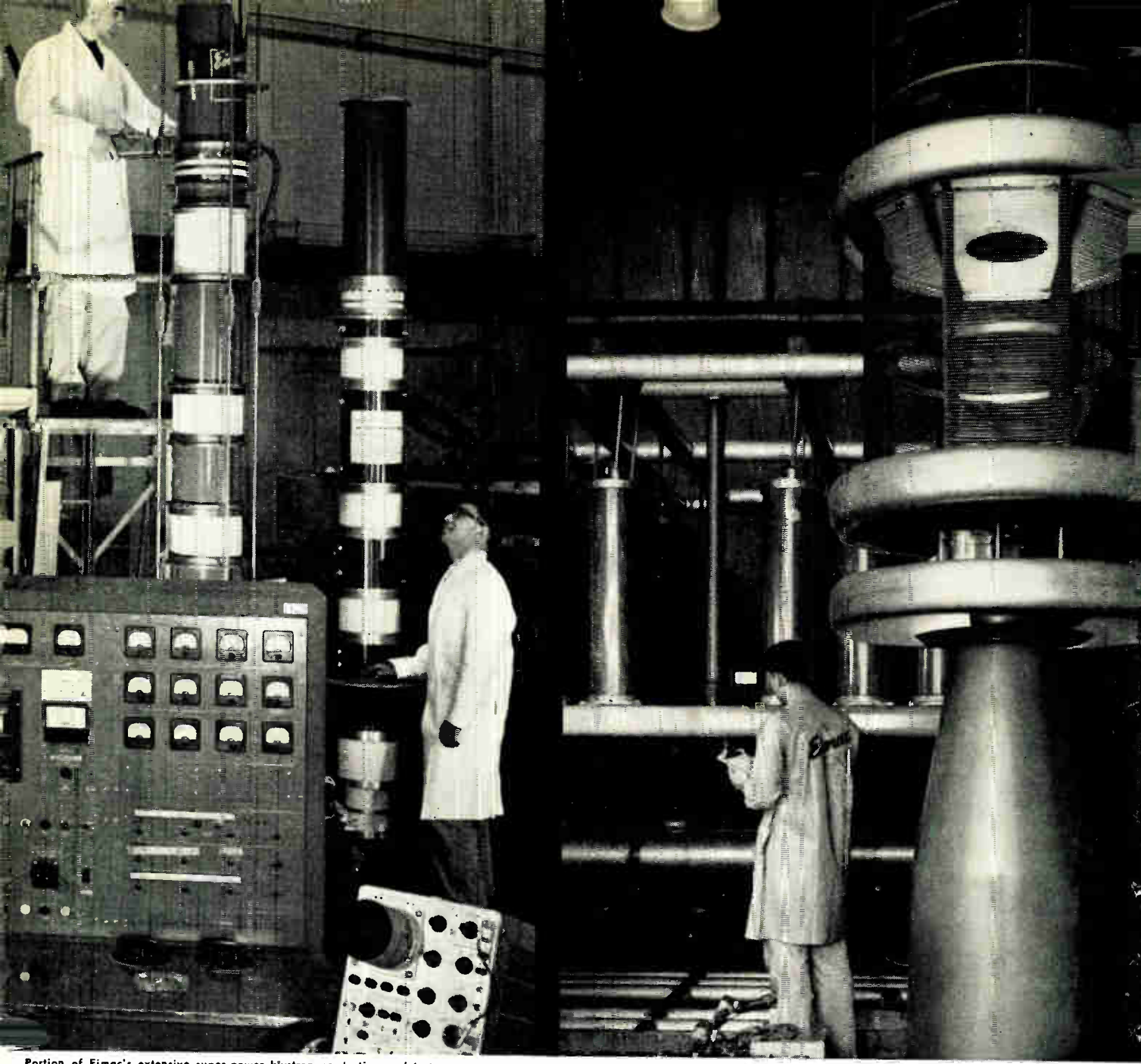

Portion of Eimac's extensive super-power klystron production and test area.

High-voltage d.c. supply used in manufacturing Eimac super-power klystrons.

SUPER-POWER UHF KLYSTRONS FOR SPACE RADAR NOW IN FULL PRODUCTION AT EIMAC

Tracking fast-moving ballistic missiles and satellites at great distances requires exceptionally powerful radar equipment. Eimac super-power amplifier klystrons, capable of one and one-quarter megawatt peak power and 75 kw average power at ultra-high frequencies, have made these new "space radars" possible. Development of these klystrons, the world's largest electron tubes, has been completed at Eimac and full power tubes have been delivered. They are now being manufactured in production quantities. In addition to radar, Eimac super-power klystrons can be used in linear accelerator and high-power tropo-scatter applications.

Production of these tubes is being carried on at the Eimac High-Voltage Laboratory in San Bruno, California, where development work was done. Complete facilities are available there for the fabrication, assembly, pumping and testing of these giant tubes. Two power supplies, each capable of producing 120,000 volts d.c. at two and four amperes are used in production and testing operations.

This success in developing and placing these tubes in full production in a relatively short time is indicative of Eimac's extensive experience in the field of high-power UHF electron devices. Other Eimac amplifier klystron types are used widely in military and commercial tropo-scatter networks throughout the world.

For high power at ultra-high frequencies investigate the many advantages of Eimac external-cavity amplifier klystrons.

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meanwhile . . . . . back on the earth
Rockets, missiles, moon shoots and interplanetary space travel make highly fashionable advertising these days. Naturally, it is gratifying to us to know that Fusite Glass-to-Metal Hermetic Terminals are aboard nearly all these history making trips into the outer universe. But at least part of the excitement of participation is passing us by. We have no top secret labs or special assembly on exotic military model terminals. The Fusite Terminals that are performing so well under these extremes of temperature, pressure, and mechanical shock are pretty much the same kind of terminals we produce every day by the tens of thousands for commercial production. We're fairly certain that this proves something or other about the ability of Fusite Terminals to perform rather well in your earth-bound electronic components. But we suspect nothing can prove this point to your satisfaction quite so well as trying them yourself—testing and comparing with other kinds of terminals. It may seem like an "earthy" approach, but if it makes sense to you, samples are yours for the asking.
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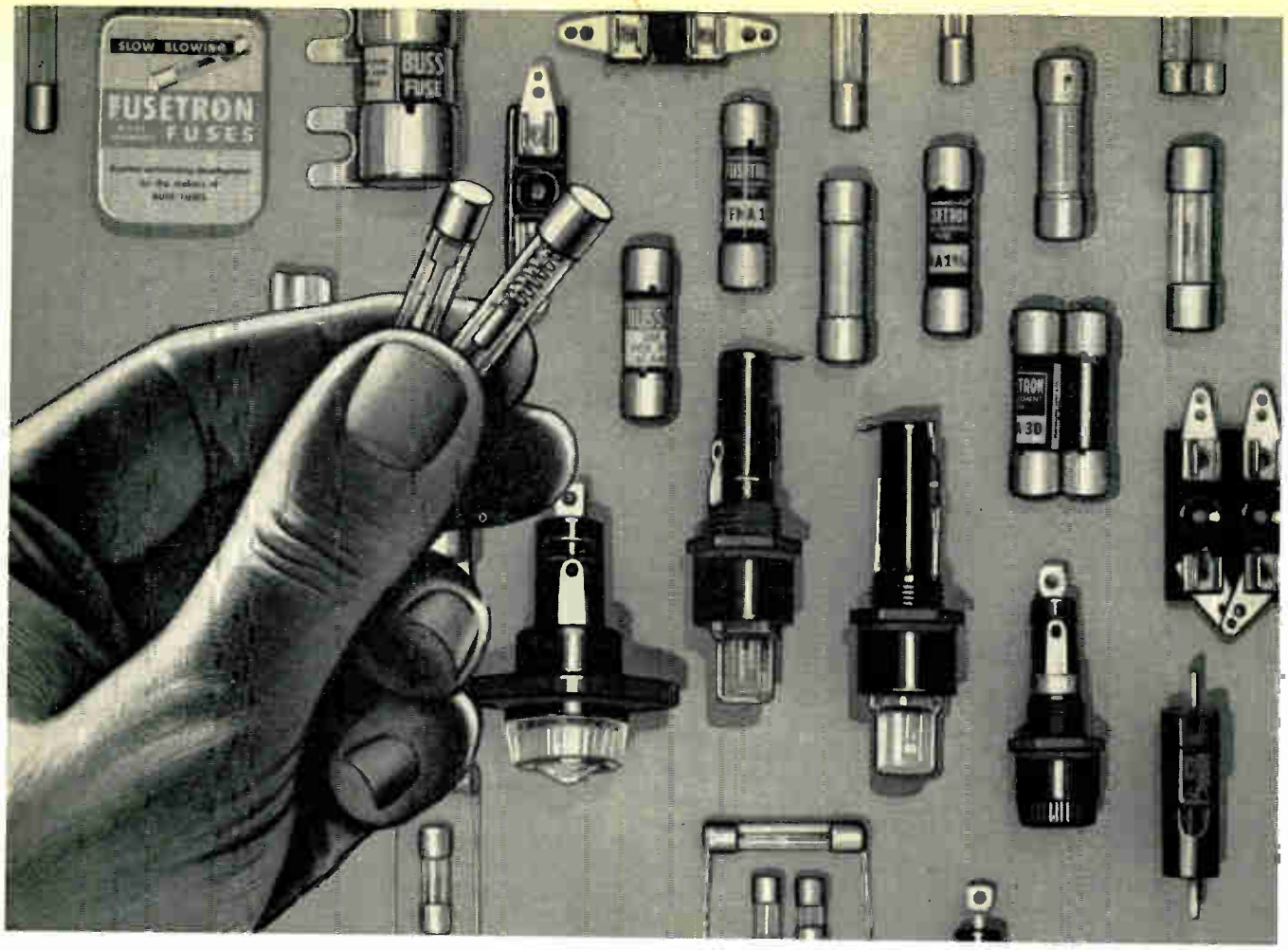

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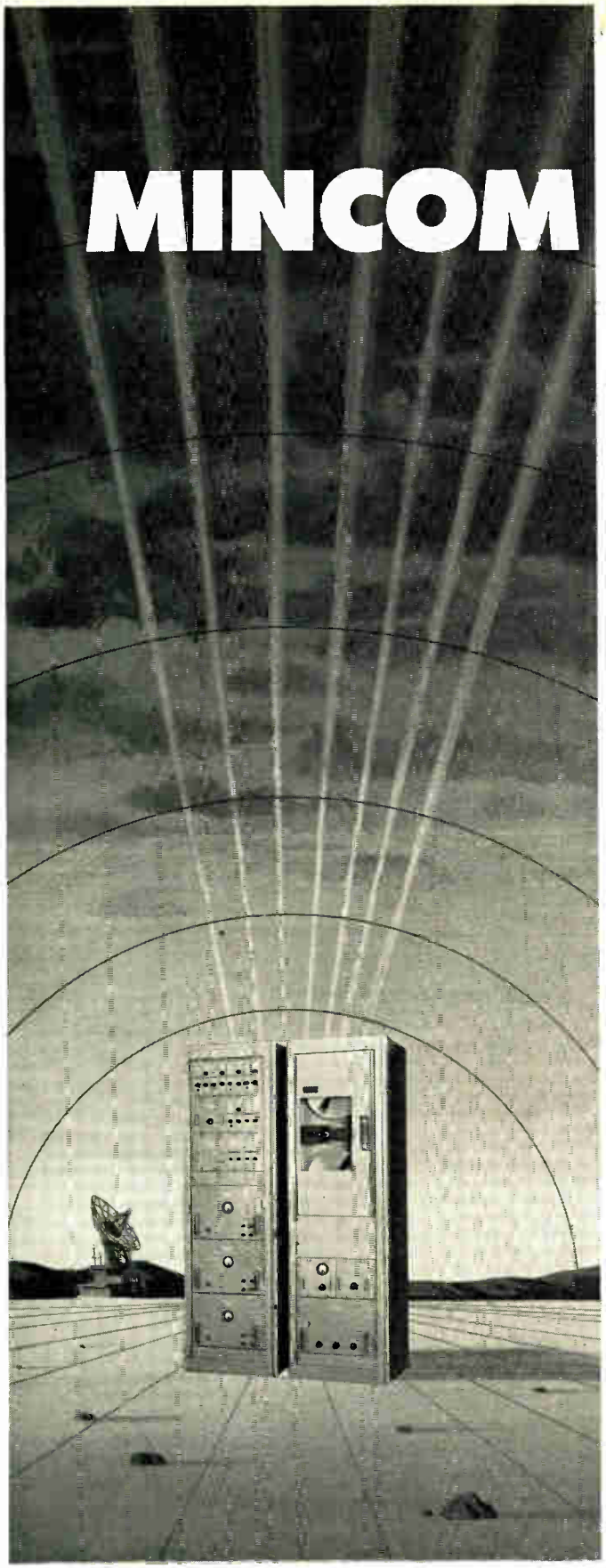
THE MINCOM STORY: *One of a series*



MINCOM *Model* CV-100

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The new Model CV-100, another 'first' in the field for MINCOM Division of Minnesota Mining and Manufacturing Company, is designed for the recording and reproduction of extremely complex video, radar and other electronic signals of frequencies from 400 cycles up to 1.0 megacycle.

Model CV-100 records and reproduces these signals on seven tracks, using SCOTCH Brand ½ inch magnetic tape. Tape speed of 120 ips, plus specially-designed recording and playback heads, make possible a reliable frequency response at extreme band widths. Any thickness of SCOTCH Brand tape from 0.75 mil to 1.5 mil (backing thickness) can be used with no degradation of performance.

Write or wire MINCOM for complete specifications or arrange for a demonstration.

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Tape Speed:	120 ips.
Number of Tracks:	7.
Tape Width:	½ inch.
Running Time:	12 minutes using 1 mil tape.
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Timing Accuracy:	0.005% (using Cyclelock).
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Stop Time:	2 seconds.
Rewind Time:	2 minutes.
Flutter and Wow:	.1% peak, measuring all components from 0.1 cycle to 4,000 cycles.
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Crosstalk:	35 db.
Input Level:	0.1 volt peak-to-peak.
Input Impedance:	93 ohms.
Output Level:	2.0 volts peak-to-peak.
Output Impedance:	93 ohms.
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MINCOM DIVISION

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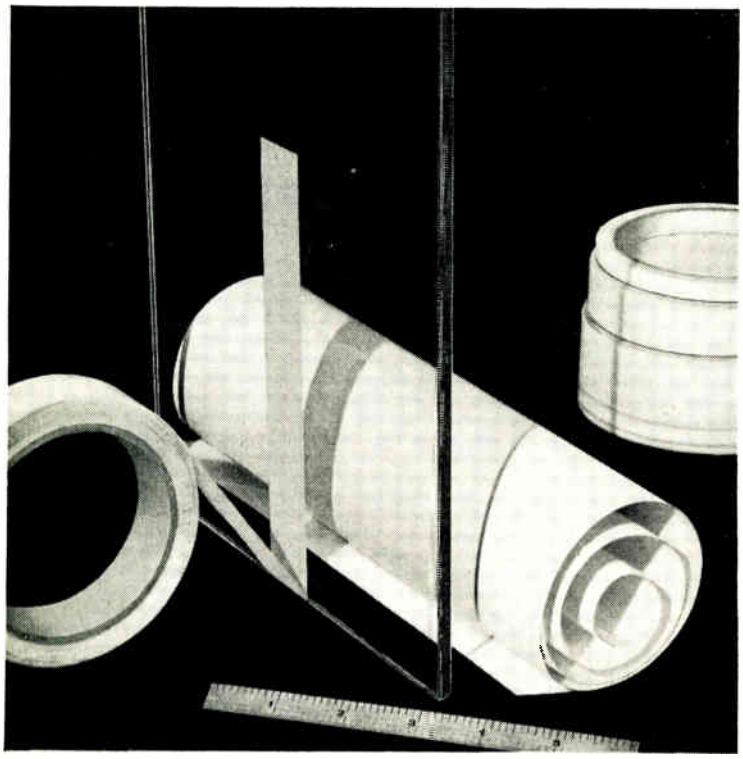

Pressure-Sensitive TEFLON Tapes

easy to apply in both electrical and mechanical applications

The electrical uses of Temp-R-Tape include slot lining, interlayer and interphase insulation, harness bundling, wrapping for microwave components, transformer coils, capacitors and high voltage cables, etc.

As a low friction, non-stick facing, Temp-R-Tape applications range from facings for film guides in sensitive electronic instruments to the facing for heat sealing bars, forming dies, chutes, guide rails, etc.

Chemical resistant facing applications include masking tape in high temperature dipping operations.

All four of these pressure-sensitive Teflon tapes are available from stock in rolls and in sheet form. In addition to Teflon tapes, CHR also makes a fiberglass tape with thermal curing, pressure-sensitive silicone adhesive (Temp-R-Tape GV) and silicone rubber coated fiberglass tape with thermal curing, pressure-sensitive silicone adhesive (Temp-R-Tape SGV).

FREE SAMPLES and folder — write, phone or use inquiry service.

— −100°F to 500°F applications

— Class H and Class C insulation

— Non-stick and low friction facing

— Chemical resistant facing

TEMP-R-TAPE T is a .006″ pressure-sensitive Teflon tape with −100°F to 400°F (−70°C to 200°C) temperature range. It has high dielectric strength, low power factor, negligible moisture absorption, high elongation, is non-corrosive and non-contaminating. Meets Class H Temperature requirements.

TEMP-R-TAPE TH is a .013″ pressure-sensitive Teflon tape with −100°F to 400°F temperature range. It is similar to Temp-R-Tape T except that it is made of .010″ Teflon film to which .003″ silicone polymer adhesive has been added. Often used where a single, thicker dielectric barrier is desired or where a more rigid, abrasion resistant wrap is required.

TEMP-R-TAPE C is a .002″ pressure-sensitive, thermal curing Teflon tape with −100°F to 500°F temperature range. It is made with a cast Teflon film which provides dielectric strength (2750 v/m) higher than any other type of Teflon film. When cured in place, it will operate at temperatures up to 500°F and will withstand much higher temperatures for short periods. Meets Class H and Class C temperature requirements.

TEMP-R-TAPE TGV is a thermal curing, pressure-sensitive Teflon impregnated fiberglass tape with −100°F to 500°F temperature range. Although it is used extensively for mechanical and electrical applications, its dielectric strength is lower than other Temp-R-Tapes.

CHR products include:

COHRlastic Aircraft Products — *Airframe and engine seals, firewall seals, coated fabrics and ducts*

COHRlastic Silicone Rubber Products — *Silicone rubber moldings and extrusions, silicone rubber sheets, silicone sponge rubber*

Temp-R-Tapes — *Pressure sensitive, thermal curing Teflon and silicone tapes*

Allied Products — *COHRlastic silicone cements and conductive gasketing*

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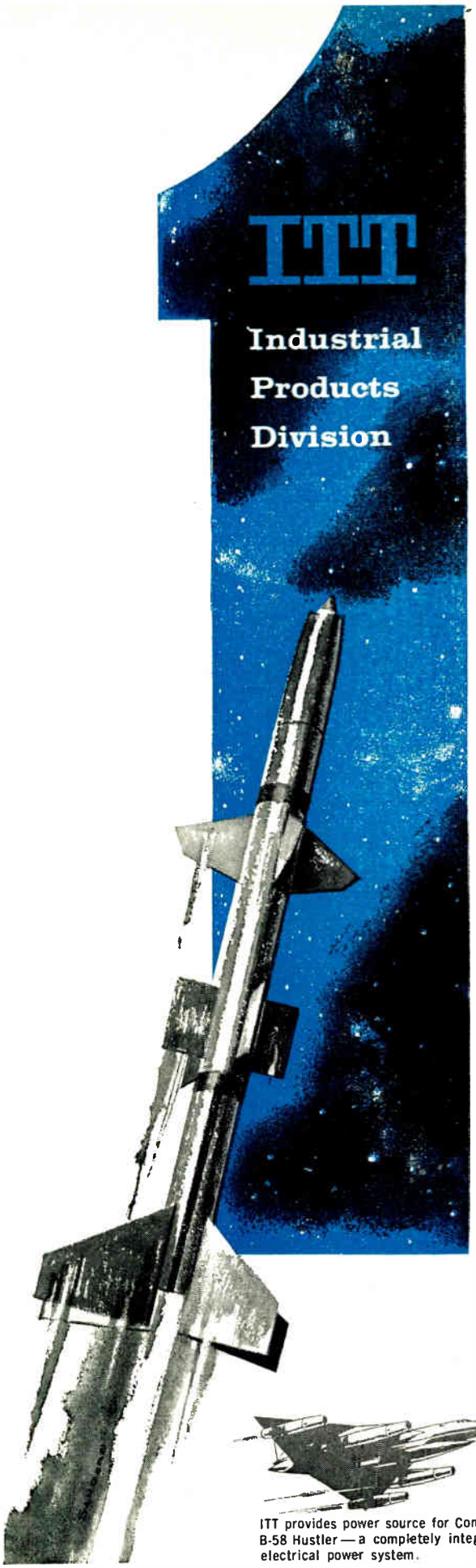

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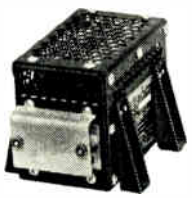

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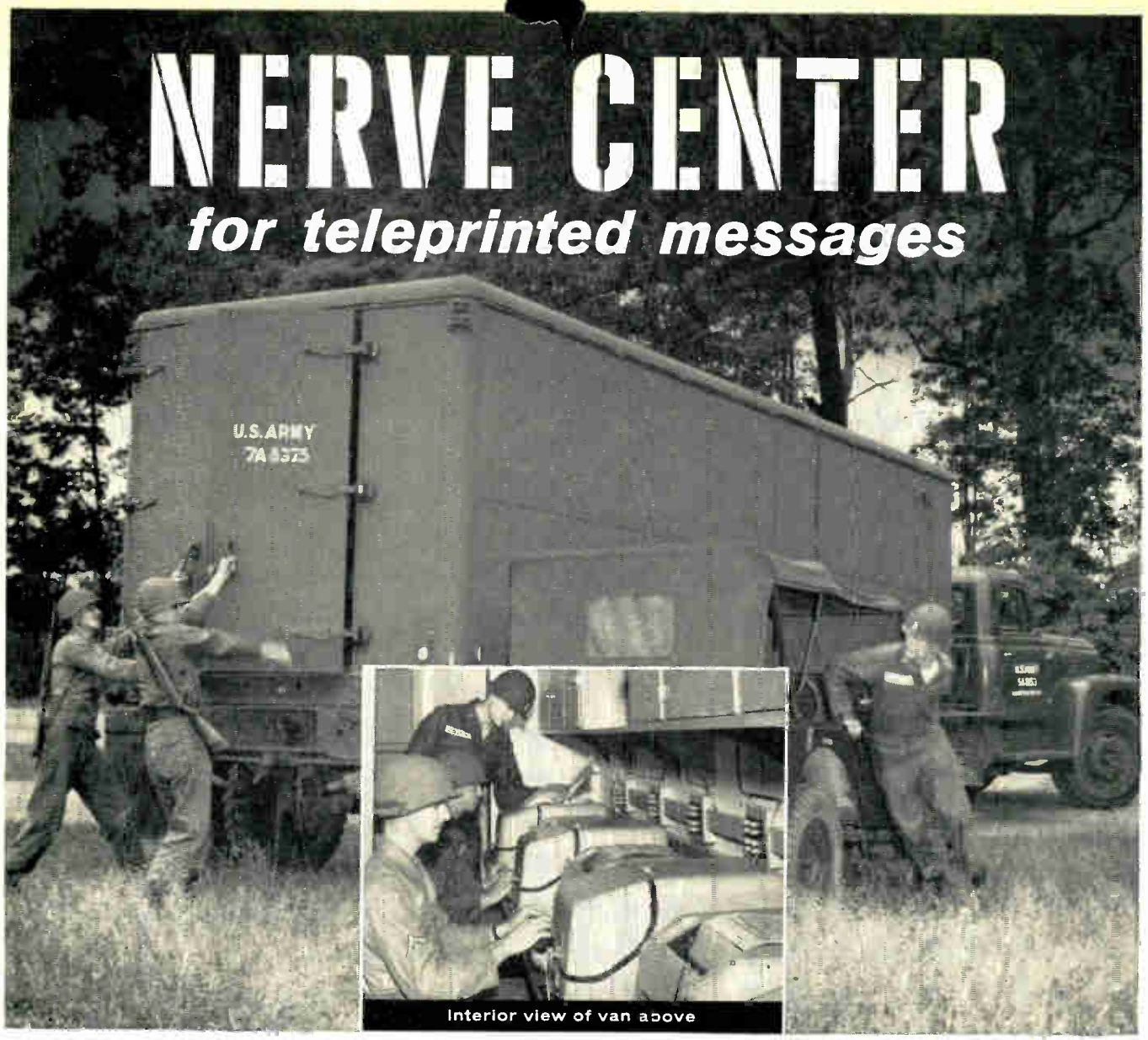

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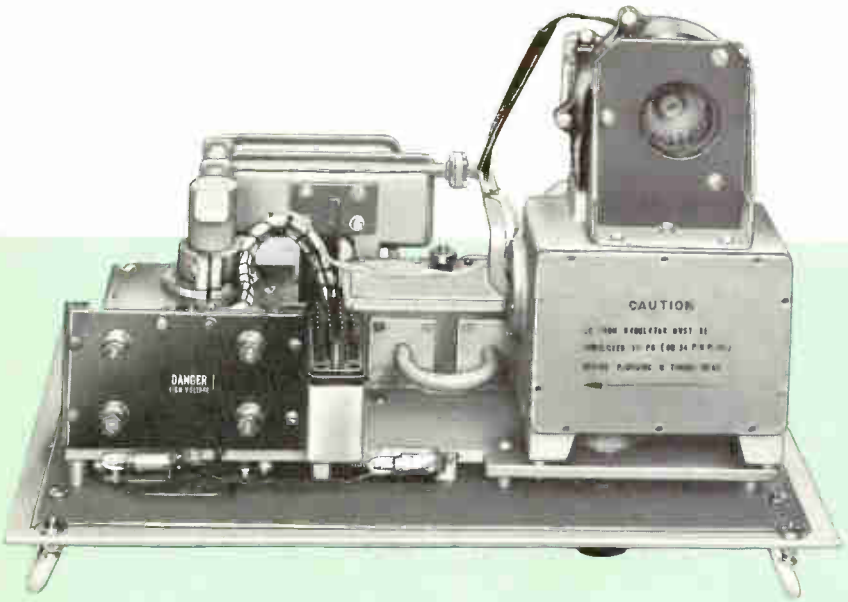

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Fig. 1: The Iatron, a storage tube, is used in the radar indicator to obtain a high degree of brightness

By EDWARD W. KOENIG
ITT Labs.
Fort Wayne, Ind.

For Aircraft Cockpits . . . . . .

High Brightness Radar Indicators

Normal CRT's have been acceptable in radar indicators on shipboard and ground locations where ambient light conditions are controllable. It's a different story in aircraft cockpits due to bright sunlight. The use of storage tubes has licked this problem.

NORMAL CRT radar indicators have been accepted for shipboard use where ambient lighting could be controlled. They are not acceptable for the high ambient light levels in aircraft cockpits. A display with at least 1,000 foot-lamberts of illumination is considered necessary under bright daylight conditions.

Modern aircraft and radar system designers have searched for a display capable of this brightness. One of these systems, the AN/APG-53 radar, was developed at the Naval Avionics Facility in Indianapolis. It was designed with such a display as an integral part. The Farnsworth 7176 Iatron was chosen as the display element, and Farnsworth Electronics was chosen to develop the indicator circuitry (the cognizant group is now organized as part of ITT Labs.). This indicator has been completed and it shows great promise of being accepted as a component for airborne radar systems.

The indicator has the dimensions of approximately 5⅝ inches square and 16 inches long, and weighs less than 14 lbs. The unit contains a five-inch diameter storage tube and all the necessary circuitry for a multi-purpose radar indicator. Transistorized circuitry, printed wiring boards and miniature components make this assembly possible.

Display Tube

As background information, it is necessary to understand the state of the art of storage tubes. The circuitry necessary for this tube will be described. Also the configuration of the display given that was chosen to best use the tube. Selection of a display tube was made on the basis of the brightness requirements more than any other single factor. Signal storage capability was originally considered only as a means of producing the required brightness. It has proven to be a desirable factor on its own. A disadvantage inherent in storage tubes was their comparatively lower resolution. In this application, the resolution was not considered unduly restrictive. A view of an Iatron as usd in this indicator is shown in Fig. 1.

Characteristics of the tube are as follows:

Brightness—3000 foot-lamberts at 10 KV and full storage;
Resolution—Approximately 30 lines per inch;
Contrast—Five shades of grey;
Length—Twelve and one-half inches;
Diameter—Five and one-sixteenth inches at the bulb, two and nine-sixteenth inches at the neck;
Useful screen diameter—Four inches maximum.
Focusing Method—Electrostatic;

Deflection Method—Electrostatic.

The method of operation of the Iatron can be shown by reference to Fig. 3. The Iatron comprises all of a normal CRT plus additional parts, these being a flooding gun cathode, anodes, and a pair of fine mesh screens.

The storage tube operation is partly like a normal cathode ray type deflection gun emitting a writing beam that impinges on the backing electrode. This backing is constructed of a fine mesh nickel screen. It is coated with an insulating material. Backing has a high secondary emission ratio. Each electron that hits the backing electrode causes secondary emission, leaving a slight positive charge in the location of the hit. Secondary electrons generated here are gathered by the meshed collector screen and carried away.

While the writing beam is continually scanning its pattern, the flooding gun cathode is continually emitting an unmodulated beam of electrons. These are allowed to spray out in an unfocused fashion. Electrostatic lens action of wall coatings (flood gun anodes) control this spray such that it is collimated and approaches the screen section as a parallel beam. When this spray approaches a portion of the backing electrode, it will either be repelled by the slight negative charge on the insulator material or it will pass through the electrode in those regions where information has been written. Once these flooding gun electrons have passed through the backing electrode, they are rapidly accelerated to the viewing phosphor by its potential of approximately 8,500 volts.

Characteristics

From this description, several characteristics may be noted:

1. Writing gun performance is dependent on the grid characteristics of the writing gun, and on the characteristics of the backing electrode and its secondary emission characteristics. The low values of beam current needed for full writing allow the beam to be controlled by a relatively small dynamic grid voltage range, in the order of 5 volts. Since the beam current must be kept low, the writing gun grid will be operated near cutoff at all times.

2. The phenomenon of writing a charge pattern on the insulator material allows an information storage time in the order of minutes. It also allows buildup of signal patterns by integration of presented information as desired. These effects may be utilized to increase viewing time, and to improve signal to noise ratio, thereby increasing radar range. In the design of a radar indicator, it is necessary to determine the amount of signal buildup required. Long storage time may be undesirable if it causes confusion by the display of retained targets. It may be highly desirable in other applications because it will display the track of a moving target.

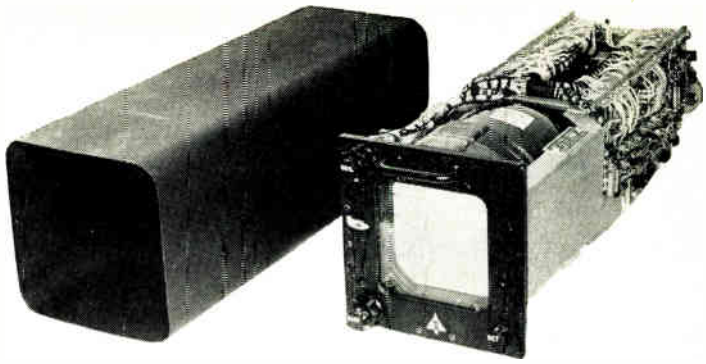


Fig. 2: Considerable time was spent packaging the indicator

3. Instantaneous light output of a written line on the Iatron is comparable to that of a CRT with the same accelerating potential. However, with the inclusion of the storage screens it is possible to retain the same brightness as the original writing spot of a CRT. Storage for even a short time will then increase average brightness to phenomenal values. Brightnesses in the order of 1,000 to 3,000 foot-lamberts.

4. Storage time of this display tube may be controlled by applying voltage pulses to the backing electrode. Any variation in the backing electrode voltage will have an effect on the charge pattern on the insulator coating. By applying a sharp repetitive pulse to this screen, the insulator tends to equalize its charge depending on the amplitude and rate of the erase pulses applied. Erase rate control becomes a very effective storage control and is presented as such to the pilot. For the present application, a storage time of one-half to about three seconds is provided. Control may be adjusted to give storage time from milliseconds to minutes.

5. Adverse effects of magnetic fields on the slow flooding beam require the use of a good magnetic shield. In normal use, the shield is made to fit closely around the tube. However, in this application, the space required did not allow a separate shield, so the dust cover is made of mu-metal. A separate shield is fitted around the neck of the tube.

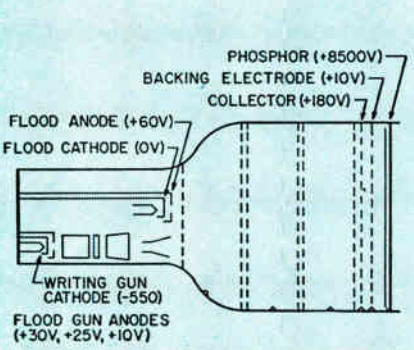


Fig. 3: Drawing shows the Iatron storage tube elements

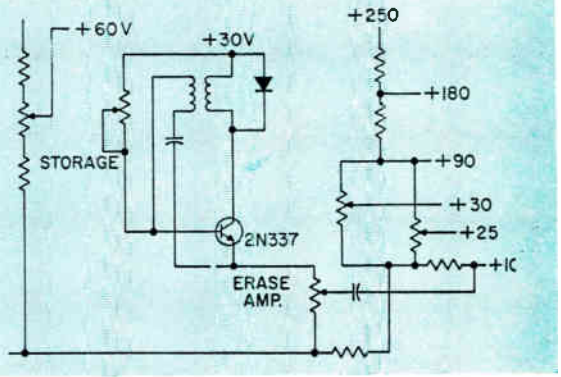


Fig. 4: Circuitry associated with the storage tube is shown

Radar Indicator *(Continued)*

6. Ruggedizing of this tube has been done by careful design of the mechanical structure. Strengthened joints and improved supports have stiffened the inner parts. This allows the tube to be used in an aircraft with little or no isolation. The tube is supported by the large plastic ring potted to the front portion of the tube and by a spring mounted socket assembly. The tube has been tested to MIL-T-5422 specifications and is capable of operating under those conditions.

Circuitry that is unique to a storage tube display includes: voltage supplies for the flooding gun grid and anodes, voltage for the collector and backing electrode, and an erase pulse generator. These requirements were combined by a relatively simple resistance divider network and a transistorized blocking oscillator pulse generator. The schematic for this circuitry is given in Fig. 4.

Deflection Circuitry

Although 8,000 or more volts are used on the phosphor of the storage tube, this is not the accelerating potential against which the writing gun and deflecting plates are working. Storage screens between the writing gun and the phosphor act as a shield; hence, the accelerating potential is that of the writing gun cathode to the backing electrode screen. This voltage may be quite low, in this case about 550 volts. For circuit simplicity, it is easiest to float the writing gun section at a negative potential. This allows the storage screens and flooding gun circuit to operate near ground potential. This relatively low accelerating potential permits a deflection sensitivity of 30 volts per inch, and makes the sweep circuit design compatible with transistor techniques. The sweep circuit is capable of 140 volts peak to peak deflection. A simplified schematic (Figs. 5 and 6) shows that the circuit is comprised of a triggered multivibrator with amplitude reset, a bootstrap waveform generator, and an emitter follower output followed by a low gain amplifier.

Silicon transistors are used throughout. The choice of transistors is shown on the schematics. Circuit designing had to consider the wide variations among transistors of a single type, variations of hfe and I_{co} with an increase in temperature and the additional base current requirements of low temperature operation. Some of the techniques were to choose only high quality transistors that had the limits of manufacture

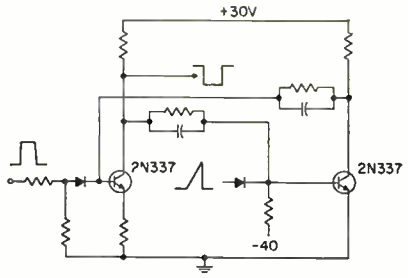


Fig. 5: Triggered multivibrator used in the sweep circuitry

clearly defined. Each stage then was designed for the lowest gain that might be expected over the complete temperature range. The base current circuits were designed such that an additional 2 ma. could be supplied for reliable low temperature operation.

Triggering

Triggering of the multivibrator is possible over a wide range of input signal amplitudes and pulse widths. The method of returning the flip-flop to its quiescent state after a sweep period is somewhat unique. The controlling factor is the amplitude of the sweep signal and not the sweep length. This method of triggering reduces the likelihood of jitter. It removes much of the dependence on the trigger action from active elements (transistors) and allows it to depend more on the passive elements of the charge path.

The transistorized sweep generator uses a 30 volt double anode zener diode as the bootstrap coupling element. This allows generation of a 70 volt sawtooth with a linearity better than 1%. Because of resistor and capacitor tolerance variations, it is necessary to specify the zener voltage to within 5%. Sweep rate or slope can then be controlled by a variable resistor in the charge path.

Following the bootstrap sweep generator is an emitter follower. This provides a low impedance for the bootstrap circuit and for the flip-flop trigger return. This emitter connection is also used for one of the deflection plates. The other deflection plate receives an inverted signal from a low gain amplifier driven by the emitter follower. A large amount of dynamic feedback is used to reduce drift and variations caused by temperature. Control of the amount of signal current determines the voltage output and acts as an amplitude control. Control of the quiescent base current is used as a centering adjust. The self bias feedback resistor is nearly the same value as the load resistor, providing a strong degeneration of any variation in output signal.

Fig. 6: Sweep circuit output is 140v p-p

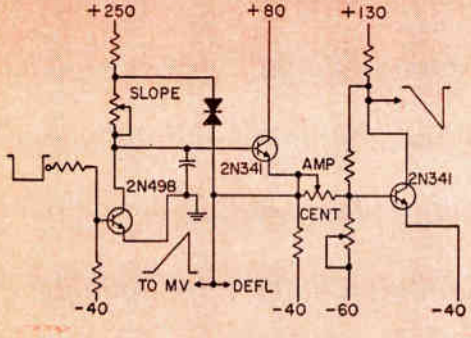


Fig. 7: Transistorized video amplifier

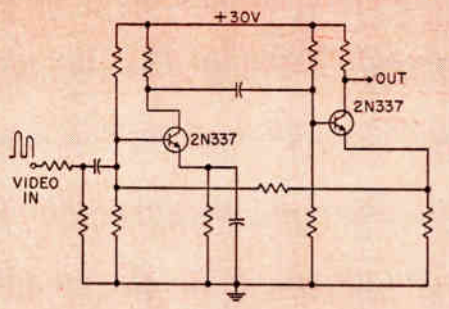
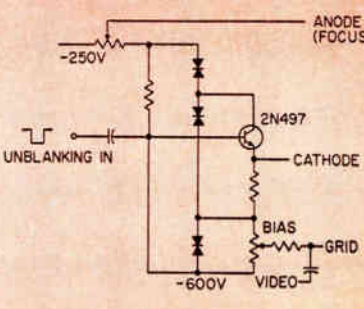


Fig. 8: Writing gun circuit of indicator



Video Amplifier

Video amplification of the radar signals as received at the indicator is accomplished by two pairs of transistors, one pair of which is shown in Fig. 7. Each pair has a feedback path from output emitter to input base. This feedback, in conjunction with partially bypassed emitter resistors, allows the amplifier to be flat in response to over 6 MC at room temperature, and flat to at least 4 MC at elevated temperatures. Each feedback pair has a low input impedance and fairly low output impedance (in the order of 30 and 1,000 ohms respectively). A maximum signal of 12 volts appears at the output. It is capacitively coupled to the writing gun grid. Blanking of the Iatron is accomplished by coupling a square wave from the sweep multivibrator to a blanking emitter follower operating at cathode potential. (Fig. 8.) This blanking signal (negative going during the sweep period) brings the Iatron grid-cathode voltage from beyond cutoff to a bias setting chosen on the bias potentiometer. Radar information is applied positively to the grid. Complete schematics of the sweep and video circuits are included in Figs. 9 and 10 for an overall understanding of the techniques used.

PERFORATED PAGES!

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Packaging

Although the circuitry described is not a complete description of all that is in the indicator, it is felt that the remaining portions are unimportant for a general discussion. Selection of components was restricted to MIL approved parts where it was possible to include them. Derating of components and mounting procedures were used that would give a maximum of reliability consistent with the design requirements. Two etched printed wiring boards are used, containing a total of 15 transistors, 9 relays, 15 trimmer potentiometers, and all of the associated components.

To contain the necessary circuits and components in the package size, yet retain accessibility and good construction, it was necessary to spend considerable effort on the package. As shown in Fig. 2, there is a frame closely fitting the Iatron tube. It acts as a mount for the tube, two printed wiring boards, the high voltage supply and the front panel. The tube base is held in a spring mounted socket and the front end is supported by a relatively soft potting material. The unit is then placed in a semi-tight dust cover and is ready for insertion into the aircraft instrument panel.

Pilot reaction to the high brightness display is extremely favorable. This indicating that the 1000 foot-lamberts of brightness available from the display will satisfy their requirements. Transistorized circuitry has kept heat dissipation to a minimum and compact packaging has allowed construction of a complete radar indicator as a cockpit panel instrument.

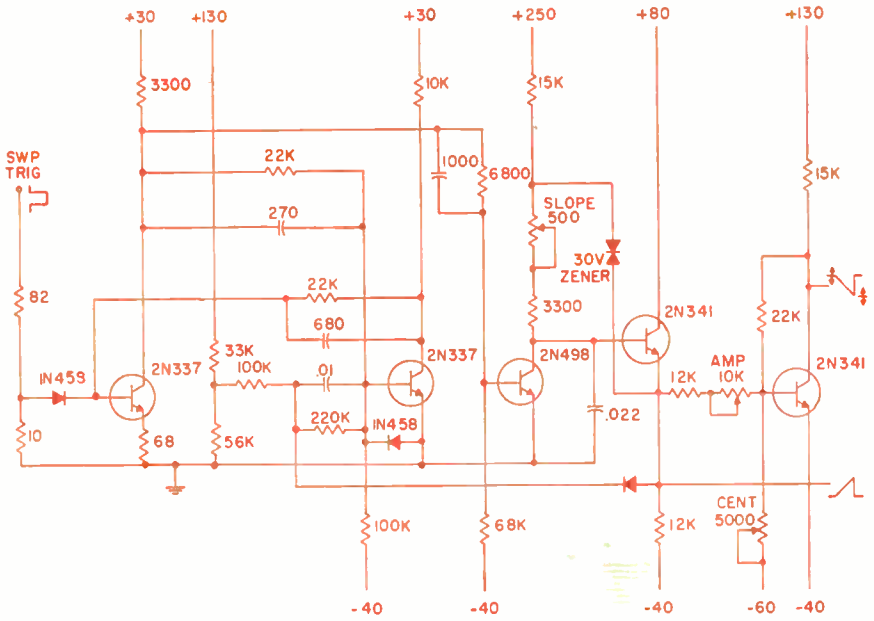
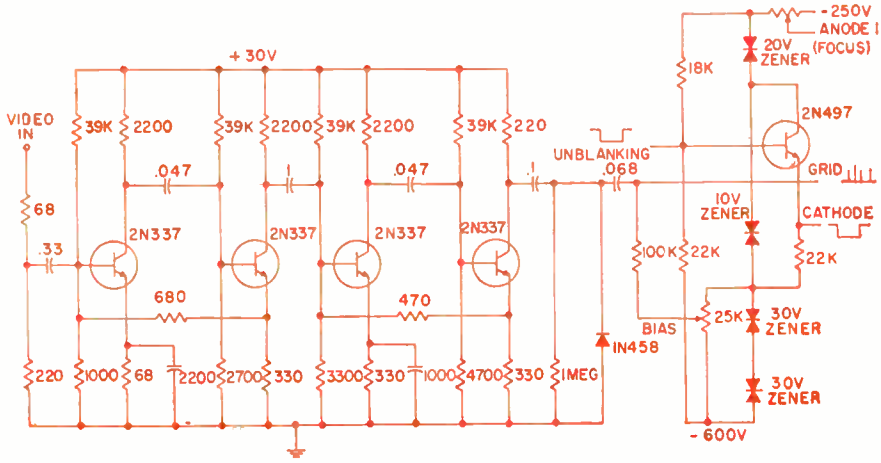


Fig. 9 (above): Complete indicator sweep circuit schematic includes component values

Fig. 10 (below): Complete video circuit with the necessary information for building



Acknowledgment

The development reported in this paper was performed under subcontract to Douglas Aircraft Company on Contract NOas-57-183. The indicator is a portion of the AN/APG-53A Radar Set, developed at Naval Avionics Facility, Indianapolis.

Reliability improvement, an engineering responsibility, must be a continuous process. The requirements of management, design, production, and quality control are detailed here.

Planning Dynamic Reliability

By J. H. DE FRENNE
Senior Engineer
Member of Technical Staff
Hughes Aircraft Co.
El Segundo, Calif.

SUSTAINED performance is the objective of reliability.

Reliability is a relation of actual performance to required performance.

Stresses can be internal and external; the sum total of these stresses forms the total stress a component or equipment has to endure.

How well a device stands up under stress depends on its strength. Good reliability then depends upon an adequate reserve of strength to withstand the stresses of use.

Variability of Characteristics

When considering components or equipments, we encounter a complex situation. If components were identical in strength and characteristics, we could determine the reliability of a small sample and predict the performance of all ensuing products.

Electronic components are in a different category. A simple part may consist of several materials. Material characteristics vary, and the relationship and interaction of materials becomes important.

The functional characteristics of electronic parts are frequently less predictable than those of mechanical parts. We have to contend with material characteristics, interaction, stability, dynamic properties, process variability and other heterogeneous factors.

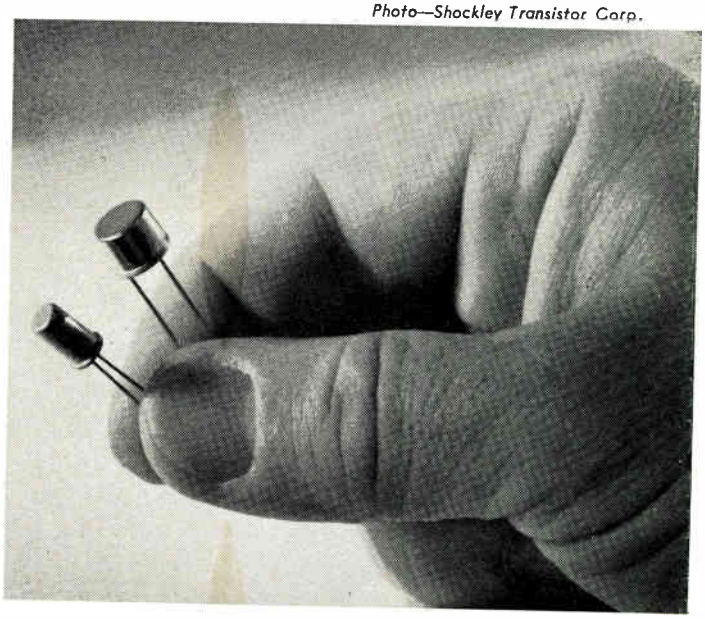
Reliability Determination

Reliability determination and prediction can be difficult. First, on account of the large variation in conditions of use; secondly, on account of the difficulty of manufacturing parts within close tolerances. There is a spread of characteristics in a batch of components, and characteristics often vary from batch to batch.

To determine reliability of components, a large number of factors must be considered. Also much valid information must be accumulated, analyzed and verified.

" . . . application must consider dynamic limits of parameters . . . "

Photo—Shockley Transistor Corp.



Due to the variations in component characteristics and stability, it is dangerous to go by average values or ratings. Component application must consider the dynamic limits of parameters and stresses.

Improvements in equipment and components may result from corrective action. Failure analysis, by itself, does not produce reliability. Failures require extensive analysis of symptoms and conditions. The analysis never produces improvement by itself. Only action taken as a result of analysis gets results.

Data Analysis

One of the difficulties in reliability improvement is evaluation and correlation of information.

Though there are instances where isolated effort may correct deficiences or weaknesses, reliability improvement remains a continuous effort. Continuity of effort means to start with the raw materials, and to proceed with manufacturing processes and techniques, all the way through to the completed end product.

The following analysis endeavors to illustrate the general data flow, what may be contained in it, and what additional effort is required to obtain improvements.

Proof of control, in all phases, is required. The relativity of reliability to application must be considered. It requires that nothing should be taken for granted.

Routine information—defect descriptions, test data and out of tolerance conditions—can be regarded as vague symptoms; causes of failures are rarely known without further investigation.

There are several areas where production information can be obtained:

1. The producers of materials and components, as a result of in-process control and test data.
2. Receiving Inspection results.
3. Assembly and Test, in the form of defects or difficulties encountered in meeting specifications, and as test data.
4. Product evaluation results, survival under stress, time between malfunction.

Information obtained from these sources differs in kind and in validity. We may segregate defects and deficiencies in the following classes of causes:

1. *Characteristics:* excessive variation.
2. *Strength:* low safety factor under stress.
3. *Wear:* insufficient life under conditions of use.
4. *Compatability:* not adaptable to companion parts or application.
5. *Selectivity:* not sufficiently interchangeable, not sufficiently reproducible.
6. *Workmanship:* errors; substandard production techniques.
7. *Construction Defects:*

The causes of symptoms must be detected. Investigations may employ different techniques i.e. through duplication of the failure condition, through study of conditions of manufacture and of usage, and by means of parts analyses. These investigations are expensive and time consuming. Analysis of defective parts by suppliers can be an excellent motive for correction. If failed parts are returned to suppliers, the conditions of use must be explained and circuit data may be required.

Photo—Alite Div., U. S. Stoneware

If sapphire window non-metalically bonded to high alumina ceramic endures severe environments, it may be used as missile infrared dome.

Sources of Information

Table 1 illustrates sources of information, the classes of information generally encountered and the degree of validity that might be assignable in general to symptoms of parts failures.

This is only a general indication of validity, and

Table 1

SOURCES	CLASSES OF INFORMATION					
	Characteristics	Strength	Wear	Compatibility	Selectivity	Workmanship
Mfg. Process Information	1	—	—	—	2	—
Receiving Inspection	1	—	—	—	2	1
Assembly and Test	2	3	—	1	1	1
Systems Test	—	2	—	2	1	2
Product Evaluation Test	—	1	2	1	2	2
Field Information	—	1	1	2	2	3

1. May be assumed to be significant symptoms.
2. May be assumed to be a useful indication.
3. May or may not be useful

may vary according to specific products. We must assure that information received is a true description of the symptoms encountered.

The inherent limitation of routine testing and data processing systems lies in the fact that symptoms must be coded in advance. Unfortunately, we cannot predict exactly what might happen. There is also, a lack of time and opportunity for adding significant details.

Significant and valid data can best be obtained at the time failure diagnosis is made. Reliability planning will, therefore, require qualified engineering support and surveillance throughout all phases. Reliability engineering is primarily interested in the nature of defects, while production quality control concerns itself mainly with the number of defects.

Manufacturing process variability is difficult to correlate and control. Questions arising: How far back can we go? How to acquire understanding of a large variety of components, materials, processes, designs, the viewpoints of people? How to make our requirements known to our suppliers? This definitely points to specialization in reliability engineering.

Failures are most often a result of variables. A smaller portion can be attributed to deterioration.

Defects could be classified in these categories:

1. Sudden failures, or abrupt cessation of normal operation.
2. Malfunction, an inadequacy of performance.
3. Weakness, a marginal performance or shortcoming.

The most distinct malfunction symptoms are found in category 1. Categories 2 and 3 require further study; they are more subjective, the viewpoint of operators enter as a factor.

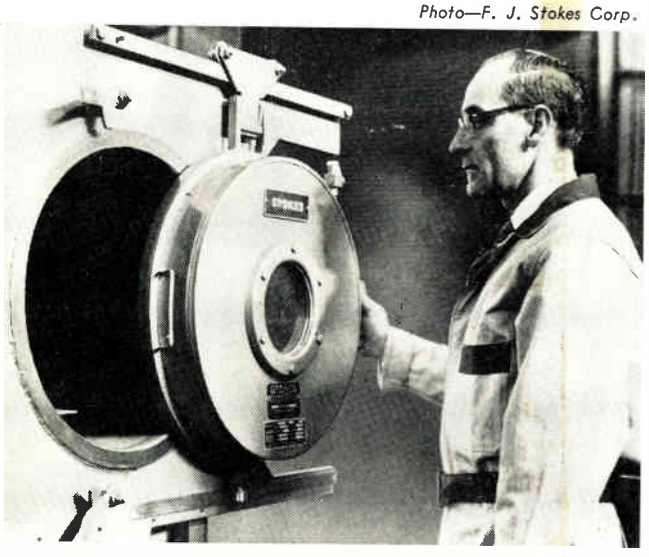
It is not suitable to design equipment in which the desired performance can be obtained only by careful adjustment and balancing. Design must allow tolerance latitude, incorporate safety margins and consider the human engineering factors. Many of the more subtle criteria are often not included in specifications, but are requirements for mature design.

This requires a dynamic and consistant approach. The implications may carry us far afield. For instance, it is not only necessary to determine *how* good reliability is, but we must eventually also know *why* one item is better than another, and under what conditions.

Corrective action based on tabulated routine information is based only on symptoms. It can, therefore, never be very effective. A "pot-shot" approach of investigation may, or may not, hit something worthwhile. If it does have an effect, it may provide only a temporary improvement.

Improvements in manufacturing facilities, such as this sliding door on baking oven, contribute to better predictability by better control.

Photo—F. J. Stokes Corp.



Causes of Failures

The "mode of failure" is important and should be extended to all reliability factors.

We then must consider modes of variation in characteristics, strength, wear, compatibility and selectivity in relation to factors of operation, such as temperature, contamination, vibration, voltage, transients and other stresses.

The modes of failure, stability and behavior, can together be called reliability variables—the factors that determine the degree of immunity against malfunction under conditions of use.

Some of the most important reliability factors are listed in Table 2.

Development and Specifications

An upgrading of reliability standards has to be done gradually, generally and uniformly. If weak points remain, they will tend to cancel improvements. Standards or specifications should be considered as stepping stones which prevent a sliding down from certain levels. They should be "one-way" signs, leaving open the possibility of improvement. Inflexible specifications would have a tendency to freeze a situation. Since variability is a frequent cause of unreliability, *more* rigid specifications may be required.

A high degree of organization with detailed specifications will be limiting. Such limitation will curb error in production, but will also limit progress if accepted as the final word. This freezing process is often necessary to get production; it should take place only when available possibilities of improvement have been developed to a specified point. This requires time, often not available in accelerated programs.

Different types of specifications and standards reflect the degree of freedom of an operation. Specifications for quantity production are firm. Engineering has a greater degree of freedom. Research and development have the greatest freedom of all.

A concept of perfection must remain active. Besides "temporary" specifications, there must be general plans and objectives for further perfection. These objectives must be made known to design engineering, research and development, production and suppliers, to generate a concerted effort towards improvement.

Most efforts toward reliability improvement have,

Table 2

Reliability Factors

CHARACTERISTICS

The individual qualities that distinguish and identify an item.

NOT ACCEPTABLE TOLERANCES: Marginal values and characteristics that may cause early failure under stress.

NOT ACCEPTABLE ACCUMULATIVE TOLERANCE: Not acceptable composite tolerance, where a number of simultaneous tolerance conditions exist.

SHIFT AND DRIFT: The permanent changes in values due to stress, time or environment. Shift is the change due to transient stress or shock. Drift, the slow changes due to aging, corrosion and stress.

DYNAMIC PROPERTIES: Characteristics and behavior during operation, as they may differ from the static characteristics as measured in acceptance tests.

HIDDEN CHARACTERISTICS: Those properties of materials and design that are not discovered during normal use or test. Tests can be designed to investigate these characteristics and their relationship to suitability of materials, construction and workmanship.

STRENGTH

Capacity for endurance.

STABILITY REGIONS: The regions of parameters and stresses under which an item will perform satisfactorily without early failure. The boundaries of those regions can be called dynamic limits. Stability is the absence of variations in performance during normal operation.

RELIABILITY RESERVE: The margin of safety between operating conditions and the dynamic limits where early failure will occur.

EFFECT OF INTERMITTENT OPERATION: Failures frequently result sooner when power is switched on and off continuously.

WEAR

The gradual wearing away of materials during use, resulting in loss of strength, tolerance, emission, contact or other factors, rendering the item inoperative or ineffective.

COMPATIBILITY

The ease in which a part can be made to operate in conjunction with companion parts or application. Could, also, be described as adaptability.

INTERACTION: The manner in which characteristics and behavior of parts are influenced by associated parts and circuitry. (Heat dissipation and crosstalk are examples of interaction factors.)

COMPOSITE BEHAVIOR: The performance and behavior of a closely associated group of parts or materials in a particular application. This situation may occur in delay lines, networks, and other sub-assemblies, especially when pulses are present or when r-f signals are involved.

SELECTIVITY

An item can be called selective if it is not sufficiently interchangeable.

INTERCHANGEABILITY is determined by the homogeneity of the operating characteristics.

REPRODUCIBILITY, the ease and consistency in which homogeneity can be maintained in production.

WORKMANSHIP

Factors such as errors, contamination and variations in methods of assembly.

LATENT DEFECTS: Hidden, not measurable discontinuity, contamination, imperfection, stress, error or other weakness that may cause malfunction or failure.

CONSTRUCTION

The manner in which an item is built or put together.

DESIGN AND MATERIALS: Visible deficiencies.

HIDDEN STRUCTURAL CHARACTERISTICS: Those features of design, production methods and materials that cannot be tested or inspected without disassembly, but that may be important reliability factors.

FAIL SAFE PROVISIONS: Those provisions of design that prevent catastrophic consequences in case of failure.

so far, been made as a result of difficulties and trouble encountered in trying to meet specifications.

There are several schools of thought in the field of reliability. Some concentrate on selection of components, some rely on a theoretical and statistical approach, others advocate that life testing is the answer. Redundancy and improved parts application are being considered.

These approaches are limited by present state of the art; their potential has by no means been exhausted, it will continue to be effective for some time to come.

However, greatly increased reliability and capability must be pursued through a deliberate effort to advance the state of the art of electronic manufacturing.

Research and development on production techniques, processes and materials must supply the ideas and break-throughs that will provide superior design and production reliability.

This type of advanced effort does not limit itself to existing specifications and concepts, it is more a branch of experimental physics. This effort rigorously follow a fixed program, but must rely on ingenuity and inspiration to chart its course.

Its function is to:

1. Develop advanced production processes, techniques and materials.
2. Evaluate new production processes and techniques with emphasis on reliability and economy.
3. Develop special production equipment and tooling.
4. Assure production reliability.
   a) Determine process variables.
   b) Develop process control techniques.

It provides information and ideas to:

1. Research and Development.
2. Product Design.
3. Manufacturing.
4. Quality Control.

Process Control vs. Inspection

Inspection and test, as it is normally encountered in industry, is basically a sorting operation.

Inspection is often performed far removed in time and place from production. Feed-back is ineffective in such cases; correlation of cause and effect has be-

come extremely difficult. When correction eventually takes place, a lot of water may have passed under the bridge.

Incoming inspection does not give much information regarding the relative merits of the products of different producers. Minimum requirements as stated in the purchase order are the only common denominator used for comparison.

"After the fact" type of information tells whether we are in immediate trouble or whether there is some assurance that we may proceed "as usual."

If "as usual" means that quality and reliability are excellent, then there will be little incentive to go to more extensive controls.

On the other hand, if conditions are contrary to good, then we must look for improved means of control and improved materials, parts, processes, production techniques and designs.

Inspection and test under these conditions is aimed at discovery and correction of process variability. Instead of maintaining a *status quo*, a dynamic effort must be made to improve all reliability factors.

When all criteria are met, we do not have to worry about sorting "good from bad." Knowing that "all is well" reduces or eliminates routine inspection. Under such circumstances, processes are controlled instead of products. We work from the assumption that good materials, good processes and good designs result in good products. Highly reliable products can only be obtained after this condition is established!

Production-process control is aimed at prevention of defects, a "before the fact" type of control. Instead of curing symptoms, we try to immunize production by installing early controls, rapid feedback and immediate, effective correction. This type of controlled production is also often more economical.

Communication and Coordination

Reliability requires a concerted effort of all phases of business, most certainly of suppliers. It relies on good communication as a means to accumulate and share knowledge.

An effective system for the transmission of information can be installed. However, co-ordinated effort must be instilled. Reliability improvement was discussed earlier. Additional stimulus is required to coordinate the sometimes isolated efforts into a more universal reliability endeavor. This stimulus is often money and where can we get it?

There is a continuous need for information that can, for instance, be demonstrated by the multiple contacts that take place with vendors. It is entirely possible that a single vendor is contacted by several persons from the same organization to communicate on facets of reliability. Undoubtedly, most of the contacts are necessary, it may, however, safely be assumed that there is a considerable element of duplication.

Communications on acceptance problems pertain to matters of conformance to purchase orders. Responsibilities are fairly well defined, and are centered around specific requirements, transactions and shipments. The prime objective is to maintain a predetermined *status quo*.

Communications on reliability and application problems are much more complex. Reliability is relative to application, and depends on variables not covered in detail by the purchase order requirements. The prime objective is to improve the *status quo* by upgrading standards.

Several individuals, groups, departments and divisions contact a producer on similar problems. Problems may require correction by vendors or the vendor is contacted to obtain information, or to give time information. Considerable knowledge may be gained this way.

The knowledge gained through multiple contacts, either slowly filters through to others, or is lost as far as the entire organization is concerned. As a result, a great deal of duplication takes place.

As reliability is such a large task, differentiation is necessary to partition the task into manageable portions.

A mere multiplication of effort will not suffice. A complex purpose requires division of responsibilities so both duplication and neglect are avoided.

Hard coating of aluminum potentiometer mandrels increases life. Here a mandrel is checked for megohm resistance under mercury.

Photo—Anachrome Corp.

Responsibilities

Design Engineering must balance their designs by considering reliability variables such as described under causes of failures. Designs and specifications must assure the required degree of immunity against malfunction.

Production, including the producers of materials and parts, must concentrate on maximizing the inherent reliability of the designs. This can be accomplished through effective production process controls and through continued verification of the reliability characteristics of manufactured purchased items.

* * *

Designing Transistorized Video Amplifiers

In an easy to follow step-by-step procedure, this article gives engineers the background to design practical receiver video amplifiers to given requirements. Two types of three-transistor circuits are described.

By R. G. SALAMAN*
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Part One of Two Parts

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TRANSISTOR development has progressed to the point where practical video amplifiers of quality comparable to those of vacuum tubes can be designed. Limitations such as collector-emitter voltage, power, and alpha cut-off frequency continue to pose problems in designing a one stage video amplifier.

However, using drift transistors, such as the 2N247, a 3 stage video amplifier more than fulfilling large picture tube receiver video requirements has been designed. A one stage amplifier driven by a transistor detector presents sufficient drive to a small CRT.

Requirements

A TV receiver video amplifier should have the following requirements:

A. Negligible loading on a 4.7 source impedance.
B. Bandwith of 3.5 MC.
C. At least 80 vpp output to cathode ray tube.
D. Gain of 20 for vacuum tube driven or 40-80 for transistor driven detectors.

To maximize diode detector efficiency, a detector load of the order of 4.7 K must be used. However, it will be shown that a low source impedance is needed to produce a bandwidth of 3.5 MC with a usable gain.

As the maximum collector-emitter voltage rating of the available h-f drift transistor at present is 35-50 volts, a means of doubling this voltage must be utilized.

It is advantageous to feed the cathode of the CRT as 15-20% less drive is needed. As the drive required is directly proportional to the screen to cathode voltage, the signal is in the direction to increase beam current by increasing the screen voltage and also by grid cathode action.

Two basically different circuits will be discussed in this article; the voltage doubler and the cascaded push-pull.

Common Emitter Stage

The common emitter stage is used in both of the video amplifier circuits as it has the higher input impedance of the two configurations having voltage gain.

A. R-C Load Considerations: It is desirable to design a circuit which will produce the maximum gain for a specified bandwidth and load.

The problem may be divided into 3 cases.

1. The time constant of the input is much larger

Fig. 1: Hybrid-pi equivalent circuit

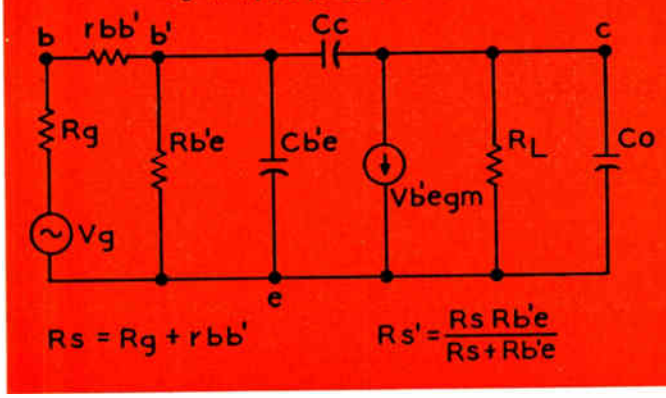
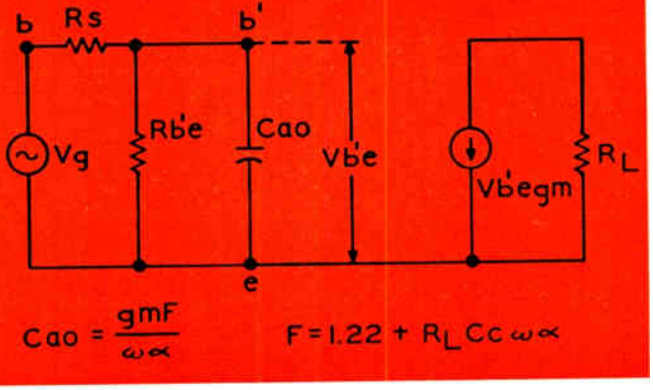


Fig. 2: Unilateralized equivalent circuit case I



than that of the load, but near the required bandwidth.

2. The time constant of the load is much larger than that of the input, but near the required bandwidth.

3. The time constants of the input and load are close together.

The familiar hybrid-pi equivalent circuit is shown in Fig. 1.

Case 1: Rs' Cb'e >> R_LCo

Referring to Fig. 1, it can be seen that when R_LCo is smaller than Rs' Cb'e, the bandwidth will be determined by the latter; the load being substantially resistive. Fig. 2 shows the equivalent circuit after transforming Cc to the left side of the circuit.

Cao is usually such a large value that the bandwidth is less than is required and a partially bypassed emitter resistor, Re, is added as negative feedback to increase it. Re alone produces an increase in bandwidth of approximately (1 + gm Re) and a reduction in gain by the same factor, conserving gain bandwidth product. This is shown in Fig. 3.

If R_L = Rg, the expression for the optimum value of R_L has been developed.[1] In the general case (when $R_L \neq Rg$) it will be noted that if gm Re >> 1 and Re is varied to maintain constant bandwidth, the low frequency gain will not be affected by changing R_L. This results from the condition that the entire voltage aperture be utilized, which relates Ie to $1/R_L$ by a constant. Since in a transistor Gm is directly proportional to Ie, it varies inversely with R_L keeping gm R_L constant. If Re is also adjusted for constant 1 + Gm Re the low frequency gain and the bandwidth will be conserved. It will be noted, however, that when R_L is raised, the bandwidth will also be raised as Cb'e varies directly with Ie. Rb'e varies inversely with Ie but is usually swamped out by Rg + rbb' in the practical case.

The above results indicate that R_L should be made as high as possible consistent with the condition that Rs' Cb'e >> R_LCo.

Bypassing Re with a small capacitor will not affect the low frequency gain but will increase the bandwidth.[1]

Case 2: R_L Co >> Rs' Cb'e

It is again desirable to transform the equivalent circuit of Fig. 2 into a unilateral one representing the new load condition. The steps in calculating the new shunt impedance representing the capacitance C_c is shown below.

The current through Cc equals

$$I = (Va - Vb)\,Ccj\omega = Va\,Y$$

$$\therefore Y = \left(1 - \frac{Vb}{Va}\right) Ccj\omega$$

If all the current from the generator (Va Gm) goes into the load, i.e, $R_L << XCc$, then

$$Vb = -\frac{Va\ gm}{Yo}$$

$$Y = \left(1 + \frac{gm}{Yo}\right) Ccj\omega$$

Hence

$$Y = Ccj\omega + \frac{1}{\frac{G_L}{gm\ Ccj\omega} + \frac{Co}{gm\ Cc}}$$

$$\text{if } j\omega\ Cc \text{ is } << \frac{1}{\frac{G_L}{gm\ Ccj\omega} + \frac{Co}{gm\ Cc}}$$

then

$$Z = \frac{1}{Y} = \frac{1}{j\omega\ gm\ Cc\ R_L} + \frac{Co}{gm\ Cc}$$

When Vb >> Va, the effect of Cc on the output circuit can be approximated by placing Cc across the load. The complete transformation can be represented by the equivalent circuit in Fig. 4.

The equivalent circuit (Fig. 4) indicates that minimum Rs is desired.

Algebraic methods may be used to calculate R_L with a given Rs for maximum gain for a given bandwidth but the equations are extremely complex. Other factors involving the limitations imposed by the transistor, and intuitive reasoning directly dictate the value of R_L obviating the necessity for solving the equations.

For present day transistors, the maximum collector-emitter voltage must be utilized to obtain the large output voltage required and the transistor must operate within the maximum power dissipation. Referring to the figure below, the maximum load resistance which can be used within the above limitations is

$$(1)\quad R_L \text{ min.} = \frac{(Vc \text{ max.})^2}{4P}$$

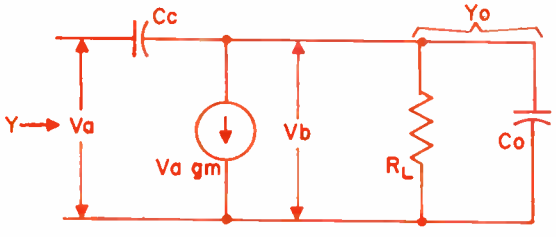
where R_L = Load resistance

Vc max. = Maximum collector-emitter voltage

P = Maximum power dissipation

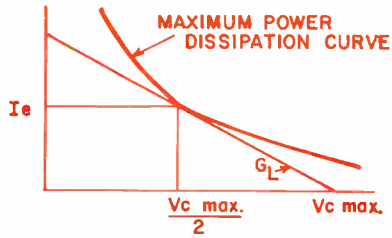
Ie is fixed by Vc and R_L for maximum voltage swing;

$$(2)\quad Ie = \tfrac{1}{2}\,\frac{Vc \text{ max.}}{R_L}$$



(Left) Steps in calculating the new shunt impedance representing the capacitance C_c

(Right) Graphical presentation of equation above



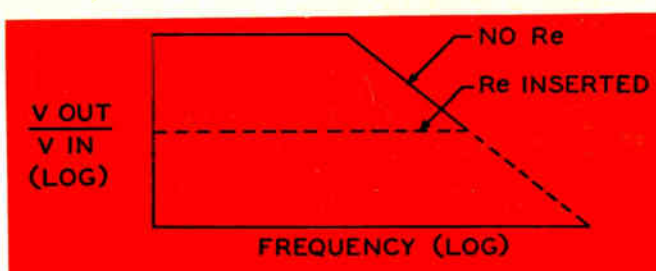


Fig. 3: (above) Emitter peaked frequency response — Case I

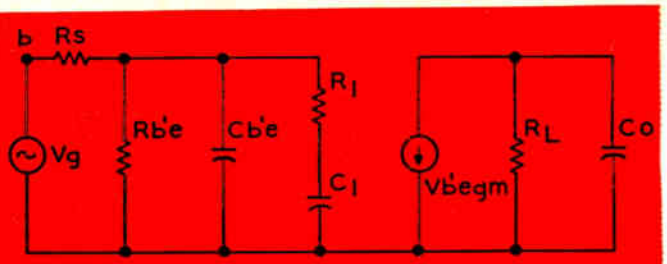


Fig. 4: (right) Unilateralized equivalent circuit — Case XXXX II

$$C_1 = gmCcR_L\,,\quad R_1 = \frac{Co}{gmCc}\,,\quad \omega_1 = \frac{1}{R_L Co}$$

$$\text{GAIN LOW FREQ.} = \frac{Rb'e}{Rs + Rb'e}\,gmR_L$$

For the case in which Re=0, greater values of R_L will decrease the gain bandwidth as follows. Ie and therefore gm will decrease (gm = Ie/26) by the same factor as R_L increases—gain is constant, but bandwidth is reduced as load time constant, R_L Co, increases.

If the bandwidth, determined by R_L Co is below the requirements, emitter peaking can again be used, but in this case the addition of Re does not conserve gain bandwidth. As the current through the load is independent of the load impedance the bandwidth imposed by the load will not be reflected through Re. (See Fig. 5)

To repeat, this is only true in this case where the input circuit corner frequency is well above the load circuit corner frequency.

Re will merely reduce the gain as shown in Fig. 6.

The addition of the bypass capacitor across Re which produces a flat response increases the bandwidth (when the emitter is fully bypassed) to the point where gain bandwidth conservation is again realized. This stems from the fact that the 6 db rise from the emitter peaking cancels the 6 db fall dictated by the load.

With this in mind, the values of Re and Ce can be calculated when R_L and Co are known:

$$\frac{\omega_1}{\omega_2} = \frac{1}{\text{Re gm} + 1}$$

where

ω_1 = unpeaked frequency response

ω_2 = desired frequency response

Then

$$\text{Re} = \frac{1}{\text{gm}}\left(\frac{\omega_2}{\omega_1} - 1\right)$$

$$\text{Ce} = \frac{1}{\omega_1\,\text{Re}}$$

The low frequency gain without peaking is:

$$G = \frac{Rb'e\ gm\ R_L}{Rs + Rb'e}$$

and the modified gain with peaking equals

$$G' = \frac{1}{1 + gm\ Re}\,G$$

Substituting for (1 + gm Re)

$$G' = \frac{1}{\omega_2 R_L}\,Co \times \frac{Rb'e\ gm\ R_L}{Rs + Rb'e}$$

From Eq. (1) and (2),

$$R_L = \frac{V^2}{4P} \text{ and } R_L\,gm = \frac{V}{52}$$

$$G' = \frac{Ie}{26\,\omega_2\,Co}\left(\frac{Rb'e}{Rs + Rb'e}\right)$$

Case 3: Rs' Cb'e ≈ R_L C_O

It is obvious that the bandwidth of an emitter peaked amplifier of this third category will fall somewhere between that of the first and second cases; the exact frequency response is difficult to determine intuitively.

Fig. 5: Emitter peaked equivalent circuit

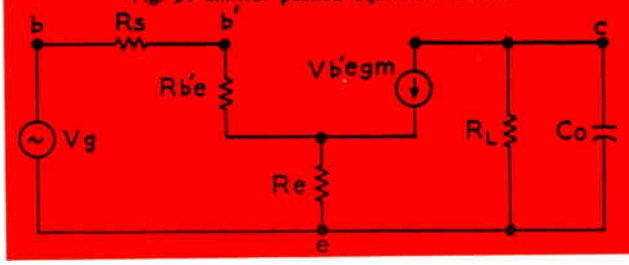
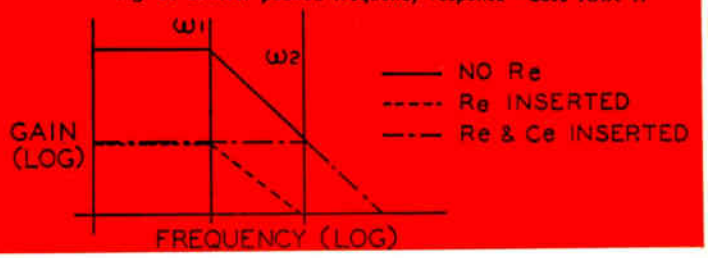


Fig. 6: Emitter peaked frequency response—Case XXX II



The importance of the exact difference between the input and output time constants increases as they approach each other.

It will be remembered that for case I, R_L should be as high as possible consistent with the initial assumption that Rs' Cb'e >> R_L Co. The optimum operation of a Case II amplifier dictated a minimum value of R_L without overheating the transistor. When Rs' Cb'e ≈ R_L Co it is correctly assumed that the optimum R_L will fall somewhere in between Case I and II but the exact value is not obvious. Two approaches can be considered to obtain the optimum values of components for this case.

The transfer function of a general common emitter video amplifier can be derived. Then the magnitude at the desired cut off frequency is set equal to one-

Video Amplifiers

(Continued)

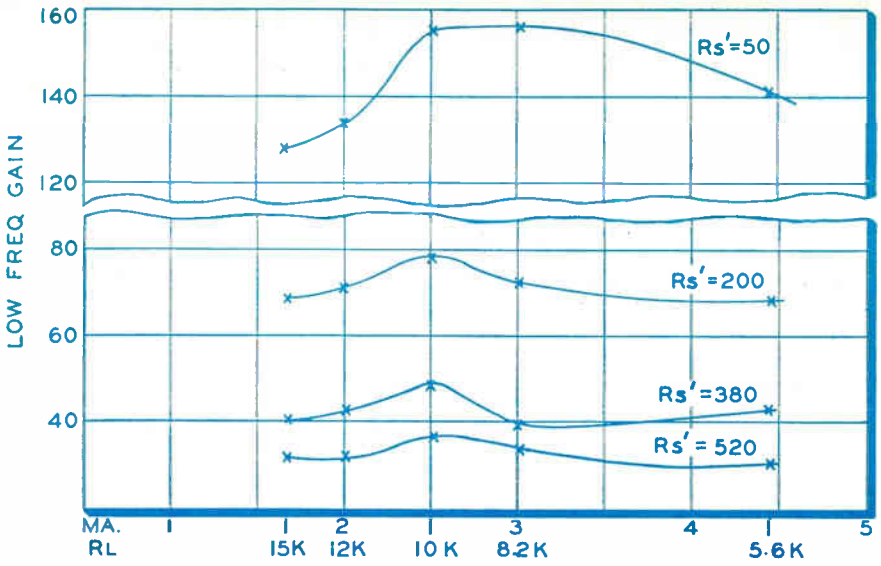


Fig. 7 (left): Lowest value of Rs produces the maximum gain for a given band width.

half the low frequency voltage gain, and the values of the variables which satisfy this equation and in addition give the maximum low frequency voltage gain and most flat response, can be found. This required the use of a computer.

The variables may also be found experimentally by plotting the gain as a function of R_L for a given Rs. As before, the lowest Rs will produce the maximum gain for a given bandwidth. The value of R_L can be found from the relation

$$R_L = \frac{Vc\ max.}{2\ Ie}$$

which insures utilization of maximum aperture. Ie can be adjusted by means of the base bias resistors always adjusting Re and Ce for maximum flat gain over the required bandwidth. The values of R_L can then be plotted vs. l-f gain; this is shown for a specific case in Fig. 7.

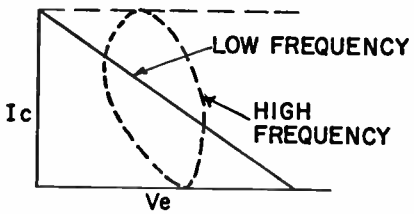
B. D.C Consideration: A large dc negative feedback resistor (RE) must be provided to stabilize the transistor for temperature variations.[2] The bypass condenser must present a small reactance to the equivalent series emitter resistance ($re = 26/Ie$).

Bias for the base to allow the device to operate at the calculated $Ie = Vc/2\ R_L$ max., is provided by a large valued resistance divider.

C. General Considerations: The addition of Re may be thought of as increasing the aperture of the circuit when the load is imposing the bandwidth limitation. When R_L is made smaller to increase the bandwidth, the aperture must be decreased to remain within the maximum power limitation. The addition of Re also has the effect of increasing the bandwidth at the expense of gain without affecting the aperture.

Shunt and series inductive peaking can increase the bandwidth by a factor of about two depending on the video circuit. Peaking of this sort is accomplished by well known methods.[3]

A factor which should be pointed out, although usually not important, is the high frequency power limitation. At the higher video frequencies the load line becomes elliptical as the load becomes reactive.



Load line becomes elliptical as load becomes reactive at higher video frequencies.

This limits the maximum voltage swing available for the available transistor current, decreasing the effective aperture at the high frequencies. The inductive peaking in the collector tends to resonate out some of the capacitance, but peaking in the emitter and other parts of the circuit other than the collector will have no effect in increasing the effective aperture. This means that the maximum voltage swing available decreases with the frequency response of the output circuit alone. As more peaking is performed in the output circuit than in the cathode of a vacuum tube amplifier, the aperature limitation is not as great as with an emitter peaked transistor amplifier. As the bulk of the signal energy of a video signal appears at low frequencies, this effect does not impose a practical limitation.

Common Collector Stage

One of the requirements of the video amplifier is that it has negligible loading on a 4.7K detector source impedance. As the gain must be of the order of 40 with a bandwidth of approximately 3.5 MC., the input impedance of a common emitter 2N247 can be shown to be in the order of 500 to 1,000 ohms. One means of transforming this impedance up to the required amount is by means of a common collector stage which has a high input and low output impedance.

From the equivalent circuit of Fig. 8 it can be shown that

$$Z\ in = \frac{Vb}{Ib} = -rb + (re + R_L)(1 + \beta)$$

and

$$Z\ out = \frac{Vo}{Ie} = re + \frac{Rg + rb}{1 + \beta}$$

It will be noted that β is frequency dependent and increases Z out as frequency is increased.

In general, R_L is made fairly large and the values of the biasing resistors are adjusted to produce the required input impedance. If the effect of the fall-off introduces shunting of the biasing resistors, inductive peaking can be added in series with the bias resistors to equalize the overall input impedance. (See Fig. 9.)

The output impedance can be calculated for the

upper part of the video spectrum by the above formula giving the source impedance for the common emitter stage. At lower frequencies, the impedance will be lower but this will not change the overall voltage gain substantially.

Voltage Doubler Amplifier

Cathode ray tubes require a drive of twice the maximum available voltage swing in present day transistors. The common emitter stage can be used to drive a common base voltage doubler as a means of achieving sufficient video drive. Another method of obtaining required output swing is described in the next section.

It can be seen in Fig. 10 that if Ro/2 >> Rg, Vo must equal 2 Vg since the resistors in the collector-ground voltage divider are equal. This type of voltage doubler calls for a non-phase reversing or common base configuration.

The transfer function can be developed from the equivalent circuit in Fig. 11

$$I_L = \frac{(1+\alpha)\, R\, ie}{Z_L + 2R}$$

$$Z\,in = \frac{V}{ie} = re + \left[1 - \frac{\frac{R^2}{Z_L + 2R} + rbb' + \alpha\, X\, Cc}{R - \frac{R^2}{Z_L + 2R} + rbb' + X\, Cc}\right]$$

$$(rbb') + \left[1 - \frac{\left[1 + \frac{\frac{R^2}{Z_L + 2R} + rbb' + \alpha\, X\, Cc}{R - \frac{R^2}{Z_L + 2R} + rbb' + X\, Cc}\right] R}{Z_L + 2R}\right] R$$

For low frequencies, this reduces to

$$Z\,in_{Low} = \frac{Z_L\, R}{Z_L + 2R}$$

if $R >> rbb' + re$, $2R >> Z_L$, and

$X\, Cc >> R - \frac{R^2}{Z_L + 2R} + rbb'$; $Z\,in = \frac{1}{2} Z_I$

$$G = \frac{Z_L\, I_L}{Z\,in_{Low}\, ie} = \frac{\frac{Z_L\,(1+\alpha)\, R\, ie}{Z_L + 2R}}{\frac{Z_L\, R}{Z_L + 2R}\, ie} = 2$$

when $2R >> Z_L$ and $\alpha \approx 1$

The various resistors in this stage closely affect both its ac and dc operation and must be chosen to satisfy both requirements.

DC Condition (See Fig. 12):

When I in equals zero

$$Ie = \frac{E - \frac{1}{2} V}{R_L} - \frac{\frac{1}{2} V}{2R}$$

V = maximum PP voltage output

When I in = − Ie

$$E = \left(\frac{R_L}{2R} + 1\right) V$$

$$Ie = V\,\frac{(R_L + 2R)}{4\, R_L\, R} \qquad R = \frac{V\, R_L}{4\, Ie\, R_L - 2V}$$

for R to be real; $R_L \geq \frac{V}{2\, Ie}$

PERFORATED PAGES!

In response to many reader requests the pages in the main editorial section have now been perforated. This will enable readers to easily remove material for their reference files. If the copy of Electronic Industries you receive already has pages removed that you want, please let us know. We'll be glad to provide the missing pages.

R can then be calculated.

Referring to Fig. 12, $V_1 = \frac{1}{2}$ so $Rb = \frac{V}{2\, Ie}$

AC Condition:

as $R >> rbb' + re$

$$Z\,in = \left[1 - \left[\frac{1 + \frac{\frac{R^2}{Z_L + 2R} + \alpha\, X\, Cc}{R - \frac{R^2}{Z_L + 2R} + X\, Cc}\, R}{Z_L + 2R}\right] R\right] R$$

If $R >> Z_L$

$$Z\,in = \left[1 - \frac{\left(1 + \frac{R/2 + \alpha\, X\, Cc}{R/2 + X\, Cc}\right) R}{Z_L + 2R}\right] R$$

from which Z in can be calculated at any frequency. At low frequencies it was shown that Z in

$$= \frac{ZL}{2}, \text{ if } 2R >> Z,$$

which is usually the case.

(To be continued)

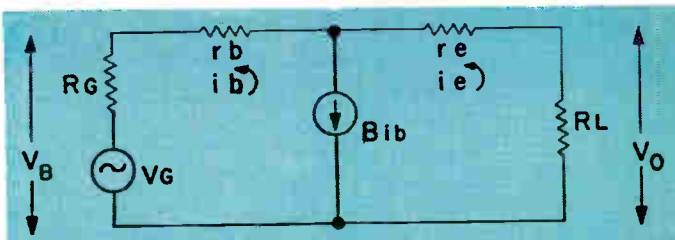


Fig. 8 (above): Equivalent circuit of common collector stage used to transform common emitter stage up to desired impedance.

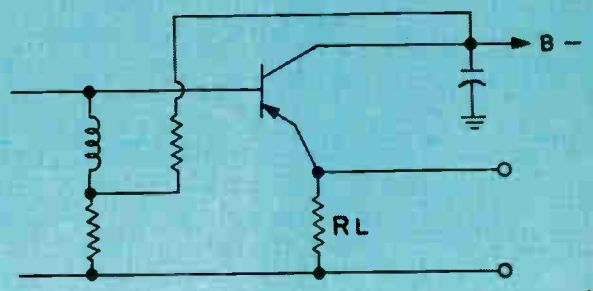
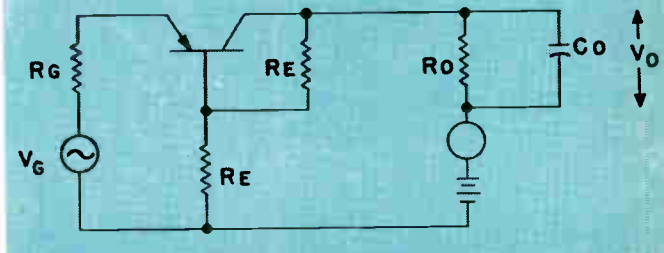
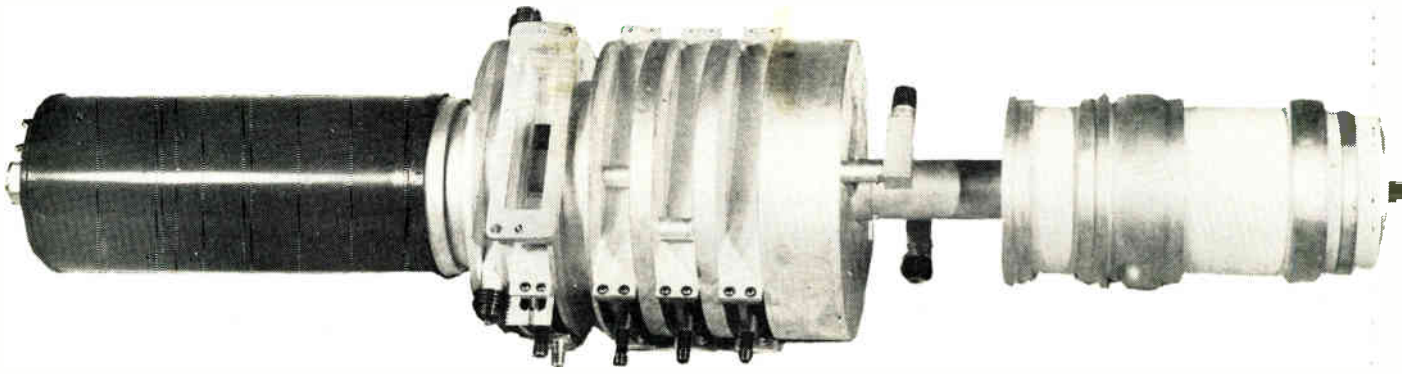


Fig. 9 (above): Peaked common collector stage used to equalize overall input impedance is added in series with biasing resistors

Fig. 10 (below): Common base voltage doubler is used to achieve drive not available in present day transistors, required by CRTs.



The power output of Klystrons is limited by heating of the output cavity windows, but the exact cause has not previously been determined. This new study evaluates the stresses produced by temperature gradients in cylindrical windows caused by dielectric losses and electron bombardment.



Calculating the

Thermal Stresses in Klystron Windows

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THE multi-cavity klystron power amplifier with external cavities using cylindrical ceramic windows to contain the vacuum was pioneered in 1952. The first tube of this kind had 3 cavities and gave a power output of about 5 kilowatts CW at 720 MC with a power gain of about 30 db. Since that time, a wide range of klystrons of this basic type has been produced from 200 MC to 3000 MC. These tubes have been used for CW, FM-CW, and AM-CW at power levels around 1 to 75 kilowatts CW and, in addition, a number of pulse tubes have been developed capable of megawatts of peak power.

Fig. 1 shows a section through a typical output cavity of an externally tunable klystron of the kind considered here. The power is taken from the cavity to the load by means of a coupling loop or an iris when a waveguide output is used. (Not shown.) It will be seen that apart from the possible disturbing effects of the coupling device, the electric field in the cavity is symmetrical about the axis. This field will cause heating of the ceramic due to dielectric losses.

In addition to this heating, there may be heating caused by bombardment of the inside of the ceramic cylinder by secondary electrons emanating from the downstream tip of the output gap. In general, this heating will also be symmetrical about the axis but may not occur uniformly along the length of the cylinder. It was frequently observed that the heat would be concentrated in a band which could be moved over the length of the cylinder with adjustments of the magnetic field.

It was clear at the start that the power output of the tube might be limited by heating of the cylindrical ceramic window in the output cavity. Events confirmed this and in the course of the development, failures of the klystrons occurred from time to time

for this reason under conditions of severe overloading or maladjustment. The failures would usually take the form of peripheral cracks appearing in the ceramic cylinders. Accordingly, a study was made of the conditions that would cause this type of failure. Results of this study are described below.

Thermal Stresses

We shall consider the stresses set up in ceramic cylinders due to heating by dielectric loss and by electron bombardment.

The following assumptions will be made.

a. The ceramic is perfectly elastic; that is, it obeys Hooke's law of strain being proportional to stress up to the breaking point of the ceramic. This is well authenticated in the literature on ceramic[1] except at very high temperatures near the softening point which are much higher than any we are considering here.

b. The ends of the cylinder are unconstrained. This is true in the case of weak and flexible copper sealing rings.

c. All the heat is removed by conduction along the cylinder to a heat sink at each end.

d. Heating is uniform in any plane perpendicular to the axis, meaning that there is no variation in temperature around the cylinder in any one plane, and also that there is no variation in temperature through the cylinder wall. (The effects of non-uniform heating will be considered later.) Thus the only temperature gradients in effect are axial.

e. The only stresses considered are those caused by steady state temperature conditions. Stresses caused by thermal shock where temperatures are changing rapidly are not considered here.

A simple method of analyzing the stresses caused by a temperature distribution such as (b) in Fig. 2 is as follows. Imagine a cylinder to be split longitudinally to form a large number of parallel bars tied together at the ends. When the center is heated as shown, the cylinder becomes barrel shaped. Each bar will expand lengthwise, which it is free to do, and will be pushed radially outward at the center by the action of the bars next to it. This causes all bars to bend outwards, and using simple bending theory, it can be shown that there will be a tensile stress in the outer surface and an equal compressive stress in the inner surface.

To obtain numerical values for the stresses it is necessary to know the deflection of the bar along its length, and this will depend on the temperature distribution and on the reactive forces it exerts on the neighboring bars when heated. This becomes somewhat complicated.

At this point it may be noted that in addition to the axial tensile stress there is a circumferential compressive stress with the kind of heating considered, about equal in value to the tensile stress. Since ceramic is about ten times as strong in compression as in tension, and several times as strong in shear as in tension, failure will always occur in tension under these conditions. Only the tensile stresses will be considered in what follows.

A study of the literature on thermal stresses in ceramic bodies shows no published work relevant to the conditions above. There is a considerable amount of analysis of stresses in cylinders caused by heating the inside with the outside cold, because this is a condition met with in the walls of furnaces, but nothing on the effect of axial temperature gradients which chiefly concern us here.

The literature on heating of steel cylinders is slightly more rewarding, because of the work done in calculations of stresses in the cylinder walls of heat engines, but even so, remarkably little attention has been paid to stresses caused by axial temperature gradients. Only two references have been found.[2,4] These are valuable because they show that the exact method of analysis is similar to that used for calculating the deflection of a beam on an elastic foundation, invented by August Foppl many years ago and used in the practical cases of railroad tracks and rings shrunk on to cylinders.

It is shown that the basic differential equation in such cases is the following:

$$E\,I\,\frac{d^4y}{dx^4} = q - KY \qquad (1)$$

Where K is a constant expressing the stiffness of the elastic foundation and q describes the loading of the beam. In our case q will be a function of temperature. E is the modulus of elasticity and I the moment of inertia of the section. Y is the deflection of the beam.

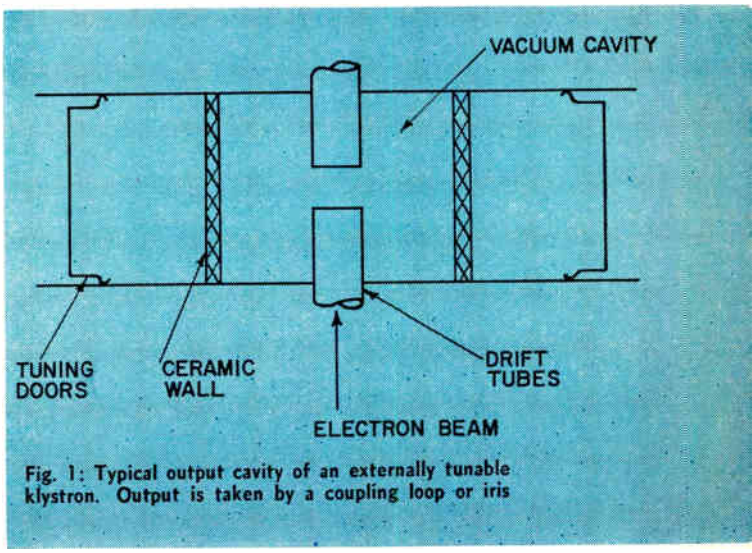

Fig. 1: Typical output cavity of an externally tunable klystron. Output is taken by a coupling loop or iris

Stresses with Linear Temperature Gradients

We are chiefly interested in two temperature distributions (as will be shown later) illustrated in Fig. 2.

(a) $t = [t_1 - Kx] \qquad 0 < x < \frac{l}{2}$

$t = [t_1 + Kx] \qquad -\frac{l}{2} < x < 0$

(b) $t = t_1 - K^1x^2$

The first of these has been treated by Timoshenko.[2] He shows first that a purely linear temperature distribution with no discontinuities will produce no thermal stresses. An example would be a cylinder heated at one end and cooled at the other, with free ends. He next considers a distribution in which part

Klystron Windows
(Continued)

of a cylinder has a linear distribution and the rest is at constant temperature (Fig. 2). The equation for tensile stress is as follows:

$$\sigma_x = 0.66\,(1-\mu^2)^{-\frac{3}{4}}\,E\alpha\,\frac{(CR)^{\frac{1}{2}}}{l}\,(t_1 - t_2) \qquad (2)$$

Where σ_x is tensile stress parallel to the cylinder axis, in p.s.i.

μ is Poisson's ratio (usually 0.25 for ceramic).

E is modulus of Elasticity in p.s.i.

α is coefficient of expansion in cm./cm./°C.

C is thickness of wall in inches.

R is radius of cylinder in inches.

l is length of cylinder in inches.

t_1 is temperature at center of cylinder in °C.

t_2 is temperature at cold end of cylinder in °C.

This stress is greatest at the outside surface of the cylinder, and is greatest in the plane where the temperature is highest. The stress occurs because of the bending of the cylinder as described qualitatively at the beginning of this section. There will be a corresponding compressive stress at the inside surface.

It is a small step from this condition to the one where the temperature distribution is as shown in (a) Fig. 2; the stresses are simply doubled.

$$\sigma_x = 1.32\,\frac{E\alpha}{(1-\mu^2)^{\frac{3}{4}}}\,\frac{(CR)^{\frac{1}{2}}}{l}\,(t_1 - t_2) \qquad (3)$$

This is the equation for a cylinder heated locally at the mid-plane.

For cylinders heated in some other plane distant "a" from the mid-plane (see Fig. 2d), the stress will be:

$$\sigma_x = 0.33\,\frac{E\alpha}{(1-\mu^2)^{\frac{3}{4}}}\,(CR)^{\frac{1}{2}}\left(\frac{1}{\frac{l}{2}-a}+\frac{1}{\frac{l}{2}+a}\right)(t_1 - t_2) \qquad (4)$$

These equations neglect end effects. If the plane of heating is close to one end $\left(a \to \frac{l}{2}\right)$, the stress is less than that given in the equations and the procedure for calculating it exactly is given in reference[3]. However, when the distance "a" is greater than about half the radius R, the error in the equations is negligible.

Stresses with Parabolic Temperature Gradients

Next, we shall consider the second temperature distribution, the parabolic distribution, shown graphically in Fig. 2b.

This is of special interest because it represents the case of pure uniform dielectric heating of the cylinder. The parabolic temperature distribution is obtained by considering the cylinder to be uniformly heated by heat generated within the material itself, and conducted away to a heat sink at each end.

Thus at any plane distant x from mid-plane, and assuming

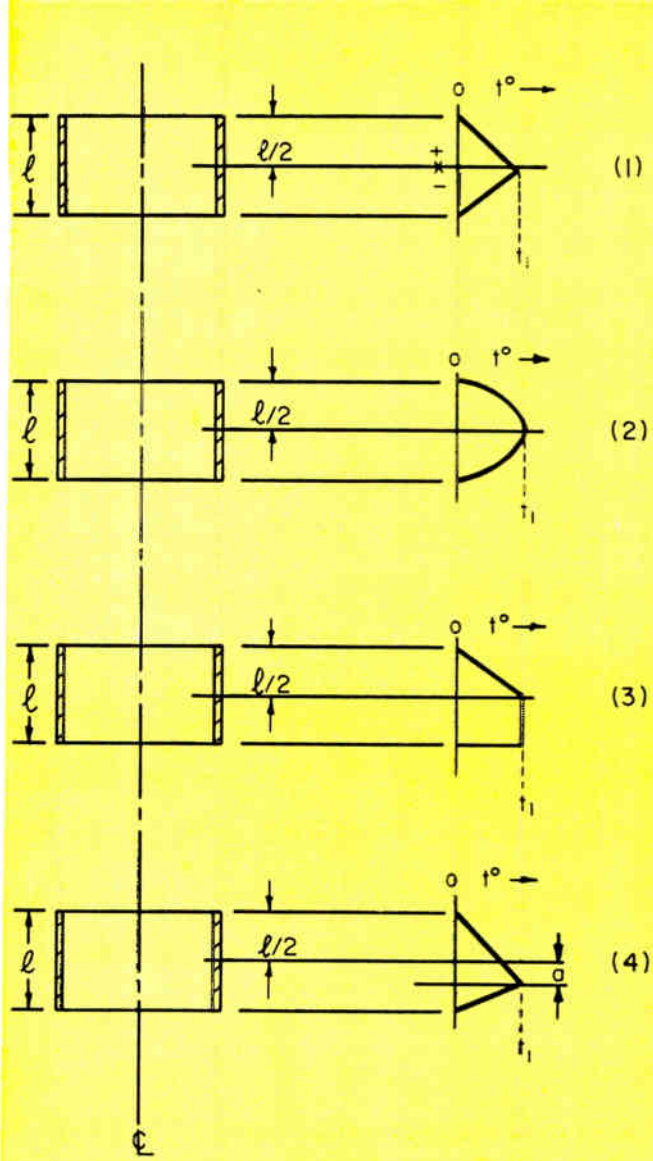

Fig. 2: Various axial temperature distributions

Heat flux at x = k'x,

k is thermal conductivity (c.g.s. units),

t is temperature in °C.,

A is cross-sectional area in cm²:

$$-4.2\,AK\,\frac{dt}{dx} = F \text{ watts} = k'x \qquad (5)$$

Integrating with respect to x:

$$t = \frac{-k'}{4.2\,KA} - \frac{x^2}{2} + k'' \qquad (6)$$

which is a parabolic temperature distribution. When x = o, t = t_1, (See Figure 2b,); hence k'' = t_1. To find k', it is necessary to know the dielectric losses per unit volume of the material, which depends on the loss factor for the material at the frequency considered and the electric field strength. The latter cannot usually be measured directly in the most interesting cases of cavity resonators with ceramic cylindrical windows. It can be estimated roughly from the geometry if the r-f voltage across the resonator gap is known, and in the case of the output cavity of a klystron, the dielectric loss itself may be calculated if the loaded Q and the unloaded Q with

and without the ceramic cylinder and the power output are measured.

If Qu_1 is unloaded Q with ceramic,

If Qu_2 is unloaded Q without ceramic,

If Q_L is loaded Q,

If W_O is power output,

the dielectric loss in the cylinder will be:

$$W_L = \left[\frac{1}{1 + \frac{Qu_1}{Q_L}}\right]\left[1 - \frac{Qu_1}{Qu_2}\right] W_O \qquad (7)$$

Returning to Eq. 5 we may say that when

$$x = \frac{l}{2},\ F = \frac{W_L}{2},$$

meaning that half the total dielectric loss heat is conducted away from each end of the cylinder.

Substituting in 5:

$$\frac{W_L}{2} = k' \frac{l}{2}$$

$$k' = \frac{W_L}{l}$$

and substituting this in 6:

$$t = \frac{-W_L x^2}{8.4\ KAl} + t_0$$

and when:

$$x = \pm \frac{l}{2}$$

Table 1

Comparison of Calculated and Measured Cracking Temperatures of Commercially Available Ceramic Cylinders of Various Compositions and Sizes

Ceramic Type	Wall Thickness	Length	Measured Cracking Temp. °C (Average)	Calculated Cracking Temp. °C
Body 1, 95% Al_2O_3	0.125	1.0	330	260
Body 1	0.050	1.0	535	420
Body 2, 97% Al_2O_3	0.125	1.0	260	260
Body 2	0.050	1.0	420	410
Body 2	0.070	1.0	330	350
Body 2	0.070	2.0	685	700
Body 3, 97% Al_2O_3	0.050	1.0	375	420
Body 4, 98% Al_2O_3	0.050	1.0	340	420
Body 5, 100% Al_2O_3	0.070	1.0	215	350

Table 2

Comparison Between Single Wire Filament and Wide Band Filament. Values are Temperatures at Failure in ° C

Body No.	Length	Wall	I. D.	Filament	
				½ in. Band	0.125 in. Wire
1	1.00	0.050	1.735	500	510
2	1.00	0.070	1.735	350	330
2	2.00	0.125	1.625	402	455

$$t = t_2 = \frac{-W_L l^2}{4 \times 8.4\ KAl} + t_1$$

giving:

$$t_1 - t_2 = \frac{W_L l}{33.6\ KA} \qquad (8)$$

This formula enables the temperature rise to be calculated from the dielectric loss, assuming no surface cooling.

A satisfactory theory giving the tensile stress under these conditions has not yet been found. An apparently valid theory is given in reference (4) in which the stresses are much less than the stresses with local heating. This may seem reasonable but experimental results do not agree with it. Instead, as will be shown below, the stresses appear to be about the same for parabolic and linear temperature distributions, and it will therefore be assumed that Eq. 3 holds for both cases.

Interpretation of Stress Equations

We have derived a basic equation connecting the stresses in the cylinders with the temperature and certain properties of the material. We shall now consider the implications of this in some detail. For convenience the equation 3 is repeated here,

$$\sigma_x = 1.32 \frac{E\alpha}{(1-\mu^2)^{\frac{3}{4}}} \frac{(CR)^{\frac{1}{2}}}{l} (t_1 - t_2) \qquad (3)$$

The following observations may be made at once by inspection:

(1) Stresses are directly proportional to the temperature difference between the hottest point and the cold ends.

(2) Stresses are dependent on two factors: one being

$$\frac{E\alpha}{(1-\mu^2)^{\frac{3}{4}}}$$

which depends on the physical characteristics of the material, and the other depending on the geometry of the cylinder. (That is, the relationship between R. C. and l, the radius, thickness, and length.)

(3) Because the temperature difference $(t_1 - t_2)$ is set up by the flow of heat by conduction to the cold ends, $(t_1 - t_2)$ will be inversely proportional to the thermal conductivity K of the material.

Thus,

$$t_1 - t_2 \propto \frac{1}{K}$$

Hence,

$$\sigma_x \propto \frac{1}{K}$$

(4) The geometrical factor is:

$$\frac{(CR)^{\frac{1}{2}}}{l}$$

For a given value of heat flux, as in the case of electron bombardment the temperature difference is a function of geometry.

Thus:

$$t_1 - t_2 \propto \frac{l}{KCR}$$

Klystron Windows
(Concluded)

Substituting in 3:

$$\sigma_x \propto \frac{E\alpha}{(1-\mu^2)^{\frac{3}{4}} K} \cdot \frac{1}{(CR)^{\frac{1}{2}}}$$

which is independent of l.

(5) Heating caused by dielectric losses will be uniformly generated in every unit volume of the material provided that the electric field strength remains constant all over the cylinder. To a first approximation this is true in a klystron cavity with an electric field symmetrical about the axis. Therefore any variation in the cross-sectional area of the cylinder will not affect $(t_1 - t_2)$ since the conduction change is proportional to the volume change and therefore to the change in heat generated. However, the longer the cylinder the greater the temperature difference, for constant electric field.

But in practice if l is increased the electric field is usually proportionately decreased, since to a rough approximation the voltage across the cylinder stays constant as the length is varied.

Concerning the effect of changing the radius of the cylinder in a typical cylindrical cavity, the electrical field will increase as the radius is decreased.

Summing up these effects, it is clear that $(t_1 - t_2)$ will be largely independent of length and wall thickness but varies inversely as some function of the radius.

Assuming for simplicity that the function is linear,

$$t_1 - t_2 \propto \frac{1}{KR}$$

and substituting in equation 3 we have:

$$\sigma_x \propto \frac{E\alpha}{(1-\mu^2)^{\frac{3}{4}} K} \left(\frac{C}{R}\right)^{\frac{1}{2}} \frac{1}{l}$$

Summing up, we conclude that whichever of the two causes of heating is considered, the stresses will be reduced if the factor

$$\frac{E\alpha}{(1-\mu^2)^{\frac{3}{4}} K}$$

is reduced.

As far as geometry is concerned, there are conflicting requirements depending on which kind of heating predominates. If electron bombardment predominates, the thickness and the radius should be maximized. If dielectric loss predominates, the thickness should be minimized and the length and radius should be maximized.

In cases where both kinds of heating are important, the length and radius should be maximized. The thickness will not be critical.

It has been shown in Eq. 3 that the most important stress is a tensile stress in the outer surface of the ceramic, and that the highest stress will be in the plane where the temperature is highest. If the temperature gradients are large enough, the cylinder will crack peripherally at the hottest plane where the tensile stress becomes equal to the tensile strength of the material. Obviously, the stronger the material the highest temperature gradients it will withstand, other things being equal. This factor then is important in determining the choice of material.

Thermal Stress Resistance

We therefore arrive at the concept of "thermal stress resistance" as a criterion of the ability of the material to withstand thermal stress, and we find that this resistance may be expressed as

$$R'' = \frac{KT}{\alpha E}$$

Where T is breaking tensile strength.

Where K is thermal conductivity.

Where E is modulus of elasticity.

Where α is coefficient of expansion.

This factor neglects μ which is usually not greater than 0.3 for the materials of greatest interest and is therefore insignificant under these conditions. In other conditions of heating the factor

$$R' = \frac{KT}{\alpha E}(1-\mu)$$

has been shown to be of value.[1]

Experimental Verification of Theory

In order to check the theory and to investigate variations between different ceramic bodies as has been described elsewhere, a test setup was made in which ceramic cylinders could be heated to reproduce as closely as possible the conditions in the klystron cavity.

Pictured in Fig. 3 is the test console used for most of the work described in this report. A ceramic cylinder, between 1 and 2 inches long and 1⅞ inches in diameter, was placed over the single coil tungsten filament of 0.125 in. tungsten wire approximately 3 inches long, and platinum brazed to ¼ in. diameter, 1 in. long moly rods which were clamped to ⅜ in. copper tubing. A glass bell jar, with two graded seals for the filament connections, supports the water-cooled copper plate.

A grease vacuum seal was made between the ends of the ceramic and the water-cooled end plates. A fore-pump vacuum of 1-10 microns, measured with

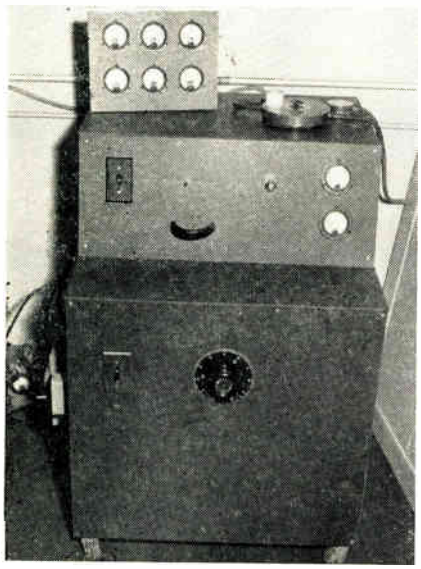

Fig. 3: Shown is the test console used for most of the work described here

a thermocouple meter, was sufficient to protect the filament from excessive oxidation. A clip-on ammeter was used to measure filament current. A modified Alpert trap was used to protect the pump from the oxide which formed on the filament each time a cylinder was cracked.

The distance between the filament and a ceramic of 1.625 I.D. was about 0.080 in. The temperature of the ceramic was measured with 0.010 in. iron-constantan thermocouples which were cemented in place with Saureisen cement. (The thermocouples were easily attached if the ceramic was first heated to about 100°C so that the cement hardened almost immediately.) Six meters scaled from 0° to 500°C were used simultaneously for indicating temperature.

Because of the exploratory nature of this work, several sources of experimental error, arising from the mechanical limitations of the arrangement, were tolerated. As a result, experimental error was found to be about ±30°C. However, even this error gives results which are sufficiently accurate to indicate important trends in ceramic performance.

In addition to using the test setup described, various special tests were made using heat applied by a torch and by hot wires in order to establish different types of temperature distributions. Also, a wide-band filament was substituted in the regular test equipment in order to study the effects of a parabolic temperature distribution instead of the nearly linear distribution produced by the single tungsten filament. This tungsten band was one-half inch wide and approximately the same diameter as the regular filament.

Experimental Results

The equations show that a numerical value for temperature difference required to cause cracking can be computed if α, T, E, and μ are known from manufacturers' published data.

We will now see how well the observed temperature differences at cracking fit the computed values.

From 3 assuming:

$E = 40 \times 10^6$ p.s.i.

$\alpha = 6 \times 10^{-6}$ in./in./°C.

$T = 30 \times 10^3$ p.s.i.

$\mu = 0.25$.

The temperature difference required for cracking is

$$t_1 - t_2 = \frac{30{,}000}{1.4 \times 40 \times 10^6 \times 6 \times 10^{-6}} \frac{1}{(CR)^{\frac{1}{2}}} \text{°C.}$$

$$= 90 \frac{1}{(CR)^{\frac{1}{2}}} \text{°C}$$

The observed cracking temperatures are compared with the temperatures calculated from this formula in Table I, from which it can be seen that the agreement between theory and experiment is good. The discrepancies between calculated and measured results with other ceramics is most probably due to the fact that the actual tensile strength is not the assumed 30,000 p.s.i. but some other value.

The theory shows that the temperature difference to cause cracking varies as

$$\frac{1}{(CR)^{\frac{1}{2}}}$$

The experiments show that the stress required to produce failure (σ_t) does in fact vary as $\frac{1}{C^{\frac{1}{2}}}$ where C is the thickness. (Table 1) The effect of R was not checked. Doubling l gives nearly double the temperature difference, which agrees with the theory quite well.

With more uniform heating sufficient experiments have been run to prove that

$$\sigma_t \propto \frac{1}{C^{\frac{1}{2}}}$$

as for local heating. (Table 2)

It therefore seems probable that Eq. 3 will hold for both linear and parabolic distributions.

Application to Klystrons

It has been shown above that the thermal stresses in a ceramic cylinder depend on the material and on the temperature distribution and from the equations given, it is possible to calculate the stresses if the temperature distribution is known numerically. If the breaking tensile strength of the material is also known, the margin of safety under any operating conditions can be determined. Further, an examination of the geometrical factor and how it affects the stresses will indicate the most desirable proportions for the cylinder.

It became clear as a result of this study and from subsequent measurements on klystrons that at frequencies below about 2000 mc the effect of secondary electron bombardment on the output windows of the tubes was much more severe than the effect of dielectric losses and, accordingly, the development work on these tubes has centered around means for reducing or eliminating this electron bombardment. As a result, it will be possible to extend the power output of tubes of this kind a considerable way beyond previous practice.

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In the Realm of Possibility . . .

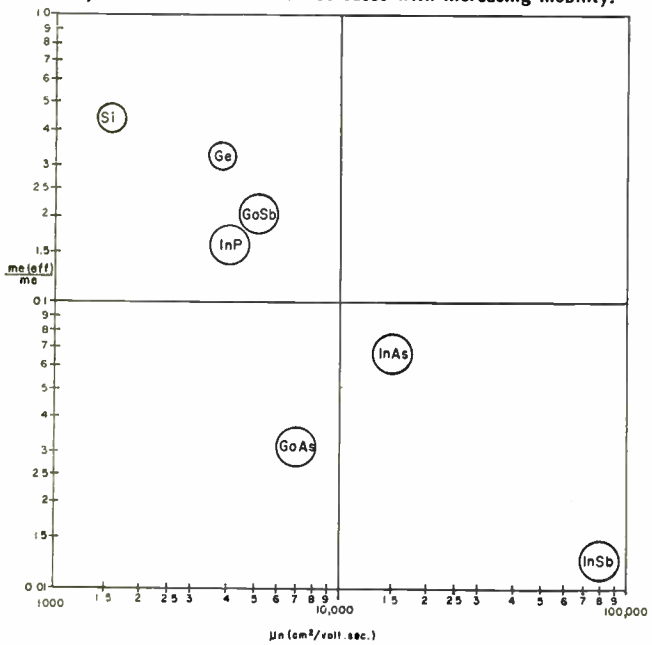
Using Unusual Semiconductors

Only germanium and silicon of the many semiconductors have been exploited. Possible advantages of going to unusual materials, especially compounds, are presented and studied. It appears that work on such semiconductors could be well worth while.

ALTHOUGH only a few semiconductors have had any real use at all, two in transistors, there are many, especially compounds. The number is still being extended.

This article investigates the possibilities of some of the unusual (i.e., other than germanium and silicon) semi-conductors in future transistors and transistor-like devices. Under the heading, "transistor-like devices," the consideration will be restricted to electrical amplifying devices.

Fig. 1: Ratio of effective electron mass to free electron mass vs. mobility. Note that the ratio decreases with increasing mobility.



Possible Advantages

It is conceivable that many different materials might give some kind of transistor action; indeed, this was observed several years ago, in point-contact structures.[1] However, strange materials will scarcely be used for their own sake, but only when they offer some advantage over the conventional. Advantages which might be sought include:

a. Operation at higher temperatures,
b. Operation at higher frequencies,
c. Operation at higher power levels,
d. Operation at higher voltages,
e. Greater ease of fabrication,
f. Better resistance to unfavorable environments, and
g. Miscellaneous special properties.

Higher Temperatures

Operation at higher temperatures is currently a matter of great interest because of military requirements; to what extent materials superior to silicon in these properties would be required for peaceful appli-

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cations is still somewhat uncertain. Certainly, it is advantageous for material for high-power devices to be capable of operation at fairly high temperatures; this is just the matter of elevated temperatures due to power dissipation in the device.

In military applications, on the other hand, high ambient temperatures are often the problem. Then high-temperature material is desirable for devices operating at any power level. In either case, the property of the semiconductor which is of importance here is just the width of the forbidden energy gap. One easy way to express that is by an equivalent temperature, being the temperature at which the saturation current would be equal to that for a reference material at room temperature.

If the reference material is germanium, the reference temperature, T_{Ge}, is given in terms of **E**, the energy gap in electron volts of the material under consideration by

$$T_{Ge} = 400\ E_g - 270\ ^\circ C$$

If silicon,

$$T_{Si} = 270\ E_g - 270\ ^\circ C$$

Thus silicon carbide, with an energy gap of 3.3 ev, at 1000°C would be comparable with germanium at room temperature; at 600°C, with silicon at room temperature. The quantity, T_{jM}, the maximum allowable junction temperature, is added as a figure to give the temperature at which the material would be in the same situation as silicon at a junction temperature of 200°C, which is about the upper limit for silicon. It is given by

$$T_{jM} = 430\ E_g - 275$$

It must be emphasized that the energy gap does not tell the whole story. Such matters as surface effects may modify profoundly (and usually for the worse!) any conclusions reached from considerations of energy gap. On the other hand, for bipolar devices at least, the increase in intrinsic carrier density with temperature will set a limit to the operation of the device. In that sense, the effect of the energy gap, expressed, if desired, in terms of an equivalent temperature such as those given above, will set an upper limit on the temperature range over which the device will work.

A very important practical matter is the consideration of mechanical problems. Presumably, devices will not be kept at the high temperature all the time. Matching coefficients of expansion and bonding the semiconductor to the refractory materials used in the packages will be serious problems. Unfortunately, these are matters on which not much is yet known, and data even on expansion coefficients, let alone bonding properties, etc., are quite scanty for the more unusual semiconductors.

To sum up what information is readily available about possible high temperature materials, **Table 1** lists a number of such materials, along with their energy gaps, equivalent temperatures referred to silicon, and other information which may be relevant and available. Note that the value quoted for the energy gap is that around room temperature; the gap usually decreases around 5 x 10^{-4} ev/°C with increasing temperature.[5]

Table 1

Material	E_g	T_{si}	T_{jM}	Electron Mobility	Hole Mobility	References
Si	1.1	25	200	1800	600	—
B	1.6	160	315	$\lesssim$10(?)	~1(?)	3
InP	1.3	80	285	3500	700	2
GaAs	1.35	95	305	4000	400	2
AlSb	1.52	140	385	50	150	2
GaP	2.25	340	695	?	?	2
AlAs	~2.2	320	690	?	?	2
Ca_2Si	1.9	240	545	?	?	2
SiC	3.3	620	1145	~200(?)	(?)	4
C (Diamond)	5.6	1230(!)	2147	1800	1200	5

Table 2

Material	Electron Mobility	Temperature Variation	Hole Mobility	Temperature Variation	E_g
InSb	80,000	$T^{-5/3}$(?)	4,000	$T^{-2.1}$(?)	0.17
InAs	20,000	$T^{-3/2}$	?	$T^{-5/2}$(?)	0.33
GaSb	5,000	?	1,000	$T^{-3/2}$	0.70
GaAs	4,000	$T^{-3/2}$(?)	400	?	1.35
InP	3,500	$T^{-3/2}$(?)	700	?	1.3

Higher Frequencies

The material properties which would be of most interest here are the carrier mobilities. Since we are concerned only with mobilities higher than those obtained with conventional materials, the only materials worth consideration are a few of the intermetallic semiconductors. These substances, moreover, have very high mobility ratios, the electron mobility being sometimes as much as 10 to 100, or even more, times the hole mobility.

In bipolar devices, both kinds of carrier must be mobile to maintain charge neutrality. The slower carriers can effectively act as a drag on the faster. In fact, at high enough current densities, matters can go as if both kinds of carrier had about the same mobility, being the harmonic mean of the two mobilities. This is an interesting analogue to the situation in gaseous electronics where the positive ions have velocities so much less than those of the electrons that they could be considered stationary.

The problem of transport does not arise in the turn-on of a thyratron, because the ions can be produced *in situ*. It does in the turn-off. The limitations on thyratrons due to the time necessary for ions to diffuse to suitable surfaces and recombine are well known. Thus, the high frequency capabilities of conventional bipolar transistors made from the high-mobility intermetallic semiconductors might be rather disappointing. On the other hand, unipolar

Semiconductor Advantages

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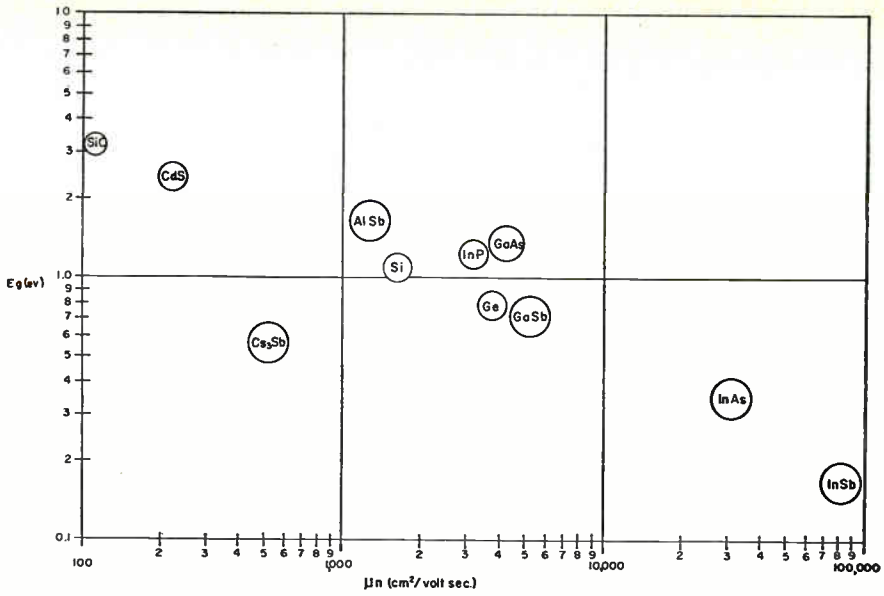


Fig. 2: Note that energy gap tends to decrease as electron mobility increases.

devices, such as the field effect transistor,[6] are concerned with only one type of carrier, the majority carrier. A field effect transistor, made from n-type material with a high electron mobility (e.g., indium antimonide) might be expected to have rather superior high-frequency behavior.

Intermetallics

There is another reason why the field effect device may be the best one if the intermetallic semiconductors are to be used. It appears so far that these substances have inherently short minority carrier lifetimes, perhaps around 10^{-7} sec.[2] This is very unfavorable to the operation of devices which depend on minority carriers (although the situation may not be quite as bad as it would seem at first). For a field effect transistor, about the only effect of the short lifetime would be to increase the leakage current of the gate electrodes, thereby reducing the input impedance to the transistor. In many applications this might not be very serious, since in high-frequency circuits, impedances are not ordinarily very high anyway.

A point to be kept in mind, in considering these high-mobility semiconductors, is that the carrier velocity will presumably not increase indefinitely with increasing field, but will saturate at some maximum velocity. This phenomenon has been investigated in germanium and silicon; the saturation velocities seem to be of the order of 10^7 cm/sec. Nothing has yet been reported on the variation with field of mobility in intermetallics, but presumably such effects exist.

Since the saturation of carrier velocity can occur quite easily in the field-effect transistor, more information on this matter would be very helpful. It would seem reasonable to assume that the saturation velocity will be of the order of the thermal velocities; hence, the saturation velocities might vary inversely as the square root of the effective mass. The effective mass of electrons in the various semi-conductors typically ranges from about 1% of the free electron mass to slightly more than 100%,[2] usually being less the greater the mobility, Fig. 1.

Saturation Velocities

One expects that the saturation velocities of electrons in a group of many semiconductors might vary over a range of 10 to 1, and spectacular differences in this velocity are probably not to be expected among the various materials. In general, in these materials, the effective hole mass ranges from 0.1 to 1 free electron mass, thus the saturation velocity for holes should be less than that for electrons.[2]

It should be mentioned that the velocity may not truly saturate at high fields; it may increase in some slow way with field (e.g., as the fifth root).[7] However, even operation where the velocity is proportional to the square root of the field is not a very efficient proposition; thus, as a practical matter, the concept of a limiting velocity remains valid.[6]

Another point to be kept in mind is that, in general, the semiconductor with the largest mobilities will have the smallest energy gaps. Fig. 2 shows energy gap vs. (electron) mobility for a number of semiconductors; there is almost an inverse relationship (or, rather, E_g is almost inversely proportional to the square root of μ_n). This can be understood in a qualitative way from consideration of the energy band structure, the curvature of the band, which is inversely proportional to the effective mass, and hence increases or decreases along with the mobility, being greater the less the energy gap.[8] Thus it seems unlikely that any substance can be found which will combine a large carrier mobility with a large energy gap. Since it is necessary to have a sufficiently large energy gap, especially if high-temperature operation is intended, one must probably be satisfied with effective mobilities not enormously greater than those found in silicon, at least for bipolar transistors.

Table 2 gives mobilities and other information about a few high-mobility semi-conductors.[2] The mobilities quoted are for around room temperature; they vary ordinarily as something between the inverse three-halves and inverse five-halves power of absolute temperature. There is a tendency for mobilities to increase with increasing mean atomic weight; Fig. 3 illustrates this.

Higher Power Levels

While several of the properties of the material are of interest in connection with high-power operation, the viewpoint will be taken here that the great concern is that of keeping the interior temperature of

the device, e.g., the collector junction temperature, for an ordinary transistor, below some maximum, meanwhile getting as much heat as possible out through the device. Thus, from this viewpoint, a large thermal conductivity is desirable. On the other hand, it is desirable that the junction be able to operate at as high a temperature as possible, within reason. On this basis, it is suggested that a figure of merit might be a "power density relative to silicon" given by

$$P = \frac{\sigma_T}{\sigma_{TSi}} \frac{T_{jM} - 25}{175} = \frac{\sigma_T}{\sigma_{TSi}} \left(\frac{T_{jM}}{175} - \frac{1}{7} \right)$$

σ_T being the thermal conductivity of the semiconductor in question, σ_{TSi} that of silicon, and T_{Si} the temperature equivalent to silicon. This compares the heat flow through similar structures of the semiconductor in question and of silicon, under the assumption that both have heat sinks at 25°C, that the silicon junction can run at 200°C and the junction in the other material at T_{jM} degrees. This comparison is rather restricted, nevertheless it shows how the thermal conductivity must be taken into account, and how materials might be quite unattractive because of low σ_T. If, for example, a material had $\sigma_T = \sigma_{Si}/10$ (and this is by no means an impossible situation) it would need to have $T_{Si} = 1750$°C, approx., to have the same figure of merit as silicon. The figure of merit could be modified for sink temperatures, T_s, other than 25°C; the result would be

$$P = \frac{\sigma_T}{\sigma_{TSi}} \frac{T_{jM} - T_s}{200 - T_s}$$

It is not likely that it will be found possible to improve greatly on this figure of merit by finding semiconductors with thermal conductivities much greater than that of silicon. In fact, silicon has a thermal conductivity which is extraordinarily high, for a nonmetallic substance. The figure of merit has possibilities of being useful, however, in warning against expecting too much of an improvement in power capabilities, under the conditions for which the figure of merit is valid, from materials with an appreciably larger energy gap, but much lower thermal conductivity, than silicon.

Other properties of the semiconductor are not expected to limit the power capabilities of the transistor very much, if a transistor can be made at all. It should be possible to reach quite reasonable operating voltage and current densities with many semiconductors. The carrier lifetime may need consideration in a bipolar device. Too short a lifetime could lead to excessive base current, which would make the problem of crowding of current to the edges of the emitter much worse.[9, 10, 11] Generation in depletion regions might also give troublesome effects.[12] These considerations may act to rule out the use of some of the intermetallics in bipolar transistors, since the intermetallics seem to have inherently low lifetimes.[2]

In general, for non-metals, thermal conductivities decrease with increasing mean atomic weight of a substance.[13] It is also true, in general, that the energy gaps of semiconductors decrease with increasing mean atomic weight. See Fig. 4. This can be understood qualitatively, since the substances of lower atomic weight have tighter binding.[5] Thus it is to be expected that semiconductors which are good for high-power operation because of energy gap will also have good thermal conductivities. Some of the intermetallics, especially indium antimonide, have anomalously high thermal conductivities; this is apparently due to the conduction of heat by free carriers, as well as by lattice vibrations.[2]

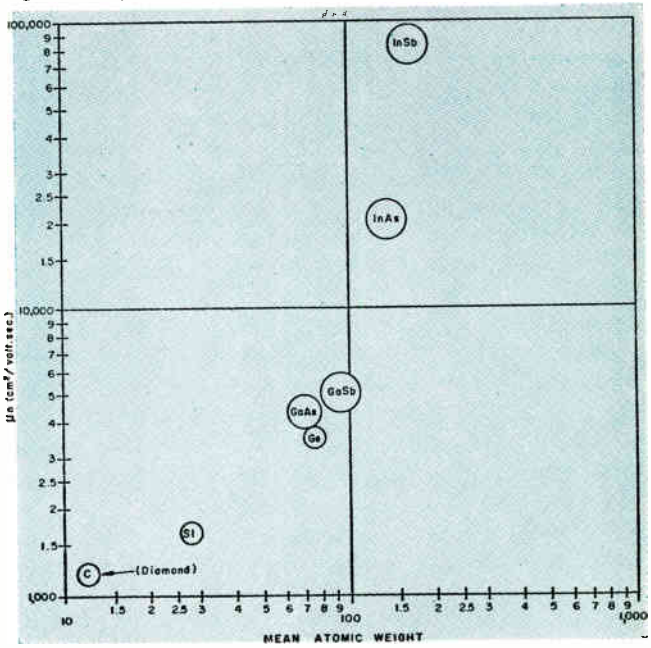
Higher Voltages

It might be said, rather roughly, that, as far as is known at the present, the upper limit on collector voltage for commercially available transistors is about 100 volts. This limitation comes about because of the effects of carrier avalanching in the collector-depletion region, and is especially severe for transistors operated in the common-emitter configuration, with a moderately high input resistance. Then carriers of one sign, produced by the avalanching, return to the base region and add a component to the base current. The outcome of this is that the effect of avalanching is multiplied by the current gain of the transistor. Thus the avalanching can be a much more severe problem for a transistor than for a diode.[14, 15]

While avalanching (the Townsend mechanism) is usually what causes the voltage limitations on devices, it appears that, under certain circumstances, direct excitation of valence electrons (the Zener mechanism) can be dominant.[16] However, these circumstances are so special, and the field necessary for the Zener mechanism is so much greater than that for the Townsend (the ratios being of the order of the ratio of the mean free path of conduction electrons to the major axis of the "orbit" of valence electrons, which, in turn, will be around the interatomic distances) that avalanching is the only mechanism that will need consideration.

In general the condition for avalanching is that

Fig. 5: In general, mobility increases strongly with atomic weight.



Semiconductor Advantages

(Continued)

the field be strong enough that there is an appreciable probability that a carrier will acquire enough energy in a free path to be able to make an ionizing collision. The energy required will be of the order of twice the energy gap of the material.[15] Thus the conditions for good resistance to avalanching are a wide energy gap and a short mean free path. The mean free path is typically in the range 10^{-6} to 10^{-7} cm for semiconductors. From the relations among mobility, effective mass, and mean free path, one concludes that the mobility will be about proportional to the mean free path.[17] Thus, it is to be expected that the high-mobility materials will have long mean free paths; and this, along with their relatively small energy gaps, makes them unsuitable for high-voltage operation. It is to be expected that semiconductors with large energy gaps, and only moderate mobilities, will be best for high voltage purposes.

Of course, avalanching is not the only problem to be considered under high-voltage operation. Devices may be limited, not by true avalanching and volume breakdown, but by surface breakdown.[18]

It is easy to recognize this problem of surface breakdown; it is difficult to say much about it. Even for the relatively well-studied semiconductors, germanium and silicon, surface breakdown phenomena are not too well understood. There is one thing which must be considered; surface breakdown can depend strongly on the actual condition of the surface, as influenced by ambient conditions. Thus this matter of surface breakdown comes partly under the heading of resistance to unfavorable environment.

Ease of Fabrication

It seems likely that all usable semiconductors will be hard, brittle substances; the type of lattice structure necessary for semiconduction would seem to preclude the possibility of a ductile, malleable, material. The ease of melting, of course, deserves consideration here. In general, the lower the melting point, the easier it will be to work with a material. However, the materials with relatively low melting points will usually have small energy gaps, Fig. 5. This is reasonable, since the energy gap and melting point both increase with tightness of binding.[5]

Other points of interest are the properties of a material with respect to etching, and to soldering or bonding to metals for actually assembling a semiconductor device. Not much seems to be known about these matters. In general, the difficulty both of etching and of bonding will probably increase with increasing melting point; thus silicon carbide seems to be a rather difficult material in this respect. On the other hand, if a material is found to be desirable in other respects, these matters can no doubt be overcome, although possibly only with the expenditure of much work and time.

Two other things deserve brief consideration. For materials harder than germanium or silicon, say approaching silicon carbide or diamond in hardness, the cost of machining to shape may become severe. One expects again, that in general, extreme hardness will go along with large energy gaps. The other thing to be mentioned is that some of the compound semiconductors, which contain a volatile component or tend to decompose at their melting point, must be handled in a special atmosphere during crystal growing. The arsenides often have this behavior.[2] This can add complications to fabrication.

Unfavorable Environments

The environment considered here may be gases; they may be water adsorbed on the semiconductor surface; they may be various contaminants which the device encounters at some stage in its fabrication, or they may be such circumstances as bombardment by energetic elementary particles.[19]

Some of the intermetallics may be rather vulnerable to environment. Aluminum antimonide, for instance, decomposes in a moist atmosphere, while aluminum phosphide and arsenide are quite unstable.[2] Compounds containing magnesium, such as Mg_2Si, Mg_2Sn, and Mg_2Ge, also react with water vapor.[2] It would no doubt be quite difficult to protect a transistor made from such material against water vapor adequately, to secure good reliability.

One might expect that, aside from such drastic examples as the above, the semiconducting compounds would be similar to germanium and silicon in their susceptibility to trouble from environment and contamination. At present, not much information seems to be available on this subject; in fact, a study of surface effects may have to wait on the making of actual devices of these semiconductors, since study of a device is often the best way of obtaining information about surface effects. There may be some reason for believing that the refractory semiconductors, such as silicon carbide, may be quite resistant to surface troubles. As for the effects of energetic elementary particles, it would seem likely that one material would be about as vulnerable as another. Certainly this would be true with respect to mechanical damage from radiation, except that materials of lower atomic weight are, in general, more vulnerable. The cases in which nuclear transmutation will produce donor or acceptor elements, changing the resistivities of the various regions, will need further consideration in each particular case; usually, in fact, mechanical damage is the more severe problem. However, it seems that only a minority of transistors will ever be used in places where they will be subjected to bombardment by elementary particles in significant amounts. Thus it would perhaps not be economical to make this consideration a major cri-

terion in the selection of material for general use. On the other hand, the possibility of choosing a semiconducting compound of elements such that, under bombardment, equal numbers of new donors and acceptors would be produced by the transmutations, the doping density thus remaining constant, offers at least an interesting intellectual exercise.

Special Properties

Under this heading will be considered a variety of properties which might have some particular applicability in a transistor-like device. There are other special properties which arise in connection with other uses of semiconductors. Bismuth telluride, for instance, is especially attractive for Peltier refrigeration, partly because of its low thermal conductivity,[20] while carbon (diamond) has shown some advantages for counting particles.[21] Special applications of photoeffects, taking advantage of special properties of a material, can also occur.

One interesting possibility is that of ferromagnetic semiconductors (such as, semiconducting ferrites). Such a substance might be advantageous in magnetically controlled devices, such as Hall and Corbino amplifiers, in reducing the effective length of the gap which must be introduced into the magnetic circuit.[2,22] However, it seems likely that ferromagnetic semiconductors would be rather complex compounds, with rather low mobilities; thus they might not be so attractive from the viewpoint of sensitivity and efficiency. More data are needed here.

Another possibility is the use of ferroelectric semiconductors, such as, barium titanate suitably doped.[23] The very high dielectric constant of these materials could lead to very wide depletion regions, low fields in the depletion regions, and large junction capacitances. The fact that the junction capacitances would be nonlinear, and moreover that, at a certain applied field, the dielectric constant decreases rather abruptly, might lead to some rather curious trigger devices. This is mentioned here merely as something possibly deserving more thought.[24]

Another feature of some semiconductors, which might possibly be put to some use, is their anisotropic conductivity. It is conceivable, for instance, that a base region might be anisotropic, having a lower conductivity in the direction normal to the planes of the junctions than in a direction parallel to them. Thus the effect of low normal conductivity would give good emitter efficiency, while the effect of higher transverse conductivity could reduce emitter-current crowding.[9,10,11] Selenium and tellurium are two substances which are somewhat anisotropic. This suggestion is highly speculative.

Another possibility in compound semiconductors is that of having the energy gap vary with position by having a crystal containing varying proportions of gallium arsenide and gallium phosphide. A device using this idea has been reported.[25]

Organic Semiconductors

The many organic semiconducting compounds have not been particularly considered in this discussion. This is because their use in transistor-like devices seems very problematic at present; the mobilities, in particular, are very low, except for a very few compounds, and the mobility figures for those are still in some doubt. Coblenz,[26] in a recent article, has presented much of the information now available on these organic semiconductors.

(*Acknowledgments and References found on page* 168)

Fig. 4: The energy gap decreases with increasing mean atomic weight.

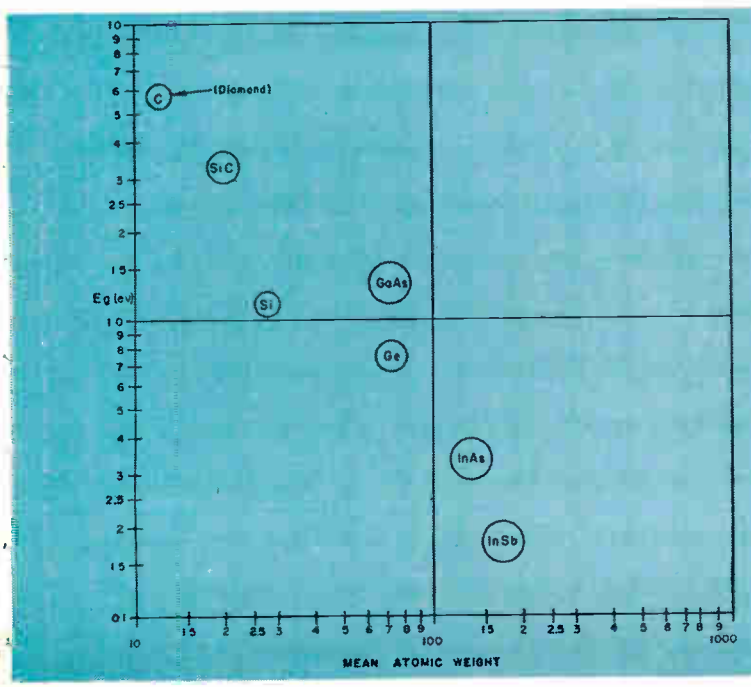
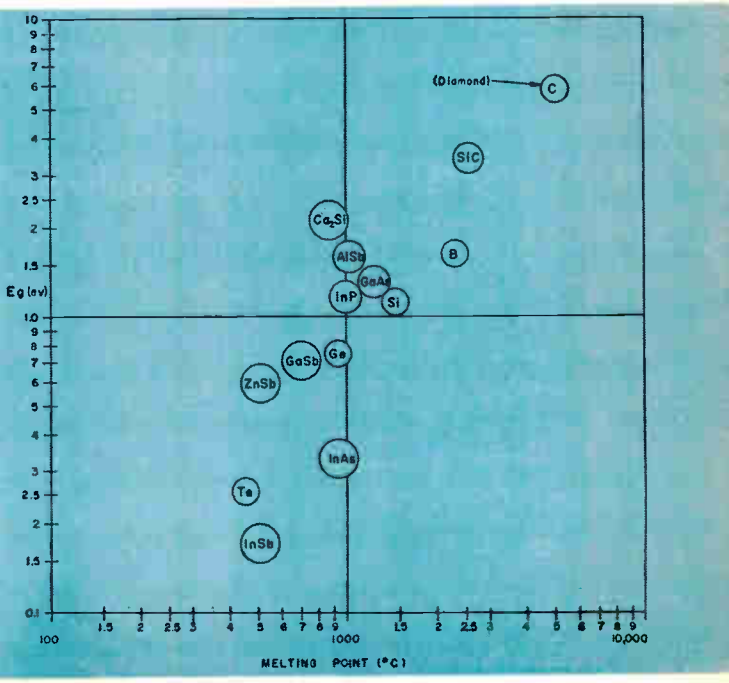
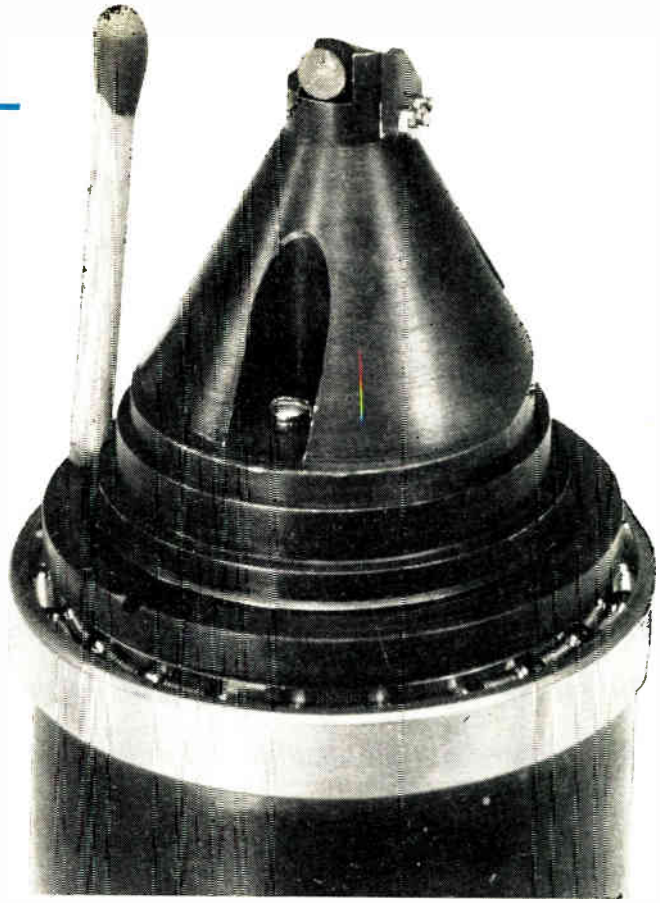


Fig. 5: With increasing melting point, the energy gap increases.



What's New . . .

"Visulation"



Tip of the TV lens is seen in comparison to the average "wind" match.

"VISULATION" represents the most significant advance in electronic flight training since the invention of the electronic flight simulator. Offering a new dimension in electronic flight training, it is made possible by the coupling of a flight simulator with the Visulator which was designed and developed by the Curtis Wright Corp., Electronics Div., Carlstadt, N. J.

Instrument flight simulation now affords training in instrument flight emergency procedures, aircraft familiarization, and radio and navigational procedures — all simulated to a high degree of realism.

When an aircraft breaks out of the overcast, its pilot sees the airport and surrounding terrain. So it is with "Visulation"—the pilot sees in true perspective, the entire airport as well as the runway upon which he is about to land. With the Visulator, the gap between existing simulation and real life is virtually closed. Nucleus of the equipment is a closed-circuit television system designed for the training of flight crews in the visual aspects of flight. Attached to the modern flight simulator, the training syllabus is extended to include visual take-off, instrument flight, instrument approach, visual approach, and contact landing.

The Curtiss-Wright Corp. discarded the use of standard TV components after analysis revealed a number of serious shortcomings for visual flight training purposes. Existing equipment dictated the use of very large models and, consequently, large studio areas.

Standard lenses provided viewing angles of less than 45°. In the Visulator, a "panoramic viewing angle" of 90° has been achieved with a specially designed refractive projection lens.

A miniature periscopic lens, the culmination of three years of research and development, has been designed and allows the use of very

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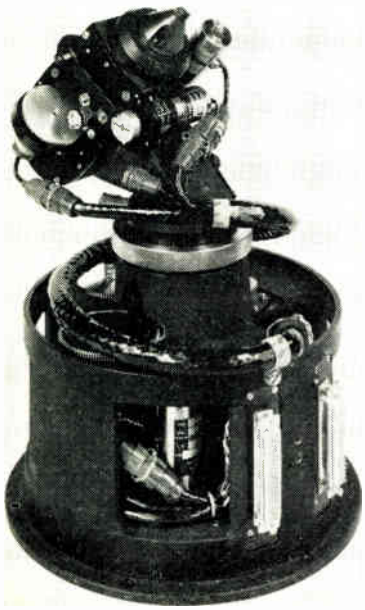
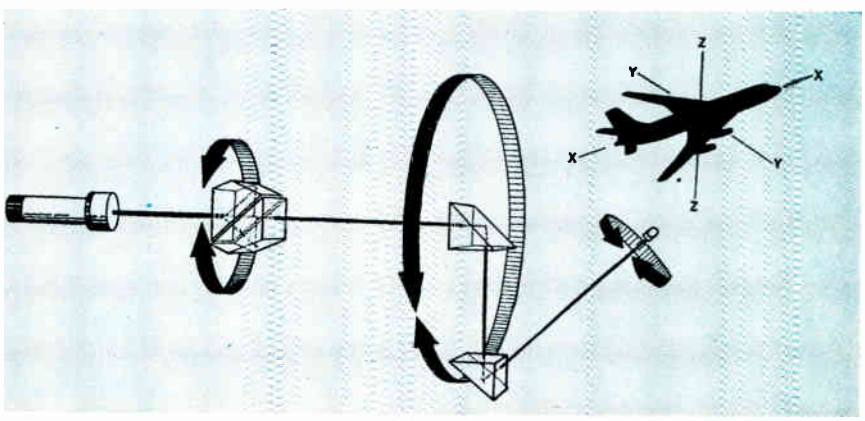
These controls achieve rotational view.



Rotation—roll, pitch, and heading—is accomplished by rotation of the optical elements in the lens assembly. Translation—motion in range, side drift, and altitude—is accomplished by moving camera in x, y, and z directions.



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For Designers . . .

Transistorizing a Flip-Flop

To ease the construction of complex logical equipment, it's to the designer's advantage to use basic building-block circuits. One such block, a bistable multivibrator, is designed here. An example illustrates the design methods used.

TO ease the construction of complex logical equipment, it is to the designer's advantage to use basic building-block circuits. One such block will be described here and a typical example will be shown to illustrate the design methods.

This article describes a bistable multivibrator, or "flip-flop." The design is one in which the transistors are allowed to switch between saturation, near-zero collector voltage when conducting, and cutoff, a no-current condition. The general form of this circuit is shown in Fig. 1.

The choice of a saturating-type circuit is justified when the storage time of the transistors is small compared to the time interval between successive inputs, since a component economy is effected by eliminating the need for biasing circuitry and/or bias power supplies.

Characteristics

Before attempting to determine the circuit parameters, the following characteristics of the circuit should be established:

V = Supply voltage to be used.

ΔV_c = Desired output voltage excursion from ground potential.

f_m = Max. repetition frequency of input signals.

t_r = Max. rise time of the input pulse (It is assumed that the amplitude of the input pulse will be equal to the amplitude ΔV_c).

It is necessary, when selecting a transistor, to consider the following items:

β = Short-circuit current gain.

$(V_{be})'$ = Twice the base-to-emitter voltage while conducting a current I_c (defined later). The doubling is incorporated to permit design realizability.

f_{co} = Frequency at which the transistor short-circuit current gain drops to 0.707 of its low frequency value.

It is next necessary to select a value of operating current, I_c. This is the maximum current through the ON transistor at any time. It should be large enough to override the effects of any reverse current in the base-collector junction. The choice should be based upon examination of the transistor characteristics and reflect the requirement that:

$$I_{max} > I_c > > \beta I_{co}$$

where I_{co} = reverse collector current with the base circuit open, and I_{max} = absolute max. (rated) current of the transistor.

A reasonable range of values is thus left open. The designer is free to select a value which is compatible with such other requirements as power supply loading limitations, dissipation restrictions, etc.

With the current thus established, a value of R_L may be selected, Fig. 1. Since the transistor collectors are to be allowed to switch between some OFF value and nearly zero (saturation), the value of R_L is determined by the output excursion and the maximum current as:

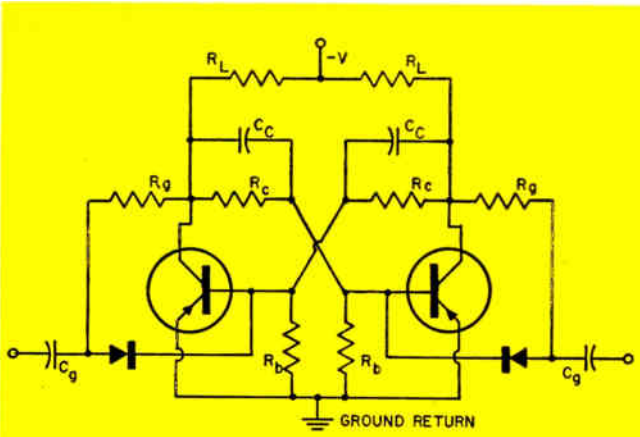


Fig. 1: General form of the basic flip-flop circuit.

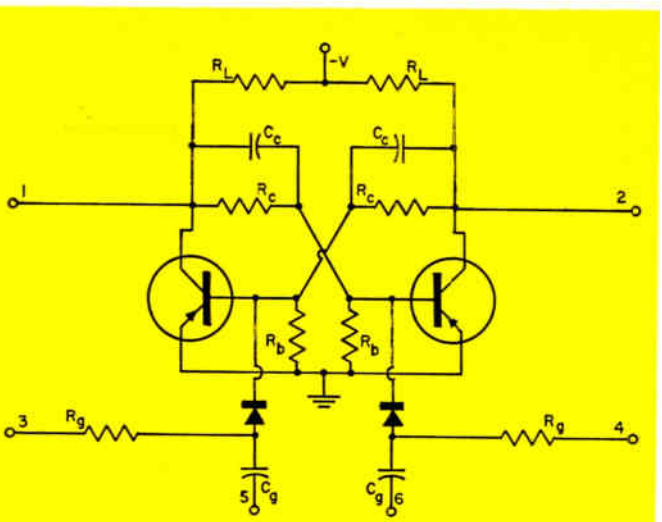


Fig. 2: General-purpose package using basic flip-flop.

Flip-Flop *(Continued)*

$$R_L = \frac{\Delta V_c}{I_c} \tag{1}$$

The base-to-emitter driving voltage, $(V_{be})'$ will be established at the ON transistor's base by the voltage divider network which includes R_b, R_c, and R_L. With the emitters at zero volts,

$$\frac{R_b}{R_b + R_c + R_L} = \frac{(V_{be})'}{V} \tag{2}$$

or

$$R_b = \frac{(V_{be})'\,(R_c + R_b + R_L)}{V}$$

from which:

$$R_b = \frac{(V_{be})'\,(R_c + R_L)}{V - (V_{be})'} \tag{3}$$

OFF Collector Voltage

The voltage at the OFF collector will be determined by the same voltage dividing network, and:

$$V_{co} = V\left(\frac{R_b + R_c}{R_b + R_c + R_L}\right) \tag{4}$$

where V_{co} is the collector voltage of the OFF transistor. Since we do not know the relationship of V to V_{co} in the general case, the information may be carried in calculations by establishing the constant K, where:

$$K = \frac{V_{co}}{V} = \frac{\Delta V_c}{V} \tag{5}$$

substituting (5) in (4),

$$K = \frac{R_b + R_c}{R_b + R_c + R_L} \tag{6}$$

Rearranging the terms of Eq. (6), we obtain:

$$R_b\,(K - 1) + R_c\,(K - 1) + R_L\,(K) = 0 \tag{7}$$

Similarly, from Eq. (3);

$$R_b\,(V - (V_{be})') - R_c\,(V_{be})' - R_L\,(V_{be})' = 0 \tag{8}$$

To solve for the values of R_b and R_c, Eqs. (7) and (8) are solved as simultaneous linear equations:

Multiplying Eq. (7) by $(V - (V_{be})')$ and (8) by $(K - 1)$;

$$R_b\,(K - 1)\,(V - (V_{be})') + R_c\,(K - 1)\,(V - (V_{be})') + R_L\,(K)\,(V - (V_{be})') = 0$$

$$R_b\,(K - 1)\,(V - (V_{be})') - R_c\,(K - 1)\,(V_{be})' - R_L\,(V_{be})'\,(K - 1) = 0$$

$$R_c\,(KV - V - K\,(V_{be})' + (V_{be})' + K\,(V_{be})' - (V_{be})') + R_L\,(KV - K\,(V_{be})' + K\,(V_{be})' - (V_{be})') = 0$$

$$R_c\,(V)\,(K - 1) + R_L\,(KV - (V_{be})') = 0$$

$$R_c = \frac{-R_L\,(KV - (V_{be})')}{V\,(K - 1)} \tag{9}$$

With this value obtained, R_c may then be substituted in Eq. (3) to yield a value of R_b.

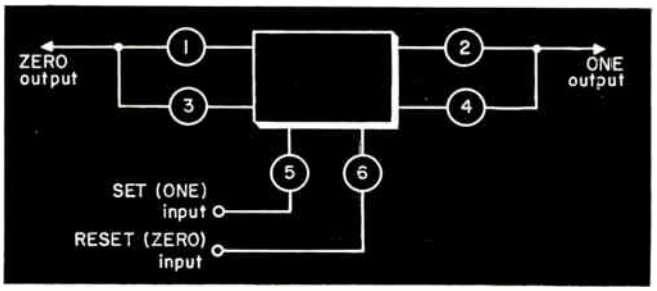
Values of C_c are generally on the order of 50 to 100 μμf as a rule of thumb. Calculation of the exact value for some unique situation is possible by use of the inequality below. A value will be obtained which permits rapid discharge of the RC combination within the allotted time at frequency f_m:

$$C_c < \frac{R_b + R_c + R_L}{\pi f_m R_c\,(R_b + R_L)} \tag{10}$$

Circuit Triggering

Triggering of the circuit is accomplished by applying a pulse to one of the input diodes. Note that resistors R_g are connected from the collector of each transistor to the anode of the diode driving that

Fig. 3: Using the terminal numbers of Fig. 2, the basic element is interconnected as a flip-flop stage for logical circuitry.



transistor's base. The cathodes of these diodes are connected to the transistor bases, thus placing them at essentially ground potential at all times. The base, even during conduction, is only a few tenths of a volt from ground. When a collector is at some negative potential (in the case shown, a p-n-p transistor), that potential is connected to the diode anode and holds it cut off. Pulses entering the diode cannot pass through and trigger the transistor circuit.

If, on the other hand, the collector is at zero volts (the transistor is conducting), the diode will have the same potential on its anode and its cathode, and positive-going pulses will act to cut off the transistor. If the two inputs are tied together, the pulses will complement the circuit; that is, each pulse will change the state of the flip-flop, regardless of its condition at the time the pulse arrives. The necessary circuitry for pulse steering is provided by the diode-resistor gate.

Capacitors C_g function to permit isolation of these gates from the input. Their value, however, is somewhat critical and is defined by two factors. The first of these is the impedance presented by the capacitor to an input pulse. To prevent excessive attenuation, the impedance of the capacitor must be related to the resistive input of the circuit by the expression:

$$X_c << R_s \tag{11}$$

where R_s = combination of diode forward resistance and R_b in series. To determine this impedance, we must consider the rise time of the input as though it were the first quarter of a sine wave defined as having a frequency

$$f_r = \frac{1}{4\,t_r} \tag{12}$$

Since

$$X_c = \frac{1}{2\,\pi\,f_r\,C_g}$$

Eq. (11) may be rewritten as:

$$C_g >> \frac{1}{2\,\pi\,f_r\,R_s} \tag{13}$$

Substituting Eq. (12) in Eq. (13);

$$C_g >> \frac{2\,t_r}{\pi\,R_s} \tag{14}$$

The second restriction placed upon C_g is its effect in conjunction with R_g in delaying the buildup of voltage at the input diode anode to the value at the collector. Since R_g need be only large enough to prevent crosstalk to the collector circuit, its value may be arrived at by specifying that $R_g > 10\ R_L$. R_g and R_L form the series voltage divider which might tend to introduce input signals to the collector circuit.

The value of C_g may then be specified by noting that

$$C_g\,R_g << \frac{1}{f_m} \tag{15}$$

to assure that the capacitor C_g will be fully charged between successive inputs. This charging cycle assumes a low-impedance input, the most likely condition when a large number of circuits are being simultaneously operated.

From Eq. (15);

$$C_g << \frac{1}{f_m\,R_g} \tag{16}$$

Combining the limitations of Eqs. (14) and (16);

$$\frac{2\,t_r}{\pi\,R_f} < C_g << \frac{1}{f_m\,R_g} \tag{17}$$

We are now fully equipped to establish component values.

Problem Solution

Assume a circuit which has the following restrictions:

$\beta = 50$ $\qquad$ $\Delta V_c = 10$ v. $(K = 10/12 = 0.83)$,

$V = 12$ v. $\qquad$ $f_m = 1$ kc and $t_r = 1\ \mu$ sec.

A transistor will be selected which has a maximum voltage rating of 20 v. to allow the limit of V with tolerance, and an f_{co} of 1 MC, to cover the 1 μsec requirement with a wide margin. We also learn from the transistor characteristics that I_{co} at the maximum temperature of interest is 5 μamp, and that I_{max} is 20 ma. $(V_{be})'$ is 0.2 v.

Step 1: Select I_c.

$$20 > I_c >> (50)\ (0.005)\ \text{ma.}$$

Select I_c at 2.5 ma to meet these requirements while imposing low power supply drain.

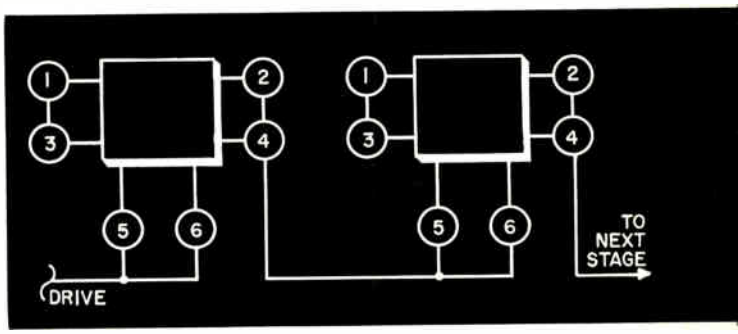


Fig. 4: The basic "black box" is connected as a binary counter.

Step 2: Select R_L from Eq. (1):

$$R_L = \frac{10}{2.5 \times 10^{-3}} = 4000\ \Omega$$

Step 3: Select R_c from Eq. (9):

$$R_c = \frac{-4 \times 10^{-3}}{12\ (0.83 - 1)} = 18{,}700\ \Omega$$

Step 4: Select R_b based on Eq. (3):

$$R_b = \frac{0.2\ (4 \times 10^3 + 20 \times 10^3)}{12 - 0.2} = 407\ \Omega$$

Step 5: Determine the value of C_c, based on the calculation indicated in Eq. (10):

$$C_c << \frac{407 + 4000 + 18700}{\pi \times 10^3 \times 18700\ (4407)} = (0.092\ \mu f)$$

The value of R_g is selected to be greater than $10 \times 4000\ \Omega$, and a standard value of 47000 is chosen. Similarly, the values for R_b, R_c, R_L, and C_c are adjusted to the nearest standard component. When making this adjustment, choose the next higher value for R_b and R_L and the next lower value for R_c.

Based upon a value of 500 Ω for the diode forward resistance and a series R_b of 470 Ω, C_g is determined from Eq. (17) as:

Flip-Flop *(Continued)*

$$\frac{2 \times 10^{-6}}{\pi \times 0.907 \times 10^{3}} < C_g < < \frac{1}{10^{3} \times 4 \times 10^{4}}$$

and C_g is chosen to be 0.001 μf. Note that an increase in t_r or an increase in f_m cannot be arbitrarily made, since alteration of these factors will affect the reliability of the circuit should either of the limits in Eq. (17) become incompatible with the other. For example, a rise time of 1 μsec is not compatible with a f_m of 100 KC.

Converting all calculated values to the nearest standard components, the circuit parameters become:

$R_b = 470\ \Omega$ $\quad C_c = 0.005\ \mu f$

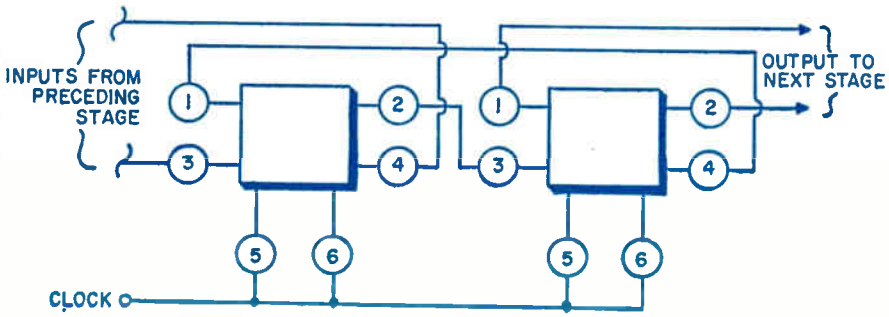
$R_c = 18{,}000\ \Omega$ $\quad C_g = 0.001\ \mu f$

$R_L = 4200\ \Omega$

These values are illustrative of a computation for the basic circuit configuration. The same circuitry, however, can be rearranged to form a general-purpose basic circuit, Fig. 2. The only change is the breaking of the connection between R_g and the transistor collectors and the connection of these point to separate terminals. A basic unit is thus formed, having 6 input/output terminals available, and one ground and voltage input.

By utilizing the "package" form, a basic circuit element may be constructed which will permit the use of the element as a "black box" in logical circuitry, with the 8 numbered terminals of Fig. 2 as the only accessible points. Figs. 3, 4, and 5 show the manner in which these circuits may be interconnected to form, in addition to the basic flip-flop, a binary counter stage and a shifting register.

Fig. 5: Two of the basic elements are shown here connected as a shifting register.



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Lo et al, *Transistor Electronics.*
R. F. Shea, *Transistor Circuit Engineering.*

Aluminum Strip

SPECIAL aluminum strip conductor in thicknesses ranging from all gages of foil to light-gage sheet, is now available for winding coils from small solenoids to power transformers.

No. 3 EC alloy, developed by Aluminum Co. of America expressly for this use, has a minimum conductivity of 61% I.A.C.S.

Coils wound with aluminum strip are in general less expensive than copper-wire-wound coils. A useful rule-of-thumb guide is that most coils wound with copper wire size AWG 24 gage and larger will be less expensive if wound with aluminum strip.

Specific advantages of the material include: lighter weight, higher space factor, better heat dissipation, adaptability to mass production techniques, and reduced insulation requirements.

In general an aluminum strip winding weighs only ½ as much as the copper in an equivalent winding. Space factor of aluminum strip can be 85% to 90% and even higher; for copper wire 55% to 65% is typical. Thus, although more conductor volume is required, the total space occupied including insulation, is about the same. Variations in space factors will be dependent on the strip-to-insulation thickness ratio.

Aluminum strip windings permit higher current densities, because each turn has lateral radiating edges exposed to the cooling medium. This feature permits considerable design latitude in either reducing the cross section of the aluminum used, or increasing the current rating for equivalent heat rise. Layer-to-layer temperatures are nearly uniform; hot spots inherent in conventional windings are virtually eliminated.

Experience thus far indicates that aluminum strip windings can be manufactured at considerably lower cost than equivalent wire windings.

Conventional wire windings require heavier insulations to withstand abrasion during winding, abrasion from point-to-point contact between turns, and layer-to-layer voltage (which may be many times the turn-to-turn voltage). Aluminum strip, insulation needs to withstand only turn-to-turn voltage, because a single turn occupies the entire width of the coil. Possible insulations are: inter-leaved sheets of Mylar or Kraft paper; coatings of varnish, lacquer, or epoxy; anodized films; or vitreous enamel.

Also of advantage are the requirements of joining aluminum. Successful joining may be accomplished with ultrasonic welding, high temperature soldering, shielded inert arc welding, cold pressure welding, resistance welding, and mechanical joining.

Property	Hard-Drawn Copper Wire	Aluminum Strip No. 3 EC
Weight (lb/ cu in.)	0.321	0.098
Specific gravity	8.89	2.70
Coefficient of linear expansion (/°C)	0.000017	0.000023
Thermal conductivity at 20°C (watts/sq in.) / (in./°C)	9.7	6.0
Electrical conductivity at 20°C, per cent IACS	97	61.0
Electrical resistance at 20°C (microhms/sq in./ft.)	8.40	13.14
Temperature coefficient of electrical resistance at 20°C (/°C)	0.00381	0.00409
Modulus of elasticity	17 x 10⁶	10 x 10⁶

CINCH HEAT DISSIPATING

TUBE SHIELDS

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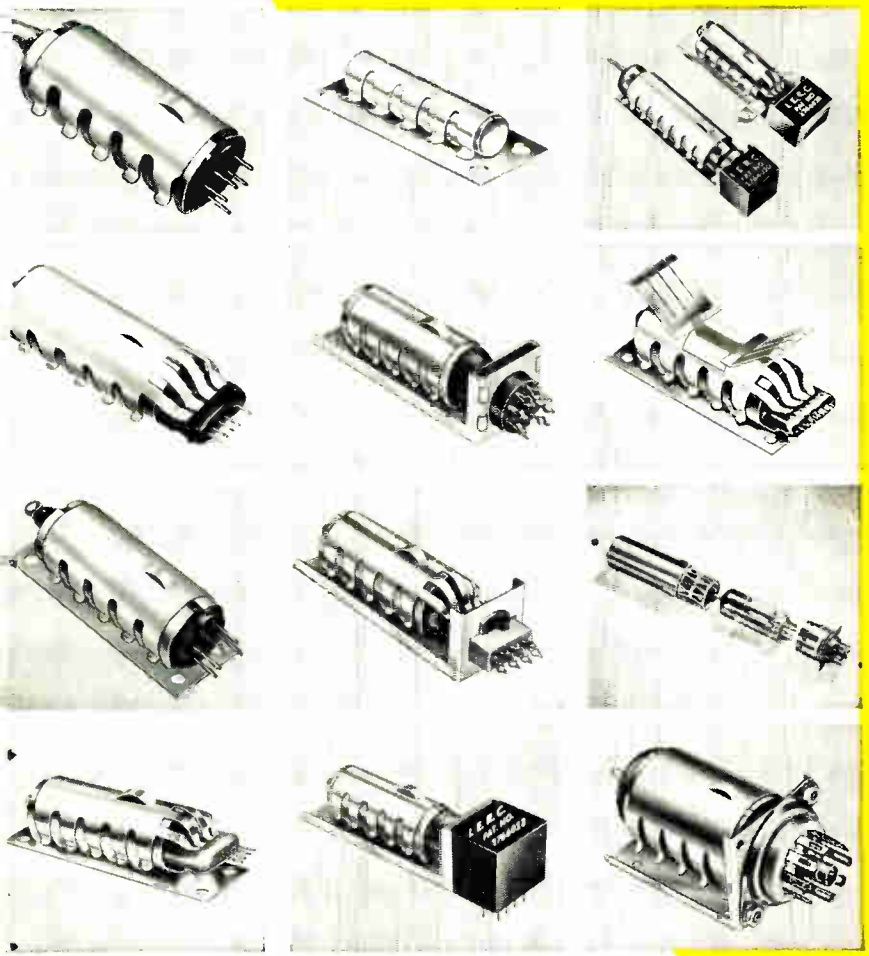
from CINCH—the complete line of HEAT DISSIPATING TUBE SHIELDS, for Miniature, Subminiature, Octal and Power Tubes.



SUBMINIATURE AND MINIATURE SHIELDS

T5 and T6

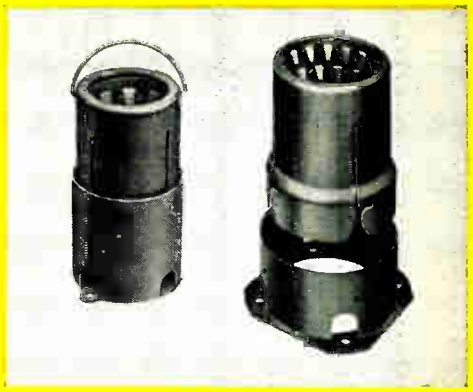
TR5 and TR6

The 7 and 9 pin Miniature Series, T, TR and NW Series are variously covered by Military Specifications:

MIL-S-9372B (USAF)
MIL-S-242A (Ships)
MIL-S-19786A (Navy)
SCL-6307/2 (Signal Corps)

In the Octal and Power Series, the shields are covered by Redstone Arsenal and Signal Corps approval.

Where shields are required blackened, Henderlube is supplied as the Standard finish.



OCTAL and POWER SHIELDS

Centrally located plants at Chicago, Illinois, Shelbyville, Indiana, La Puente, California and St. Louis, Missouri.

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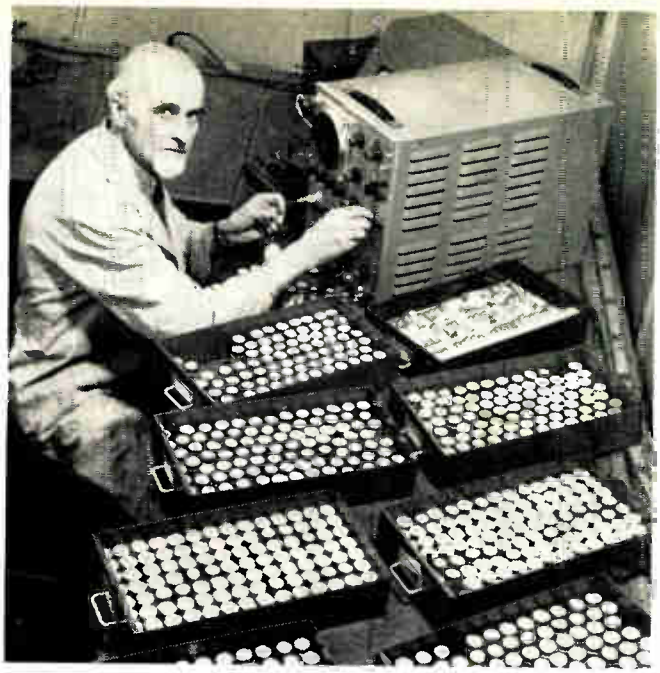
Circle 53 on Inquiry Card

(Above) High-speed core handler that picks up and positions 12 cores per second is demonstrated by inventor, V. Goldswaithe

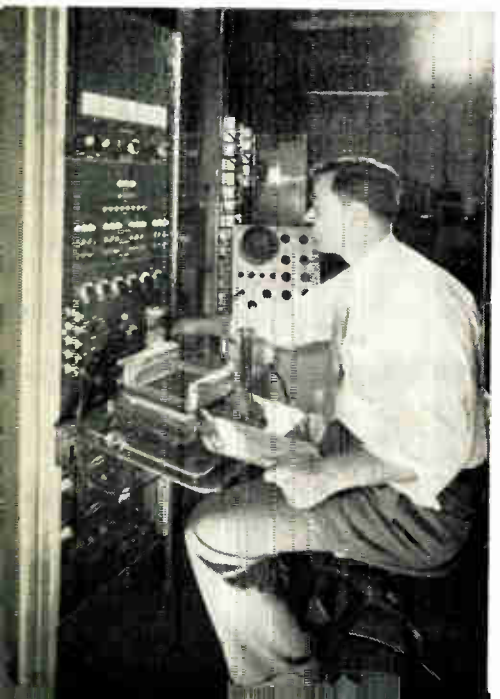


Dr. E. Albers-Schoenberg, vice-pres. and director of research at General Ceramics, checks characteristics of ferrite materials

Ferrite Cores— for Computers

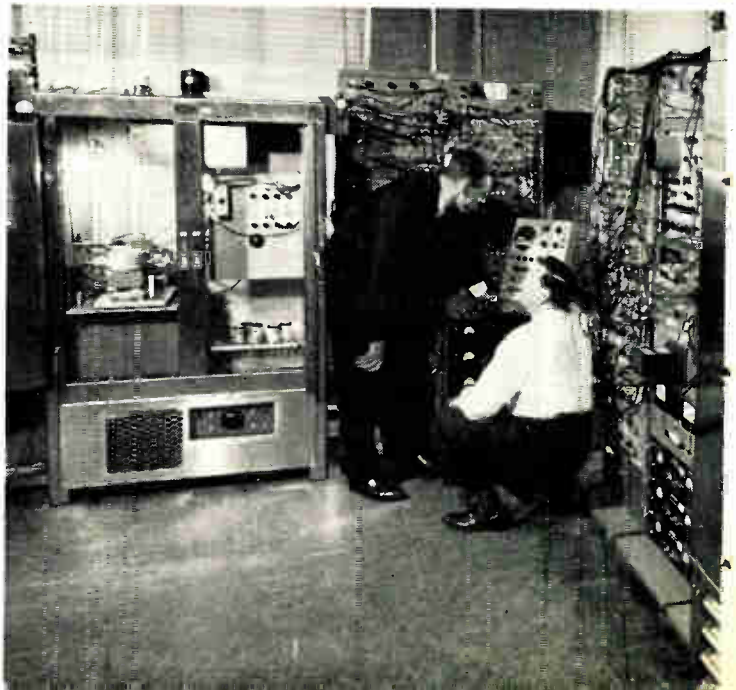
(Right) Ferrite memory cores are only slightly larger than pin heads

By applying automatic production

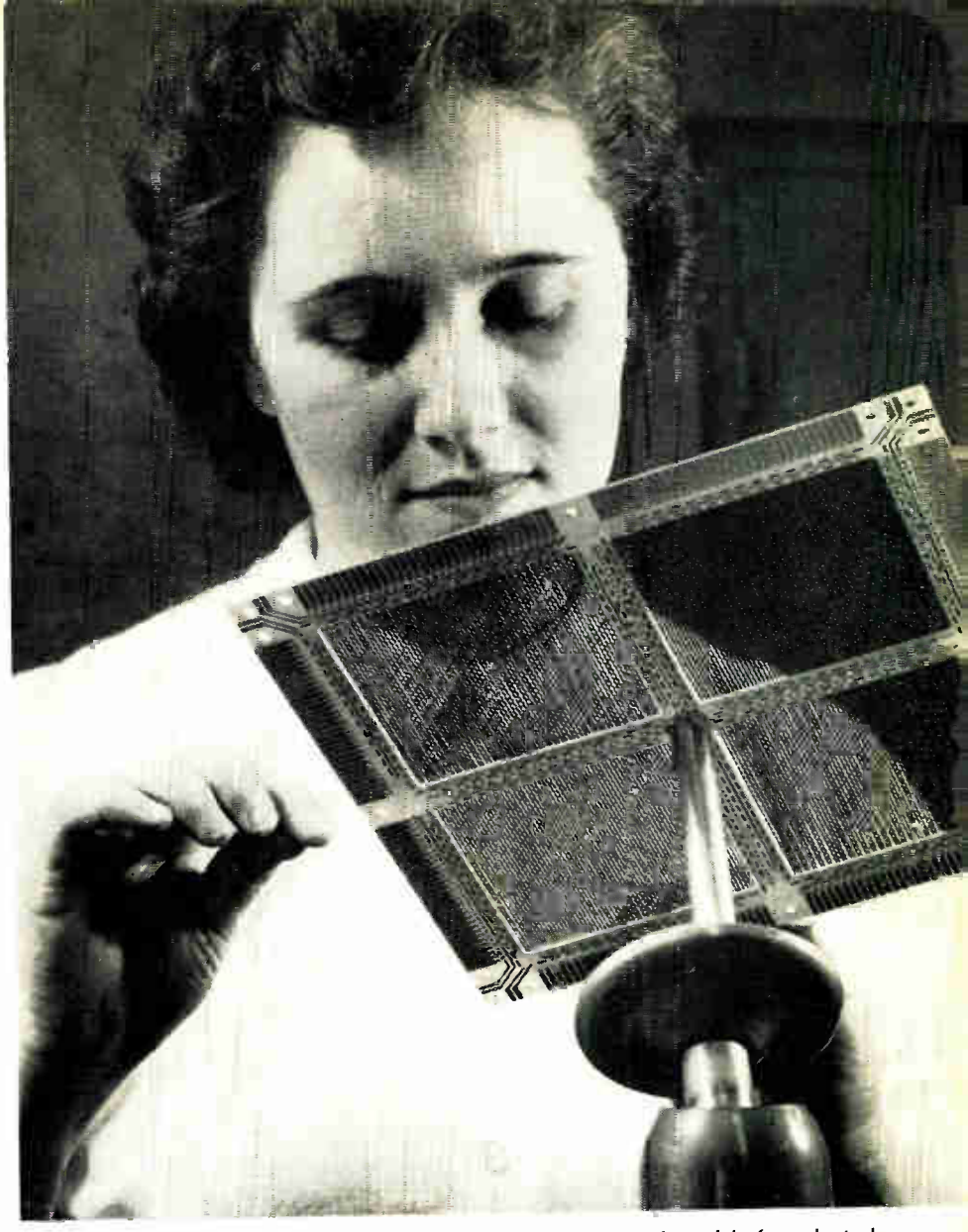


Fully automatic plane tester (left) is unique in the industry

Core testing units (right) check electrical performance at rate of 12 per second



Pneumatic core positioner lines up ferrite memory cores so that girls can wire them

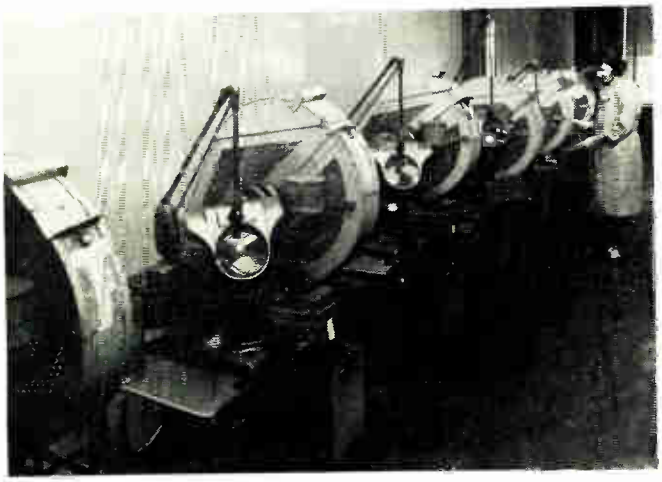


Cores are wired into memory plane. Work is done in an air conditioned, dust-free room

Wiring a memory plane. Job formerly took 70 to 80 hrs, now it takes only 7 to 8 hrs.

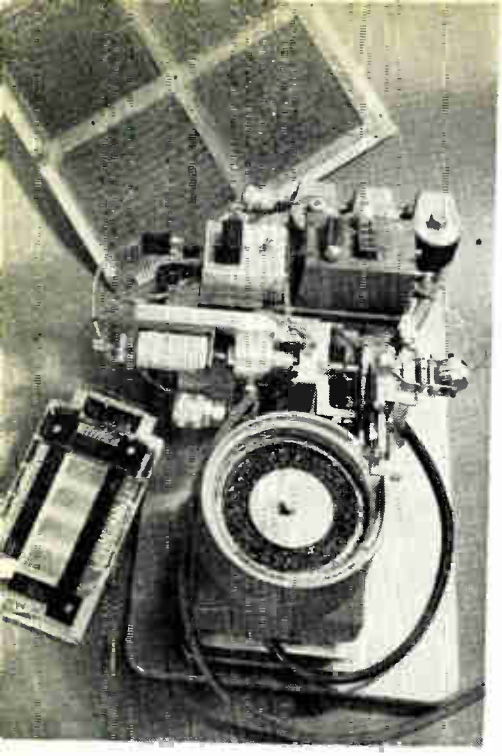
and testing equipment General Ceramics has reduced

the price of memory planes from $800 to $275

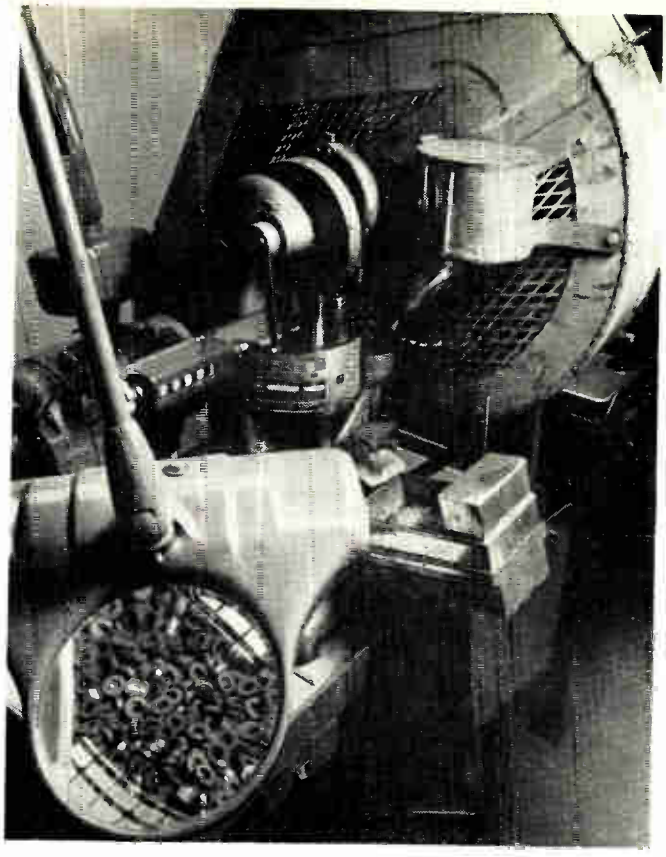


(Left) Battery of Stokes presses forms memory cores. Cores are then fired

(Right) D. Haagens, engineering manager, checks plug-in assembly and memory plane



(Left) Core handler handles 12 cores per sec., as small as .050 in. diameter

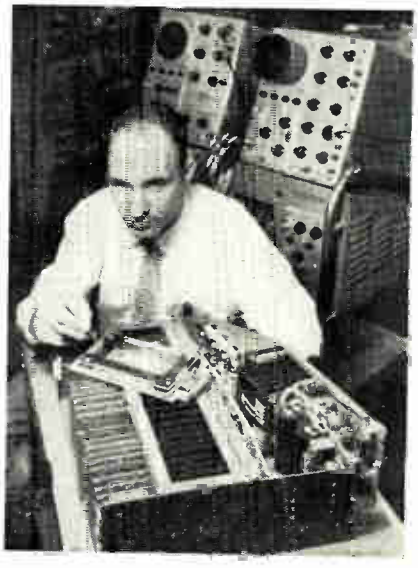


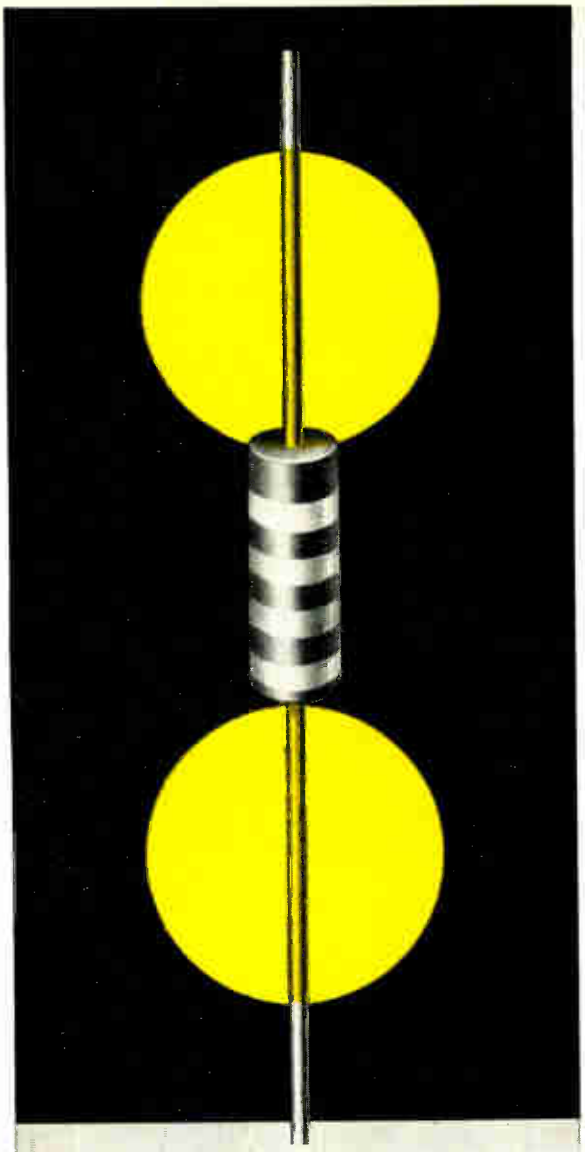
Core press (Right). Cores in the 'green state' (before firing) may be seen through magnifying glass

Ferrite Cores— for Computers

(Concluded)

(l) Performance of new buffer memory is checked on oscilloscope at Applied Logics Division. (r) Frank Lewis checks new buffer memory designed for Kineplex transmission system





Coldite 70+ Resistors Save You Money on Assembly Work!

Stackpole Coldite 70+ resistors solder easier and stay soldered more surely. Thanks to an extra solder coating applied AFTER the usual tin-lead coating, they solder perfectly by ANY method — dip or iron. Moreover, resistance variations from normal soldering heat are negligible.

Get a head-start on production

with "solder-coated" resistors

You can pretty well take for granted that any one of several leading resistor brands will meet or exceed your performance requirements. But there's another factor to be considered too—ease of handling on your assembly lines. Mainly that means ease of soldering — and here Stackpole Coldite 70+ "solder-coated" fixed composition resistors stand head and shoulders above the field. Not only do these famous cold-molded resistors meet today's critical specifications, but they provide unmatched "solderability" on any hand or automatic, open wiring or printed circuit operation. That makes not only for a real saving in assembly work, but also stands to reduce subsequent service costs resulting from poor soldered connections.

ELECTRONIC COMPONENTS DIVISION
STACKPOLE CARBON COMPANY, S.T. MARYS, PA.

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Coldite 70®+

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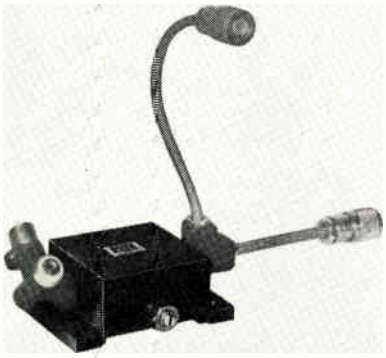
CERAMAG® FERROMAGNETIC CORES • SLIDE AND SNAP SWITCHES • VARIABLE COMPOSITION RESISTORS • CERAMAGNET® CERAMIC MAGNETS • FIXED COMPOSITION CAPACITORS • ELECTRICAL CONTACTS • BRUSHES FOR ALL ROTATING ELECTRICAL EQUIPMENT • HUNDREDS OF RELATED CARBON, GRAPHITE, AND METAL POWDER PRODUCTS

Circle 54 on Inquiry Card

New Products . . . for the Electronic Industries

S-BAND FILTER

A new S-Band microwave filter is available for radar systems applications. The 12-ounce filter, with a tuning range in excess of 300 MC, is available with non-tunable mixer and

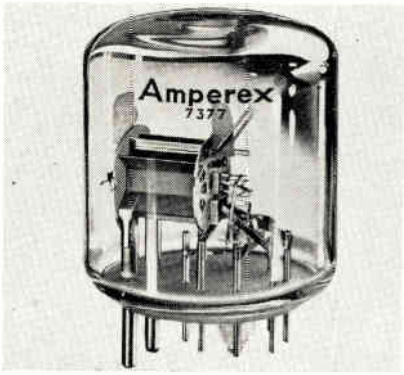


diplexer units. Insertion loss is less than 1.5 db for 15 MC bandwidth. Input VSWR less than 1.5 to 1 and load VSWR less than 1.5 to 1. Overall dimensions are: 2 in. long, 3 in. wide and 1¼ in. high. Single tuning adjustment with locking device, or individual tuning adjustments, are optional. Avion Div., ACF Industries, Inc., 11 Park Place, Paramus, N. J.

Circle 177 on Inquiry Card

UHF AMPLIFIER

New type 7377 tube is a radiation cooled, indirectly heated, twin tetrode with low output impedance. It is designed for applications as an RF amplifier and tripler in mobile and small

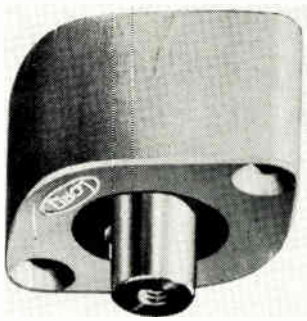


transmitters and in link communications for TV programs. Plate output capacitance is 0.82 uuf for both sections of the tube in push-pull. Plate to grid capacitance is neutralized internally and amounts to 0.145 uuf for each section. High transconductance (10,500 micromhos). Amperex Electronic Corp., Power Tube Div., 230 Duffy Ave., Hicksville, L. I. N. Y.

Circle 179 on Inquiry Card

MOUNTINGS

Two new sizes, HTO-1 and HTO-2, extend the BTR (broad temperature range) elastomeric mountings into the lower load ranges. They have load capacities of 1 and 2 lbs. Unit weight



of each is 1 oz. Characteristics include: broad temperature operation from −65° to +300°F., extreme environmental resistance, all-attitude protection, isolation of frequencies to 2000 CPS and high internal damping. They are designed for protecting small electronic units in jet aircraft and guided missiles. Lord Mfg. Co., Erie, Penna.

Circle 181 on Inquiry Card

REFERENCE PACKS

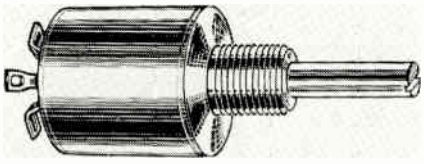
Miniaturized voltage reference packs capable of maintaining voltage regulation to within ±0.01% are now available to replace standard cells or dry cell batteries in all equipment requiring stable voltage references. Output voltages of either 8.4 or 16.8 vdc are available in 5 distinct types that allow operation from either 28 vdc or 115 vdc, 400 and 60 cycle power supplies. Temperature coef-

ficient of these devices is ±0.001%/°C from −55° to +100°C. Voltage regulation is ±0.01% (at ±10% line voltage variation). International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.

Circle 178 on Inquiry Card

"WATER-TIGHT" POTS

New APW ½ in. water-tight potentiometer has a glass-to-metal solder sealed header, including terminal lugs installed with a glass-to-metal seal, and positioned for easy wiring. The brass case is plated in conformance with military requirements. Sealed against moisture and salt spray by means of an "O" ring shaft seal, as specified in MIL-E-5272A and other military specifica-

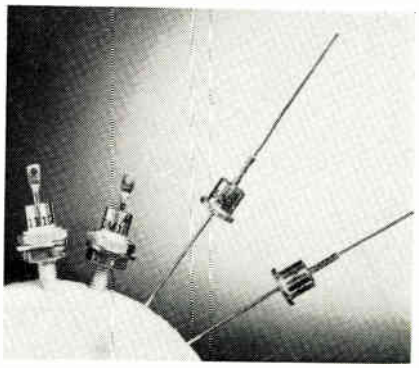


tions, and the terminal board is solder sealed to the case, assuring a watertight seal. High temperature feature, with the potentiometer derated to zero watts at 125°C. Waters Mfg., Inc., Wayland, Mass.

Circle 180 on Inquiry Card

SILICON RECTIFIERS

A wide variety of diffused junction silicon rectifiers is now available in industry standard "Top Hat" and "Stud Mounted" welded packages. All units have very low back currents at high temperatures. Exceptionally high surge current handling capacity and excellent stability. Meet or exceed environmental conditions of MIL-T-19500A. The new Stud Mounted rectifiers are types 1N1115

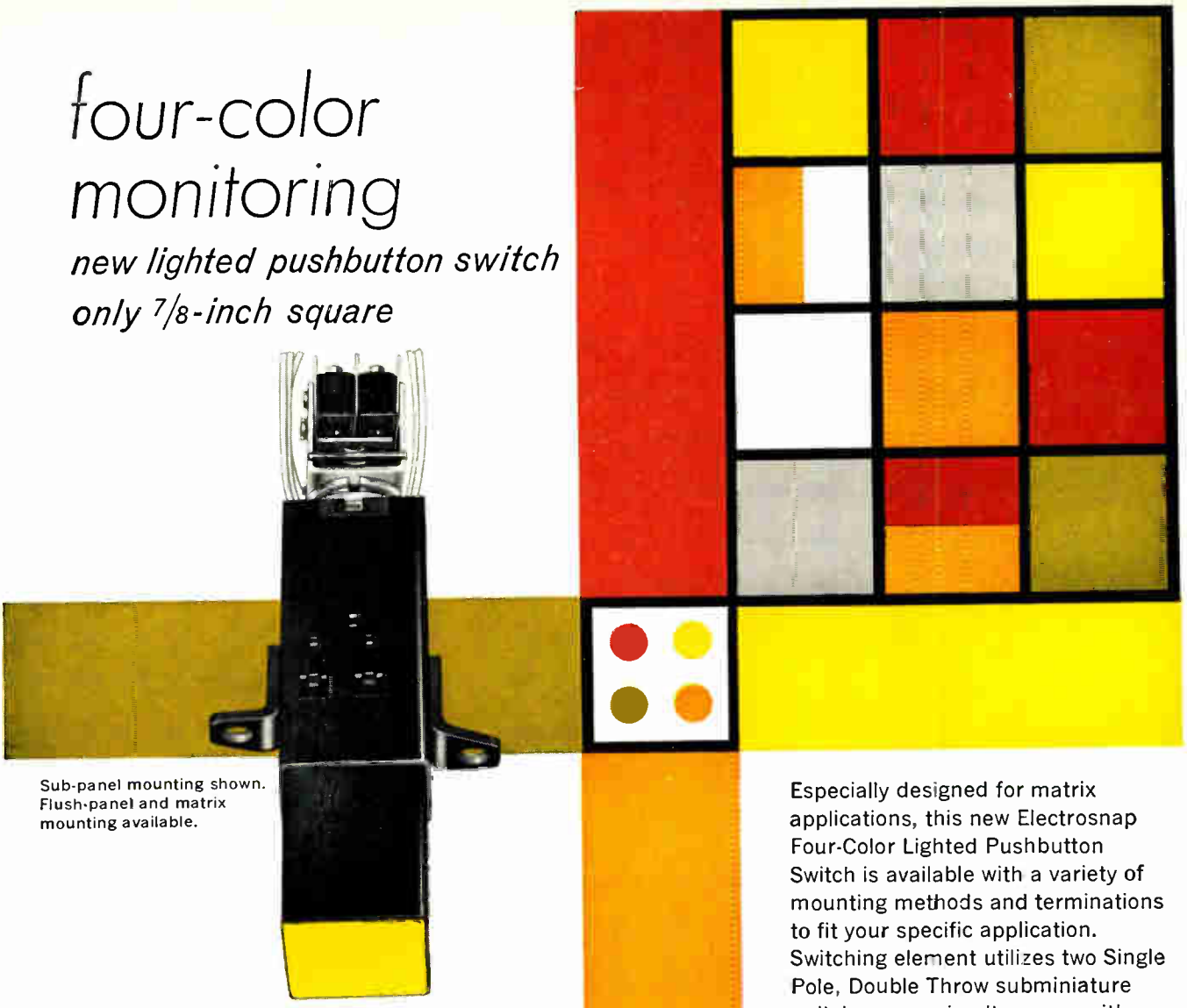


thru 1N1120 and 1N253 thru 1N256. The Top Hat rectifier are types 1N536 thru 1N540, 1N1095, 1N1096, and 1N547. Motorola Inc., Semiconductor Products Div., 5005 E. McDowell Rd., Phoenix, Ariz.

Circle 182 on Inquiry Card

four-color monitoring

new lighted pushbutton switch only 7/8-inch square



Sub-panel mounting shown. Flush-panel and matrix mounting available.

Drastically reduces panel space requirements.

Designed to meet human factor specifications.

Switches mount in matrix on 1/8-inch centers, both directions.

Mechanical Interlocking for master resetting or mutual cancellation.

All four bulbs and color filters easily removed from front of panel.

Mounts with or without barriers.

Especially designed for matrix applications, this new Electrosnap Four-Color Lighted Pushbutton Switch is available with a variety of mounting methods and terminations to fit your specific application. Switching element utilizes two Single Pole, Double Throw subminiature switches, non-simultaneous, with Alternate Action (push-on, push-off) or positive-feel Momentary Action. Switches and lamps may be interwired or terminated independently. Color filters available in combinations of any of six standard colors, plus white. For indicating duty only, unit is supplied without switches.

We would like to send you a specification drawing which meets your requirements. What are they?

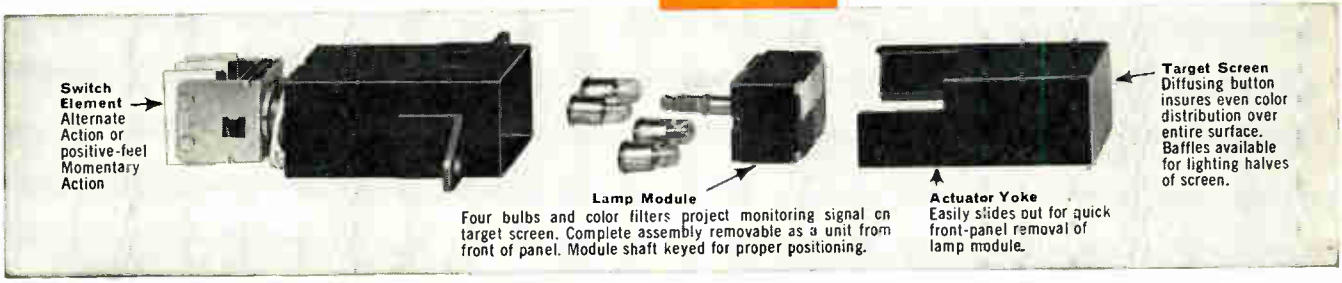
ELECTRO SNAP

ELECTROSNAP CORPORATION

SWITCH DIVISION

4244 West Lake Street, Chicago 24, Ill.

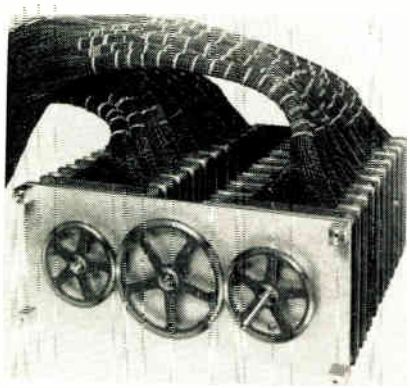
Telephone VAn Buren 6-3100 • TWX No. CG-1400



New Products . . . for the Electronic Industries

GEAR DRIVEN SWITCH

Gear driven switch, substantially larger than the standard switch size, expands the CES and NETE types. Prewired for easy assembly into the customer's equipment. Gear driven



switching arrangement is for 72 positions and 20 poles. Unit is fabricated with rugged aluminum frame. Available in phenolic and glass epoxy deck materials. Contacts may be either nickel silver or coin silver. Custom-built for individual requirements. Cinema Engineering Co., 1100 Chestnut St., Burbank, Calif.

Circle 183 on Inquiry Card

POWER RECTIFIER

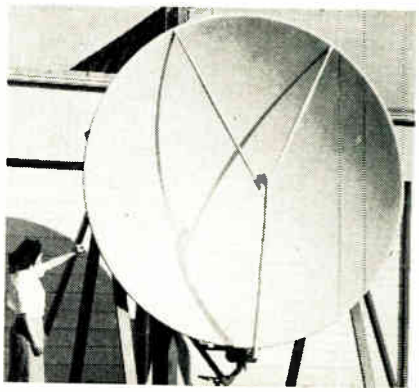
New heavy-duty silicon rectifier, a stud-mounted unit, features a high-current rating of 35 amperes at 150 degrees C case temperature. A standard 11/16 in. hex base encap-

sulation provides ease of mounting and an adequate heat-sink. Peak inverse voltage ratings range from 50 to 400 volts. Operating and storage temperatures range from −65 to 200 degrees centigrade. For detailed information write for preliminary bulletin PB 54. Transitron Electronic Corp., Wakefield, Mass.

Circle 185 on Inquiry Card

PARABOLOID REFLECTOR

A large, paraboloid reflector-antenna structure for use in determining the reflection of radio waves from objects at great heights and distances is available. The antenna-re-

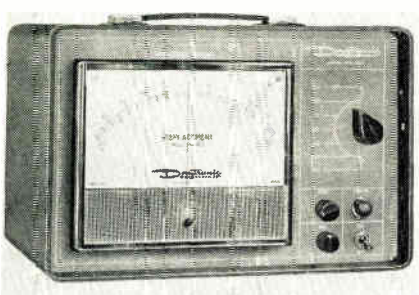


flector unit measures 10 ft. in diameter and provides for aiming or steering the assembly about two axes. Radio energy is fed to the "dish" by an S-band waveguide horn to generate a "pencil radio beam" that can be accurately focused on objects at great distances. Blaine Electronics Inc., Van Nuys, Calif.

Circle 187 on Inquiry Card

INDICATOR

Accurate, large scale indication and recording of linear motion, size, weight, force, pressure and other quantities measurable by differential transformer transducers is achieved with the new Model 300A differential transformer indicator. Completely self-contained, the instrument features a 10 in. Weston panel meter, a constant current excitation supply, self-checking features which elimi-

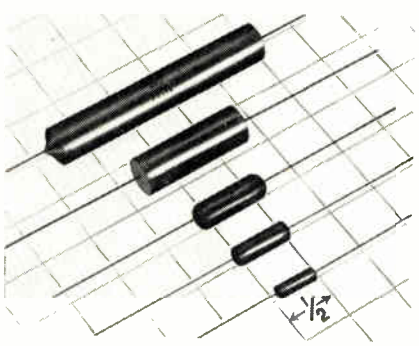


nate drift errors, and five calibrated sensitivity ranges Accuracy is 1% with maximum resolution of 0.000005 in. of core displacement. Daytronic Corp., 216 S. Main St., Dayton 2, Ohio.

Circle 184 on Inquiry Card

FILM RESISTORS

New Dalohm MF Type molded metal film resistors combine advantages of high vacuum evaporated metal film techniques with Dalohm molding process to provide the best characteristics of wire wound resistors in a miniature size. Good high frequency characteristics and low noise levels; also high stability, full insulation, low and controllable temperature coefficients. Rated at 2,

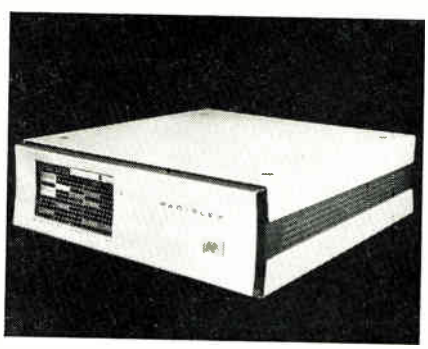


1, ½, ¼ and ⅛ watts. Resistance range is from 100 ohms to 4 megohms. Temperature coefficient is ±50 ppm or ±100 ppm. Operating temperature range is −55° to 150°C. Dale Products, Inc., Columbus, Nebr.

Circle 186 on Inquiry Card

ELECTRONIC COMMUTATOR

"Radiplex" Electronic Commutator is said to mark a major step in multiplexer design, particularly in programming flexibility; selected channels can easily be sampled much more frequently than subordinated channels. Two models: the high-level unit has a full-scale input of ±10 v. with a resolution of ±2 millivolts. The low-level model is a particularly unique engineering innovation which



provides a full-scale input of ±10 millivolts with a resolution of ±10 microvolts. Both models have a 50-channel capacity and a 24-kc sampling rate. Radiation, Inc., P. O. Box 37, Melbourne, Fla.

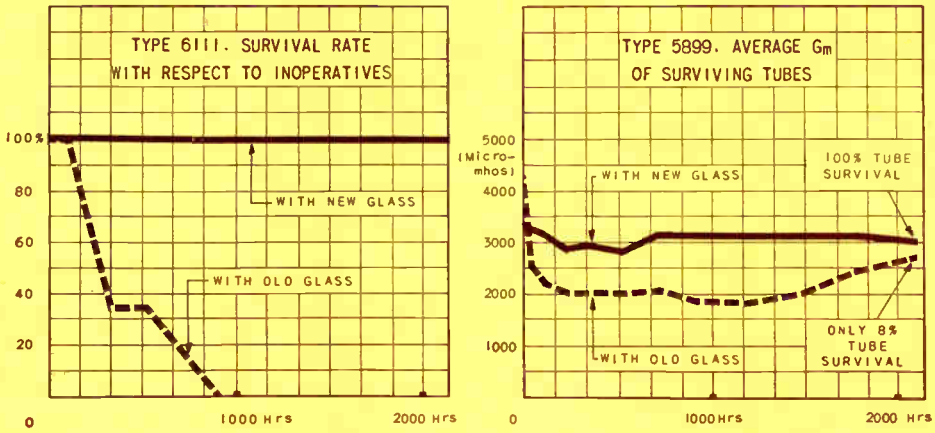
Circle 188 on Inquiry Card

GENERAL ELECTRIC

TUBE DESIGN NEWS

FROM THE RECEIVING TUBE DEPARTMENT OF GENERAL ELECTRIC COMPANY

G-E Subminiatures with New High-Resistivity Glass Show *NO* Inoperatives after 2000-Hr Tests at 300°C!



Life tests above to military specifications except for bulb temperatures, raised to 300°C. Left: shows 2000-hour inoperative percentages for Type 6111, a subminiature known to suffer from glass electrolysis at higher-than-rated temperatures. Right: shows reduced G_m drop for new glass versus old, Type 5899. At high temperatures this tube had a tendency to slump in transconductance.

The G-E Receiving Tube Department has taken an important step forward in tube technology by applying Corning Glass Works' new high-resistivity glass to 5-Star subminiature types. Test results, as indicated at left, show a spectacular increase in tube reliability.

First with high-resistivity glass for tubes, General Electric now is building subminiatures able to withstand heats that before have shortened tube life materially. Glass electrolysis—cause of 90% of subminiature failures at high temperatures—is "stopped in its tracks."

Resistance Factor 20 Times Greater

The new glass in G-E subminiatures actually has a factor of resistance 20 times that of the old. A designer can use in two ways the improved tube performance now offered him:

1. He can design with a greater safety factor.
2. He can work with assurance to equipment specifications that call for high-temperature tube operation.

Ask any General Electric tube office on the next page for further facts!

Three Advanced Tubes Now in Production by G.E.

TYPE 6EZ8. First triple triode ever designed and manufactured! General Electric's pioneering 6EZ8 is an entertainment tube for use in FM radio tuners . . . . . makes possible a *one-tube tuner*, boon to space-cramped set designers. Saves extra tube cost, too. By itself, the new 6EZ8 will handle either of these jobs: (1) r-f amplifier, oscillator, and mixer, (2) oscillator, mixer, and AFC tube.

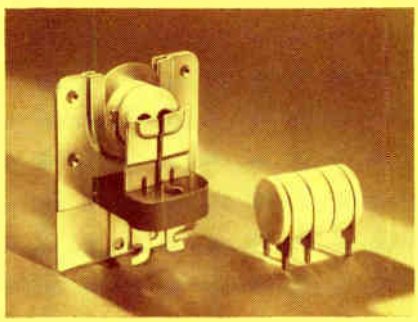
TYPE 6222. Extra-sensitive high-mu subminiature triode. A 5-Star military type, for first-stage amplification in infra-red detection circuitry. Noise level is extremely low—a maximum of 1.2 microvolts at the grid, in a test circuit of 200 cycles band width. The 6222's low noise characteristic, especially at very low frequencies, makes the tube useful in other advanced applications.

TYPE 6814. Only subminiature computer type! A 5-Star high-reliability triode intended for military use in airborne fire-control computers. Designed for binary-counter or cathode-follower applications. The 6814's extremely small size assists in optimum miniaturization of equipment.

Ready Soon: New Printboard Version of 7077 Triode

Type 7077 ceramic triode—famous as the General Electric tube which sent information to earth from Pioneer IV sun satellite for a world record distance of 407,000 miles—soon will be available for standard printboard circuitry. The new lug version has ratings which are approximately the same as those of the 7077.

The short, solderable lugs of the new tube, cut lead inductance and capacitance to a minimum. This helps make the lug version of the 7077 ceramic triode an ideal tube for application in distributed amplifier circuits.



Side by side: socket-mounted 7077 ceramic triode and new lug version (at right) for standard printboard use. Both are shown actual size. Note smaller mounted height for printboard tube, aiding the circuit designer who is faced with rigid space limitations.

Tear off and keep this sheet for reference. It contains useful tube-application data.

FOR BROAD-BAND WORK, WHAT TUBE GIVES BEST NOISE PERFORMANCE?

The Answer Is Found by Evaluating Both Tube and Circuit Parameters

As an equipment designer, you have today a choice between several low-noise, high-frequency, high-performance triodes for broad band amplifier service. Selection becomes your problem. Which tube—in the new circuit on your drawing-board—will give optimum noise performance?

High-definition radar, to name one of several applications, requires that first-stage tubes show consistent low noise over band widths of 10% to 15%. At the same time, tube gain must be sufficiently high to meet the needs of subsequent circuit stages.

In obtaining high first-stage gain, two parameters predominate —transconductance and tube capacitances. For grounded-grid work, the principal tube capacitance is the output, or grid-to-plate. Input capacitance plays a minor part.

In order to calculate power gain, you may employ this simplified expression:

$$\text{P.G.} = \frac{\mu R_L}{rp + R_L} \quad \mu >> 1 \qquad \text{—where } R_L = \frac{1}{2\pi \triangle f C_t}$$

$\triangle f$ = band width in cycles

C_t = total interstage capacitance in farads

For minimum noise figure, it is necessary to know first the equivalent noise resistance (R_{eq}) and equivalent shunt noise conductance (G_n). The expression follows:

$$NF_{min} = 1 + 2\sqrt{\frac{R_{eq}}{G_n}}$$

The optimum source resistance under this condition is:

$$R_{s\ opt} = \sqrt{\frac{R_{eq}}{G_n}}$$

After calculating $R_{s\ opt}$ it becomes evident that minimum noise figure and maximum power gain can both be obtained only when input to the tube amplifier equals $R_{s\ opt}$, and a power-match condition exists at the input network. The value R_{in} for a grounded-grid amplifier can be estimated to be:

$$R_{in} = \frac{rp + R_L}{\mu + 1}$$

Therefore, we find that input impedance depends not only on tube parameters, but also upon plate load, which in turn is dependent on the desired band width and inter-stage capacitance.

With second-stage noise, first-stage gain, and input conditions at each stage entering into the picture, it becomes clear that the available noise figure of an amplifier tube is affected by system band width, as well as tube parameters.

In order to help the designer choose between three low-noise, high-gain, high-frequency tubes—all of advanced design, but with widely different size and cost—these determining factors are calculated below for the grounded-grid case:

	TYPE 7077	TYPE 6299	TYPE 6280
Transconductance, micromhos	10,000	15,000	50,000
Amplification factor	90	115	200
Capacitance (G-P), micromicrofarads	1.0	1.7	1.5
Equiv. noise resistance (R_{eq}), ohms	285	167	50
Equiv. shunt noise conductance (G_n), micromhos at 425 mc	3,120	5,280	11,400
Minimum NF at 425 mc, in decibels	4.6	4.6	4.0
Opt. Source resistance ($R_{s\ opt}$), ohms	300	178	66
Grounded-grid input ($R_L = rp$), ohms	200	133	40
Grounded-grid gain ($R_L = rp$), decibels	16.5	17.6	20.0
Inter-stage capacitance (C_t); $C_{G—P}$ +3 micromicrofarads*	4.0	4.7	4.5
Plate load in ohms (R_L); $\triangle f = 50$ mc	800	680	710
Grounded-grid gain in decibels; $\triangle f = 50$ mc	8.6	9.7	14.8
Over-all NF in decibels, two stages**	6.8	6.4	5.7
Over-all NF in decibels, at 1/2 power points	7.2	6.7	5.8

* *Assumes 1 micromicrofarad for socket and 2 micromicrofarads for strays and tuning.*

** *Assumes power match at input.*

Minor factors have been omitted from the above calculations, but the results check fairly closely with known and published figures. They emphasize that:

1. Under optimum conditions, tubes with widely different transconductance may have similar noise levels.
2. For broad-band applications, tubes with high transconductance generally give more gain per stage with less over-all noise.
3. In broad-band work, high G_m is needed not alone for low noise, but also for enough gain at band edges to assure a relatively flat noise level across the over-all band pass.

Noise and gain at other band widths can be calculated in the same manner, to help the designer obtain optimum tube performance in line with size and cost limitations. More detailed information is available from any G-E tube office listed below.

For further information, phone nearest office of G-E Receiving Tube Department below:

200 Main Avenue, Clifton, New Jersey
Phones: (Clifton) GRegory 3-6387
(N.Y.C.) WIsconsin 7-4065, 6, 7, 8

3800 North Milwaukee Avenue
Chicago 41, Illinois
Phone: SPring 7-1600

11840 West Olympic Boulevard
Los Angeles 64, California
Phones: GRanite 9-7765; BRadshaw 2-8566

Progress Is Our Most Important Product

GENERAL ELECTRIC

2-411-103

Three-day show and convention at Dayton's Biltmore and Miami-Pick Hotels will feature 100 exhibits and 125 technical presentations. Conference theme: "Electronics Systems in the Space Age."

NAECON Meets In Dayton, May 4-5-6

THE 1959 NAECON scheduled for May 4-5-6 at Dayton, Ohio, promises to set another record in the quality of the technical presentations and the number of outstanding scientists and engineers in attendance.

This year's conference under the guidance of J. Paul Georgi, president, will feature simplified and consolidated locations of presentations and exhibits. Approximately 100 exhibits and 125 presentations are planned. Both the Biltmore and Miami-Pick hotels in Dayton are being used for both exhibits and technical presentations. Registration and conference headquarters will remain at the Biltmore.

NAECON
Technical Papers
Listed on page 172

Aside from physical layout, the conference theme: "Electronic Systems in the Space Age," has provoked many interesting comments and papers from both the individual scientist and engineer and the aircraft and electronic complexes engaged in the space effort.

The very popular technical panels which allow the audience to participate in questioning the author after a series of presentations have been expanded and will number 7 out of the 24 technical sessions. These panel sessions are in addition to the interesting forum consisting of well-known experts in their field which is scheduled for Tuesday afternoon of the confer-

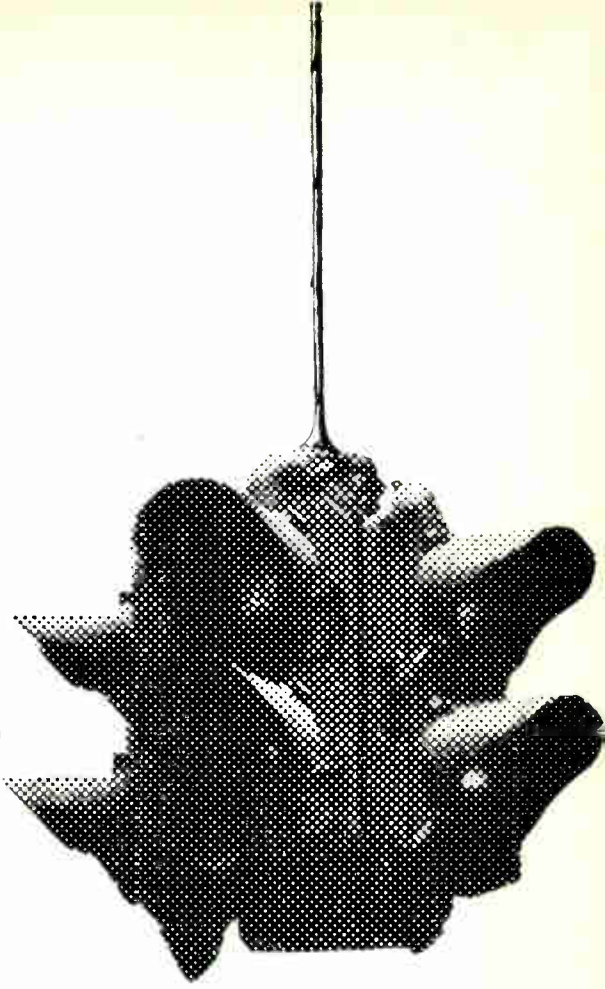
(*Continued on page* 171)

NAECON Exhibitors

Cannon Electric Co.
Chicago Aerial Industries, Inc.
Cinch Manufacturing Co.
Clifton Precision Products Co., Inc.
Collins Radio Co.
Crossley Associates, Inc.
Cubic Corp.
J. R. Dannemiller Associates
The Daven Co.
Eitel McCullough, Inc.
Electronic Communications, Inc.
Electronic News
(Fairchild Publications, Inc.)
General Electric Co.
Hoffman Electronics Corp.
Hughes Aircraft Co.
The Institute of Radio Engineers
International Telephone and Telegraph Corp.
Federal Electric Corp.
ITT Federal Division
ITT Laboratories
Kellogg Switchboard and Supply Co.
K. W. Johnson and Co., Inc.
Kay Electric Co.
Keithley Instruments, Inc.
General Precision Laboratory, Inc.
(A General Precision Company)
Librascope, Inc.
(A General Precision Company)
Kearfott Co., Inc.
(A General Precision Company)
The Satullo Co.
Sperry Rand Corp.
Sprague Electric Co.
S. Sterling Co.
Stromberg-Carlson Co.
Sylvania Electric Products, Inc.
The Tiby Co.
Tower Engineering Co.
Transitron Electronic Corp.
Universal Match Corp.
Westinghouse Electric Corp.

Aircraft Radio Corp.
Amphenol Borg Electronics Corp.
Anderson Electric Corp.
Avco Manufacturing Corp.,
Crosley Division
Avion Division, ACF Industries, Inc.
Bendix Aviation Corp.
Bird Electronic Corp.
Bomac Laboratories, Inc.
Burroughs Corp.
CGS Laboratories, Inc.
Laboratory for Electronics, Inc.
Lear, Inc.
The Martin Co.
The W. L. Maxson Corp.
Modine Manufacturing Co.
Motorola, Inc.
Norden Division of United Aircraft Corp.
Autonetics Division,
North American Aviation, Inc.
Nortronics, A Division of Northrop Corp.
Packard Bell Electronics
Philco Corp.
Radiation, Inc.
Radio Corporation of America
Raytheon Manufacturing Co.
Robinson Aviation, Inc.
Rotron Manufacturing Co., Inc.
Divco Wayne Electronics

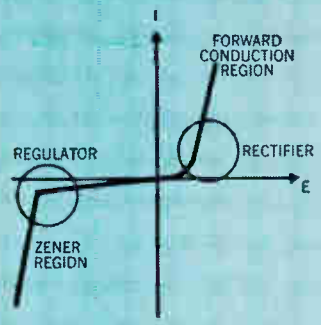
A HOFFMAN SEMICONDUCTOR APPLICATION CASE HISTORY



THIS CIRCUIT PROBLEM HAD TO BE SOLVED

FOR ELECTRONIC TRAFFIC CONTROLS

Hoffman Silicon Diodes were the solution



typical I E characteristic curve for Hoffman Silicon Diodes

ELECTRO-MATIC® Traffic Controls manufactured by Eastern Industries Inc. of Norwalk, Connecticut, require stable circuitry under extreme environmental conditions.

Hoffman Silicon Diodes were chosen to be used as "clippers" in a relay circuit which is incorporated into the magnetic amplifier for a novel vehicle radar detector.

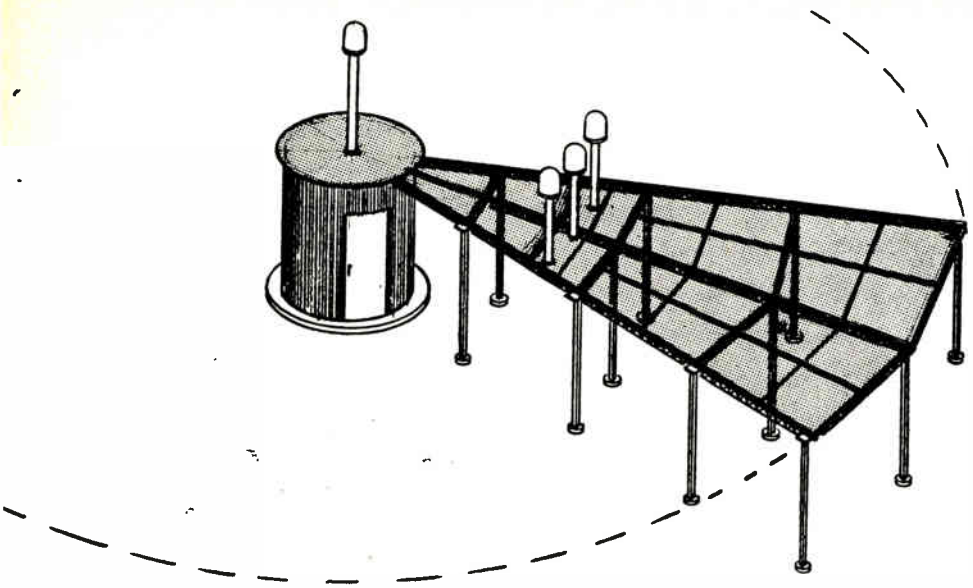
Hoffman offers the circuit designer the widest range of silicon diodes to choose from, with PIV's from 6.8 volts through 470 volts and maximum forward current ratings of 130mA down to 9mA . . . extended operating temperature range of from −65°C to +200°C. Designed to operate under severe environmental conditions, Hoffman Silicon Diodes are encapsulated in an oil filled, hermetically welded can with compression type glass-to-metal sealing at the lead ends.

For details consult the Hoffman Semiconductor Applications Specialist in your immediate area or write Department SJD.

If you need a job in electronics done quicker and better, contact

Hoffman Electronics
CORPORATION
SEMICONDUCTOR DIVISION
930 PITNER AVENUE EVANSTON, ILLINOIS

Circle 58 on Inquiry Card



The antenna counterpoise uses standard sizes of prefabricated truss sections in the horizontal structure. The vertical supports are standard rectangular tubing.

What's New

Compatible Doppler VOR

A FLEXIBLE new air navigation system offers a significant improvement in air traffic control.

High navigational accuracy of this Compatible Doppler Omnirange System can provide important improvements in the en-route guidance of aircraft along airways and can afford more effective and reliable handling of increasing air traffic at terminal areas.

System suppresses site errors due to obstructions such as hangars, power lines, trees and water towers. It is now feasible to provide navigation aid at hitherto impossible sites located in or about city, mountainous or heavily wooded areas. It will permit locating air route structures at the most desirable locations at minimum cost.

The new navigation system culminates eleven years of research and development by Servo Corp. of America, New Hyde Park, N. Y., in the field of Doppler omnirange and Doppler direction finding systems.

The new Doppler VOR system is not limited by problems of site locations, as proved in tests conducted at seven of the nation's most difficult ground sites near major airports. The test sites, selected because of their particularly difficult conditions, included airport ground stations at Indianapolis, Indiana; Charleston and Florence, South Carolina; Daytona Beach, Florida; Jackson, Michigan; New York's LaGuardia Airport; and Hermosa Beach, California, near Los Angeles.

The six major advantages of the system are described as follows:

1. It provides the pilot with a more accurate indication of the location of his aircraft. "Course scalloping" and "course bends" are minimized by the positive, accurate bearing information.

In FAA evaluation tests of Doppler VOR as compared to conventional VOR, flight check recordings showed a reduction of course scalloping at the best sites of at least 6 to 1. At the worst sites, records showed reductions as great as 20 to 1.

2. The new system increases air traffic which can be handled by reducing the width of air lanes. With the ever-increasing number of planes in the air today, this factor is extremely important.

According to one typical test report, "the roughness and scalloping on the conventional VOR occurs at all azimuths, and varies between ± 0.6° and ± 1.5°. The amplitude of any roughness, scalloping, or bend was too small to be measured on the Doppler VOR recordings." Elimination of course scalloping and course bends makes possible a corresponding reduction in required air lane width, as well as in the width of the safety bands separating air lanes. Ability to make individual air lanes narrower makes it possible to increase the total number of lanes available for increasing air traffic.

3. The system is compatible with existing airborne receivers, thus protecting an investment of over $300,000,000 in existing airborne navigation equipment.

No modification is required of the 104,000 airborne receivers estimated to be in operation today in general aircraft, commercial aircraft, and military planes throughout the world.

4. It effectively makes available double the number of radio frequencies for aircraft communication and navigation purposes.

Being a single sideband system,

the Compatible Doppler VOR System frees 50 KC of each of the 100 KC radio channels alloted to VOR.

5. The new system offers a solution for the handling of "mixed" traffic by permitting stacking of private aircraft in holding patterns.

The elevation angle feature allows for stacking of private aircraft in holding patterns to make way for jets to land. Elevation angle indication accurate to approx. ± 1.5° may be obtained at angles above 15°.

6. It provides a simple, inexpensive way for private planes to determine ground speeds.

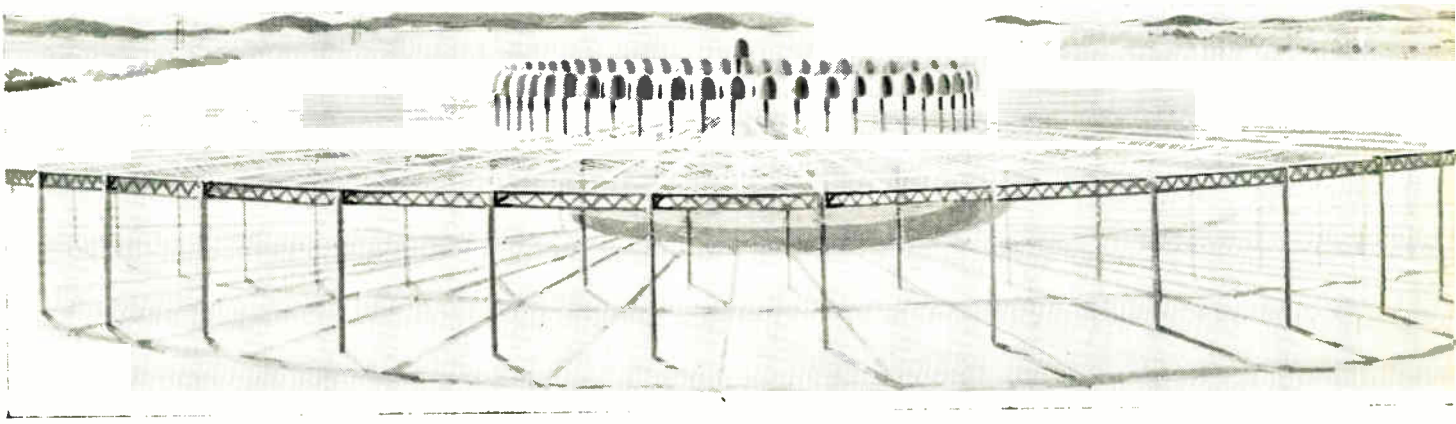
A plane over a station can determine ground speed quickly and accurately. Thus, the system affords general aviation an easy method for planning trips and reporting times of arrival.

Basic System Principles

In a quasi-Doppler omnirange the revolving antenna of a simple Doppler system is simulated by commutating a circularly disposed array of fixed antenna elements. The signal radiated from the commutated antenna system carries direction-dependent frequency modulation of information. VOR compatibility is achieved by transmitting a second carrier from an independent fixed antenna. This carrier differs in frequency by 9.96 KC from the carrier supplied to the commutated antenna. Also it is amplitude-modulated with a reference signal synchronized to the antenna commutation.

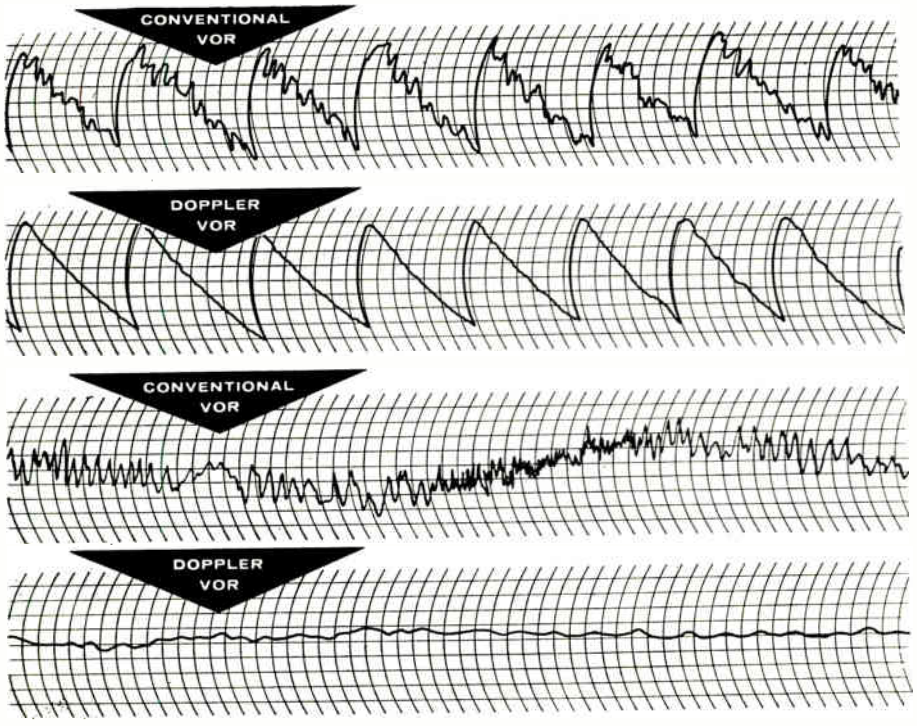
In the airborne receiver, the reference signal is detected directly and the two carriers beat together to produce a subcarrier which is frequency modulated by the bearing information. This subcarrier is demodulated by the normal subcarrier discriminator in the VOR receiver to recover a signal whose phase, relative to the reference signal, is equal to the bearing.

In the VOR-compatible Doppler omnirange, the data and reference signals are interchanged with respect to their roles in the standard VOR. This is of no practical consequence since the bearing intelligence is contained in the relative phase of the two signals.



Typical wide-aperture array of antennas used in the Compatible Doppler VOR System.

Parallel flight check recordings give comparison of bearing indications. Course roughness and scalloping are greatly suppressed and "bends" are eliminated in the Doppler System.



VOR Characteristics

The essential characteristics of the present VOR are:

Carrier Frequency Range: 108 to 118 MC.

Direction-Dependent Data: 30% amplitude modulation at a 30 CPS rate.

Reference Data: 9.96 KC subcarrier frequency modulated at a 30 CPS rate with a maximum deviation of 480 CPS. This subcarrier is 30% amplitude modulated on the transmitted carrier.

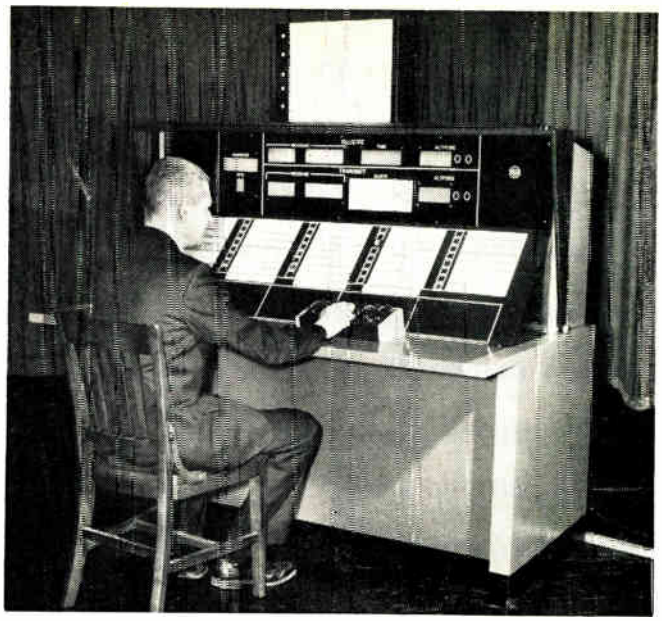
Compatibility Requirements

The Doppler omnirange signal will be compatible with existing airborne equipment if it produces the following two signals at the airborne receiver output:

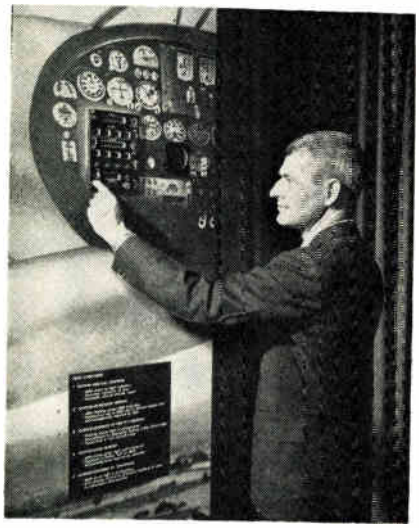
(*Continued on page* 148)

Push-Buttons Control Flight Messages

A COMMUNICATIONS system, enabling an airplane pilot and a ground control station to exchange flight information messages by merely pressing a button is under development by RCA for the Federal Aviation Agency. The purpose is to enhance safety by facilitating control of the nation's growing air traffic through increased speed and reliability of communications. It is designed to permit automatic two-way radio communications between ground control and up to 500 aircraft every two minutes.



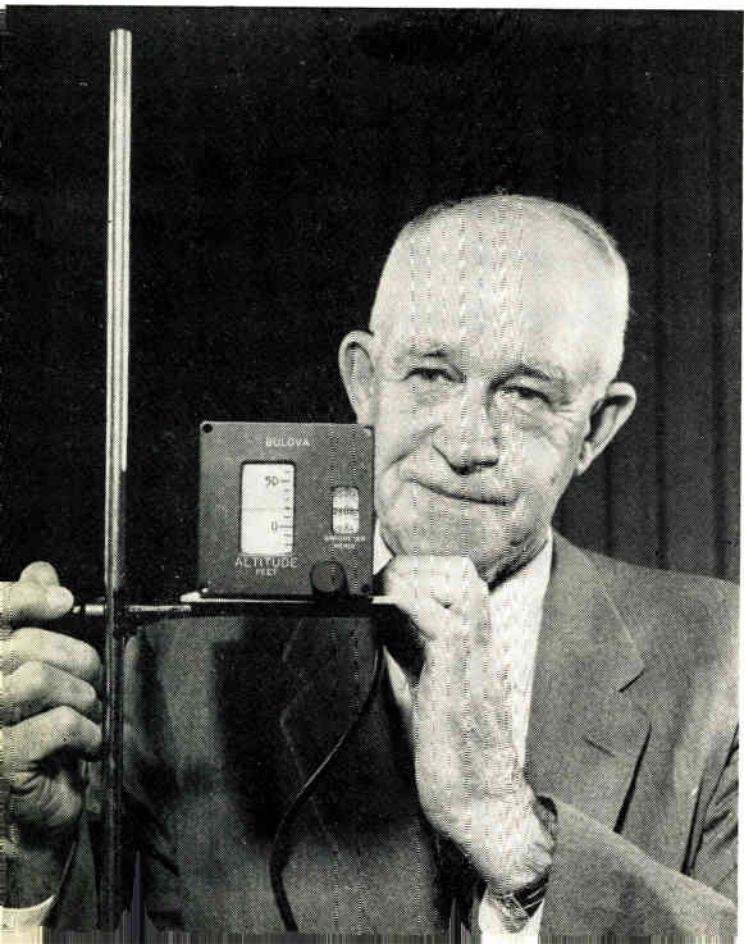
(Right): Controller presses button to display last received and transmitted messages for aircraft associated with flight progress strip.



(Left): Pilot views messages on the Airborne Display and Insertion Unit; upper portion for ground-to-air; lower, for pilot-composed.

The system, known as the Automatic Ground (Air) Communications System (or AGACS, pronounced "Ajax") is part of a long-range FAA experimental program which also includes electronic surveillance of aircraft on the ground, including their landing, taxiing and preparing for takeoff. RCA is scheduled to deliver initial models of the AGACS equipment in August, after which the

(*Continued on page* 140)



Gen. Omar N. Bradley, Board Chairman, demonstrates the extremely accurate and highly sensitive altimeter.

Easy-to-Read Altimeter

TRADITIONALLY, dating back almost to the Wright brothers, aircraft altimeters have been designed with dial faces and hands or pointers to indicate altitude. They required analyzing or interpretation, and there has been a great deal of research aimed at producing an instrument that would eliminate such requirements.

A radically different type of aircraft altimeter—said to cut reading time in half and virtually eliminate reading errors—was demonstrated recently by the Bulova Watch Co.

The USAF has ordered a test quantity of 25 Bulova altimeters for extensive laboratory testing and flight evaluation in many types of Air Force planes.

In addition to its readability the altimeter is extremely accurate and highly sensitive, reacting instantaneously to changes in altitude even in very rapid ascent or descent and thus providing improvement in the safety factor of aircraft operation.

The new instrument indicates al-

(*Continued on page* 118)

Tung-Sol moves ahead!

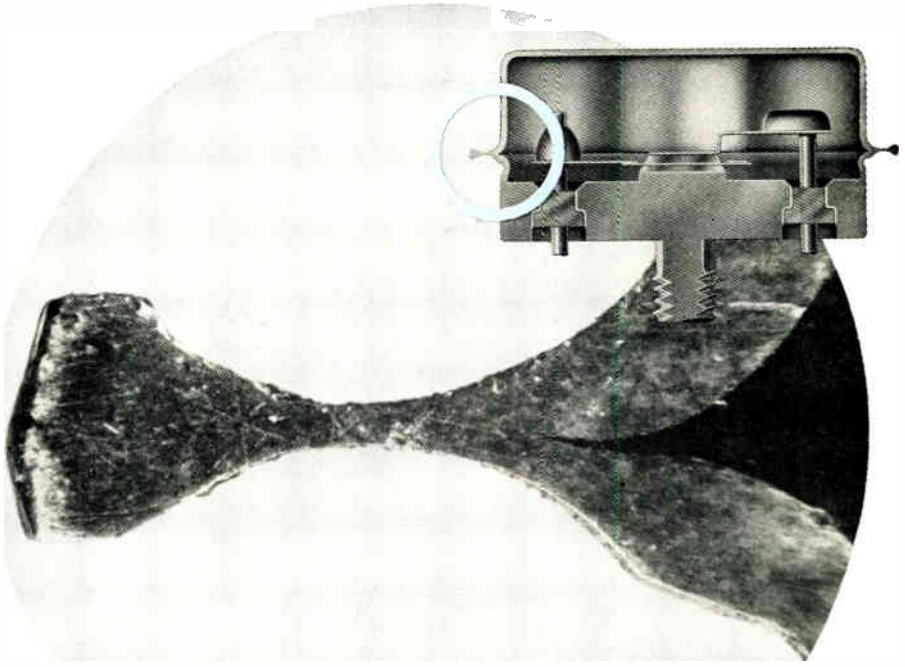
High power transistors with new **cold-weld** seal

Improved cold-weld seal gives new Tung-Sol high-power transistors three-way quality boost

True hermetic, copper-to-copper seal improves transistor thermal characteristics.

Elimination of heat-damage, heat-caused moisture and "splash" increase reliability.

Vacuum-tight, moisture-proof cold-weld seal lasts even through "breathing" over long life operation.



Photomicrograph (45X) shows circled area of cross section of Tung-Sol high-power germanium transistor cold-weld seal. Note absence of seam, indicating actual integration of copper molecules and a true, hermetic, copper-to-copper seal.

Once again Tung-Sol shows the way. Now, for the first time, Tung-Sol brings designers high-power germanium transistors with quality benefits of the advanced cold-weld seal.

The new Tung-Sol types feature a stud-mounted package and maximum collector current of 13 amps. Military environmental tests combine with the radioactive gas leak detection test to assure maximum reliability.

Technological advancements such as this keep Tung-Sol ahead of the field. For full data on the new high-power switching transistors . . . to meet any need with the latest in transistor design and efficiency, contact: Semiconductor Division, Tung-Sol Electric Inc., Newark 4, New Jersey.

Circle 59 on Inquiry Card

Easy-to-Read Altimeter

(Continued)

titude with an error of less than ten feet at sea level. Tests made by a major aircraft company show a deviation (plus or minus) of 20 feet for a Bulova altimeter at 12,000 ft, against a 200-foot deviation for a conventional altimeter on the same evaluation. Its sensitivity is such that raising or lowering the instrument as little as two feet gives a visible indication on the scale when one is at or near sea level.

Altitude readings are shown on a continuous logarithmic tape. The tape, about 40 ft long, ranges from minus 1000 ft to plus 65,000 ft, and is driven past a window in the instrument by a servo motor. It follows the true altitude without fluctuation or hunting.

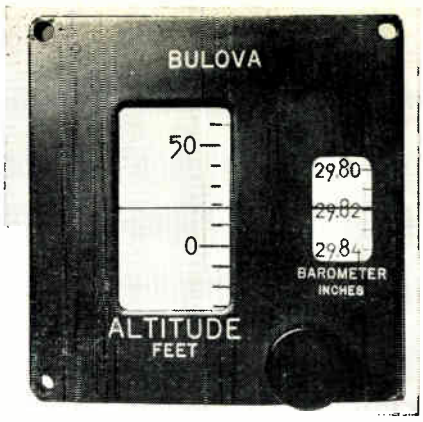
At sea level the numbered graduations are separated a full inch for each 50 ft of altitude. At 20,000 ft the numbered graduations mark each 100 ft; at 40,000 ft the graduations stand for 200-foot increments, and from 60,000 ft up the increments are of 500 ft each. There are smaller, unnumbered graduations dividing each of the major segments throughout the tape. This tape presentation supplies greatest readability and accuracy where most needed—at lower elevations and landing altitudes.

The altimeter's sensing elements are Melchoir type aneroid capsules. Bulova manufactures these itself to achieve consistently reliable performance.

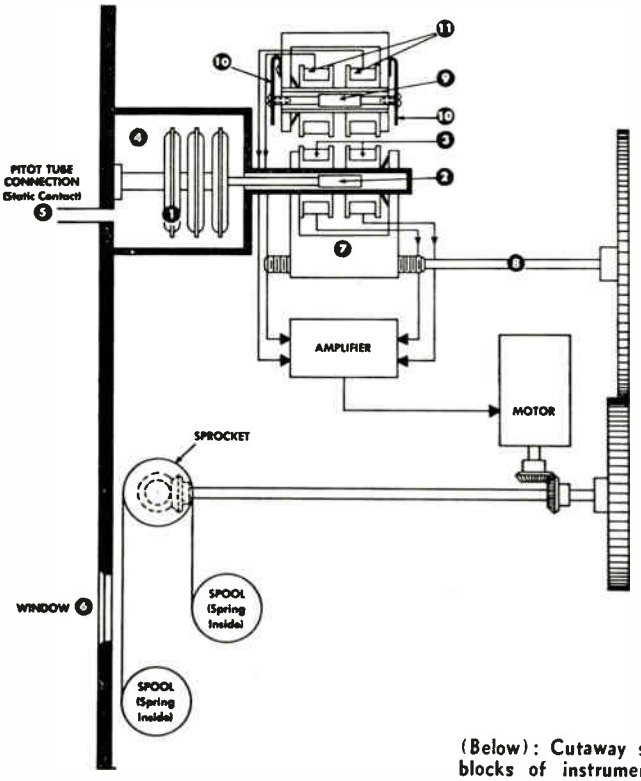
The output of the sensing elements is transferred to the indicating mechanism electrically, freeing the sensing elements of all mechanical work, eliminating friction and producing a sensitivity previously unknown. It also obviates the need for vibrational stimulation of the instrument. There have been cases where faulty functioning of an altimeter was attributed to "stickiness" due to the "too smooth" flight of a jet plane.

The new instrument is the product of a company-sponsored four-year altimetry project conducted at the Bulova Research and Development Laboratories in Woodside, New York. Production will be carried on by the industrial and defense division of the Bulova Watch Company at Jackson Heights, New York.

* * *

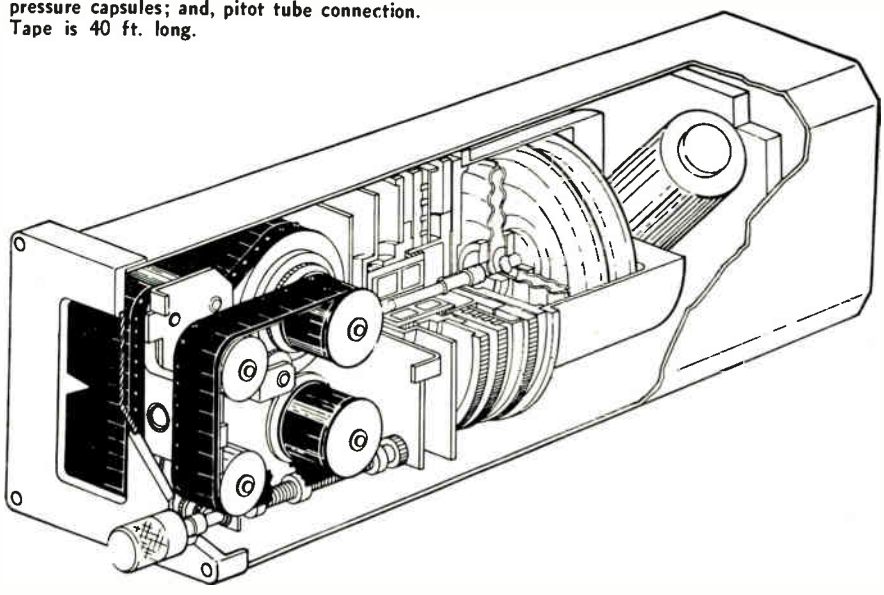


Pilot's view shows how altitude is clearly indicated on tape. Meter measures 3¼ inches square by 8½ inches in length.

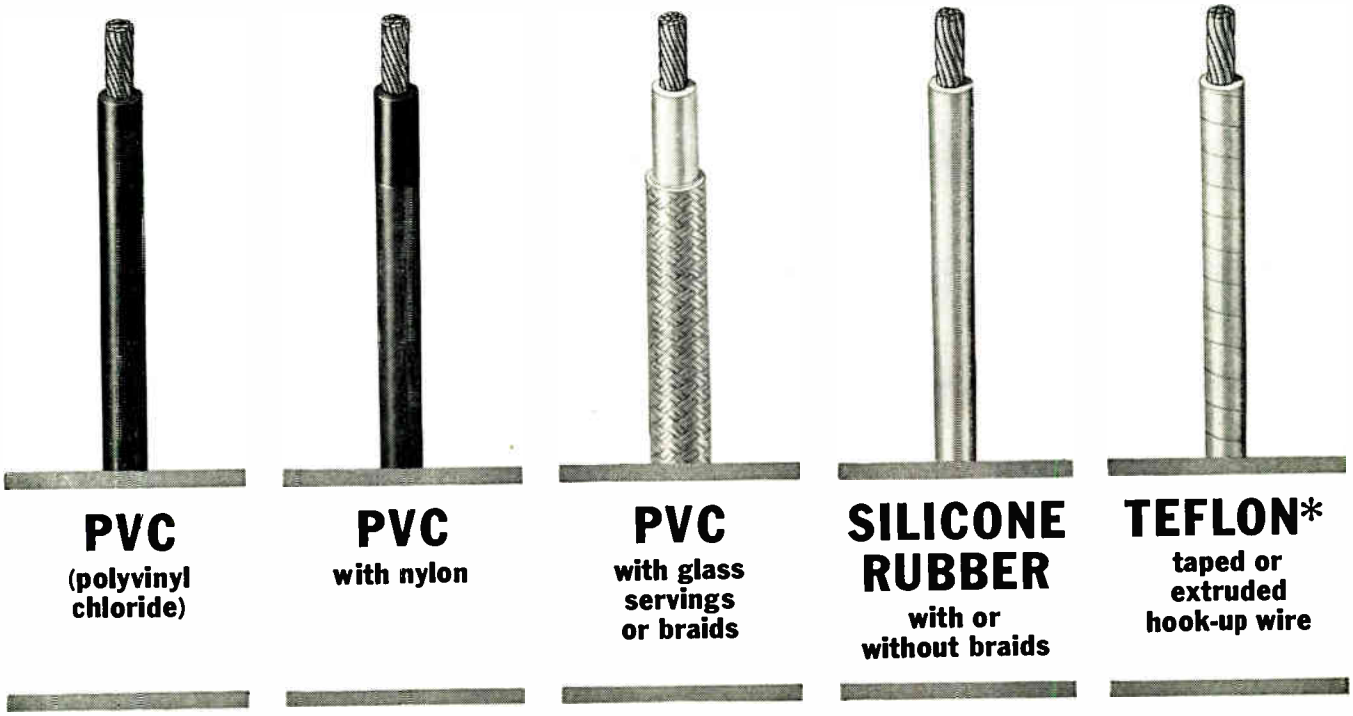


(Left): Expansion or contraction of pressure capsules (1) moves soft iron armature (2) in coils (3). Pitot tube connection (5) supplies outside air to capsule chamber (4). Signal from coils actuates servo motor which moves tape past window (6). Frame (7), transporting coils, is moved by screw (8) geared to motor returning them to null. Second armature (9), restrained by parallel motion springs (10), and second set of coils (11) eliminate gravity and acceleration errors.

(Below): Cutaway shows four basic building blocks of instrument: windows, barometric correction knob, and tape drive; servo motor; pressure capsules; and, pitot tube connection. Tape is 40 ft. long.



Auto-Lite gives you One-stop Service on all basic hook-up insulations



PVC
(polyvinyl chloride)

PVC
with nylon

PVC
with glass servings or braids

SILICONE RUBBER
with or without braids

TEFLON*
taped or extruded hook-up wire

Whatever your wire problem, you'll find the answer at Auto-Lite

You get unmatched service on any wire problem at the new Auto-Lite Wire Research Laboratory at Port Huron, Michigan. This ultra-modern facility is completely equipped to perform all qualification tests of wire for military specifications. These facilities are also available to solve *your* problems quickly and efficiently.

ANY QUESTIONS? Our new Wire Research Center will give you quick answers to your wire problems. Write for full information.

COLORS • MARKING
HIGH & LOW TEMPERATURES
ABRASION • FLEXIBILITY
VIBRATION • OVERLOAD
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MIL SPECS: MIL-W-16878
TYPES B, C, D, E, EE, F, FF, N,
MIL-W-76A, NAS-702, NAS-703

**DuPont registered trademark*

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Circle 60 on Inquiry Card

WASHINGTON News Letter

NO EXPANSION OF MILITARY BANDS—The DOD did not seek expanded military radio frequency bands when discussing the problem of providing a competitive nationwide TV system with the FCC. Lt. Gen. Arthur G. Trudeau, Chief, Army R&D, pointed out that Army requirements for electronics have increased tenfold since World War II and "we are expecting another tenfold increase by 1970." Gen. Trudeau emphasized that the military services respect peacetime frequency allocations and "carefully engineer our (electronic) operations to insure that they will be compatible with nationally allocated services in the various frequency bands."

FREQUENCY CONSERVATION METHODS — To conserve military frequencies because "the rapidly advancing radio and electronic techniques being developed for the space age require an enormous number of radio frequencies," Gen. Trudeau outlined engineering improvements. These included: transistors and other similar devices capable of operating at frequencies up to 1000 MC at low power and with output powers up to 1000 watts at lower frequencies; continued R&D in frequency control devices and techniques to conserve the spectrum and reduce interference; and, increased stability and accuracy of oscillators operating at increasingly high frequencies to permit greatly increased use of SSB radio transmission. A very important innovation will be high capacity power sources from nuclear energy, solar energy or fossil fuels.

PAY-TV TESTS—After securing the concurrence of House ICC Chm. Oren Harris (D., Ark.), formerly opposed to establishment of pay TV systems, the FCC has approved the launching of limited and controlled pay-TV single-market, single-system tests in 20 areas of the country. The areas are those with four or more commercial TV stations and the test authorizations are permitted for a period of three years only. The FCC also stipulated that no pay-TV program may be broadcast simultaneously over more than one station. Further, that viewers of test programs must not be required to buy any special equipment which they do not use for commercial television. Applications from the pay-TV organizations were slow in being submitted to the Commission.

CONGRESSMAN'S VIEWS—One of the sponsors of a Congressional inquiry into frequency allocations, Rep. Bray (R., Ind.) and a member of the House ICC, emphasized that "with the tremendously expanded use" of frequencies by broadcast and non-broadcast radio the nation has "undoubtedly reached the point where inefficient use or wasteful hoarding of the spectrum can no longer be afforded." Rep. Bray seeks an impartial investigation with a commission of experts, some of whom should be named by Congress so there would be no charges of the body being loaded or slanted in behalf of the military or the executive branch. The Indiana Congressman was skeptical of military demands for spectrum space because he intimated the armed services always felt they never have sufficient men, equipment, or communications.

NATIONAL MOBILE RADIOTELEPHONE— The FCC has commenced a study of expanding TV spectrum space, including the UHF band. However, it already has before it, in its inquiry into present and future allocation and uses of the spectrum between 25 and 890 MC, a significant presentation by four top-level Bell System officials. Bell seeks sufficient radio space for the establishment of a nationwide common carrier mobile radio system. The Bell System broadband radio plan would have a thousand channels, amounting to 8.3 MC in the 800 MC band. Bell officials stated that this would provide "for the first time, adequate communications service to people on the move." The system would not only provide for public mobile service, but for public mobile communications to aircraft and one-way signaling contact.

COMMUNICATIONS SATELLITES—With the number of overseas communications messages, including intercontinental TV, expected to multiply by sevenfold in the next decade, Dr. T. Keith Glennan, Administrator of NASA predicted that communications satellites offer the probability of solving the "growing problem of world communications." He stated that using existing microwave techniques, a satellite system could be provided with almost unlimited bandwidth. Television, which requires the equivalent of a thousand voice channels, would find great utility in this feature.

National Press Building
Washington 4

ROLAND C. DAVIES
Washington Editor

New "Custom Quality" Family By GENERAL TRANSISTOR

RESEARCH ACTIVITIES APPROACH IDEALIZED TRANSISTOR RELIABILITY

A bright new chapter in transistor history is being recorded at GT's research laboratories, resulting in progressive transistor design of unprecedented reliability, performance and stability. Advanced production control techniques have made possible the New "A-Types" with specification refinements providing . . .

TIGHTER PARAMETER CONTROL

HIGHER SWITCHING SPEEDS

HIGHER OPERATING VOLTAGES

WIDER APPLICATION RANGES

New process controls highlighted by high sensitivity hermetic seal testing, pre-tinning of internal parts, automatic welding of the hermetic seal case and individual handling of units in process insure **improved reliability, uniformity of electrical properties, high mechanical strength** and **superior hermetic seal.** All transistors are pre-aged for 100 hours at 100°C.

SPECIFICATIONS: POWER DISSIPATION: 150 MW @ 25° C STORAGE TEMPERATURE: —65° C to +100° C

TRANSISTOR TYPE (EIA)	POLARITY	CUT-OFF STATE		CONDUCTING STATE (SATURATED)		TYPICAL SWITCHING CHARACTERISTICS WITH CIRCUIT GAIN OF 20 AT I_C LISTED UNDER CURRENT GAIN		ALPHA CUT-OFF
		Collector-Base Rating BVCBO	Oper. Volt V_{CER} min. $I_{CMAX} = 10\mu a$ $V_{BB} = 1.5V$ $R_{BB} = 62K$	D.C. Current Gain h_{FE}	Conditions	Delay + Rise Time $t_d + t_r$ μSEC	Storage + Fall Time $t_s + t_f$ μSEC	f_{ab} MC Typical
2N317A	PNP	25V	12V	20— 60	$I_C = 400ma, V_{CE} = .25V$	0.3	0.7	20
2N316A	PNP	30V	18V	20— 50	$I_C = 200ma, V_{CE} = .2V$	0.4	0.9	12
2N358A	NPN	30V	20V	25— 75	$I_C = 300ma, V_{CE} = .25V$	0.4	0.9	9
2N357A	NPN	30V	25V	25— 75	$I_C = 200ma, V_{CE} = .25V$	0.5	0.9	6
								Minimum
2N523A	PNP	20V	10V	100—400	$I_C = 20ma, V_{CE} = .25V$	0.2	0.6	21
2N522A	PNP	25V	12V	80—300	$I_C = 20ma, V_{CE} = .25V$	0.3	0.8	15
2N521A	PNP	25V	15V	60—250	$I_C = 20ma, V_{CE} = .25V$	0.4	0.9	8
2N447A	NPN	30V	15V	80—300	$I_C = 20ma, V_{CE} = .25V$	0.4	0.7	9
2N446A	NPN	30V	18V	60—250	$I_C = 20ma, V_{CE} = .25V$	0.7	1.0	5
2N445A	NPN	30V	20V	40—150	$I_C = 20ma, V_{CE} = .25V$	1.0	1.3	2

WRITE FOR BROCHURES G-140A AND G-150A

Popular computer types 2N311, 2N312, 2N404, 2N426, 2N427, 2N428, 2N439 and 2N440 are also available.

You grow fastest with the products that serve you best. Prove it to yourself today with GT.

GENERAL TRANSISTOR

CORPORATION

91-27 138TH PLACE • JAMAICA 35, NEW YORK

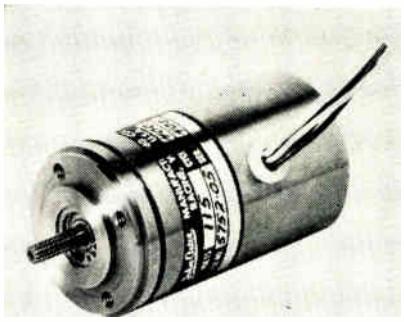
"YEARS AHEAD IN RELIABILITY"

Circle 61 on Inquiry Card

New Products

VISCOUS DAMPED MOTOR

Type 5752-05 adjustable viscous damped size 11 motor is smaller, lighter and more economical than a motor tach used in feedback damping applications. It consumes less power

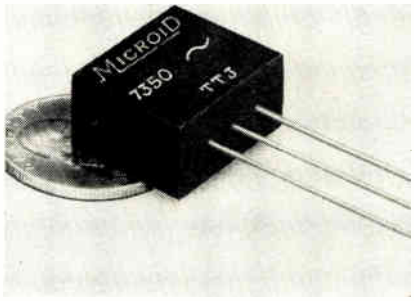


and presents no null or phasing problems in the feedback loop as compared with the motor tach which it replaces. Damping and gain may be independently adjusted. No-load speed can be quickly, easily adjusted to any speed desired between 4800 and 7300 RPM depending upon damping characteristic required in the system. Meets MIL-E-5272A. Ambient temperature range −55°C to +125°C. John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wis.

Circle 204 on Inquiry Card

MINIATURE FILTERS

"Microid" low pass and band pass filters are miniature and subminiature components for solving small space problems. Features include compactness and high reliability. Low pass "Microid" filter, Type TCLJ starts at 400 cps. Physical size is 11/16 x 1 11/16 x ½ in. max. For higher frequencies from 7,500 cycles up to 100 kc. size is ¾ x 1 x ½ in. Band pass filter Type TTJ is designed for performance on 7,350 cycles and



up to 100 kc. Physical size is ½ x 19/32 x 15/16 in. with a weight of 0.3 oz. Bandwidth is 15% at 3 db and +60%-40% at 40 db. Burnell & Co., 10 Pelham Pkwy., Pelham Manor, N. Y.

Circle 205 on Inquiry Card

New Products

POWER AMPLIFIER

Model 1012 Power Amplifier is designed to amplify the power of sine waves, square waves or pulse signals whose amplitudes range from 1 to 40 v. It is completely dc coupled and

its input circuit is provided with a level control for matching the power amplifier to any dc level input from −20 to +20 v. A dual range input-step attenuator provides for either normal or inverted output with attenuation steps of either 25%, 50%, 75% or 100% of the input amplitude. Frequency response of the amplifier is dc to 6 db down at 12.5 MC. Output voltage range with a 1000-ohm load is +30 to −30 v. Technitrol Engineering Co., 1952 E. Allegheny Ave., Philadelphia 34, Pa.

Circle 206 on Inquiry Card

TRANSISTOR RADIATOR

Model 3AL-672 Transistor Heat Radiator offers an inexpensive method of cooling diamond shape transistors as much as 30°C under typical operating conditions. Providing 12 sq. in. of radiating surface, the new radiator is ideal for use with transistors when they are used above ground potential and heat cannot escape into the chassis. Tests have indicated that the extensive radiating surface provided

by the radiator dissipates sufficient heat to prevent "thermal runaway" and transistor destruction, even when isolated from the chassis by a mica washer. The Birtcher Corp., 4371 Valley Blvd., Los Angeles 32, Calif.

Circle 207 on Inquiry Card

New Products

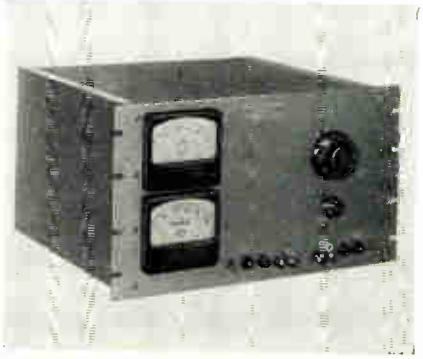
MODULE CAPACITOR

A solid tantalum capacitor half the thickness of a dime, and a tiny mercury battery the size of an aspirin have been developed for the Army Micro-Module Program. The Mallory micro-module tantalum capacitor was developed in two thicknesses, 0.028 in. in ratings up to 15 mfd x volts, and 0.035 in. in ratings up to 30 mfd x volts. Three different ratings and 5 terminal arrangements were developed in each thickness. The RM 3t2 mercury battery, for modules requiring a self-contained source of power, has a diameter of 0.305 in. and is 0.135 in. thick. P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind.

Circle 208 on Inquiry Card

POWER SUPPLY

New 500 MA laboratory power supply, Model 62-126, has a voltage range from 3 to 1000 vdc, continuously variable. A vernier voltage control permits fine settings. No derating is necessary—the full 500 MA output current can be drawn from this supply at any voltage setting. A second output supplies 6.3 vac at 10 amps. DC regulation—for load: 450 MV or 0.045%—whichever is greatest. Regulation for line: 0.045% or 450 MV—whichever is greatest. Maximum ripple: 8 MV RMS. Unit is 19 in. wide x 17 in. deep x 10½ in. high. Dressen-Barnes Corp., 250 N. Vinedo Ave., Pasadena, Calif.



Circle 209 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

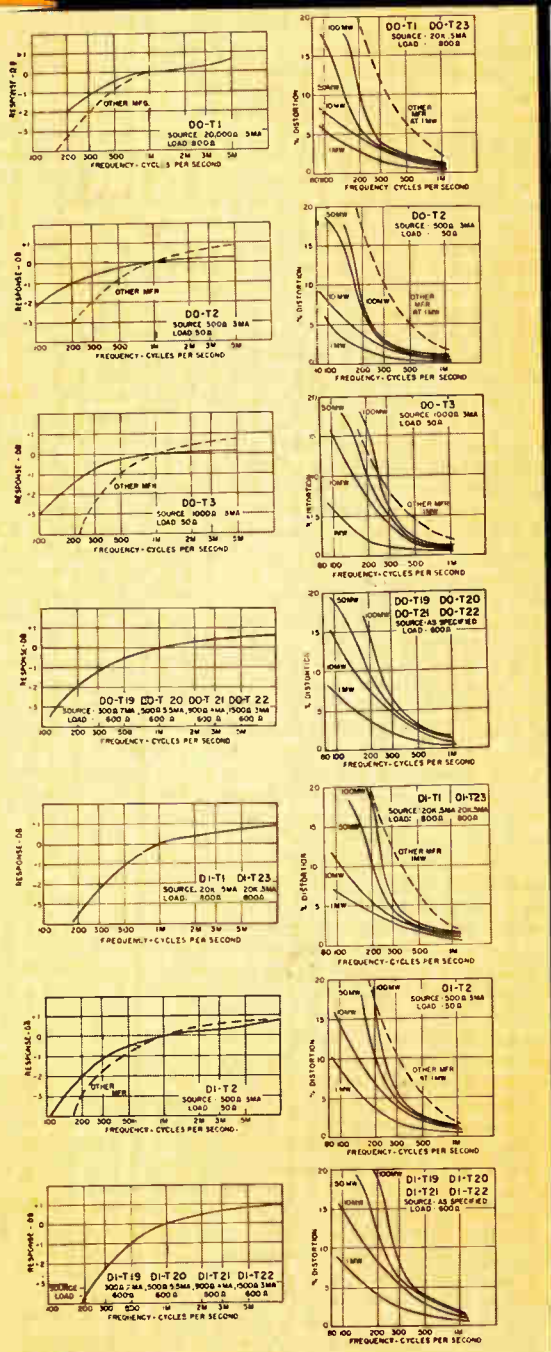
5/16 Dia. x 13/32, 1/10 Oz.

- **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	1000		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 12,500	1 1	500 CT 600 CT	800	870	100	DI-T9
DO-T10	TF4RX13YY	Driver	10,000 12,500	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.

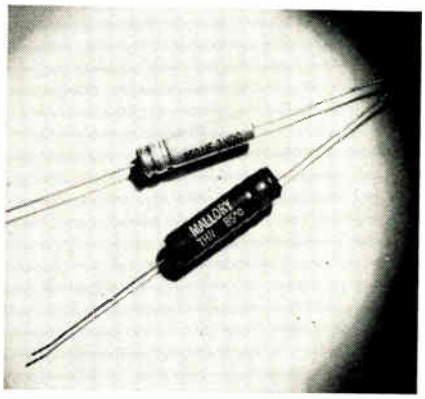
And Special Units to Your Specifications

UNITED TRANSFORMER CORPORATION
150 Varick Street, New York 13, N. Y.
PACIFIC MFG. DIVISION: 4008 W. JEFFERSON BLVD., LOS ANGELES 16, CALIF.
EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y. CABLES: "ARLAB"

New Products

ELECTROLYTICS

New line of THR capacitors makes the high reliability and long life of premium and computer grade capacitors available in small size. Especially applicable to transistorized low volt-

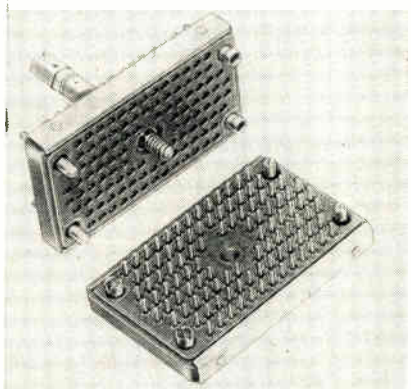


age power supplies and to airborne uses requiring extreme reliability. An economical equivalent of tantalum foil capacitors. Ratings from 75 mfd 3vdc to 100 mfd 25vdc. In ⅜ in. dia. cases from ¾ in. to 1½ in. long, fitted with No. 20 tinned axial leads. Capacity tolerance is −10% to +100%; temperature range is −40°C to +85°C. P. R. Mallory & Co., Inc., Indianapolis 6, Ind.

Circle 210 on Inquiry Card

CONNECTORS

Series 1900 miniature rectangular connectors have center screwlock and closed entry contacts. They are designed for heavy duty applications in aircraft and electronic equipment. High dielectric and mechanical strength. Stainless steel channels are riveted to the long sides of plug and receptacle. Body material is glass



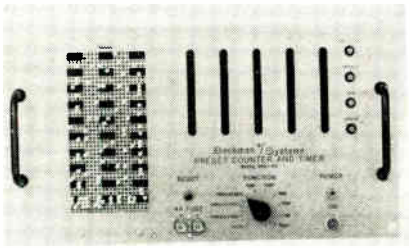
filled Diallyl Phthalate (MIL-M-19833, Type GDI-30, green color). A choice of 104 and 34 contacts is available. Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle 211 on Inquiry Card

New Products

COUNTER-TIMER

Model 5690-80-Preset Counter and Timer is capable of measuring frequency of a sine wave input from 10 to 1,000,000 cps., and time intervals in milli-seconds from 1 to 99,999. As



a frequency measuring device, the 5690-80 counts pulses for 0.1, 1 or 10 seconds and displays the total on a bank of 5 decimal counting units. The results are multiplied by 10, 1 or 0.1 to arrive at frequency in cycles per second. The internal clock is a crystal oscillator with a stability factor of ±1 part per 10^5 per week. Beckman Systems Div., 325 N. Muller Ave., Anaheim, Calif.

Circle 212 on Inquiry Card

DIGITAL MOTOR

Bi-directional digital motor and technically related rotary solenoid are utilized to generate intermittent movements for pulsed cameras and can be programmed by a tape to actuate many types of automatic equipment in the automation field. Featuring a minimum number of parts for replacement and repair, the motor has specific applications in flight

control for missiles, as an actuator for automatic pilots, for automatic feeds in the machine tool industry, positioning and synchronization of aerial cameras, and miscellaneous uses in computer accessories. Electronics Div., Curtiss-Wright Corp., 620 Passaic Ave., West Caldwell, N. J.

Circle 213 on Inquiry Card

New Products

POWER & BIAS SUPPLY

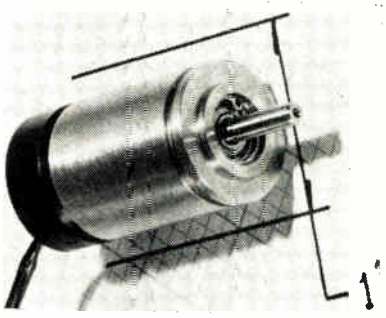
Model 1020, transistorized, low ripple, dc power bias supply serves as a universal power supply. It is also intended for use as a variable bias supply to bias transistors or vacuum tubes in circuit development or study.

It may also be put to use as a dc filament supply or a filament bias source, to check the operating voltage or current of high resistance relays, to recharge small storage batteries, or to do light electroplating. Unit provides continuous variable output voltage monitored by a dual range voltmeter (0-6, 0-30 vdc). Electronic Instrument Co., 33-00 Northern Blvd., Long Island City 1, N. Y.

Circle 214 on Inquiry Card

RESOLVERS

New winding-compensated resolvers, available in the miniature Size 8 configuration, are said to retain all of the accuracy and reliability of Size 11 units. These resolvers weigh only 1.2 oz., and have a frame diameter of 0.750 in. with maximum frame length of 1.241 in. All are designed for the 26 volt, 400 cycle input signals. Null voltage of these units does not exceed 1 millivolt/volt output. Maximum fractional error is held to 0.1%. Slip



ring and wiper assembly is designed to withstand shock loads, up to 45G at 2000 cps. American Electronics, Inc., 1025 W. 7th St., Los Angeles 17, Calif.

Circle 215 on Inquiry Card

New Products

ATTENUATORS

Three new attenuators — Model 40-0, at nominal 50 ohm input and output impedance, Model 41-0 at 70 ohms, and Model 42-0 at 90 ohms— provide attenuation from 1 db to 119 db in 1-db steps. They operate from

dc to 500 MC, and are useful up to 1000 MC. Attenuation is controlled by two concentrically placed rotary switches graduated in 1 db and 10 db steps. The high frequency switches have solid silver contacts set in teflon. 1% carbon film resistors. Specifications: Insertion Loss: 0 db at low frequencies; approx. 0.1 db at 250 MC; approx. 0.2 db at 500 MC. SWR: Max. of 1.2:1 up to 250 MC; max. of 1.4:1 from 250 to 500 MC. Kay Electric Co., Maple Ave., Pine Brook, N. J.

Circle 216 on Inquiry Card

SYNCHRONOUS MOTORS

Size 10 and 11 hysteresis synchronous motors are available for 26, 55 or 115 volt ac 400 cycle operation. These are 6-pole units with a pull in torque of 0.12 oz. in. and operate at 8000 rpm. They are designed for use

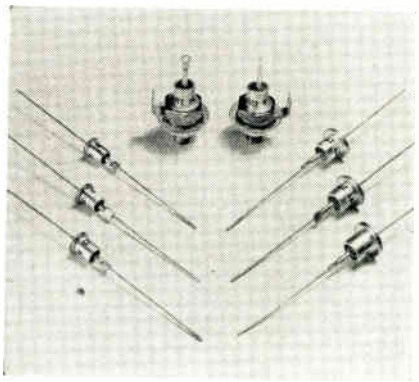
in ambient temperatures from −65°C to +125°C. These motors measure 1 11/32 in. in length. Western Gear Corp., Electro Products Div., 132 W. Colorado St., Pasadena, Calif.

Circle 217 on Inquiry Card

New Products

ZENER DIODES

New line of silicon zener regulator diodes has carefully controlled characteristics for use as power supply voltage regulators, meter protectors, go-no-go indicators, clippers, bias controls, filament voltage controls and

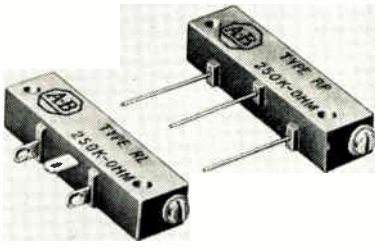


voltage references. Components are available in 4 basic power ratings: Series B, 750 milliwatts; Series T, 1 watt; Series G, 3.5 watts; and Series K, 10 watt; the first two in an axial pigtail top hat package and the higher power devices in 10-32 stud-mounted cases. Breakdown voltage ranges cover from 3.6 v. to 30 v. in each power rating. International Telephone & Telegraph Corp., 67 Broad St., N. Y. 4, N. Y.

Circle 218 on Inquiry Card

ADJUSTABLE RESISTOR

Adjustable fixed resistor (Trimmer Potentiometer) provides high stability for critical electronic circuitry. These compact Type R adjustable fixed resistors have a solid hot molded resistance element and a molded carbon brush to provide long life and reliable performance. Operation is smooth. The moving element is self-locking and it is adjustable through



a 25-turn range. They are 1¼ in. long. Available from 100 ohms to 2 megohms ±10% and ±20%. Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 4, Wis.

Circle 219 on Inquiry Card

New Products

DC AMPLIFIER

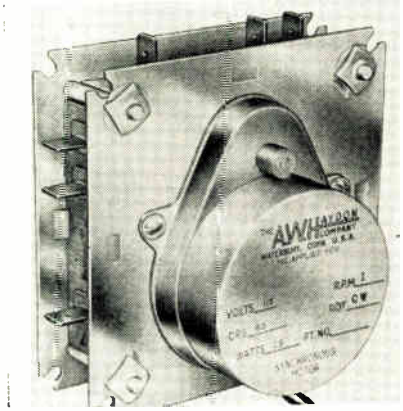
A transistorized dc amplifier designed specifically for driving galvanometers from a high impedance source is available. The specifications are: Input range, ±150 mv; output range, ±3.0 v into a 300 ohm load;

Frequency response, 0.10 KC (Low pass filters available for any cutoff); Input impedance, 10,000 ohms; Long term drift, 10 mv—centering pot in top of unit; Power requirements, +28 v at 32 ma and −28 v at 32 ma. (Power supplies available); Potted and hermetically sealed in MIL-T-27 FA case; Actual Plug-In Model AM 103 is shown. Deeco Instruments, Inc., 14737 Arminta St., Van Nuys, Calif.

Circle 220 on Inquiry Card

PROGRAMMERS

New series of electrical programmers offers versatility in solving complex electrical switching problems, where pre-determined electrical switching must be accomplished reliably, repeatedly and economically. Outstanding features: from 1 to 8 single-pole-double-throw snap action switches; option on mounting with 4 studs and 4 corner notches supplied;



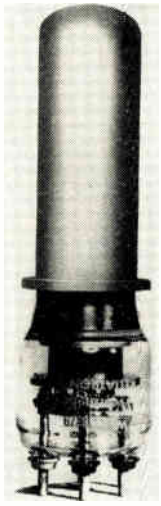
wide range of cycling times—from 30 sec. to 24 hrs. per cycle; power input only 2 watts to motor at 115 v., 60 cps. The A. W. Haydon Co., Waterbury, Conn.

Circle 221 on Inquiry Card

New Products

LOW-MU TRIODE

Low amplication-factor triode tube (WL-6379) for use in Class AB amplifiers is rated at 150 kw, 17.5 dc plate voltage. It is specially adapted for service in "shaker" table power supplies or for use as a series voltage



regulator tube in high-voltage power supplies. Spring-loaded center support holds the high-efficiency thoriated-tungsten filament under tension, and a sturdy basket-type grid is mounted securely to prevent motion relative to the filament. This type of construction prevents the shifting of tube characteristics due to shock and vibration. Westinghouse Electronic Tube Div., P. O. Box 284, Elmira, N. Y.

Circle 222 on Inquiry Card

CRYSTAL OVEN

Miniature change-of-state crystal oven, named "Thermal-Set," and designated Model 35, was developed to meet requirements for an oven combining small size with precise temperature control, freedom from thermal oscillation or contact noise, low power consumption, and long-term cavity temperature stability. Cavity temperature variation is less than 0.01°C per degree ambient tem-

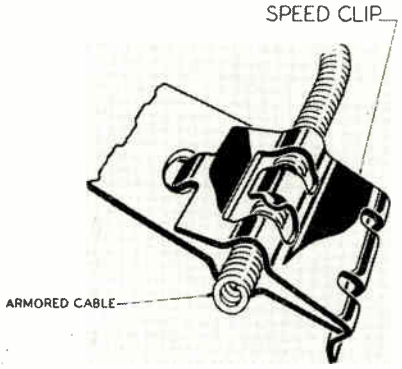
perature change. Oven is 1 7/16 x 1⅞ x 4 1/16 in. Aeronautical & Instrument Div., Robertshaw - Fulton Controls Co., Santa Ana Freeway at Euclid, Anaheim, Calif.

Circle 223 on Inquiry Card

New Products

CABLE CLIP

New Speed Clip is designed to secure small-diameter armored control cables on electrical equipment. To assemble, a small L-shaped tab on the clip is inserted into a panel hole provided. The armored cable is then

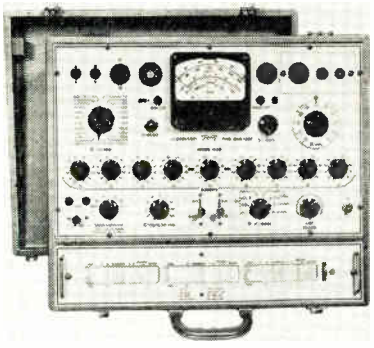


positioned between an embossed groove on the panel and a mating groove in the Speed Clip and is clamped securely in place as the clip is snapped over the panel edge. A sheared spring arm with turned down tabs extending from the center portion of the fastener grips the spiral turns of the cable to prevent it from moving out of adjustment. Tinnerman Products Inc., P. O. Box 6688, Cleveland, O.

Circle 224 on Inquiry Card

TUBE ANALYZER

New, portable true Dynamic Mutual Conductance Tube Analyzer, Model 3444, of interest to laboratory and research engineers, measures true Gm without any extra compensating factors. It uses proper value DC electrode potentials, 5 KC-ac signal source, and a vacuum tube microammeter. Very low (33 ohm) plate impedance for best correlation. There are 4 direct reading Gm ranges: 0-1,000 micromhos; 0-3,000 micro-



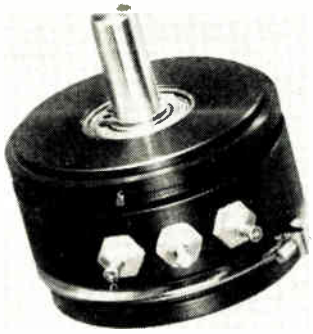
mhos; 0-10,000 micromhos; and 0-30,000 micromhos; dc filtered leakage measures (0-10 megohms at 85 v.). The Triplett Electrical Instrument Co., Bluffton, O.

Circle 225 on Inquiry Card

New Products

PRECISION POT

New Series 5400 all-metal 1 7/16 in. precision potentiometer has a power rating of 4.5 watts at 40°C, derated to 0 at 150°C. The small, single-turn units are available in resistance ranges from 55 to 115K



ohms. Standard linearity is ±0.5% and tolerances as low as ±0.15% can be supplied. Either sleeve or ball bearings. Shaft speeds up to 240 rpm will cause no damage. Ball bearing units have a standard torque of 0.6 oz. in. All applicable sections of NAS 710, JAN-R-19, and MIL-E-5272A are met or exceeded. Helipot Div. of Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif.

Circle 226 on Inquiry Card

PORTABLE POWER SOURCE

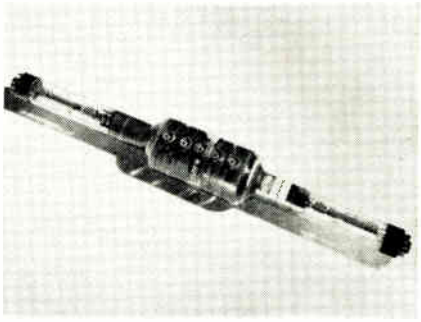
New, portable "Invertron" Model 151-C-1 E, electronic AC power source, is compact, portable, and versatile. Measures only 8 x 13 x 14¾ in. deep. It requires an input of 115 v., 60 cps, single phase, producing an output of 150 v. amperes, 0-130 v., 400 cps, single phase. Other fixed output frequencies available on request. The output frequency is held to an accuracy of 0.5%. A front

panel jack will permit the use of an external signal over the range of 100 cps to 4000 cps, for use as a power amplifier. Behlman Engineering Co., 2911 Winona Ave., Burbank, Calif.

Circle 228 on Inquiry Card

DUAL-GUN STORAGE TUBE

Dual-gun, cathode-ray recording storage tube, has been specially designed for scan conversion of conventional radar scope patterns into composite television signals for viewing on a regular TV receiver. The tube

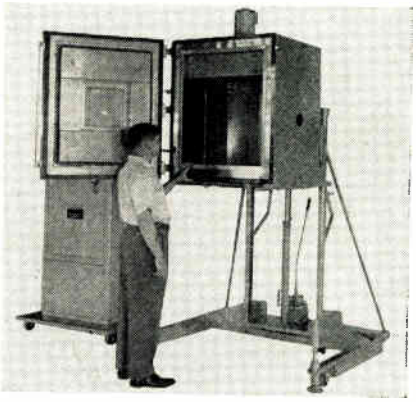


is also applicable to slow-down video systems, making it possible to transmit TV or radar pictures over commercial telephone lines. Resolution of 1,000 lines nominal at 50% modulation is obtained with improved gun design. Signals can be stored in less than 1/60 sec., held for many hours, and read out more than 10,000 times. Raytheon Mfg. Co., Microwave & Power Tube Div., Waltham 54, Mass.

Circle 227 on Inquiry Card

TEST CHAMBER

Requirements for a portable self-contained environmental test chamber of minimum floor space are met by the new Conrad Temp. Rac 19. The unit fits into a standard 19 in. wide relay rack. The chamber is 1½ cu. ft. The unit is completely packaged as an assembly to slide into a customer's standard relay rack or can be furnished with the relay rack housing enclosure. The unit is supplied with



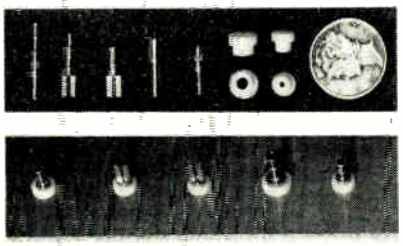
indicating controller, forced air circulator, electric heating, and direct refrigeration with patented Conrad Cascade F-13-F-22 system. Conrad, Inc., Conrad Square, Holland, Mich.

Circle 229 on Inquiry Card

New Products

TERMINALS

"Loc-Fit" is a new series of Teflon insulated terminals, feed-thrus and test points suitable for hard usage and general purpose applications. They utilize a unique two-piece construction consisting of a Teflon grom-

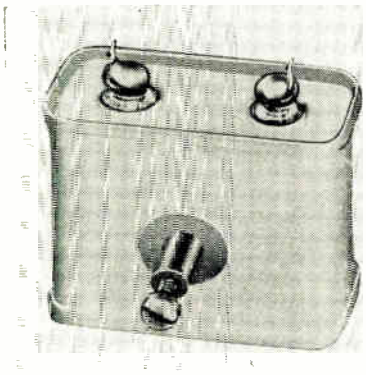


met, which mates during the assembly operation, with any one of numerous standard terminal configurations available. Only 2 sizes of grommets—miniature and sub-miniature—are required to make up the entire series which presently offers as many as 20 terminal feed-thrus and test point configurations. Litton Industries, U. S. Engineering Co., Div., P. O. Box 2368, Van Nuys, Calif.

Circle 230 on Inquiry Card

ADJUSTABLE CAPACITORS

New hermetically-sealed adjustable capacitors are designed for use in ultra-precise circuits where a large capacitance of an extremely close tolerance is required, and yet, cannot be predicted in advance due to second order effects in the circuitry. The polystyrene capacitors can be adjusted over a range of ±1% of nominal value (±2% for values of 0.1 mfg or lower can be attained.) These capaci-

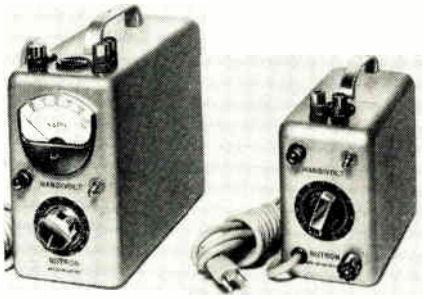


tors employ a self-rigid type of winding. Windings are completely non-inductive, minimizing power factor and soakage. Film Capacitors, Inc., 3400 Park Ave., New York 56, N. Y.

Circle 232 on Inquiry Card

DC/AC POWER SUPPLY

Compact DC/AC power supply, the "Handivolt," features high power, small size, high efficiency at all voltage settings, smooth stepless control and choke type filter for low ripple content. Manufactured in many volt-



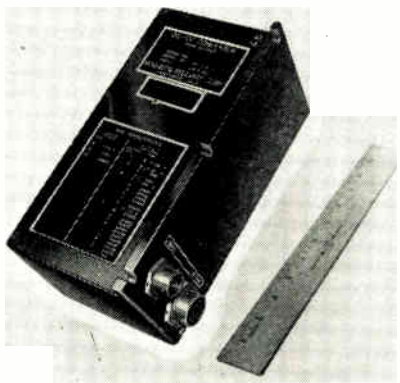
Series B Series A

age and amperage combinations to handle every laboratory and electronic problem. Series B units are isolated from line and have a voltmeter to monitor DC voltage output. All models are rated for heavy duty. Variable AC output is brought out to line receptacle. Low voltage models have 2 variable AC outlets. Nutron Manufacturing Co., Inc., 67 Monroe Ave., Staten Island 1, N. Y.

Circle 231 on Inquiry Card

DC-DC STATIC CONVERTER

New DC-DC Static Converter has been developed for computer, portable test equipment, emergency equipment and airborne equipment applications. The unit is hermetically sealed and has been designed so that it is insensitive to physical orientation. Specifications of the DC-DC Converter are: Output power: multiple, 150 watt max., its size is 5.0 x 3.5 x 3.7 in. and weighs 3.5 lbs. The DC-DC Con-



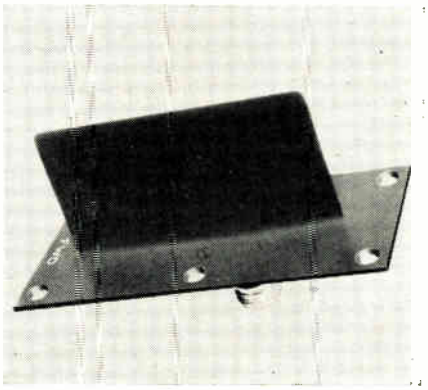
verters efficiency is greater than 75%. Line regulation less than ±1%. The unit is short-circuit proof and offers 28 vdc input. Magnetic Research Corp., Hawthorne, Calif.

Circle 233 on Inquiry Card

New Products

L-BAND ANTENNA

Model 9955 L-Band Blade Antenna, for the 1400 MC telemetry band, is the latest in a series of high performance types designed for high speed aircraft and missile applications. All-

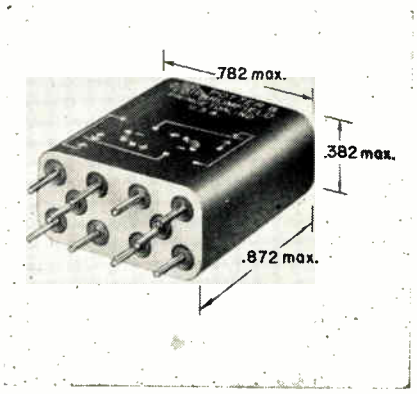


metal leading edge provides maximum strength and erosion resistance. The high aspect ratio with straight or swept-back leading edge insures minimum drag. Ideal for supersonic applications. Polarization is perpendicular to the mounting surface and the resulting radiation pattern is circular. Max. VSWR of 1.5 over a 25% frequency band. Canoga Div., Underwood Corp., 15330 Oxnard St., Van Nuys, Calif.

Circle 260 on Inquiry Card

MICRO-MINIATURE RELAY

Relays with terminals located on 0.2 in. x 0.2 in. co-ordinates permit mounting on printed circuit boards by automatic assembly techniques. The new terminal layouts are avail-

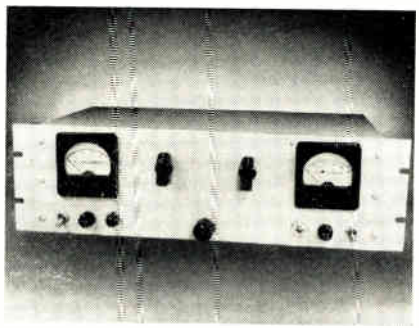


able on both dual coil magnetic latching and on single coil action relays. Both relays operate under 100g shocks and 30g vibrations to 2000 cps with no contact openings in either armature position. Relays with single coil action pull-in at 260 milliwatts at 25°C.; dual coil latching relays at 230 milliwatts. Relays are 0.890 in. high x 0.795 in. wide x 0.370 in. thick, and weigh less than 20 grams. Potter & Brumfield, Inc., Princeton, Ind.

Circle 262 on Inquiry Card

H-V POWER SUPPLY

Model S-325 brings the regulation and stability of the laboratory-reference supply to the high-voltage ranges required by photomultipliers, klystrons, radiation counters, and cathode-ray devices. Regulation against line voltage fluctuations is better than ±50 ppm. Ripple is never more than 10 ppm. Load regulation is never more than ±60 ppm, over the entire output range of 500-2500 v., and 0-10 milliamperes dc. Polarity

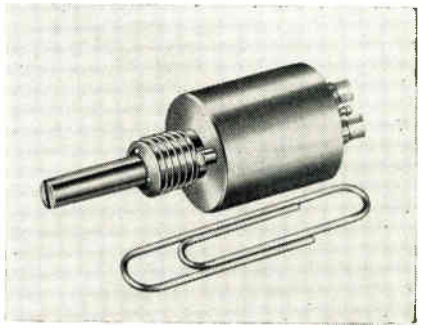


is reversible, and both current and voltage meters are standard equipment. NJE Corp., 345 Carnegie Ave., Kenilworth, N. J.

Circle 261 on Inquiry Card

MICRO-MINIATURE POT

Series C-050 ½ in. precision potentiometer has an exclusive, one piece metal case and bearing design that eliminates any need for special assembly precautions. Components are completely enclosed by unique molded covers with integrally cored, solid terminals that cannot loosen or transmit solder, resin or other foreign matter into the unit. Completely sealed covers and "O" ring sealed shafts are available. Multi-finger precious metal



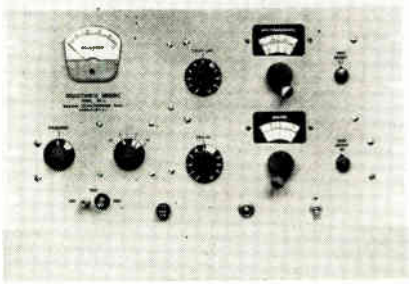
contact brush. Threaded bushing, servo, ball bearing and other shaft arrangements. Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Boulevard, Long Island City 1, N. Y.

Circle 263 on Inquiry Card

New Products

INDUCTANCE BRIDGE

Model 63A, inductance bridge, measures inductance from 0.002 μh to 100 mh with an accuracy of the order of 0.25%. High resolution, approximately 0.01%, and good stability

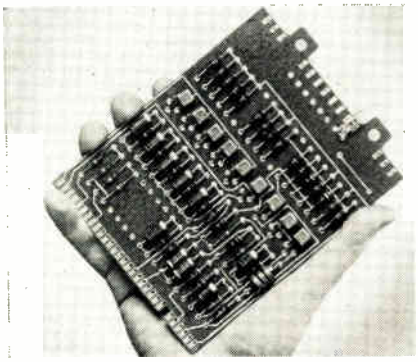


make it useful for temperature coefficient and inductance matching work. An internal oscillator with several frequencies between 1000 CPS and 100 KC is provided along with an internal detector and a null indicator. A switching arrangement allows the use of external oscillators and detectors. Series resistance can be measured from 0.01 to 10,000 ohms. Boonton Electronics Corp., 738 Speedwell Ave., Morris Plains, N. J.

Circle 264 on Inquiry Card

LAMINATED PLASTIC

The risk of fire in computer printed circuits is minimized through a new copper-clad paper epoxy base laminated plastic, Formica EP-37. It has good dimensional stability compared with other paper base materials, excellent insulation resistance and punchability. A new adhesive secures the copper to the base laminate, so that EP-37 offers greater resistance to plating solutions. The new lamin-



ate will also withstand longer exposure to dip soldering at higher temperatures than XXXP 36. Formica Corp., 4614 Spring Grove Ave., Cincinnati 32, Ohio.

Circle 265 on Inquiry Card

VOLTMETER

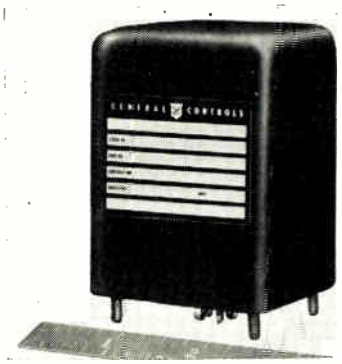
Low cost, all-transistorized battery operated AC Voltmeter combines laboratory performance and range with easy portability. The unit has full scale readings of 1 mv. to 300 v. in

12 ranges, with an essentially flat frequency response of 20 cycles to 1.5 MC. It has a DB scale and a "battery OK" scale. An input impedance of 10 megohms, shunted by 15 mmf. is provided in the 1-300 volt range, and input impedance of 1 megohm shunted by 25 mmf. is provided in the 1-300 millivolt range. Accuracy is within ±5% up to 1 MC. Motorola Communications & Electronics, Inc., 4501 W. Augusta Blvd., Chicago 51, Ill.

Circle 266 on Inquiry Card

SINE WAVE OSCILLATOR

Transistorized sine wave oscillator with unusual voltage stability over a temperature range from −55°C to +105°C fills the requirements for precise frequency control and high amplitude control. Features: harmonic distortion under 1%; variation in output voltage amplitude under 0.2% for ±10% variation of input voltage; no heater required; mechanical strength to withstand extremes of vibration and "g" forces; frequency



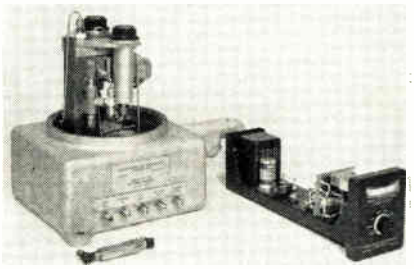
stability of ±0.25%; voltage regulation of ±0.5%. The nominal voltage output is 3 volts; nominal power approximately 30 mw. General Controls Co., 801 Allen Ave., Glendale 1, Calif.

Circle 267 on Inquiry Card

New Products

MOISTURE DETECTOR

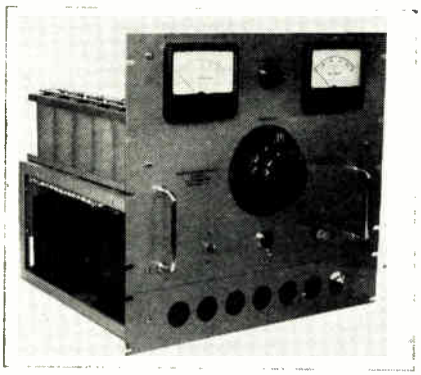
CEC 26-312 Moisture Monitor gives a continuous readout of the amount of moisture in many liquids. Quantities as small as one part-per-million can be detected immediately. The instrument provides for the measurement and/or control of trace moisture in liquids. The important applications are the instant detection of moisture in catalytic reformer feeds, solvents in metal cleaning systems, transformer oil or other liquids where dielectric properties are hydraulic system oils, refrigerants such as F-113, foods, such as margarine and edible oils. Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.



Circle 268 on Inquiry Card

DC POWER SUPPLIES

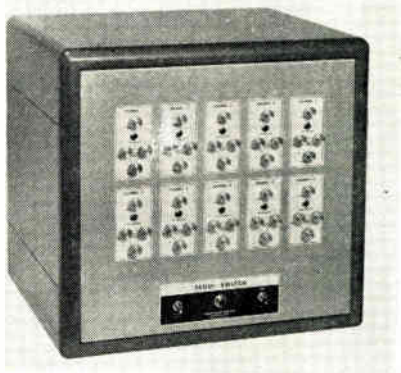
The TRM series is an integrated group of 14 dc power supplies offering a broad range of voltages centered about 4 popular industrial values in the 5 to 160-volt region for loads of up to 120 amperes. The unique combination of magnetic-amplifier regulation, with its high-current capability and immunity to short-circuit damage, and a transistorized driver amplifier, with its high-speed response, enables these supplies to furnish large amounts of dc power with precise regulation. A static load change from zero to rated maximum, even for the 120-ampere units, causes the dc output voltage to deviate less than 0.1% or 50 mv (whichever is greater). NJE Corp., 345 Carnegie Ave., Kenilworth, N. J.



Circle 269 on Inquiry Card

SEQUENCING SWITCH

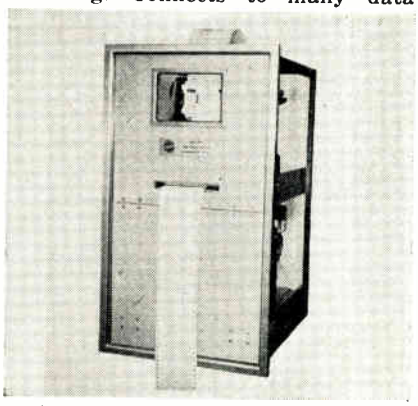
For use in scanning transducers, the new "Sequi-Switch" has many applications in telemetering, dynamic force and pressure studies and multi-point data gathering. It may be used in conjunction with an oscilloscope to give simultaneous readings that can be photographed for analysis. It can be adapted for printed readout. High signal-to-noise ratio. The "Sequi-Switch" utilizes a 10-channel beam switching tube that switches at a pre-selected rate up to 1 MC. In addition the switching pulses provide, in effect a carrier for transducers. Control Devices, Inc., 925 S. Eton, Birmingham, Mich.



Circle 270 on Inquiry Card

HIGH SPEED PRINTER

Model 3260 Alphanumeric Printer is an integrally housed drum type printer and electronic storage and control system for rack or desk mounting. Connects to many data producing devices with a minimum of installation effort. Data can be accepted from digitizers, magnetic or perforated tapes, electronic counters or computers. A printout rate of 48,000 digits per second is possible. As a logger of digitized data from a series of analog to digital converters a scan and printout rate of 200 3-digit numbers is realizable. Printing is on Multiple Copy fanfold paper with standard ribbon. Potter Instrument Co., Inc., Sunnyside Blvd., Plainview, L. I., N. Y.



Circle 271 on Inquiry Card

New Products

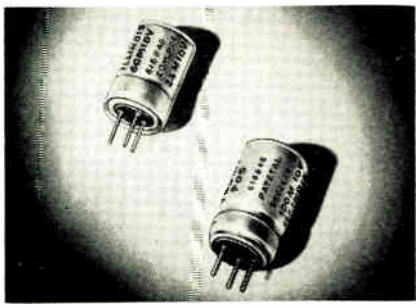
LINEAR DETECTOR

New compact linear detector, for use with distortion meters, and designated Model 404, incorporates a vacuum tube rectifier for RF detection and a bridging transformer. The unit meets requirements for FCC proof-of-performance measurements. It operates on a 20-30 volt RF carrier and has a frequency range of 400 KC to 30 MC. When operated as a bridging transformer input impedance of the detector is approximately 6000 ohms and the insertion loss is 1 db. Frequency response is essentially flat from 20 to 50,000 cycles. The detector has a 40 db pad adjustable in 10 db steps and a function selector switch. Barker & Williamson, Inc., Bristol, Pa.

Circle 272 on Inquiry Card

COMMON ANODE CAPACITORS

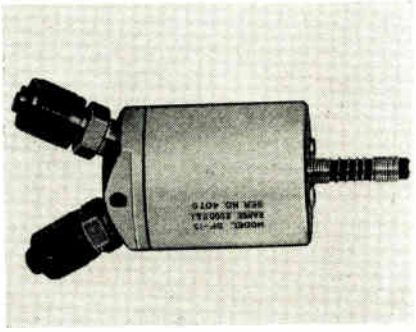
Type SMTUCP common anode miniature electrolytic capacitors are similar to the well known line of type SMT tubular and upright mounting miniature electrolytic capacitors. However, these are dual capacitors in one case, and their common anode construction with isolated cathodes allows economy and space savings in modern transistor electronic circuitry. Isolation between cathodes allows the electronic designer to use individual capacitors for dual filtering, bypass, or coupling where two or more individual capacitors were previously needed. Illinois Condenser Co., 1616 N. Throop St., Chicago 22, Ill.



Circle 273 on Inquiry Card

PRESSURE TRANSDUCERS

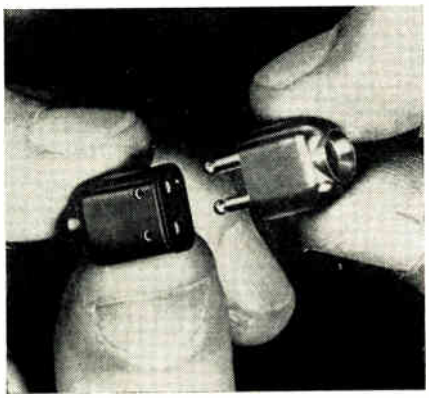
New series of high performance, high range miniaturized pressure transducers includes Model GP-15D, a miniaturized unit, highly resistant to mechanical shock and vibration. The pressure sensing diaphragm, the only moving part, is integral with the steel body. The unit is designed to convert pneumatic or hydraulic pressure into a proportional electric signal for measurement under both static and dynamic conditions. Available ranges extend from 10 psig to 6,000 psig. The Model DP-15D is a differential pressure transducer incorporating dual bleed screws, similar in most other respects to the GP-15D. BJ Electronics, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif.



Circle 274 on Inquiry Card

MINIATURE CONNECTOR

New CHEMELEC miniature connector features cost-saving snap-fit assembly. It is made of Nylon FM 101. The entire unit weighs only 0.053 ounces, and is used for Air Force pilot helmet earphones and other applications where size and weight are critical factors. The male and female sections are 0.490 and 0.580 inches in length respectively; 0.306 inches wide and 0.453 inches deep. Fluorocarbon Products Inc., Division of United States Gasket Company, Camden 1, New Jersey.



Circle 275 on Inquiry Card

Push Button

(*Continued from page* 116)

system will be extensively flight-tested for a year. Engineering models are scheduled for delivery in mid-1961.

It consists of a piano-sized control console, manned by a ground control operator, and a mural display with dotted lines of lights, representing the message signals, flashing between simulated planes and ground installation. In actual operation only a quarter of a second is required for routine two-way exchange of information with each aircraft.

The system is designed to relieve both pilots and ground control operators of the necessity of oral conversation about routine flight information.

This will be done instead by electronic instruments. Some information, such as altitude and identity of the aircraft, will be transmitted automatically without any action by the pilot. Other information—any one of 32 pre-conceived messages—can be transmitted by either the pilot or ground operator flicking a dial to the desired message number and pushing a button. Lights on both ends confirm receipt of the messages.

In emergencies, however, either pilot or ground controller can override the automatic system merely by pushing a button and then can communicate by voice.

This combination will speed up the transmission of flight pattern information to such an extent that one ground control point can be in touch with as many as 500 planes in its area at least once every two minutes. This is regarded as an important potential contribution to the elimination of collision paths and "near-misses."

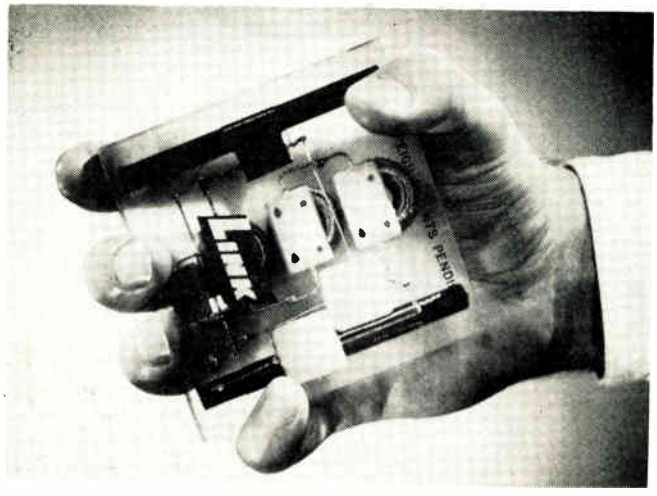
Servomechanisms, Inc., holds a subcontract for development of a device used in the AGACS system known as the airborne data readout and insertion device. It is used with the data-processing, receiving and transmitting equipment being developed by RCA.

The exact nature of the 32 prearranged messages that can be handled automatically has not been determined finally. But they will be such typical exchanges as: "Report reaching Palm Springs" "Climb to 11,000 feet," or "ETA (estimated time of arrival) Denver 0630 (time) 9000 (present altitude)."

When a ground-air message is received in the aircraft, a tape spins to position the message display and a lamp lights on the control panel, remaining lit until the pilot acknowledges the message by touching a button.

The ground controller's console consists of a series of display panels on which both incoming and outgoing messages are shown visually, an input keyboard and flight strips (one for each airplane under surveillance) on which flight information is posted as received.

Identification Control Unit



This Response Block relays an identity-signal while passing through the magnetic field of a stationary interrogator. Manufactured by Link Aviation, Inc., it is part of the Tracer Identification Control System. Suggested applications include control of aircraft movement on the ground, vehicles in restricted areas, mail movement, and railroad car identification.

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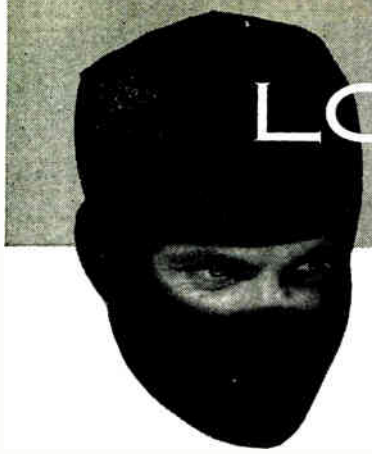
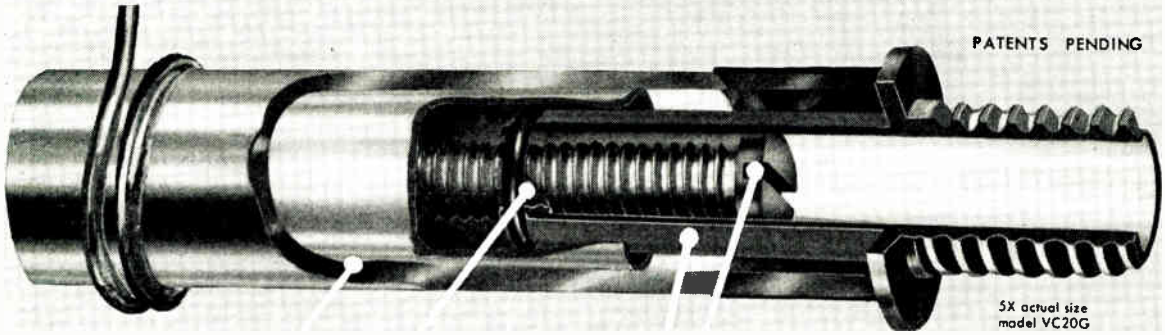


LOOK INSIDE

JFD Electronics

PRECISION TRIMMER PISTON CAPACITORS

UNCOMPROMISING DESIGN AND CONSTRUCTION
UNCOMPROMISING ACCURACY AND RELIABILITY



Precision bore special process glass or quartz dielectric cylinder with specially fitted tuning piston provides the minimum air gap (.0002" maximum) for linear tuning.

(No compromises here that must be compensated for by substitution of expanding core type piston.)

Painstaking assembly of precision-machined bushing and full-threaded anti-backlash adjusting mechanism insures perfect coaxial alignment of piston inside cylinder for all adjustments. Result: No tuning reversals. Absolute repeatability.

(No compromise here with direct traveling mechanism that requires additional encumbering parts leaving no room for vital anti-backlash spring . . . or square adjusting shaft threaded only at corners and having short rotational life.)

Gold plating over special JFD alloy plating enables all metal parts to withstand 50 hour salt spray test and provides superior R.F. conductivity.

(No compromise here with porous silver-plating which permits corrosion of base metal.

Screwdriver adjust slot (or hex socket) recessed within well for ease of location and blind hole tuning.

(No compromise here with protruding adjusting shaft which adds to overall length of capacitor and lacks ease of tuning.)

actual size
model VC20G
0.8 mmf. min.—8.5 mmf. max.

actual size
SEALCAP
model SC133
0.8 mmf. min.—8.5 mmf. max.

Same line features of model VC 20G Plus permanently sealed interior construction that seals out moisture and humidity.

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"Visulation"

(*Continued from page* 96)

small 3-dimensional models. An airport and surrounding terrain totaling approximately 10 sq. miles is contained on a model which measures only 8 to 13½ ft.

Motion is achieved through the use of two independent systems. One controls translation in X, Y, and Z, namely, motion in range, side drift, and altitude;—a second controls rotational degrees of freedom, roll, pitch, and heading.

Translation is accomplished by moving the camera and lens in X, Y, and Z, and rotation is achieved by the rotation of only the optical element in the lens assembly. Coupled to the appropriate output of the flight simulator, the six degrees of freedom respond accurately and instantaneously to simulator output voltage variations.

The panoramic view is non-programmed in all respects. The same signals which so accurately activate the pilot's instruments also "fly" the camera. Any control displacement, however slight, causes a corresponding change in the panoramic view. Just as in the aircraft, errors in judgment are known immediately—thus assuring maximum training value.

The Visulator may be readily attached to any Curtiss-Wright Dehmel Flight Simulator and simulators of other manufacturers provided the output voltages approach the response fidelity characteristics of the former's simulators.

Three dimensional models may be obtained for any airport in the world and all come equipped with any specified airport runway lighting configuration.

Booklet Lists All U. S. Air/Space Craft

Copies of U. S. Aircraft, Missiles and Spacecraft—1959, published by The Aircraft Industries Association, may be obtained from the National Aviation Education Council, 1025 Connecticut Ave., N. W., Washington 6, D. C., for $1.00 each.

Included in this edition is a listing of all the aircraft and missiles that could be identified at the time the booklet went to press. The booklet also includes a summary of outstanding aviation events, people in the news, records made and summary coverage in the field of astronautics.

Compatible Doppler VOR

(*Continued from page* 115)

1. A 30 CPS fixed-phase reference signal.
2. A 9.96 KC subcarrier signal frequency modulated at a 30 CPS rate, with a maximum deviation of 480 CPS and with the envelope phase of the frequency modulation equal to the bearing.

The basic design rule for a VOR-compatible Doppler effect omnirange is, therefore, that the aperture should be close to 5.1 wavelengths. This means that the antenna aperture for the 112 to 118 MC carrier frequency range of the VOR is in the range of 45 to 43 ft. With an aperture in this range, the bearing errors and course perturbations, commonly referred to by such terms as "site error," "multipath error," and "course scalloping" are negligibly small, relative to the instrumental errors of the highest grade of VOR receiving equipment.

Performance Characteristics

The radically improved accuracy of the Doppler VOR is the combined result of several inherent factors. These are:

a. *Wide Aperture.* Improvement in site error characteristics are inherently associated with a wide aperture antenna regardless of the form of wide aperture system used.

b. *Ease of Instrumentation.* An Adcock type of directional system requires extremely careful amplitude and phase balancing and matching of antenna elements and cables. In addition, because of the small aperture which must be used with an Adcock system, the phase differences among the antennas are so extremely small that even a very small phase unbalance becomes significant. In contrast, the Doppler system does not fundamentally require a rigorous amplitude balance among the antenna elements, and, in addition, the phase differences sampled in a quasi-Doppler array are so extremely large that small unbalances are insignificant. Critical matching and balancing of cables and antenna elements are not required in a Doppler system.

c. *Redundancy.* A minimum of three antenna elements must be used in any phase measuring system to obtain azimuth and elevation angles. A small error in the phase sample observed by any single element in a three or four element system has a relatively large effect on final accuracy. A quasi-Doppler system with 48 to 50 elements obviously has such an enormous redundancy that small errors in the samples become relatively insignificant.

Some of the other factors which contribute to the superior operational performance of the Doppler VOR are discussed in the following paragraphs.

Polarization Error Suppression

The Doppler VOR is superior to the conventional VOR in regard to polarization errors by a factor roughly equal to π times the diameter of the antenna system in wavelengths. Since the compatible Doppler VOR has an antenna diameter of 5.1 wavelengths, the polarization errors are reduced by a factor of 16. This assumes no reduction in the radiation of waves of undesired polarization. Actually, because of the greater ease of instrumentation inherent in the quasi-Doppler array, the polarization error improvement experienced in practice is considerably greater than 16.

Multipath Error Suppression

The course scalloping experienced with conventional VOR is a form of multipath propagation error. In the wide aperture Doppler system, errors of this class are suppressed because of: (a) the aperture, (b) the single criterion for phase sampling, (c) the capture effect in the limiter and FM detector of the airborne receiver.

Reduction of multipath errors or course scalloping by a factor between 7 and 20 times may reasonably be expected from a compatible Doppler VOR.

Distant Co-Channel Error Suppression

Interference from a distant co-channel VOR transmitter causes negligible error or perturbation of the indicated course. This is the result of capture effect in the limiter and FM detector of the airborne receiver.

High-Angle Performance Characteristics

In considering the performance of the Doppler VOR at high elevation angles we should separate the following two factors:

a. Site error and scalloping effects.

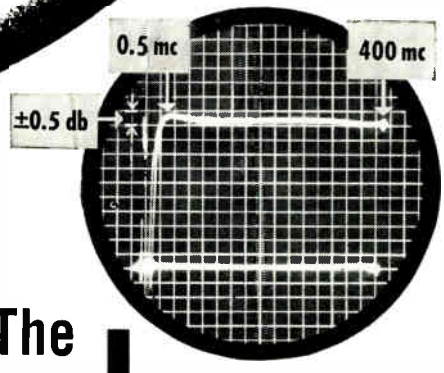
b. Course-deviation sensitivity.

Site Error and Scalloping

The amount of site error or course scalloping produced in any system is a function of the ratio of the direct signal to the multipath signal. The conventional VOR has an antenna system from which the desired signal varies as the $\cos^2$ of the elevation angle. Assuming that the multipath signal is, to a first approximation, unaffected by elevation angle, the high angle performance of a conventional VOR is degraded by a $\cos^2$ factor. In contrast, the direct signal from a Doppler system varies only as the first power of the cosine of the elevation angle so that, in practice, a greatly improved ratio of direct to multipath signal is experienced. This means that the stability of bearing in the "cone" is much greater for a Doppler VOR than for a conventional VOR.

Course Deviation Sensitivity

The course deviation sensitivity of the Doppler VOR varies as the cosine of the elevation angle, whereas, ideally, this factor does not vary for the conventional VOR. This should result in a superior indicating characteristic from the point of view of the pilot since he is more interested in course deviation in distance than he is in degrees. The "course-softening" in the cone should also result in improved dynamic stability when flying with an auto-pilot.



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ANTENNAS, PROPAGATION

On the Theory of Coupled Helixes in an Absorptive Medium, L. N. Loshakov. "Radiotek." Jan. 1959. 11 pp. The paper studies the propagation of slow electromagnetic waves along a system of two coaxial helixes when a portion of the space between them and the entire external space, are filled with a semiconducting medium. For certain conditions the dispersion equation is derived, and approximate expressions are given for the propagation constant in several simple particular cases. (U.S.S.R.)

The Effect of Periodic Nonuniformity of the Phase of the Field in the Mouth of an Antenna on its Directional Properties, E. Iu. Shered'ko. "Radiotek." Feb. 1959. 8 pp. A method is proposed for computing the directional properties of antennas with excitation that is not in-phase. The method is applicable for the case where the expression which characterizes the phase variation in the mouth of the antenna can be approximated by a combination of trigonometric functions of the form $\beta \sin(m\pi x)$ and $\alpha \cos(n\pi x/2)$. As an example, results are cited for the computation of directivity patterns when the phase variation of the field in the antenna mouth is sinusoidal. (U.S.S.R.)

Directivity Pattern of 3 CM. Parabolic Reflector, Feed of Which Is Displaced from the Focus, Shanker Swarup and G. P. Srivastava. "J. ITE." Dec. 1958. 5 pp. Directivity pattern of a 3 cm. paraholic reflector has been studied, placing the dipole at various distances from the vertex. (India, in English.)

A Simple Graphical Method of Preparing Power Distribution Diagrams for Horizontal Dipole Arrays, P. J. Joglekar. "J. ITE." Dec. 1958. 6 pp. The paper describes a simple graphical method for constructing the power distribution diagrams for horizontal dipole arrays. Theoretical considerations underlying the method have been discussed starting with the directional characteristics of these arrays. Charts showing the constant value contours in db. for the horizontal directivity factor for H1/-, H2/- and H4/- types have been presented which are of immediate practical use. (India, in English.)

Double Polarization Directional Aerials, G. Parmeggiani. "Alta. Freq." Dec. 1958. 21 pp. The reasons are recalled which have favored the development in the recent years of double polarization directional aerials. A distinction is also made between the two main applications of such antennas: simultaneous transmission or reception of two radio channels or of two groups of radio channels by a single aerial; simultaneous transmission and reception. The two groups of signals may be polarized either linearly (at 90° separation) or circularly with opposite rotation. The former case is particularly studied. (Italy.)

Calculated Radiation Resistance of an Elliptical Loop Antenna with Constant Current, J. Y. Wong and S. C. Loh. "J. BIRE." Feb. 1959. 3 pp. Approximate formulae for the radiation resistance of small and large loop antennas of elliptical shape are derived by the Poynting vector method based on the assumption of a uniform current distribution on the loop conductor. Some calculations of radiation resistance are presented for loops of different sizes and shapes in order to illustrate the derived results. (England.)

The Crystal Palace Band I Television Transmitting Aerial. "BBC Mono." Feb. 1959. 9 pp. This monograph describes the design, testing, and installation of the eight-tier Band I transmitting aerial at the BBC's Crystal Palace Television Station. Structural considerations made it necessary to mount the upper four tiers and lower four tiers of the aerial on sections of the tower having very different cross-sections and this raised many electrical and mechanical problems which had not occurred in previous aerial designs. (England.)

AUDIO

A Further Coupling of Loudspeakers to a So-Called Transformerless Push-Pull Output Stage, W. Auer. "El. Rund." Mar. 1959. 1 p. In addition to some circuits already known a new circuit which is applicable in two loudspeakers or multi-loudspeaker systems is pointed out. (Germany.)

The Method of Difference Measurement in Sound Recorder Technique, K. Schonbrunn. "El. Rund." Mar. 1959. 5 pp. The method of difference measurement, which can be applied advantageously in three different fields of sound recorder technique is demonstrated. (Germany.)

CIRCUITS

Some Novel Circuits Employing Cold-Cathode Tubes, Part 2, R. S. Sidorowicz. "El. Eng." Dec. 1958. 5 pp. (England.)

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 Electrotechnizne

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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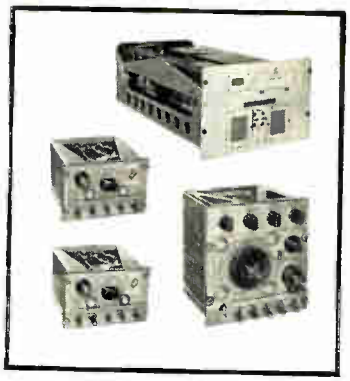

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Incremental Frequency Control of RC Oscillators, D. L. A. Smith. "El. Eng." Jan. 1959. 2 pp. The provision of a continuously-variable, incremental frequency control which is accurately calibrated has not hitherto been available with an oscillator of the resistance-capacitance type. It is shown in this article that, by introducing a phase-shifting circuit auxiliary to the conventional phase-shift circuit, the generated frequency can be varied incrementally over a small range. It is further shown that, where a comparatively large increment is required, an error in the increment exists which is, to a first order, proportional to the time-constant of the main phase-shift circuit. A practical means of systematically correcting this error is also included. (England.)

On the Use of a Blocking Oscillator for Frequency Division of Sinusoidal Waves, V. V. Goncharov. "Radiotek." Jan. 1959. 9 pp. The paper studies the processes which occur in a blocking oscillator before the step-variation occurs in the system. The rising nature of the oscillations which precede the pulse makes it possible to increase the frequency-division coefficient and to use low-amplitude voltages for locking in the blocking oscillator. (U.S.S.R.)

The Effect of the Network Parameters and the Transistor Parameters on the Rise and Decay Times in a Pulse Oscillator with One Reactance, I. I. Litvinov. "Radiotek." Jan. 1959. 7 pp. The paper analyzes the fast processes in a transistorized pulse oscillator with one reactance. Based on a study of the phase space for the oscillator, analytical expressions are derived which determine the duration of the leading and trailing edges and permit an evaluation of the effects produced by the network and transistor parameters on the nature and duration of the fast processes. (U.S.S.R.)

Optimum Passbands for "Comb" Filters, M. I. Finkel-shtein. "Radiotek." Jan. 1959. 6 pp. The paper studies the effect of a finite number of pulses on a filtering system with a "comb" frequency response. The optimum conditions for which the signal-to-noise ratio reaches a maximum value are determined. (U.S.S.R.)

Practical Determination of Certain Parameters for the Tank Circuits and Tubes of a Tuned Amplifier, I. M. Furmanov. "Radiotek." Jan. 1959. 2 pp. Design formulas are derived for determining the transconductance of the tube, the intrinsic capacitance of a single tank circuit and the resonant impedance of the tank circuit on the basis of two measurements of the gain or passband when various shunt resistances are used. (U.S.S.R.)

Semi-Analytical Method for Determining the Combined Frequencies in a Superheterodyne Receiver, M. Ia. Umanskii. "Radiotek." Feb. 1959. 8 pp. The paper presents a semi-analytical method for determining the combined frequencies in a superheterodyne receiver. Examples of the application of this method are cited. (U.S.S.R.)

A Tuned Amplifier with a Grounded Plate, I. L. Poliakov. "Radiotek." Feb. 1959. 9 pp. An analysis is made of a tuned amplifier with a grounded plate when the tank circuit is not entirely in the cathode circuit. The following conclusions are arrived at: 1) a grounded-plate anode has a lower input admittance than other single-stage circuits; 2) a grounded-plate amplifier will assure an identical band width and selectivity at the extremes of the tuning range (with a maximum overlap of the frequency band), provided a definite optimum coupling is chosen; 3) the input capacitance of the amplifier is sufficiently small; 4) the use of negative feedback in the amplifier assures a decrease in the nonlinear distortion; 5) a grounded-plate amplifier is surpassed only by a multistage amplifier with regard to noise properties. (U.S.S.R.)

On the Synchronization of an Oscillator by a Modulated External EMF, E. S. Voronin. "Radiotek." Feb. 1959. 9 pp. Formulas are derived which permit a simple evaluation of the synchronization bandwidth as a function of the various oscillator parameters and external signal parameters; a physical analysis of the resulting relationship is made. It is shown that when there is a difference between the natural oscillation frequency of the oscillator and the center frequency of the modulated external signal, the synchronized oscillations are phase modulated in synchronism with the modulation frequency of the external signal. (U.S.S.R.)

Asymptotic Methods for Computing the Transient Response in Low-Pass Filters, B. V. Elizarov, G. N. Krylov, G. I. Makarov. "Radiotek." Feb. 1959. 7 pp. The paper treats the general theory of transient response in low-pass filters with arbitrary loads. The output voltage for the filter is derived under conditions where the filter is excited by a current generator. The transfer coefficient is determined for any arbitrary number of filter sections and arbitrary loads. The solution is formulated in the form of a D'alembert sum of Mellin integrals. The conditions for matching the filter to the load are studied. (U.S.S.R.)

The Automatic Compensator as D. C. Amplifier, W. Luck. "El. Rund." Mar. 1959. 3 pp. After the general description of the compensator in the first part of the article, the present part deduces the dynamic features following the static ones. (Germany.)

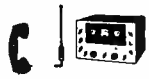
Parameters of Feedback Amplifier and Methods of Their Determining, W. Majewski, Jr. "Roz. Elek." Vol. 4, No. 4. 1958. 78 pp. Formulae are deduced for return difference, return ratio, gain with feedback, gain before feedback, nonlinear distortions, sensitivity, input and output impedances. The above values are connected with the formerly determined parameters of feedback amplifier. Finally, formulae are deduced for parameters of basic feedback amplifying systems. The calculus of cracovians is also applied here. In conclusion, a few other methods for determining parameters of feedback amplifier are characterized and compared. (Poland.)

Matrix Analysis of Vacuum Tube Circuits, M. N. Srikantaswamy and K. K. Nair. "J. ITE." Dec. 1958. 10 pp. The matrix representation of four-terminal passive networks is briefly surveyed. The methods developed by Brown and Bennett for the representation of vacuum tube circuits as four-terminal networks is extended to the analysis of amplifier and oscillator circuits. The general ABCD matrix for the feedback amplifier is derived and is used to find the gain, the input and the output impedances of a compound feedback circuit. Also the Barkhausen criterion for the feedback oscillator is derived in terms of the ABCD parameters and is applied to the analysis of a general feedback oscillator. (India, in English.)

Regulated Power Supplies, D. J. Collins and J. E. Smith. "El. Eng." Apr. 1959. 5 pp. Regulated, or stabilized, d. c. power supplies are required for a number of purposes. In this article the various types of regulators are briefly reviewed and the closed loop series stabilizer is dealt with in some detail. The design problems of this type of unit are considered and particular reference is made to the loop stability. In an Appendix the design of a typical unit is detailed. (England.)

A Simple Very Low Frequency Oscillator, J. F. Young. "El. Eng." Apr. 1959. 3 pp. The usual methods of amplitude stabilization of resistance capacitance oscillators are frequency sensitive. In the simple oscillator described a Zener diode limits the amplitude and the resulting harmonics are filtered out by a selective circuit which also controls the frequency of oscillation. A reasonable waveform can therefore be obtained even at very low frequencies. (England.)

Transistor Amplifier for Magnetic Tape and Drum Playback, A. E. Bachmann. "El. Eng." Apr. 1959. 5 pp. Magnetic tapes and drums are frequently used as storage or transmission elements, containing the information in a digital form. This information is made available again by playing back the tape or drum through a magnetic head and an amplifier. The article discusses the problems involved in the realization of such an amplifier, when using transistors only. An analysis is given and the design procedure is worked out. (England.)



COMMUNICATIONS

Triple V.H.F. Reflectometer, Measurement of Power and Reflection Coefficient, G. H. Millard. "E. & R. Eng." 3 pp. Jan. 1959. A description is given of a multiple reflectometer designed for use in Band I (41-68 Mc/s) and Band II (88-95 Mc/s) with powers of 1 kw or less. Three reflectometers were required for each transmission line and these are combined in one compact unit. (England.)

A Low Frequency Phasemeter, N. Hambley. "El. Eng." Jan. 1959. 3 pp. The unit described in this article provided a quick and accurate measurement of the phase difference between two waveforms. (England.)

Statistic of Fading Dependent Noise of Broad-Band Microwave Links with Many Hops, W. Hormuth. "Arc. El. Uber." Aug. 1958. 11 pp. On the basis of certain assumptions, the average value of high noise power values appearing for short periods of time, can be calculated. The calculation is carried through for reference circuit. The theoretical results are compared with the practical observations. (Germany.)

The Noise Effect Caused by Irregular Spectral Distribution of Noise Fluctuations, E. Sennhenn. "El. Rund." Jan. 1959. 4 pp. The irregular spectral distribution of noise fluctuations as well as the noise distributed constantly over the frequency range has a ratio at 6:1 to 7:1 between peak and effective values of the noise voltage. The noise effect is influenced by various picture properties. The article gives description of measurements displaying the dependency of the noise voltage on the frequency for different pictures. (Germany.)

Fault Location on Telephone Lines by Means of an Echograph, H. G. Bauer and F. Weilker. "Nach. Z." Jan. 1959. 12 pp. Fault location on lines by means of pulses has advantages particularly in those cases where several faults, intermittent faults, etc., are present. The requirements for a multipurpose device are compiled in this paper. The echograph is a small, easy to handle and easy to operate unit for fault location by means of pulse echoes and is designed for measurements on cables of 10 to 20 km length or open wire lines of up to 200 km length. The delay corresponding to the distance of the fault is shown in u secs. on a CRT with a calibrated time base and with a delay line. The circuit and the construction of the equipment is described. Measurement results from examples of echo pictures and their interpretations are used to demonstrate typical line faults. Advice is given for advantageous applications of the equipment in installation work and fault location. (Germany.)

Type and Characteristics of the Selecting Mechanism in the Telephone Industry, G. Rothert. "Freq." May 1958. 6 pp. Reviewed is the development of the switching and selecting devices in the various countries. Common characteristics are highlighted. (Germany.)

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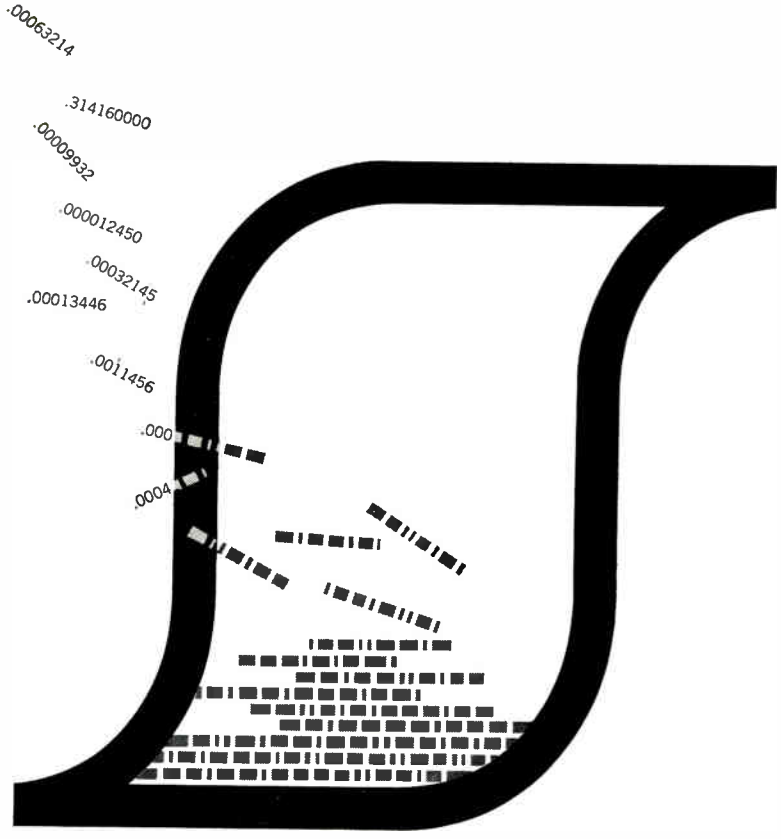

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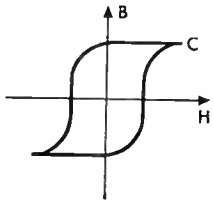

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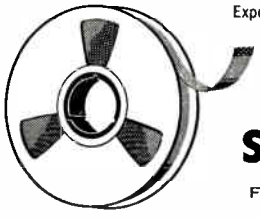

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A Fully Transistorized Remote Control Receiver for 72 mc, H. Schreiber. "Toute R." Nov. 1958. 4 pp. Described is a superregenerative receiver using four transistors. The first stage uses a 2N247 transistor. The unit is packaged on a small printed board, 50 mm x 90 mm, and weighs 120 grams. The output feeds a 2,000 ohm, 4 ma relay. (France.)

Demodulation and Detection, D. A. Bell. "E. & R. Eng." Jan. 1959. 4 pp. (England.)

The Noise Immunity of an Autocorrelation Receiver for Amplitude-Modulated Signals, L. Z. Kliachkin. "Radiotek." Feb. 1959. 6 pp. The paper studies the noise immunity for autocorrelation reception of amplitude-modulated signals with respect to fluctuating noise. The author examines the delay time and the passbands of the filters preceding the detector or multiplier on the increase in signal-to-noise ratio which is assured by an autocorrelation receiver in comparison to a receiver with a square-law detector. It is shown that for an optimum filter passband the average improvement over the entire spectrum of the modulating frequencies does not exceed 1.5 db; when the passband is increased above the optimum value, the improvement tends toward 3 db in the limit. (U.S.S.R.)

Optimal Noise Stability Parameters of Telemetering Systems, V. A. Kashirin. "Avto i Tel." Feb. 1959. 13 pp. Telemetering signals transmission noise stability is determined for time and width modulation with weak or relatively strong fluctuation noise. Various kinds of modulation are compared as to their noise stability. (U.S.S.R.)

Noise Stability of Pulse Width and Pulse Time Telemetering with Great Fluctuation Noise, N. V. Posin. "Avto i Tel." Feb. 1959. 10 pp. The paper treats the problem of real noise stability of pulse width and pulse time telemetering. (Real noise stability takes into account main ways of information transmission realization.) Mean and mean-square errors are taken for noise stability criteria. Distortions due to relatively strong noise in channels are analyzed by the method of signal sampling. Calculation formulae for noise stability estimation are obtained. Various telemetering devices are compared as to their noise stability. (U.S.S.R.)

The Effect of Restricted Frequency Characteristics on Intelligibility of Speech in Radio Telephone Channels, A. R. Ravi Varma and H. D. Krishna Prasad. "J. ITE." Dec. 1958. 6 pp. This paper describes the effect on intelligibility in radio telephone channels when restricted speeeh frequency characteristics are employed. (India, in English.)

Interference Area Covered by a Tropospheric Scatter Transmitter, A. Chinni. "Alto. Freq." Dec. 1958. 8 pp. Owing to the high power emitted by a tropospheric scatter transmitter, the interference with the other radio communication systems covers a large area in any direction. To calculate immediately the magnitude of the interference area with an approximation of the order of ten kilometers, a nomogram has been constructed, furnishing the distance at which the interference field intensity exceeds a given value only for 0.1% of time, frequency, radio power, antenna gain and radiation pattern having been fixed. (Italy.)

Correlation Between Meteorological Phenomena and Propagation Beyond the Horizon Over the Mediterranean Sea, L. Bonavoglia. "Alta. Freq." Dec. 1958. 10 pp. On the basis of the results obtained from propagation tests beyond the horizon, on the open sea at different heights of the terminals, performed between stations in Minorca and in Cardinia, the behaviour of the surface refractivity index and at different heights has been calculated, and correlations have been established between received levels, refractivity indexes and gradients. (Italy.)

Multiplex for High Quality Broadcast Channels, A. Pasini. "Alta. Ferq." Dec. 1958. 11 pp. A multiplex equipment, apt to translate three broadcast channels to a frequency range suitable for transmission via radio link, has been recently developed and installed. The three broadcast channels, each ranging from 50 to 1500 c/s, modulate a 44 kHz carrier in a germanium-diodes modulator, the upper sideband and the carrier being eliminated at the modulator output. (Italy.)

A 300 Channel FV8 Radio Link System at 6000 MHz, E. Viti. "Alta. Freq." Dec. 1958. 27 pp. After a general description of the FV8 radio link system, an investigation of the characteristics of the component parts in view of the obtainment of the required qualities is conducted, which is followed by a detailed description of the equipment, and measuring instruments and accessories. Information on the results of overall tests carried out on laboratory proto-types is then given. (Italy.)

Automatic Switching Problems, A. Ricagni. "Alta. Freq." Dec. 1958. 17 pp. Considerations are made on the opportunity of using a standby-equipment with automatic switching in the communication systems for public service. in order to guarantee the continuity of service without intervention of personnel. (Italy.)

Telemetering Employing the Principle of the Gas-Filled Stepping Tube, Yoshisuke Hatta. "El. Eng." Apr. 1959. 3 pp. A method of telemetering of mechanical displacement employing the principle of the gas-filled stepping tube is described. As it is an electronic device it has good high speed operation, and is, therefore, superior in some respects to electromagnetic systems which have considerable inertia. (England.)

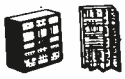
COMPONENTS

The Use of Zener Diodes in Electrical Engineering and Electronics, W. Taeger. "El. Rund." Mar. 1959. 3 pp. After a description of the zener effect and several applications in electrical engineering, for instance, for zero-point suppression in measuring instruments, stabilizing circuits are given for the production of constant, load-independent voltages. Finally, a calculated example is given. (Germany.)

New Components for Miniaturized Microwave Radio Link, M. Mueller. "Alta. Freq." Dec. 1958. 16 pp. A description is given of components that led to a marked reduction in size of a 4000 Mc/s microwave repeater for 600 telephone channels or one television program. The miniaturization is attained by the use of a high gain traveling wave power amplifier and flat type waveguides in the RF part. (Italy.)

Solid Electrolyte Tantalum Capacitors, Prof. Robert Aries. "El. Eng." Apr. 1959. 2 pp. Solid electrolyte tantalum capacitors have found ready acceptance for use in miniaturized equipment. In this article a brief description of the manufacturing process is given together with the results of life tests and temperature characteristics. (England.)

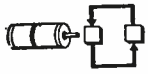
Linear Multi-Tapped Potentiometers with Loaded Outputs, K. C. Garner. "El. Eng." Apr. 1959. 8 pp. An analysis of multi-tapped linear potentiometers is given for the type where shunt resistors are connected between adjacent tapping points, and in the presence of an output load resistance. Using the relationships of a generalized network with appropriate numerical substitutions obtained from the particular potentiometer arrangement being considered, evaluation is simple and systematic. (England.)



COMPUTERS

Digital Integrator Device for Programming the Second Order Curves, A. A. Voronov and G. N. Sikolov. "Avto i Tel." Feb. 1959. 8 pp. Digital analog computers are used to program the second order curves. A programming device circuit is presented as applied to milling machine for manufacturing profiles consisting of straight lines and of circles. (U.S.S.R.)

Electronic Analogue Computers: II. The Integrator, J. V. Ranga Rao. "J. ITE." Dec. 1958. 5 pp. A high gain D. C. amplifier, with feedback capacitor and input resistor, can integrate any voltage present at its input, with respect to time and it overcomes many short-comings of a simple R. C. network integrator. (India, in English.)



CONTROLS

Distributed Objects Remote Control Complex System, V. A. Ilyin, et al. "Avto i Tel." Feb. 1959. 4 pp. Remote control complex system with contactless elements as applied to control of distributed objects is considered. The system has frequency selectors in the form of resonance electric circuits with transistors. New short-period pulse time telemetering system is used in the system under consideration. (U.S.S.R.)

On Stability of a Control Nonlinear System with a Neutral Object, L. I. Kuprianova. "Avto i Tel." Feb. 1959. 8 pp. The problem of stability of unsteady movement of a control nonlinear system with a neutral object is solved on the basis of the second Liapunoff method. Possibility of evaluation of dependence of stability limits on coefficients variability is proved. (U.S.S.R.)

United Two-Drive Servosystems, P. F. Klubnikin. "Avto i Tel." Feb. 1959. 15 pp. The theory of united two-drive servosystems is expounded. Transfer functions and error coefficients of the systems mentioned are obtained. The experimental results of the analysis of the systems are presented. (U.S.S.R.)

GENERAL

Choice of the Optimal Amplifying Coefficient in Self-Adjusting Programme Control System, I. I. Perelman. "Avto i Tel." Feb. 1959. 8 pp. The paper deals with a self-adjusting programme control system. The optimal amplifying coefficient is determined in the system in question when its input cyclic disturbance is described statistically. The amplifying coefficient is considered to be optimal from the point of decreasing mean-square error. (U.S.S.R.)

International ELECTRONIC SOURCES—

The Effect of the Shield on the Q of Long Single-Layer Coils, I. V. Gorenshtein. "Radiotek." Feb. 1959. 6 pp. The paper studies the effect of a shield on the current and field distribution in the coil. It is shown that when the dimensions are properly selected, the presence of the shield leads to an increase in the Q of the coil. A method is described for computing the dimensions of the shield. A formula is derived for selecting the optimum wire diameter. (U.S.S.R.)

On the Passband of a Magnetostrictive Delay Line, G. V. Glebovich (patent). "Radiotek." Feb. 1959. 2 pp. The investigations which were performed show that the passband depends on the properties of the magnetomechanical member of the transducer and on the characteristic of the electrical circuit of the transducer. The boundaries of the passband are computed. In order to expand the passband for the transducer it is desirable to create a magnetic field distribution which is close to rectangular; the field should be concentrated over a very small section of the sound conductor. (U.S.S.R.)

Biology and Electronics, Prof. A. V. Hill. "J. BIRE." Feb. 1959. 8 pgs. (England.)

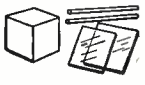
INDUSTRIAL ELECTRONICS

Statistical Estimation Automatic Control of Milling In A Ball Mill, V. Sh. Bereza. "Avto i Tel." Feb. 1959. 11 pgs. Changes of milling fineness as compared to desirable value are shown to be accidental. Accidental fineness errors are proved to follow normal distribution law in automatic control of milling and high-peak law in hand control of milling. Mean-square error is used to estimate automatic control of milling in a ball mill. (U.S.S.R.)

Concerning Computer To Control Power In Dielectrical Arcfurnace, Yu M. Alyshev, et. al. "Avto i Tel." Feb. 1959. 5 pgs. Design principles of a computer to control power in electrical arcfurnace are considered. The results of the computer test are presented. (U.S.S.R.)

Analysis of Compensation of the Strip Thickness Variations With the Electronic Analog Computer, S. A. Doganovsky and A. A. Feldbaum. "Avto i Tel." Feb. 1959. 14 pgs. The paper deals with theory, design and application of the computing device to compensate variations of the strip thickness in a rolling mill. The experimental results of compensation of the strip thickness variations with the rolling mill electronic analog computer are described. (U.S.S.R.)

Acceleration Current Circuit of Bobbin Gears, A. Voget. "El. Rund." Mar. 1959. 2 pgs. It is demonstrated, how in a simple way the magnitude of the acceleration current may be determined graphically. A corresponding circuit diagram is designed. The acceleration current circuit of a bobbin gear in a cold rolling reversing plant is taken as an example. (Germany.)



MATERIALS

Ferrites in Microwave Radio Links, M. Vadnjal. "Alta Freq." Dec. 1958. 14 pgs. The features of ferrite at UHF are briefly recalled and its applications in radio link technique are considered. Experimental data are given on resonance and field displacement isolators, as have been realized in 4000, 6000 and 9000 MHz wave band are given. (Italy.)

Ferroelectrics and Computer Storage, M. Prutton. "J. BIRE." Feb. 1959. 10 pgs. Some of the known ferroelectric materials are described together with those properties which are of immediate interest to the designer of a computer memory. The experimental techniques used to investigate the switching process in single crystals of ferroelectric materials are reviewed and some information on the new material triglycine sulphate is presented. (England.)

MEASURE & TESTING

On a Method for Analyzing the Operational Reliability of Electronic Equipment, N. M. Sediakin. "Radiotek." Jan. 1959. 8 pp. In recent times a great deal of attention has been devoted to the problem of the operational reliability of electronic equipment. However, the available literature does not provide a quantitative expression for the "reliability" parameter (the probability of faultless operation over a specified period t) for equipment while taking into account the initial status of the equipment and the duration of the inoperative time caused by failure of circuit elements. In this paper a basis is laid for a more general method of analyzing the operational reliability of electronic equipment. A number of new expressions which are of definite practical interest are derived. (U.S.S.R.)

Electropneumatic Transducers, Yu V. Krementulo. "Avto i Tel." Feb. 1959. 9 pgs. The paper deals with electropneumatic transducers elaborated in the Institute of Automation and Telemechanics of the Academy of Sciences of the USSR. Block-diagrams of the transducers mentioned, their operation and experimental results are described. Error due to non-linearity of the characteristics of the primary pneumatic relay is determined. The problem of amplification coefficient of the secondary amplification pneumatic relay is considered. Calculation of a temperature compensation circuit is presented. (U.S.S.R.)

The Digital Voltmeter, a New-Measuring Instrument, W. A. Mayerhofer. "El. Rund." Mar. 1959. 2 pgs. The apparatus described measures d. c. and a. c. voltages up to 1500 v with an accuracy of 0.5% and resistors up to 10 m with an accuracy 1%. (Germany.)

Power Determination of Thermic Neutrons, H. Mahnau. "El. Rund." Mar. 1959. 2 pgs. By way of general considerations on thermic neutrons it is demonstrated that the speed of thermic neutrons is relatively small and can easily be measured with electronic equipments, if the velocity measurement is traced back to a timing measurement for a known distance. (Germany.)

Measurement of Atmospheric Noise, B. B. Ghosh and S. N. Mitra. "J. ITE." Dec. 1958. 15 pgs. Two methods of measuring atmospheric noise levels, subjective and objective, have been described. The various technical aspects underlying the instrumentation for carrying out the measurements by these methods have been critically examined and the results of the experiments, used as basis for subjective measurements, have been described. (India, in English.)

Methods and Measurements for the Quality Standards of Radio Links Equipments, G. Monti-Guarnieri. "Alta Freq." Dec. 1958. 36 pgs. The capacity of transmission of a given type of radio link equipment depends on the transmitted modulation band and on the maximum distance which may be reached by performing specific quality standards. This note describes the laboratory methods and procedures of the capacity of transmission in well known and repeatable reference conditions, as near as possible to the average practical applications. (Italy.)

The Recording and Collocation of Waveforms, Part 2, R. J. D. Reeves. "El. Eng." Apr. 1959. 9 pgs. (England.)

Analysis Of Impact Noise, F. M. Savage. "El. Eng." Apr. 1959. 4 pgs. In this article a small portable instrument for the measurement of impulsive noise is described. The instrument may also be used for other purposes, such as the measurement of peak accelerations when used with a suitable accelerometer. (England.)

RADAR, NAVIGATION

Dynamic Properties of Electric Pilot Vibration Servomechanism, I. N. Krutova. "Avto i Tel." Feb. 1959. 12 pgs. The paper deals with an electric vibration servomechanism. Switching of speed in its servomotor is accomplished with electromagnetic clutches. Two instances are analyzed: when servomechanism motion is described by the first order equation and when it is described by the second order equation. The analysis yields parameters relations that characterize stability limit. (U.S.S.R.)

A Comparison Between Pulse and Frequency-Modulation Echo-Ranging Systems, L. Kay. "J. BIRE." Feb. 1959. 9 pgs. A general theory of the operation of frequency-modulation systems has been developed which can be applied to either Asdic or Radar, and the information obtained from such a system is compared with that from a conventional pulse system and a multipulse system. (England.)

SEMICONDUCTORS

On the Use of Transistors of the p-n-p and n-p-n Types in Push-Pull Output States, M. E. Movshovich. "Radiotek." Feb. 1959. 6 pgs. The paper studies an amplifier with a push-pull output stage using transistors of the p-n-p and n-p-n types. The optimum variant of such an amplifier circuit is determined. An example based on the computation of the specific circuit is given. (U.S.S.R.)

Design of an Emitter Current Controlled Common Emitter Transistor I.F. Amplifier Stage, M V. Joshi. "J. ITE." Dec. 1958. 15 pgs. The present paper together with a subsequent paper discusses the design of I.F. amplifier and detector stages with stabilized bandpass characteristics suited for use in the community receiver. In the present paper a method of partial neutralization is described and it is shown that with surface barrier transistor it is possible to design a double tuned I.F. amplifier stage whose performance is close to that predicted from measurements carried out to determine transistor parameters at a single value of emitter current. (India, in English.)

TELEVISION

A Feeder Echo Absorber for Television Transmitters, E. S. Glazman. "Radiotek." Feb. 1959. 14 pgs. The paper studies the use of a bridge circuit for adding UHF oscillator power outputs in order to absorb the reflected signals which occur in the antenna-feeder system of the television transmitter. The author determines the special features of operation for the oscillators in the circuit of the echo-absorbing bridge; suggestions are made concerning the application of the circuit in television transmitters. It is shown that the use of the echo-absorber permits an appreciable lowering of the specifications for the antenna-feeder system, as well as a simplification of the construction and control of the system elements. (U.S.S.R.)

Radio Links for Television Transmission, F. Frisoni. "Alta Freq." Dec. 1958. 4 pgs. The author investigates the applications of radio links to television transmission and their characteristics in comparison to those of radio links for the multichannel telephony. (Italy.)

THEORY

On the Theory of Transmitting Signals Having Many Discrete Values, B. A. Varshaver. "Radiotek." Jan. 1959. 11 pgs. The general relationships derived by C. E. Shannon in information theory and by V. A. Kotel'nikov in the theory of potential (ideal) noise immunity are used to determine the transmission capacity for the transmission of signals with many discrete values. The upper limit of the transmission rate is determined for the case when corrective codes are used. The paper proves that for frequency modulation and pulse-time modulation the utilization of the average power may not exceed a definite value when element-by-element code combinations are used. A quantitative evaluation of the efficiency of corrective codes is given for different code bases and various types of modulation. Detailed graphs and formulas are given for the purposes of designing communication systems for a number of different cases. (U.S.S.R.)

The Problem of Establishing Steady-State Oscillation in a High-Frequency Oscillator with Lagging Feedback, I. S. Gonorovskii. "Radiotek." Jan 1959. 9 pgs. The paper studies the circulation of RF pulses in a ring with lagging feedback and describes the mechanism by which oscillations arise. The paper delineates the specific features which are due to various relationships between the transmission band of the tuned system of the oscillator and the amount of lag, and to the relationship between the amount of lag and the duration of the triggering pulse. (U.S.S.R.)

On the Potential (Ideal) Noise Immunity for a Signal of Random Phase, L. M. Fink. "Raidotek." Jan. 1959. 12 pgs. The paper derives inequalities which express the optimum criterion for reception of discrete messages in the presence of fluctuating noise when the initial phase of the r-f carrier is a random quantity. The minimum error probabilities are computed, and the methods for realizing potential (ideal) noise immunity are determined. (U.S.S.R.)

On Stability of Relay System Equilibrium, D. V. Anosov. "Avto i Tel." Feb. 1959. 15 pgs. Accurate mathematical treatment of relay system equilibrium stability is described. (U.S.S.R.)

To The Theory of γ-Relay Devices With Gas Discharge Counter, A. G. Vasiliev and K. S. Klempner. "Avto i Tel." Feb. 1959. 6 pgs. Connection of reliability of γ-relay devices operation and radiation source activity is analyzed. Calculation formulae are presented. (U.S.S.R.)

An Electronic Counter of Statistical Distribution, E. Paulsen. "El. Rund." Mar. 1959. 3 pgs. The article examines the possible errors which may arise in counting the statistical distribution of a function by pulse-like parts of this function. (Germany.)

TUBES

Grounded-Grid Triode Amplification of Microwaves, G. B. Stracca. "Alta Freq." Dec. 1958. 37 pgs. The paper treats the amplification of decimetric waves by conventional electronic tubes, namely microwave triodes, chiefly analyzing the wide-band case normally arising in television and multichannel telephone radio links. The use of conventional electronic tubes became of remarkable interest also in reception since the new low noise tubes appeared, allowing an improvement in the noise figure of receivers, obtained by amplification operated before the converter. (Italy.)

Frequency Control of Klystrons by Reference Cavity, L. Del Bello. "Alta Freq." Dec. 1958. 5 pgs. A negative feedback automatic frequency control circuit uses a discriminator operating at the same frequency of the controlled klystron. Through a directional coupler a signal of about I mW obtained from the transmission klystron is led to a modulated cavity, which consists of a waveguide terminated by a silicon diode to which is also applied a signal at frequency fm of 10,000 Hz. (Italy.)

The Linearization of Reflex Klystrons Used as Frequency Modulated Oscillators, G. Cicconi. "Alta Freq." Dec. 1958. 49 pgs. After stating the advantage of using reflex klystrons as FM generators in FM radio link equipments, the electrical characteristics of the available types are analyzed, thereby ascertaining the impossibility to obtain the extremely high values of modulation linearity over the frequency deviation range required in the FM radio links. A merit figure is formulated, which represents quantitatively the feasibility of a reflex klystron to be used as FM generator. (Italy.)

* * *

U. S. PATENTS

Complete copies of the selected patents described below may be obtained for $.25 each from the Commissioner of Patents, Washington 25, D. C.

Amplifier Circuit for Correcting Distortion Therein, #2,831,928. Inv. E. McPhail Assigned Electric & Musical Industries Limited. Issued April 22, 1958. A.M. signals are applied to a tuned input circuit with an amplitude to cause the control grid to take current and produce a damping effect. A bias is generated which automatically varies with the instantaneous value of the modulation and of an amplitude to reduce variations in the damping effect due to modulation and to leave rhw oscillations modulated in amplitude. The amplitude modulations are fed unlimited to the output circuit.

Electronic Gate Circuit, #2,831,971. Inv. C. R. Wischmeyer. Assigned Esso Research and Engineering Company. Issued April 22, 1958. The gating pulse is fed to a separate grid. A first resistor extends between this grid and the output terminal, a second resistor between the plate and the output terminal and a third resistor between the cathode and the output terminal. The original gating voltage conducted through the first resistor and the phase-opposed gating voltage conducted by the second resistor cancel each other across the third resistor with respect to the output terminal.

Electron Discharge Systems, #2,832,001. Inv. R. Adler. Assigned Zenith Radio Corporation. Issued April 22, 1958. A guiding field along a predetermined portion of an electron stream reference path not only confines the beam but also establishes a transverse-resonance frequency for the beam. The signal subjects the beam to a variable transverse deflection field substantially at the transverse-resonance frequency to produce excursions of the beam from the reference path. A deflection sensitive electrode system is coupled to the beam, which system is adapted to increase the transverse beam excursion and to generate an amplified signal.

Trigger Circuit, #2,831,983. Inv. B. Ostendorf. Assigned Bell Telephone Laboratories, Inc. Issued April 22, 1958. A transistor having a current-amplification factor exceeding unity is connected as a flip-flop circuit. The negative-resistance characteristic is established by the base resistor. The collector may be reversely biased with respect to the base. The emitter resistor is connected to a source of relatively high negative potential, while a rectifier connects the emitter to a source of relatively low negative potential, whereby a split-emitter load-line is obtained.

Automatic Gain Control Circuits, #2,834,877. Inv. W. Milwitt. Assigned Radio Corporation of America. Issued May 13, 1958. The automatic gain control voltage is applied to a first voltage divider network comprising two resistors, and a predetermined portion thereof is applied to a first amplifier stage. The automatic gain control voltage is further applied to a second voltage divider network comprising one resistor and one varistor of the exponetial type, the voltage derived from the divider network is applied to a second amplifier stage. Thus the two applied automatic gain control voltages do not vary proportionally with a change in signal amplitude.

Pulse Generator, #2,834,880. Inv. G. L. Clapper. Assigned International Business Machine Corp. Issued May 13, 1958. A capacitor connected the anode of a first tube and the grid of a second tube. A first rectifier establishes a feedback path for rising potentials between the anode of the second tube and the grid of the first tube and a first rectifier is connected at the input terminal.

Peak Amplitude Indicator, #2,834,883. Inv. H. Lukoff. Assigned Sperry Rand Corp. Issued May 13, 1958. A varying amplitude input signal is applied to a peak detector which follows the signal excursions in only one direction. The peak detector output is applied to one input terminal of a differential amplifier and the varying amplitude input signal to the other input of the differential amplifier which provides an output indicative of the difference in potential in its inputs.

Electron Discharge Device, #2,834,905. Inv. R. A. Lee. Assigned Bendix Aviation Corporation. Issued May 13, 1958. An elongated concave shaped cathode is positioned in an envelope also containing an inverted L-shaped anode and varium filled rods supported substantially parallel to the cathode.

Traveling Wave Tube, #2,834,908. Inv. R. Kompfner. Assigned Bell Telephone Laboratories, Inc. Issued May 13, 1958. Two helices are provided to alternately focus the electron beam in a first plane parallel to the axis for a portion of its travel and then in a different plane parallel thereto for a portion of its travel. Each helix has a flat-sided cross-section which is periodically angularly rotated along the length of the helix. The two helices are at different potential.

Variable Transconductance Amplifier, Modulator Tube, #2,834,910. Inv. H. J. Wolkstein. Assigned National Union Electric Corp. Issued May 13, 1958. The target electrode comprises a dynode and an anode both mounted transversely of the beam trajectory so that, when the beam is in its normal position, it impinges in a predetermined ratio on both target electrodes to produce a zero combined current. This ratio of interception is varied by deflecting the beam resulting in a current output from the connected anode and dynode. The entire dynode surface impinged upon by the beam has substantially uniform secondary emission characteristics.

Subscriber Television System, #2,833,850. Inv. E. H. B. Bartelnik. Assigned General Precision Laboratory, Inc. Issued May 6, 1958. The interlaced horizontal scanning lines are delayed with respect to the horizontal synchronizing signal in accordance with a selected harmonic time function of the field frequency. In the receiver a circuit neutralizing the time delay of the horizontal scanning lines is provided and controlled by a decoder voltage. A code signal generator, which adjusts the time function of the decoder voltage, is positioned at a point remote from the receiver and connected to the receiver by a line circuit, such as a telephone line.

Color-Television Signal-Modifying Apparatus, #2,833,851. Inv. B. D. Loughlin. Assigned Hazeltine Research, Inc. Issued May 6, 1958. A signal representative of the ratio of the amplitude of the luminance and chrominance components of a T.V. signal is applied to a square-law detector which controls the gain characteristics of a modulator in a channel for the high frequency component of the luminance signal, thereby modified in accordance with the saturation of the color. The unmodified luminance signal is combined with this modified high-frequency component signal to correct for the tendency to degrade the fine detail of a color image.

Frequency-Shift Signalling System, #2,833,857. Inv. H. K. Robin. Assigned National Research Development Corp. Issued May 6, 1958. Two bursts of oscillations of different frequency are received. The two bursts are separated into two channels and one of them is changed in frequency and delayed by a time interval equal to the time delay between the commencement of the two bursts. An oscillation whose frequency is dependent on the difference of the two channel frequencies is derived.

(*Continued on page* 160)

FROM

F. W. SICKLES

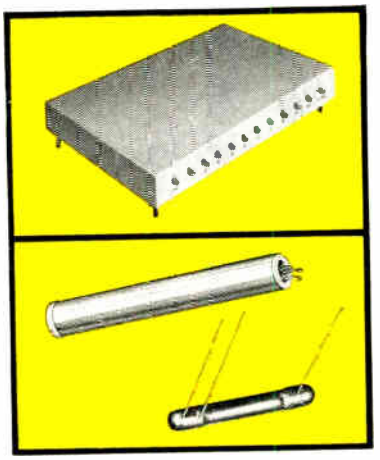
lumped and distributed DELAY LINES

SICKLES world's largest manufacturers of coils and windings

Sickles, oldest and most famous name in electronic coils, windings and assemblies, brings an unbeatable combination of experience and facilities to the delay line art. Experience — more than 35 years of it — enables us to select the right techniques to design and produce delay lines for everything from color TV right through to complex missiles and computers.

And Sickles' facilities are impressive. Modern winding machines, many specially designed and built by us, give us a capacity and versatility unequalled in the industry. Form factors are almost unlimited, automation and mass production an accomplished fact, with the result that we are producing varied types of delay lines in quantity at amazingly low prices.

Our specialized skills and vast production capacity are at your disposal. We'll be glad to have a qualified representative discuss your delay line problem with you. For information, please write Section EI-7.



The delay line at upper left measures approximately 6" x 4" x 1" with the following characteristics: Td (usec) 5.0 tapped each .5 usec; Tr (usec) .13 usec; Z (Ω) 300. Sickles design techniques permit us to make the same line in a much smaller box if necessary.

Distributed lines at lower left can be supplied with time delays up to 25 usec with impedances of 300 to 5000 ohms. They may be hermetically sealed, potted, resin dipped or encapsulated.

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U. S. Patents

(*Continued from page 158*)

System for Determining Listening Habits of Wave Signal Receiver Users, #2,833,859. Inv. H. A. Rahmel, R. L. Freeman, Chas. H. Currey and D. W. Holbrook. Assigned A. C. Nielsen Co. Issued May 6, 1958. The system is intended to monitor home receivers. A constant speed motor at the sender end is energized when the receiver is tuned. A transmission line, such as telephone lines, connects this sender motor to a follower motor at the monitoring station. The operation of the two motors is synchronized, and both motors are stopped when the receiver tuning operation is terminated.

Communication Systems, Intermediate Relay Repeater Station, #2,833,861. Inv. F. B. Anderson and J. O. Edson. Assigned Bell Telephone Laboratories, Inc. Issued May 6, 1958. A source of permutation supplies code groups of successive pulses. Each of a plurality of different signalling conditions represents, in accordance with the permutation code, the instantaneous value of a message wave. The time position of the pulses is modulated in accordance with another message wave to simultaneously transmit both messages.

Amplifier, #2,833,918. Inv. L. A. Knox. Assigned International Business Machines Corp. Issued May 6, 1958. A desirable phase component is separated from a phase component in quadrature therewith by a gating tube. A gating pulse of very short duration and coincident with the minimum of the quadrature component voltage causes the gating tube to conduct. A subsequent capacitor circuit is charged during the conducting period of the gating tube and discharged immediately before the next gating period.

Intelligence Transmission System, #2,832,817. Inv. P. Raibourn. Issued April 29, 1958. To widen the effective bandwidth of a color television signal channel, the brightness component signal is transmitted on a principal carrier, the sidebands of which are within the channel width, while the chromaticity component signal is transmitted on a subcarrier, the effective sidebands of which lie at least partly in an adjacent channel. The subcarrier frequency is stabilized at an odd multiple of half of the line scanning frequency of the brightness signal of the adjacent channel and the chromaticity component signal is synchronized with the brightness component of the adjacent channel.

Color Television, #2,832,819. Inv. S. W. Seeley and A. Macovski. Assigned Radio Corporation of America. Issued April 29, 1958. A carrier, capable of being demodulated at different phases to produce different information, is applied between anode and cathode of two amplifiers. Each amplifier tube contains a grid excitation source to operate for class C operation at a common prescribed frequency and at different prescribed phases. A mutual cathode output circuit produces a prescribed addition of both signals.

Beam Power Amplifier, #2,832,847. Inv. H. E. Goldstine. Assigned Radio Corporation of America. Issued April 29, 1958. The beam power amplifier tube is provided with two plate elements, each element being coupled to one of a pair of inductively coupled windings in a resonant circuit. The plate voltage for the first element is less than the plate voltage for the second element. A constant voltage is applied to the first deflection plate and a voltage indicative of the signal level to the second deflection plate, which is thereby operated to selectively cause electron flow to one of the plate elements in accordance with the signal level.

Electronic Function Generator, #2,832,886. Inv. Chas. D. Morrill. Assigned Goodyear Aircraft Corp. Issued April 29, 1958. Two oppositely poled series diode-resistance negative feedback paths connect the input and output of a first amplifier. The input is coupled to this ampli-

(Continued from page 160)

fier and to a summing amplifier which also receives a signal from the junction between one of the diodes and the associated resistor. A modifying variable each may be introduced at the two amplifier inputs.

Antenna System, #2,832,955. Inv. H. Jasik. Issued April 29, 1958. Four tubular elongated conductive radiating elements are radially arranged on an axis with their elongated sides parallel to the axis. These elements are energized by a two-conductor transmission line, each conductor being connected to a point common to two of the radiating elements.

Compensated Charge Storage Circuit, #2,832,887. Inv. A. E. Kirschner. Assigned Sperry Rand Corp. Issued April 29, 1958. To produce a d.c. output voltage in response to an input pulse, a storage capacitor, connected between the control grid and cathode of a first tube, is switched into the pulse circuit for the pulse duration. Simultaneously a compensating capacitor, connected between control grid and cathode of a second tube, is charged by a constant source. The output is derived from the plate of the first tube, while the second tube plate provides the screen grid potential for the first tube.

Apparatus for Reproducing Images in Natural Colors, #2,835,727. Inv. J. L. Rennick. Assigned Zenith Radio Corp. Issued May 20, 1958. The fluorescent screen of the T.V. display tube has a multiplicity of triangularly shaped clusters of three fluorescent color elements. A brightness information signal continuously scans this screen. Original control signals, individually representative of the difference in amplitude between one primary color signal and a predetermined fraction of the brightness signal, are modified inversely with respect to the amplitude variations of the brightness signal. The modified signals concurrently control the angular and radial deflection of the scanning beam relative to the center of each multi-color fluorescent cluster to determine the color contribution of each such cluster to an image in natural color.

Television Receiver with Color Signal Gate, #2,835,728. Inv. R. D. Flood and L. R. Kirkwood. Issued May 20, 1958. Normally the composite chrominance and luminance video signals are impressed on a synchronous demodulator to recover the chrominance signal from the color subcarrier. However, during periods of color synchronizing signal burst of unmodulated color subcarrier waves, the signal is not impressed on the synchronous demodulator.

Negative Feedback Transistor Amplifier, #2,835,748. Inv. J. Ensink and J. Verhagen. Assigned North American Philips Co., Inc. Issued May 20, 1958. The input is applied to the base of a first non-current amplifying transistor, and the collector of this first transistor is connected by a d.c. path to the emitter of a second current amplifying transistor. A common d.c. circuit extends between the base of the second transistor and the emitter of the first transistor and a negative feedback impedance connects one point on this circuit to the power supply.

Diversity Receiving System, #2,835,793. Inv. J. A. Doremus. Assigned Motorola, Inc. Issued May 30, 1958. A control signal having a frequency which varies with the strength of the received carrier wave is derived at each receiving station and supplied with the received signal to the central station. At the central station, the control signals and the received signals are separated and the received signal with the strongest carrier wave is selected.

Linear Frequency Modulation Detector, #2,835,802. Inv. J. R. Day. Issued May 20, 1958. A time-delay phase shifter is inserted in at least one of the two input paths for the f.m. wave, the magnitude of the relative phase shift in the two paths varying linearly with the frequency. The two outputs are coupled, respectively, to the two inputs of a phase comparator switch producing a constant-amplitude rectangular wave. One switch input initiates each element of the rectangular wave and the other input terminates it.

* * *

New Tech Data for Engineers

Bathtub Capacitors

Engineering bulletins No. 2220A and 2221A describe Type Nos. 143P and 144P drawn metal case "bathtub" metallized paper capacitors and their application to noise suppression circuits and similar applications in airborne and military equipment. Data includes electrical characteristics, physical dimensions, and a general description of their advantages. Sprague Electric Co., North Adams, Mass.

Circle 161 on Inquiry Card

Ceramic

Bulletin 118, 1-page data sheet, describes Duramic grade HT-2-M readily machinable high temperature heat shock resistance ceramics suitable to 2200°F. Duramic Products Inc., 262-72 Mott St., New York 12, N. Y.

Circle 162 on Inquiry Card

DC Motor

Bulletin, 1-page, describes 1.6 HP, 28 VDC motor that incorporates explosion proof construction, radio noise filter, integral gear reduction and high altitude brushes. Hoover Electric Co., 2100 So. Stoner Ave., Los Angeles 25, Calif.

Circle 163 on Inquiry Card

Seals

Engineers concerned with making pressure and vacuum type seals with hard glasses will be interested in a new 8-page booklet on Kovar Alloy. The feature of this iron-nickel-cobalt alloy is that its thermal expansivity matches almost perfectly the curves for several hard glasses. The Carborundum Co., Refractories Div., Perth Amboy, N. J.

Circle 164 on Inquiry Card

Precision Potentiometers

A new 12-page folder covers a complete line of miniature precision pots (bushings series and servo series). Included is a complete line of standard precision potentiometers, also potentiometers for special applications. Electrical and mechanical specifications, power ratings, and mechanical tolerances. Waters Mfg. Inc., Wayland, Mass.

Circle 165 on Inquiry Card

Capacitors

Catalog 59-1, 8 pages, describes the line of "Vitramon" capacitors, in 5 different designs and values from 0.5 mmf to 6800 mmf. Data includes electrical characteristics, design applications and information on the manufacture. Vitramon Corp., P. O. Box 544, Bridgeport 1, Conn.

Circle 166 on Inquiry Card

Transformers

Data sheet, 1-page, gives technical specifications on a line of transformers for electronically regulated power supplies, and a wide range of applications. Data also covers special chokes and special purpose transformers. Sterling Transformer Corp., 297 N. 7th St., Bklyn. 11, N. Y.

Circle 167 on Inquiry Card

Synchros and Motors

Complete electrical characteristics, mechanical characteristics and drawings are given for all types of synchros, size 8 through 22, in a new multicolor 26-page catalog from Clifton Precision Products Co., Inc., 9014 West Chester Pike, Upper Darby, Pa. Information is included on a wide line of precision computing resolvers and linear transformers (induction potentiometers), also gearhead motors and 8 DC motors.

Circle 168 on Inquiry Card

Power Connectors

Series 14 power connectors with closed ring entry contacts, are available in 7, 9, 10, 15 and 19 contacts. Telescoping barriers around each contact provide unusually long creepage paths and high current rating. An illustrated bulletin on the connectors is available from Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle 169 on Inquiry Card

Multiplier Phototubes

Current line of multiplier phototubes, their specifications and circuit data, in addition to detailed information on a complete line of potted voltage dividers and ultraviolet and "solar blind" response MPTs, are presented in a new 90-page catalog released by Allen B. Du Mont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N. J. This is the 2nd edition of the comprehensive "Du Mont Multiplier Phototubes."

Circle 170 on Inquiry Card

Voltage Divider

The Model DT-72 DEKATRAN is a 7 decade rack-mounting transformer type ac voltage divider with accuracy of better than one part per million terminal linearity. Features include excellent long term stability, high input impedance, low out impedance, and minimum phase shift. Specifications are described in a new 4-page catalog from Electro-Measurements, Inc., 7524 S. W. Macadam Ave., Portland 1, Ore.

Circle 171 on Inquiry Card

Plating Materials

"Gold for Industry and the Arts" is a new data file that answers questions about the uses and methods of gold plating and other pertinent facts about the industrial and decorative applications of the metal. The data is contained in an attractive 12-page brochure. Also available is a description of a new hydrogen-purifying unit based on the palladium diffusion process. Both catalogs are being made available by Engelhard Industries, Inc., 113 Astor St., Newark 2, N. J.

Circle 172 on Inquiry Card

Slip Ring Assemblies

Various types of slip ring assemblies are described with lists of applications and a fundamental description of their use in a new data file made available by the D. E. Makepeace Div. of Engelhard Industries, Inc., 113 Astor St., Newark 2, N. J. File also contains illustrated data on radio frequency and video, high voltage, high speed instrumentation and power pulse slip ring assemblies.

Circle 173 on Inquiry Card

Chassis Latches

An improved chassis latch, designated the 35L, and described in a new bulletin, features a push-button release mechanism on the locking device which permits simplified, quick, mechanical release of multiple pin connectors commonly used with plug-in chassis. Mechanical advantages provided to engage connector plugs with forces as high as 400 lbs. without the danger of deforming structures. Camloc Fasteners Corp., 130 Spring Valley Rd., Paramus, N. J.

Circle 174 on Inquiry Card

Coaxial Cable

The line of new "Spir-O-Line" semiflexible aluminum coax cable and "Spir-O-Lok" connectors are described in catalog 591, together with related transmission components, complete performance data graphs and charts, specifications and all other data needed by design engineers. Prodelin Inc., 307 Bergen Ave., Kearney, N. J.

Circle 175 on Inquiry Card

Standoff Insulators

Over 75 different ceramic standoff insulators, in 14 basic JAN styles are described in the new catalog, Form 42-181R3. All are made of grade L-5 material in accordance with JAN-1-8 and JAN-1-10 specifications. Centralab, A Div. of Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee, Wis.

Circle 176 on Inquiry Card

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REFERENCE DATA FILE Folio 59-3

SANGAMO

a continuing series on technical topics of specific interest to engineers

What makes mica the unique dielectric?

Mica is as old as the earth itself. Ancient Hindu writings show that mica was thought to be the remains of lightning flashes from which sparks had emanated and had become preserved in the earth. It was therefore regarded as being endowed with extraordinary properties, and was used in medical ritual. The replacement of such charming stories with modern technical knowledge has, however, not altered the fact that mica is endowed with extraordinary properties.

Mica is found in pegmatite rock, formed in the early stages of the cooling of the earth's mass. Crystals of mica were formed under high heat and pressure, and in the presence of moisture vapor and magnetic fields. The physical and chemical changes during this period served to impart a unique stability in physical, chemical and electrical properties. The chemical structure of mica is represented as $H_2KAl_3(SiO_4)_3$ which is Muscovite; India Ruby is one of the grades of exceptional quality and is used in most mica capacitors. Other types of mica, to name a few, are Phologopite, Lepidolite and Biotite, of which only Phologopite is of limited interest in experimental capacitors for very high temperature operation.

Mica is found in varying degrees of purity, some with less mineral or vegetable constituent, or stain, and some with more nearly perfect physical integrity — that is, free from cracks or air inclusions. As a result, raw mica must undergo careful physical examination and be graded according to quality and size. Sangamo has had over 35 years experience in the selection and processing of mica, together with a knowledge of mica capacitor production. Capacitor grades of mica film are generally obtained from the Bihar, Bengal, or Madras provinces of India. Mica for other purposes may be found in Canada, Brazil, Argentina, Madagascar, Africa, Russia, New Hampshire, South Carolina and South Dakota. This list is by no means complete. An idea of the magnitude of the task of selecting suitable mica can be obtained from the fact that only an estimated ten per cent of all the world's mica deposits are suitable for use in mica capacitors.

The earliest mica capacitor was probably made by Matteuci, a contemporary of Faraday's, about 1845. However, capacitors did not become commercially interesting until the advent of radio in the early years of this century, as a result of the growth of electrical technology. Both the electrical and electronics industries have depended significantly upon mica. Mica insulation between commutator segments in rotating machinery and the mica spacers in vacuum tubes are still vital to these industries.

In capacitors, the choice of dielectric material is as important as the method of construction. Mica, because of its sheet form, lends itself to stacked construction, resulting in a lower inductance assembly than can be obtained in wound capacitors. Mica capacitors are therefore suitable for very high frequency operation.

The mechanical or dimensional stability of mica allows blanking or die-cutting of dielectric plates to a desired size with only a very few thousandths of an inch variation. Precise assemblies may therefore be obtained and result in a greater ability to achieve accurate miniaturization. Electrodes may be permanently bonded to the mica dielectric plates by screening on conducting silver paste. This process has been refined to a high degree of accuracy, and results in superior electrical stability when compared to laying foil between mica plates to form the electrodes. Silvered mica capacitors exhibit exceptional stability in extremes of temperature.

The Q and dielectric constant (therefore, the capacitance) of mica change very little over wide ranges of frequency and temperature. Such small changes are due to the fact that the molecular structure of mica is essentially non-polar — that is, the molecules of mica do not have an unbalanced electrical charge. Thus they are not free to swing freely as magnets do (mica is practically non-magnetic) when in the presence of an electric field. Such fields are present when the capacitor is charged. Movement of the molecules would result in heating by the friction of their motion. Poor dielectrics exhibit considerable heating, as is shown by the heat developed in wood and glue in the process of laminating plywood in dielectric heating devices.

Heating effects may become very pronounced when high frequency alternating voltages are applied. The rapid changes in the direction of current flow cause polar molecules to literally vibrate about their rest position. The low heating of mica under such conditions is evidenced by the fact that certain types for transmitting applications will carry apparent currents to 50 amperes, at a few megacycles, resulting in only few degrees temperature rise.

Minimum dielectric heating is very essential since it has been shown that the life expectancy of a capacitor is reduced by a factor of approximately one-half for each ten degree centigrade rise in temperature.

All mica capacitors do not possess the ultimate characteristics of natural mica, since designs and manufacturing procedures differ according to original intent and application. However, the characteristics shown in the table could be realized under ideal conditions.

Characteristic	Approximate or Ideal Value
Dielectric Constant	7 (resulting in a moderate degree of miniaturization)
Q	3000 or greater
Power Factor	0.05% or less
Self Resonant Frequency	Up to 500 megacycles
Insulation Resistance	100,000 megohms or greater
Operating Temperatures	Up to 230°C. (85°C standard for commercial types)
Temperature Coefficient of Capacitance	0 to +70 parts per million per degree centigrade
Capacitance Drift or Capacitance Retrace	0.05% or less

At Sangamo all mica capacitors are designed and manufactured to exceed the physical and electrical requirements of applicable military specifications. The wide variety of Sangamo mica capacitor types allow flexibility of design and superior products for the most critical applications to meet individual specification requirements. Engineering catalog and bulletin giving full information on types and characteristics are available upon request for your examination.

SC59-3

SANGAMO ELECTRIC COMPANY, Springfield, Illinois

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New Tech Data for Engineers

Control Equipment

GE tape-controlled Burgmaster 6 and 8 spindle turret drilling, tapping, and boring machines are covered in a 12-page bulletin that tells how to program a part, prepare the tape and operate the machine. It explains the cost reducing machine features that work equally well on short run jobs or high production. M. R. Crossman Co., 546 N. Hollywood Way, Burbank, Calif.

Circle 189 on Inquiry Card

Synchros

A new 16-page bulletin discusses complete line of GE Selsyn and Synchro electro-magnetic devices used for extremely accurate transmission of electrical angular data between 2 or more points. Most commonly used models of the high-accuracy class for precise remote control applications are described. Rated accuracy is from plus or minus 1.50° to plus or minus 0.3°. General Electric Co., Schenectady 5, N. Y.

Circle 190 on Inquiry Card

Permanent Magnets

Catalog No. 20, describing Alnico V permanent magnets for microwave load isolators has just been released by The Indiana Steel Products Co., Valparaiso, Ind. Data includes the basic sizes and shapes of "C" type magnets as well as information on how they can solve load isolator design problems.

Circle 191 on Inquiry Card

Digital Instruments

The complete KIN TEL line of digital instruments is described in a new 4-page, illustrated bulletin, No. 19-36. The line features the use of fifth-digit over-ranging in all dc operations. The data covers voltmeters, ratiometers, ohmmeters, preamplifiers, input scanners, and a variety of accessories for driving punches, tape punches, and printers. KIN TEL Div., Cohu Electronics, Inc., Box 623, San Diego 12, Calif.

Circle 192 on Inquiry Card

Instruments

New instruments and components catalog for communication and industry, published by American Electronic Laboratories, Inc., 121 N. 7th St., Philadelphia 6, Pa., 4-pages, 2-colors, presents a line of conical helix antennas, crystal video detector mounts, optimum linear microwave horns, pulse generators, and transistor curve tracers.

Circle 193 on Inquiry Card

Tape Recorders

Five new instrumentation bulletins describe a series of ruggedized, miniaturized magnetic tape recorders for use in rockets, missiles and other airborne applications. Models covered are the Model MR-53, Model MR-1B, Model MR-2B, Model MR-100. BJ Electronics, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif.

Circle 194 on Inquiry Card

Transducers

"Bourns Instrument Brochure," an illustrated 8-page brochure, summarizes key information on a complete line of linear motion potentiometers, pressure transducers, accelerometers and angular position transducers. Specification on range, resistances, resolution, linearity, hysteresis, and power rating are given for individual models. Bourns Laboratories, Inc., P. O. Box 2112, Riverside, Calif.

Circle 195 on Inquiry Card

Microwave Components

Waveguide components, coaxial components, instrumentation and high-power plus modulators are described and listed separately in a new short form catalog being made available by FXR Inc., 26-12 Borough Place, Woodside 77, N. Y. Data includes technical specifications and illustrations for the microwave engineer, as well as prices on all pieces of equipment.

Circle 196 on Inquiry Card

Insulation

GET-2929, 12 pages, describes in text, tables and pictures the characteristics and application range of insulating materials for electrical insulation systems. Mica mat, varnished cloths and papers, insulating varnishes, wire enamels, "Irrathene" irradiated polyethylene, and sealing and filling compounds are included. General Electric Co., Schenectady 5, N. Y.

Circle 197 on Inquiry Card

Specialized Equipment

The design and manufacture of automatic wideband countermeasures, special equipment and complete systems is described in a new brochure available from Instruments for Industry, Inc., 101 New South Rd., Hicksville, L. I., N. Y. Included are listings of some of the specialized equipments completed or near completion for the military, illustrations of their engineering facilities and graphic presentation of I.F.I.'s growth.

Circle 198 on Inquiry Card

Resistors

The "Handy-Pak" concept of resistor packaging in which 3 to 6 carbon composition resistors packaged in a heavy paper packet surrounded by a slim plastic sleeve is a subject of a new catalog sheet. The resistors are kept factory fresh until use, with the color-code bands bright and clear. International Resistance Co., 401 N. Broad St., Philadelphia, Pa. The "Handy-Paks" are available in 77 resistance values and each contain six ½-w., four 1-w. or three 2-w. resistors.

Circle 199 on Inquiry Card

IC Tuners

Bulletin No. 216, with illustrations and descriptions of electrical and mechanical characteristics of a new LC Tuner series resonant frequency vs. capacitance load charts and self frequency vs. screw-turns graphs for each of 12 LC tuners covered. JFD Electronics Corp., 6101 16th Ave., Brooklyn 4, N. Y.

Circle 200 on Inquiry Card

Production Machinery

Two new catalogue sheets from Kahle Engineering Co., 3322 Hudson Ave., Union City, N. J. describe two production machines: The No. 3117 automatic glass diode sealing machine which seals up to 1500 glass diodes per hr. and the Model No. 3042 cat whisker soldering machine.

Circle 201 on Inquiry Card

Servo Amplifier

Bulletin A3105-02 describes a miniature transistorized servo amplifier capable of delivering a maximum power of 2½ watts to drive such Kearfott servo motors as R119-5 or R124-5. Small, lightweight and rugged, the unit is particularly suited to high-speed aircraft and missile applications. Kearfott Co., Inc., 1500 Main Ave., Clifton, N. J.

Circle 202 on Inquiry Card

Power Supplies

Basic data on a new "hybrid series" of voltage regulated power supplies is contained in a new 4 pager from Kepco Laboratories, Inc., 131-38 Sanford Ave., Flushing 55, N. Y. Power supplies have a voltage range of 125 to 325 v., are rack-mounting, and only 3½ in. panel height.

Circle 203 on Inquiry Card

EDITORIAL HIGHLIGHTS— 8th ANNUAL WESCON ISSUE

TWO ANNUAL WEST COAST ELECTRONIC INDUSTRIES DIRECTORIES—(1) Avionic, Guided Missile and Electronic Manufacturers listed by company name, address, telephone number and major product . . (2) Latest listing of West Coast Distributors and Manufacturers and Representatives and their addresses and telephone number.

TECHNICAL PAPERS AUTHORED BY WEST COAST ENGINEERS—In such fields as radar, underwater sound, aircraft electronics, guided missiles, spacecraft, computers, telemetering, microwave, etc.

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SHerwood 8-2000

San Francisco 3
Don May
1355 Market St.
UNderhill 1-9737

Chicago 1
George Felt
360 N. Michigan Ave.
RAndolph 6-2166

Los Angeles 57
B. Westley Olson
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Cleveland 15
Shelby A. McMillion
930 Keith Bldg.
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Dallas 1
Hal Mott
Meadows Building
Expressway at Milton
EMerson 8-4751

New York 17
Gerald Pelissier
100 E. 42nd St.
OXford 7-3400

Atlanta 3
John Sangston
911 William-Oliver Bldg.
JAckson 3-6791

New Tech Data for Engineers

D-C Amplifier

The new D-C amplifier, Model 2HLA-4a with isolated diferential input is described in a new 4-pager together with 14 applications showing how it can be used in laboratory, production and process control. Catalog number is B-C2HLA-4. Minneapolis-Honeywell, Boston Div., 40 Life St., Boston 35, Mass.

Circle 234 on Inquiry Card

Power Pentodes

RCA-6BQ5 and RCA-8BQ5 are 9-pin miniature type power pentodes for use in the audio-output stage of radio and TV receivers and in phonographs. As single ended class Al amplifier tubes they will deliver a maximum-signal power output of 5.7 watts. Technical bulletin is available from Electron Tube Div., Radio Corp. of America, Harrison, N. J.

Circle 235 on Inquiry Card

Transistor Guide

"Transistor Characteristics and Interchangeability Guide," the second edition, lists the characteristics and ratings of a wide variety of transistors used in entertainment, industrial, and military applications. Close to 700 transistor types are included. The 20-page booklet also contains glossary of transistor parameter symbols and definitions as well as mechanical specs and connections for Sylvania's complete line of transistors and sockets. Sylvania Electric Products, Inc., 1100 Main St., Buffalo, N.Y.

Circle 236 on Inquiry Card

Tantalum Capacitors

New "Hi-Rel tan-TI-cap" capacitors reportedly meet or exceed all known or anticipated MIL specs for reliability. Units are designed for −80 to +125° C operation . . . 134 capacity-voltage ratings; 1 to 330 mf, 6 to 35 volts. Designated type SRM, these capacitors are described in a 12-pager available from Texas Instruments Inc., Semiconductor - Components Div., 13500 N. Central Expressway, Dallas, Tex.

Circle 237 on Inquiry Card

AC Drive Motors

New data sheet from John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wis., tabulates a complete line of −55° C to +85° C missile quality AC drive motors. Includes size, voltage, frequency, number of phases (supply), no load speed, running current amperes, running watts input.

Circle 238 on Inquiry Card

Frequency Meters

The DRD meters (direct-reading digital frequency meters) cover the spectrum from 1.1 to 18.0 kmc in 9 models. The various coupling elements permit the use with waveguide or coaxial lines. A 1-page data sheet is available from Kay Electric Co., Maple Ave., Pine Brook, N. J.

Circle 239 on Inquiry Card

Antenna Handbook

The new, revised, expanded 2nd edition of ITE Circuit Breaker Company's "Antenna Handbook," 28 pages and 2 colors, is a unique compilation of basic reference material—charts, graphs, and data—for engineers dealing with radar and microwave antenna systems. The 25 graphs and charts provide data on losses, beam widths, range coverages, wind loadings, and waveguide lengths. ITE Circuit Breaker Co., Philadelphia, Pa.

Circle 240 on Inquiry Card

Gears and Motors

The "PIC Master Catalog No. 20," 416 pages, contains technical specs on over 2000 newly designed products with complete alphabetical index, catalog parts code index for comprehensive line of master gears, precision shafts, bearings, pins and additional couplings. PIC Design Corp., 477 Atlantic Ave., E. Rockaway, L. I., N. Y.

Circle 241 on Inquiry Card

Hall Generator

The Halltron Type HS-51 is a solid state device based upon the Hall effect, and designed for general purpose applications. Its characteristics are functions of 2 inputs, current and applied magnetic field. 4-page bulletin is available from Ohio Semiconductors, Inc.. 1035 W. Third Ave., Columbus 8, Ohio.

Circle 242 on Inquiry Card

Printed Circuits

"Reliability and cost in Printed Circuits" discusses the relationship between various factors affecting cost and reliability and points out the money-saving aspects of proper printed circuit design. Arthur Ansley Manufacturing Co., New Hope, Pa.

Circle 243 on Inquiry Card

Variable Transformers

Catalog A-56 describes the "Adjustavolt" line of variable transformers, featuring high performance strip silicon steel cores. Auto-isolated-metered motor driven variable transformers for remote control are included. Standard Electrical Products Co., Dayton 3, Ohio.

Circle 244 on Inquiry Card

Hi-Temp Transformers

A line of high temperature transformers for applications where ambient temperatures approach 350° C are described in a new catalog, HT-325, available from Acme Electric Corp., Cuba, N. Y. Catalog points out the necessity for special wire and rare and precious metal coatings in coil construction and discusses the insulation materials, ceramics, glass and mica required for this temperature range.

Circle 245 on Inquiry Card

Variable Transformers

Colorful new bulletin No. 151 provides operating data on a line of Ohmite "no — overvoltage" variable transformers. The maximum output voltage is no greater than the input voltage, but the transformers offer a sizeable bonus in additional current capacity. Ohmite Manufacturing Co., 3681 Howard St., Skokie, Ill.

Circle 246 on Inquiry Card

Oscilloscope Reader

The "data reader" is a handy scale for reading both amplitude and time history of oscilloscopic patterns. An entire time history can be read without readjusting. 1-page. Electro-Kinetics Co., P. O. Box 869, Lancaster, Calif.

Circle 247 on Inquiry Card

Variable-Cap. Diodes

"Varactors," a new 16-page brochure from Microwave Assoc., Burlington, Mass., describes a line of PN junction semiconductor diodes whose capacitance depends upon the voltage across the junction.

Circle 248 on Inquiry Card

Voltmeters

A new 4-page sales brochure from Ballantine Laboratories, Inc., Boonton, N. J., describes a line of high precision electronic voltmeters, a dc to ac inverter, decade amplifier, voltage multipliers and a series of precision shock resistors to convert voltmeters into sensitive and accurate microammeters and ammeters.

Circle 249 on Inquiry Card

Microwave

Bulletin ECM-71 describes a new 6 KMC line of microwave equipment which features a capacity of up to 120 channels, time or frequency division multiplexing, passive bridging, plug-in circuits and high reliability klystron tubes. General Electric Co., Communication Products Dept., Lynchburg, Va.

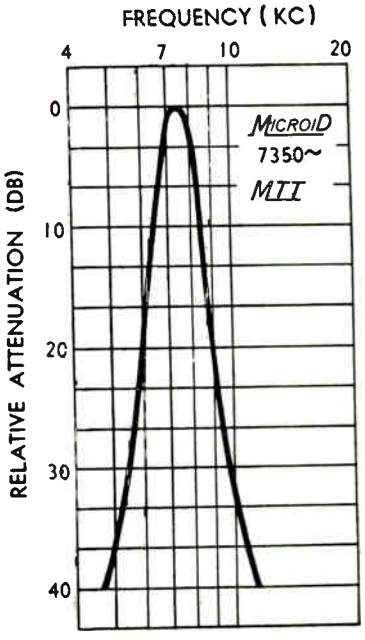
Circle 250 on Inquiry Card

(*Continued on page* 170)

Burnell & Co. may not be experts in the art of head shrinking. But when it comes to toroids, filters and related networks, Burnell has the know-how to solve an infinite variety of small space problems. The new *MICROID* ® filters by Burnell & Co. are a notable achievement in the shrinking of filters which can be designed for low pass or band pass applications.

For example, as a low pass filter, Type *MLP* starts at 400 cps. Physical size is 11/16" x 1-11/16" x 1/2" max. For higher frequencies from 5 kc up to 100 kc, size is 3/4" x 1" x 1/2".

The band pass filter, Type *MTT* pictured here, ranges from 7,350 cycles up to 100 kc. Physical size is 1/2" x 19/32" x 15/16", weight .3 ounces, band width 15% at 3 db and + 60% — 40% at 40 db. Wherever space and performance are critical requirements, miniaturized *MICROID* ® low pass and band pass filters provide utmost reliability as well as more unit surface economy on printed circuit boards. Completely encapsulated, they are ideally suited to withstand high acceleration, shock and vibration environments.



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RYAN 1-2841
TELETYPE PASACAL 7578

Circle 105 on Inquiry Card

Semiconductor Advantages

(*Continued from page 95*)

Acknowledgments

The author wishes to acknowledge the valuable assistance and advice received from Mr. M. A. Clark in the work leading to this article. The article is based on work done under the sponsorship and support of the Electronic Components Laboratory of the Wright Air Development Center, under Contract No. AF 33(600)-35088, and contains material from Scientific Report No. 2 under that contract.

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I. M. Ross, No. 2791760, May 7, 1957.
J. A. Morton, No. 2791761, May 7, 1957.
D. H. Looney, No. 2791758, May 7, 1957.
W. L. Brown, No. 2791759, May 7, 1957.

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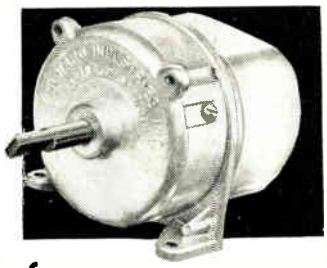

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MODEL 3000—2 Pole Shaded Pole with Gear Unit

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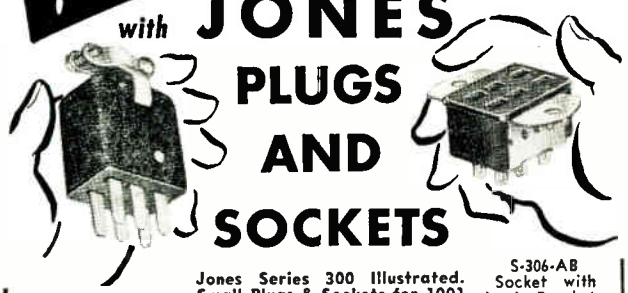

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Circle 109 on Inquiry Card

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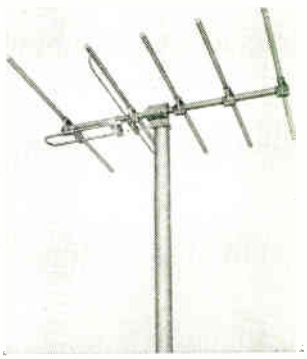


Rugged mechanically and electrically, the Scala Model CA5-150 is a 52-ohm 5 element yagi. Nine db gain on the major lobe is assured by careful design and Scala's exclusive feed system which eliminates radiation from the feed line and provides equal distribution of current to the driven element. The unit is available in anodized aluminum and plated or stainless steel. This exceptionally rugged antenna exceeds the demanding requirements of railroads, utilities and government agencies. 72 ohm, 5 and 10 element yagis (HDCA models) also available for community systems and TV off the air pickup.

Write for complete catalog on Scala corner reflectors, UHF-VHF yagis, paraflectors, ground plane and heated ground plane antennas. Please address Dept. EI 5.

SCALA RADIO COMPANY

2814 19th Street • SAN FRANCISCO 10, CAL.

Circle 115 on Inquiry Card

New Tech Data

(*Continued from page* 166)

Selenium Cells

A new 8-page catalog, "Selenium Photovoltaic Cells," describes a line of self generating photo cells. Over 25 standard selenium cell types are described, with cell structure and operation, and performance characteristics. Bulletin PC-649A. International Rectifier Corp., El Segundo, Calif.

Circle 251 on Inquiry Card

Control Instruments

Operation of the Level-Tek level detection and control system is described in the 4-page illustrated brochure from Aeronautical & Instrument Div., Robertshaw-Fulton Controls Co., 401 Manchester Blvd., Anaheim, Calif. The device indicates and controls a predetermined level in liquids or solids.

Circle 252 on Inquiry Card

Insulation Checker

One-page tech data sheet from Mid Eastern Electronics, Inc., 32 Commerce St., Springfield, N. J. describes the "Megatrometer," Model 710, that measures insulation resistance and capacitive leakage up to 5,000 million megohms.

Circle 253 on Inquiry Card

Tantalum Capacitors

"What to Expect from Fansteel Tantalum Capacitors" is the title of a new 16-pager describing the capabilities and limitations, tables, charts, and curves on miniature tantalum capacitors of the wet electrolytic type. Fansteel Metallurgical Corp., Dept. EIP, North Chicago, Ill.

Circle 254 on Inquiry Card

Wire and Cable

"Turbo" wire and cable, manufactured by the William Brand & Co., Inc., Willimantic, Conn. is described in a new 6-pager. Includes technical specs, dimensions and military specs on hook-up wires, rubber insulated wires, coaxial cables, aircraft wire and cable.

Circle 255 on Inquiry Card

Pressure Transducers

Series P2-1200 to P2-1400 series of dc pressure transducers, for telemetering, data systems and static stands applications is described in a 4-page bulletin from Wiancko Engineering Co., Pasadena, Calif.

Circle 256 on Inquiry Card

Electronic Kits

Two electronic analog computers, a wide line of test equipment, and hi-fi and amateur radio gear—all in kit form—are described in a new 24-page catalog from Heath Co., Benton Harbor, Mich. The economy priced analog computer is a new feature.

Circle 257 on Inquiry Card

Circle 111 on Inquiry Card

Connectors

New 12-page, illustrated technical catalog gives specifications, outline drawings and general information on the Series 250 line of miniature rectangular power connectors. The series is available in a variety of contacts, from 7 to 104, with optional polarizing screwlocks, aluminum hoods and protective shells. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle 258 on Inquiry Card

Waveguide-Coax Adapter

One-page data sheet from Tamar Electronics Inc., 1805 Colorado Ave., Santa Monica, Calif., describes a waveguide-to-coaxial cable adapter for the frequency range of 2350-3600 MC. Power handling capability is 500 watts, VSWR—1.2 to 1.0 maximum.

Circle 259 on Inquiry Card

NAECON

(*Continued from page* 112)

ence. The forum this year will be chairmanned by Dr. John P. Hagen, chief of the Vanguard Division of the National Aeronautics and Space Agency.

Attendees will also hear several addresses at non-technical sessions which should prove highly educational and entertaining. Dr. Ernst Weber, President of Polytechnic Institute of Brooklyn and new president of the Institute of Radio Engineers will address the Welcoming Luncheon on Monday, May 4. On Tuesday May 5th a noted top military speaker will address the Fellows' Luncheon. This luncheon is given in honor of the Fellows of the IRE who may be present. The NAECON Banquet scheduled for Tuesday evening will have as principle speaker, Mr. James Fain, Editor of the *Dayton Daily News* and who is also associated with the Cox Newspapers, Inc., of Dayton and Atlanta. At this banquet the professional group on Aeronautical and Navigational Electronics of the IRE will present pioneer awards to Mr. Henri Busignies, President of ITT Laboratories, Nutley, N. J., and Mr. Francis Moseley, President of the Moseley Company, Pasadena, Calif., for their pioneer efforts in development of automatic direction finding equipment.

The NAECON Ball following the

(*Continued on page* 172)

NAECON

(*Continued from page* 171)

banquet will feature two bands for continuous dancing pleasure.

On Wednesday, May 6, the Professional Group for Aeronautical and Navigational Electronics of the IRE will sponsor the luncheon at which Dr. George Haller, vice-president of General Electric, manager of the Defense Products Division, and Chairman of this professional group will speak on the subject of "The Defense Business."

TECHNICAL PROGRAM
1959 NATIONAL AERONAUTICAL ELECTRONICS CONFERENCE

DAYTON, OHIO

Monday Morning—May 4, 1959
Sessions: 9:00-12:00

SYSTEM DESIGN, PREDICTION, EVALUATION AND TEST

Moderator: Ludlow B. Hallman
Wright Air Development Center
Biltmore Hotel—English Room

"Systems Engineering in Communications Systems," R. Filipowski, Westinghouse Electric Corp.

"Quality Control Influence Toward Reliable System Design," F. Burns and R. H. Johnson, Westinghouse Electric Corp.

"Check List for Design and Development of Flight Control Systems," Ray Duethman, Minneapolis-Honeywell Regulator Co.

"Logical Event and Time Period Testing as Applied to Automatic Test Equipment," Melvin P. Siedband, Westinghouse Electric Corp.

"Operational Reliability of Radars in a Countermeasures Environment," Richard W. Hanford, Missouri Research Labs, Inc.

"The Dynamic Analysis Technique and Facilities for Evaluation of Advanced Reconnaissance Systems," James C. Haley, WADC.

ELECTRONIC SYSTEMS FOR AIR WEAPONS CONTROL

Moderator: Dr. George L. Haller
General Electric Company
Biltmore Hotel—Jr. Ballroom

"Integrated Systems for Aero-Space Defense," Col. Wilfred H. Tetley, Air Defense Systems Integration Division, USAF.

"Omega VLF Navigation System," John L. Loeb, Bureau of Ships, Navy Dept.

"Matching the Man System and the Electronic System in Design and Operations," Launor F. Carter, System Development Corp.

"Army Anti-Air Weapons Coordination," John J. Kelleher, Office of the Chief Signal Officer, U. S. Army.

"The Role of Electronics in Improved Air Space Management," Lt. Col. Carl B. Fisher, Federal Aviation Agency.

"Air Weapons Control System," James K. Chapman, General Electric Co.

MILITARY SYSTEMS MANAGEMENT

Moderator: Norman L. Winter
Sperry Gyroscope Co.
Biltmore Hotel—Main Ballroom

"Military Systems Management," Maj. General V. R. Haugen, Director of Systems Management, USAF.

"Programming Technical Development to Advance Weapon Systems," Maj. Gen. M. C. Demler, Director Research and Development, USAF.

"Weapon System Project Management," Dr. Henry M. Watts, The Martin Co.

"R.C.A. BMEWS System Management," R. H. Baker, Radio Corp. of America.

"B-52 Weapon System Management," J. J. Clark, Boeing Airplane Co.

"Profile of a Systems Manager," J. K. Records, General Electric Co.

ELECTRONIC SYSTEMS AND SPACE FLIGHT

Moderator: Dr. Irvin Travis
Burroughs Corporation
Pick-Miami Hotel—Aviation Room

"Altitude Reference Device for Space Vehicles," P. E. Kendall and R. E. Stalcup, ITT Laboratories.

"A Long Range Tracking System for Space Vehicles," Maurice Franco and Peter F. Paul, Radio Corporation of America.

"High Power Beacon for Earth Satellites and Long Range Missiles," G. Bouchard, Stromberg-Carlson Company.

"Search Theory Applied to Astronautical Vehicle Detection Systems," Norman S. Potter, W. L. Maxson Corporation.

"Space Vehicle Applications of Self-Contained Doppler Radar," Martin Y. Silberberg and James P. Campbell, General Precision Laboratory.

WORLD-WIDE COMMUNICATION SYSTEMS

Moderator: Col. W. S. Heavner
Detachment #1, Hq. ARDC
Pick-Miami Hotel, Empire Room

"Space Communications," Dr. P. A. Castruccio, Westinghouse Electric Corporation.
"Passive Reflection and Scatter Media for Satellite Communications," H. F. Meyer, Ramo-Wooldridge.
"An Active Communications Satelite," Jahn K. Webb, General Electric Company.
"The Advantages of Digital Techniques for Communications in the Space Age," Dr. Jona Cohn, Motorolo, Incorporated.
"The Increasing Significance of Message Switching," C. R. Fisher, Stromberg-Carlson Company.
"Recent Developments and Applications of Kineplex," R. R. Mosier and M. L. Doels, Collins Radio Company.
"Comparison of Different Transmission Techniques for Long-Range Communication Systems," W. E. Morrow, Jr., Lincoln Laboratory, MIT.

RELIABILITY

Moderator: R. J. Framme
Wright Development Center
Pick-Miami Hotel—Sky Terrace

"On the Reliability of Large Electronic Systems," Peter R. Dax, Westinghouse Electric Corp.
"A Dynamic Failure Analysis System," S. J. Bailer and M. Schinagel, General Electric Co.
"Designing Reliability into a Solid State Switching System," Sherman B. Weiner, Stromberg-Carlson Co.
"Response of Electronic Equipment to Random and Sinusoidal Vibration Excitation," J. Earl Foster, Collins Radio Co.
"An Automatic Test System for the Volscan Air Traffic Control Central," R. Balmut, Crosley Division, AVCO Manufacturing Corp.
"Protection of Airborne Transistorized Equipment Against Voltage Transients," Melvin W. Coguelin, Collins Radio Co.

Monday Afternoon—May 4, 1959
Sessions: 2:00-5:00

ELECTRONIC TUBES

Moderator: William C. Brown
Raytheon Manufacturing Company
Biltmore Hotel—English Room

"High Powered Beam Tetrode Amplifier for Pulsed Service," S. G. McNees and L. G. Sutton, Radio Corp. of America.
"A New Reliable, Low-Noise, Ceramic, UHF Triode," L. P. Debacker and J. J. Thompson, Radio Corp. of America.
"Reflex and Low-Power Amplifier Klystrons for Microwave Applications," M. J. Bowen and R. W. Haegele, Eitel-McCullough, Inc.
"A New 5 Inch Display Storage Tube and Its Applications," N. W. Patrick, Radio Corp. of America.
"Rugged Gap-Tuned Reflex Klystrons," M. W. Barylski, L. H. Sandstrom and J. H. Walters, Sperry Electronic Tube Division.
"Voltage Tunable Magnetron Packages," Dr. M. Weinstein, General Electric Co.

(Continued on page 174)

NAECON

(Continued from page 173)

Monday Afternoon—May 4, 1959
Sessions: 2:00-3:30

PANEL: ELECTRONIC SYSTEMS FOR AIR WEAPONS CONTROL

Biltmore Hotel—Jr. Ballroom

Moderator: Dr. George L. Haller, Panel Members: Col. W. H. Tetley, John L. Loeb, L. F. Carter, J. J. Kelleher, Lt. Col. C. B. Fisher, J. K. Chapman.

PANEL: MILITARY SYSTEMS MANAGEMENT

Biltmore Hotel—Main Ballroom

Moderator: Norman L. Winter, Panel Members: Maj. Gen. V. R. Haugen, Maj. Gen. M. C. Demler, Dr. H. M. Watts, R. H. Baker, J. J. Clark, J. K. Records.

PANEL: ELECTRONIC SYSTEMS AND SPACE FLIGHT

Pick-Miami Hotel—Aviation Room

Moderator: Dr. Irvin Travis, Panel Members: P. E. Kendall, R. E. Stalcup, M. Franco, P. F. Paul, G. Bouchard, N. S. Potter, N. Y. Sillberberg, J. P. Campbell.

Monday Afternoon—May 4, 1959, continued
Sessions: 2:00-3:30

PANEL: WORLD-WIDE COMMUNICATION SYSTEMS

Pick-Miami Hotel—Empire Room

Moderator: Col. W. S. Heavner, Panel Members: Dr. P. A. Castruccio, H. F. Meyer, J. K. Webb, C. R. Fisher, R. R. Mosier, M. L. Doels, W. E. Morrow, Jr.

Monday Afternoon—May 4, 1959
Sessions: 3:45-5:00

TELEMETERING AND DATA TRANSMISSION

Moderator: Joseph General, Hq. Air Research and Development Command
Pick-Miami Hotel—Empire Room

"A Pulse Position Telemetry System," Lloyd Weisman and Erwin S. Teltscher, Ford Instrument Co.
"The Use of the Tuned Discriminator in Tracking a Doppler Navigation Radar Spectrum," Edwin M. Stryker, Jr., Collins Radio Corp.
"The Auto and Cross Correlation Functions of Elementary Waveforms," E. Muehldorf, J. Hatcher and G. K. McAuliffe, Westinghouse Electric Corp.

Tuesday Morning—May 5, 1959
Sessions: 9:00-12:00

AIR SAFETY

Moderator: Donald S. King
Federal Aviation Agency
Biltmore Hotel—Main Ballroom

"Determination of Navigational Accuracy by Aircraft Tracking," Lloyd E. Wallingford, Federal Aviation Agency.
"The Airport Surface Detection Equipment Program," J. S. Turner, Federal Aviation Agency.
"Technical Aspects of the Peripheral Communications System of the FAA," P. R. Colby, Federal Aviation Agency.
"Electronic Scan on Teletypewriter System," Louis P. Davis, Federal Aviation Agency.
"Weather and Air Safety," N. A. Lieurance, Federal Aviation Agency.
"International Short Distance Navigation—After the ICAO February Meeting," Henry I. Metz, Federal Aviation Agency.
"Proximity Warning Equipment," John N. Byrne, Charles Roudenbush and Sidney Kelly, Motorola, Incorporated.

COMPONENTS I

Moderator: H. L. Holley
Radioplane Div., Northrop
Biltmore Hotel—Jr. Ballroom

"High Reliability Electro-Magnetic Relay Design," Leon J. Stratis, Wright Air Development Center.
"General Principles of Precision Crystal Design and Specification," John Deininger, Motorola, Incorporated.
"Application of Variable Capacitance Diodes as Components in Electronic Systems," W. E. Danielson, Bell Telephone Laboratories.
"A Transistorized Log Video Amplifier," F. J. Muller and V. V. Milukas, Airborne Instruments Laboratory.
"A High-Frequency NPN Silicon Transistor," F. Katnack and W. Bosenberg, Radio Corporation of America.
"Low-Temperature Coefficient Ultrasonic Delay Lines," W. H. Jenkins, Corning Glass Works.

THERMAL DESIGN

Moderator: Walter Robinson
Consulting Engineer
Biltmore Hotel—English Room

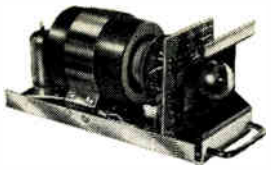
"A Note Concerning the Effects of Altitude and Package Compactness on the Internal Temperatures in Un-Sealed Electronic Packages," Dr. M. Mark, M. E. Stephenson, and D. R. Fairbanks, Raytheon Manufacturing Co.
"A Preliminary Study of Pulsing Coolant Flow Applied to Electronic Equipments," A. H. Schroeder and W. V. White, Collins Radio Co.
"Peltier Thermostating for Increased Reliability," E. L. Armi and C. G. Kirkpatrick, Collins Radio Co.
"Auxiliary Cooling of Electronic Equipment by Evaporation for High Temperature Environments," W. Stubstad and C. Toussaint, Collins Radio Co.
"A Flexible Container for Evaporative and Liquid Cooled Electronic Equipment," Dr. M. Mark and C. E. Goltsos, Raytheon Manufacturing Co.

NAVIGATION

Moderator: Vernon I. Weihe
General Precision Equipment Corporation
Pick-Miami Hotel—Empire Room

"An Astro Digital Doppler Speedometer," John Abate, Astronautics Laboratory, Kearfott Co.
"A Coherent High Performance FMCW Doppler Radar Navigation System," Paul G. Wulfsberg, Collins Radio Co.
"A Low Frequency Navigation System with a Simple Airborne Display," James Kirch, Motorola, Inc.
"Helicopter Electronic Landing Path Equipment," Jesse R. Kays, Aeron Wallace and Charles Schmidt, W. L. Maxson Corp.
"A Navigation Computer for Antisubmarine Warfare," George E. Iddings and William Zdon, Sperry Gyroscope Co.
"A High Accuracy Data Package for Navigation Systems," B. J. Clayton, Convair, Fort Worth.

(Continued on page 176)

NO OTHER  COUNTERS PROVIDE

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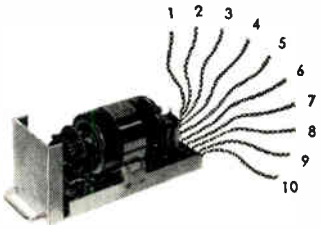
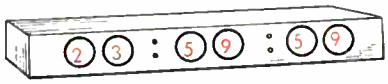
TEN INDIVIDUAL OUTPUTS 

MULTIPLE  REMOTE READOUT

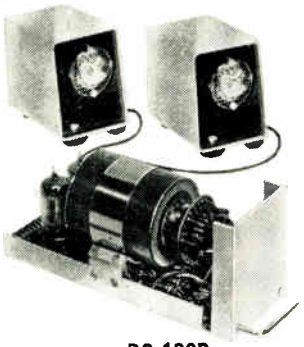
VARIABLE COUNT 

① ③ ⑤ ② ULTRA LONG LIFE IN-LINE  READOUT

Burroughs **Visual and Electronic Error Free** Decade Counters are based on the unique properties of the Beam Switching Tube wherein a single cathode controls an electron beam to 10 outputs. In contrast to other types of counters, the Beam Switching Tube output is directly capable of driving an in-line indicator such as the Nixie® Tube. This complete line of seven counter types is designed for maximum reliability while providing advanced electrical characteristics not readily obtainable with other components. Such features include:

- Ultra reliable operations at one megacycle and over
- Electronic resetting in less than 1 microsecond
- Electrical output in each of its 10 positions
- Provisions for BOTH LOCAL AND REMOTE INDICATORS
- Extreme noise insensitivity
- Minimum components and power consumption

Write for eight pages of circuit information — Bul. 826A.



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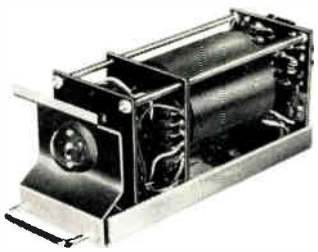
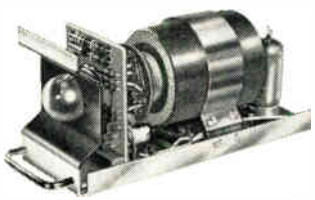
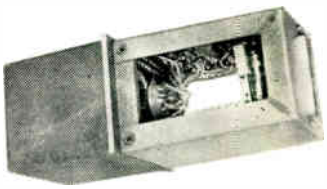


DC 101



DC 105, DC 106A



DC 130 — Mil Spec Counter

ANOTHER ELECTRONIC CONTRIBUTION BY

Burroughs Corporation

ELECTRONIC TUBE DIVISION

Plainfield, New Jersey

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NAECON

(Continued from page 174)

CIRCUITS

Moderator: Dr. A. M. Skellett
Tung-Sol Electric Company
Pick-Miami Hotel—Sky Terrance

"The Micro-Module Design Concept," J. P. Gilmore, Radio Corp. of America.
"Frequency Compensation of Gyro Reference Systems," James G. Nelson, Minneapolis-Honeywell Regulator Co.
"A Traveling-Wave-Tube Amplifier Chain—An Aid to Reliable Communications in Aircraft Service," H. J. Wolkenstein, Radio Corp. of America.
"The Parametron as a Logic Element," C. A. Jorgensen, Stromberg-Carlson Co.
"Design of a Transistorized Airborne Equipment Using Computer Techniques," Martin Cooper, Motorola, Inc.
"Noise Characteristics of Low-Level Transistor Amplifier," G. A. Klingler, Wright Air Development Center.

Tuesday Afternoon—May 5, 1959—2:00-5:00
Forum: Patterson High School Auditorium, 118 East First Street

MANAGEMENT OF ELECTRONIC SYSTEMS IN THE SPACE AGE

Moderator: Dr. John P. Hagen, NASA

Wednesday Morning—May 6, 1959
Sessions: 9:00-12:00

IMPACT OF ELECTRONIC ENVIRONMENT ON AIRBORNE WEAPONS

Moderator: R. J. Nordlund
Wright Air Development Center
Biltmore Hotel—Main Ballroom

"An/Arc-62 Design Concepts to Meet Stringent Airborne Weapon System Requirements," D. H. Westwood, Radio Corp. of America.
"Problems on Bomb-Nav Equipment Design for Aircraft," Clinton Grace, International Business Machines Corp.
"Use of Inertial Techniques for Airborne Equipment," John Moore, North American Aviation, Inc.
"Nature of Air Force Electronic Environments," William J. Sen, Air Research and Development Command.
"Missile Guidance Systems," Dr. S. W. Herwald, Westinghouse Electric Corp.

SYSTEM FLEXIBILITY THROUGH MODULAR DESIGN

Moderator: W. Melnick
Wright Air Development Center
Biltmore Hotel—Jr. Ballroom

"Uniform Design Criteria — A Philosophy Toward Achieving System Flexibility," John Whitman, Wright Air Development Center.
"Effect of Modularization on Electronic Systems Design," G. C. Schutz and Paul Sondeen, Bendix Systems Div.
"Marriage of Modules to Flight Vehicles," B. E. Winfree, North American Aviation, Inc.
"Modularized Electronic Hardware Consideration," Andrew Nalbandian, North American Aviation, Inc.
"Ground System Flexibility with Functional Modules," Kenneth Porter, Motorola, Inc.

OPERATIONS RESEARCH IN ELECTRONIC SYSTEM DESIGN

Moderator: Dr. Max Astrachan
U. S. Air Force Institute of Technology
Biltmore Hotel—English Room

"Avoiding Dynamic Obsolescence in System Planning," Dr. R. C. Raymond, Tempo, General Electric Co.
"Operations Research in Air Defense Systems," M. E. Hawley, Radio Corp. of America.
"Operations Research of the Effectiveness of Orbital Electronic Systems," Edward Ostroff, The Martin Co.
"The Advantages of Functional Packaging of Electronic Equipment," E. H. Sharkey, The Rand Corp.
"Operations Research in Design of Communications Systems," Roman Krzyczkowski, Westinghouse Electronic Corp.

CIVIL AVIONIC SYSTEM DESIGN

Moderator: William T. Carnes, Jr.
Aeronautical Radio, Incorporated
Pick-Miami Hotel—Empire Room

"Message Composing Equipment," Dr. Gene M. Amdahl, Aeronutronic Systems, Inc.
"An L-Band Air Traffic Control Transponder," C. D. Fidde and J. B. Majerus, Collins Radio Co.
"The Application of Self-Contained Navigation Equipment to Air Traffic Control," Walter R. Fried, General Precision Laboratory, Inc.
"Design Considerations for a Doppler Navigation Computer," H. I. Walker and E. R. Hattendorf, Collins Radio Co.
"Automatic Communication System for Air Traffic Control," D. T. Gross and R. E. Davis, Radio Corp. of America.
"Infielder — A Novel Ranging System," Stanley I. Kramer, Fairchild Astrionics Div., Fairchild Engine and Airplane Corp.

COMPUTERS

Moderator: Dr. C. Ross
National Security Agency
Pick-Miami Hotel—Aviation Room

"The Logic Unit Board," Theodore A. Conant and Wayne L. Walters, General Mills, Inc.
"Flight Plan Computer for the Volscan Air Traffic Control Central," T. A. Kessis and C. A. Tulloh, Crosley Division, AVCO Manufacturing Corp.
"A Central Analog to Digital Converter," Kurt Merl and Stanley Oken, Ford Instrument Co.
"Circuit Reliability Life Test Planning and Data Reduction Methods for a Digital Computer," E. A. Reeve and P. L. Magnani, International Business Machines Corp.
"Equipment for Evaluating Contact Noise in Brush Encoders," C. C. Packard, International Business Machines Corp.
"A Small Special Purpose Digital Computer for Process Control Applications," Raymond Stuart-Williams, I. L. Wieselman and David J. P. Byrd, Telemeter Magnetics, Inc.

ANTENNAS

Moderator: Dr. Paul Mayes
University of Illinois
Pick-Miami Hotel—Sky Terrace

"The Effective Noise Temperature of Antennas," D. C. Hogg and W. W. Mumford, Bell Telephone Laboratories.
"Polarization Control with Oppositely Sensed Circularly Polarized Antenna," S.

R. Jones, Melpar, Inc., and Edwin M. Turner, Wright Air Development Center.
"A Circularly Polarized Slot Antenna," E. J. Wilkinson and K. W. Rau, Sylvania Electronic Systems.
"Liaison Antenna and Automatic Coupler for Army Aircraft," L. P. Reiche, Stanford Research Institute.
"Inflatable Antenna for the Space Age," S. H. Saulson and C. N. Gosnell, Westinghouse Electric Corp.
"Recent Developments in Spiral Antennas," John D. Dyson, University of Illinois.

Wednesday Afternoon—May 6, 1959
Sessions: 2:00-3:30

PANEL: IMPACT OF ELECTRIC ENVIRONMENT ON AIRBORNE WEAPONS

Biltmore Hotel—Main Ballroom

Moderator: R. J. Nordlund
Panel Members: D. H. Westwood, Clinton Grace, John Moore, William J. Sen, Dr. S. W. Herwald

PANEL: SYSTEM FLEXIBILITY THROUGH MODULAR DESIGN

Biltmore Hotel—Jr. Ballroom

Moderator: W. Melnick; Panel Members: G. C. Schutz, P. Sondeen, B. E. Winfree, Andrew Nalbandian, Kenneth Porter.

PANEL: OPERATIONS RESEARCH IN ELECTRONIC SYSTEM DESIGN

Biltmore Hotel—English Room

Moderator: Dr. Max Astrachan; Panel Members: Dr. R. C. Raymond, M. E. Hawley, Edward Ostroff, E. H. Sharkey, Roman Krzyczkowski

Sessions: 2:00-5:00

MAINTAINABILITY

Moderator: H. D. Voegtlen
Reliability Research Projects Section
Radio Corporation of America
Pick-Miami Hotel—Empire Room

"Maintenance—Key to Useability," David Brown Dabson, Radio Corp. of America.
"A Study Involving the Collection and Analysis of Maintainability Data," R. M. Lewis, International Business Machines Corp.
"Factors Affecting Two Fundamental Decisions in Planning the Maintainability of a Complex Electronic System," Dr. M. J. Marcus, International Business Machines Corp.
"Automatic Testing—A Realistic Approach," John M. Laskey, Radio Corp. of America.
"A New Approach to the Doppler Radar Test Problem," Donald H. Meyer, Collins Radio Co.
"The RADC Engineering Laboratory's Program on Maintainability," 1/Lt. Kenneth J. Crain, Rome Air Development Center.

RADAR

Moderator: Prof. J. Francis Reintjes
Massachusetts Institute of Technology
Pick-Miami Hotel—Aviation Room

"The 'See' System for Radar Augmentation," Henry E. Prew, Sperry Gyroscope Company.
"Broadband High Gain Transistorized i-f Amplifiers with Reduced Gain vs. Tem-

(Continued on page 179)

This busy metropolitan area is the termination of over 1000 miles of microwave systems, providing reliable communications across town and country for the Western Union Telegraph Company. ANDREW's experience in research, development and manufacturing is the reason why the dependable performanee of an ANDREW PS8-37, eight-foot Parabolic antenna was selected for this installation.

All ANDREW parabolic antennas conform to the newly proposed RETMA-FCC standards governing radiation patterns and side lobes, and they are *guaranteed* to give specified pattern and VSWR in your microwave system.

From a selection of over thirty stocked parabolic antennas, you can choose the type and size that will give optimum system performance with absolute mechanical and electrical reliability.

Microwave engineers have found ANDREW a valuable partner in planning their communication systems. A parabolic antenna computer for calculating system performance is available to you upon request. Write today for information and expert advice relative to your microwave antenna system requirements.

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NAECON

(Continued from page 177)

perature Variations," Grover Kennet, Motorola, Incorporated.

"Application of Frequency Modulation Techniques to Doppler Radar Sensors," Robert D. Tollefson, Collins Radio Company.

"New Precision in Doppler Cycle Counting," Bernhard E. Keiser, Missouri Research Laboratories, Incorporated.

"Micro-Wave Radar Relay," E. K. Peterson, Motorola, Incorporated.

"A Combined Display of Radar and ATC Data," Robert Sorenson, CAA and J. E. Lethin, Airborne Instruments Laboratory.

COMPONENTS II

Moderator: R. E. Long
Wright Air Development Center
Biltmore Hotel—Sky Terrace

"A Stable C. W. Source at C-Band—The SOC-150," C. M. Garretson, Sperry Gyroscope Company.

"A New Backward Wave Oscillator for the 4 to 5 Millimeter Region," J. A. Noland and L. D. Cohen, Sylvania Research Laboratories.

"A Ruggedized Coupled-Cavity Tunable Magnetron for Airborne Service," V. J. Stein and T. J. Kelly, Radio Corporation of America.

"A Quasi-Logarithmic Counter," A. Boecker, Airborne Instruments Laboratory.

"A 10 Megacycle Transistorized Binary Counter," A. Basil, Airborne Instruments Laboratory.

"Features of Two Novel Band-Pass Filter Types," S. H. Klug and William J. Keane, Airborne Instruments Laboratory.

Wednesday Afternoon, May 6, 1959
Sessions: 3:45-5:00

EXTREME ALTITUDE ENVIRONMENTS

Arranged and Presented by the Institute of Aeronautical Sciences
Moderator: J. R. Milliron
Wright Air Development Center
Biltmore Hotel—Jr. Ballroom

"High Altitude Waveguide Development," H. Zucker and S. I. Cohn, Armour Research Foundation, and J. I. Meulemans, Wright Air Development Center.

"Microwave Tube Amplifiers for the Space Age," Robert Strauss, Sperry Electronic Tube Division.

"An Inertial Guidance Technique Useable in Free Fall," M. Streicher, R. Zehr and R. Arthur, Bell Aircraft Corporation.

"Vertical Sounding," Frank L. Adams, Bendix Aviation Corporation.

SIMULATORS

Moderator: Hans H. Giesecke
Federal Aviation Agency
Biltmore Hotel—English Room

"Digital Simulation of an Air Traffic Control System," J. T. Harvey and J. E. Bybee, AVCO Manufacturing Corporation.

"Evaluation of Electronics at Intense Sound Levels," R. W. Sevy, Wright Air Development Center.

"A Microwave Single Sideband Modulator Suitable for Doppler Simulation Signals," M. M. Zimet, Ford Instrument Company.

Student Sets Own Pace With TV Tape System

A television tape system for home and classroom that will permit greater personal instruction and let a student set his own educational pace is under research by the Radio Corporation of America.

The compact "Hear-See" system, now in early development form at the RCA Laboratories, includes a magnetic tape player capable of reproducing pictures as well as sound through a standard TV receiver. It also includes a recorder attachment which can pick up a program from a TV set, a closed-circuit system, or a studio.

When the television tape system is available for classroom and household use, it will open the way for truly personal instruction in school and in the home.

This will permit a student to select a rate of presentation—including repetition—to correspond with his or her ability to master the subject.

Traveling Symposium Will Air Spectrol Story

Spectrol Electronics Corp., San Gabriel, Calif., has organized an engineering symposium outlining their approach to Electro-Mechanical Assemblies and Solid State Devices as utilized in sub systems applications.

The presentation consists of technical slides explaining solid state circuitry, sub systems designs, and describing many examples of work being done in these fields.

A completely operating Position Servo System powered by Transistorized Power Converters and Amplifiers will also be demonstrated.

Spectrol is planning to tour the country visiting engineering groups composed of Design Engineers, Project Engineers, Systems Engineers and Vendor Liaison Engineers. Meetings will last approximately 45 minutes, then be open to a technical question and answer session.

These presentations are being scheduled to begin July 1, 1959.

Any engineer who wishes to attend this technical presentation should contact his local Spectrol Engineering Representative or write Spectrol Electronics Corporation, 1704 S. Del Mar Avenue, San Gabriel, Calif., Attn.: Technical Information Dept.

Survey Microwave And End Equipment Mfrs.

The Electronics Division, Business and Defense Services Administration, U. S. Dept. of Commerce, is surveying electronic end equipment and microwave component manufacturers for information essential to defense mobilization planning.

Schedules for the two surveys are now being mailed out to approximately 550 electronic end equipment and 150 microwave component firms.

These surveys, authorized under the Defense Production Act, will require reports, by establishment, from manufacturers of selected electronic end equipment and microwave components on shipments, unfilled orders, inventories and related information which will provide the Government mobilization planning authorities with needed data not obtainable from any other source.

Individual company information will be protected against disclosure of proprietary information, and in accordance with Federal security regulations.

Uniform Specification Adopted for Drawings

Adoption of a uniform specification (MIL-D-70327), for the procurement of engineering drawings and associated lists for use by the armed forces is announced today by DOD.

This specification, developed jointly by DOD and industry, culminates two years' work to achieve greater uniformity in technical and administrative practices connected with the preparation and use of engineering drawings.

The uniform specification is a first step in a long-range program to establish a basis for interchange of costly engineering data among the military departments and their contractors. Interchange of drawings would bolster economy and efficiency in drafting rooms of industrial concerns by reducing the variety of requirements military contractors must now meet. This in turn will result in appreciable savings in engineering talent.

Specifically the uniform specification will replace, in whole or in part, 158 specifications formerly used by the military departments to procure drawings.

Problem Clinic

"High Wattage Coating"

Editor, ELECTRONIC INDUSTRIES:

Do you have any information as to *a source* for a thin material (perhaps a coating) which can reach a wattage of about 800 watts?

We have a product in mind for use as a heater in the home using such material.

Michael Lechner
Oscillation Products Co.
105 Joanne Terrace
Garfield, New Jersey

"Air-Whistle Generator"

Editor, ELECTRONIC INDUSTRIES:

I'd like to contact the company or companies manufacturing audio equipment to frighten birds. I'd also like the address of the company manufacturing a multi-whistle air jet generator.

Wm. R. Klemme,
516 Lyon,
Des Moines 16, Iowa

IPC Officers Are Reelected

W. J. McGinley, Pres. of Methode Manufacturing Corp., was re-elected to serve his second term as President of the Institute of Printed Circuits. Also re-elected to office during IPC's second annual meeting in New York was R. L. Swiggett, Vice president of Photocircuits Corp. Swiggett will serve the IPC as Treasurer in 1959.

New officers and directors elected at IPC's second annual meeting include R. G. Zens, Vice President of Printed Electronics Corporation, elected IPC Vice President. Directors of the Institute for 1959 include K. W. Clayton, Tingstol Company; R. C. Rennie, Bureau of Engraving, Inc.; P. P. Pellegrino, Photo Color Process Corporation; and Charles Sabel, Precision Circuits, Inc.

Make British Tubes Here

Gem Mill, Oldham, Lancs.—Klystrons designed by Ferranti Ltd., will be manufactured in the U. S. under an agreement between Ferranti and Raytheon Corp., Ltd., Boston, Mass.

The agreement covers two tubes to be used in American Military equipment. One is an oscillator rated at 15 watts. The other is an amplifier, 2 kw at 10,000 mc. The tubes are used in Doppler radar systems.

DO IT THE

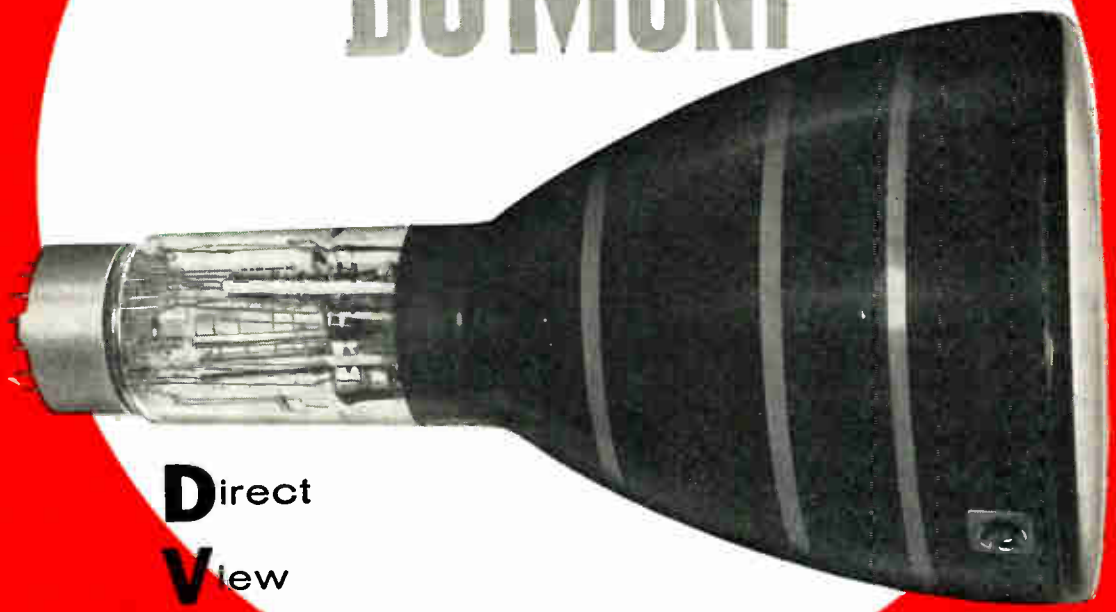
MODERN

WAY

. . . . . .

ADD
DISPLAY RETENTION

VIA DU MONT®



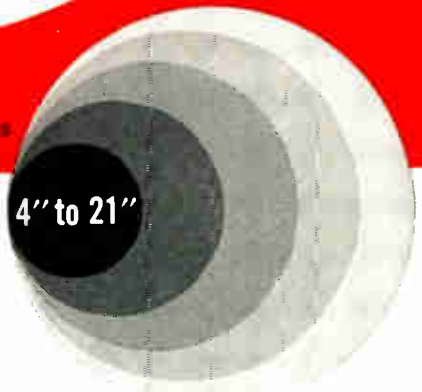
Direct

View

Storage

Tubes

AVAILABLE IN WIDE RANGE OF SIZES AND DEFLECTION MODES



Du Mont DVST cathode-ray tubes offer the distinct advantage of display retention far beyond the capabilities of usual phosphor persistence, **plus** the added feature of erasing **all or part** of presentation. This is the modern display method, adding virtually all the advantages of other types of display to the exclusive, inherent advantages of CRT display.

Write for details . . .

DU MONT now makes available the most complete capabilities and production models in DVST cathode-ray tubes. From 4" to 21" in screen diameter incorporating both electrostatic and electromagnetic deflection. A type and size for every application . . .

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INDUSTRIAL TUBE SALES

Allen B. Du Mont Laboratories, Inc., 750 Bloomfield Ave., Clifton, New Jersey, U.S.A.
International Division • 515 Madison Ave. • New York, N.Y. • Cable: ALBEISAL, N.Y.

Circle 138 on Inquiry Card

Industry News

Melvin L. Doelz has been named Vice President, Western Div., of Collins Radio Co.

Thompson Ramo Woolridge Inc. has named four new Vice Presidents: **Pierce C. Angell, Robert E. Cummings, William M. Jones, Karl L. Kahlert.**

John L. Pfeffer has been elected President of the National Association of Relay Manufacturers.

Charles E. Perkins has been promoted to Chief, Puerto Rican Liaison, at Philips Control Corp.

Rene D. Wasserman, President of Eutectic Welding Alloys Corp., has been appointed Welding Industry Chairman of the United States Committee for the United Nations.

Roy Olerud has been appointed Sales Administrator of the ITT Components Div. of International Telephone & Telegraph Corp.

F. William Monge has been appointed Plant Manager at Farnsworth Electronics-Pacific Div., Inc., subsidiary of ITT.

H. E. Ruehlemann has been promoted to Vice President in Charge of Engineering and Research Development at Elco Corp., Philadelphia.

H. E. Ruehlemann

F. J. Gaffney

F. J. Gaffney has joined FXR, Inc., as Executive Vice President and General Manager. Mr. Gaffney was formerly with Teleregister Corp. and earlier General Manager of Polytechnic Research & Development Co.

Dr. David A. Conrad, formerly of Bell Labs., has joined Hughes Aircraft Co. as Head of the Analysis Group of the Engineering Laboratories Servo-Mechanics Section.

David B. Tolins moves up to the newly created position of Advertising and Sales Promotion Manager of the Semiconductor Div. at Sylvania Electric Products, Inc.

Logan J. Hines has been appointed to the newly created position of West Coast Marketing Manager for defense products at the National Cash Register Co., Electronics Div., Hawthorne, Calif.

Kent J. Worthen fills the newly created position of Manager of Product Planning for Point-to-Point Communication at GE's Communications Products Dept., Lynchburg, Va.

K. L. Worthen

D. R. Lea

Donald R. Lea is the new Marketing Director of the Electronic Components Div. of the Deutsch Co.

Joseph B. Tate has been named Manager, Military Electronics Div. of Southwestern Industrial Electronics Co., Div. of Dresser Industries, Inc. Mr. Tate was formerly Manager of the Electronic and Ultrasonic Dept. at Curtiss-Wright Research Div.

Robert F. Davis has been named Manager, Two-Way Radio Sales in the Midwest by Motorola.

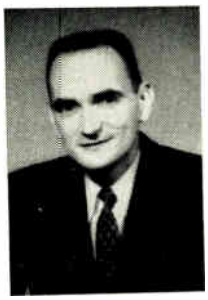
Don Rappaport has been promoted to Assistant Sales Manager at Alpha Wire Corp.

Paul S. Goodwin has joined Ling Electronics, Inc., as Special Staff Assistant to Vice President and Chief Engineer, James A. Ross, and with duties as Senior Project Engineer for underwater sound systems.

Rocco R. Reale has been promoted to Manufacturing Manager of the Industrial Electronics Div., Allen B. DuMont Laboratories, Inc.

John W. McDonald has been elected President of Shielding Inc. Other changes: **T. P. (Pat) Reath** has been named Vice President in charge of Sales and Advertising, and **David J. Shamp** becomes Vice President for Engineering; **William J. Ryan** becomes General Manager and **Agustus J. Dicciana**, Chief Engineer.

J. W. McDonald



G. H. Gage

George H. Gage leaves GE, Syracuse, to become Manager of Product Planning for CBS-Hytron.

Marvin I. Steinberg and **Leonard J. Patterson** have been named Executive Vice Presidents and members of the Board of Directors at Sensitive Research Instrument Corp., New Rochelle, N. Y.

Frank Grady has left the Semiconductor Div. of Hughes Aircraft to head the Manufacturing Dept. at Fairchild Semiconductor Corp. **William E. Conrad** becomes Midwest Regional Sales Manager for Fairchild.

Charles Eisen, Treasurer of Polarad Electronics Corp., has been named a Vice President of the company.

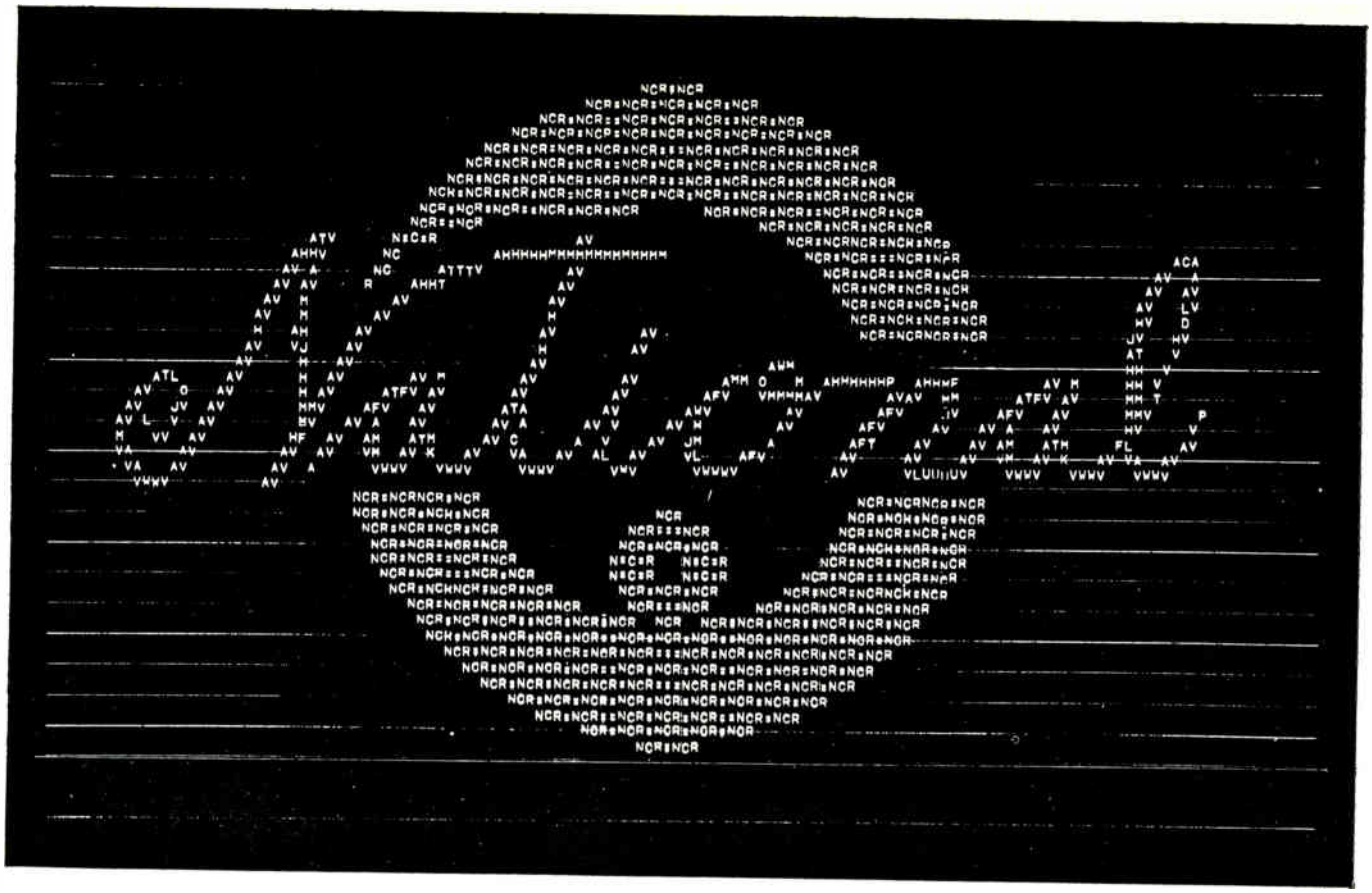
Jack Gasaway fills the newly created post of Sales Manager of the Instrument Div. at American Electronics, Inc., Culver City, Calif

J. Gasaway

O. J. Greenway

Oliver J. Greenway has been named General Manager of Communication Accessories Co., subsidiary of Collins Radio Co.

Stanford B. Spracklen will head up the new Custom Products Dept. established in the Scientific and Process Div. of Beckman Instruments, Inc.



COMPUTER ENGINEERS

HERE ARE THE TYPES OF ENGINEERS WE NEED:

- **SENIOR SYSTEMS ENGINEERS**
- **SENIOR CIRCUIT DESIGNERS**
- **SENIOR LOGICAL DESIGNERS**
- **SENIOR ELECTRONIC DESIGN ENGINEERS**

COMPUTER ENGINEERS:

Senior Systems Engineers—Strong Theoretical and Design Knowledge in Electronic Engineering, including familiarity with electro-mechanical digital machines. Prefer experience with commercial application of digital-processing equipment, will consider scientific or defense application. Operational experience a distinct asset. Advance degree desired.

Your Work at NCR — analyze and direct product improvement of digital computers.

Senior Circuit Designers — experienced in the design, development and analysis of transistorized computer circuits, including application of magnetic cores to high-speed memories.

Your Work at NCR—opportunities involving decision making concerning reliability, cost and component selection are offered.

Senior Circuit and Logical Designers —similar experience and duties as noted for Senior Circuit Designers plus evaluation and debugging arithmetic and control areas of computer systems.

DATA-PROCESSING ENGINEERS:

Senior Electronic Design Engineers— experienced in the development of logical design using standard computer elements.

Your Work at NCR — to evaluate and design transistorized circuits including voltage regulated power supplies and circuitry related to decimal to binary coding.

WHERE YOU WILL WORK . . .

at NCR's NEW Engineering Research Center, Dayton, Ohio.

You'll be working under the most stimulating and advanced R and D facilities with broad creative freedom in the engineering field which is *yours*.

HOW DO I APPLY?

Simply send your résumé to: Mr. K. E. Ross, Professional Personnel Section E, The National Cash Register Company, Dayton 9, Ohio.

THE NATIONAL CASH REGISTER COMPANY, DAYTON 9, OHIO

ONE OF THE WORLD'S MOST SUCCESSFUL CORPORATIONS

75 YEARS OF HELPING BUSINESS SAVE MONEY

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National *

VERSATILE DATA PROCESSING
ADDING MACHINES • CASH REGISTERS
ACCOUNTING MACHINES • NCR PAPER

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

NSF Increases Support to Scientific Publications

Support of scientific publications and information services by the National Science Foundation as part of a st pped-up program under its Office of Science Information Service totaled more than half a million dollars in 12 grants during the first quarter of 1959.

The intensified program is designed to assist scientific publications faced with difficult problems in making available to the scientific community mounting quantities of newly produced research results.

Support of this type by the Foundation during calendar year 1958 totaled $1,032,994 in 51 grants. Compared with the 1959 first quarter figure of $527,803, eight grants totaling $109,300 were made during the same quarter of 1958.

National Science Foundation grants assist publications during critical periods, encourage testing of experimental methods of speeding valuable laboratory results into print, and develop new ways of helping scientists find what they need. Support also extends to strengthening data compilation centers, studies of existing bodies of knowledge to guide researchers, and other projects to enable scientists to use existing but unanalyzed data.

Missiles Benefit Medical Research

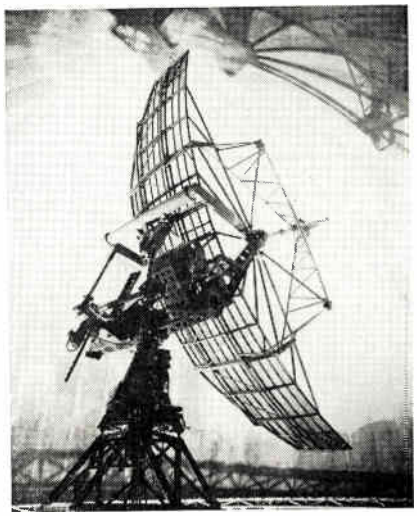
The technique used to analyze the "heartbeat" radio signals from a missile in flight may map the way for the conquest of the nation's number one killer disease.

Lockheed scientists—using sensitive magnetic tape and high speed electronic computers—have helped develop a pioneering new weapon for the early detection of arteriosclerosis, hardening of the arteries.

The magnetic tape used in the new method records the heartbeat pulsations and blood vessel vibrations of suspected arteriosclerosis victims via plastic cuffs on the wrists and ankles.

A specially-modified technique converts the sounds on the tape into mathematical terms and then into points and lines on graphs through computers. These can be analyzed not only statistically but to an ultra-fine degree that could not be accomplished practically by technicians.

SAGE SENTRY



High power FPS-6 height finding radar is used in combination with search radar to supply SAGE Sectors with information on approaching aircraft. Antenna measures 30 ft. x 7½ ft.

13 New Occupations In Data-Processing Systems

Thirteen new occupations resulting from the development and use of computers and other high speed data-processing equipment are described in terms of duties performed and qualification requirements in a pamphlet issued by the U. S. Dept. of Labor's Bureau of Employment Security. The title of the new publication is "Occupations in Electronic Data-Processing Systems."

The thirteen occupations described are those considered to be the basic jobs presently concerned with the operation, maintenance, and supervision of electronic data-processing systems. Job categories range from "coding clerk," with a minimum educational requirement of a high school diploma or its equivalent, to "computer analyst," requiring a college degree with emphasis on mathematics.

Copies of this new publication may be obtained by writing to the Superintendent of Documents, U. S. Govt. Printing Office, Washington 25, D. C. The price is 25 cents per copy. Only a limited number of copies are available.

FOR MORE INFORMATION . . . on positions described in this section fill out the convenient inquiry card, page 145.

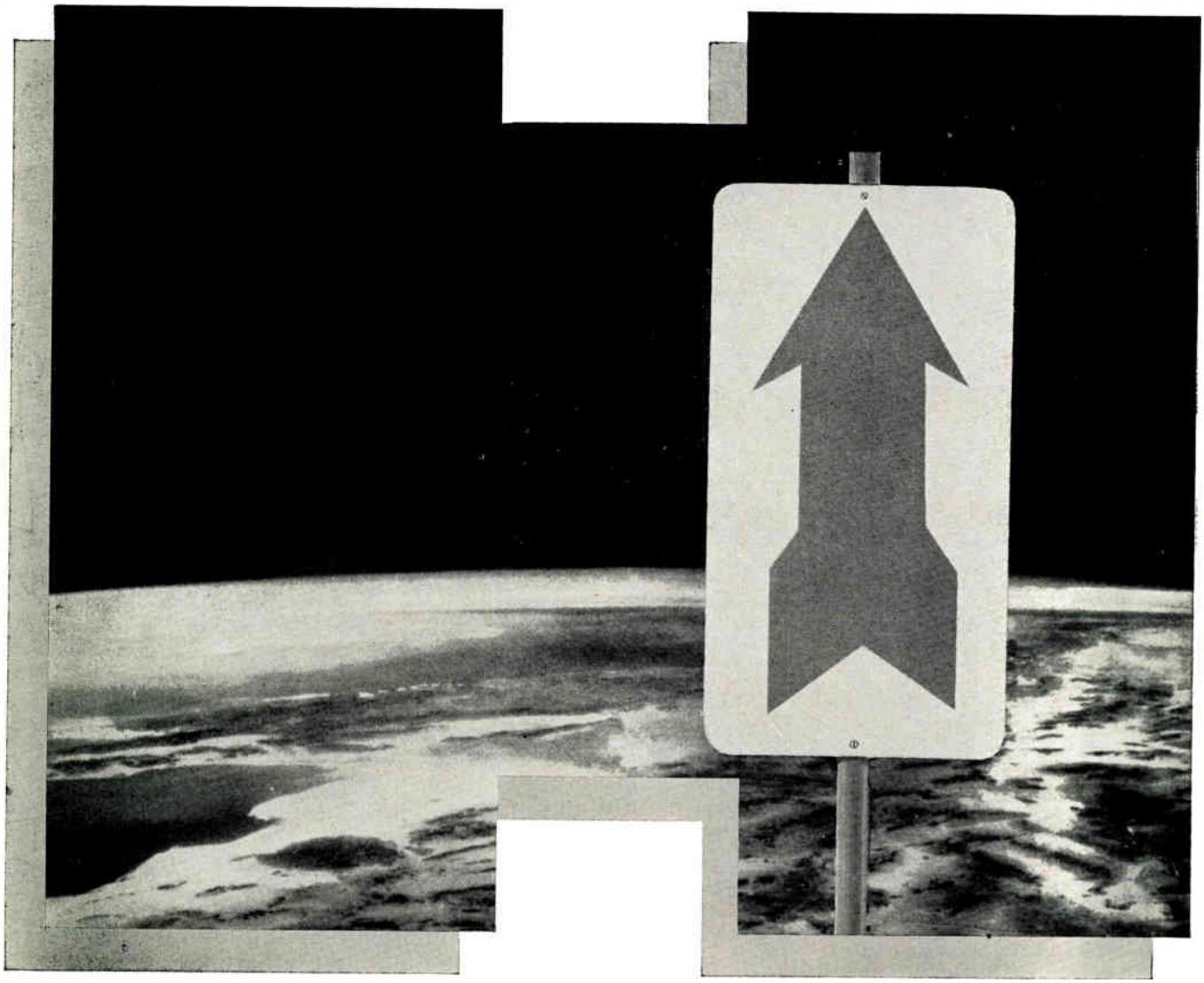
Government Conference On Scientific Manpower

Several hundred Federal officials concerned with the staffing needs of the Nation's No. 1 employer of engineers and scientists—the Federal Government—met for an all-agency Conference on Scientific Manpower in Washington on April 28-29. The meeting was sponsored by the Civil Service Commission, with the Office of Naval Research acting as host agency.

Prominent scientists from Government, industry, and universities discussed problems involved in recruiting and keeping high-quality personnel for engineering and scientific programs in Federal laboratories and installations throughout the country.

Keynote speaker at the dinner, Richard E. Horner, Assistant Secretary of the Air Force for Research and Development, spoke on "Competition for Quality."

Sign of the



Southern California and Arizona from 143 miles up, *photographed from a Navy Viking 12 rocket, fired from White Sands, N.M. Dark patch at lower left is the Gulf of California.*

times

Going up... and out into space... this is one of the assignments of engineers in the laboratories at Hughes.

To meet the demands of the Space Age, a wide variety of new projects is being initiated. Here are just a few examples:

Space Ferry Systems—To provide the initial apparatus for space station assembly.

Communications Satellites—Unique packages for space satellite applications.

ALIRBM—Air launched intermediate range ballistic missiles.

Global Surveillance Satellite Systems—To keep the world under surveillance.

Satellite Interception Systems—To destroy hostile satellites.

Meteor Communications—Scattering electromagnetic energy off meteors to establish long-range communications.

Futuristic Instrumentation Displays—Instrumentation displays for satellites and hypersonic vehicles.

Other Hughes activities are also participating in advanced Research and Development. Engineers at Hughes in Fullerton are developing new types of radar antennas which scan by electronic rather than mechanical means. Hughes Engineers in El Segundo develop test equipment which is as advanced as the equipment being tested. At Hughes Products, the commercial activity of Hughes, new ways have been found to *cast* silicon into desired configurations... and storage tubes with 21" diameters have been developed.

Today Hughes offers Engineers and Physicists the chance to work on stimulating projects in a wide variety of fields. Never have the opportunities been more promising!

Newly instituted programs at Hughes have created immediate openings for engineers experienced in the following areas:

Field Engineering	Systems Analysis
Communications	Components Engineering
Industrial Dynamics	Circuit Design
Digital Computers	Electron Tubes
Microwave Engineering	Industrial Systems
Semiconductors	Development Engineering

Write in confidence, to Mr. R. A. Martin, Hughes General Offices, Bldg. 6-C5, Culver City, California.

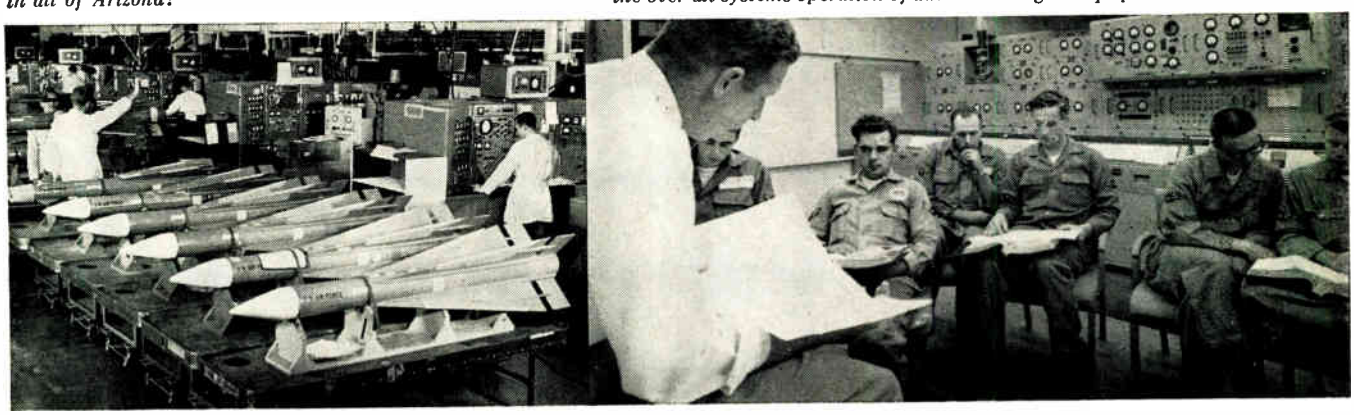
The West's leader in advanced ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY
Culver City, El Segundo, Fullerton and Los Angeles, California
Tucson, Arizona

Advanced Falcon guided missiles *are manufactured by the Hughes facility in Tucson... the largest electronics facility in all of Arizona!*

Maintaining liaison *with Air Force Personnel and airframe manufacturers, Hughes Field Engineers give instruction in the over-all systems operation of advanced Hughes equipment.*



The Personal Side of

More and more the factor that most influences whether an engineer gets into the upper salary brackets is simply: Is he willing to re-locate? One does not have to go far to hear about what moving does to your family, to the children, how it upsets your home life, and the psychological effects of "tearing up the roots." But too often we are hearing only from the disgruntled few. Here is how the "average" family takes to moving.

THE study on which this article is based was conducted by Greyvan Lines, cross-country movers. It was designed to guide management personnel in handling the delicate job of moving their employees, to alert them to the problems that accompany moving and also to give them a glimpse of what other firms—their competitors among them—were doing for their employees.

The first part of the article deals with what other firms are doing. The answers are based on returns from 688 companies, a random sampling of the U. S. industries.

The second part deals with the employee's reaction to moving, the discomforts that his family experienced, and other aspects.

First let's take a look at what the "average" firm sees as its responsibility to the employee being transferred to a new location.

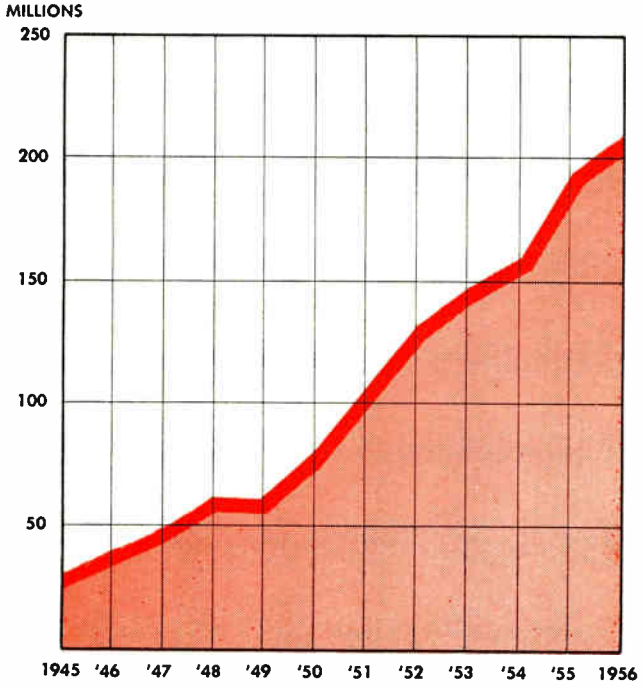
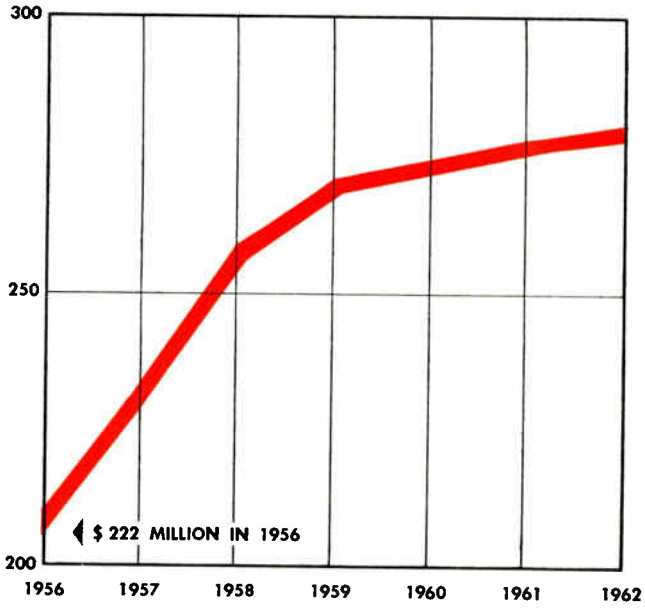


Fig. 1 (left): Increase in relocation of personnel, as indicated by long-distance hauling figures, in dollars, since 1945.

Fig. 2 (below): The estimated continued increase in relocation



'Re-Locating'

Moving household goods
100% pay for moving
92% pay for packing*
83% pay for unpacking*
57% pay for servicing appliances

In moving to the new location
92% pay the employee's transportation
87% also pay transportation for his family

Who makes the moving arrangements?
31% leave this up to the employee
64% company makes arrangements

Is one individual or department responsible for arranging all details?
55% say yes
24% say no
57% Traffic Department
25% Personnel Department

Do you encourage the employee to do some of the packing himself?
22% say they do
62% advise employee to leave all packing to movers

When employee travels in own car—
22% pay actual expenses
80% pay mileage:
24% 7¢ per mile
29% 8¢ per mile
2% 9¢ per mile
4% 10¢ per mile
83% also pay for hotel and meals

House-hunting trip to new city
75% give employee time off for this purpose
51% also pay wife's expenses on this trip
20% pay wife's transportation only
52% pay all expenses
7% have an allowance

* NOTE: This discrepancy is presumably due to some respondents not realizing that normally the packing charge also covers unpacking.

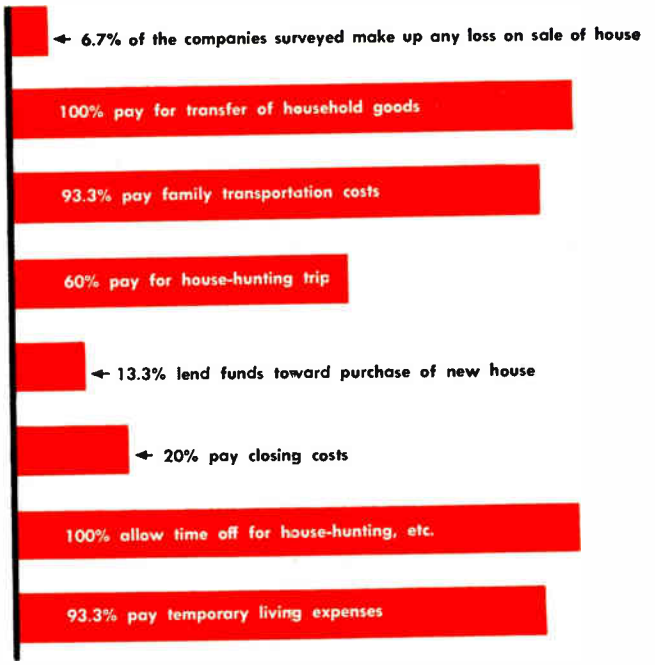


Fig. 3: What companies do to defray direct & indirect moving costs.

When a married employee lives alone temporarily in the new city—
80% pay his actual living expenses
10% pay a per diem allowance
44% pay expenses of weekend visits home
6% allow such trips every week
7% allow such trips every two weeks
2% allow such trips every three weeks
4% allow such trips every month
3% have other arrangements—usually based on distance

When employee is unable to sell his home before moving—
7% take it off his hands
19% lend him down payment on new home
20% help him in some other way

(Continued on following page)

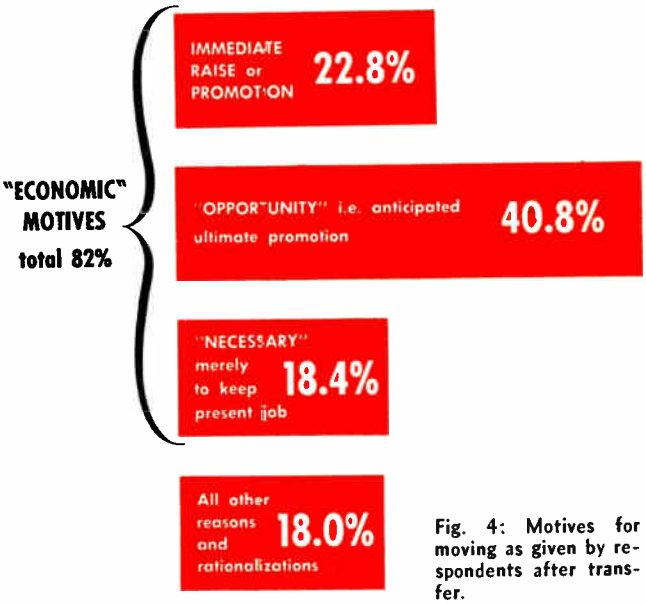


Fig. 4: Motives for moving as given by respondents after transfer.

'Re-locating' *(Continued)*

When employee sells his home

14% pay broker's commission
8% pay legal closing costs

When the employee has unusual living expenses, due to delay in getting in new home—

43% pay actual expenses
4% pay a per diem allowance

Rug and drape allowance

18% pay such an allowance, usually related to salary

Does a transfer by your company mean a salary increase or promotion?

60% say usually
24% say sometimes
14% say there is no connection

Does your company have any program for helping transferred families get acquainted in new city?

10% have an employee responsible for this duty
10% ask a fellow employee to act informally
6% have a social club for employees
5% have other programs

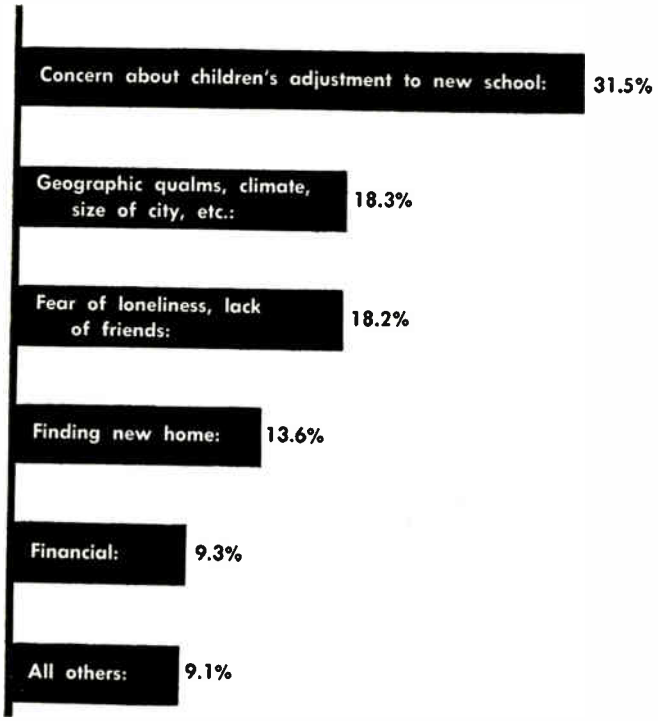
Does your company have any kind of manual or listing of standard procedures and allowances?

28% say they have

The Employees' Side of Moving

This part of the study is based on replies to questionnaires mailed to 893 families who were known to have been transferred to a different city more than eight months, and not more than eighteen months, before the survey was made.

Fig. 5: These are the primary reasons for hesitating to relocate.



333 completed questionnaires were returned in form acceptable for tabulation.

Some of the questions parallel questions in the Employer Survey and the answers in general offer statistical confirmation as to the present practices of industry. The Employee Survey, however, goes much further. It seeks to find out whether the employee feels present practices are adequate, and what else industry should do to make a transfer palatable.

Note: Percentages are always in terms of the entire group, not of subdivisions. For instance, in the question, "Did you get a fair price for your house?"—the answers are in percentage of the entire group and not of those who owned and sold their own homes. Since people sometimes skipped certain questions, or gave qualified answers, or gave more than one answer, the percentages often do not add up to 100%.

Size of Family

The 333 families reported a total of 340 boys and 346 girls for an average family of 1.02 boys and 1.04 girls. Less than 1% reported mothers-in-law or other relatives.

Number of previous moves

Most were experienced movers, reporting an average of:
4.7 moves within the same city
5.6 moves to a different city

Time with Company

Average time with present employer was 7.8 years. The longest 40 years.

Nature of employment

39% were in sales
36% were in management
25% were in engineering
5% were in production

Some thirty other occupations had less than five mentions each.

Who initiated the move?

31% said it was their own idea
68% said the move was at the employer's request

What went with the transfer?

51% said it involved promotion
60% said higher salary
64% said better opportunity

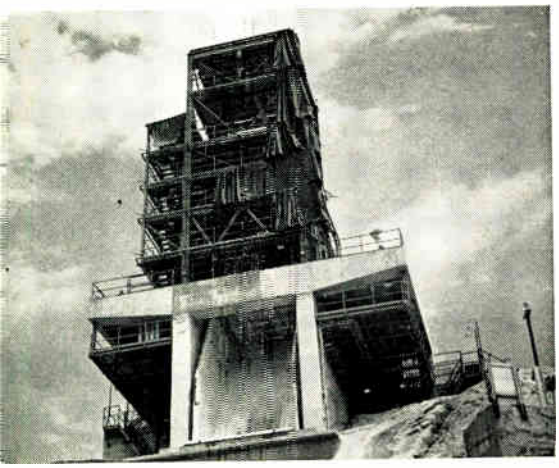
Scattered reasons included: More attractive location, better climate, opening new office, broader experience, "or else."

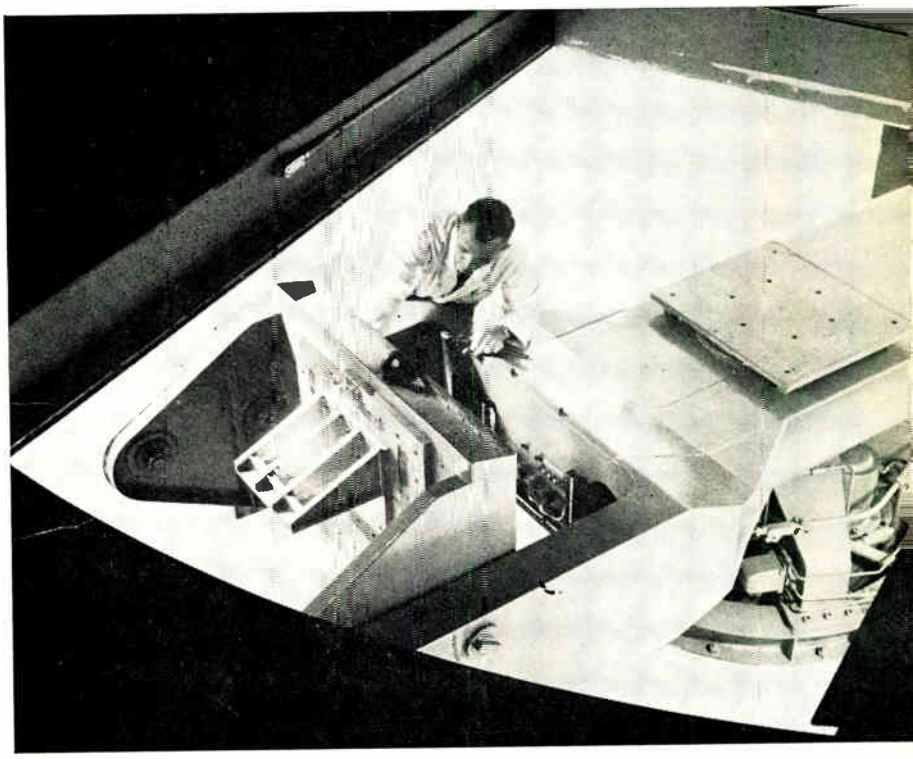
(*Continued on page* 194)

(left) Navy Polaris AX-1 flight test vehicle at beginning of launch. Lockheed's Polaris fleet ballistic missile is more than a year ahead of original schedule.

(below left) One of the Santa Cruz test stands with dynamic thrust mount to simulate flight environment. Vibration oscillator functions during static firings.

(below right) Large centrifuge for environmental testing has unique shaker attachment to provide vibration simultaneously with high G-loadings.





TEST / Expanding the Frontiers of Space Technology

Testing is a vital part of every stage in the development of missile and space programs at Lockheed Missiles and Space Division.

The Division maintains one of the most completely equipped missile and space test laboratories in the world. Equipment includes: altitude, temperature and humidity chambers; shaker and vibration systems; G-accelerators; and apparatus capable of performing chemical, metallurgical, plastic, heat transfer, hydraulic, pneumatic, shock, acceleration, sinusoidal and random vibration, structural, electrical, and electronic tests. Static field testing; research and development testing on controls; testing in ordnance and hydraulics and high-pressure gas and propulsion systems are conducted at the 4,000 acre, company-owned test base in the Ben Lomond mountains near Santa Cruz, California.

Flight testing is conducted at Cape Canaveral, Florida; Alamogordo, New Mexico; and Vandenberg AFB near Santa Maria, California; in a unique manner. All components and sub-systems of a new project are initially tested on known-performance, production missiles. Thus, when the final system is ready for first flight, its individual components already have flight-tested reliability. This new concept of flight testing is a major contribution and has enabled Lockheed to produce extremely complex missile systems in record time and at greatly reduced expense.

Underwater launch tests—including studies of cavitation, wave simulation and skip motion—are carried on at the Sunnyvale facility and at the Navy test base on San Clemente Island. In addition, structural and other tests are performed at Hunter's Point Naval Shipyard, California.

If you are experienced in any of the various phases of testing, we invite your inquiry. Positions also are available in physics, mathematics, chemistry, or one of the engineering sciences. Write: Research and Development Staff, Dept. E-48, 962 W. El Camino Real, Sunnyvale, California. U.S. Citizenship required.

"The organization that contributed most in the past year to the advancement of the art of missiles and astronautics." NATIONAL MISSILE INDUSTRY CONFERENCE AWARD

Lockheed / **MISSILES AND SPACE DIVISION**

Weapons Systems Manager for Navy POLARIS FBM; DISCOVERER SATELLITE; Army KINGFISHER; Air Force Q-5 and X-7.

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO • HAWAII

'Re-locating'

(*Continued from page* 192)

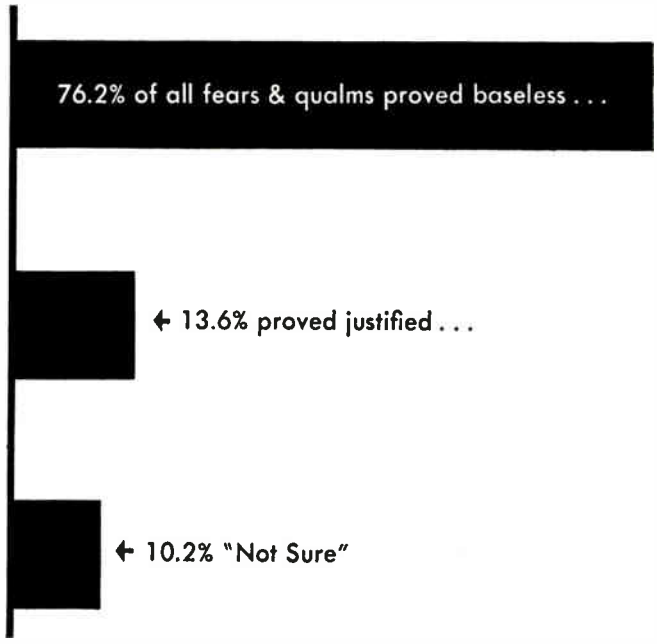


Fig. 6: The results of what transferees themselves say about whether their original forebodings, or reasons for hesitation were borne out.

How much advance notice was employee given?

16% said less than one month
21% said one month
31% said one to three months
17% said over three months

The shortest period mentioned was one week; the longest a year.

Was it enough time?

77% said yes
11% said no

Did any members of the family have serious objections to moving?

18% said yes
79% said no

Has your experience since moving shown that these objections were justified?

10% said yes
8% said no

If transferred again, would you feel the same objections?

9% said yes
6% said no

Housing

Although the most serious difficulties disclosed by this survey had to do with selling the house, it is interesting to note that more of the families ended up as home owners in the new city than had owned their homes before moving.

In the previous location—

55% owned their own homes
20% rented houses
25% rented apartments

If you owned your own home, were you able to sell it before you moved at what you considered a fair price?

34% said yes
19% said no

If you had difficulty selling, did your company help you in any way?

5% said yes
20% said no

If you were renting, did you have any difficulty or expense in breaking your lease?

6% said yes
35% said no

Did your company help you in any way?

6% said yes
15% said no

In the present location—

66% own their own homes
17% rent houses
15% rent apartments
22% reported difficulty in finding satisfactory home
44% had no difficulty
30% were satisfied with the home they bought
5% were not
33% had to pay more than they received for their previous home
9% did not

How did they find these homes?

39% found it through a realtor
10% found it through an advertisement
10% found it through a friend
5% found it by "just looking"
2% had a home built

Activities

Several questions were designed to bring out the extent of family participation in church and other community activities in both the former and the present locations.

Analysis of the answers shows that:

44% are now more active in the community
29% are now less active
20% are about equally active
30% are now more active in church
21% are now less active in church
49% are about equally active in church

Community adjustment

82% believe the present community is as friendly or more so than the old
17% believe the present community is less friendly than the old
80% report the family is as happy in the present community as in the old
19% report the family is not as happy
5% say their company had a program to help newcomers get acquainted
92% say there was no such program
41% say fellow employees made a special effort to help them get acquainted
53% say there was no such effort

What did they find most helpful in getting acquainted with neigh-

(*Continued on page* 196)

ENGINEERS

Why engineering staff turnover at General Electric's Heavy Military Electronics Dept. is less than 3½%*

A Success Story of Particular Interest To The Engineer Capable of More Creative Productivity

There are many reasons for Heavy Military's remarkable turnover record. We believe that the preponderant factor is Heavy Military's policy of advancement based *solely* on individual contributions. Where a man goes — how fast he goes—is not determined by artificial standards: degrees, "salary norms," age, seniority. Recognition and renumeration, under our Salary Administration Plan, increase directly with accomplishment. And there are *two* parallel paths of advancement: as specialist consultant — or as manager-supervisor, with equal compensation and status.

The result? Professional achievements that have steadily enlarged Heavy Military's responsibilities. This has meant a 5-fold growth of the professional staff; a 4-fold increase in number of engineering management and supervisory positions in just 4 years.

Does this environment of vigorous accomplishment appeal to you?

If so, look into Heavy Military's openings on long-range projects in *all* the areas listed to the right:

Radiometry
3-D Radar Systems
Ultra-Range Radars

Data Processing
Sophisticated Display
Digital Detector Trackers
Integrated Air-Defense Environments
Air-Space Management Systems

Unconventional Communications Systems
Synchronous and Scatter Systems
Secure Communications
High-Speed Data Links
Space Communications

Advanced Sonar Systems
Long-Range Search Sonar
Doppler Sonar
Secure Underwater Communications
Mine Warfare Sonar

Your confidential resume will receive careful attention.
Write to: MR. GEORGE B. CALLENDER, DIV. 44-ME
HEAVY MILITARY ELECTRONICS DEPARTMENT

GENERAL ELECTRIC

COURT STREET, SYRACUSE, N. Y.

* *A 4-year average including transfers to other G-E components, retirements, etc.*

Re-locating

(*Continued from page* 194)

bors, stores, organizations and recreational facilities?

39% mention church
38% mention Welcome Wagon
13% mention neighbors
15% mention school
15% mention children
6% mention Newcomers Club
6% mention charity drives
5% mention PTA

Other scattered mentions were: politics, civic organizations, YMCA and YWCA, Scouts.

Schools

One frequently-raised objection to moving is fear that the children will have trouble adjusting to the new school and making new friends. Here is what the survey showed:

33% said the schools in the new community were better than in the old
35% thought them about the same
14% said the schools were not as good
48% said the children had no difficulty in adjusting to the new school
8% reported some such difficulty
56% thought the children well adjusted now
2% did not
17% reported grades higher in new school
33% reported grades about the same
2% reported grades lower now
65% said the children had made friends readily in the new community
2% said they had not

Many suggestions were offered as to how parents could best help the children in adjustment. The following are typical:

Children adjust much easier than adults—no trouble at all with our children. May depend on age of children.

Move into a neighborhood with children their own age.

Encourage friends to come to your home. It is necessary for a mother to assist children in

(*Continued on page* 198)

ENGINEERS BUILD BETTER CAREERS AT LINK AVIATION

The materials with which an engineer constructs his future are the knowledge, skill, ingenuity, and energy he can apply to complex technical challenges. At Link, these challenges are numerous and interesting, and the rewards for accomplishment are tangible and prompt.

That's why outstanding engineers find Link the place to build a successful, satisfying career. Achievement is recognized, salaries are high, benefit programs are generous, advanced-study tuition is paid by Link and the working and living climate is ideal in upstate New York's year-'round vacationland.

Opportunities exist for you at Link if your experience places you at an intermediate or senior level in any of these fields:

- *analog computers*
- *optical systems*
- *electronic packaging*
- *radar simulators*
- *digital computers*
- *automatic checkout equipment*

If you want to build a better future for yourself and your family, look to Link for unmatched opportunity. The time is *now!* Get in touch today with Mr. A. D. Darrah
Link Aviation, Inc., Binghamton, New York.

LINK AVIATION, INC.
A subsidiary of
General Precision
Equipment
Corporation

LINK | A GENERAL PRECISION COMPANY

Circle 504 on "Opportunities" Inquiry Card

Re-locating

(*Continued from page* 196)

locating friends by inquiring through neighbors.

Love them more than ever—see that they become active in church and school affairs—and encourage them to bring home new friends they make. In other words—open house, open heart.

Explain on children's level reason for move and let them take an active part in moving plans.

Leave them alone.

Planning the Move

44% report some one individual in the company was responsible
54% say no
31% were provided with a form telling what the company would do
67% were not
68% felt they were given all the help and information they needed
27% felt they were not
22% were left with doubts and unanswered questions, of which the following are typical:

It was not clear as to what the company would pay toward moving expenses, or who should select the mover.

A written form of costs covered would help, such as: Is there compensation for installation of appliances, overlap of rent, fee for various licenses in new state (car driver's, nurse's, etc.)

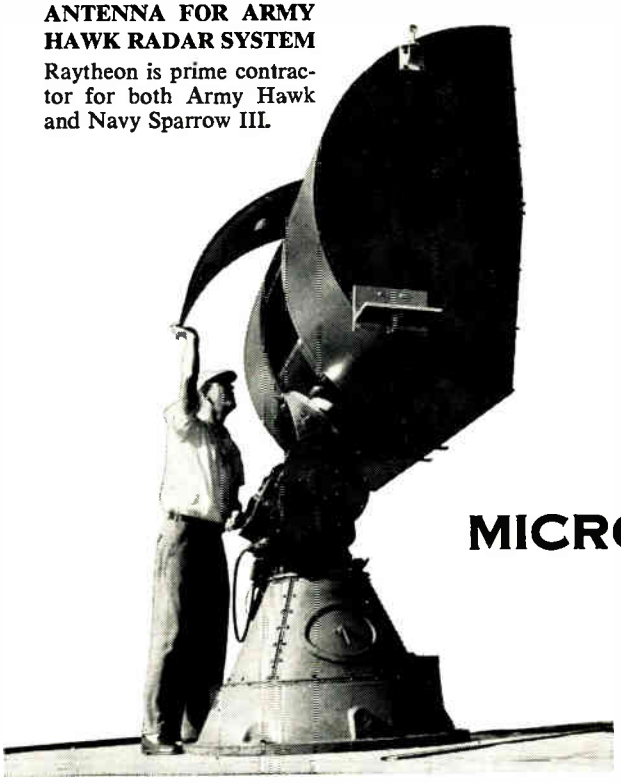
Primarily what costs the company would pay and what they wouldn't.

Didn't know what kind of living accommodations I could have while house-hunting in new location or how often I could visit family in old location at company expense.

We were in doubt as to how much expenses would be cov-

(*Continued on page* 200)

ANTENNA FOR ARMY HAWK RADAR SYSTEM
Raytheon is prime contractor for both Army Hawk and Navy Sparrow III.



MICROWAVE ENGINEERS

ANTENNA • RF COMPONENTS

...FOR RAYTHEON'S LONG-RANGE PROGRAM OF ADVANCED MISSILE DEVELOPMENT

Engineers and physical scientists interested in professional association with a *future* in the challenging areas of microwave development and design should consider Raytheon's advantages.

Senior and intermediate engineers with BS or advanced degrees and appropriate experience are needed for microwave equipment and component development and design of the most advanced types.

- **Antenna (ground, airborne and missile application).**
- **RF Components (strip-line, broadbanding techniques; high-power components, filters, rotary joints, mixers).**

You and your family will enjoy the advantages of living in the Boston metropolitan area. Modern benefits.

Please send complete resume to William F. O'Melia, Raytheon Manufacturing Company, Missile Systems Division, Bedford, Massachusetts.

RAYTHEON MISSILE SYSTEMS DIVISION

Excellence in Electronics

Circle 505 on "Opportunities" Inquiry Card

Re-locating

(*Continued from page* 198)

ered by the company (personal expenses).

Procedure as to billing moving charges. Company responsibility so far as paying temporary living costs.

Details of moving — insurance fees whether I could select a mover, how mover is paid, what employer would pay, etc.

No real understanding of what exactly I was authorized in expenses. I submitted what I considered it cost me and company reimbursed me.

Who pays for what?

Question of expenses and who paid motel bill and food bills before family could be moved.

Expenses Paid By the Company

Percentages show the instances in which the company actually paid these items. Presumably many more of the companies would have paid such items as storage, broker's fee, etc., if it had been necessary.

100% paid for moving
89% paid for packing
35% paid for storage in transit
68% paid for a preliminary visit to find a home in the new locality
15% paid broker's commission on sale of former home
6% paid loss on sale of home
14% paid legal costs on sale of home
40% paid extraordinary living costs during moving
90% paid rent on temporary housing
7% paid a rug and drape allowance
15% paid other expenses

The average total cost paid by the company was $1,197.26. The highest cost paid by the company on one moving was $7,350.00.

Many employees also reported

(*Continued on page* 202)

Circle 506 on "Opportunities" Inquiry Card

William Karush
Assistant Director for Research
Operations and Management Research
System Development Corporation

11-105

SYSTEM DEVELOPMENT CORPORATION

SANTA MONICA, CALIFORNIA

Re-locating

(*Continued from page* 200)

additional costs paid by themselves. The average was $748.18 and the highest $6,555.00.

84% feel that their company paid a fair share of the moving cost.

13% thought the company had been less than fair.

However, a number of both yes and no answers were qualified by some such remarks as these:

Yes, but there are always many small hidden expenses. Would like to see us get an extra month's salary with each promotional move.

At the time we did, but since have checked with other couples transferred by various companies and think now we could have had more help.

No—they should make an allowance for rugs, drapes, cleaning, etc. They should allow us to buy a home and take it off our hands when transferred, or make up any losses, or they should maintain houses to rent at reasonable rents.

No—in view of the fact that our move was made for the convenience of the company, I feel they should have seen to it that we were reimbursed for out-of-pocket expenses, in necessary purchases for curtains, drapes, etc. Many of these items that were useable in old home are of no value here.

Future Transfers

55% expect to be transferred again
28% do not
67% are willing to make another move though some of these qualify their willingness with remarks like this:

Since the last move put us behind $500.00—plus a higher mortgage payment on the house—it would have to be a very inviting proposition.

19% never want to move again

Additional Suggestions

Three questions were designed to draw out any ideas these families might have developed out of their experience. We have selected a few of the more constructive responses to each question. Many other comments were equally good but expressed much the same ideas.

What would you do on the next move that you didn't do this time?

Try to get company to take realistic view of all contingent expense involved, broker's and legal fees, drapes and carpeting.

Know exactly what portion of expense I would have to pay.

Get company commitments on paying for real estate and legal fees connected with sale and purchase of homes.

Would like to have more time to look the town over. Clearer understanding of what the company would pay. I think a company should have some kind of housing rental service and help the newcomer to get located in the better sections of town.

Request an advance visit to the new community so my wife and I could pick a place to live.

We would move as soon as possible after a transfer rather than wait to sell house. Real estate sells just as fast whether you are living in the house or not. Separating the family for 6 to 8 months is difficult on all concerned.

Try harder to sell house before moving out of it. Makes things so much easier.

Would sell house before my leaving city.

Probably quit.

What suggestions do you have for other families who are being transferred?

Lease a place to live for a year,

(*Continued on page* 204)

Re-locating

(*Continued from page* 203)

or less, if you can. After a year, you'll know where you want to live in a city. When you lease or rent get moved and settled before you start your new assignment. Commuting weekends to another city and having an unhappy family will hurt you in getting off to a good start.

Contact realtor or rental agency rather than depending on want-ads for house-hunting. Don't buy new furniture, etc., just before moving—in case it develops a defect, it is difficult to adjust when hundreds of miles separate you from the place of purchase.

Do the same as I did—take no part in it but let those who specialize in such services handle the whole deal.

Get everything in writing before agreeing to move and don't forget to add $1,000 to all the expenses you can think of.

Write the Chamber of Commerce for brochure on new community so that the interesting facts can be learned in advance —also subscribe to local papers by mail and study history of new area.

If you haven't used an item recently—throw it away. Get a floor plan of your new location and work out the furniture arrangement in advance.

Talk to everybody they know who has moved and get their opinions as to why they moved and how they felt about moving.

Attempt to locate in a new development rather than an established neighborhood. It is easier to get acquainted and become part of a group. It is less clannish.

If other families are as fortunate as we were in having their employer take care of all details for them, including advance cash for transportation, they have no trouble.

Always sell home or arrange with company to appraise their property and agree on a fair selling price. If sold below that figure — company should reimburse employee the difference.

Don't dread it. Moving can be more pleasant than you think.

Other ideas or suggestions on the general subject of moving?

If possible, place children with friends or relatives until unpacking is completed.

It seems to be the new way of life, so a good proportion of young Americans had better adjust to the idea and learn to plan long-range, accordingly.

It would be nice if the office to which you were moving had prepared a list of reputable doctors, desirable living sections in town, tax set-up of state, county and city, driver's and car licensing procedure, unusual city ordinances.

Have flexible program, allowing employees to sell furniture.

Shades of Buck Rogers!

A "reactor gun" that will allow spacemen to propel themselves around under conditions of weightlessness is being studied by the Air Research and Development Command's (ARDC) Wright Air Development Center (WADC).

Control problems are being studied during the 12 to 15 seconds of weightlessness attainable in a C-131B airplane flying a kaplerian trajectory (an arc flown to produce weightlessness).

The present equipment consists of a package of high-pressure air bottles, a short length of hose, a nozzle, and valves for controlling the amount and direction of the air discharged. The man holds the nozzle in his hand, aims it directly away from the point to which he wishes to go, and presses the handle. The reaction of the high-pressure air rushing out of the nozzle provides sufficient force to propel the man from one point to another.

North Carolina Plant Location Engineers

Show Documentary Proof of Your Opportunity In a Multi-Million Dollar Component Market

These men invite you to study their latest survey of the Electrical Machinery and Equipment Industry in North Carolina. It reveals an amazing record of growth continuing by leaps and bounds.
They are ready to show you opportunities for your expansion into a ready-made market in the South's pace-setting state —

NORTH CAROLINA

Where it's Profitable to Produce and Wonderful to Live

If you are interested in discussing confidentially "A Market Survey of the Electrical Machinery and Equipment Industry of North Carolina," write or phone Wm. P. Saunders, Director, Dept. of Conservation and Development, Raleigh, North Carolina.

News of Reps

REPS WANTED

Manufacturer of **component testing equipment** wants reps for metropolitan N. Y., and Phila., Baltimore and Washington areas.

A manufacturer of **cooling equipment** is looking for reps to cover Western Wisconsin and Minnesota. Contact Ben Eckenhoff, McLean Engineering Co., Princeton, N. J.

The Solid State Electronics Co., Van Nuys, Calif., has appointed 6 sales reps: **G. H. Vaughan Co.**, Pasadena, for California, New Mexico, Arizona, and Colorado; **Industron Co.**, New York, for New York, New Jersey and Philadelphia; **Walter C. Stemler & Assoc., Inc.**, Aberdeen, for Maryland, Washington, D. C., Delaware, Eastern Pennsylvania and Virginia; **Saunders & Co.**, Waltham, for Massachusetts, Connecticut, Rhode Island, Vermont, New Hampshire and Maine; **Specialized Equipment Corp.**, Atlanta, for Georgia, Florida, Tennessee, North Carolina, South Carolina and Alabama; **Ohio Instrument Co.**, Dayton, for Ohio, Western Pennsylvania, Kentucky and West Virginia.

Wesrep Corporation, Los Angeles, has been named engineering reps for the "Electropot" line of precision, custom and standard potentiometers manufactured by Electronic Controls Corp. Wesrep will handle the western defense areas of the United States in addition to the states of California, Arizona, Nevada and New Mexico.

Webster Electric Co., Racine, Wis. has announced the appointment of 3 sales reps for the company's electronic components division: **Simonite-Lewis & Assoc.**, Los Angeles, to service the Southern California-Arizona territory; **Moulthrop & Hunter**, San Francisco, to service the Northern California and Nevada territory; **Mingins Sales Co.**, New York, N. Y. to service New York City and Northeast New York State. These companies will represent Webster's phono pickups and cartridges, amplifiers, Ekotape tape recorders and industrial sound components.

James S. Heaton Co., Redwood City, Calif., has been named field rep by Eitel & McCullough, Inc., San Carlos, California manufacturer of Eimac electron-power tubes.

Cashin - Tipton and Assoc., San Diego, Calif., will represent Fairchild Controls Corp. in San Diego County.

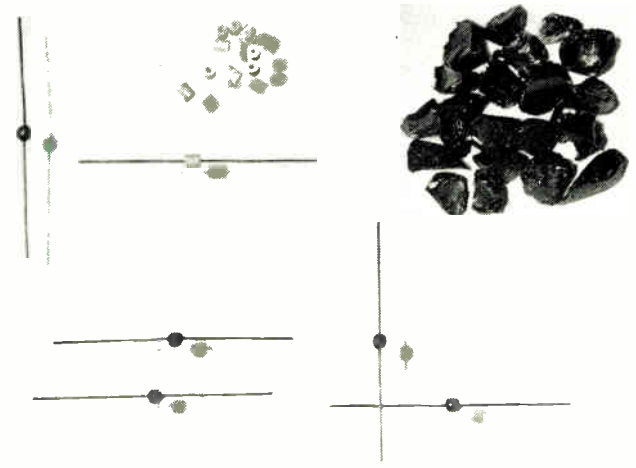
(*Continued on page* 208)

3 Significant Recent Developments in "Electronic-Grade" Chemicals from Baker & Adamson®

To meet the exacting needs of the electronic industry, Baker & Adamson has developed a broad line of special high purity "Electronic-Grade" chemicals, metals and other materials. Among its newest specialties are the products featured below.

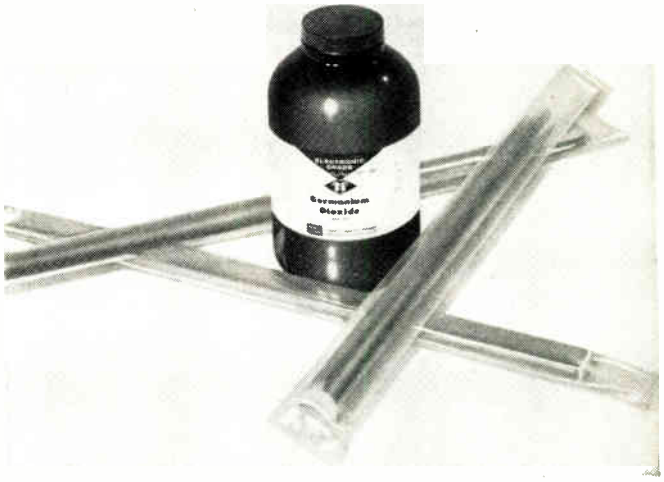
Our new folder, "B&A Electronic-Grade Chemicals," lists them all, with specifications for some . . . brief description of properties and applications for others. Write for your free copy now.

Remember – as America's foremost producer of laboratory and scientific chemicals, B&A has the wide range of products, the versatile production facilities and the specialized experience to meet virtually every electronic chemical need.



Low-Melting Glasses for Encapsulation

B&A low-melting-point glasses hold promise of a major breakthrough in economical and highly efficient protective coating of semiconductors, capacitors, diodes and other types of electronic devices. Coating can be accomplished by dipping or preform operations. These new encapsulating agents are now available in research quantities.



Special High Purity Germanium

B&A offers the electronic industry a dependable domestic source of special high purity germanium dioxide and ingots of germanium intrinsic or first reduction metal. B&A germanium dioxide is dustless and free from fine particles. It has 60% to 70% higher bulk density and contains about 0.5% less volatile than many other oxides.

Solvents Quality Controlled by Resistivity Measurement

B&A special high purity solvents for washing and drying semiconductor crystals are quality controlled by resistivity measurement – a new technique developed by B&A which makes it possible to detect and control impurities to a degree surpassing all previous quality standards.

BAKER & ADAMSON®
"Electronic Grade"
Chemicals

Allied Chemical

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

Circle 148 on Inquiry Card

News of Reps

(*Continued from page 206*)

American Electronic Labs., Inc., of Philadelphia, manufacturers of commercial test and microwave equipment have appointed 3 manufacturers' reps: **Charles W. Fowler**, 2125 Hearst Ave., Berkeley, Calif. covering Arizona, California and Nevada; **Landfear Enterprises**, P. O. Box 68, Nutley, N. J. covering metropolitan New York City, Long Island and the counties of Dutchess, Orange, Putnam, Westchester and Rockland in the state of New York and New Jersey; **Lawrence D. Bruno**, P. O. Box 61, Far Hills Branch, Dayton, Ohio covering Ohio and Western Pennsylvania.

Samuel A. Dixon will represent Molecu-Wire Corp. in the areas of Southern New Jersey, Western New York, Pennsylvania, Delaware, Maryland, Washington, D. C., North and South Carolina. **Budd Cato Assoc.** will represent the company in New England.

Ault Assoc., Menlo Park, Calif., is now sales rep for Northern California for Shockley Transistor Corp., subsidiary of Beckman Instruments, Inc.

V. T. Rupp Co. has been named sales engineering reps for Southern California, Arizona, New Mexico and Southern Nevada, by Precision Instrument Co., San Carlos, Calif.

R. O. Whitesell & Assoc. was appointed Ungar Electric Tools, Inc. rep for the Kentucky-Indiana area.

New reps firm serving New York Metropolitan area—**Q.E.D. Electronic Sales, Inc.**, 9 Elm Ave., Mt. Vernon, N. Y. Principals are: Sid Gordon, Gene Rotundi and Raymon S. Sterman.

F. Edwin Schmitt Co., New York City, has been named rep for the Stancor line in the metropolitan New York area by Chicago - Standard Transformer Corp.

Anderson Electronics Co., 27050 Gratiot Ave., Roseville, Mich. is now sales rep in the state of Michigan for Telemeter Magnetics, Inc., Los Angeles.

Barry E. Houser, Perth Amboy, N. J., has been named sales rep for Delaware, Maryland, Washington, D. C., Eastern Pennsylvania, New Jersey and parts of Virginia by Deltime, Inc., Mamaroneck, N. J., manufacturer of delay lines and associated equipment.

Aeromart, Inc., will represent United States Radium Corp.'s line of dials, nameplates and panels in the South and Southeast.

(*Continued on page 210*)

ELECTRONIC INDUSTRIES Advertisers — May 1959

*In Operations Edition only

News of Manufacturers' Reps

Miles Wagner has been appointed manufacturers rep for Arizona by Triad Transformer Corp., div. of Litton Industries.

H. H. Buggie, Inc., Toledo, Ohio has appointed 4 new reps for the company's line of electronic connectors and components: **Carlson Electronic Sales Co.**, Chicago, for Illinois; **Winfield Electronics Co.**, North Miami, for Florida; **Allen C. Craft, Jr.**, Atlanta, for Georgia and **Charles W. Kinsley Co.**, Huntsville, for Alabama.

Mid-Eastern Electronics, Inc., Springfield, N. J. announced the appointment of 2 reps: **Kenneth W. Meyers Co.**, Park Ridge, for Northern Illinois and Southern Wisconsin; and **J. L. Pierce Co.**, Detroit, for all of Michigan.

EFCON (Electronic Fabricators, Inc.) of New York, N. Y. manufacturers of precision plastic film capacitors, has appointed 2 additional sales reps: **Specialized Electronic Corp.**, Cocoa Beach and Atlanta, to cover Florida, Georgia, North Carolina, South Carolina, Tennessee and Alabama; and **Engineering Products Assoc.**, St. Paul, to cover Minnesota, North Dakota and South Dakota.

Deltron, Inc., Phila., has appointed 6 additional reps to handle its power supply line: **Lawrence C. Fuller, Jr.**, Ardmore, Pa., covering Southern New Jersey, Eastern Pennsylvania, Maryland, Virginia and District of Columbia; **Stanley K. Wallace Assoc., Inc.**, Lutz, Fla., covering the Southeast area; **Robert G. Moye Co.**, Alhambra, Calif. covering the New York Metropolitan area; **Leo Jacobson Co., Inc.**, Buffalo, covering Upper New York State and **Northwest Sales & Eng. Service Co.**, Seattle, covering Oregon, Washington, Idaho, Montana, British Columbia, Northern California South to and including Fresno.

Koehler - Pasmore Co. of Detroit, has been named sales rep for the commercial and military electronic components of Avion Div. of ACF Industries, Inc., for the state of Michigan.

Brown Technical & Associated Sales has been named Mountain States engineering rep by Designers for Industry, Inc.

Par Co. has been named technical and sales reps for the state of Florida by Hitemp Wires, Inc., Westbury, N. Y.

Simberkoff Sales Co., Hoboken, N. J., has been named rep for sales of Waters Mfg., Inc. potentiometers, components, and instruments in New York state excluding greater New York City and Long Island.

Howard & Co. has been appointed rep for Wyle Associates in the Northern California-Nevada area. Howard & Co. has offices at 938 N. Linden Ave., S. San Francisco.

Scientific Sales Engineering Co., manufacturer's reps with offices in Atlanta, Winston-Salem and St. Petersburg, has been named to represent Ultronix, Inc., San Mateo, Calif., manufacturer of precision wire wound resistors and trimming potentiometers.

Aerol Assoc. will represent Zero Mfg. Co., Burbank metal products firm, in the San Francisco Bay area.

Mid-Eastern Electronics Inc. has appointed 2 West Coast sales reps for their line of ultra high resistance measuring instruments, power supplies and special test equipment. **The George H. Vaughan Co.**, Pasadena, will cover Southern California and Nevada and **Eicher & Co.**, Seattle, will handle Washington, Oregon and Idaho.

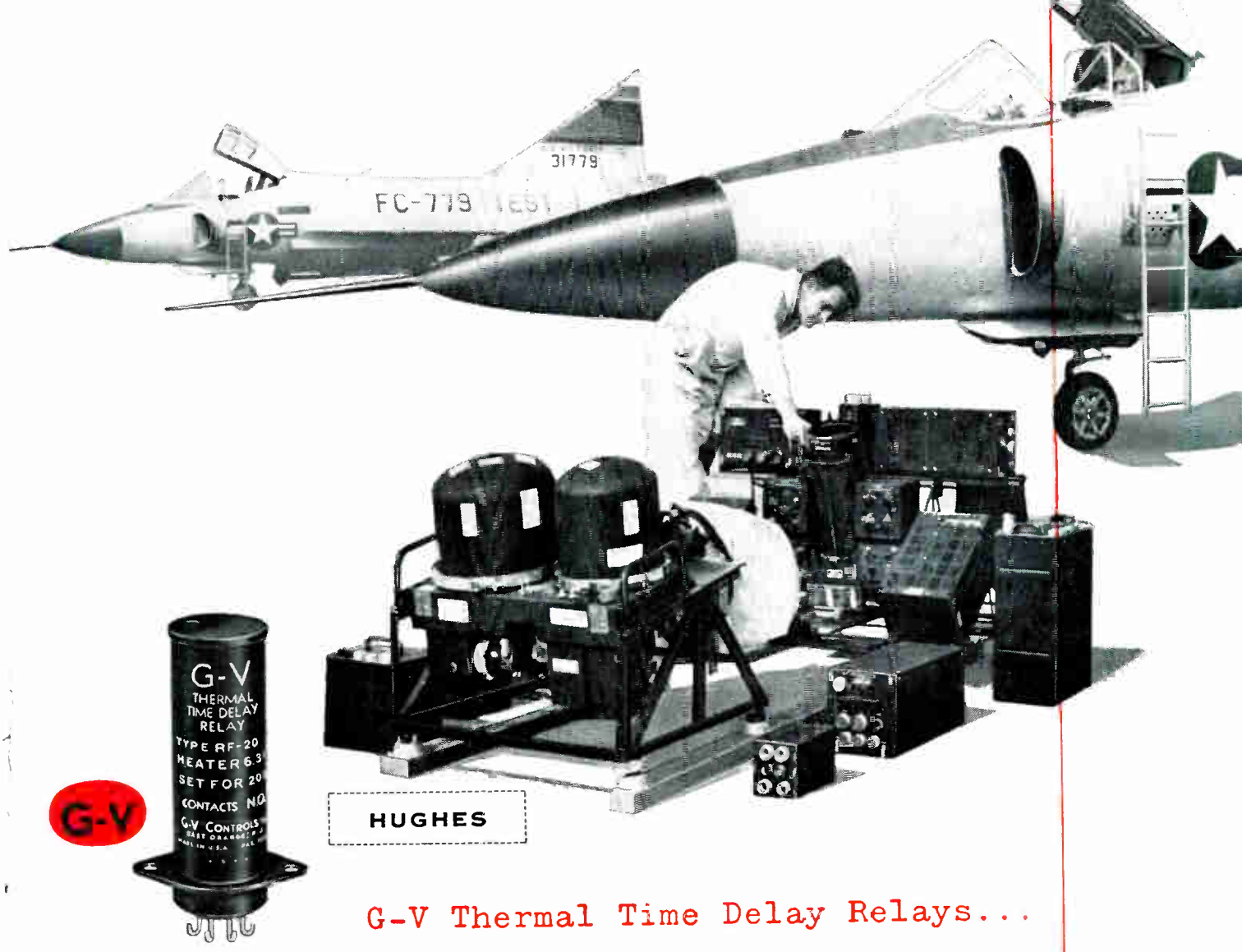
The Garrett Corp.'s Aero Engineering and Airsupply Divisions have undertaken sales representation for Elgin Micronics Div. of the Elgin National Watch Co. Elgin Micronics manufacturers motor operated timing devices and special instrument mechanisms.

M. W. Riedel & Co. has been appointed sales rep for the line of magnetic components produced by Magnetic Circuit Elements, Inc. for the territories of California and Arizona.

Howell Sales, Inc., Denver and Seattle, has been named by Inso Electronic Products, Inc., as its western sales rep. Inso produces insulated wire.

Arthur H. Lynch and Assoc., Inc., will represent Panoramic Radio Products, Inc., in Florida.

A.P.M. Sales Corp. has appointed 5 new sales reps to handle its line of high-pressure seals and fasteners: **Koehler & Pasmore**, Detroit—Michigan; **Jack Geartner Co.**, Miami Beach —Florida; **Wayne Goldie Co.**, Sierre Madre—lower California; **Morris Steel & Alum. Co.**, Albuquerque — New Mexico; **J. Tyler Griffin**, Devon, Pa.— Eastern Pennsylvania and Southern New Jersey.



G-V

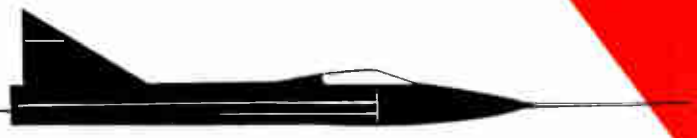
G-V Thermal Time Delay Relays...

used in Hughes Airborne Armament Control System

The F-102A all weather interceptor and many other planes in the U. S. and Canadian Air Defense Commands are fully equipped with this system developed and manufactured by the Hughes Aircraft Company. G-V thermal time delay relays are relied upon in all of these systems.

In both military and industrial equipment, G-V thermal relays are providing long, dependable, proven service in time delay applications, voltage and current sensing functions and circuit protection.

Write for extensive application data and catalog material.



G-V

G-V CONTROLS INC.

Livingston, New Jersey

Circle 2 on Inquiry Card

...from watts to megawatts

Typical RCA Ceramic-Metal Power Tubes utilize beam power design, and feature high-efficiency forced-air cooling.

RCA Ceramic-Metal Power Tubes

Known throughout industry and military services for high-efficiency operation and ability to withstand high voltages at ultra-high frequencies, RCA Ceramic-Metal Power Tubes are the answer for the designer who requires higher power in a smaller, compact tube design. No other power tubes in this class combine features such as: coaxial-electrode design; low-loss ceramic bushings between electrode contact surfaces; matrix-type cathode; extra-sturdy heater, low screen current, virtually no primary screen grid or control grid emission!

RCA Ceramic-Metal Power Tubes merit the attention of new equipment designers for a wide variety of applications. Your RCA Representative will be glad to discuss with you your requirements for RCA Ceramic-Metal Tubes and the availability of developmental types on a sampling basis.

Typical RCA Ceramic-Metal Power Tubes

Type No.	CW Service max. Plate Input (Watts)	Pulse Service max. Peak Plate Input (Watts)	max. Frequency for full Input (MC)	max. Plate Dissipation (Watts)
A-2582*	30	–	1215	25
A-2587*	–	3750	1215	25
6816	180	–	1215	115
A-2543-A*	–	9000	1215	115
A-2572*	1250	–	1215	600
A-2585*	–	64000	1215	600
7213	2500	–	1215	1500
A-2576-A*	–	180000	1215	1500
A-2545*	20000	–	400	10000
A-2581*	–	2000000	500	10000

*RCA Developmental Type—Available on Sampling Basis

GOVERNMENT SALES

HARRISON, N. J.
415 S. Fifth St., HUmboldt 5-3900
DAYTON 2, OHIO
224 N. Wilkinson St., BAldwin 6-2366
WASHINGTON 6, D.C.
1625 "K" St., N.W., District 7-1260

INDUSTRIAL PRODUCTS SALES

NEWARK 2, N. J.
744 Broad St., HUmboldt 5-3900
CHICAGO 54, ILLINOIS
Suite 1154, Merchandise Mart Plaza, WHitehall 4-2900
LOS ANGELES 22, CALIF.
6355 E. Washington Blvd., RAymond 3-8361
DETROIT 2, MICHIGAN
714 New Center Building, TRinity 5-5600

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