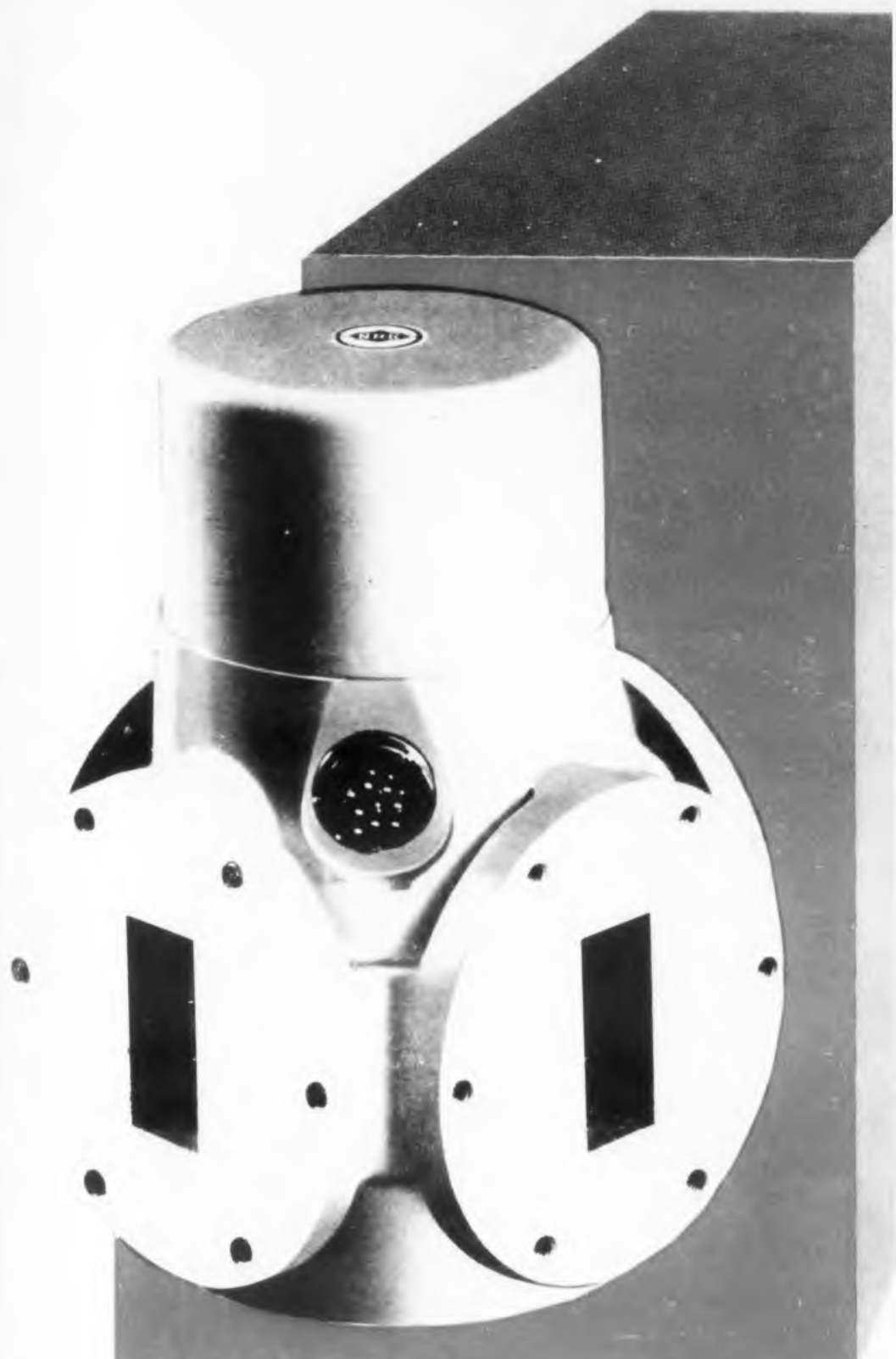
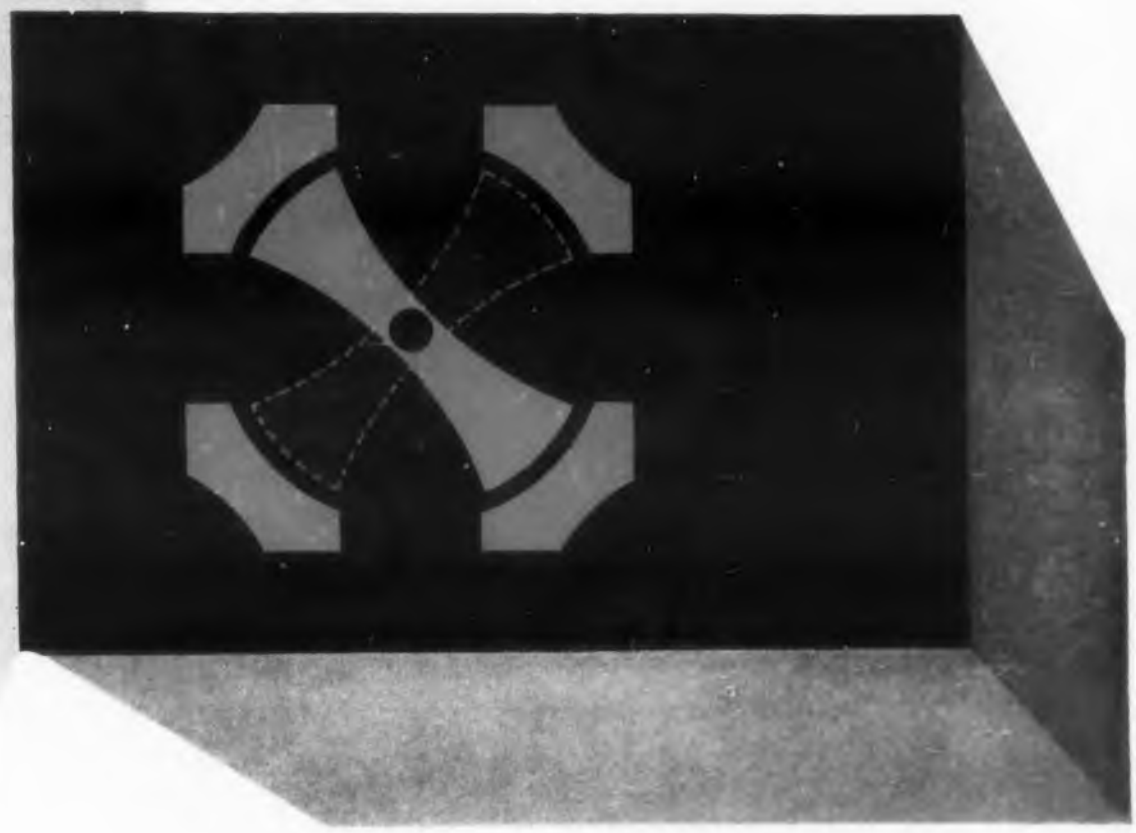


RONIC ESIGN

DECEMBER 1, 1956

Rotary Waveguide Switch page 22



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Associate Editors E. T. Ebersol, Jr., L. D. Shergalis, E. Burger

Assistant Editors S. Dresner, P. J. Lahey, D. S. Viebig

Washington Editor H. H. Rosen, National Press Bldg., 1346 F St., NW, Washington, D.C., STerling 3-8912

West Coast Editor H. C. Jordan, 5720 Wilshire Blvd., Los Angeles, Calif., WEbster 5-5158

Contributing Editors S. H. Hubelbank, J. M. Monstream, J. D. Adashko, R. D. Thornton, A. Jorysz

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New York: 19 E. 62nd St., TEmpleton 8-1940 — Owen A. Keon, Lawrence Conover, Bryce Gray, Jr., Robert W. Gascoigne

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ELECTRONIC DESIGN

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Editorial

Mica Status Needs Clarifying

One of our basic electronic materials may be in short supply in case of war—or maybe not! We refer to mica. Its status is confusing.

Recently advised that a "hot mica potato" is simmering close to boil with political intrigue and international overtones, we decided to "see for ourselves." After talking to many people concerned with all aspects of the high-quality mica situation we aren't certain whether we have a roaring bull by the tail or not. It seems to be quite tame, in fact—fortunately.

Mica has been such an important insulating material for electronic and electrical equipment that its shortage is reliably reported to have been a factor in the defeat of Germany and Japan in World War II. Since over 90 per cent of U. S. electrical-grade mica now comes from India, it would appear on the surface that its loss would prevent us from getting off the ground in case of an attack. But, would it?

Faced with a mica shortage in wartime since World War I, our government has tackled the problem to an extent at least, partially in cooperation with industry. In any event, it has been spending $20 million developing U. S. mica mines (which are mighty expensive to mine) and in stockpiling a "3-years' supply" of high-grade electrical mica. Just now it is getting ready to spend $4,000,000 to advance research on reconstituted (large sheet) synthetic mica, with early success expected. Synthetic mica now is suitable to replace over 90 per cent of electrical-grade natural mica. It can stand much higher temperatures and is practically pure. The only "bug in the ointment" is its much higher cost than India's mica. With India mica unavailable, it would be much more attractive.

The truth seems to be this: Natural mica is critical; existing workable mines are rapidly being depleted, somewhat unnecessarily because of old-fashioned mining and grading methods and resistance of the British, French and U. S. mining and importing interests to technological improvements. India's Ruby muscovite is of sufficient quality and cheaper as long as we can get it. But, when we can't get it, we can supply 90 per cent or more of our requirements for high-grade mica from synthetic sources (Synthetic Mica Corp. of America, Brush Beryllium Co., etc.) within a year or so. The government stockpile should carry us until then.

The evidence points to the fact that we won't get caught flat-footed next time. We wonder, though, if anyone really knows **for sure!** If he does, will he please step forward and relieve our case of jitters? ETE

Engineering Review

For more information on developments described in "Engineering Review," write directly to the address given in the individual item.

9.7 Billion Electronic Giant

Electronics became a $9.7 billion industry in 1955, nine times bigger than it was at the end of World War II, according to the second edition of RETMA's "The Electronics Industry Fact Book." Moreover, it is destined to double its present size over the decade ahead.

Demand for automation is seen as pushing sales of industrial electronics to more than $1.2 billion by 1960 and to $2 billion by 1965. This would be up from $700 million in sales last year.

Deliveries of military electronics equipment are expected to run for several years at the 1954-55 rate of $2.4 billion. According to RETMA's statistical report, actual deliveries increased from $500 million to $1.5 billion in 1951, to $2.5 billion in 1952 and to a record $2.8 billion in 1953.

Missiles and rockets will replace piloted aircraft in 50% of strategic missions and 30% of tactical missions, according to the RETMA study. It was noted that expenditures in this field had increased 50 fold—from $21 million in '51 to nearly $1 billion last year.

Production of TV, radio and phonograph sets continues to break records. In 1955, for the third consecutive year, there were more than 7 billion TV sets manufactured. Last year's production was 7.8 million sets factory valued at $1.1 billion. Radio set production last year was at its highest point since 1950, with output of auto radios exceeding 6 million for the first time.

RETMA's Fact Book contains a number of the electronic industry's growth, including statistics on retail outlets, and exports.

Copies of the "Fact Book" are available to non RETMA members and the general public for 50 cents a copy from Radio-Electronics-Television Manufacturers Association, 777 - 14th St. N.W. Washington 5, D.C.

Portable Air-Inflated Radar Antenna

A light-weight mobile radar set with an unusual giant balloon antenna has been developed by Westinghouse Electric Corp. Electronics Div. for the Air Research and Development Command.

Resembling a giant lollypop, the Paraballoon antenna stands more than 30 ft high. The fiberglass-cloth balloon is preshaped so that when inflated it forms a double parabolic reflector coated on one inside surface with vaporized aluminum to reflect radar waves

The new radar antenna weighs only 1690 lb compared to 10,000 lb for equivalent existing metal antennas and their support structures. The light-weight unit can be disassembled in minutes and packed into airlift containers weighing only 200 lb each. The entire radar set can then be air-dropped into tactical areas for detection of hostile aircraft.

The original idea was conceived by Westinghouse engineer Coleman Miller. Development was carried out under a contract with ARDC's Rome Air Development Center, Griffith Air Force Base, Rome, N.Y.

The Paraballoon, when deflated, can be unzipped into sections. The magnesium supporting structure also is collapsible. While such a radar set can be packed into only a few boxes about 21 cubic feet each, antennas of comparable range require three to five 2-1/2 ton cargo trucks.

When erected in the field, the Paraballoon will be protected from high winds, rain and snow by an air-supported radome, similar to some now in service at fixed radar sites. The radome in this case however, is extremely lightweight, sectionalized and designed for mounting directly on the ground. The radome serves to protect the complete radar system from the elements, including antenna, electronics equipment, and operating personnel.

Westinghouse engineers explained that neither the Paraballoon antenna nor the radome are easy prey to deflation by gunfire. More than fifty 20 mm projectiles can pierce the radome and antenna without affecting normal operations. This is because a constant stream of air is sent into Paraballoon and radome to maintain their low-pressure (less than 0.02 lb per square inch for the Paraballoon).

Paraballoon antenna radar units are now being manufactured by Westinghouse for the Air Force and the U.S. Marine Corps.

"Sidewinder" Missile Joins Fleet

"Sidewinder," a lightweight, but extremely deadly air-to-air guided missile is now part of the Navy's arsenal. The name, "Sidewinder," is derived from a term used in the Southwest for vicious rattlesnakes. Small and light enough to be carried in quantity by single-seat interceptor planes, the missile may be fired single or in salvos. "Sidewinder" requires no complex launching equipment but is fully maneuverable at supersonic speeds. It has an unusually high single-shot "kill" reliability.

Although details on the missile's guidance system have not been disclosed, the Navy revealed that "Sidewinder" requires no special pilot training. It has been implied that electronic components are fewer than what ordinarily appear in a radio. It may be launched well beyond reach of an enemy aircraft's defense.

Philco's Government and Industrial Division, Philadelphia, which assisted the Naval Ordnance Test Station, China Lake, California in the research and development program of Sidewinder, is now manufacturing the missile and has begun scheduled deliveries. Other companies working on the Sidewinder project include: G. E., Avien Div. of ACF, Eastman Kodak, and Bulova.

"Sidewinder" is classed as a guided missile in that it can change its course to account for tactical movements of an enemy target. Although the time of interception is very short, the missile displayed extreme deadliness during recent field tests.

Narrow-Band A Must For Mobile Transmitters

To utilize more fully the 152-162 mc band, the FCC has ruled that within 7 years all mobile transmitters in this range must use only narrow-band equipment (15 or 30 kc). By October 1958, all equipment being manufactured will be capable of satisfying the requirement so that taxicabs, railroads, trucks, utilities, police and fire-fighting agencies should anticipate little difficulty in complying with the ruling.

It is expected that the technical standards to be set up will be discussed in a forthcoming report by the FCC. Mobile radio users will be urged to leave the 25-50 mc band and go to the higher frequencies.

Jets Get New Boost From Hi-Temp Alloy

Westinghouse soon will begin full scale tests on a new combination of high-temperature alloys that may increase the efficiency of jet engines more than 15 per cent. Described as a possible key to a major advance in the field of jet engines and gas turbines, the development involves the sandwiching of one high-temperature alloy around another to take advantage of the heat resisting qualities of each.

Current high-temperature alloys restrict maximum turbine inlet temperatures to about 1600 degrees F. While these alloys are somewhat better than those of 10 years ago, they are still essentially of the same composition. However, with the use of Inconel-clad molybdenum, inlet temperatures of between 1800 and 1900 degrees will be possible. At the present stage of progress on jet engines and gas turbines, an increase in temperature boosts efficiency on an almost directly proportional basis.

The qualities of the alloys were demonstrated by subjecting three specimens to stresses at high temperatures. Inconel alone broke when the temperature hit between 1350 and 1450 degrees. Molybdenum did not break even at 1850 degrees, but did begin smoking at about 1300. This is due to oxidation which would rapidly burn up the metal if this were allowed to continue. However, when heat was applied to "clad moly," the specimen neither burned nor broke even at 1850 to 1950 degrees, due to the oxidation resistance of the outer layer of Inconel and the strength of the molybdenum.

Current tests are being conducted at the Westinghouse aviation gas turbine division in Kansas City.

Materials Study Urged

The study of the science of materials should become a part of an electrical engineer's training, says W. W. Mullins of Westinghouse Electric Corp., Pittsburgh, Pa.

"There is need for more top quality engineers in materials research and development because the electrical engineer has an intimate knowledge of the demands of electrical technology for special materials, and can judge the practical performance characteristics a material must have to be acceptable," Mullins noted.

He also feels that training in materials science would attract more electrical engineers to the fields of research and development.

Guaranteed Printed Wiring

Reliability of printed wiring is no longer of concern to Dumont since they have announced a 5-year guarantee with their new "400" line of instruments. Perfection of the art on a production basis has come a long way since the early trials were first initiated in the laboratory.

Engineering Scholarships

Four-year scholarships, valued at $2200 each, have been established at the University of Tennessee by the Filton Sylphon Division of Robertshaw-Fulton Controls. In inaugurating the scholarship program, the company announced that it wished to encourage students to enter the field of engineering.

The scholarships will be awarded on a competitive basis, two being given to children of employees and the other to a Knox County High School graduate.

Radar For Private Aircraft

A fifty-pound radar, the smallest and lightest of its type ever developed, will soon be available for private and business aircraft. The system (AVQ-50) developed by RCA Custom Aviation Equipment, Camden, N.J. will enable pilots to "see" and avoid storms up to fifty miles ahead.

High Temperature Electron Tubes

Several high temperature glass electron tubes are presently being manufactured in production quantities by Sylvania. Types 6049 and SD 1063A are hard-glass, high-temperature tubes and are the forerunners of a group rated at 300 C, instead of the present maximum of 220 C.

A pilot line of the tubes has been completed under a manufacturing methods contract by the Sylvania Electric Co., Emporium, Pa. The joint services requirements have been estimated at 100,000 tubes a month. The use of improved production techniques instead of laboratory methods has substantially reduced the cost of the tubes. They are designed for use on devices such as missiles, which require high-temperature ratings.

Nickel Oxide Standards Available

Two new nickel oxide powder samples, intended for checking and calibrating spectrochemical and chemical analysis of nickel, particularly cathode-grade material, are available from the National Bureau of Standards in 25 gm. containers. The sample standards are analyzed and certified for nine minor and trace elements.

Camera Marker Withstands 100 G's

A virtually "G immune" timing generator which can be designed to pulse at any rate from 1 to 3000 times per second will be used to establish a time base on the film of airborne data recording cameras.

Sandwich construction is achieved by placing subminiature tubes between fiberglass boards which bear the printed circuitry. In its present application, the units have a pulsed 150 v dc output which actuates a neon bulb. An "optical probe" conducts the light to the film and makes possible a sharply-defined timing mark.

Manufactured by the Electromation Co., 116 So. Hollywood Way, Burbank, Calif., the device can withstand loads in excess of 100 G's, high vibration levels, high altitudes, and temperature variations from —65 F to +185 F. Weighing 2-1/4 ounces it can be installed as an integral part of a recording camera.

Vanguard Essay Contest

An essay contest for college seniors and graduate students, with ten prizes totaling $12,000 plus duplicate prizes for the colleges, is being conducted by the Glen L. Martin Co.

Contestants may use any approach they wish, so long as their thoughts bear on some problem associated with the design, manufacture or use of orbital vehicles. Equally acceptable are papers on the non-technical aspects of satellite vehicles.

The purpose of the contest is twofold: to stimulate interest among engineering students in the comparatively new field of rocketry and its application to upper atmosphere research, and to point out the fact that the Martin Co. is interested in this phase of aviation and offers opportunities to outstanding engineering graduates.

FM Air to Ground TV

An experimental model of a uhf air-to-ground military television system was displayed by the Admiral Corp. 3800 Courtland St., Chicago 47, Ill. at the Army Association meeting in Washington D.C. Feature of the system is that frequency modulation is employed for picture transmission rather than conventional amplitude modulation.

CIRCLE 7 FOR MORE INFORMATION ➤

Nobel Physics Prize Awarded

For their development of the transistor, the 1956 Nobel Physics prize has been awarded to Dr. William Shockley, Dr. John Bardeen and Dr. Walter H. Brattain. The three men, who worked together at Bell Telephone Laboratories, will share an award of about $38,600 made under the will of Alfred Nobel, Swedish inventor of dynamite.

Dr. Shockley joined Bell Labs in 1936 as director of transistor physics. He resigned last year to become director of the Shockley Laboratory of Beckman Instruments, Inc.

Dr. John Bardeen, winner of many awards for his work in physics, was assistant professor of physics at the University of Minnesota from 1938 to 1941. He was principal physicist for the Naval Ordnance Laboratory from 1941 to 1945 when he joined Bell Labs.

Dr. Walter Brattain was born in Amoy, China in 1902 where his father taught in a private school. He joined Bell Laboratories in 1929. During World War II he worked with the National Defense Research Committee at Columbia University where he studied magnetic detection of submarines.

Computers Aid Heart Research

High speed electronic computers are working to defeat heart disease.

The computers, located at the Lockheed Missile Systems division, spend their spare moments between missile calculations in a fantastically detailed new study of the human heart's activity.

The heart studies are a cooperative effort by the missile division and Dr. Travis Winsor, eminent Los Angeles cardiologist, director of the Nash Cardiovasculuar Foundation.

The electronic computer makes it possible for the first time to analyze rapidly and accurately the human heartbeat in terms of contractions, flutters, valve actions and other motions.

Dr. Winsor said the use of such electronic equipment is the first major advancement in the accurate compilation of heart data in 50 years. The Nash-Lockheed program is one of the few cooperative industry-medical heart studies in the nation.

CIRCLE 8 ON READER-SERVICE CARD ➤

Autopilot Mockup

The automatic flight control system that controls and assists the nation's top-production supersonic jet fighter was shown for the first time in working model form at the Aircraft Electrical Society show in Los Angeles.

This "MB-3" system, which is manufactured by the Aeronautical Division of Minneapolis-Honeywell Regulator Company, is the first designed and manufactured for North American Aviation's F-100 Super Sabre.

Besides offering the usual stabilizing and pilot-assisting characteristics of an autopilot, the Honeywell system is integrated with a special navigational and weapons systems for the jet fighter.

Color TV Still A Question

Two conflicting statements by the leading receiver manufacturers have made the color TV receiver picture cloudier than ever.

It all began with GE President Ralph Cordiner's statement that color TV was not yet ready for the market (ELECTRONIC WEEK; Oct. 22). The statement brought a prompt and heated response from RCA Chairman David Sarnoff.

"Anyone," said Sarnoff, "who wants to wait until the wagon is rolling and then get on for a free ride should have the courtesy to remain silent."

While RCA keeps plugging away at its theme that now is the time for color TV, there is widespread disagreement in the industry as to just when color receivers will dominate the mass market.

Automatic Telephone Dialing

Automatic dialing of telephone numbers can now be done by an electromechanical device the size of a standard handset telephone. The device, known as a Dialaphone, is a product of the Automatic Electric Company, 1033 W. Van Buren St., Chicago, Ill. Up to 850 names and numbers can be placed on a coded tape-like "directory" operated by a small hand crank. To make a call, the tape is turned to place the desired name in a viewing frame. When a button is pressed, the number is automatically dialed.

◀ CIRCLE 8 ON READER-SERVICE CARD

World's Smallest Radar

Development of the world's smallest known radar set, with a maximum range of 6000 yards, has been announced by the Dept. of the Army.

The lightweight, portable set, built by the Sperry Gyroscope Co., Great Neck, N.Y., provides mobile Army forces with local battle area surveillance of enemy movements despite smoke, darkness or fog.

Lightness and ruggedness is attained by eliminating a cathode-ray tube and substituting audible signals.

Upper Atmosphere Research

Stanford Research Institute, Menlo Park, Calif., has been awarded a USAF contract to gather information about the effects of irregularities in the upper atmosphere on vhf and uhf radio transmission.

First phase of the program is being carried out in the hills immediately to the west of the Stanford campus. Observations and findings are expected to be utilized in the second portion of the program which will be continued in conjunction with the Geophysical Institute, University of Alaska, near Fairbanks.

Radio signal scattering and reflection by meteor trails in the 100 to 400 mc range and reflection of radio waves by the ionization associated with the Aurora Borealis will also be studied.

Earth Satellite Launching Vehicle

Critical tolerances constitute the outstanding manufacturing feature of the Vanguard launching vehicle which will attempt to place the world's first man-made satellite in its orbit 300 miles above the surface of the earth. When fueled for take-off, Vanguard will weigh approximately 11 tons.

Every pound of structural dead weight eliminated in a rocket yields an increase in the vehicle's attainable velocity. The vital importance of weight saving with a consequent velocity gain is apparent when it is considered that if the launching vehicle fails to attain the required initial altitude of 300 miles and a velocity of approximately 25,000 ft per second about 18,000 miles per hour) the satellite will fail to orbit, and will spiral down to earth.

Temperature up on Semi-Conductors

Semiconductors whose junction temperatures are limited to 150 C should soon be a "thing of the past." Recent work by United States Dynamics Corporation, Boston, Mass., has resulted in semiconductors having a storage temperature of 500 C and a conservatively rated operating junction temperature of 375 C. Up to now, announced maximum temperatures have been around 200 C storage and 150 C operating. Need for the use of relatively low-temperature solders has been largely responsible for the temperature limitation.

It is understood that the higher temperatures have been made possible not only by refinements in the manufacturing process but also by forming an environmental surface barrier around the junction area.

Recent announcements of 300 C power rectifier developments by Automatic Manufacturing of Newark, N.J., a Division of General Instrument Company, further accentuates the scientific advance heralded here. Higher-power silicon transistors and diodes are assured, and are coming none too soon for many critical applications.

It should be emphasized that the 500 C temperature units reported are still somewhat in the laboratory stage, yet, there is every reason to believe that in a few months limited production quantities will be available.

Non-Degaussable Magnet

A permanent magnet, which is difficult if not impossible to demagnetize, is now in the laboratory stage. The process, developed at General Electric, consists of encasing ferromagnetic cobalt in an anti-ferromagnetic case of cobaltous oxide. This shifts the hysteresis loop completely to the left of the zero axis in the second and third quadrants.

So far the tests have been made at below room temperature (the temperature of liquid nitrogen); but it is expected in time to be entirely practical at ordinarily encountered temperatures. The cause of this effect between the ferromagnetic and anti-ferromagnetic materials is known as "exchange anisotropy."

CIRCLE 10 ON READER-SERVICE CARD ➤

Letters to the Editor

Reflex Circuit

Dear Sir:

My colleague, W. A. Higinbotham, and I were highly amused with the article on page 36 in the October (1) issue of ELECTRONIC DESIGN, entitled "Pentode Does Two Jobs." We are afraid we must really be getting old when the reflex circuit can be resurrected without being recognized. If memory serves me it was 1925 when it was the rage.

J.B.H. Kuper
Brookhaven National Lab.

Dear Sir:

The article in the October 1, 1956 issue of ELECTRONIC DESIGN, "Pentode Does Two Jobs," leaves me wondering how the application described differs in principle from the "reflex" radio receivers of the early 1920's. In these receivers, tubes in the rf stages were used jointly as audio amplifiers. A short discussion of reflex amplifiers appears in "Radiotron Designer's Handbook," third edition, chap. 21, published in 1941. The circuit discussed in this chapter uses a pentode and is essentially similar to that described in the article referred to above.

Fred West
Bell Telephone Labs.

Messrs. Kuper and West are right. The "reflex circuit" is so old it had been all but forgotten. However, as far as we know this is the first application to commercially available television receivers. Where a large segment of our readership may be interested in a practical circuit application but unfamiliar with its availability, we feel we are rendering a useful service by publishing the information in ELECTRONIC DESIGN.

Derivations

Dear Sir:

Regarding Mr. Lange and derivations (Oct. 1), it seems to me a logical solution is to offer, upon request to your office, duplicated sheets with derivations relating to the particular article. This would preclude the use of important *ED* space and yet satisfy those who want the full analysis. Many books employ a system of "appending" material of a derivative nature (although in this case, probably more for continuity than anything). Adopting this system should satisfy most readers.

Kenneth G. Leib
Sylvania Electric Products Inc.

Washington Report

Herbert H. Rosen

In and around Washington

Four national meetings held in the Washington Area during the month of October.

Association of the U.S. Army: The AUSA theme was the FUTUR-ARMY. Gen. Medaris emphasized the direction the Army was going in the missile field. It looks like the range will be at least 1500 miles in the immediate future.

Wehrner Von Braun envisioned manned space satellites circling the globe at about 1700 miles within the next 4 or 5 years. He saw missiles being guided and controlled to their targets by crews perched in their satellites far above the earth.

Edward Teller, master-mind of the H-Bomb, predicted small independent units fighting the next war. Each unit would be self-sufficient and equipped with nuclear weapons and several varieties of launchers.

Symposium on Electron Devices: This IRE Professional Group had more than 1000 people present to hear more than 60-odd papers. Dr. William Shockley predicted that 1962 would see the 25 cent transistor. Other predictions from other speakers included production of 40 million transistors next year and frequency cut-off in excess of 1000 mc. Also discussed was a new 24 hour regenerative type storage tube which could be read out indefinitely with no fading.

Symposium on the Physics of Semiconductors: The meeting sponsored by NBS and NRC groups drew some 200 engineers and physicists to hear some 22 papers. The topics covered mostly the theoretical aspects of semiconductors and the results of the experiments (where they were conducted) of the application of these theories.

Aero and Navigational Electronics: Feature of the meeting was a talk by Assistant Secretary of the Air Force Richard E. Horner. He emphasized the qualitative superiority the Air Force is hoping to attain through a careful selective process in its R&D Programs. What this means is that a penetrating scrutiny will precede each stage of a program before it is allowed to continue. At any time a program may be stopped if progress to date does not show that future work will allow it to fit into the overall scheme of the Air Force's mission. Many basic research programs, therefore, will survive for some time as long as they show promise and cost little more than salaries. But when the activity passes through applied research and into development—and therefore a more costly phase—selectivity will be applied where necessary.

Meetings

Dec. 3-4: Second Midwest Symposium on Circuit Theory.
Michigan State University. Symposium will consist of four sessions: Topology and Circuit Theory, System Analysis and Synthesis, Circuit Theory and Applications, and the Place of Circuit Theory in Education. A talk on "Engineering Education for the Future" will be given by Dr. J. D. Ryder on Monday evening. Papers will also be presented by engineers in the education field. Contact for further information, IRE, 1 West 79th St., N. Y., N. Y.

Dec. 5-7: Second IRE Instrumentation Conference.
Biltmore Hotel, Atlanta, Ga. Sponsored by the Professional Group on Instrumentation and the Atlanta Section of the IRE. Sessions will be devoted to industrial applications, missile range instrumentation, and the application of solid state devices. For further information, contact the IRE, 1 E. 79th St., New York, N. Y.

Dec. 10-12: Eastern Joint Computer Conference.
Hotel New Yorker, New York, N. Y. Sponsored by the IRE, AIEE, Association for Computing Machinery. "New Developments in Computers" is the theme of the meeting. In addition to an extensive program of technical papers, the meeting will feature exhibits by many manufacturers in the computing field. For information, contact Al Forman, Room 639, 480 Lexington Ave., New York 17, N. Y.

Dec. 12: Information Theory and the Written Word.
New York Academy of Science, New York, N. Y. Lecture discussion by J. R. Pierce. Sponsored by the New York Chapter of Technical Writers and Editors. For more information, write to J. A. Lippke, ELECTRONIC DESIGN, 19 E. 62nd St., New York 21, N. Y.

Dec. 19-20: RETMA Symposium on Applied Reliability.
Bovard Hall, University of Southern California, Los Angeles, Calif. Sessions on Mechanical Reliability, Information Feedback, Component Evaluation Usage will be presented. "Failure Feedback —Is It Effective" is highlight of the meeting. Registration in advance is $3.00. Further information received from RETMA Engineering Office, Room 650, 11 West 42nd St., New York 36, N. Y.

Dec. 26-27: American Association For the Advancement of Science.
Statler Hotel, New York, N. Y. General theme of program on the Aids for Environmental Control. Various discussions will be held. For further information contact the American Association for the Advancement of Science, 1515 Massachusetts Ave., N.W., Washington 5, D. C.

Jan. 9-11, 1957: Symposium on Communication Theory and Antenna Design.
Boston University, Boston, Mass. Sponsored by the Air Force Cambridge Research Center and Boston University. For information, contact Miss Alice Cahill, Air Force Cambridge Research Center, Air Research and Development Command, Laurence G. Hanscom Field, Bedford, Mass.

Jan. 14-15, 1957: Third National Symposium on Reliability and Quality Control in Electronics.
Hotel Statler, Washington, D. C. Sponsored jointly by the IRE Professional Group on Reliability and Quality Control, the American Society for Quality Control, the American Institute of Electrical Engineers, and RETMA. For information, write to IRE, 1 E. 79th St., New York 21, N. Y.

Jan. 16-18: Society of Plastics Engineers, Inc., Thirteenth Annual Technical Conference.
Sheraton-Jefferson Hotel, St. Louis, Mo. Sixty-eight advanced technical papers will be presented. For further information contact Jas. R. Davidson, Executive Secretary, Society of Plastics Engineers, Inc., Suite 116-18, 34 East Putnam Ave., Greenwich Conn.

Jan. 21-25: Annual AIEE Winter General Meeting
Hotel Statler, Sheraton McAlpin New York, N.Y. Information to be available at a later date.

Jan. 23-25, 1957: Very Low Frequency Symposium.
NBS Boulder Laboratories, Boulder, Colo. Co-sponsored by the Denver-Boulder chapter of the IRE PGAP and the Boulder Laboratories, National Bureau of Standards. The program is titled "Theoretical and Experimental Results in the Propagation and Radiation of Very-Low-Frequency Electromagnetic Waves (less than about 100 kc)." Authors are being requested to submit summaries for appraisal as soon as possible to Dr. J. R. Wait, Chairman, Denver-Boulder PGAP Chapter, National Bureau of Standards, Boulder, Colo. For further information, contact U. S. Dept. of Commerce, NBS, Boulder Laboratories, Boulder, Colo.

February 5-7: Twelfth Reinforced Plastics Division Conference.
Edgewater Beach Hotel, Chicago, Ill. Latest developments in both technical and practical aspects of reinforced plastics. Subject matter will range from reports on research and testing to product design to production methods to marketing techniques. A complete program, listing papers and speakers, registration forms for the three day Conference and hotel reservation blanks will be available after December 26. Those interested should write now to The Society of the Plastics Industry, Inc., 250 Park Ave., New York 17, N. Y.

Feb. 7: Annual Symposium of the New York Section of the ISA.
Garden City Hotel, Garden City, N. Y. Short papers on "Practical Accuracy of Measurement" will be presented followed by a discussion. Afternoon session will be on "Data Handling." For further information contact G. Newberg, Publicity Chairman, Fairchild Engine Division, Fairchild Engine & Airplane Corp., Deer Park, L. I., N. Y.

Feb. 7: Operations Research Symposium.
University Museum Lecture Hall, University of Pennsylvania. Sponsored jointly by the Professional Group on Engineering Management of the Philadelphia Section of IRE and the Society of Industrial and Applied Mathematics. Major theme will be Mathematical Models in Management Decision Making. Contact Haydn Ringer, 1303 Highland Ave., Palmyra, N. J.

February 14-15: 1957 Transistor and Solid State Circuits Conference.
University of Pennsylvania, Philadelphia, Pa. Sponsored by the Institute of Radio Engineers, American Institute of Electrical Engineers, and the University of Pennsylvania. For further information contact G. H. Kunstadt, Radio Corporation of America, Defense Electronic Products, Camden 2, N. J.

Feb. 26-28: Western Joint Computer Conference.
Statler Hotel, Los Angeles, Calif. The Conference is under the joint sponsorship of the IRE, AIEE, and ACM. Theme of the meetings will be "Techniques For Reliability." For further information contact S. Dean Wanlass, Aeronutronic Systems, Inc., 13729 Victory Blvd., Van Nuys, Calif.

March 11-15: The 1957 Nuclear Congress
Convention Hall, Philadelphia, Pa. Exhibits and conference sessions covering latest developments relating to the utilization of atomic energy in its various non-military forms for civilian use. For further information contact Atomic Exposition Office, 304 Architects Bldg., Phila. 3, Pa.

March 18-21: The 1957 SPI Annual National Conference and Pacific Coast Plastics Exposition.
Hotel Biltmore, Los Angeles, Calif., sponsored by the Society of the Plastics Industry, Inc. Sessions will cover plastics in the fields of electronics, aircraft and defense, building, and processing. Exposition will be held at the Shrine Exposition Hall. Further information may be obtained from the Society of the Plastics Industry, Inc., 250 Park Ave., New York, N. Y.

April 8-11, 1957: Fourth National Electrical Industries Show.
71st Regiment Armory, New York, N.Y. Sponsored by the Eastern Electrical Wholesalers Association. For more information, contact William S. Orkin, Co-Producer, The American Electrical Industries Expositions, Inc., 19 W. 44th St., New York, N.Y.

April 11-13, 1957: Southwestern IRE Conference and Electronics Show.
Houston, Texas. Sponsored by the Houston Section of the IRE. This conference will be augmented by the National Simulation Conference which will be sponsored by the IRE Professional Group on Electronic Computers. For information, write to Ninth Southwestern IRE Conference and Electronics Show, P. O. Box 1234, Houston 1, Texas.

May 16-18: Eighth Annual Conference and Convention, American Institute of Industrial Engineers.
New York City, Hotel Statler. For information write to AIIE, P.O. Box 8, Substation 135, The Bronx 53, New York.

Transistor Thermal Resistance Measurement

Bernard Reich
Signal Corps Engineering Lab
Fort Monmouth, N. J.

THE method described here for the measurement of thermal resistance of power transistors lends itself to rapid determinations. It excludes the need for prior transistor calibrations which are often very time consuming. This type of measurement is also applicable to silicon devices with monor modification.

It is necessary to know the junction temperature while the unit dissipates power so that reliability on the basis of manufacturers' data is assured. In addition, this information is needed when the transistor is encased in a final package for accurate analysis. Estimation of junction temperatures based on initial saturation and collector cut-off currents are made.

Considering a triode junction transistor operating with normal bias, the dc base current can be considered in terms of two currents, the collector cut-off current, I_{CO}, and the normal base current, $(1-\alpha)\, I_E$ as,

$$I_B = (1-\alpha)\, I_E - I_{CO}$$

Considering the above equation, when I_E equals zero, the base current consists of the I_{CO} component only. Utilizing this information, it is then possible to measure the value of the "hot" I_{CO}. This is done primarily by taking the transistor and mounting it on a hollow copper block through which water, at a controlled temperature, is circulated. This places the case or stud at some fixed temperature. A block diagram of the system is shown in Fig. 1.

If we assume that I_{CO} consists of two components, namely, a saturation component and a leakage component, in accordance with the following equation:

$$I_{CO} = I_S + I_L$$

It is known from experimental work that the saturation component of I_{CO} varies approximately 9% per degree C and from previous work done by the author, it has been found that the leakage component for germanium devices does not vary with temperature for the practical purposes of this measurement. From this data, it is then possible to estimate the junction temperature value for the thermal resistance measurement. For example, let us assume that the value of I_{CO} at 28 v is 0.5 ma. Let us assume further, that the saturation component of I_{CO} as measured at a collector to base voltage of 2 v is .09 ma. This makes the leakage component of I_{CO} 0.41 ma. Let us assume for simplicity that this measurement was made at 25 C, and that for the thermal resistance measurements we will operate at a junction temperature of 70 C. The saturation component of I_{CO} will increase by a factor of approximately 16, yielding a saturation component at 70 C of 1.44 ma and a total value of I_{CO} at 70 C of 1.85 ma. Thus, it is possible to go ahead and raise the junction to this value of approximately 70 C with a resultant I_{CO} of 1.85 ma.

The circuit for measuring junction temperature is shown in Fig. 2. It consists of a constant voltage supply in the collector circuit which is in the form of a battery supply. It has been the experience at this laboratory, that 28 v is a convenient operating voltage in the collector circuit. A measuring resistance is inserted in the base circuit across which a cathode ray oscilloscope displays the appropriate wave forms. It has been the experience that a 200 ohm resistance is sufficient for measurement purposes and that a Tektronix Scope #531 or equivalent is used for displaying the base current wave form. The collector voltage and collector current are monitored during the measure-

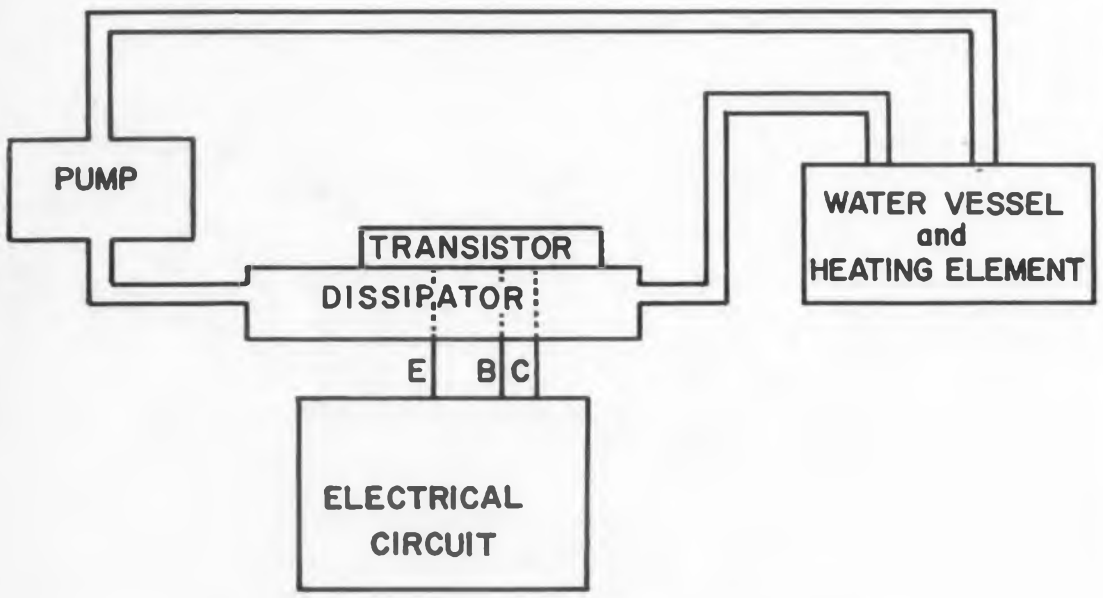


Fig. 1 Block Diagram of Thermal Measurement System

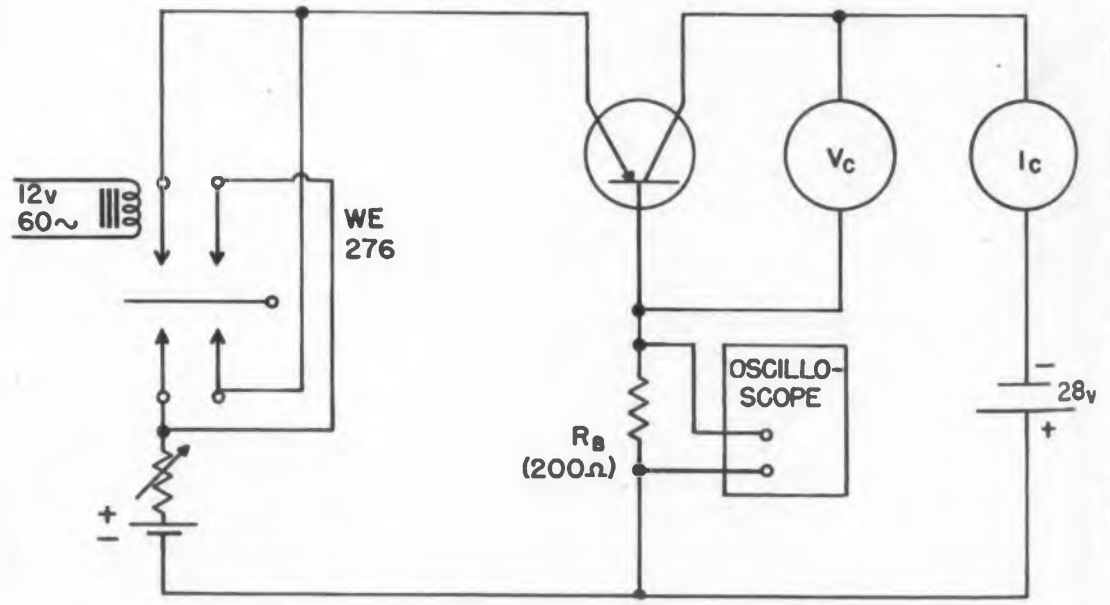


Fig. 2 Thermal Resistance Measuring Circuit

ment period to determine the transistor power. In the emitter circuit, it is noted that we include an emitter supply in the form of batteries, and a Western Electric relay, Type 276, which is hooked up in the manner shown in Figure 2. The relay is on for approximately 15 milliseconds and off for 3 milliseconds, as this latter time is the break time of the relay.

Returning to the transistor mounted on the copper dissipator, through which water is flowing at 25 C, we now raise the junction temperature to 70 C by increasing the emitter current and producing resultant collector power. The amount of emitter current is increased until an I_{CO} of 1.85 ma multiplied by 200 ohms in the base circuit, or 370 mv appears across the 200 ohm, measuring resistor. This establishes one point on the transistor derating curve shown in Fig. 3.

The temperature of the water is now increased to a higher temperature. Let us say, 45 C by either using another vessel or heating the fluid in the existing vessel. Again power is dissipated in the transistor until we again read 370 mv across the measuring resistor. This establishes the second point on the derating cover. If it is assumed that it was necessary to inject X watts at the 25 C dissipator temperature to raise the junction to 70 C and Y watts at 45 C dissipator temperature for the same junction temperature, then the value of thermal resistance is

$$\frac{(45-25)^\circ C}{(X-Y)\text{ watts}} \quad \text{or} \quad \frac{20}{X-Y} \quad \text{degrees C per watt}$$

The resultant method has been applied mainly to germanium power transistors and has yielded excellent results. The range of thermal resistances measured has been between 0.3 to 8 C per watt. The method lends itself to rapid thermal measurements and could also be used to determine the thermal time constant of the junction. Several companies have adopted this technique with success and it is suggested that the industry in general examine this method as a possible standard for thermal resistance determination.

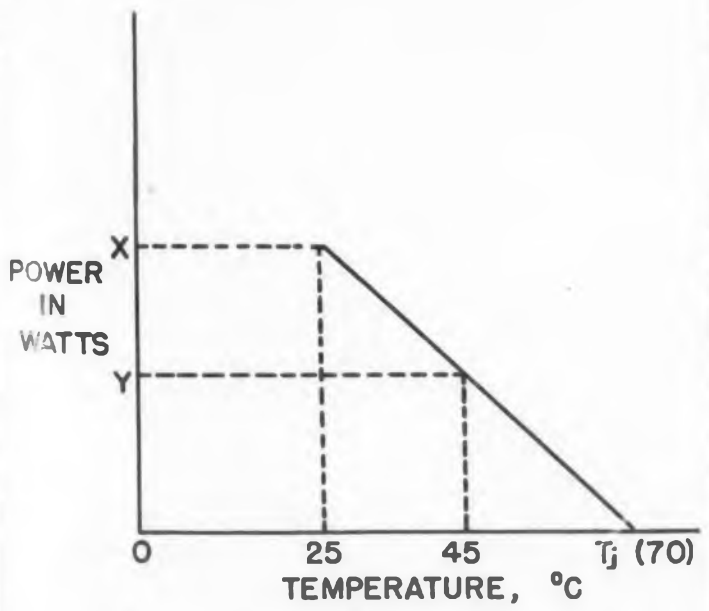
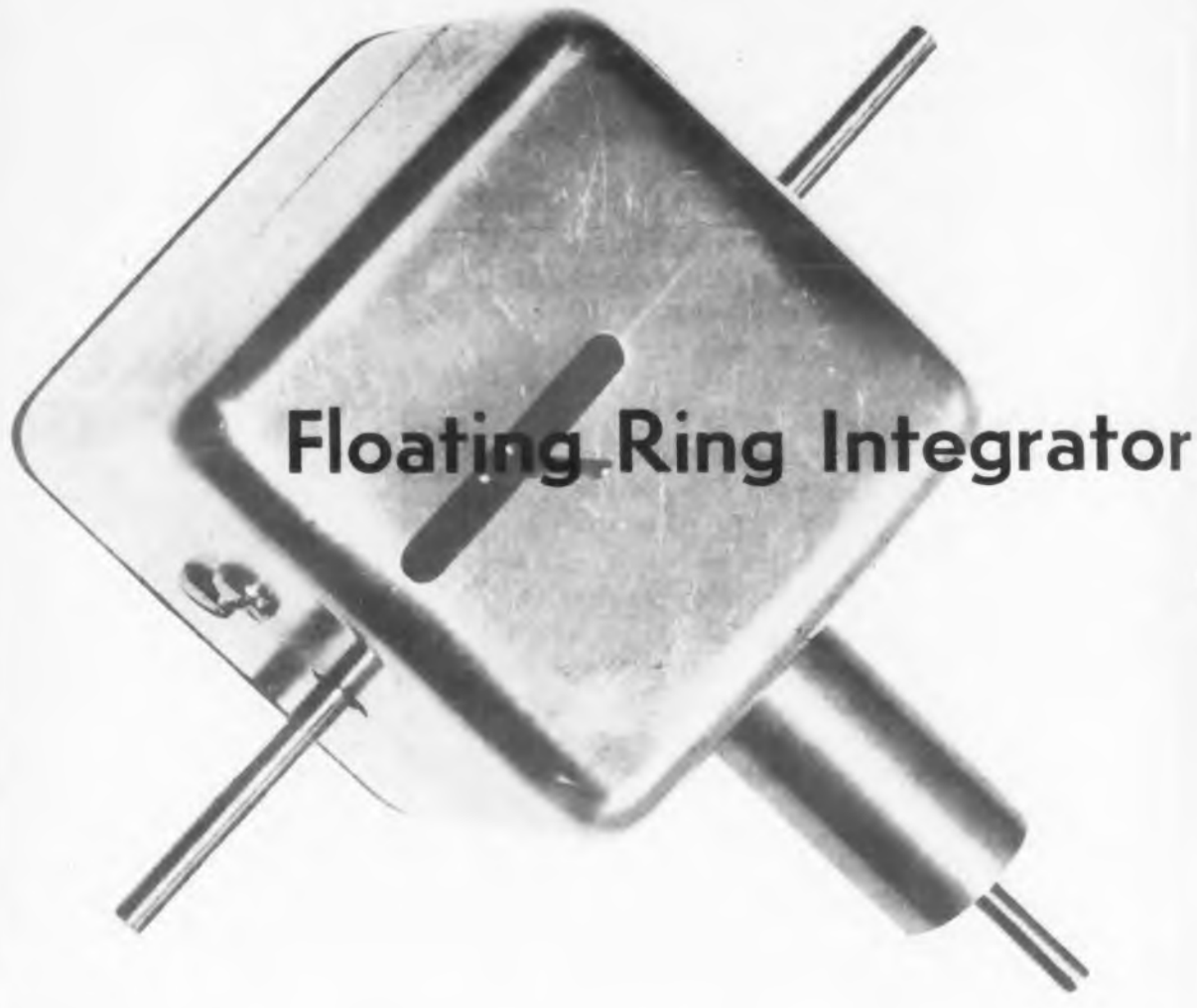


Fig. 3 Power Transistor Derating Curve



Floating Ring Integrator

CONTRASTED to the ball and disk types now commercially available, this floating ring integrator can be controlled from a minute force acting through a small distance. The force required to actuate the control yoke on the ring is less than 0.5 grams. Forces of this magnitude are directly available from standard instrument type pressure spirals and filled thermometer elements. In many applications it eliminates the need for electronic amplifiers and servo mechanisms because of its low control power requirements and its mechanical power amplifying characteristics.

The integrator, designed and developed by the Optimum Engineering Co., 2017 Willow Street, Grand Prairie, Texas, operates by moving the control yoke, which causes the ring to tilt about the axis of the drum, as would occur when the measured variable changed. The ring will then move along the drum and on the face of the disc until it is aligned under the controlled point of the yoke, and is perpendicular to the axis of the drum. This alignment is automatic. The output speed of the drum shaft relative to the input speed of the disc varies in direct proportion to the ring's position from the center of the disc. Since the ring rotation would be zero at the center, it would be difficult to move it from that position. Excessive wear would also occur on both the disc and the ring. To prevent the ring from moving to the center of the disc, a physical stop is employed which limits the travel of the ring. Normally, the ring may be positioned within .01 of the disc's center.

The relation existing between the input shaft speed and the output shaft speed may be expressed by the following formula:

$$\theta_o = (\theta_i)\,(d)\,(k)$$

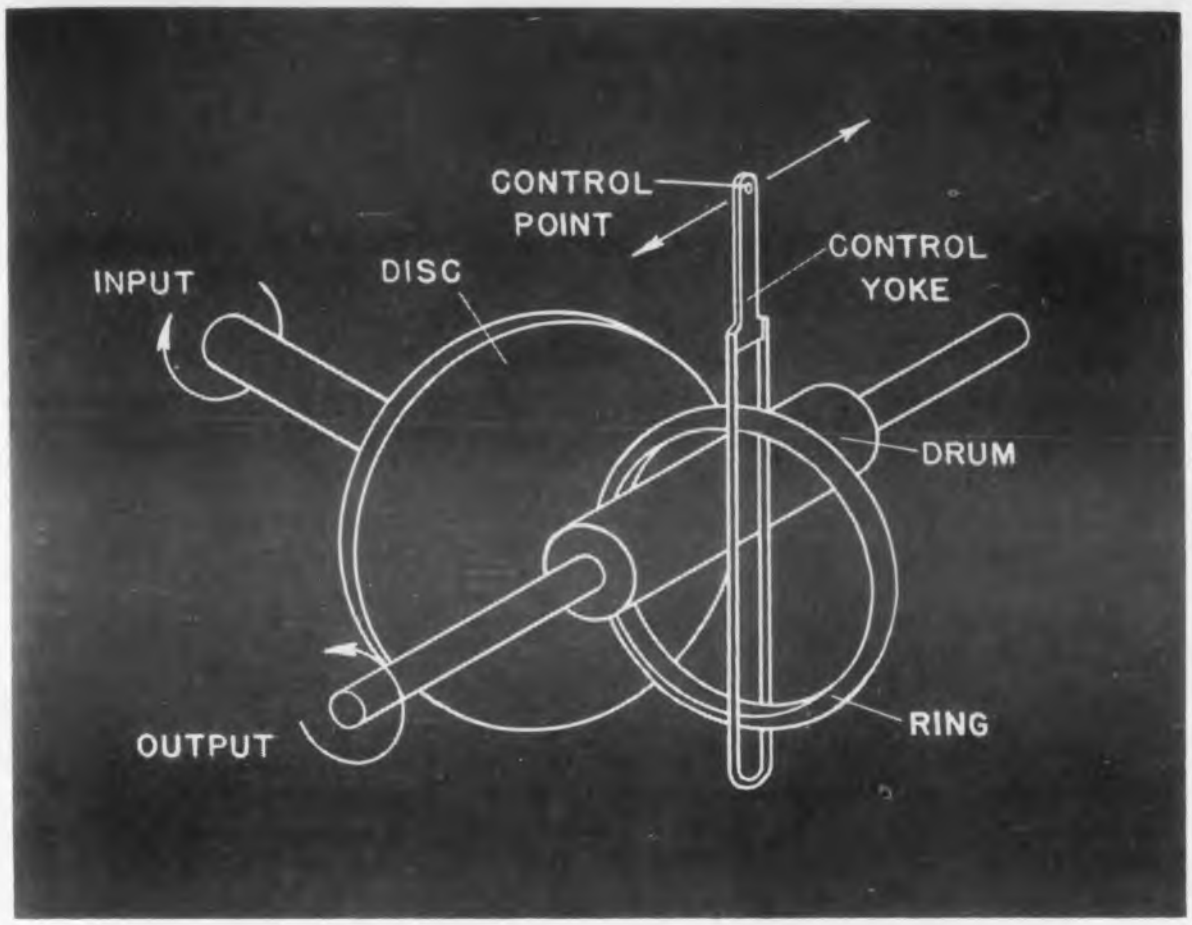
where: θ_o is the angular travel of the output shaft, θ_i is the angular travel of the input shaft, d is the distance from the center of the disc to the point of contact with the ring and k is a constant.

Evaluation of the constant k is as follows:

$$k = \frac{2D_2}{D_1 D_3}$$

where: D_1 is the diameter of the drum, D_2 is the inside diameter of the ring, and D_3 is the outside diameter of the ring.

The integrator can operate in any position. Normally, however, the integrator runs



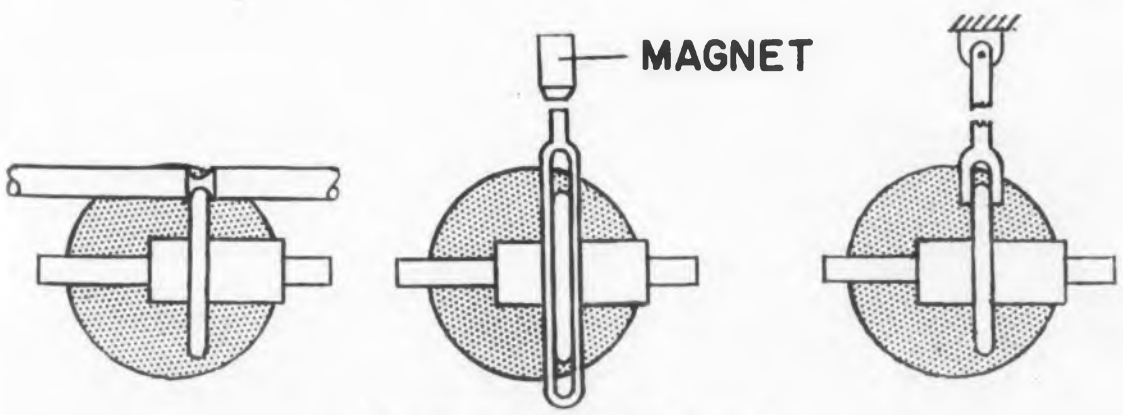
Pictorial diagram of Floating Ring Integrator. Motion is imparted by the disc to the drum through the ring, which makes only point contact with the disc, and is held between the disc and the drum by spring loading of the disc.

in an oil bath which is contained in the lower half of the cover, and the unit should be mounted horizontally to take advantage of the oil bath lubrication which assures longer life.

The rate at which the ring will reposition itself varies as its distance from the center of the disc and the speed of the disc itself vary. The degree of tilt of the ring, and the direction it is moving relative to the center of the disc also affect the repositioning rate. Generally the time required for repositioning is under one second, except for very low disc speeds.

A standard model of the Floating Ring Integrator is available with a constant k of 2.830. The unit is 6 in. x 4 in. x 3 in. including shaft extensions. By varying the design ring, integrators can be built with constants ranging from less than 0.1 up. Output torque is 3-in. oz max. More spring loading can be added if necessary.

For more data about this product, fill Reader's Service Card and circle 19.



Alternate methods of Ring Control

cppc SIZE 8 SYNCHROS FOR ACCURACY • RELIABILITY • LESS BULK • LESS WEIGHT

In our new size 8 series of synchros shown below, we are guaranteeing accuracies of 7 minutes or less from EZ.

In no other synchros is such accuracy packed in so light and small a package. Length from face is 1.240" and weight 32 grams.

Write or telephone us your requirements (MAdison 6-2101, Suburban Philadelphia).

Look to CPPC for Synchro Progress

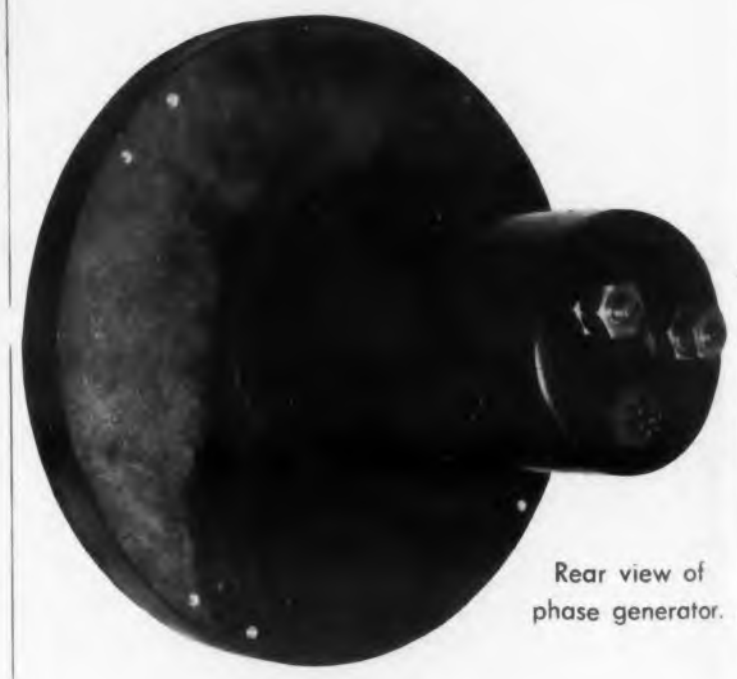
CLIFTON PRECISION PRODUCTS CO., INC. Clifton Heights, Pa.

STANDARD UNITS		ROTOR						STATOR						IMPEDANCE							
SYNCHRO FUNCTION	CPPC TYPE	Input V400cy	Input Amps	Input Watts	Ohms (DC)	Output Rotor	Sensitivity (MV/deg.)	Output Volts	Sensitivity (MV/deg.)	Input Volts	Input Amps	Input Watts	Ohms (DC)	Zro	Zso	Zrss	Phase R-S	Shift S-R	Nulls (MV)	Possible Error	Spd.	Length in inches
Torque Transmitter	CGC-8-A-7	26.0	100	.5	37	—	—	11.8	200	—	—	—	12	54+j260	12+j45	76.4+j19.6	8°	—	30	7′	14′	1.240
Control Transformer	CTC-8-A-1	26.0	.050	.25	143	24	410	11.8	200	11.8	.090	.23	25	220+j740	28+j110	246+j60		8.5°	30	7′	14′	1.240
Control Transformer	CTC-8-A-4	—	—	—	381	24	410	—	—	11.8	.037	.09	60	508+j1680	67+j270	640+j190	—	9.2°	30	7′	14′	1.240
Control Differential	CDC-8-A-1	—	—	—	36	11.8	200	—	—	11.8	.085	.21	25	38+j122	27+j120	48.6+j13.8	—	9°	30	7′	14′	1.240
Electrical Resolver	CSC-8-A-1	26.0	.039	.43	230	23.2	400	10.6	180	11.8	.084	.27	27	280+j600	38+j136	70+j136	20°	11°	30	7′	14′	1.240
Torque Receiver	CRC-8-A-1	26.0	.100	.50	37	—	—	11.8	200	—	—	—	12	54+j260	12+j45	85.1+j20.4	8°	—	30	30′	30′	1.240

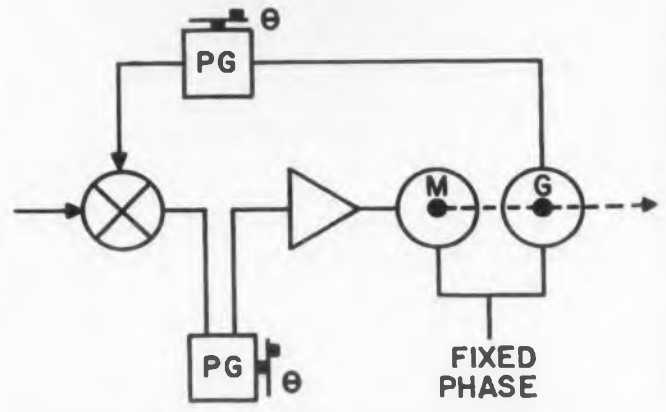
CIRCLE 21 ON READER-SERVICE CARD FOR MORE INFORMATION

Phase-Shift

SIMPLE, accurate phase shifting is made possible by this electro-mechanical device of unlimited life and stability. It can rotate the time phase of any single fixed frequency over 360 degrees and display it upon a dial to an overall accuracy of 12 min. of arc. This makes it particularly applicable to ac Servo synthesis problems.



Rear view of phase generator.



Servo-Loop with two Phase Generators inserted in order to experimentally determine the carrier phase shift required for proper loop operation.

Using no active components, the PG-2 phase generator, made by the Theta Instrument Corp., 204 Market St., East Paterson, N.J., has only three basic parts; an inductive synchro-resolver, a 90 degree time-phase shift network, and a geared dial. The input voltage is passed through the phase-shift network to excite the stator (instead of the rotor) of the synchro-resolver, thereby increasing the phase-shift accuracy. The output voltage is taken off the rotor by the usual brush and slip-ring assembly. Due to low current output and low speed, brush life is practically unlimited.

The phase generator can be applied in the design of ac Servo systems where input, feedback, and reference signals must be accurately phased. In this case the required phase shift is read on the dial and a fixed network can be designed accordingly. It can also be applied to measure the phase of an unknown voltage, by using a bridge transformer and a null-reading VTVM. If used in conjunction with a phase-sensitive detector where the phase reference is not readily available, the phase generator, excited by a fixed voltage source, can be set to any desired phase and used as a reference.

The output voltage is constant, as the attenuation between input and output is a fixed parameter which does not vary with the phase rotation. Since the input frequency is rather critical for any given unit, an adjustment is provided to compensate for any small variations in frequency. Standard models are designed for carriers of 60 cps and 400 cps, but special units can be produced to operate at any one frequency between 30 cps and 150 kc.

No calibration or alignment procedure is required prior to use. Since all the elements within the assembly are passive, the unit is rugged, stable, and long-lived.

For further information about this product, fill out Reader's Service Card and circle 22.

CAPABLE of being tripped by a single pulse in less than 70 milliseconds, this four-arm waveguide switch for microwave relay service can be applied to standby operations, or used for switching the direction of transmission.

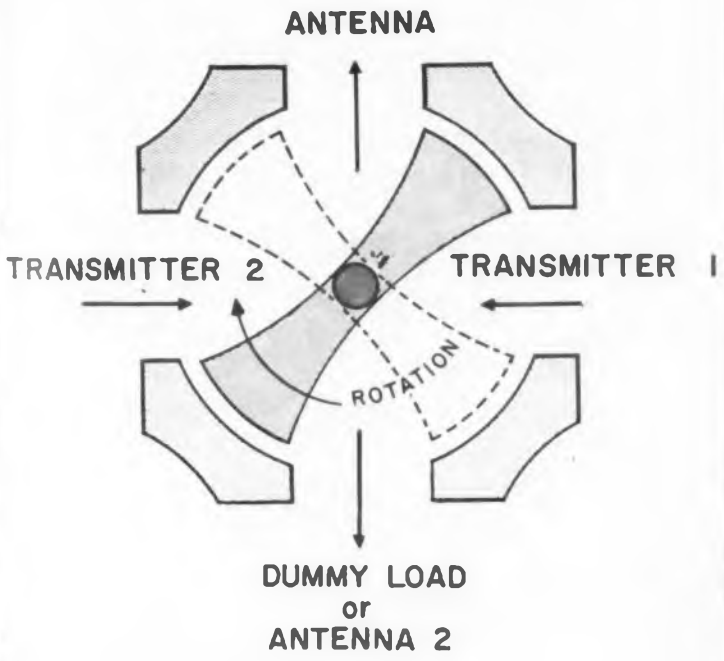
Covering the frequency range between 5900 and 8200 mc, the NRK No. 28900 rotary switch has been developed for use with the RG-50/U waveguide by the N. R. K. Mfg. & Engineering Co., 4601 W. Addison St., Chicago 41, Ill.

When used for standby service, two arms can be connected to signal inputs, a third arm connected to the antenna, and the fourth arm terminated in a polyiron load. Either of two signals can then be switched to the antenna while the other signal is switched to the polyiron load. For application in reversing direction of transmission, two antennas can be connected to two opposite arms of the switch, and two channels connected to the other two opposite arms. Four polyiron loads are supplied with the switch to cover the full frequency range. The maximum voltage standing-wave ratio for a standby arm terminated in any one of the loads is 1.15, while the maximum VSWR from either signal arm into the antenna is 1.10. Crosstalk is greater than 40 db.

Rotary Waveguide Switch

Constructed of aluminum, the four-pound switch requires an actuating voltage of 80 to 110 dc or it can operate on ac with additional selenium rectifiers. A selector switch is mounted on the waveguide switch shaft for remote indication of switch position.

For further information about this product fill out the Reader's Service Card and circle **No. 25.**



Background for Designers

Insulation Resistance of Capacitors

George Mistic
Director of Research
Condenser Products Co.
Division of New Haven Clock & Watch Co.
New Haven, Conn.

THIS article shows the common methods by which leakage resistance of capacitors is measured, and gives applications to show where a knowledge of this factor will aid the circuit designer in overcoming shortcomings of circuit operation.

The insulation or leakage resistance of a capacitor (IR) is the applied voltage divided by the effective leakage current flowing through the dielectric. The applied voltage can be constant, transient or sinusoidal. However, for IR values, voltages are applied for a certain length of time. The resulting IR (megohms) is multiplied by the capacitance (microfarads). This yields a quality factor—megohms times microfarads. Usually capacitor manufacturers designate capacitance values of 0.01 μf and greater in Meg μf and in megohms for capacitance values below 0.01 μf. All ratings are at room temperature. In this way capacitor IRs can be directly compared.

Capacitor Equivalent Circuit

The capacitor equivalent circuit has not only a capacitance shunted by a constant resistance value but is also shunted by a complex impedance which includes effects of ion migration, dielectric polarization, voltage, time, self inductance, etc. For practical use, one can gain a working knowledge of IR by observing the common factors which affect it and methods of its measurement.

Insulation Resistance and Circuit Operation

The most common troubles of circuitry are related to poor insulation resistance of capacitors. The effects of external influences such as radiation from radio active sources, humidity, dust, etc., can be alleviated through shielding, dessicating and air conditioning the surroundings. However, the major cause of low leakage resistance is directly related to the type of dielectric used, as will be shown. The remaining factors —such as dielectric absorption, dissipation factor and frequency—although seemingly bearing no relationship to IR, do affect IR but are usually separately measured.

Methods of IR Measurement

1. Basically, resistance can be determined from calculation of the leakage current and applied voltage (Fig. 1). It is, therefore, only necessary for the instrument to determine this leakage current in terms of the voltage drop across a precision resistor at any time during which the voltage is applied. Instruments using this principle are marketed as Megohmmeters, Ultra-Ohmeters, etc., and incorporate dc amplifiers, self contained dc voltage sources and indicating meters which give direct ohm readings to 10^{15} ohms with a maximum

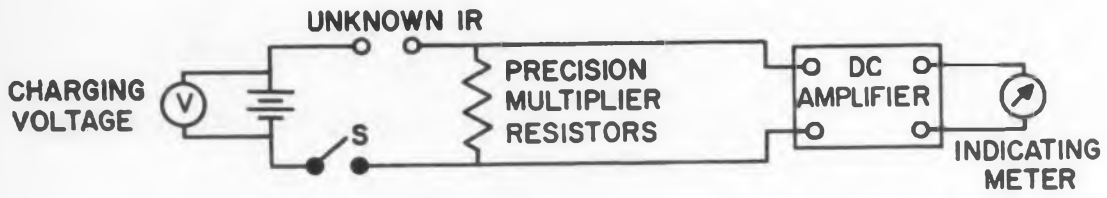


Fig. 1. Megohmmeter Circuit

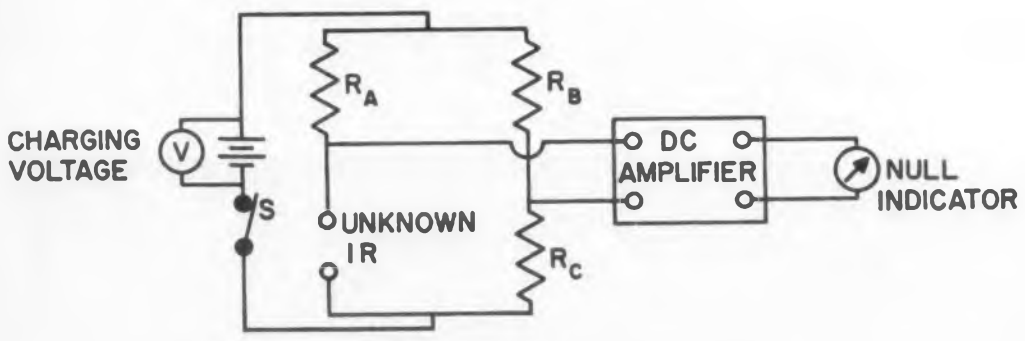


Fig. 2. Comparison Method. Wheatstone Bridge.

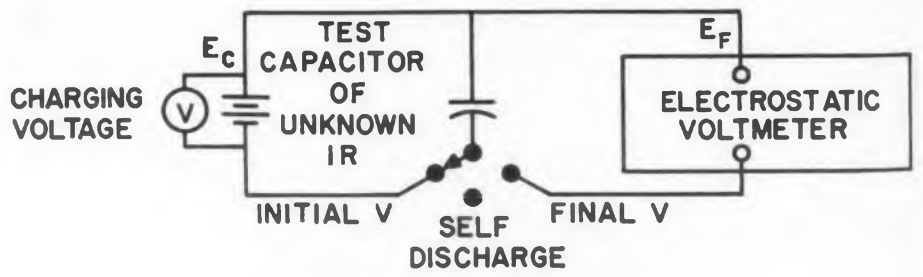


Fig. 3. Self Time Constant Method.

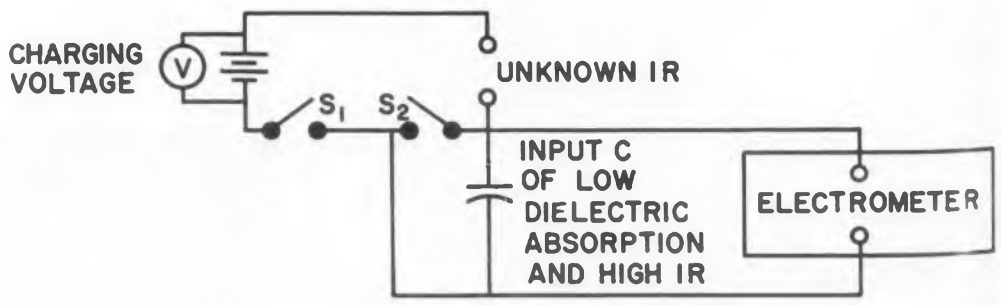


Fig. 4. Rate of Change Method Using Electrometer.

error of plus or minus 5%.

2. Another type of apparatus using a comparison method incorporates a null detector indicating a balance with a known resistance in a Wheatstone bridge arrangement (Fig. 2). With this method resistance values of 10^{14} ohms can be detected with a maximum error of plus or minus 6%.

3. The self time constant method is employed in those instances where a capacitor is required to hold a charge for several thousand hours (Fig. 3). In this method the capacitor is charged from a well regulated dc voltage source for a length of time sufficient to overcome effects of dielectric absorption (usually one hour), and the capacitor is allowed to discharge through its own volume and surfaces for a length of time selected to yield a final voltage at least 25% less than the initial charging voltage. The resistance is then calculated from the basic transient equation:

$$E_{final} = E_{initial\ e} - t/RC$$

A high resistance electrostatic voltmeter is used to measure the final voltage on the capacitor electrodes.

4. The rate of charge method (Fig. 4) employs an electronic electrometer, dc charging source, and an input capacitor in series with the capacitor whose resistance is to be measured. The leakage resistance is calculated from the time of charge of input capacitor voltage as measured with the electrometer. Maximum error is about the same as when using the Megohmmeter circuit (Fig. 1).

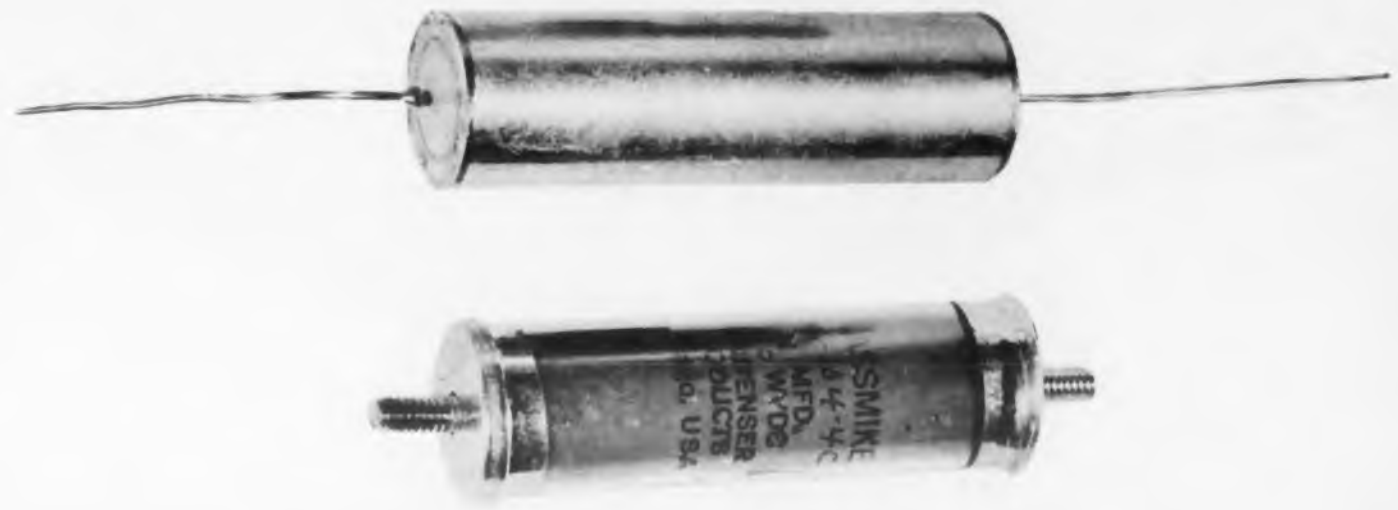
5. Other methods of testing include specialized instruments such as "Meggers" incorporating two current coils in an electromagnetic field, serviceman's ohmmeters, and leakage testers using pulsed voltages for rapid checking of capacitors without disconnecting them from the circuit. The first four methods are more generally used in laboratories and for production testing by the capacitor manufacturer.

Although the diagrams of the measuring circuits 1, 2 and 4 do not so indicate, it should be pointed out that facilities are provided to bypass the heavy initial surge of charging current for a time not exceeding two seconds, whereupon the effective leakage resistance is then measured. This IR will be continuously increasing with continued application of the charging voltage source due to dielectric absorption (interfacial polarization and migration of ions). The applied charging voltage usually used is between 100 and 500 v dc.

Factors Affecting Insulation Resistance

IR is dependent upon several factors: 1. applied voltage; 2. time of application of voltage; 3. temperature; 4. polarization phenomena; and 5. environment.

Applied Voltage. Capacitor IR is inversely affected by increasing charge voltage. Table 1 shows the effects of different voltages on IR of a Mylar film capacitor and a Cellulose Acetate capacitor at 25 C and 65 C. At any defined temperature the IR will decrease nonlinearly with increasing voltage. As a criterion of comparison between various capacitors an arbitrary voltage of between 100 and 500, but not greater than



rated voltage, is selected for IR testing. The effects of voltage on dielectric constant of materials mentioned in this article are negligible.

Time of Voltage Application. Since the leakage current continues to decrease to an ultimate constant value (which in some types of capacitors will take several days or weeks) the time at which a final IR reading is to be taken must obviously be chosen. This time is usually two minutes, but in some types of applications it can be as little as 1/4 second or at intervals while the unit is on life test. Fig. 5 shows the dependency of IR on time of voltage application for several types of dielectrics. All IR values are expressed in terms of megohms x microfarads in order to compare the various dielectrics.

Temperature. The insulation resistance of a dielectric is inversely affected by temperature. As Table 1 indicates, there is a considerable decrease of IR as temperature of operation exceeds 25 C. In order to maintain a high IR at high temperatures approaching 200 C, the type of dielectric container and terminals becomes of extreme importance. Fig. 6 shows the effects of temperature on the IR of several capacitors. All measurements were made at the end of a two minute charge period using 250 v dc. Although not shown, at all temperatures metallized paper exhibits a lower IR than comparable paper and plastic film dielectrics. This is due to partially conductive surrounding pinholes cleared by self-healing.

Polarization Phenomena. Dielectric absorption resulting from interfacial, electronic, atomic and dipole polarizations and ion migration produces an anomalous current which is added to the ultimate constant leakage current through a dielectric. In all cases where IR is measured immediately after a capacitor is charged the actual current measured is the sum of this anomalous current and the ultimate steady state current.

This explains why the IR continues to increase with time of applied voltage. All dielectrics have some dielectric absorption. Dry non-polar dielectrics such as Teflon, Polystyrene and Polyethylene have the least amount whereas polar materials such as Cellulose Acetate, Mylar, paper, etc., have a fairly large dielectric absorption. Included in the latter group are all fluid and oil impregnated dielectrics. Table 2 indicates the voltage build-up to saturation due to dielectric absorption for several capacitor dielectrics after the units were discharged for two seconds from 100 v initial charge for 18 hours. Table 3 gives several types of dielectrics illustrating the two chief methods of IR measurement—initial charging and self-time constant method. Note that non-polar capacitors such as Dry Teflon and Polystyrene have extremely high insulation resistance after two minutes charge whereas paper, acetate and oiled units have a lower IR even though the self-time constant method yields unusually high IR values.

Another effect of dielectric absorption is to change the rate of charge and discharge of RC timing circuits. The capacitance appears to be larger when it is discharging and smaller when it is charging due to dielectric absorption. This effect is enhanced even more at higher temperatures causing increasingly serious errors in timing.

Previous history of a capacitor will cause IR readings to appear different from expected values. Residual charge in the dielectric from a previous voltage can cause IR to appear higher as Table 4 shows.

In trial 1 the unit was charged with 300 v dc and IR measured at the end of two minutes. The unit was then immediately shorted for one minute and then the next two minute measurement taken until four trials were completed.

In the fifth trial, immediately following trial 4, the unit was first shorted for 15 minutes, then the IR was again read after a two minute charge. The longer shorting period removed more residual charge thus bringing the IR more in line with the initial trial reading.

These results show that (1) residual charge will affect IR measurements and (2) repeated short time

Table 1.

Effects of Voltage on Insulation Resistance IR (Meg x μf)

Dielectric	Temperature	Resistance Applied Voltage (2 Minutes Charge) 100 v dc	250 v dc	500 v dc
Mylar	25 C	100,000	90,000	85,000
(no oil fill)	65 C	55,000	45,000	30,000
Cellulose Acetate	25 C	33,000	20,000	10,000
(no oil fill)	65 C	3,000	2,000	1,000

Table 2.

Voltage build-up to saturation due to dielectric absorption for several capacitor dielectrics after the units were discharged for two seconds. Initial charge of 100 v was applied for 18 hours.

Dielectric	2 min	10 min	20 min	60 min	300 min
Teflon—dry	.01	.01	.01	.01	.01
Teflon in Silicone	2.0	2.7	3.0	3.4	3.5
Polyethylene in Silicone	1.0	1.2	1.5	2.9	3.7
Cellulose Acetate—dry	1.4	1.8	2.1	2.7	3.0
Cellulose Acetate in Silicone	2.0	2.8	3.4	3.9	4.6
Polystyrene	.01	.02	.02	.02	.02
Paper—mineral oil impregnated	4.5	5.5	7.2	8.2	8.0
Paper—chlorinated di-phenyl impreg.	12.0	11.0	9.0	7.0	2.0
Mica—transmitting	3.7	4.7	5.1	6.0	6.9

Table 3.

Comparison of Methods of Insulation Resistance Measurements of Dielectrics at 25 C, 100 v dc

Dielectric and Container	Voltmeter Ammeter and Electrometer Methods Meg x μf (2 min. charge)	Self Time Constant Method Meg x μf
Teflon—glass tube	1.2×10^6	1.9×10^7
Teflon—metal shell and glass bead terminals	2.4×10^6	2.0×10^7
Teflon in Silicone fluid metal shell	3.5×10^4	$5. \times 10^5$
Mylar—uncased	$1. \times 10^5$	1.4×10^7
Mylar—metal shell and glass bead terminals	$1. \times 10^5$	$5. \times 10^6$
Mylar on Teflon—glass tube	2.3×10^5	$4. \times 10^6$
Mylar on Teflon in Silicone—glass tube	2.1×10^4	4.4×10^5
Polystyrene—glass tube	$1. \times 10^6$	1.5×10^7
Polyethylene in Silicone—glass tube	1.1×10^4	1.1×10^5
Cellulose Acetate Dry—glass tube	3.3×10^4	$4. \times 10^5$
Cellulose Acetate in Silicone—glass tube	$2. \times 10^4$	$1. \times 10^5$
Paper—oil impregnated—card board case	$5. \times 10^3$	$7. \times 10^4$
Transmitting Mica—ceramic case	$8. \times 10^3$	$2. \times 10^5$
Metallized Paper—metal shell	$1. \times 10^3$	—

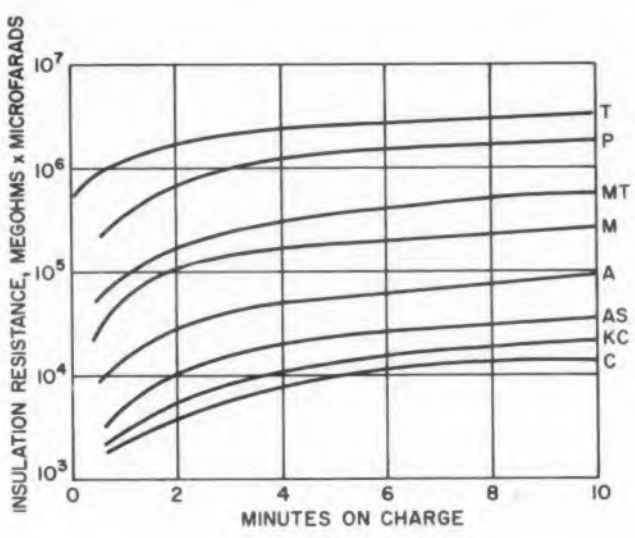


Fig. 5. Insulation Resistance vs Time of Voltage Application for Several Dielectrics*. Charging voltage, 250 dc, at 25 C.

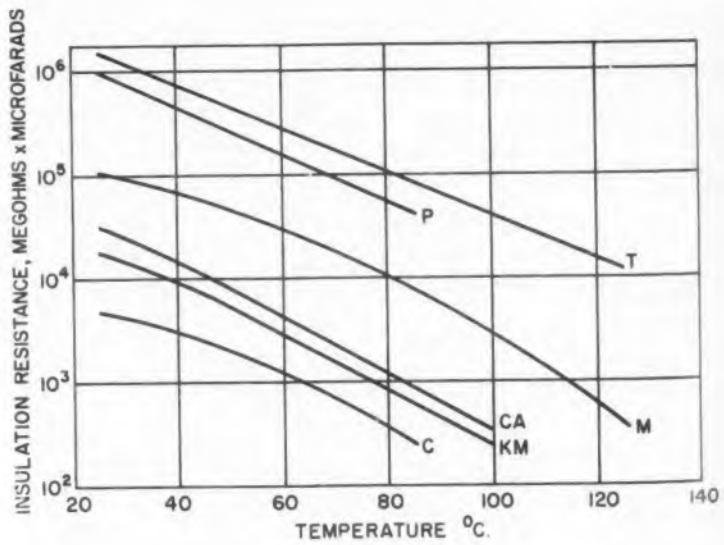


Fig. 6. Insulation Resistance vs Temperature for Several Dielectrics*; after 2 min charge to 250 v dc.

*T—Teflon dry
M—Mylar dry
C—Ceramic
MT—Series Mylar Teflon
CA—Cellulose Acetate dry
AS—Cellulose Acetate siliconed
P—Polystyrene dry
KC—Paper-chlorinated Di-Phenyl
KM—Paper-Mineral Oiled

Table 4.

Effects of Previous Voltage Applications on Insulation Resistance of A Dry Mylar Unit

Trial	IR (Meg x μf)
1	59,000
2	87,000
3	94,000
4	98,000
5	66,000

charging and discharging tends to increase the IR of a dielectric.

If dissimilar dry dielectric films are placed in series between the capacitor foil electrodes the result on the IR will depend upon the chemical composition of the dielectric and the amount of dielectric absorption contributed by each film type. For instance, from Table 3, if non-polar Teflon (2 minute IR 1 x 10^6 meg x μf) is wound in series between foil electrodes with Mylar (1 x 10^5 meg x μf) the new double layer dielectric will have an increased two minute IR of 2.3 x 10^5 meg. x μf. An advantage of plastic films is that the dielectric can be tailored to meet IR requirements.

Environmental Conditions. Excluding temperature, which was previously mentioned, the outstanding conditions under which the capacitor IR is affected are humidity, acid fumes, dust, conductive lint, salt spray, and high-energy radiation.

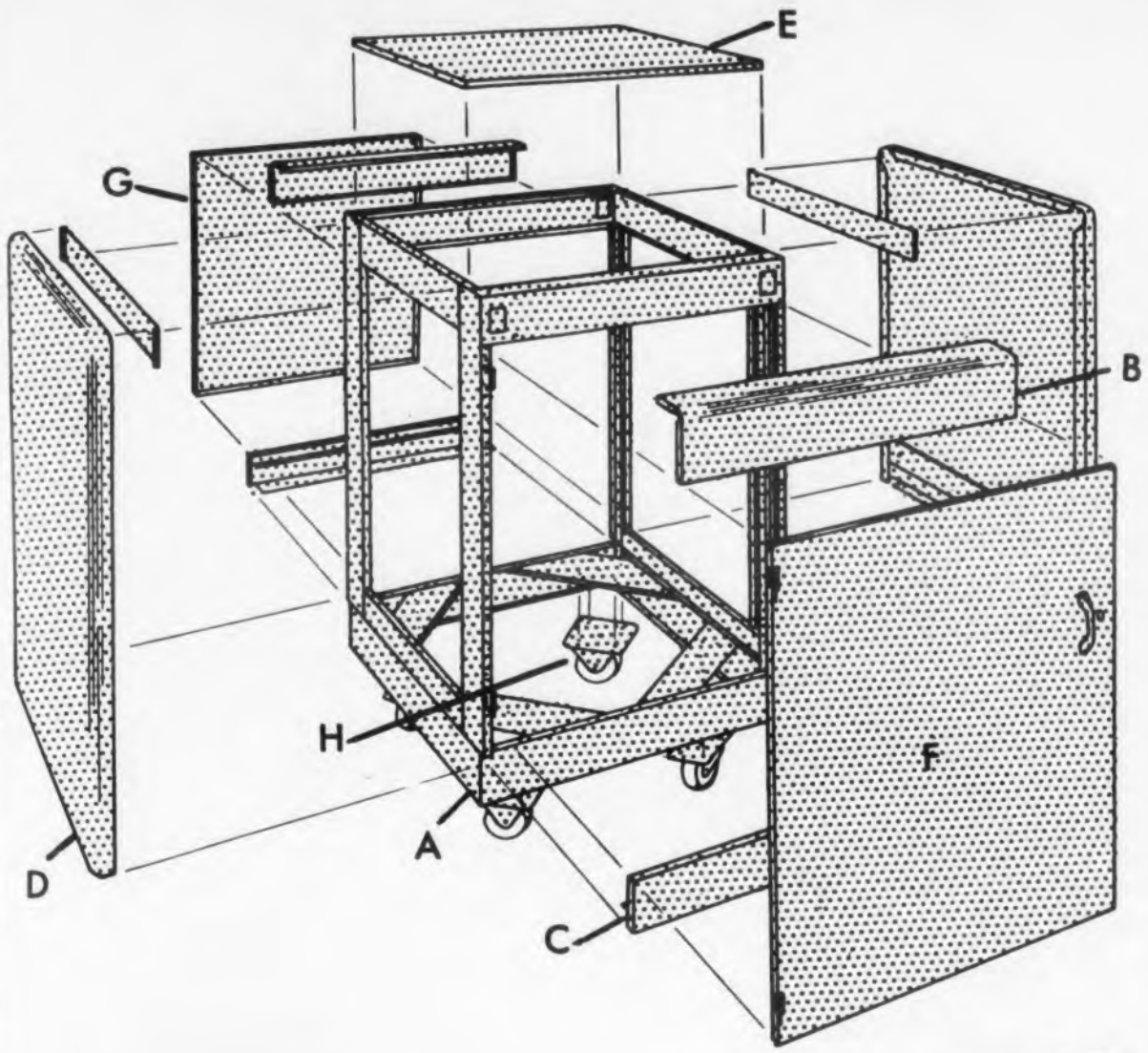
If the capacitor is plastic embedded, or hermetically enclosed, high humidity, dust, etc., will not affect IR. In the majority of instances this is not the case. A thin surface layer of moisture can increase surface leakage over insulating terminals, bushings and container.

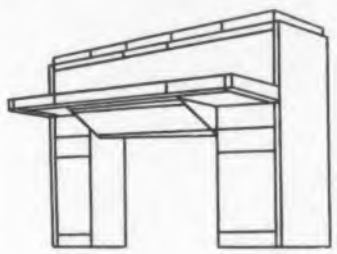
The effects of these surface contaminants are usually decreased but never eliminated by such methods as convolutions of the insulating terminal and various baked silicone treatments.

High resistivity plastic containers of Polystyrene, Teflon and Polyethylene retain surface and volume charge due to molding by the manufacturer. This charge tends to precipitate dust, lint, etc., upon the plastic surface causing an increase in surface leakage currents. Sharp discontinuities of the plastic case will alleviate the effects of these conducting surface films in some instances.

Capacitors used on high voltages will exhibit leakage due to corona discharge due to conductive contaminating films, high humidity, and sharp metallic points. Silicone treatments and plastic sprays on the market reduce the corona discharge considerably.

Electronic equipment used near nuclear reactors and sources of radiation is adversely affected, particularly with respect to the IR of dielectrics and insulators. Considerable research is being done presently in this field. In general it can be said that resistivity decreases for all known dielectrics, but IR of Polystyrene seems to be the least affected by radiation.





Potting With Epoxy Resins

William H. Crandell
Frederick S. Bacon
Laboratories
Watertown, Mass.

AS PART of a project undertaken on behalf of the United States Air Force, under a Prime Contract held by the Division of Industrial Cooperation at the Massachusetts Institute of Technology, a microsyn stator was modified (Fig. 1) to be used in a gyroscope. As a means of improving the overall performance of the gyro, encapsulation of the microsyn was considered the first step. In the potting of this part precision was particularly important, since the dimensions and properties of the completed unit were critical. Because of these stringent requirements, it was decided to use epoxy resins.

Advantages of Epoxies

Potting of the stator with epoxy resins offered these advantages:

1. Individual coil windings and the coils themselves are rigidly held in a fixed location from which they cannot shift. This prevents variation in electrical output of the microsyn in use.

2. Dirt and other foreign matter cannot be trapped in the unit and subsequently be transferred to the assembled gyro.

3. The microsyn is protected from damage if accidentally dropped.

4. Potting with these resin formulations provides increased resistance to humidity and vibration.

TABLE I Effect of Fillers on the Coefficient of Expansion of Epon 828

Compound No.	Composition	Parts by Weight	(Particle Sizes of Filler)	Coefficient of Linear Thermal Expansion (in./in./°F.)	Remarks
1	Epon 828	100	—	4.1×10^{-5}	Fluid at room temp. Very fluid at 212F.
	piperidine	6	—		
2	Epon 828	100		3.6	Not pourable at room temp. Very viscous at 212 F.
	Celite Superfloss	30	2 - 4 microns		
	piperidine	6			
3	Epon 828	100		—	Rather fluid at room temp. Very fluid at 212 F. Sand settles rapidly at room temperature
	white sea sand	140	124 - 246 microns		
4	Epon 828	100		2.3	Very viscous at room temp., pourable at 212 F. Filler settles noticeably after 1 hour at 212 F.
	1240 silica	140	99.5% less than 43 microns		
	piperidine	5	68% less than 10 microns		
5	Epon 828	100		1.7	Viscous at room temp. Fluid at 212 F. Very slight settling after 1 hour at 212 F.
	calcium carbonate	200	5 - 15 microns		
	piperidine	5			

TABLE II Physical Properties of a Typical Electrical Potting Compound

Physical Property	
Formulation	
Epon 828	100 parts by weight
Calcium Carbonate (5-15 microns)	200 parts by weight
Piperidine	7.5 parts by weight
Cure	8 hours at 212 F
Coefficient of Linear Expansion (in./in./°F.)	1.7×10^{-5}
Evolution of Volatile Matter on Heating 10 days at 250 F	None
Flow under a 15 lb load for 24 hours at 250 F	3%
Effect of 24 hours immersion in solvents at room temperature	
Carbon tetrachloride	Casting unaffected
Perchlorethylene	Casting unaffected
Trichlorethylene	Casting slightly softened
Freon 113	Casting unaffected
Alkazene 42	Casting unaffected
R-200 Gauge Fluid	Casting unaffected
Toluene	Casting unaffected
Methanol	Casting slightly softened
Acetone	Casting slightly softened
Methyl ethyl ketone	Casting slightly softened

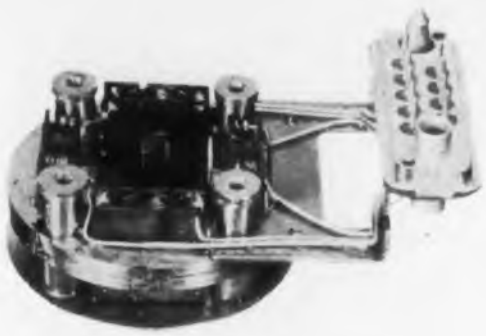


Fig. 1. A Microsyn Stator

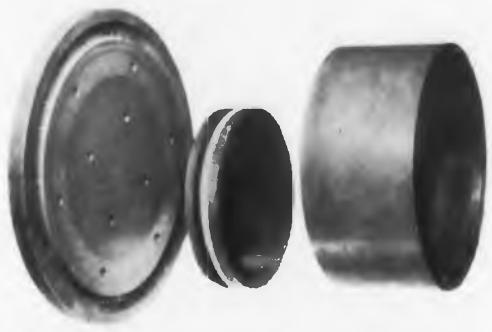


Fig. 2. Potting Reservoir—Exploded View

The selection of Epon* 828 resin rather than a polyester or phenolic resin, as the base material for the potting compound, was made because of the specific requirements that had to be met.

Polyesters Ruled Out

Polyester resins were ruled out because of their weakness and tendency to degrade at elevated temperatures together with their high shrinkage during cure. The latter property would make polyesters more susceptible to cracking during temperature cycling because of the stresses set up during curing. Phenolic resins were not suitable because of the volatile products given off during polymerization.

By actual laboratory tests, we proved that the epoxy-based potting compound will not crack under stresses set up from thermal expansion and contraction of the various microsyn parts when the unit is cooled to —70 F or heated to plus 200 F. Other advantages are: it is highly resistant to solvents used to wash gyroscope parts before and during assembly; and it resists flow under load at gyro-operating temperatures, ensuring that the potted parts will remain rigidly in position. In addition, no gaseous by-products are evolved by the compound during prolonged heating. Such products, condensing within the gyroscope, would shift the unit's delicate balance.

Cured epoxy potting formulations are rigid, giving better encapsulation than flexible compounds which might have allowed the potted parts to move in relation to one another. Inert fillers were incorporated with the epoxy resin to give a coefficient of expansion close to that of the potted metal parts. Of the fillers

*Reg. Trade Mark, Shell Chemical Corporation.

Fig. 3. Potting Mold Assembled

Fig. 5. Microsyn Mounted on Upper Half of Potting Mold

Fig. 7. Top View of Potted Microsyn

Fig. 4. Potting Mold—Two Halves

Fig. 6. Assembled Mold Preparatory to Potting

Fig. 8. Bottom View of Potted Microsyn

available for this purpose, we chose a calcium carbonate with 5-15 micron particle size range. Because of its low density, this material gave the least tendency to settle out upon standing.

The physical properties of the calcium carbonate-filled epoxy formulation are given in Table II. Note that the properties after an 8-hour cure at 212 F are adequate for most commercial purposes. If the ultimate in chemical resistance is required, an additional cure of 40 hours at 300 F is given.

Piperidine, one of the least active of the amine hardeners, was selected as the curing agent. Being a liquid, it decreases the viscosity of the resin when mixed, and produces a compound with a fairly long pot-life at elevated temperatures.

Mold Design

An ideal potting mold should provide: a) complete impregnation of the item to be potted; b) precise positioning of parts during potting; and c) control of final unit dimensions. Also, there should be no shrink marks on the surface of the resin nor the need for costly machining.

A transfer-type aluminum mold was used to eliminate surface shrink marks and keep pressure on the compound during cure. As the material increases in viscosity and decreases in volume during polymerization, more resin is forced into the mold cavity to fill the void produced by shrinkage.

Aluminum was selected as the mold material because its thermal expansion coefficient was close to that of the potting compound—when the mold was cooled, the part did not shrink around inserts which would have made it difficult to eject. A 1-1/2-mil coating of Teflon was applied to the aluminum as a release because epoxy resin adheres to most metals but not to this plastic.

The mold used has two parts: the potting reservoir, and the mold or force. The reservoir (Fig. 2) consists of a 3/4″ wall thickness 5-1/4″ I.D. cylinder approximately 3″ high. The reservoir is sealed at the bottom by a plug and silicone rubber O-ring. Bolts through the reservoir base plate hold the cylinder wall and plug in position.

The mold or force (Fig. 3) is made in two parts (Fig. 4), the lower part containing the actual mold cavity. The outer wall of the lower part is recessed to hold a silicone rubber O-ring, which prevents leakage of resin between the force and the reservoir wall. All inserts in the mold cavity are bolted from the underside, the bolts recessed, and the holes plugged. To prevent resin from flowing under the inserts during potting (making ejection of parts difficult) the underside of the insert is recessed to leave a 1/16″ land around the outside edge of the insert base. When bolted to the mold, enough force is exerted against the land to pull the metal into the Teflon release film, insuring a positive seal.

The upper part of the mold is shown alongside the lower part in Fig. 4. The four holes closest to the center hole are for mounting the microsyn stator. Four equally-spaced holes near the periphery of the mold and the one hole in the center are for bolting the mold together. The other six holes on the periphery of the upper mold half are for ejection screws. The large recessed hole in the upper half of the stator mold is for the plug connector.

Loading the Mold

Prior to loading the mold, 5-mil Teflon gaskets were placed over the four mounting posts on the microsyn and a 15-mil silicone rubber gasket set on the lip of

the plug connector. The stator was inverted and placed on the upper mold half (Fig. 5). Machine screws were inserted through the mold into the four mounting holes in the microsyn, and two 0-40 machine screws were inserted through the mold and screwed into the plug connector. After an alignment fixture was positioned on the mold to locate the microsyn center, the mounting screws and plug connector screws were tightened.

The alignment fixture was then removed and the two halves of the mold bolted together.

Potting Procedure

The Epon resin, previously warmed to 212 F, was catalyzed with piperidine and poured into the reservoir which was kept at 212 F on a hot press platen. At this temperature, the resulting potting compound does not stratify during cure and has good fluidity.

The mold was positioned in the top of the reservoir cylinder (Fig. 6) and the outlet line connected to a vacuum system through a trap. Thumbscrews extending from the bar on top of the mold were adjusted to keep the bottom of the mold 1/4" above the warmed resin. The unit was then evacuated at 1/2-1 mm. Hg. absolute pressure.

At this stage both resin and stator were being evacuated. This was necessary to remove dissolved gasses and air bubbles from the resin, and also to eliminate air from the potting cavity.

After about ten minutes, the thumbscrews were turned slowly. This allowed atmospheric pressure to force the mold downward into the reservoir, introducing resin into the mold cavity.

When the resin could be seen in the glass trap near the exit hole on the mold top, lowering of the mold was stopped and the evacuation continued for five minutes to remove any residual air. Thumbscrews were then completely loosened and the vacuum released. The mold was pressed into the reservoir, using light pressure (500 lbs) until more resin flowed out of the mold. When the pressure was released, the vacuum fitting was replaced with a pressure-tight fitting, and a pressure of 30,000 psi applied to the unit in the press for four hours at 212 F.

By this time, the mold was cooled in the press and the bar across the top of the mold and base plate of the reservoir was removed. The mold, polymerized excess resin, and reservoir base plug were pushed from the reservoir cylinder walls and the excess resin and base plate taken off the mold. The bolts fastening the mold halves together were then removed and ejector screws inserted into the upper portion of the mold. These screws go into the upper half of the mold and turn against the lower portion, ejecting the lower mold half and leaving the potting attached to the upper part of the mold.

After the screws holding the potted microsyn and plug connector are removed, the potting was easily removed from the mold by hand. The potted microsyn is shown in Figs. 7 and 8.

Attenuation and Phase Shift Changes In RC Sections From Curves

Sidney K. Benjamin
General Precision Laboratory
Pleasantville, N. Y.

WHEN using rc circuits as coupling circuits, filter sections or other applications, it is often desirable to know the effect of component tolerances, temperature changes, etc., on attenuation and phase shift. The curves given here may be used to find the percentage change in attenuation and the percentage change in phase shift for a given percentage change in corner frequency for one section (either high or low pass). The corner frequency f_o is defined as $1/2\pi RC$. The percentage change in resistance is dR/R, the percentage change in capacity is dC/C and the percentage change in corner frequency is $df_o/f_o = -(dR/R + dC/C)$. The equations from which the curves are derived are given later.

Example

As an example of the use of these curves, consider a three-stage 400 cycle amplifier containing three identical rc coupling circuits. Assume the objective is to use at best 5% tolerance resistors and capacitors for these coupling circuits. The problem is to determine what corner frequency to design the rc sections for, to keep the total percentage change in gain to 0.5% or less. Since R and C are 5% components dR/R and dC/C are 5%, from the above equation the percentage change in corner frequency df_o/f_o is 10%. For a 0.5% change in amplifier gain for three stages the gain per stage is 0.167%. Then the change in gain divided by the change in corner frequency is .167/10 or .0167. A horizontal line drawn from this value across to the intersection with the gain curve gives a value of f_o/f of .13. Since f is 400 cycles f_o is 52 cycles. This means the corner frequency for each rc coupling stage must be equal to or less than 52 cycles to insure an overall gain variation of 0.5% or less.

The change in phase shift may also be found from the curves. Drawing a vertical line from a value of f_o/f of .13 to where it intersects the phase shift curve, we find the change in phase divided by the change in corner frequency to be .13. Since the change in corner frequency is 10% this means a 1.3% change in phase shift for one stage or 3.9% for three stages.

Derivation of Gain Equations

$$G = E_O/E_{in} = \frac{1}{1 + jwRC}$$

$$\text{For } w_O = \frac{1}{RC}$$

$$|G| = \frac{1}{\sqrt{1 + \left(\frac{w}{w_O}\right)^2}} = \frac{1}{\sqrt{1 + f^2/f_O^2}} \qquad (1)$$

Taking the derivative with respect to f_o and dividing by Eq. (1)

$$\frac{dG/G}{df_O/f_O} = \frac{f^2}{f_O^2\,(1 + f^2/f_O^2)} \qquad (2)$$

Derivation of Phase Shift Equations

$$\theta = \text{arc tan } f/f_O \qquad (3)$$

$$\frac{d\,\theta}{d\,f_O} = \frac{1}{1 + \left(\frac{f}{f_O}\right)^2} - \left(\frac{-f}{f_O^2}\right)$$

Dividing by Eq. (3)

$$\frac{\frac{d\,\theta}{\theta}}{\frac{df_O}{f_O}} = \frac{-\frac{f}{f_O}}{\left[\text{arc tan } \frac{f}{f_O}\right]\left[1 + \left(\frac{f}{f_O}\right)^2\right]} \qquad (4)$$

To find $d\,f_O/f_O$

$$f_O = \frac{1}{2\pi RC}$$

$$d\,f_O = \frac{\partial\,f_O}{\partial R}\,d\,R + \frac{\partial\,f_O}{\partial\,C}\,dC$$

$$\frac{\partial\,f_O}{\partial^R} = \frac{1}{2\pi C}\left(-\frac{1}{R^2}\right)$$

$$\frac{\partial\,f_O}{\partial C} = \frac{1}{2\pi R}\left(-\frac{1}{C^2}\right)$$

$$d\,f_O = -\frac{dR}{R^2C\,(2\pi)} - \frac{dC}{RC^2(2\pi)}$$

$$\frac{df_O}{f_O} = -\left(\frac{dR}{R} + \frac{dC}{C}\right) \qquad (5)$$

f/f_o	$(f/f_o)^2$	$1+\left[\frac{f^2}{f_o}\right]$	$\frac{\Delta G}{\Delta f_o}$	$\text{Tan}\frac{-1\ f}{f_o}$	$\frac{\Delta\theta}{\Delta f_o}$
.1	.01	1.01	.0099	.097	.12
.15	.0225	1.0225	.022	.1495	.147
.2	.04	1.04	.0385	.1975	.194
.25	.0625	1.0625	.0588	.245	.24
.3	.09	1.09	.0826	.292	.283
.35	.1225	1.1225	.109	.338	.323
.4	.16	1.16	.138	.381	.363
.45	.2025	1.2025	.168	.423	.398
.5	.25	1.25	.20	.464	.43
.75	.5625	1.5625	.36	.645	.556
.85	.7225	1.7225	.42	.705	.595
1.0	1	2	.5	.786	.635
1.2	1.44	2.44	.59	.878	.675
1.4	1.96	2.96	.664	.954	.695
1.6	2.56	3.56	.72	1.015	.708
2	4	5	.8	1.11	.72
2.5	6.25	7.25	.864	1.19	.725
3	9	10	.9	1.25	.72
3.5	12.25	13.25	.925	1.295	.715
4	16	17	.945	1.33	.71
5	25	26	.962	1.37	.705
6	36	37	.975	1.41	.694
7	49	50	.98	1.43	.685
8	64	65	.985	1.45	.675
9	81	82	.988	1.46	.675
0	100	101	.99	1.47	.675

(3)

(4)

(5)

New Products

10-Crystal Oven

High Frequency Miniature

A new miniature crystal oven, housing 10 high-frequency HC-18U holders is designed for extreme temperature stability and minimum power consumption. It has a temperature stability of ±0.25 C at a constant ambient temperature and has a temperature variation after warm-up of 2 C over ambient temperature range of −55 C to +75 C.

The JKO-11 comes in a choice of heater voltages from 6.3 v to 115 v, ac or dc. Its power requirements are 25 w maximum, and it weighs 1.6 oz.

It has a detachable cover, high temperature heater bonding tape and bifilar low-inductance heater winding.

James Knights Co., Dept. ED, Sandwich, Ill.

CIRCLE 34 ON READER-SERVICE CARD FOR MORE INFORMATION

Light Spot Wattmeter

Precise to 0.1%

A precision light spot wattmeter, Model GLM, built for accurate power measurement in laboratories, is a precision instrument conforming to extreme requirements. The accuracy of indication for dc and ac is within a limit of error of ±0.1 per cent, with constant calibration guaranteed.

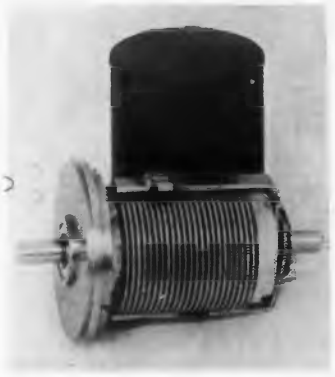
Time setting is 0.6 sec; test voltage is 2000 v. Built for various ranges from 0.025 a up to 10 a and for voltages from 30 v up to 300 v; it has a parallax-free reading on a double strip scale.

Epic, Inc., Dept. ED, 154 Nassau St., New York 38, N.Y.

CIRCLE 35 ON READER-SERVICE CARD FOR MORE INFORMATION

Precision Potentiometer

Linear To 0.01%



The Model MD20 2 in. diameter ultra-precision potentiometer is designed for use under extremely rugged conditions.

A new potentiometer design provides independent linearity to as close as 0.01 per cent. For stability, the resistance coil is externally wound on a non-hygroscopic ceramic core, and for strength and dimensional accuracy.

Electrical angle is 3600 degree with 90 degree overtravel at each end. Resistance values of 1K to 100K are standard for the 2 gang, 10 turn version. Torque on dual section versions is as low as 1.5 in. oz.

Litton Industries, Components Div., Dept. ED, 215 S. Fulton Ave., Mt. Vernon, N.Y.

CIRCLE 36 ON READER-SERVICE CARD FOR MORE INFORMATION

Open Linear Bearing

For Supported Shafts

This linear ball bearing permits the use of shaft support members along the length of the shaft traversed by the bearings. These bearings are known as open type ball bushings and are useful where extreme rigidity or unusually long shafts are required.

The open construction of the bearing permits adjustment of its bore diameter by use of set screws or other clamping arrangements.

The ball bearings do not depend on the maintenance of an oil film. The open bushings are manufactured to standard dimensions for shaft diameters ranging from 1 in. to 4 in.

Thomson Industries, Inc., Dept. ED, Manhasset, N.Y.

CIRCLE 37 ON READER-SERVICE CARD FOR MORE INFORMATION

Dynamic Pressure Pickup

Uses Liquid Cell

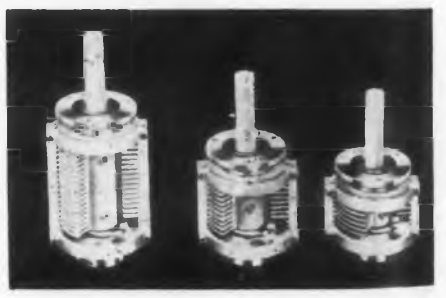
In the Type 4-340 dynamic pressure pickup, dynamic pressure applied to the diaphragm of a sealed, liquid-filled cell causes an infinitesimal amount of polar liquid to flow through a porous disk, generating an electrical signal. About 1 in thick and 1-7/8 in. in diameter, the new pickup will operate at a pressure range of 10^{-4} to 100 psig and temperature range of −10 F to +140 F. It will respond "flat" between 3 cps and 2500 cps. It has an internal impedance of 100,000 ohms and a 100 psig oscillating pressure and yields an unusually high output of 35 v.

Consolidated Electrodynamics Corp., Dept. ED, 300 N. Sierra Madre Villa, Pasadena, Calif.

CIRCLE 38 ON READER-SERVICE CARD FOR MORE INFORMATION

Variable Air Capacitor

For Instrument Use



Machined from solid metal, the Type 1420 variable air capacitors have both rotors and stators gang milled from shaped extruded aluminum rods.

Electrical gains include good linearity, lower metallic resistance and inductance than a soldered stack, low thermal drift, and a minimizing of microphonic tendencies. The insulators used are machined from a cast bar of cross-linked polystyrene for thermal adequacy.

General Radio Co., Dept. ED, 275 Massachusetts Ave., Cambridge 39, Mass.

CIRCLE 39 ON READER-SERVICE CARD FOR MORE INFORMATION

Copper-Clad Steel

Carbon-Hardened

A new clad metal combination, Conflex, consists of medium carbon hardenable steel (SAE-1065) clad on one or both sides with oxygen-free, high conductivity copper. The metals are inseparably bonded by a solid-phase bonding process. This produces a composite metal having high conductivity, excellent spring characteristics by heat treatment, resistance to corrosion, ductility, and good operating characteristics at elevated temperature.

The standard cladding ratio with copper on one side is 80 per cent steel to 20 per cent copper. With copper on either side the standard is 10-80-10. Other single and double clad ratios can be produced in 90-10, 70-30, 5-90-5, and 20-60-20.

Metals & Controls Corp., Dept ED, General Plate Div., 43 Forest St., Attleboro, Mass.

CIRCLE 40 ON READER-SERVICE CARD

COMING JANUARY 1st
DESIGN '57
Yearly Feature Issue of ED

Permalloy Powder Cores

Offered From Stock

This firm's production facilities for unstabilized permalloy powder cores have increased. Popular standard sizes are now available for immediate delivery.

All cores are performance guaranteed. They are widely used as loading coil cores to provide suitable response in the audio and carrier frequency ranges. They are also widely used as filters in communications circuits. High Q applications, such as high, low, and band pass filters, and noise suppression filters are some uses.

The cores are made to a 2% molybdenum, 81% nickel, 17% iron formula. They can be color marked in 2% bands from −5% to +15% of published nominal inductance for 1000-turn winding.

Magnetics, Inc., Dept. ED, Butler, Pa.

CIRCLE 41 ON READER-SERVICE CARD

CIRRCLE 42 ON READER-SERVICE CARD ➤

Error Computor

For Wire Strain Gages

The K-7 error computor is a time-saving device for use with wire strain transducer systems. These systems are subject to small but cumulative errors, and a realistic solution involves 14 variables and 9 simultaneous equations requiring many hours to solve for one variable.

The Type K-7 error computor isolates this error in five minutes. It simulates all the system components and presents the error in per cent of correct magnitude.

Allegany Instrument Co., Inc., Dept. ED, 1091 Wills Mountain, Cumberland, Md.

CIRCLE 45 ON READER-SERVICE CARD FOR MORE INFORMATION

Traveling Wave Tube

X-Band Amplifier

This broadband traveling wave amplifier tube, the HA-9, operates from 8.2 to 11.0 K mc without the necessity of any electrical or mechanical operating adjustments. A high-gain, medium power broadband device suitable for many microwave applications, it includes provisions for grid modulation with which any electrode may be operated at ground potential. Important specifications include a small signal gain of 36 db min (8-11 K mc), a saturation gain of 30 db min, and a power output of 30 dbm.

Huggins Laboratories, Inc., Dept. ED, 711 Hamilton Ave., Menlo Park, Calif.

CIRCLE 46 ON READER-SERVICE CARD FOR MORE INFORMATION

Split-Contact Switch

Has Snap-Action

A new snap-action split-contact switch has a capacity of up to 3/4 hp, dual circuitry, five terminals, and the rolling spring snap-action principle.

The Model C-11008, a normally closed switch, can control two single pole throw circuits, or can be used for double make or break in a single circuit. Rating of the switch is 15 amps and it is furnished with a pin plunger or other actuator.

Acro Mfg. Co., Dept. ED, Columbus 16, Ohio.

CIRCLE 47 ON READER-SERVICE CARD FOR MORE INFORMATION

Ultra Low Range Ohmmeter

Has Kelvin Test Leads

A portable instrument capable of measuring extremely small values of resistance, the Model 555 centi-low ohmmeter is used for detecting low resistance circuit troubles.

There are two ranges, the low ohm range with lowest increment of 0.01 ohms, center 0.5 ohms, high 5 ohms, and the high ohm range with lowest increment of 0.02 ohms, center 5.0 ohms, high 50 ohms. Kelvin principal test leads, which introduce no error into the meter indications are included. Power is supplied by a dry battery.

Chicago Industrial Instrument Co., Dept. ED, 865 N. Sangamon St., Chicago 22, Ill.

CIRCLE 48 ON READER-SERVICE CARD FOR MORE INFORMATION

High Speed Sampler

Shock Resistant

Providing single pole sampling of 60 contacts at rates up to 30 rps, the Type AB high speed sampling switch requires only 3 oz in. torque. It is compactly built to provide long life under rugged conditions. Designed for direct mounting to standard servo appliance frames, it is completely shielded and all wiring can be potted. It has ball bearing construction with glass base contact plate and silver contacts.

Applied Science Corp. of Princeton, Dept. ED, P.O. Box 44, Princeton, N. J.

CIRCLE 49 ON READER-SERVICE CARD FOR MORE INFORMATION

AC Power Supply

Has Autotransformer

Intended for general utility service in the laboratory, or on the test bench, the Model 109 AC power supply features a fuse protected variable autotransformer, a neon pilot light, and a legible 4 1/2 in. voltmeter with an essentially linear scale.

Nominal input is 115 v, 60 cy, and output rating is 5 amp, with voltage infinitely variable from 0 to 135 v.

Slaughter Co., Dept. ED, Piqua, Ohio.

CIRCLE 50 ON READER-SERVICE CARD FOR MORE INFORMATION

Casting Resin

Flexible Epoxide

Controlled flexibility is possible when using Stycast 2741, a new epoxide casting resin. Supplied as two components, cure is effected at room temperature, but can be accelerated at elevated temperature. The material retains flexibility at —70 F and is recommended for encapsulating, potting and sealing applications requiring low temperature use. Shrinkage during cure is negligible and adhesion to most materials is excellent.

Emerson & Cuming, Inc., Dept. ED, 869 Washington St., Canton, Mass.

CIRCLE 53 ON READER-SERVICE CARD

Hot Tin Plate Process

Complete Absence of Slag

A special hot tin plate process which will provide the smooth surface, solderability, adherence and complete absence of slag essential to manufacturers of printed circuits, capacitors, and cable wrappings has been developed. Tin coatings of 0.00002 to 0.00008 and 0.0002 to 0.0003 are available on brass, copper, bronze and other thin strip metals in gauges from 0.012 down to 0.002, widths from 1/8 in. to 6 in. and wider.

Somers Brass Co., Inc., Dept. ED, Waterbury, Conn.

CIRCLE 54 ON READER-SERVICE CARD

Tape Duplicator

1200 Codes Per Minute

The punched paper tape regeneration unit consists of a motorized tape punch cable connected to a motorized tape reader. The regeneration unit duplicates 5, 6, 7 or 8 channel tape at the rate of 1200 codes per minute, producing a composite tape.

Composite tapes are valuable as inputs to computers. Problems or phases of problems are prepared on an automatic writing machine which produces a by-product punched tape automatically. The tapes can be converted into a composite tape on the regeneration unit and the entire problem is ready for fast feed into the computer.

Commercial Controls Corp., Dept. ED, 1 Leighton Ave., Rochester, N.Y.

CIRCLE 55 ON READER-SERVICE CARD

◄ CIRCLE 52 ON READER-SERVICE CARD

New Duo-Triodes from Sweden

Ruggedized-Longlife

Ericsson of Sweden has in production three new tube types, the 2C51/2C51L, 18C51 and 407A.

Each tube is a duo-triode, medium mu, 9-pin miniature. The triode sections are internally shielded and independent of each other except for the common heater, making the tubes useful in cascade amplifiers.

Life expectancy of the tube is above 10,000 hours. The use of pure nickel cathode sleeves insure freedom from interface formation, and suitability for on-off application. The tubes are highly resistant to impact shock and vibration.

The 2C51/2C51L has a 0.3 amp heater at 6.3 v, while the 18C51 is rated at 0.105 amps at 18 v. 407A has a center-tapped heater and may be operated in series at 0.050 amps, 40 v, or in parallel at 0.1 amps, 20 v.

State Labs Inc., Dept. ED, 649 Broadway, New York 12, N.Y.

CIRCLE 56 ON READER-SERVICE CARD

Plastic Gasket

Seals Vacuum Lines

Vacuum line sealing problems are being solved by a plastic gasket material, which by adding 1/64 in. film or coating to flange faces and gasket surfaces, reduces vacuum line leakage to a minimum.

Any leakage which may occur after line has been in service can be corrected without dismantling flanges by simply applying 1/32 in. of plastic gasket material around the outside surfaces of the flange where they meet with the gasket.

It is available in two formulations; one for air, steam, water, mild chemicals, and the other for gasoline, oil, solvents, etc. Where flange faces are unmarred and come together evenly, the material can be used alone without any other type gasketing material. The plastic is non-hardening, and flanges are easy to dismantle.

Flexrock Co., Packing Div., Dept. ED, 3608-B Filbert St., Philadelphia 1, Pa.

CIRCLE 57 ON READER-SERVICE CARD

CIRCLE 58 ON READER-SERVICE CARD ➤

Blower Motor

Has Variable Frequency

A new single phase 4-pole variable frequency blower motor maintains a fairly constant speed over a wide frequency range through the use of 2 small external capacitors. With a 2 in. blade fan, frequencies between 400-1800 cps, speed is between 7800-11,600 rpm. With a 3 in. blade fan, frequencies between 300-1000 cps, speed is between 4400-5200 rpm. Excitation is 115 v, continuous duty and operating ambient temperature range — 54 C to +70 C. Housing and bearings are stainless steel, and lead wires are Teflon. Type 11-A-8223-01 is designed to run a fan which cools electronic and other equipment.

John Oster Mfg. Co., Dept. ED, Avionic Div., Racine, Wisc.

CIRCLE 60 ON READER-SERVICE CARD FOR MORE INFORMATION

One-Inch Meter

Has Long Scale Arc

A new 1 in. round panel meter for flush mounting provides long scale arc in small panel space. The Model 104 employs a miniaturized D'Arsonval type movement, and accuracy is held to ±3 per cent of full scale deflection for dc instruments and ±5 per cent for ac instruments.

By using an optional external shroud, it can be adapted for edge-lighting requirements.

Model 104-W Meters, with a watertight seal, are designed for a dielectric strength of 1500 v rms.

International Instruments Inc., Dept. ED, New Haven 15, Conn.

CIRCLE 61 ON READER-SERVICE CARD FOR MORE INFORMATION

Floating Anchor Nut

Has Deep Counterbore

The new F1934 floating anchor nut is a deep counterbore, two-lug, floating anchor nut developed principally for use around access doors or openings that require constant grip-length screws for different thicknesses of materials. It can be used wherever a long screw is required.

The Kaynar Co., Kaylock Div., Dept. ED, Box 2001, Terminal Annex, Los Angeles 54, Calif.

CIRCLE 62 ON READER-SERVICE CARD FOR MORE INFORMATION

◀ CIRCLE 59 ON READER-SERVICE CARD

Ultra Compact Scaler

Counts Sine Waves

A scaler of quite unique characteristics has been developed which combines high counting capacity with extremely small size and weight. Measuring only 4-1/4 x 6-1/4 x 7 in. and weighing 8-1/2 lb, it has a binary capacity of over one million without the use of additional counters.

It will count sine waves of any frequency from 10 cps to 10 mc, and will also count pulses at any repetition rate from 0 to 10 mc. The scaler has a 3-pulse resolution time of 0.2 μsec and a 2-pulse resolution time of 0.1 μsec; and a sensitivity of 1 to 1-1/2 v over the entire range of frequencies.

The scaler accommodates a wide range of input waveforms due to a specially designed trigger circuit. Utilizing plug-in construction throughout, the scaler's light weight makes it particularly useful for field or airborne operation.

The Jacobs Instrument Co., Dept. ED, Bethesda 14, Md.

CIRCLE 64 ON READER-SERVICE CARD

Metallic Copper-Dispersion

For Plating Non-Conductors

A colloidal dispersion of metallic copper in a lacquer solution that provides a highly conductive surface coating has been introduced for use in printed circuitry, electro-plating of non-conductors, and for application on components for radar equipment.

Application of 'dag' dispersion No. 235 may be by spray or brush, no baking is required, and the film will air-dry.

The electrical resistance of 'dag' 235 is 6 ohms per sq in. for 0.001 in film thickness, and 1 ohm per sq in. for 0.003 in film thickness.

A spray application can give a film thickness of 0.0005 in per pass. The lowest resistance is obtained by applying multiple layers rather than a single thick coating.

Acheson Colloids Co., Dept. ED, Port Huron, Mich.

CIRCLE 65 ON READER-SERVICE CARD

FILTORS SUB-MINIATURE RELAYS

OUR MODERN PRODUCTION FACILITIES AND PRECISION TEST EQUIPMENT *mean QUANTITY + RELIABILITY*

More than 1000 relays a day are being shipped to the largest manufacturers of military equipment in the United States. Constant testing of sample lots from production runs (100% testing in the case of low level relays) has given Filtors relays a reliability rating second to none.

Below is a brief description of the relays pictured above. For complete information regarding these types and other types manufactured by Filtors write for catalog today.

	1	2	3	4	5	6	7
CONTACT ARRANGEMENT	6PDT	6PDT	2PDT	6PDT	6PDT	4PDT	4PDT
CONTACT RATING (AMPS. RES. at 26.5 VDC or 115 VAC)	3	3	2	3	3	3	3
NOMINAL COIL VOLTAGE (VOLTS D.C.)	26.5	26.5	26.5	26.5	26.5	26.5	26.5
HOUSING DIAMETER	1"	1"	.635"	1"	1"	1"	1"
MOUNTING CENTERS	1.406	1.406	.875	.625	1.562	1.406	1.406
SHOCK (11 millisec)	50G	50G	50G	50G	50G	50G	50G
VIBRATION at 10G	5 to 500	5 to 500	5 to 2000	5 to 500	5 to 500	5 to 500	5 to 500
MAX. OPERATE AND RELEASE TIME AT NOMINAL VOLTAGE (in milliseconds)	10	10	10	10	10	10	10
RELAY TYPE	L26F18	26SP18	M26FC6	26SC18	26SE18	26SR12	L26F12

FOR DRY CIRCUIT (LOW LEVEL) RELAYS ADD THE LETTER "S" AT THE END OF THE TYPE DESIGNATION. EXAMPLE: TYPE 26SP18S

All made to MIL-R-5757 and MIL-R-25018 (USAF)

FILTORS, INC.

30 SAGAMORE HILL DRIVE, PORT WASHINGTON, L. I., N. Y., Tel. POrt Washington 7-3850

CIRCLE 68 ON READER-SERVICE CARD FOR MORE INFORMATION

Dial and Index Hanger

For Disc or Drum Dials

These type "AN" dial and index hangers are universal in design and may be used with disc or drum dials as desired. They are available in three shaft sizes 1/8, 3/16 or 1/4 in.

The material is aluminum and they are finished in chronic acid anodized to meet Military specifications.

PIC Design Corp., Dept. ED, Div. of Benrus Watch Co., P.O. Box "C", E. Rockaway, N.Y.

CIRCLE 69 ON READER-SERVICE CARD FOR MORE INFORMATION

Air Pressure Switch

Subminiature

This subminiature absolute air pressure switch can be used over a wide temperature range under conditions of high shock and vibration.

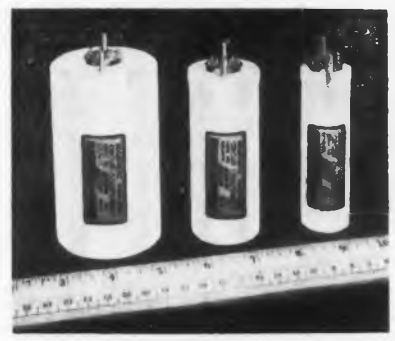
The RS-16 pressure switch is available from 5 psi absolute to 25 psi absolute with pressure differentials between "on" and "off" as close as 2 psi.

Newark Controls Co., Dept. ED, 15 Ward St., Bloomfield, N.J.

CIRCLE 70 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnetic Amplifier Components

Build Basic Circuits



Maximag magnetic amplifier circuit components are a new line designed to assemble any of the well-known basic circuits for fast response and high gain.

The units are available in up to 300 w capacity. Maximag components meet military specifications.

Three basic sizes are available to cover the range of 1.5 to 300 w, 60 cy and 400 cy. The largest unit, rated at 300 w at 400 cy measures only 4-1/16 in. in height by 2-7/16 in. in diameter. The other units for lower capacity are proportionately smaller.

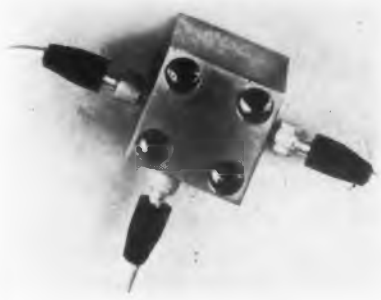
Adler Electronics, Inc., Dept. ED, 1 LeFevre Lane, New Rochelle, N.Y.

CIRCLE 71 ON READER-SERVICE CARD FOR MORE INFORMATION

WHAT NEW PROGRAMMING METHODS Are Causing Major Design Changes? READ DESIGN '57—JAN. 1ST ED

Subminiature Accelerometer

Measures Three Axes



A subminiature high temperature accelerometer has been developed that will measure three mutually perpendicular accelerations simultaneously.

The glennite Model AHT-30T will operate accurately in temperatures from —65 F to +350 F and features an acceleration range up to 500 g, frequency response from 25 to 20,000 cps, and sensitivity of 0.8 mv per g.

Excellent linearity and stability characterize the AHT-30T which can measure one longitudinal and two lateral accelerations at the same time. The unit weighs less than one ounce and is less than one cubic in. in volume.

Gulton Industries, Inc. Dept. ED, 212 Durham Ave., Metuchen, N.J.

CIRCLE 72 ON READER-SERVICE CARD FOR MORE INFORMATION

Waveform Generator

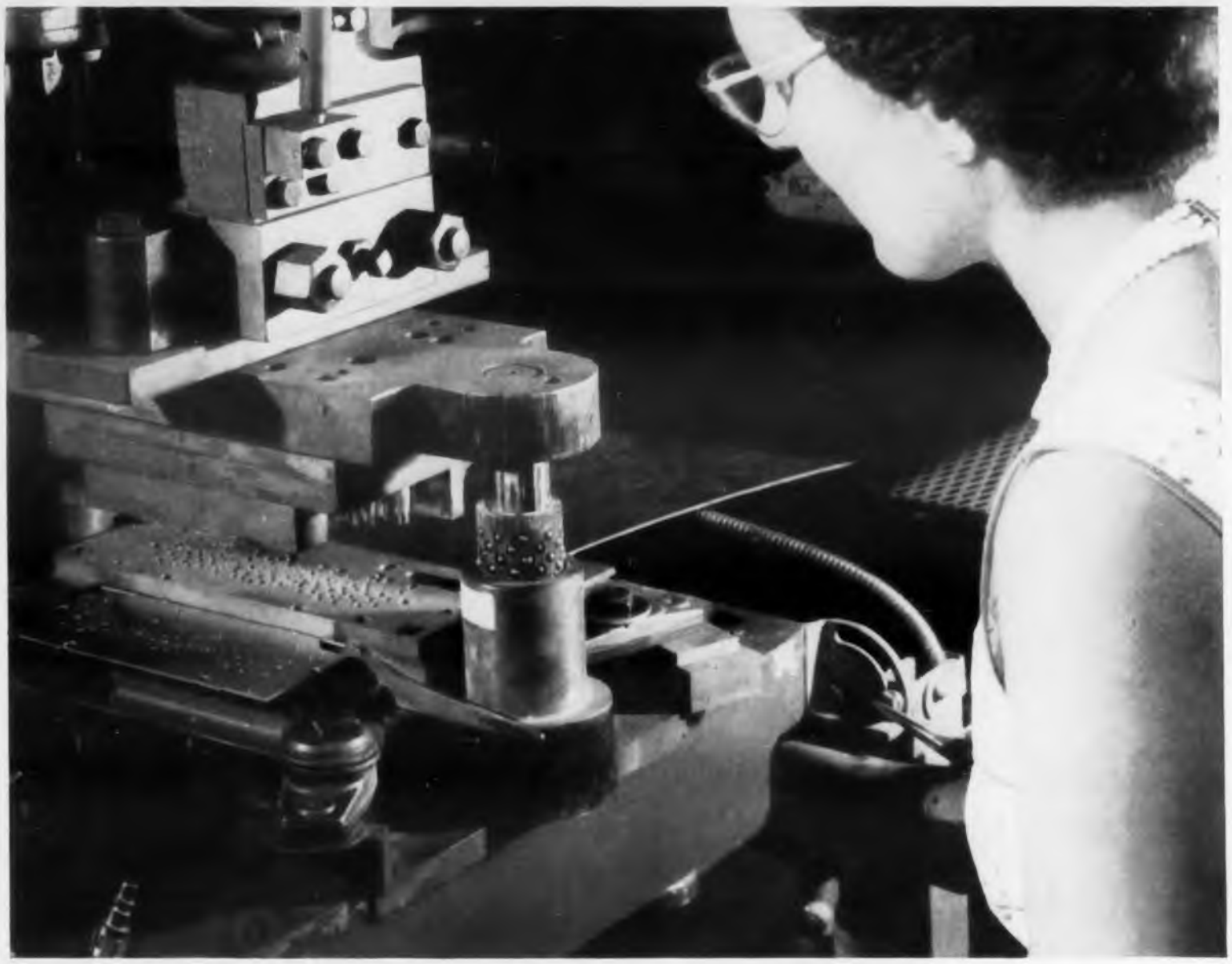
Transistorized

The first of a line of fully-transistorized, battery - powered test equipment, the Model 500 waveform generator provides clipped-sawtooth and rectangular waveform output with a variable repetition rate from 10 cps to 50 kc. A square wave output is available from 5 cps through 25 kc. With one change in a capacitor, these repetition rates may be reduced to one every 5 seconds. At full battery voltage an output of seven volts at 2000 ohms impedance is available. The rectangular wave shape is continuously variable in pulse width from 5 to in excess of 200 μsec.

With a total power drain of 300 mw, the anticipated life of the 22-1/2 v battery is better than 500 hours. As the battery output voltage drops off, there is no deterioration in wave shape or stability.

Cubic Corp., Dept. ED, San Diego, Calif.

CIRCLE 73 ON READER-SERVICE CARD FOR MORE INFORMATION



Variable Speed Control

Has Rotative Adjustment

Accurate speed settings and fine speed adjustments on zero-max variable speed reducers are obtained with a screw control that provides a rotative, instead of linear, adjustment.

In addition to providing positive setting and repeating of speeds, the new control is easily adapted to many types of remote control, and will not vibrate or creep. Fifty revolutions of the screw covers the full range of speed from zero to maximum making it easy to calibrate for fine speed adjustments.

Revco, Inc., Dept. ED, 1900 Lyndale Ave. S., Minneapolis 5, Minn.

CIRCLE 77 ON READER-SERVICE CARD FOR MORE INFORMATION

Instrument Cases

Deep-Drawn Aluminum

A complete line of drawn aluminum instrument cases for electronic and instrument manufacturers come in two styles featuring distinctive custom-designed appearance. Blank cases and covers are available, and cases and covers can be modified to specifications with holes, chassis slides, dimpled or rubber feet or other desired features.

All cases have seamless construction with close tolerances and sidewalls of uniform thickness.

Zero Mfg. Co., Dept. ED, 1121 Chestnut St., Burbank 9, Calif.

CIRCLE 78 ON READER-SERVICE CARD FOR MORE INFORMATION

RF Connectors

Subminiature

Four new subminax RF connectors in a line of subminiature components are the 27-27 hermetic seal panel receptacle, the 27-28 between series adapter designed to provide a transition between BNC and subminax, the 27-800 printed circuit receptacle and the 27-801 cable termination. All of these have an impedance of 50 ohms. Subminax connectors are available in 50 and 75 ohms, and in push-on and screw-on coupling. All are gold-plated.

Amphenol Electronics Corp., Dept. ED, Chicago 50, Ill.

CIRCLE 79 ON READER-SERVICE CARD FOR MORE INFORMATION

Millivolt Meter

Dual Unit

This dual electrolysis voltmeter is one meter with ranges of 2.5-5-10-50-100-500 mv at 2000 ohms per volt and one meter with ranges of 0.3-1-3-10-30-100-300 v at 50,000 ohms per volt. Both meters center zero. It eliminates push buttons and switching for changes in polarity and simultaneous readings, and accuracy is 1 per cent. They are clear plastic enclosed meters for better illumination, and have a wooden case, rugged meter movements.

Stewart Bros., Dept. ED, Div. of Instrument Labs., 315 Walton Place, Chicago 10, Ill.

CIRCLE 80 ON READER-SERVICE CARD FOR MORE INFORMATION

Synchronous Timer

Has Standby Clock Drive

Highly accurate, the duplex time component runs electrically or mechanically and does not stop upon power failures. It consists of an accurate synchronous electric time unit combined with a spring driven time unit which is held in reserve. If electricity should fail, the spring driven unit goes into action instantly. Upon power resumption or circuit repairs, the synchronous electric motor again takes over. The unit has been piloted in chart drives and dials, time switches and day-night thermostats.

Industrial Timer Instruments Co., Dept. ED, 189 W. Madison St., Chicago 2, Ill.

CIRCLE 81 ON READER-SERVICE CARD FOR MORE INFORMATION

Silicon Rectifier

High Inverse Rating

The silicon power rectifiers, type CK777, has a peak inverse rating of 325 v and an average current rating of 5 amp at 125 C. Maximum reverse current at the P.I.V. of 325 v is 5 ma and the maximum forward voltage drop at 10 amp is 2 v. The addition of type CK777 provides a line of 5 amp, 125 C silicon rectifiers having peak inverse ratings from 25 to 325 v.

Raytheon Mfg. Co., Dept. ED, 55 Chapel St., Newton 58, Mass.

CIRCLE 82 ON READER-SERVICE CARD FOR MORE INFORMATION

Hardness Gauge

Pocket-Size

This small, accurate hardness gauge, can be used in measuring hardness of materials such as rubber and plastics. This gauge, called Rex Model A, indicates hardness in Durometer units that comply with A.S.T.M. specifications for rubber hardness.

It has a hardened steel indentor which pushes up the runner of the vernier by direct contact. The runner is then held by friction so that the instrument can be removed and read elsewhere.

The vernier reads directly to 5 points which permits interpolation to about 2 points with average vision. With the magnifier, readings can be read more closely. Total range is 0.100 in. There are 100 divisions on the scale permitting readings of 0.001 in. or 1 durometer point. Overall accuracy is 0.001 plus or minus, and no adjustments are required.

W. F. Orth, Dept. ED, 802 S. Ada St., Chicago 7, Ill.

CIRCLE 85 ON READER-SERVICE CARD FOR MORE INFORMATION

Standard Test Jack

Beryllium Copper Contact

This new standard test jack is a rugged quality unit designed for long electrical and mechanical life. It meets all requirements of MIL-STD-242 (Ships).

The beryllium copper spring pin contact insures consistently smooth insertion and withdrawal of standard 0.080 in. diameter test prods. A nickel-plated brass mounting bushing secures mounting under extreme conditions of shock and vibration. The mounting bushing is insulated from the contact assembly by a nylon sleeve.

The contact assembly is silver plated with gold wash, providing low contact resistance with the test prod, and facilitating fast, strong solder connection at the solder terminal. The nylon insulator is available in nine colors.

Raytheon Mfg. Co., Dept. ED, 100 River St., Waltham 54, Mass.

CIRCLE 86 ON READER-SERVICE CARD FOR MORE INFORMATION

Servo Clutches

Have Adjustable Slip Torque

Three new model clutches are available in the array of Servoboard components.

The friction clutch unit provides clutch action only at a predetermined torque. The clutch can be set to slip at any torque from 2 in. oz for minimal settings to 20 in. oz for maximum friction.

The single drive magnetic clutch is used to electrically connect or disconnect two shafts at a predetermined torque or at previously set stages in operational sequence. Maximum power requirement is 30 v 27 amp. Output torque is 40 in. oz.

The reversing magnetic clutch is used either as a reversing clutch or as a two speed drive. A closed container holds the essential rotating solenoid (to which the shaft is attached) between two rotating coils. An end gear is attached to each coil housing. Maximum power requirement is 30 v, 27 amp. Output torque is 40 in. oz.

Servo Corp. of America, Dept. ED, 20-20 Jericho Tpke., New Hyde Park, N.Y.

CIRCLE 88 ON READER-SERVICE CARD FOR MORE INFORMATION

Precision Dials

By Process Engraving

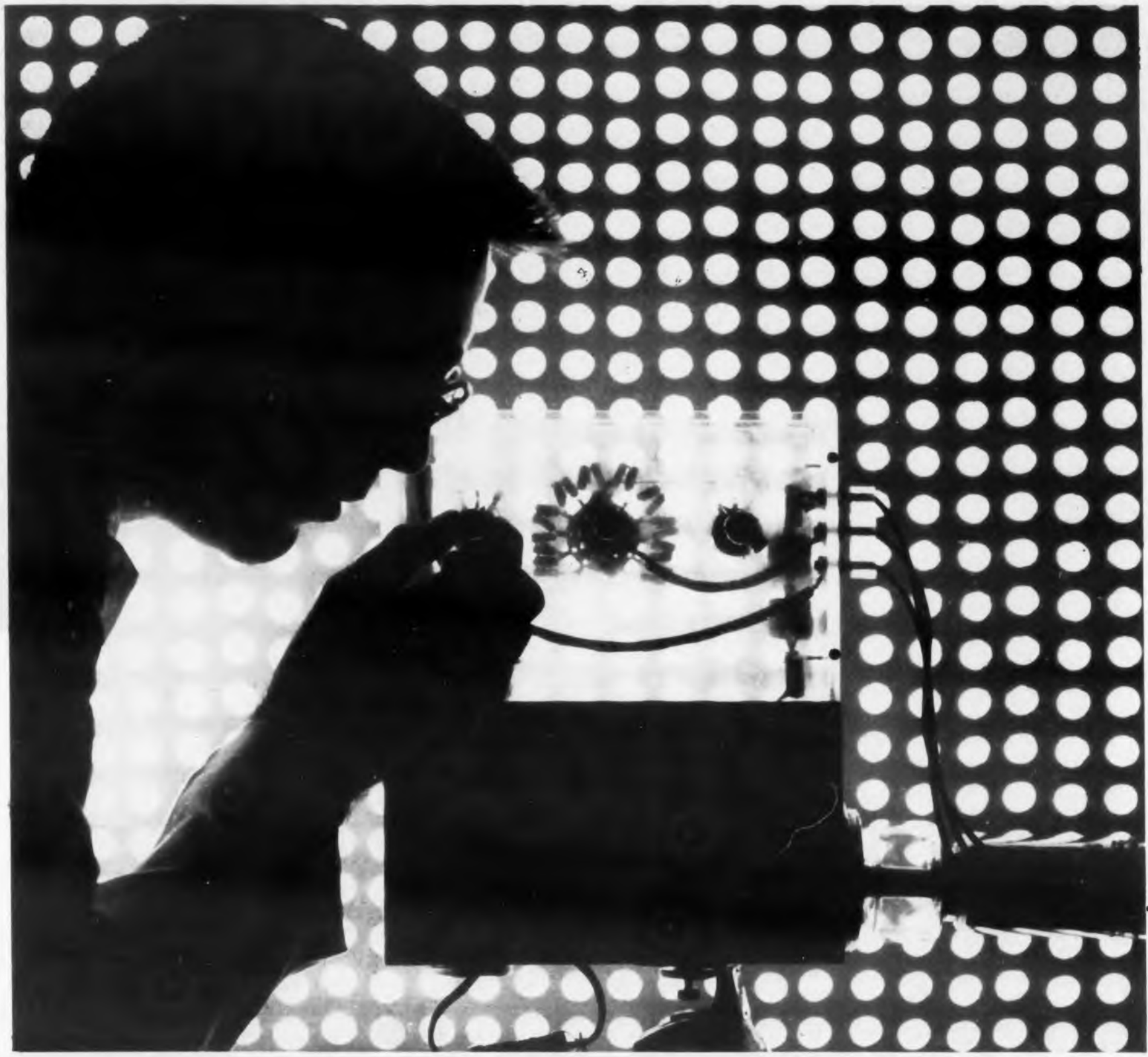
Precision instrument dials are reproduced with great accuracy by process engraving at low cost. Tolerance is as close as 2 minutes of arc, and graduations are kept concentric to locating holes within 0.0005 T.I.R. To achieve this accuracy a Master is engraved on optical flat glass and dials are reproduced photographically. The glass master enables the reproduced dials to have sharp, fine graduations; minimum graduation width being 0.002.

After processing is completed, the finish is solvent resistant and durable. Dials can be produced on metals and plastics such as, aluminum, brass, steel, laminicoid and plexiglas. Blank parts must be held to close tolerances before processing, as the accuracy of markings depends greatly on the accuracy of blank parts.

Ackerman Engravers, Dept. ED, 458 Broadway, New York 13, N.Y.

CIRCLE 89 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC WEEK



A HAYDEN PUBLICATION

October 8, 1956

Complete Electronic News Coverage—Every Week—From All Over The World

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High Sensitivity Relay

Shock-Resistant

The Model 266 VHS relay has been modified for operation under shock and vibration and ambient temperatures of —55 to 150 F. Sensitivities from 0.2 μamp to 10 amp, or 0.1 mv to 500 v —with external multipliers even higher ranges of volts or amperes can be furnished. AC relays have built-in silicon or germanium diodes, or copper oxide rectifiers, depending on the performance requirements. Trip point accuracy varies from 1 per cent to 25 per cent.

Single contact high limit or single contact low limit can be supplied as well as double contact. Contact ratings from 5 to 125 ma dc. The relay has a moving coil armature which rotates in the flux gap of an Alnico magnet, similar to microammeters. A locking coil develops additional torque to drive the contacts together with considerable pressure. Reset can be manual or automatic.

Assembly Products, Inc., Dept. ED, Desert Hot Springs, Calif.

CIRCLE 96 ON READER-SERVICE CARD FOR MORE INFORMATION

Pulse Transformers

For High Voltages

This line of pulse transformers is designed for very high voltage, peak power, and average power operation. Two typical units are a 120 kv, 2 μsec, 10 mw and a 500 kv, 2 μsec, 250 mw. The units are for immersion, without impregnation, in insulating transformer oil. For applications where the output voltage is to be exposed to air, tanked and hermetically sealed units are available.

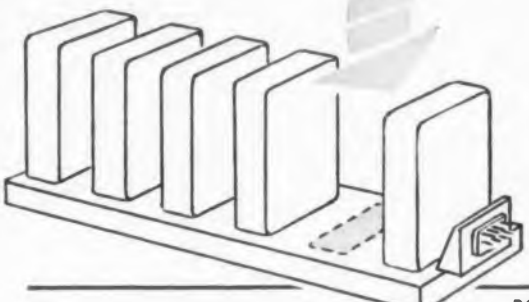
The transformers are used with klystrons, traveling wave tubes, particle accelerator injection guns, and other high voltage, high power pulse devices. Standard models cover a wide range of voltages, pulse lengths, impedances, rise and fall times and repetition rates.

Pearson Electronics, Dept. ED, 1200 Bryant St., Palo Alto, Calif.

CIRCLE 97 ON READER-SERVICE CARD FOR MORE INFORMATION

Lightweight! SERVO Magnetic Amplifiers

The servo amplifiers illustrated are typical standard types. Other models, including higher power types, are available for systems engineering. The complete MA line offers the designer a choice of compact, low cost types, amplifiers featuring fast response at high gain and all-magnetic models providing highest performance.



In addition to standard types, custom designs can be produced for special applications, or complete servo and automatic control systems can be engineered to your requirements.

TYPE	SUPPLY	POWER OUTPUT	SENSITIVITY	RESPONSE TIME—SEC.
LIGHTWEIGHT SUB-MINIATURE MAGNETIC AMPLIFIER	115 volts 400 cps.	½, 3, 5, 10 watts	.02 volts	.003
MAGNETIC PRE-AMP + SATURABLE TRANSFORMERS	115 volts 400 cps.	3, 5, 6, 10, 18 watts	1 volt AC	.03
MAGNETIC PRE-AMP + HIGH GAIN MAGNETIC AMPLIFIER	115 volts 400 cps.	5, 10, 15, 20 watts	0.1 volt AC	.008 to .1
TRANSI-MAG*: TRANSISTOR + HIGH GAIN MAGNETIC AMPLIFIER	115 volts 400 or 60 cps.	2, 5, 10, 15, 20 watts	.08 volt AC into 10,000 ohms	.01

Call or write for new illustrated bulletins.

Magnetic Amplifiers • Inc

632 TINTON AVE., NEW YORK 55, N. Y.—CYpress 2-6610

West Coast Division

136 WASHINGTON ST., EL SEGUNDO, CALIF. — EAstgate 2-2056

CIRCLE 100 ON READER-SERVICE CARD FOR MORE INFORMATION

Speed-Feed Meter

For Linear Travel

The MF-2 speed-feed meter measures and indicates linear rates of travel and rpm in a variety of applications. The linear speed pickup converts linear motion of any length of travel into an electrical signal. A meter gives the reading directly, with push-button selection of four scale ranges from 0-1 to 0-125 inches per minute. Models are available with four speed ranges or with combinations of linear rate and rpm scales. The small fixed tachometer pickup or a hand-held tachometer pickup have almost no loading effect on the driving source. Neither pickup or indicator can be harmed by overspeeding or sudden starts and stops.

Maico Co., Inc., Dept. ED, 21 North 3rd St., Minneapolis 1, Minn.

CIRCLE 101 ON READER-SERVICE CARD FOR MORE INFORMATION

Motormounting Cleat

For Synchros

These type L2 motor mounting cleats are to be used for all synchro, potentiometer motor, resolver, autosyn generator or any rotating component that has the synchro groove mounting or clamping ring. They come in 4 different heights for all sizes of steps, made of No. 303 stainless steel and clear passivated to meet Mil-specification.

PIC Design Corp., Dept. ED, Div. of Benrus Watch Co., Inc., P.O. Box "C," E. Rockaway, N.Y.

CIRCLE 102 ON READER-SERVICE CARD FOR MORE INFORMATION

Flush Clinch Nuts

Are Self-Locking

Clinch nuts combining flush mounting and self-locking features, the Kaylock line K7000, are miniature, lightweight, and self-locking. They effect weight savings up to 87 per cent, resist temperatures up to 550 degrees, and they meet AN-N-10 full strength requirements.

The Kaynar Co., Kaylock Div., Dept. ED, Box 2001, Terminal Annex, Los Angeles 54, Calif.

CIRCLE 103 ON READER-SERVICE CARD FOR MORE INFORMATION

Printed Circuit Connector

Feed-Thru Feature

Solder lugs of two printed circuit receptacles are permanently soldered together to form a single feed-thru connector which accommodates a printed circuit board on each side. Available in 6, 10, 15, 18 and 22 contacts (single or dual) with molding compounds of mineral filled Melamine or Plaskon reinforced (glass) Alkyd 440A, the contacts accommodate a printed circuit card thickness of 0.051 to 0.071 in. Overall depth of the combined connector is 0.86 in.

DeJUR AMSCO Corp., Dept. ED, 4501 Northern Blvd., Long Island City 1, N.Y.

CIRCLE 105 ON READER-SERVICE CARD FOR MORE INFORMATION

Sampling Switches

Precision Phasing

No force or phase adjustments are required in these switches which provide constant force brushes, and precision phasing. Available with one to three poles, up to 60 shorting or 30 nonshorting channels per pole, with 6, 12, or 28 v dc motor, shielded rf filter, spur gear reduction, and speed governor. Plugs are recessed and mounted into housing.

Approximate dimensions as shown 3.625 in. sq by 2.687 in. high. The units come hermetically sealed or with 400 cy ac motor.

General Devices Inc., Dept. ED, Princeton, N.J.

CIRCLE 106 ON READER-SERVICE CARD FOR MORE INFORMATION

Silicon Rectifiers

10 Kw Miniatures

A new series of miniature, 10-kw silicon rectifiers are capable of operation in an ambient temperature range of from —65 C. to 200 C. Combinations of the new rectifiers will allow power output ratings of 1000 kw and above. In most circuits the new rectifiers have efficiency ratings of 99 per cent. Because of a lack of aging effects, it is unnecessary to derate them for industrial or military applications for long life.

General Electric, Semiconductor Products Dept., Dept. ED, Electronics Park, Syracuse, N.Y.

CIRCLE 107 ON READER-SERVICE CARD FOR MORE INFORMATION

Drafting Lead Holder

Has Firm Clutch

A lead holder which offers positive protection against lead slippage and turning, the Damascus, possesses a self-cleaning clutch which eliminates build-up and clogging from graphite particles and holds the lead in a tenacious, immovable grip.

The hardened-steel clutch and socket assures maximum life and resists abrasives when sharpening points. It has a spring-loaded release mechanism which grasps the lead securely and operates quickly. The barrel is of anodized aluminum.

Richard Best Pencil Co., Dept. ED, Springfield, N.J.

CIRCLE 110 ON READER-SERVICE CARD FOR MORE INFORMATION

Ferrite Isolator

High-Power

The field displacement resonance absorption technique with the ferrite material acting as a resonant dielectric waveguide, is being applied to this line of ferrite isolators.

A new high power displacement absorption ferrite isolator, Model W-167-1A, is rated at 200 kw peak and 300 w average. Isolation is 17 db minimum and insertion loss is 0.5 db maximum. V.S.W.R. approximately 1.1—unit weight is 18 ozs and insertion length 1.75 ins.

Kearfott Co., Inc., Dept. ED, Western Div., 253 N. Ninedo Ave., Pasadena, Calif.

CIRCLE 111 ON READER-SERVICE CARD FOR MORE INFORMATION

Printed Circuit Connector

Has 15 Coded Contacts

A new connector developed for pressurized printed circuits, has 15 coded contacts mounted in Orlon filled molding compound. Design permits either horizontal or vertical mounting. A potting shell is supplied with the connector. Wiring feeds through holes in potting shell, which line up with right angle solder lugs. In assembly of printed circuit, a rubber boot fits over the printed circuit board to form a moisture-proof assembly.

DeJur-Amsco Corp., Electronic Sales Div., Dept. ED, 45-01 Northern Blvd., Long Island City 1, N.Y.

CIRCLE 112 ON READER-SERVICE CARD FOR MORE INFORMATION

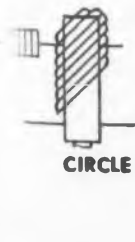
for small coils with big power -call TUR-BO JET

We'll build more ampere-turns into your small-wire magnet coils than you can—and at a lower cost. Tur-bo Jet coils—relay types for example—pull in at lower voltages, and air gap becomes less critical. You can use stronger spring action, and eliminate 50% of need for fine adjustments during assembly.

In boosting your coil power, we find ways to use larger wire and more turns, without increasing resistance or size of coil. Or we'll reduce your coil size without loss of power. Tur-Bo Jet's highly efficient techniques result in prices less than your cost-to-produce.

Winders of Mylar* bobbin and self-supporting relay coils, solenoid coils and chokes—vacuum impregnated to your specifications, and non-gassing types. Designed to meet class "H" and all A & N specifications. Fast prototype service. Write for literature: "Coil Information".

*DuPont trademark



TUR-BO JET
PRODUCTS CO., INC.
424 S. San Gabriel Blvd.
San Gabriel, Calif.

CIRCLE 114 ON READER-SERVICE CARD ➤

Shaft Mounted Motor

For Automatic Control

Designed to provide remote and automatic control, this shaft-mounted gear motor, called Shaftrol, mounts readily on shafts from 1/4 in. to 7/8 in. diam. Light and compact with both the housing and cover made of aluminum, it is furnished with a torque arm or torque plate with resilient mounting. It can be equipped with linear bushings to allow axial movement.

Speeds from 1/2 rpm to several hundred rpm can be had from the standard units. They can be had to reproduce torques from a few in. ozs to several in. lbs. Single phase Shaftrols use an instantly reversible permanent split capacitor motor and three-phase units are available in the larger sizes. They can be furnished for face or foot mounting with a wide variety of output shafts including pinion-on-shaft designs.

They provide overload protection both for themselves and for the controlled equipment, while smaller units are suitable for continuous duty under "locked rotor" conditions without damage to the motor or to the gearing.

The Jordan Co., Dept. ED, 3235 W. Hampton Ave., Milwaukee 9, Wisc.

CIRCLE 115 ON READER-SERVICE CARD FOR MORE INFORMATION

Supersensitive Meter Relays

Are Non-Locking

An improved series of meter relays feature platinum alloy contacts and increased contact force, which minimizes sticking and provides high reliability. Operating on power inputs of less than 50 mμw, the new relays will control up to one watt, a power amplification of 20 million.

They are of a non-locking type, currently available in 2 in. dc and 3 in. ac and dc models as microammeters, milliammeters, ammeters, millivoltmeters and voltmeters. Pyrometer types with bimetal compensation are also available, as well as four contact arrangements. The housing, bezel and ring are black phenolic with glass front and bezel removable. Front and back are dust-tight and splashproof.

Simpson Electric Co., Dept. ED, 5200 W. Kinzie St., Chicago 44, Ill.

CIRCLE 116 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 117 ON READER-SERVICE CARD ➤

11 million operations without a miss on low-energy switching test!

New test proves outstanding reliability of General Electric's Miniature relays

Laboratory tests using standard, production relays have confirmed the remarkable performance of General Electric Miniature relays on low-energy switching applications. These hermetically sealed relays made contact 11 million times without failure—switching 25 microamps at 50 millivolts—indicating permanent reliability.

This low-energy performance is combined with proved mechanical life. On one typical application, several of these relays continued to function after 300 million switching operations.

A key reason for this outstanding reliability is extremely high (40 to 55 grams) tip pressure—designed into all Miniature relays. Ample wear allowance provided by G-E engineers also contributes to extra-long life.

Description: Available in standard, current-sensitive, and voltage-sensitive models; in 2-, 3-, or 4-pole double-throw and 6-pole normally open forms. Rated 5 amps at 28 volts DC at 85C.

OTHER G-E RELAYS TO MEET YOUR NEEDS

1 **Micro-miniature relay:** Weighs .35 oz; rated 2 amps resistive at 28 v DC or 115 v AC. Also, current-sensitive model. Standard relays withstand ambient temp of 125C.

2 **2PDT sub-miniature relay:** 2 amps; .651 in. in diameter, 1.6 in. long; weighs one ounce. Withstands shock tests in excess of 50Gs. Available in wide variety of coil ratings.

3 **High-speed 4PDT relay:** Especially designed for use where operation as fast as 500 microseconds is required. Ideal for applications like ground-based radar, multiplexing of electronic signals, and computer circuits.

MAIL TODAY FOR SEALED-RELAY DATA

General Electric Co., Sect. E792-5, Schenectady 5, N. Y.

☐ Miniature—Bulletin GEA-6213
☐ Micro-miniature—Bulletin GEA-6346
☐ 2PDT sub-miniature—Bulletin GEA-6412
☐ High-speed 4PDT miniature—Bulletin GEA-6212
☐ HAVE G-E SALES ENGINEER CALL

NAME ..... TITLE .....

COMPANY .....

ADDRESS .....

CITY ..... STATE .....

GENERAL ELECTRIC

WHAT ADVANCED COMPONENTS and Assembly Methods are in Sight?

FIND OUT IN DESIGN '57—JAN. 1ST ED

Phone Jacks

Meet Military Specs

These Han-D Jacks, requiring a minimum of panel space and depth behind panel, assure electrical contact with pressure from nickel silver springs. Notched insulating washers that engage both spring blades and terminals provide a locking arrangement that restricts shifting of electrical connections or changes in adjustment.

Currently supplied in three models, No. 334 (Jan Type JJ-034) is a 2 conductor open circuit jack, No. 389 (Jan Type JJ-089) provides a 2 conductor closed circuit, No. 333 (Jan Type JJ-033) is a 3 conductor open circuit type. All have heavy brass nickel plated frames and fit any standard mating plug.

Richards Electrocraft, Dept. ED, 3741 N. Kedzie Ave., Chicago 18, Ill.

CIRCLE 120 ON READER-SERVICE CARD FOR MORE INFORMATION

Flyback Analyzer

And Capacitor Checker

A new television tester combines both an in-circuit horizontal system analyzer and a capacitor checker in one unit.

It will check an entire TV horizontal deflection system, in-circuit, test flyback transformers for opens and shorts, check deflection yokes for opens and shorts, measure capacitances from 10 μμf to 0.1 μfd by direct reading. It registers with better than 10 per cent accuracy, and can be used as a continuity meter.

The Model 382 has a 4-1/2 microammeter with 60 μamp, full scale sensitivity. Capacitance measurements are read from three of the meter's scales. It uses a single *6K6* tube in an oscillator circuit for the measurement of Q of horizontal circuit components, and an ac ohmmeter type circuit for continuity and capacitance measurements. Operation is on 110-125 v, 60 cycle ac, and a special test cable is included.

Simpson Electric Co., Dept. ED, 5200 W. Kinzie St., Chicago 44, Ill.

CIRCLE 121 ON READER-SERVICE CARD FOR MORE INFORMATION

5-Inch Scope Kit

With Printed Circuits

The Knight-Kit scope is designed for general purpose high frequency applications. Included among its features are a sweep range from 15 to 150,000 cps in 4 ranges; vertical response is down only 3 db at 700 kc (1000 cycle reference); high vertical sensitivity, 25 rms mv/in.; 1-v peak-to-peak, square wave, regulated calibrating voltage internally injected by front panel switch; horizontal amplifier is down only 3 db at 200 kc (1000 cycle reference); directly coupled positioning controls assure fast positioning of trace on both horizontal and vertical, free of overshoot.

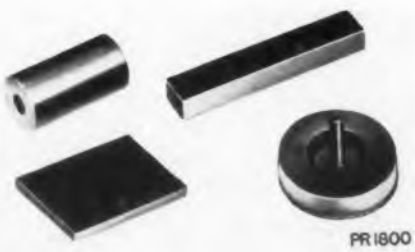
The kit is supplied complete with all tubes, including CRT; steel case with disappearing handle, all parts; plus detailed instructions and diagrams and is listed as Allied Stock Number, 83 YZ 146.

Allied Radio Corp., Dept. ED, 100 N. Western Ave., Chicago 80, Ill.

CIRCLE 125 ON READER-SERVICE CARD FOR MORE INFORMATION

Lead-Plastic Compound

For Molded Shielding



A new lead-plastic compound, leadcast, is suitable as shielding for radio-active materials, and adaptable to methods for precision molding of the material.

A plastic compound containing 95 per cent lead, it is both harder than and has a structural rigidity greater than pure lead. It may be molded with any structural members and into any shape within a tolerance of ±0.0005 in. The surface requires no finishing and is inert to oxidation or other corrosive contamination.

The amount of lead can be varied up to 95 per cent by weight, and hardness can be controlled from that of a semi-rubber like material to that of cast aluminum.

Telectro Industries Corp., Dept. ED, 35-18 37th St., Long Island City 1, N.Y.

CIRCLE 126 ON READER-SERVICE CARD FOR MORE INFORMATION

We have present openings for experienced Electronic Engineers in the design and development of ground radar systems, airborne transmitters and receivers and in the electrical systems of guided missile fuzes.

We also have a need for Mechanical, Aeronautical and Structural Engineers of the same experience levels in the design of servomechanisms, the design of large, light-weight structures of the airframe variety and the design and layout of electronic and electromechanical chassis and packages.

In the computer field, we have a need for Physicists and Mathematicians for the programming and solution of engineering problems utilizing analog computers and IBM equipment. Experience in the development of new applications and techniques for digital and analog computers combinations is also desirable. Attractive openings also available for Packaging Engineers, Technical Writers and Illustrators.

CROSLEY'S continued and extraordinary success in the sphere of government electronics, has placed the name of CROSLEY as one of the forerunners in this ever-expanding field. Our present and anticipated demands call for additional engineering personnel at all levels. CROSLEY offers you a partnership in its continued expansion program—"A Partnership in Opportunity."

CROSLEY has numerous company benefits including a group insurance and retirement plan, subsidized educational program, periodic merit reviews and up to three weeks paid vacation after five years. We would also pay relocation expenses including moving expenses, reporting to work pay, family transportation and a generous subsistence allowance.

Please send your resume to Director of Engineering

Crosley Division
AVCO

Dept. 121

CIRCLE 127 ON READER-SERVICE CARD FOR MORE INFORMATION

RADIO INTERFERENCE AND FIELD INTENSITY *measuring equipment*

Stoddart equipments are suitable for making interference measurements to one or more of the following specifications:

AIR FORCE—MIL-I-6181B
150 kc to 1000 mc

BuAer—MIL-I-6181B
150 kc to 1000 mc

BuShips—MIL-I-16910A (Ships)
14 kc to 1000 mc

SIGNAL CORPS—MIL-I-11683A
150 kc to 1000 mc

SIGNAL CORPS—MIL-S-10379A
150 kc to 1000 mc

The equipments shown cover the frequency range of 14 kilocycles to 1000 megacycles.

Measurements may be made with peak, quasi-peak and average (field intensity) detector functions.

F.C.C. PART 15—Now in effect, the revised F.C.C. Part 15 places stringent requirements upon radiation from incidental and restricted radiation devices. Stoddart equipment is suitable for measuring the radiation from any device capable of generating interference or c-w signal within the frequency range of 14 kc to 1000 mc.

Write Stoddart Aircraft Radio Co., Inc., for your free copy of the new revised F.C.C. Part 15.

NM-10A (AN/URM-6B)
14 kcs to 250 kcs

NM-20B (AN/PRM-1A)
150 kcs to 25 mcs

NM-30A (AN/URM-47)
20 mcs to 400 mcs

NM-50A (AN/URM-17)
375 mcs to 1000 mcs

The **Stoddart NM-40A** is an entirely new radio interference-field intensity measuring equipment. It is the commercial equivalent of the Navy type AN/URM-41 and is tunable over the audio and radio frequency range of **30 CPS to 15 kc.** It performs vital functions never before available in a tunable equipment covering this frequency range. Electric and magnetic fields may be measured independently over this range using newly developed pick-up devices. Measurements can be made with a 3 db bandwidth variable from 10 CPS to 60 CPS and with a 15 kc wide broadband characteristic.

STODDART *Aircraft Radio Co., Inc.*

6644-J SANTA MONICA BLVD., HOLLYWOOD 38, CALIFORNIA · Hollywood 4-9294

CIRCLE 129 ON READER-SERVICE CARD FOR MORE INFORMATION

9-Speed Direct Drive

For Recording Equipment

This 9 speed direct-shaft drive is designed for better recording equipment. Using two specially developed synchronous continuous duty motors, one worm gear and synthetic notched belts, the drive provides smooth, positive speeds of 16-2/3 33-1/3 - 45 - 66-2/3 - 78.26 - 90 - 156.52 rpm plus two additional speds useful in lab work.

Damon Recording Studios, Inc., Dept. ED, 117 W. 14th St., Kansas City 5, Mo.

CIRCLE 130 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnetic Tape Head

For Stereo Sound

This magnetic head has been designed for high quality recording and reproduction in stereophonic sound applications. The head can be compensated for flat response between 30 and 10,000 cps at 7.5 in. per sec. It is compact and has negligible oxide accumulation, excellent rejection of surrounding fields, and uniformity of frequency and amplitude response.

The Nortronics Co., Dept. ED, 1015 S. 6th St., Minneapolis 4, Minn.

CIRCLE 131 ON READER-SERVICE CARD FOR MORE INFORMATION

Photorelay

Compact Control

A new photoelectric control utilizes a broad area cadmium sulfide photocell and a relay, which are mounted on a 5-pin plug-in base and housed in a dust can measuring 1-1/2 in. square x 2-1/4 in. high.

This Model 1 photorelay operates at five foot-candles or less, releases at 0.1 fc or more, at a guaranteed speed of two operations per second. Supply voltage is 115 ac, 50 to 60 cycles and temperature range is —40 C to +75 C.

Sigma Instruments Inc., Dept. ED, 59 Pearl St., South Braintree, Boston 85, Mass.

CIRCLE 132 ON READER-SERVICE CARD FOR MORE INFORMATION

Planetary Gear Box

Wide Range of Radio Speeds

A small planetary gear box, ideal where small size and intermittent service are required, is available in ratios from 4 1/7 to 40,188. Output torque varies from 100 in. lbs at the low ratio to 250 in. lbs at higher ratios.

Ball bearings on input shaft and oilite bearings on output and planets together with hardened gears will provide long service. The TA-120 reducer can be furnished with leg or flange mounting and various housings.

Arizona Gear & Mfg. Co., Dept. ED, 3544 E. Ft. Lowell Rd., Tuscon, Ariz.

CIRCLE 135 ON READER-SERVICE CARD FOR MORE INFORMATION

Phenolic Laminate

For Cold Punching

A new paper-base phenolic laminate with excellent electrical properties has the added benefits of cold punching and cold shearing characteristics. This P-25 material punches clean and sharp at room temperature, eliminating hot punching shrinkage allowances. It is especially recommended for copper clad laminates used in printed circuitry.

P-25 has high insulation resistance and low dielectric loss at high frequencies—even under extreme humidity conditions. It is available in plain sheet form or copper clad.

Synthane Corp., Dept. ED, Oaks, Pa.

CIRCLE 136 ON READER-SERVICE CARD FOR MORE INFORMATION

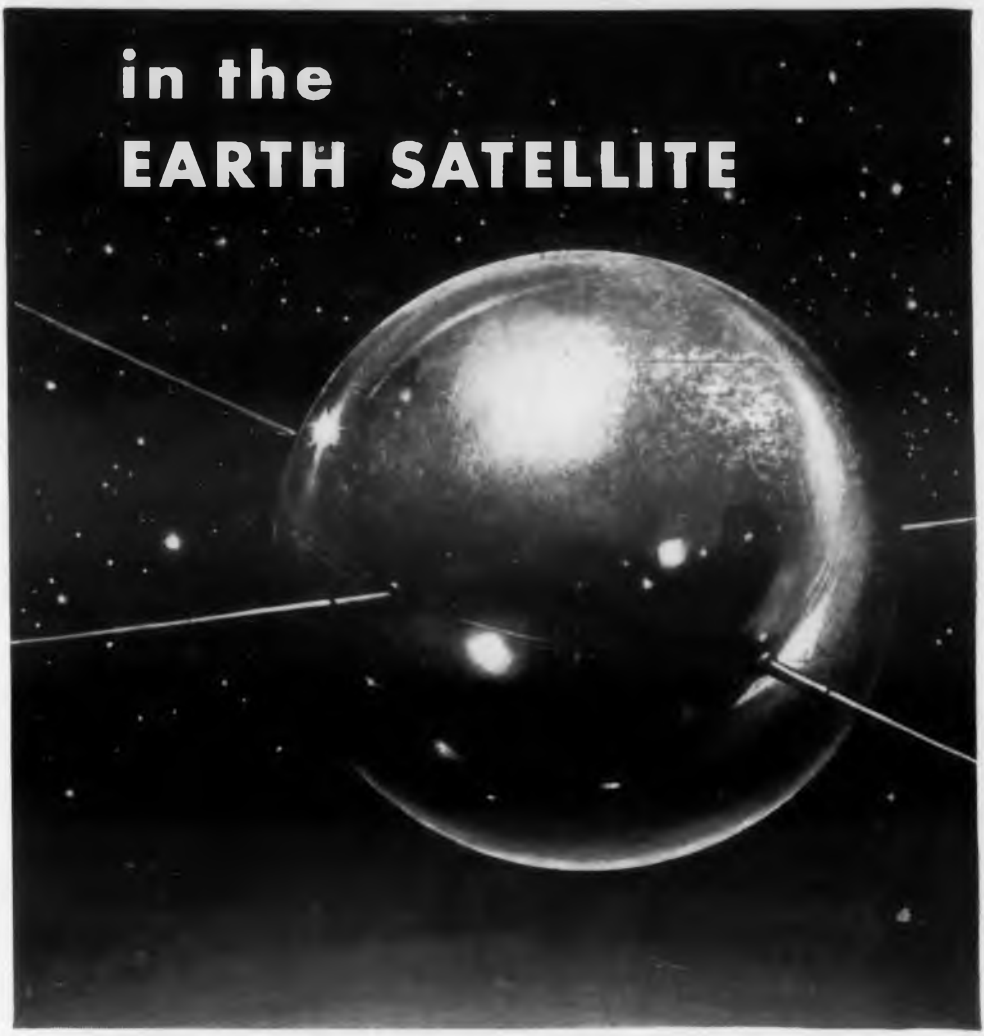
Heating Cartridges

For Instrumentation

These ceramic-body heating cartridges come in units as small as 5/32 in. in diameter and 1 in. in length. Wattage ratings are available to provide densities up to 50 w per sq in. There is a wide selection of terminal configurations. The nickel alloy leads are swaged to rigid external terminals to facilitate repair of damaged leads.

Hotwatt, Inc., Dept. ED, 16 Gould St., Danvers, Mass.

CIRCLE 137 ON READER-SERVICE CARD FOR MORE INFORMATION



...Chemelec Insulators

To withstand the shock, vibration and extreme temperatures involved in acceleration to 18,000 m.p.h., Chemelec (TEFLON*) Stand-off and Feed-Through Insulators were selected for use in the 10-pounds of vital instruments nestling inside the earth satellite.

Chemelec compression-type insulators are replacing brittle materials in many electronic devices which must withstand rigid government tests, because they offer the highest quality—electronically and mechanically—without increasing costs . . . due to the assembly savings they provide.

Simply press into position—no additional hardware.

Write for Catalog EC-756. FLUOROCARBON PRODUCTS INC., Division of United States Gasket Company, Camden 1, New Jersey.

made of du Pont TEFLON

*du Pont trademark for its tetrafluoroethylene resin.

Sold through leading electronic parts distributors by Erie Resistor Corp.

Fluorocarbon Products Inc.

CIRCLE 138 ON READER-SERVICE CARD FOR MORE INFORMATION

Voltage Stabilizers

Have Close Tolerances

A new series of constant voltage stabilizers have ±1 per cent voltage tolerance, and complete recovery within two cycles. Output voltage stabilization is automatically obtained by a parallel combination of a fixed capacitance and a magnetic core inductance to provide the variable capacitive current.

The stabilizers cannot be damaged by overloading, for as the per cent of overload increases, the output voltage decreases up to zero output voltage.

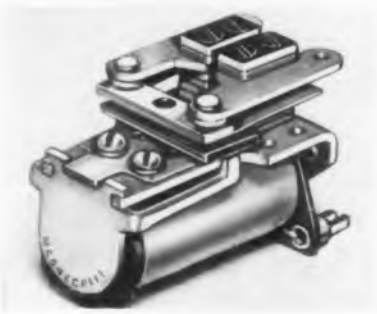
The 15, 25 and 50 VA units can be supplied with the output voltages of 6.3 v or 115 v. Units of 100 to 500 VA capacity are available with input of 95 to 130 v and output of 115 v.

Acme Electric Corp., Dept. ED, Cuba, N.Y.

CIRCLE 140 ON READER-SERVICE CARD FOR MORE INFORMATION

Small Relay

For Heavy Currents



Reliable switching of heavy current in limited space through long service life is achieved by a new Class 22D telephone type relay.

Specially designed double break contacts switch up to 20 amps, non-inductive load. Contacts are single pole, single throw, normally open.

Overall dimensions are 2-1/16 in. long, 1-9/16 in. high, 1-1/16 in. wide. Available for operating voltages to 230 dc and 440 v, 60 cy ac.

Magnecraft Electric Co., Dept. ED, 3350D W. Grand Ave., Chicago 51, Ill.

CIRCLE 141 ON READER-SERVICE CARD FOR MORE INFORMATION

Substitution Box

Has Variable R and C

The X-Checker is a substitution box with a continuously variable resistor and capacitor which may be inserted alone or in series combination in an electronic circuit. The resistance range is from 0 to 2500 ohms. The capacitance range is 20 to 450 μμf.

Ram Electronics, Dept. ED, Irvington-on-Hudson, N.Y.

CIRCLE 142 ON READER-SERVICE CARD FOR MORE INFORMATION

Advertisement

New CTC Shielded Coil Form has wide range of applications

Shown actual size

CTC's new shielded coil form LS-12 for printed circuits features a square shaped plated brass housing ½" x ½" x ½", with internally adjustable powdered iron core, tunable from top or bottom. The unit mounts by two tabs that can be inserted through a printed circuit board and the whole assembly can be dip-soldered from one side of the board at one time.

Equipped with two to six terminals, the LS-12 covers a wide range of applications from simple RF uses with conventional vacuum tube circuitry to IF transformers using transistors, where as many as six terminals may be required. The unit has a cup core assembly.

This assembly, with internal design similar to CTC's LS-9, 10 and 11, extends into the printed circuit field, the family of shielded coil forms made by the company. The LS-12 units are available as forms alone or wound to customer's applications.

For complete specifications, information and prices write Cambridge Thermionic Corporation, 457 Concord Avenue, Cambridge 38, Massachusetts.

CIRCLE 145 ON READER-SERVICE CARD FOR MORE INFORMATION

WHAT IMPORTANT DEVELOPMENTS Will Affect the Design of Microwave Equipment? Components? General Communication? SEE DESIGN '57—JAN. 1ST ED

Rack Panel Scope

Uses Square CRT

A new rack panel oscilloscope provides the equivalent of a 5 in. diameter viewing tube on its 3-1/2 in. square cathode ray tube. Model K-10-R uses printed circuits throughout. Sensitivity is 0.028 v per in., Z-axis intensity modulation is 2 to 56 v peak (negative) depending on intensity setting required to blank the beam. Input impedance to the vertical amplifier is 2 Mohm, and frequency response of vertical amplifier is flat to dc, 3 db at 300 kc. The linear sweep time base is 2 cps. to 30 kc, external capacitor position for slower sweeps. Positioning permits examination on screen of any portion of the sweep expanded to 8 times full screen diameter. Internal, external or line synchronization.

Electronic Tube Corp., Dept. ED, Philadelphia, Pa.

CIRCLE 147 ON READER-SERVICE CARD FOR MORE INFORMATION

Battery Eliminator

and Vibrator Checker

A combination battery eliminator and vibrator checker, EMC Model 905-6A, can supply 6 v at 10 amp or 12 v at 6 amp continuously. The output voltage is continuously variable from 0 to 8 v or from 0 to 16 v with smooth dc output voltage assured. Able to check both 6 v and 12 v vibrators, the unit checks both interrupter and self-rectifier types for proper starting point as well as quality of operation. It can be used as a battery charger and is housed in a single sloping rugged metal case.

Electronic Measurements Corp., Dept. ED, 625 Broadway, New York 12, N.Y.

CIRCLE 148 ON READER-SERVICE CARD FOR MORE INFORMATION

X-Band Isolator

Miniature

The Model X-146 X-band isolator which offers many advantages in applications where minimum size and weight are important considerations. This new isolator is 2-7/8 in. long, 1-7/8 in. high and weighs only 25 oz.

Frequency range is 8.6 to 9.6 kme over which VSWR is less than 1.1, (typically 1.04), forward attenuation is 0.5 db. Load isolation is 9 db at band edges and 12 db at band center. Power rating, (into load with VSWR is 2.1) is 125 w average and 150 kw peak.

Cascade Research Corp., Dept. ED, 53 Victory Lane, Los Gatos, Calif.

CIRCLE 152 ON READER-SERVICE CARD FOR MORE INFORMATION

Polarized AC Bridge

And DC Shunt Box

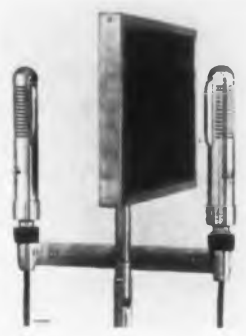
This new combined shunt box and Wheatstone bridge facilitates electrical measurements in chemistry and physics. The CM-21A Poly-Functionist uses a 10 Kohm 10 turn Helipot control alternatively as a calibrated shunt for the measurement and recording of dc currents or as the measuring arm of an ac or dc Wheatstone bridge. When used as an ac bridge, it delivers a polarized dc output signal; it is positive if the resistance being measured is lower than the balancing value and negative if it is higher. Thus the instrument provides the possibility of making measurements in a calibrated unbalanced bridge condition with proper discrimination between above-par and below-par ac resistances in the same manner in which a dc bridge indicates a deviation of a resistance beyond and below the balance point.

Millivac Instrument Corp., Dept. ED, 444 Second St., Schenectady, N. Y.

CIRCLE 153 ON READER-SERVICE CARD FOR MORE INFORMATION

Microphone Rig

For Stereo Recording



A simple method of positioning two microphones for stereo recording has resulted in what is now called the Fen-Tone B&O binor rig. This rig utilizes the polar characteristics of a velocity microphone; that is, a spiral and logarithmic increase in sensitivity from the side towards the front or back. If two microphones are placed approximately 10 in. apart and each faces 45 degrees away from the front of the rig, the side portion of the polar pattern is utilized.

Fenton Co., Dept. ED, 15 Moore St., New York 4, N.Y.

CIRCLE 159 ON READER-SERVICE CARD FOR MORE INFORMATION

Pulse Transformers

Plug-in Miniature

Featuring high reliability, these pulse transformers are mounted in several types of encasements. Type A is designed to be plugged into a seven pin miniature tube socket; Type B is designed for mounting on printed circuit boards and Type D is a molded unit for direct soldering as a permanent component.

The transformers are encapsulated in exopy resin or hermetically sealed in metal can.

Electronic Computer Co., Dept. ED, 6191 Ridge Ave., P.O. Box 5826, Philadelphia 28, Pa.

CIRCLE 160 ON READER-SERVICE CARD FOR MORE INFORMATION

Shock Mounting

Highly Damped

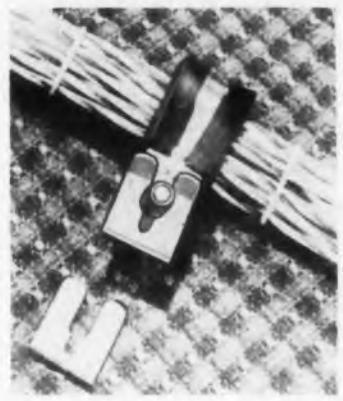
A new 125500 Series diagonal spring "Equiflex" vibration isolator and shock mounting features all-metal construction, nonlinear spring characteristics, high damping, and all-positional or all-attitude performance. It withstands hours of resonance with input of 0.036 in. double amplitude with equipment mounted either horizontally or vertically, and has low amplification at resonances—approximately 2 times input.

The Ucinite Co., Div. of United-Carr Fastener Corp., Dept. ED, Newtonville 60, Mass.

CIRCLE 161 ON READER-SERVICE CARD FOR MORE INFORMATION

Clip Fastener

For Wiring Bundles



A steel fastener clip, designed for sliding around the bolt of a wiring or hose clamp, holds tension during arranging and screwing on the nut.

The Clip-It device can be inserted around a clamp bolt to fasten or release the clamp's prongs for adjustments while arranging wiring bundles and lines on jigboards, or when fastening hose.

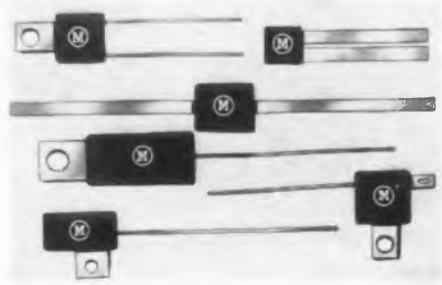
A slot extending halfway into the clip is engineered to snugly grip the inside thread diameter of the clamp's bolt. One end is bent upward for handling. It is effective as a washer, or may be taken off after the use as a grip and re-used.

Pastushin Industries, Inc., Dept. ED, 5651 W. Century Blvd., Los Angeles 45, Calif.

CIRCLE 165 ON READER-SERVICE CARD FOR MORE INFORMATION

Ceramic Capacitors

Have Ribbon or Tab Leads



These subminiature ceramic capacitors are produced with a great variety of wire, ribbon or tab leads to fit a wide range of terminal requirements.

Where high capacitance is required, connecting leads are available for any desired number or thickness, radially or axially arranged. Lower inductance for ultra-high frequency is obtained with ribbon leads. The shapes of the ceramic elements vary from square to rectangular with thickness as little as 0.065 in. if needed. Where larger values of capacitance are required in the same area, two or more plates are stacked and connected in parallel.

Mucon Corp., Dept. ED, 9 St. Francis St., Newark 5, N.J.

CIRCLE 166 ON READER-SERVICE CARD FOR MORE INFORMATION

HOW FAR WILL COMPUTERS Penetrate Industrial Applications in '57?

READ DESIGN '57—JAN. 1ST ED

Staggered starting of electric motors...

AGASTAT

Time / Delay / Relay

AGASTAT allows you to stagger the starting of three motors without imposing their load on the line at the same time.

The **AGASTAT** is
- electrically actuated, pneumatically timed.
- light, versatile, dependable.
- instantaneous recycling.
- adjustable in timing from 0.1 second to more than 10 minutes.
- available in AC or DC models which offer delays on energizing and de-energizing, manually-actuated time delay switch, remote push button control, hermetically-sealed units.

Write our application engineers for help with your timing problem. Address Dept. A25-1224.

AGA DIVISION

Elastic Stop Nut Corporation of America

1027 Newark Avenue, Elizabeth, New Jersey
Pioneers in pneumatic timing.

CIRCLE 169 ON READER-SERVICE CARD FOR MORE INFORMATION

Type 1454-A
Decade Voltage Divider: $145.00

Precision Voltage Divider

for D.C. and AUDIO Frequencies

for Calibration of Meters

Linearity Measurements on Continuously-Adjustable Transformers & Resistors

Measurements of Gain and Loss in Amplifiers, Attenuators, Filters

Precise Measurements of Frequency Response of Audio Networks

Voltage Ratio: .0001 to 1.0000 in steps of .000100

Frequency Characteristics: Error less than 0.1% to 20 kc if external shunt capacitance across output is less than 50 $\mu\mu$f

Temperature Coefficient of Voltage Ratio: Very near zero at normal room ambient temperatures

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Massachusetts, U.S.A.

Broad[illegible]enue at Linden, Ridgefield, N. J. **NEW YORK AREA** 920 S. Michigan Ave. **CHICAGO 5**
1150 York Road, Abington, Pa. **PHILADELPHIA**
1055 [illegible] St., Silver Spring, Md. **WASHINGTON, D. C.** 1000 N. Seward St. **LOS ANGELES 38**

CIRCLE 170 ON READER-SERVICE CARD FOR MORE INFORMATION

HOW WILL COLOR TV Affect the Component Parts Picture?
GET YOUR COPY OF DESIGN '57—JAN. 1ST ED

Electromagnetic Clutch
Has Double Input

These miniature electromagnetic clutches have one input gear hub normally clutched to the output shaft while the opposite end input hub is free turning. When energized the input hub is clutched to the output shaft and the other hub is free turning.

The MBC units are suited for use as a speed or direction changer in servo type applications. All units will withstand vibration as specified in MIL-E-5272A and operate on dc voltage.

A. J. Thompson, Inc., Dept. ED, Rte 1, Box 812, Florissant, Mo.

CIRCLE 171 ON READER-SERVICE CARD FOR MORE INFORMATION

50-Contact Plugs
Withstand Stress

New 50 contact plugs and receptacles feature a vise-action screw lock mechanism for maintaining positive mating under unusual physical stress. The connectors have a voltage rating of 750 v rms 60 cps at sea level.

Shells are aluminum, hinge hardware is cadmium-plated brass for extra strength and the handle and screw assembly is made of stainless steel. Male contacts are silver-plated tellurium copper. Female contacts are silver-plated leaded commercial bronze, and dielectric is brown phenolic. Connectors are available with either extended solder cup contacts or with taper pin contacts.

Amphenol Electronics Corp., Dept. ED, 1830 S. 54th Ave., Chicago 50, Ill.

CIRCLE 172 ON READER-SERVICE CARD FOR MORE INFORMATION

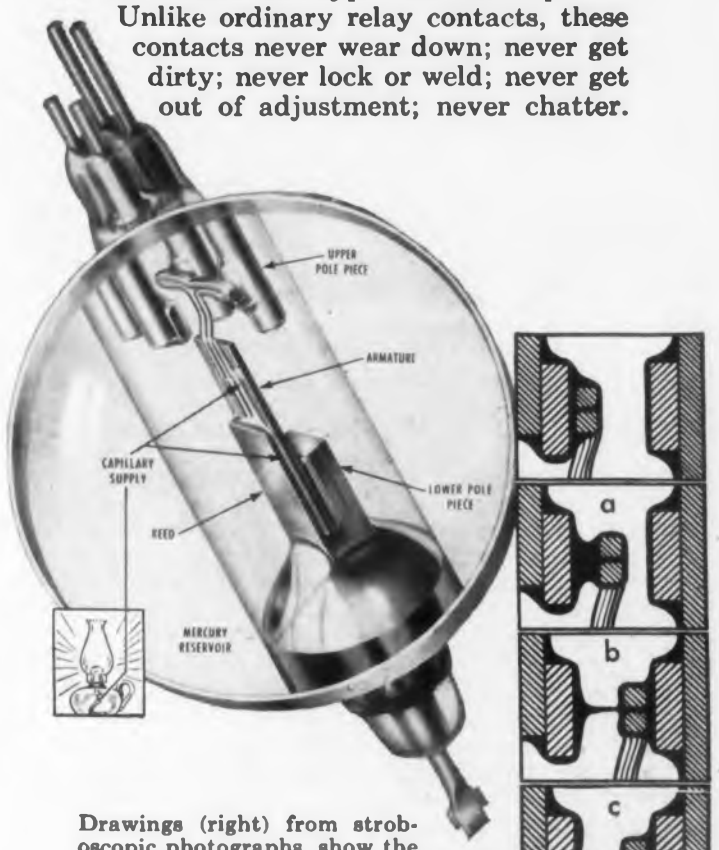
BILLIONS
of operations with

NO CONTACT WEAR OR BOUNCE

Contacts of* CLARE *Mercury-Wetted Contact Relays are constantly renewed. By capillary action, like that of a lamp wick, a new film of mercury coats each contact with every make and break.

The magnetic switch is hermetically sealed in a high-pressure hydrogen atmosphere in a glass capsule. Surrounded by the operating coil, the capsule is enclosed in a vacuum-tube-type steel envelope.

Unlike ordinary relay contacts, these contacts never wear down; never get dirty; never lock or weld; never get out of adjustment; never chatter.



Drawings (right) from stroboscopic photographs, show the cycle: (a) Filament of mercury forms between the contacts as they separate. (b) This becomes narrower in cross section and (c) finally parts at two points, allowing a globule of mercury to fall out. (d) The momentary bridging of the parting contacts—and the extremely fast break which ends it—minimizes the arc and adds greatly to contact load capacity. Contact closure between the two liquid surfaces bridges any mechanical chatter and prevents any chatter from appearing in the electrical circuit.

● **Send for Clare Engineering Bulletins Nos. 120 and 122. Address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Ill. In Canada: C. P. Clare & Co., 659 Bayview Ave., Toronto 17. Cable Address: CLARELAY.**

CLARE RELAYS
FIRST in the industrial field

CIRCLE 173 ON READER-SERVICE CARD FOR MORE INFORMATION

Precision Potentiometer

Has Air-Core Winding

A 10-turn, 1-13/16 in. diameter unit for servo or 3-hole pilot mounting, this precision potentiometer has a choice of two windings; air-core winding with a range of total resistance from 200 to 5000 ohms; copper-mandrel winding from 5000 to 200,000 ohms.

In air-core windings, linearity approaches the resolution of the unit without padding or shunting. Air-core wound units of the 7700 series have negligible phase shift in AC circuitry, less than 0.1 degree. Incorporating 11 mechanical coil turns, it provides 180 deg overtravel at each end. Mechanical stops are standard, with stop-load strength of 50 in-lbs.

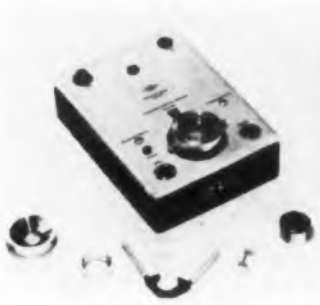
The first measurement yields the absolute sensitivity at any precalibrated standard. The second measurement gives frequency response between 20 and 20,000 cps.

Helipot Corp., Div. of Beckman Instruments, Inc., Dept. ED, Newport Beach, Calif.

CIRCLE 176 ON READER-SERVICE CARD FOR MORE INFORMATION

Microphone Calibrator

For Condenser Units



A microphone calibration apparatus, Model BL-4119, is designed for accurate calibration of the Brush condenser microphone Model BL-4111 as well as the condenser microphone cartridge MK 0002 employed in the Brush artificial ear BL-4109 or artificial voice BL-4210.

The calibration apparatus enables both a calibration procedure which is a simplified form of the standardized reciprocity calibration technique in accordance with the American Standard Association standard Z24.4, and the determination of the complete frequency response curve of the microphone by means of an electrostatic actuator.

The winding process corrects for errors in the unit resistivity of the wire.

Brush Electronics Co., Dept. ED, 3405 Perkins Ave., Cleveland 14, Ohio.

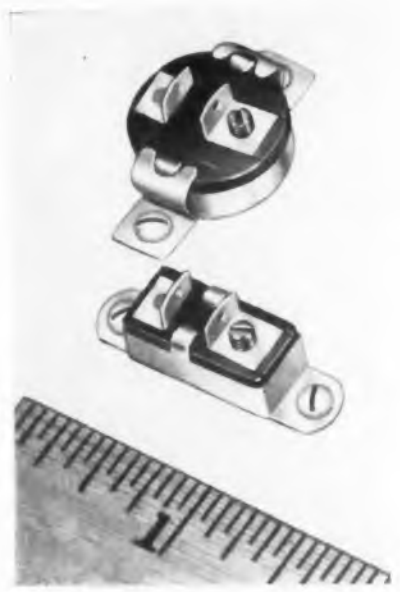
CIRCLE 177 ON READER-SERVICE CARD FOR MORE INFORMATION

DOES THE COMPUTER INDUSTRY Need More Specialized Equipment?

READ DESIGN '57—JAN. 1ST ED

Accurate Temperature Control in "Tight Spots" . . .

Fenwal Miniature controls ideal for aircraft and other applications



Sturdy Fenwal miniature controls are versatile, space-saving units that utilize the famous Fenwal THERMO-SWITCH® principle. The outer shell is the positive activating element. It is sensitive to temperature change over its entire area. Fenwal Miniature units may be controlled within 2° to 6°F — even under 5G acceleration. They have fully adjustable ranges of from −20° to 200°F or −20° to 275°F.

Ideal for aircraft, guided missiles, motors, wave guides, crystal ovens, precision instruments, radar, and other "tight spot" applications. Write for free bulletin, Aviation Products Division, Fenwal Incorporated, 912 Pleasant St., Ashland, Mass.

CIRCLE 179 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW! Spirap*

drastically reduces time and work of cable wrapping

- simple and easy to use; up to 2" cables can be wrapped
- inexpensive; one size answers all your needs
- holds wires together tightly but allows flexibility for forming cable
- provides excellent insulation and protection over entire cable length
- easily unwound to allow wires to be added, taken out, or relocated

*patent pending, trademark property of 3C

Free Sample

New SPIRAP is a modern idea that eliminates hours of tedious work. It is ideal for both prototype and production construction. Standard material is white polyethylene. Immediate delivery through your local distributor. *Write us for free sample and complete information.*

COMPUTER CONTROL COMPANY, inc.

92 Broad Street — Wellesley 57, Massachusetts

CIRCLE 181 ON READER-SERVICE CARD FOR MORE INFORMATION

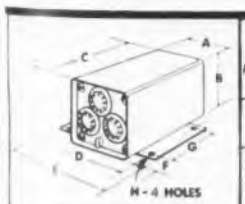
LEDEX

HERMETICALLY SEALED ROTARY SELECTOR SWITCHES AND STEPPING RELAYS

STANDARD ENCLOSURE AND STANDARD HEADERS . . . AVAILABLE ON MANY MODELS

Two standard models . . . available with a maximum of 4 wafers and 105 pins in header . . . capable of many switching combinations.

If standard Ledex models do not meet your requirements, send the design requirements for your hermetically sealed relay application today.



MODEL	MAX. NO. WAFERS	MAX. NO. HEADER PINS	A	B	C	D	E	F	G	H
No. 4	4	45*	2¼"	2⅜"	4½"	2¹³⁄₁₆"	3⅛"	¾"	3"	⅜"
No. 5	4	105*	3¾"	3⅜"	5⅛"	4⅝"	4¾"	²³⁄₃₂"	4"	⅜"

*Circuits should allow for header pins to carry arc suppression items externally.

G.H. Leland INC.

WRITE FOR COMPLETE INFORMATION TODAY!

123 WEBSTER STREET, DAYTON 2, OHIO

IN CANADA: MARSLAND ENGINEERING LTD., KITCHENER, ONTARIO
IN EUROPE: NSF LTD., 31-32 ALFRED PLACE, LONDON, ENGLAND

CIRCLE 182 ON READER-SERVICE CARD FOR MORE INFORMATION

Selenium Rectifiers

High Current

A new line of selenium rectifiers has a wide range of current handling capabilities.

The rectifiers will charge at 6 or 12 v over a current range from 30 to 100 amps dc. The rectifiers are available with either positive or negative center taps, low resistance bus connections, and strong mechanical construction. Six types of 12 volt stacks have current ratings of 30, 40, 60, 70, 90 and 110 amps respectively. The stacks are designed for use with forced air cooling, (750 L.F.M.), permitting a reduction in size. The cells vary in size from 5 in. x 5 in. to approximately 6-1/4 in. x 7-1/4 in.

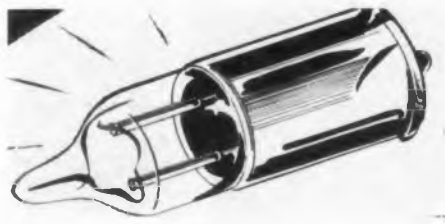
The line provides interchangeability with subminiature incandescent lamps in a full range of voltages. It provides both grounded and insulated models in all standard lens colors. It provides lenses bearing numbers, letters, and special designations.

Federal Telephone and Radio Co., Components Div., Dept. ED, 100 Kingsland Rd., Clifton, N.J.

CIRCLE 183 ON READER-SERVICE CARD FOR MORE INFORMATION

Neon Lamp

Subminiature



A subminiature neon lamp, designated the NE2C, designed with a midget flanged base will be interchangeable in many assemblies with existing miniature aircraft lamps of the No. 327 to 338 series.

Electrical design of the lamp makes it of interest for indicator and computer applications. Power consumption is only 0.04 w. Current drawn is extremely low at 0.0003 amps. The lamp produces practically no heat, and has an average life of over 25,000 hours. Starting voltage is 65 v ac. The lamp has been tooled for automated production with segmented basing construction and spot-welded shell connections.

The units are available as shelf items, eliminating custom-built stacks.

Circon Component Co., Dept. ED, Santa Barbara Municipal Airport, Goleta, Calif.

CIRCLE 184 ON READER-SERVICE CARD FOR MORE INFORMATION

WHAT IS THE TREND in Printed Circuits?

Transistors?

WATCH FOR DESIGN '57—JAN. 1ST ED

ENGRAVE

PANELS OF ANY DIMENSIONS IN YOUR OWN SHOP

with the Engravograph

The only portable machine which reproduces 15 sizes from one master alphabet.

The only one with adjustable copy holding slides for multi-line engraving in one set-up.

Self-centering holding vise for nameplates.

Send for Booklets

I-S—88 portable model • H-88 heavy duty model

NEW HERMES, Inc. 19 University Place, N.Y. 3

In Canada: 359 St. James St., Montreal

World's Largest Manufacturer of Portable Engraving Machines

CIRCLE 185 ON READER-SERVICE CARD FOR MORE INFORMATION

If Dielectric or Corrosion Problems are Causing Coil Trouble...

PRECISION can help eliminate them

Precision specializes in the fabrication of square and rectangular, round and special shaped coil forms . . . acetate or mylar covered . . . silicone, phenolic or Resinite impregnated . . . to help you solve any dielectric or corrosion problem. Forms can be made to your exact specifications in all sizes from 1/16" square to 8" square with wall thicknesses of from .010 to .125.

Only the highest quality electrical grade kraft, quinterra, acetate or various combinations of these materials are used. Precision Paper Tubes are available in standard or exclusive patented DI-FORMED construction for greater crush resistance, high tensile strength and extreme dimensional stability.

Write, wire or phone for full information

PRECISION PAPER TUBE CO.

2055 W. CHARLESTON ST. CHICAGO 47, ILL.

Plant No. 2: 1 Flower Street, Hartford, Conn.

CIRCLE 186 ON READER-SERVICE CARD FOR MORE INFORMATION

ARE THE RESULTS OF RESEARCH AND DEVELOPMENT PROGRAMS for Guided Missiles Beginning to Affect Suppliers?

SEE DESIGN '57—JAN. 1ST ED

Sensing Relay

Unbalance Detector

This negative sequence sensing relay has all static components for high reliability to protect 115/200, 3 phase, 400 cycle power systems.

Employing a circuit which is unaffected by changes in system frequency, it is sensitive to phase unbalances of as little as 5 negative sequence volts. The unit closes a three ampere output circuit when an unbalance is detected. An appropriate inverse time delay is provided to prevent nuisance tripping. Designed primarily for aircraft service, it weighs 23 ozs.

This control device has a patented circuit, and provides automatic protection.

The Hartman Electrical Mfg. Co., Dept. ED, Mansfield, Ohio.

CIRCLE 190 ON READER-SERVICE CARD FOR MORE INFORMATION

Dynamometer

Has Photocell Tachometer

This dynamometer features a system of torque indication which is independent of speed, rotor bearing friction and external sources of mechanical or electrical error. Pendulum weights, attached at the outer periphery of the hysteresis brake of the Magtrol Dynamometer, balance against the actual running torque delivered from the test motor.

There is no error due to the tachometer generator, as a photo electric pick-up is used which requires no torque. Speed accuracy is 1/2 of one percent of full scale on 60 cycle supply reference.

The torque is read on a large torque dial mounted on the brake assembly.

Magtrol, Inc., Dept. ED, 38 Virginia Place, Buffalo 2, N.Y.

CIRCLE 191 ON READER-SERVICE CARD FOR MORE INFORMATION

Self-Contained VU Meter

Saves Panel Space

A new self-contained VU meter requires the panel space of a 1-1/2 in. meter, yet provides scale length and readability of a standard 2-1/2 in. round meter. The MM-1 VU meter offers the features of improved readability and wide choice of case and dial colors.

All necessary rectifiers, associated resistors and shunts are contained within the instrument housing.

Physically, the MM-1 VU meter is interchangeable with standard 1-1/2 in. JAN types. Installation is provided by a threaded ring mount.

The meter is available in various colors to suit styling requirements.

Marion Electrical Instrument Co., Dept. ED, Grenier Field, Manchester, N.H.

CIRCLE 193 ON READER-SERVICE CARD FOR MORE INFORMATION

Multiplier Phototube

For Ultraviolet Radiation

The *6903* is a head-on type of multiplier phototube intended especially for the detection and measurement of ultraviolet radiation.

It is constructed with a fused-silica faceplate which transmits radiant energy in the ultraviolet region down to and below 2000 angstroms. At 2000 angstroms, the spectral sensitivity is more than 50 percent of the maximum response. The spectral response of the *6903* covers the range from about 2000 to 6500 angstroms. Maximum response occurs at approximately 4400 angstroms. Photoelectric current produced at the cathode is multiplied by a median value of 400,000 times.

The tube is also useful in applications involving low-level radiation sources.

Radio Corp. of America, Dept. ED, Harrison, N.J.

CIRCLE 194 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 195 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 196 ON READER-SERVICE CARD FOR MORE INFORMATION

50 Ohm Coaxial Line

High Power, Low Loss

The 6-1/8 in. RETMA 50 Ohm Line is built in accordance with RETMA Standard TR-134 for the latest coaxial transmission lines. Pin-type reactance-compensated Teflon insulators provide constant impedance and broadband characteristics. Dimensionally interchangeable with all other standard RETMA lines, these lines are also available in other RETMA-specified sizes, along with a complete line of associated components and connectors.

Prodelin, Inc., Dept. ED, 307 Bergen Ave., Kearny, N.J.

CIRCLE 199 ON READER-SERVICE CARD

Cooling Fan

For Electronic Cabinets

Suitable for a variety of electronic cooling applications, the Model 1E80 cooling fan features air deliveries of 330 or 395 cfm at zero pressure. Dimensions are 8 in. fan diameter and 10-1/2 in. OD. Motors are available totally enclosed or open and operate on 15 v, 60 cy at 1500 rpm. The case has a gray hammertone finish with mounting holes located 72 degrees apart 4-1/4 in. deep. The fan may be used in any position and with air flow push or pull over motor.

McLean Engineering Labs., Dept. ED, P.O. Box 228, Princeton, N.J.

CIRCLE 200 ON READER-SERVICE CARD

Printed Circuit Ink

Silk Screen Process

A silk screen ink for printing etched electrical circuits is now available. It is an acid resistant ink especially adapted for printing electronic circuits of any size in radio television. Effective for bringing out intricate details, the ink is being used by one of the larger electronics corporations to print circuits in an area smaller than 1-1/3 in. x 3 in. Finely ground pigments assure the ink's easy handling and sharp registration. It is easily removed with mineral spirits.

The Craftint Manufacturing Co., Dept. ED, 1615 Collamer Avenue, Cleveland 10, Ohio.

CIRCLE 201 ON READER-SERVICE CARD

◄ CIRCLE 198 ON READER-SERVICE CARD

Class H Insulating Tape

Dielectric Strength 5 Kv

Among the unique properties claimed for this tape are its high dielectric strength of 5000 v and its temperature insulation properties. The tape will withstand exposure to 550 F.

Backing of Permacel 211 is silicone varnish treated glass cloth. The silicone adhesive is both heat curing and pressure-sensitive. Overall tape thickness is 6 mils.

Basic average properties of the new tape are: tensile strength of 85 lbs per in.; elongation of 3 percent; and adhesion of 25 ozs per in. The insulation resistance at 96 percent relative humidity is 9000 megohms and the indirect corrosion current at the same relative humidity is 111 μμmohs. The tape, which is transparent, is available in 60 yd rolls, ranging in width from 1/2 in. to 1 in.

Permacel Tape Corp., Dept. ED, New Brunswick, N.J.

CIRCLE 202 ON READER-SERVICE CARD

Rosin Core Solder

30% Greater Spread

This new activated rosin core solder, designated RTS 300, has outstanding non-corrosive characteristics and minimum odor. The activating chemicals used in RTS 300 are not toxic to the touch or to the respiratory tract. The makers claim that spread is 30 percent greater than with most conventional rosin core solders. RTS 300 solder can be stored for extended periods without losing its stability.

Federated Metals, Dept. ED, 120 Broadway, New York 5, N.Y.

CIRCLE 203 ON READER-SERVICE CARD

Redesigned Gear Box

Seven Day Cycle

A reduction range of final shaft speeds from 4.5 to 1 through 2,592,000 to 1 can now be supplied through standard gearing. Shaft speeds between these limits are available in a virtually continuous range, although not all torques are available in all shaft speeds.

Gleason-Avery, Inc., Dept. ED, 45 Aurelius St., Auburn, N.Y.

CIRCLE 204 ON READER-SERVICE CARD

The "Picture phone" developed by Bell Telephone Laboratories.

PORTABLE TRANSISTORIZED BETA TESTER

for β, h_{11}, I_{co} PARAMETERS

by

BAIRD ATOMIC

MODEL KT-1

Internal Test Frequency: 1 kilocycle

Parameter Measurement Range and Accuracy

Current Gain, Grounded Emitter, β

0 to 200, $\pm 3\%$

Input Impedance, Grounded Emitter, h_{11}

0 to 10K ohms, $\pm 10\%$

Collector Saturation Current, I_{co}

0 to 50μa., $\pm 2\%$

DC Bias Ranges

Emitter Current, I_e

0.5 to 10 ma.

Collector Voltage, V_c (in steps)

1.5, 3.0, 4.5, 6.0, 7.5 volts

The Baird-Atomic Model KT-1 Beta Tester, developed for applications in quality control, inspection of incoming transistors, circuit design, trouble-shooting, etc., combines speed and accuracy of measurement with compact portability. A self-contained instrument, it houses a 1 kc oscillator with a mercury cell power supply. Life of the mercury cell is approximately 1000 hours.

Only 11½ inches high, 6 inches in width and 5¾ inches in depth, this Baird-Atomic Beta tester features a direct-reading scale, calibration adjustment for temperature variation, and an external jack for oscilloscope connection. The meter is provided with positive overload protection.

BAIRD ATOMIC

Baird Associates—Atomic Instrument Co.

33 UNIVERSITY ROAD, CAMBRIDGE 38, MASS.

CIRCLE 205 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

1957 Radio-Electronic Catalog 206

The 21st Edition of The Radio-Electronic Master will be available in December. Its 1546-pages list over 125,000 items from 350 manufacturers. With more than 11,250 illustrations, the catalog gives detailed descriptions, specifications and prices. A detailed set of indexes pinpoint the thousands of products. Among them are tubes, test equipment, capacitors, resistors, relays, coils, antennas and accessories, transformers, recording and PA systems, Hi-Fi equipment, hardware, tools, transmitters, communication receivers, wire and cable, speakers, microphones, rectifiers, converters, amateur gear, switches, and volume controls. United Catalog Publishers, Inc., 110 Lafayette St., New York 13, N.Y.

X-Ray Spectrograph Chart 207

A revised 17-1/2 x 22-1/2 in. X-ray spectrograph chart shows characteristic secondary X-ray beams for elements from Magnesium (Atomic 12) to Californium (Atomic 98). Suitable for wall display, the chart will help technicians to understand the theory and application of X-ray spectography. K Alpha and K Beta lines are shown for EDDT, ADP, topaz, lithium flluoride and rock salt. Horizontal scales show two Theta angles in degree and wavelengths in Angstroms for all elements under various operating conditions. North American Philips Co., Inc., 750 So. Fulton Ave., Mt. Vernon, N.Y.

Vibration Pickups and Meters 208

Vibration pickups and meters are featured in a 6-page illustrated bulletin. Given for these velocity-type pickups are design and method of operation, general specifications and typical frequency-response curves for damped and undamped types. The type 115 hand-held probe-type pickup is described in detail. Design features and performance specifications are given for vibration meters M-1 and M-3. A table shows natural frequency, damping factor, dc coil resistance, available stroke and sensitivity. Maximum limits on shock and acceleration magnitude and temperature are given for appropriate types. MB Mfg. Co., 1060 State St., New Haven 11, Conn.

High Temperature Cushion Clamps 211

Temperatures as high as 1500 F. are resisted by the Light-Weight All Stainless Steel Cushion Clamps now being manufactured. Both the clamp and its cushion are made of type 321 stainless steel, spec. MIL-S-6721. The TA1500 Series is available in a size range from 1/4" to 3" I.D., and the clamps are interchangeable with any standard AN, MS or commercial type cushioned loop clamps. The cushion is spot welded to the clamp and cushion edges are crimped for abrasion-free grip. TA Mfg. Corp., 4607 Alger St., Los Angeles 39, Calif., formerly Thomas Associates.

Custom Power Supplies 212

A "Custom Design File" illustrates a variety of custom power supply work in 9-pages. Included are series-tube-regulated-supplies, constant-current-supplies, unregulated high voltage power supplies, semiconductor brute-force power supplies and thyratron-controlled supplies. Data given on each unit includes voltage, current, ripple, line regulation, load regulation, and price. The publication offers a ready and reliable means of estimating price and performance of non-catalog equipment. NJE Corp., 345 Carnegie Ave., Kenilworth, N.J.

Special Copper Alloys 213

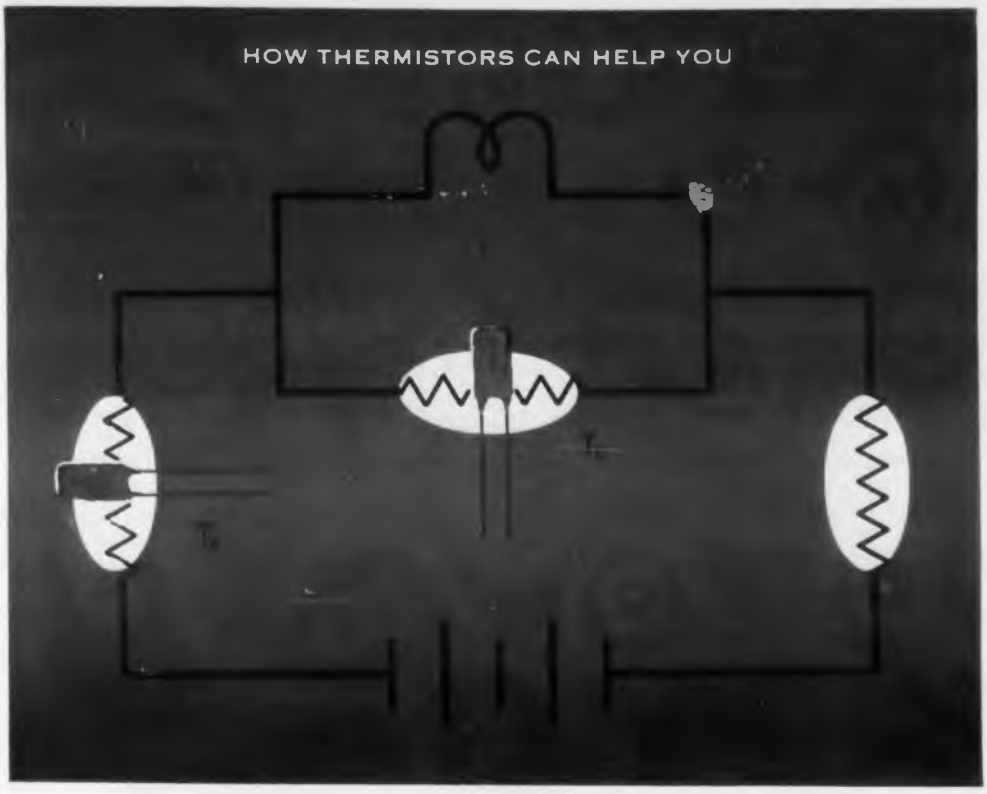
A tabulation of non-standard, wrought copper base alloys has been prepared on a 1-page sheet. The list provides the trade name, generic name, nominal composition, forms available, typical applications and mill source for each alloy. Copper & Brass Research Assoc., 420 Lexington Ave., New York 17, N.Y.

Tubing for Encapsulation 214

Two mimeographed sheets describe the use of precision cast tubing made from thermo-setting types of resin. Casting materials, characteristics, advantages, and available diameters of tubing for encapsulation and coil forms are cited. Resdel Corp., P.O. Box 217, Wildwood, N.J.

Magnetic Pickups 215

Magnetic pickups that generate electrical energy from mechanical motion without contact are discusssed in a 2-page catalog sheet. Pictured and described are performance curves and specifications for high sensitivity and miniature pickups. The sheet also details principles of operation and diversified applications. Electro Products Labs., 4500 N. Ravenswood Ave., Chicago 40, Ill.

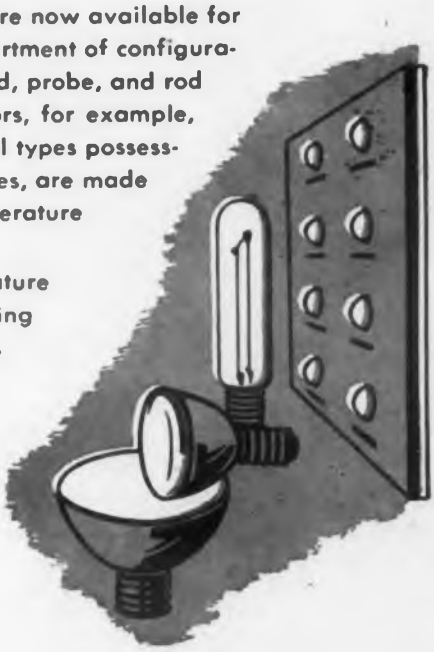


Maintaining Constant Lamp Brightness with GLENNITE® Thermistors

Versatile GLENNITE Thermistors can help you solve your circuit design problems. For instance, in the schematic shown above, by placing a thermistor (T1) in parallel with the lamp, the brightness of the lamp remains constant because this thermally sensitive resistor compensates for voltage fluctuations in the circuit or ambient temperature variations in the lamp. By using another thermistor (T2) in series with the lamp, an effective time-delay is obtained, preventing current surges from blowing the lamp filament.

Thermistors from Gulton Industries are now available for every application in a complete assortment of configurations and sizes including wafer, bead, probe, and rod units. Space-saving wafer thermistors, for example, occupy 1/5 the space of conventional types possessing the same power handling abilities, are made as small as .06", and have temperature coefficients up to 7%/°C.

If your project encompasses temperature compensating, controlling or indicating requirements, GLENNITE Thermistors can help you. And if you have a design problem that needs outside assistance, it's immediately available from our field representative without obligation.



Thermistor Division

Gulton Industries, Inc.

METUCHEN, NEW JERSEY

CIRCLE 216 ON READER-SERVICE CARD FOR MORE INFORMATION

Cluster Fittings 220

Cluster Fittings for aircraft applications titled "Aircraft Piping and Engineering Application Manual," is now available in a 44-page comprehensive booklet. It presents data on fitting dimensions, installation and assembly methods, piping application categories, and engineering recommendations. The manual contains information on the planning, selection and installation of various aircraft piping systems. The Weatherhead Company, Aviation Division, 300 E. 131 St., Cleveland, Ohio.

Automatic Purging Systems 221

Automatic systems for pressurizing and purging transmission lines are described in an 8-page catalog. Several of these units, which supply dry air at various pressures, are illustrated. The folder cites features and applications and tells how the equipment was developed. Industrol Corp., Roselle Park, N.J.

Electrical Insulating Materials 222

An illustrated booklet, B-1050, lists technical data and applications for a line of electrical insulating materials. The booklet describes properties of treated papers, organic varnished fabrics and combination insulations, organic varnished glass fabric insulation, and silicone treated and special insulations. Westinghouse Electric Corp., Micarta Div., Trafford, Penna.

Precision Wire Wound Resistors 223

A catalog of precision wire wound resistors features a complete handbook for engineers, designers and purchasing agents. The catalog lists types of wire, temperature coefficients, types of coatings, and ac characteristics. Encapsulation, installation precautions, wattage ratings, stability, operating characteristics, and typical problems are described. There are complete glossary of terms and ordering instructions. Eastern Precision Resistor Corp., 675 Barbey St., Brooklyn 7, N.Y.

Single and Multi-Turn Potentiometers 224

Standard specifications for 6 single and 8 multiturn precision potentiometers are given in illustrated data sheet 54-34, issued to supersede 54-33. Among the models described are the 1-1/4 in. diameter 5300 series, the 1-7/16 in. diameter 5400 series, the 2 in. diameter 5600 series and the 3 in. diameter 5700 series. Noise ratings and life expectancy are noted, as well as several specification changes for series AJ, B and T. Helipot Corp., Div. of Beckman Instruments, Inc., Newport Beach, Calif.

Replacement Capacitor Catalog 225

Replacement Capacitor Catalog 200D-3 for 1957 is now available. This illustrated edition covers electrolytic, paper tubular, industrial, mica, ceramic, filter and motor start capacitors. The 44-page, 3 color catalog is sectionalized and thumb-indexed for quick reference. Cornell-Dubilier Electric Corp., So. Plainfield, N.J.

Teflon Tubing 226

Bulletin 157 is a 2-page data sheet devoted to the T-500 spaghetti teflon tubing. One side of the sheet cites uses and characteristics. The other side lists specifications and available stock items. Prices are also given. Birnbach Radio Co., Inc., 145 Hudson St., New York 13, N.Y.

Heat Testing Beryllium Copper 227

Bulletin 8 presents new heat treat recommendations to produce maximum strength and hardness in beryllium copper strip. In the 4-page brochure hardness-response curves are given in detail, together with specification properties for Alloys 25 and 165. Penn Precision Products, Inc., 501 Crescent Ave., Reading, Pa.

Coil and Parts Catalog 228

Catalog 57-A lists nearly 1000 different replacement coils. Noteworthy is a series of transistor antenna rods, oscillator coils, and I.F. transformers. A complete line of adjustable RF coils and chokes is also shown. The 32-page catalog is fully illustrated and gives prices for all items. J. W. Miller Co., 5917 So. Main St., Los Angeles 3, Calif.

DC Amplifier 229

The Hilger-Negretti dc amplifier for measurement of low currents and potentials is presented in a 4-page illustrated bulletin. The zero-drift galvanometer amplifier is discussed with respect to operating principle, characteristics, application, and construction. Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass.

Temperature Controllers 230

MC-139 is an illustrated brochure which gives complete specifications on a series of bulb-and-capillary indicating temperature controllers. The brochure shows how a controller can be tailored to fit specific operating requirements with "building blocks." Also illustrated is the design of a temperature sensing response mechanism. Fenwal Inc., Ashland, Mass.

Rods, Tubes and Shapes 236

A color bulletin on acrylic rods, tubes and shapes supplied to manufacturers has been released. All these products are made of Lucite and Plexiglas, clear crystal methyl methacrylates possessing unusual optical properties. The bulletin illustrates a wide range of rods, tubes, and shapes including hard-to-obtain shapes, half rounds, squares, and twists. Illustrated also are products in which acrylic material is used. Complete tables are shown, tabulating physical properties of the material, such as refractive index, compressive and impact strength, dielectric strength and resistance to chemical agents. Exhaustive information on all types of test conditions for these factors is also included. Ace Plastic Co., 91-30 Van Wyck Expressway, Jamaica 36, N.Y.

Aircraft Fire and Overheat Detector 237

Brochure MC-130 illustrates a variety of aircraft fire and overheat detectors. Data given include physical dimensions, weight, service temperature ranges, extreme exposure temperatures, current ratings, and conformance to applicable government and MIL specifications. The 4-page booklet also contains installation instructions. Fenwal Inc., Aviation Products Div., Ashland, Mass.

Corrosion-Resistant Fastenings 238

How the "Flo-Form" process cuts the cost of corrosion-resistant fastenings is told in a book of 24 pages. Text and illustration show parts, specifications, and small and large quantity manufacturing methods. The book explains hot and cold forming and when each system is best. All fastenings described are made from stainless steel or non-ferrous metals. H. M. Harper Co., Morton Grove, Ill.

Shock-Resistant Meters 239

An 8-page illustrated catalog describes a line of shock-resistant meters which are more than .25 per cent accurate and can register 1 million ohms per volt. Information on construction, performance and characteristics is given. The catalog explains a light beam pointer that eliminates parallax and the bifilar movement used in the meters. Two pages of charts and diagrams show scales and ranges available. Gulton Industries, Inc., 212 Durham Ave., Metuchen, N.J.

Static Control 247

"Fundamentals and Features of General-Purpose Static Control Logic Elements" is an 8-page bulletin designated as GEA-6578. It defines static control, lists advantages, and describes components of a general-purpose static control system. The illustrated publication explains how static control operates without moving parts. Also covered are the logic function concept, logic functions and conventional control, basic principles of static control, circuit characteristics, monitor lights and amplifiers. General Electric Co., Schenectady 5, N.Y.

Cooling Effect Detector 248

MC 142 is a 4-page bulletin about the series 18801 cooling effect detector. Designed to protect airborne electronic equipment against inadequate cooling, the detector has its own heat source which duplicates the heat output from the protected equipment. The brochure illustrates and describes the instrument's operating principle and gives complete physical and performance specifications. Fenwal Inc., Ashland, Mass.

WHAT NEW PLANS Will Directly Affect the Component Parts Manufacturer in '57

SEE DESIGN '57—JAN. 1ST ED

Drawn Metal Boxes 249

A 60-page illustrated catalog describes deep-drawn and fabricated cases of aluminum, brass and steel. Featured is a line of aluminum instrument cases for electronic and instrument manufacturers. Over 1400 cases are listed with drawings and specifications for all types. Also described are custom deep-drawn cases, MIL-W specification cases, and complete company facilities and processes. Zero Mfg. Co., 1121 Chestnut St., Burbank, Calif.

Injection Molded Tiny Plastic Parts 250

A bulletin which describes and illustrates a specialized injection molded of tiny thermoplastic parts has been released. It states the maximum wt. is .03 oz and 1-1/4" long with no minimum size limit. The bulletin further describes approximate dimensional and weight limits for plastic molded tiny parts; illustrates many of the parts that may be molded at low tooling costs of thermoplastics, especially nylon; and includes a chart of the properties of molded nylon. A design engineers' check list is also included to help engineers. Gries Reproducer Corp., 400 Beechwood Ave., New Rochelle, N.Y.

Servo Analyzer 256

A revised 4-page bulletin TDS 1100 discusses the Servoscope servo analyzer, an instrument for solving control system problems. The booklet offers illustrations, specification, applications and outstanding features for four standard models and shows how they are used to solve various problems. Servo Corp. of America, 20-20 Jericho Tpke., New Hyde Park, N.Y.

Rare Earths 257

A brochure has been published which gives information on rare earths or lanthanons—elements of atomic number 57 through 71 in the periodic tables. The pamphlet gives background information on separation, production and applications and contains a list of prices and a table of properties. St. Eloi Corp., P.O. Box 307, Newtown, Ohio.

AC Capacitors 258

Bulletin 179 describes the KGN series of capacitors which permit size and weight reductions in existing ac equipment and are available at 236, 330, 440 and 660 v ac, 60 cy, in capacitance ranges from 1 to 60 μfd, depending on voltage. Included in the 4-page booklet are illustrations and specification tables. Cornell-Dubilier Electric Corp., So. Plainfield, N.J.

Guide to TV Picture Tubes 259

A booklet has been published classifying 211 tube types. Booklet EDT-1001C includes breakdown lists as to size, bulb structure and deflection angle, aluminization, external conductive coating capacitance, ion-trap magnet type, face, dimensions and style of anode terminal. General Electric Co., Tube Sales Div., 1 River Rd., Schenectady 5, N. Y.

Panel Instruments 265

Data sheet, 81556-T, has been published describing panel instruments. The 4-page booklet includes full-size scales of various types of panels as well as dimensional diagrams of round, rectangular and special instruments in which panels are used. Typical external shunts as well as illuminated meters are included. Triplett Electrical Co., Bluffton, Ohio.

Molding Presses 266

Bulletin No. A-456, recently released on the completely automatic compression molding presses, is now available. High production at low cost, flexible feeding mechanism, quick-set cycle control, safety interlock of all functions and other features are illustrated and described. Hull-Standard Corp., 1505 Race St., Philadelphia 2, Pa.

Digitizers 267

A 4-page bulletin CR-181 has been prepared which gives additional useful information concerning three, four, five and six decade decimal digitizers. Included in this bulletin are many typical uses and applications of these digital readout systems and ten photographs of the equipment in use. Coleman Engineering Co., Inc., 6040 West Jackson Blvd., Los Angeles 16, Calif.

Speed Reducers 268

A data sheet has been released on the Rampe SW-1 economy speed reducer. It was developed to fill the need for a more efficient, dependable and durable unit than the "clock-work" stamped gear type at a cost under that of heavy cast-metal case and cut-gear reducers. Data includes line drawing and horsepower rating table. Rampe Mfg. Co., Cleveland 10, Ohio.

THERMAL CONDITIONING OF ROCKETS AND GUIDED MISSILES

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Dead Reckoning Tracer 276

A paper entitled "Airborne Analog Computer Plots Aircraft's Own Position on a Mercator Chart," by T. A. Westover has been reprinted for distribution. Presented at a meeting of the A.I.E.E. Committee on Air Transportation, the article discusses design and application features of a navigation system which automatically traces the course of an aircraft. Photographs show the electro-mechanical analog computer and plotting board equipment, and block diagrams illustrate the system as a whole. The price of this 8-page booklet is 40 cents for A.I.E.E. members and 80 cents for nonmembers. There is an additional 5-cent charge for first class mailing. Servo Corp. of America, 20-20 Jericho Tpke., New Hyde Park, N.Y.

Standard Non-Linear Potentiometers 277

Data sheet 54-74 is 4 pages of information on standard non-linear potentiometers. The illustrated folder lists available models in a comprehensive table which gives resistance ranges and peak-to-peak conformities. A section is devoted to a standard conformity called "aboslute" and a new voltage indexing system. Helipot Corp., Div. of Beckman Instruments, Inc., Newport Beach, Calif.

Self-Locking Socket Screws 278

Vibration-proof, self-locking socket screws and how they work are illustrated in a 16-page booklet. Sizes, critical dimensions, threads per inch, package quantities and weight per box are given for socket head cap screws, socket head set screws, button head socket screws, flat head socket screws, socket head shoulder screws and socket pressure plugs. There are also locking pellet specifications on material, temperature range of application, resistance to fluids, durability and plastic memory. Standard Pressed Steel Co., Box 202, Jenkintown, Pa

Capacitor Interchangeability 279

A comprehensive guide of 24 pages shows the electrical and mechanical interchangeability of single, dual, triple and quadruple capacitor units. The booklet, TM-1-1, lists the latest twist-mount electrolytic capacitors for television receivers. There is also an index of all the firm's products. Pyramid Electric Co., 1445 Hudson Blvd., No. Bergen, N.J.

Titanium Analysis 286

A 2-page bulletin shows how X-ray diffraction is used to analyze titanium and other alloys. Illustrated with photos, graphs and charts, the literature describes specimen preparation and results obtained with three X-ray techniques: powder camera, diffractometer and spectrograph. In addition to titanium, such metals as 17-7PH, 303, 321 and 347 stainless steels, 24S, 75S and 78S aluminum alloys, nickel-chrome salt pot electrodes and lead-tin solders are discussed. North American Philips Co., Inc., 750 So. Fulton Ave., Mt. Vernon, N.Y.

Small Seamless Tubing 287

A 4-page catalog covers small seamless tubing and small tubular components. The illustrated brochure details fine aluminum alloy pointer tubing and seamless metal-shielded wire. Production facilities are also described. Uniform Tubes, Inc., Collegeville, Pa.

Pumps for High Vacuum 288

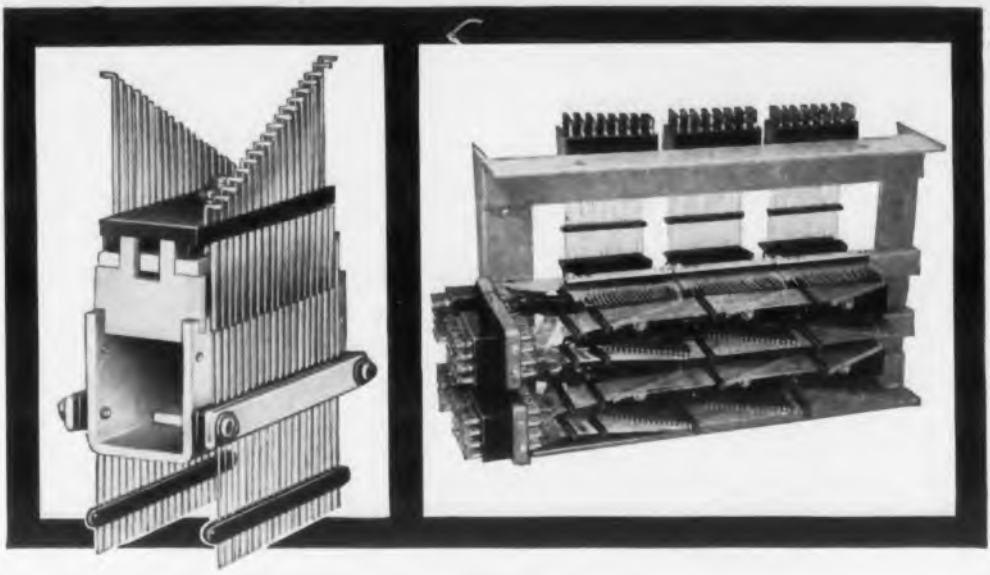
The recently increased performance ratings of rotary mechanical vacuum pumps and other useful information helpful to engineers confronted with vacuum processing problems, contained in a revised edition of the 28-page catalog on "Microvac Pumps for High Vacuum" which has just been issued. The new catalog, No. 752, includes, in addition to specifications for the complete line of pumps, valuable tables of formulas, constants, and conversion factors frequently used in vacuum processing; solutions to problems of pump selection for typical vacuum system; and useful information on continuous oil purification and other maintenance procedures for high vacuum pumps. F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20, Pa.

Instrument Bulletins 289

Publication of five technical bulletins describing recent instruments is announced. The bulletins illustrate, describe and give specifications for the 58-AS radio noise and field strength meter, the 84-TVR UHF standard signal generator, the 202-C standard barretter bridge, the 210 series of standard FM signal generators, and the model 505 standard test set for transistors. Measurements Corp., Boonton, N.J.

Parts From Laminated Plastics 290

Availability of an 8-page booklet on precision parts fabricated from plastic laminates is announced. The illustrated bulletin describes the range of parts produced by punching, turning, milling, automatic screw machining and other processes. Also shown are examples of molded, molded-macerated and postformed parts. Mica Insulator Co. P.O. Box 1076, Schenectady 1, N.Y.



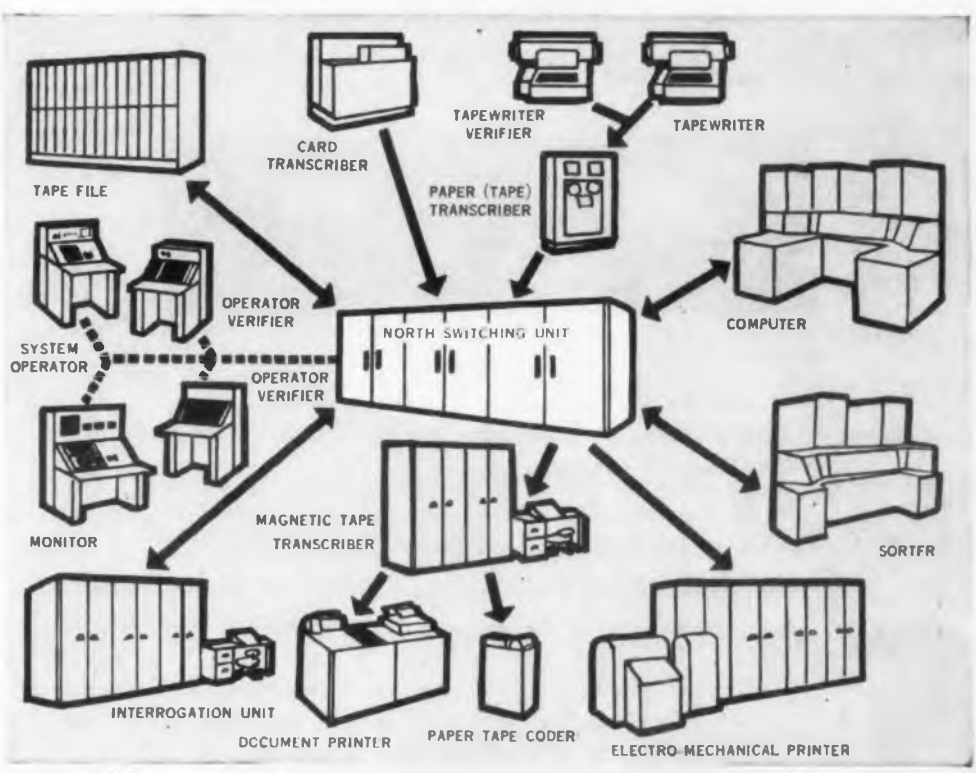
OPENING NEW HORIZONS IN DATA PROCESSING SYSTEM DESIGN

The requirements for a switching system that will handle the high information rates of input and output devices in data processing systems have been so demanding that, until now, they have constituted a serious barrier to data processing system design.

The New NORTH REED ARMATURE RELAY handles these switching chores with maximum efficiency and minimum crosstalk, opening new horizons in system design.

NORTH REED ARMATURE MATRIX SWITCHES *are being used successfully today* in "NORTH designed and built" system centrals in high speed data processing systems.

Write for complete details on how the new NORTH REED ARMATURE RELAY can provide an important link in data processing systems.



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NORTH ELECTRIC COMPANY

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CIRCLE 291 ON READER-SERVICE CARD FOR MORE INFORMATION

Silicone Rubber Selector 296

Users of silicone rubber mechanical goods may now obtain a "lightning selector" to speed their choice of compounds. Designated AD 24 E, the 4-page illustrated selector lists the major categories of silicone compounds and typical properties of each. Cross references to AMS and ASTM specifications are included. A more detailed description of silicone rubber and its applications is contained in the 24-page publication, "Imagineering with Silicone Rubber." General Electric, Silicone Products Dept., Waterford, N.Y.

Reactor Plant Types 297

A "nuclear scorecard" for laymen, with thumbnail profiles of various reactor types and how they compare or differ has been prepared in an 8-page booklet to meet the need for clarification of the basic reactor classifications and the specific reactor types. In familiar terms it tells the name of a reactor, how it was arrived at and what the reactor's essential features include. Minneapolis-Honeywell Regulator Co., Industrial Div., Philadelphia 44, Pa.

Electronic Instruments Catalog 298

Products discussed and illustrated in the 16 pages of a revised catalog include electro-mechanical, electro-acoustical and electronic devices, instruments, transducers, complete systems, thermistors, and precision-built magnetically regulated power supplies are described. Also covered are ultrasonic components, systems, consultation service, piezoelectric ceramic materials, ceramic-based electronic components, meters with bifilar suspension, and automatic controls. Gulton Industries, Inc., 212 Durham Ave., Metuchen, N.J.

Assembly Methods 299

An illustrated booklet contains 8 pages of data on high speed methods of assembling lock nuts and fasteners with specially designed wrench attachments, shanks and applicators. Manual and power tool tightening procedures are outlined. Descriptions, dimensions and prices are given for magnetic socket wrenches, internal hex wrenches, magnetic wing nut wrenches, box wrenches and applicators for pushnut fasteners. The Palnut Co., Glen Rd., Mountainside, N.J.

Seals for Toggle Switches 305

Series N-1000 high pressure seals for toggle switches are the subject of Hex-7, a 1-page bulletin. Featured is a high pressure switch boot which contains an internal hexagonal nut. Applicable military specifications, sealing materials and their properties, and operating characteristics are given. Colors, sizes and special modifications are also described. A cross section drawing shows construction. Automatic & Precision Mfg. Co., 252 Hawthorne Ave., Yonkers, N.Y.

Zinc Alloy Gears and Pinions 306

Bulletin listing gear and pinion combinations which can be furnished from stock die elements at no tool charge is available. Various combinations of these gears, pinions, hubs and shafts or hole diameters are now on hand. The combinations are die cast in one piece on specially designed automatic machines. Holes, shaft, spacers, shoulders and others are made to specifications. More than 40 individual elements are listed on this catalog sheet. Gries Reproducer Corp., 400 Beechwood Ave., New Rochelle, N.Y.

Analysis of Plating Solutions 307

"Simple Methods for Analyzing Plating Solutions," a 36-page bulletin, is prefaced by a discussion of analytical principles, use of apparatus and methods for sampling a plating solution. It then outlines the necessary steps involved in 28 analytical methods for testing nickel, copper, silver and other metalfinishing solutions. Other sections describe necessary equipment, component chemicals of solutions, atomic weights, acid concentrations and electro-chemical data. Conversion tables are included. Analytical reagents are listed for brass, cadmium, chromic acid, copper cyanide and sulfate, gold, nickel, silver, tin and zinc plating solutions. Hanson-Van Winkle-Munning Co., Matawan, N.J.

Color Difference Meter 308

Data sheet 10.10-6 describes color theory, accuracy and features of an automatic color difference meter which gives three-part numerical comparison of color samples. Photographs show the meter and its construction. Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Penna.

CIRCLE 309 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 310 ON READER-SERVICE CARD FOR MORE INFORMATION

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SMALLER "POT"

Try these for size and reliability...

Waters miniature and micro-miniature wire-wound precision potentiometers

are famous for accuracy, ruggedness, dependability and fast delivery in commercial and military uses. They are precision-machined, with anodized aluminum bodies, line-reamed phosphor bronze, ball or jewel bearings, centerless-ground stainless steel shafts, and gold-plated fork terminals; fully sealed and fungus-proofed. To meet your requirements Waters pots can be furnished ganged, tapped, servo or bushing mounts, with various electrical and mechanical angles, optional shaft locks, anti-rotation pins, 0 rings, and custom shaft or servo dimensions.

Series AP ½ — 2 watts continuous at 80°C; resistances 10 to 100,000 ohms, 5% tolerance standard; diameter ½", depth ½" standard, weight ¼ ounce; fully sealed for potting.

Series LT/LLT ⅞ — One watt at 80°C; resistances 100 to 100,000 ohms, ball or jewel bearing, for use in computers, servos, and selsyns where minimum torque is required. Weight is only ½ ounce; MAXIMUM torque is 0.01 inch-ounce per section. Ganging to six decks, internal clamps hold ⅞" diameter. Standard linearity 0.5%, on special order 0.25% above 1K; toroidal winding allows winding angles to 360°, standard is 354°

Series RT/RTS ⅞ — 3 watts continuous at 80°C; resistances 10 to 100,000 ohms; diameter ⅞", depth ⅜", weight ½ ounce; standard linearity 2%.

Series AP 1⅛ — 4 watts continuous at 80°C; resistances 10 to 150,000 ohms; diameter 1⅛", depth ½", weight less than ¾ ounce; standard linearity 1%.

Waters has advanced facilities for the design and manufacture of miniature toroidal potentiometers and windings for use in equipment of special design.

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MFG. INC.

CIRCLE 315 ON READER-SERVICE CARD FOR MORE INFORMATION

Patents

Harmonic Generator Circuit

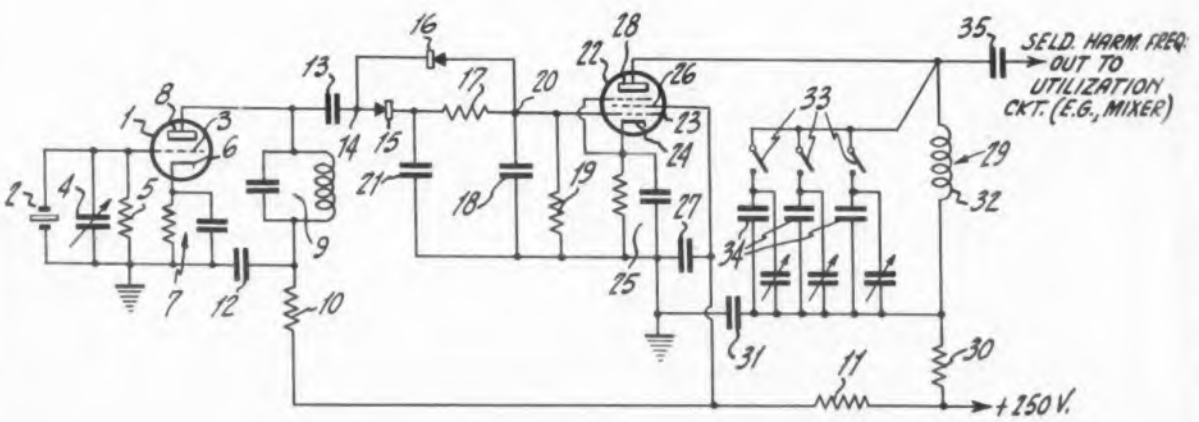
Patent No. 2,742,572. F. Papouschek. (Assigned to Radio Corp. of America)

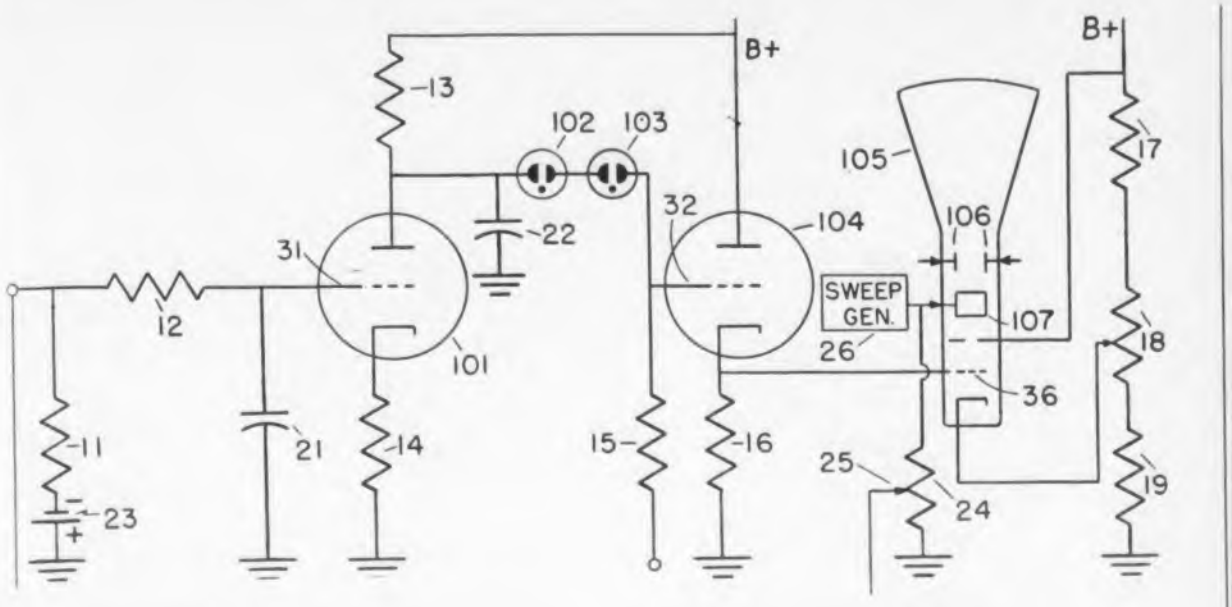
In captive oscillator systems, it is necessary to generate a wide range of harmonic frequencies from an oscillator which is crystal controlled and provides the fundamental frequency. For example, it may be necessary to secure a range of harmonic frequencies from 3 to 30 mc from a fundamental frequency of 1 mc. A class C amplifier has been used to generate these harmonic frequencies. However, the amplitude of the output is not constant throughout the range and, in addition, high amplification is necessary in the higher harmonics. Another form of harmonic generator has some similarity to the circuit of the figure which generates a saw-tooth wave. From this saw-tooth wave, the harmonic frequencies desired are secured. With this latter circuit, however, a single rectifier is used and the circuit components present some difficulties in securing rapid discharge of the condenser at the higher frequencies. A saw-tooth wave of necessary form is not obtained unless rapid discharge of the condenser is secured.

In the circuit shown, the oscillator for generating the fundamental frequency consists of the tube *1* and oscillator circuit 9, the oscillations being controlled by the crystal *2*. On the positive portion of the wave generated, the terminal *14* is positive with respect to junction *20*, and the condenser *18* is charged slowly through the resistor *17* to form the rising portion of a saw-tooth wave. Upon the negative portion of the fundamental wave, the point *14* is negative with respect to junction *20* and the condenser *18* discharges rapidly through the rectifier *16* since there is no resistance in this discharge circuit. The rectifers *15* and *16* are oppositely poled in order to secure this operation. The saw-tooth wave is applied to the grid of an amplifier *22* and the desired harmonic is selected by the tuned plate circuit *29*.

With the circuit illustrated, the parallel resistor *19* may have a high resistance, such as 500,000 ohms, so that the input impedance of the amplifier tube may be matched. This value of resistance also prevents the fundamental oscillator from being unduly loaded. This desirable high value of resistance may be used since the discharge circuit for the charging condenser *18* is through the rectifier *16* which presents very little impedance to the condenser discharge and a sharply dropping saw-tooth wave results.

In a saw-tooth type of harmonic generator, the amplitude of the harmonic will vary inversely as the number of the harmonic. The amplifier *23*, however, may be designed to amplify proportionally with respect to the number of the harmonic and thereby provide an output amplitude which is substantially uniform throughout the frequency range. The patent describes an alternative form of circuit which is not as efficient, although its operation is satisfactory.





Cathode Ray Tube Intensity Compensation

Patent No. 2,739,264. W. T. Shreve, Robert J. McCurdy. (Assigned to the United States of America.)

A cathode-ray tube circuit, particularly as used for radar and similar applications, connects the cathode with a resistor so that increased current through the tube changes the bias and in this manner stabilizes the beam brightness. This type of compensating circuit is shown in the series resistors *17*, *18*, and *19* with the cathode of the tube *105* connected with the resistor *18*. It is desirable to compensate also for any changes in sweep frequency or in the duty cycle for any particular sweep frequency.

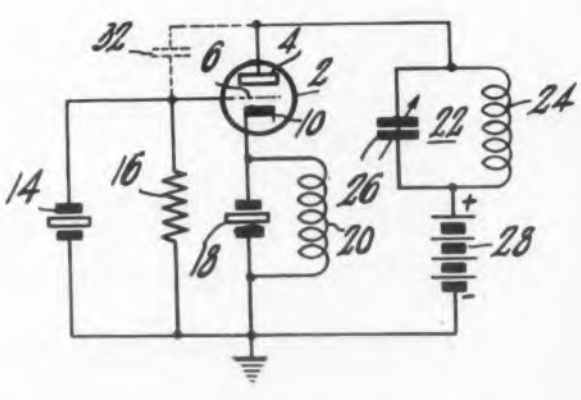
The patent shows a cathode-ray tube circuit which provides for variation of beam brightness controlled from the sweep generator *26* and therefore is controlled by the frequency of the traverse of the beam. In the circuit illustrated a portion of the voltage of the sweep generator is applied to a resistor *24* and a portion of the potential across this resistor is applied to a resistor *11* and an averaging circuit consisting of a resistor *12* and condenser *21*. The average signal is applied to the grid of an amplifier tube *101*. The amplified signal is applied to the control grid of a second tube *104*, through voltage regulating gas tubes *102*, *103*. The tube *104* is connected in cathode follower manner and the potential across the cathode resistor *16* controls the potential on the grid *36* of the cathode-ray tube. As the sweep generator frequency increases to provide an accelerated beam traverse, an increased average signal is applied to the grid *31* of the amplifier tube. This amplified signal is transmitted to the grid *36* of the cathode-ray tube through the second tube *104* and increases the potential upon the grid and increases beam brightness.

Crystal Controlled Oscillators

Patent No. 2,742,573. S. W. Seeley. (Assigned to Radio Corp. of America)

Oscillator circuits which are controlled by two or more piezo-electric crystals have been used to improve the frequency stability of the oscillator. Stray coupling between the crystals broadens the resonant curve and results in a loss in sharpness of the frequency control. Wide separation of the crystals does not materially improve the frequency stability of the oscillator. The ideal oscillator should generate a frequency with a high degree of frequency stability irrespective of changes in power supply, temperature of circuit components, and varying factors.

The oscillator, shown in the figure, uses a crystal *14* which is parallel resonant at the desired frequency. It is connected in parallel with the grid resistor *16*. In addition a series resonant crystal *18* is provided in the cathode circuit and an inductance *20* is in parallel with this crystal. Preferably, this inductance has a value of reactance the same or approximately the same as the capacitive reactance of the crystal. The tuned circuit *22* is provided in the plate circuit of the oscillator tube and is tuned to the desired frequency.



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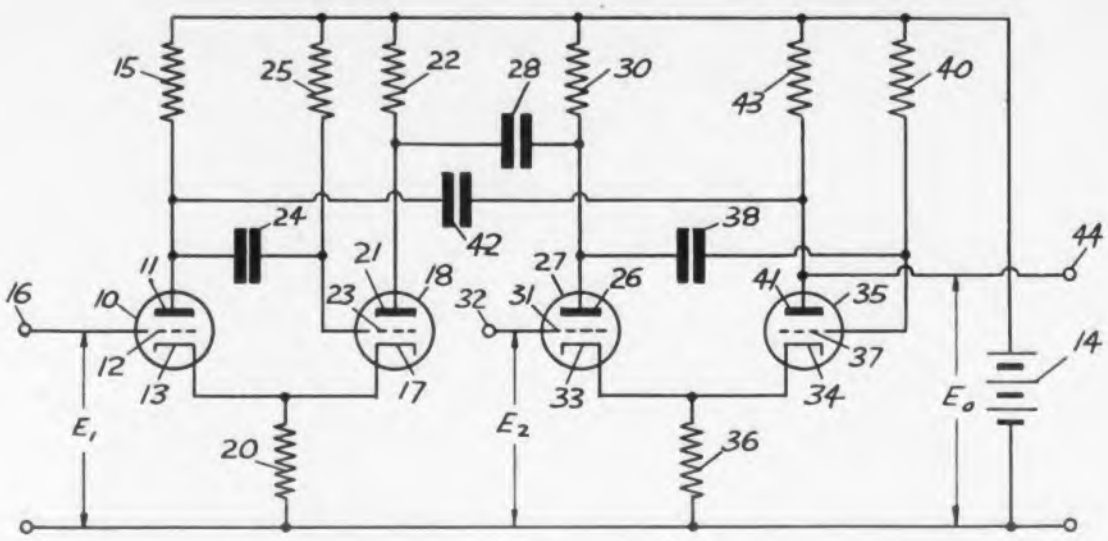


Voltage-Controlled Ring Oscillators
Patent No. 2,735,939. K. E. Forsberg. (Assigned to Raytheon Manufacturing Co., Newton, Mass.)

There are circuits, such as counters which require a series of pulses of square wave form, which are precisely generated and may be variable as to duration and repetition rate. In some circuits, too, it is desirable that the variations may be controlled by one or more controlled voltages. The circuit shown in the figure accomplishes these results using two multivibrators coupled together in a manner as will be described. The patent also describes an oscillator circuit of three multivibrators, using the design principle set forth; the oscillator may include any number of multivibrators.

In the figure, one multivibrator includes the tubes *10* and *18* in which the tube *10* is normally non-conducting but may be rendered conducting by the application of a control signal at the terminal *16*. The other multivibrator comprises the tubes *27* and *35*, which may be controlled by a controlled signal applied to the terminal *32*. The two multivibrators are monostable, cathode coupled units.

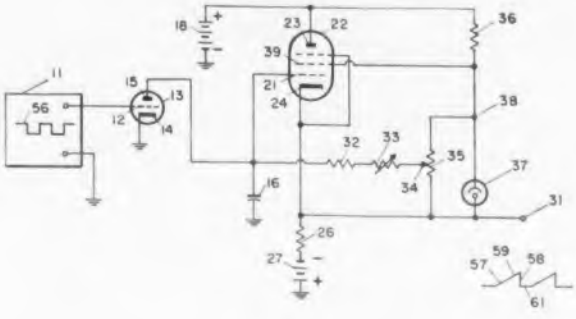
Sweep Circuit

Patent No. 2,743,357. R. F. Casey. (Assigned to Allen B. Du Mont Laboratories, Inc.)

It is desirable in the generation of a saw-tooth wave that the rising portion of the wave been linear or, more nearly, approximate linearity. It is desirable, too, that the circuit be adjustable in order to provide a wide range of frequencies. With the circuit illustrated, these results are secured with a relatively small capacitance.

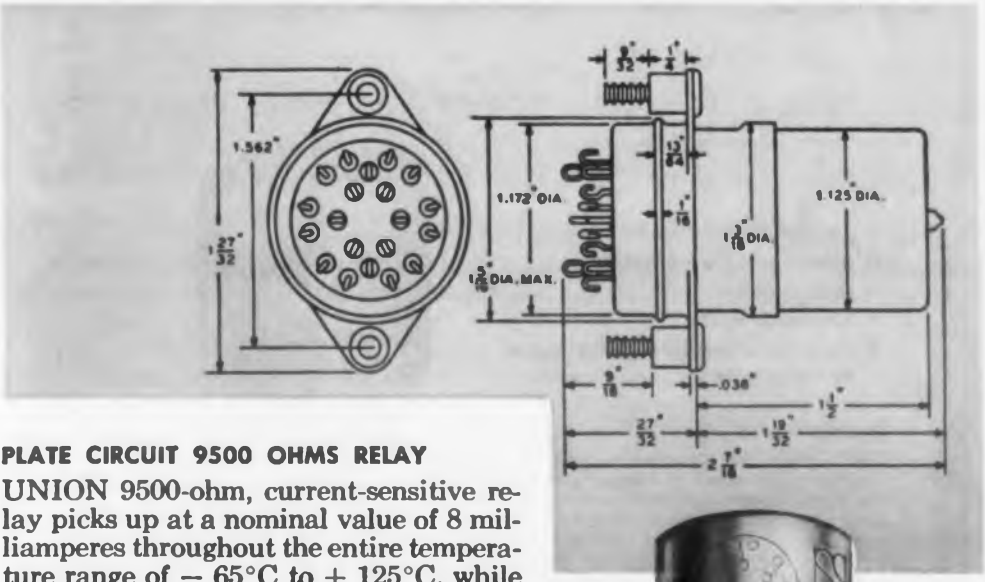
In the circuit shown, a synchronizing or gating signal such as a square wave is provided by the source *11*, and is applied to the control grid of the tube *13*. The positive portion of the signal maintains the tube conducting and discharges the charging condenser *16*. The negative portion of the signal renders the tube *13* non-conducting, so that the condenser *16* begins to charge from the potential source *18* through the resistors *36*, *35*, *33*, and *32*. The rising potential on the charging condenser *16* is applied to the control grid of a regulator tube *22* so that a rising potential or the inclined portion *59* of a saw-tooth wave is provided across the cathode resistor *26*. The output terminal *31* is connected with the cathode of the tube *22*.

In order to improve the linearity of the rising potential of the saw-tooth wave, a constant voltage device *37* is provided between the output terminal and the junction *38* of the resistors *36* and *35*. This constant voltage device feeds back some of the rising output potential to the charging condenser



16 to increase its rate of charging and thereby improves the linearity of the rising portion of the saw-tooth wave. At the end of the synchronizing pulse the tube *13* again becomes conductive and rapidly discharges the condenser until the next positive portion of the synchronizing signal repeats the cycle.

UNION Miniature Relays



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Books

Photoconductivity Conference
Edited by R. G. Breckenridge, B. R. Russell and E. E. Hahn, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 653 pages. Price: $13.50.

Available information on photoconductivity is thoroughly explored in this volume. It covers most phases of the subject in sufficient detail to serve as an introduction to the field as well as a monograph for advanced workers. It includes 30 papers by 45 authorities on solid state physics. These papers include basic theory, phenomenological theory, interpretation of photoconduction phenomena, and the most recent data on the properties of important photoconducting materials.

Currents, Fields and Particles
Francis Bitter, John Wiley & Sons, 440 4th Ave., New York 16, N.Y., 599 pages. Price: $8.50.

This book is designed to introduce the abstract concepts that stimulate a deeper understanding of natural laws. Dr. Bitter treats electricity and magnetism primarily as an introduction to atomic physics and field theory; and then brings in the basic ideas of wave mechanics. The illustrative examples and problems he has selected go beyond the usual range of electrical circuits and optical instruments. They include a variety of ideas in the general area of the physics of solids and gases and the structure of atoms.

RCA Magnetrons and Traveling-Wave Tubes

Tube Div. Radio Corp. of America, Harrison, N.J., 39 8½ x 11 in. pages. Price: $.50.

This publication includes information on operation theory of magnetrons and traveling-wave tubes, operating considerations and application, and techniques for measurement of important electrical parameters.

Illustrations included in the booklet show the structural parts of both types of tubes, typical performance characteristics, test methods and representative circuit applications. It gives detailed applications of both magnetrons and traveling-wave tubes which should be of particular value to the designer. Data is given for four commercially available RCA Magnetrons and one traveling wave tube.

Transistor Circuit Handbook

Louis E. Garner, Jr. Coyne Electrical School, Educational Book Publishing Div., Chicago 12, Illinois, 420 pages, $4.95.

A practical reference book covering over 200 basic circuits, practical applications and reference data on the uses of transistors, written in four parts. Part 1 is devoted to laboratory practice; part 2 covers basic circuits; part 3 discusses circuit applications; part 4 offers general reference material of value in circuit work.

This is an excellent self-study book for those heretofore unfamiliar with transistors and their applications and offers many practical circuits for home experiment. Included is a selected bibliographical listing of books and articles published to mid 1955. The state of the art is so rapid that many of the most important design articles are recent and not listed.

The Icosahedron and the Solution of Equations of the Fifth Degree

Felix Klein, Dover Publications, Inc., 920 Broadway, New York 10, N.Y., 290 pages. Price: $1.85.

This well known monograph covers the solution of quintics in terms of the rotations of regular icosahedron around the axis of its symmetry. The book, which is a classic of mathematics, is valuable as a source book for those interested in higher algebra, geometry, or the mathematics of crystallography. An expert knowledge of high mathematics is not required to follow the presentation, since considerable explanatory material is included.

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Simplified Equivalent Circuits For Transistor Amplifiers

WE KNOW that equivalent diagrams for transistors are considerably more complicated than those of vacuum tubes, even in the frequency region where the influence of interelectrode capacitances and inertia of the carriers is not pronounced. In the design of amplification stages with transistors this leads to complicated and cumbersome calculations while the analogous problem with vacuum tubes is solved more easily and quickly owing to the simplicity of the equivalent diagram.

It is therefore of great practical interest to reduce the equivalent diagram of the output circuit of a transistor to that of the vacuum tube. Fig. 1 is a diagram of an ac generator with an emf μU_1 (or a current generator SU_1) and an internal resistance R_1. It is particularly convenient to reduce to this equivalent diagram a transistor connected in an arbitrary manner (grounded base, emitter, or collector). Such a reduction will permit extending the usual calculation methods for amplification stages with vacuum tubes to the case of amplification stages with arbitrarily connected transistors.

Basic Parameters of Transistor Circuits

In view of the complexity of the equivalent circuit of the transistor, its properties at various connections are best represented by the generalized diagram of Fig. 2, where the transistor is arbitrarily shown in the form of an active four-terminal network. From this diagram, in which U_u and Z_u denote the emf and internal impedance of the signal source, and Z_H denotes the load impedance, it follows that:

$$\left.\begin{aligned} U_1 &= I_1 Z_{11} + I_2 Z_{12};\ U_1 = U_u - I_1 Z_u \\ U_2 &= I_1 Z_{21} + I_2 Z_{22};\ U_2 = -I_2 Z_H \end{aligned}\right\} \quad (1)$$

where Z_{11}, Z_{12}, Z_{21}, and Z_{22} are the impedances characterizing the four-terminal network.

Determining from the diagram of Fig. 2 and from (1) the values of the voltage amplification factor k_H, which is the ratio of the output voltage U_2 to the input voltage U_1, the current amplification factor k_T, which is the ratio of the output current I_2 to the input current I_1, and also the input and output impedances of the four-terminal network, Z_{BX} and Z_{BUX}, we obtain the known expressions:

$$k_H = \frac{U_2}{U_1} = \frac{Z_{21} Z_H}{Z_{11}(Z_{22} + Z_H) - Z_{12} Z_{21}} \quad (2)$$

$$k_T = \frac{I_2}{I_1} = -\frac{Z_{21}}{Z_{22} + Z_H} \quad (3)$$

$$Z_{BX} = \frac{U_1}{I_1} = Z_{11} - \frac{Z_{12} Z_{21}}{Z_{22} + Z_H} \quad (4)$$

$$Z_{BUX} = \frac{U_2}{I_2} = Z_{22} - \frac{Z_{12} Z_{21}}{Z_{11} + Z_u} \quad (5)$$

If the load impedance is zero, the current amplification factor k_T reaches a maximum called the static current amplification factor and designated a; the value of a is readily obtained by putting $Z_H = 0$ in (3)

$$a = -\frac{Z_{21}}{Z_{22}} \quad (6)$$

If the load impedance tends to infinity, the voltage amplification factor k_H reaches a maximum; this maximum can be called the static voltage amplification factor and is denoted μ, in analogy with the static amplification factor of the vacuum tube. The value of μ is obtained from (2) by putting $Z_H = \infty$:

$$\mu = \frac{Z_{21}}{Z_{11}} \quad (7)$$

Dividing the numerator and denominator of (2) by Z_{11}, and replacing Z_{21}/Z_{11} by μ we obtain

$$k_H = \mu \frac{Z_H}{\left(Z_{22} - \frac{Z_{12} Z_{21}}{Z_{11}}\right) + Z_H} \quad (8)$$

This expression does not differ from the known equation used to determine the amplification factor

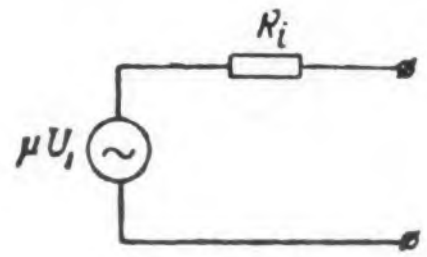


Fig. 1

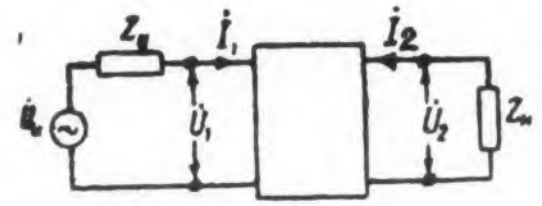


Fig. 2

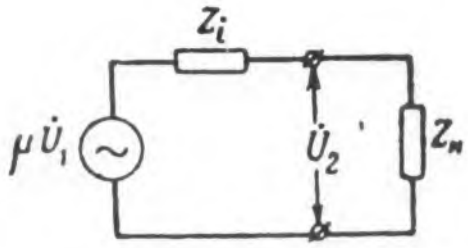


Fig. 3

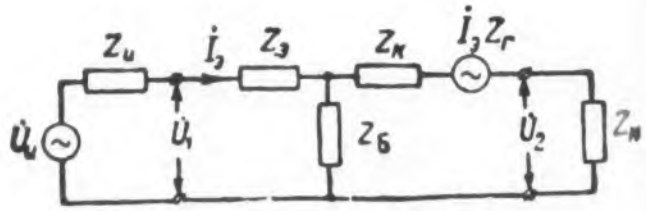


Fig. 4

of a stage employing a vacuum tube with a static amplification factor μ and an internal impedance Z_i. It corresponds to the equivalent diagram of an amplification stage shown in Fig. 3, and consequently, this diagram applies to transistors as well as to vacuum tubes. In the case of the transistor μ is given by (7), and the equivalent internal impedance, taking the internal feedback in the transistor into account, is represented by the term in the parentheses of (8):

$$Z_i = Z_{22} - \frac{Z_{12}Z_{21}}{Z_{11}} = Z_{22} - \mu Z_{12} \qquad (9)$$

The equivalent diagram of Fig. 3 is valid for a transistor connected in any manner, and also for a vacuum tube. However μ and Z_i have different values for each type of connection.

One of the generally accepted variants of the equivalent diagram of an amplifier stage employing a grounded base transistor is shown in Fig. 4, where the following symbols are used:

Z_e—emitter impedance
Z_c—collector impedance
Z_b—base impedance
I_e—current in emitter circuit
I_eZ_e—emf of equivalent generator in collector circuit

Comparison with Figs. 4 and 2 shows that for a grounded base circuit we have

$$Z_{11} = Z_e + Z_b;\ Z_{12} = Z_b;\ Z_{21} = Z_g + Z_b;\quad Z_{22} = Z_c + Z_b \ldots \qquad (10)$$

Substituting the values of Z_{11}, Z_{12}, Z_{21}, and Z_{22} in (6), (7), and (9) we obtain for a transistor in a grounded-base circuit the following values of a_b, μ_b, and Z_{ib}:

$$a_b = -\frac{Z_g + Z_b}{Z_c + Z_b};\ \mu_b = \frac{Z_g + Z_b}{Z_e + Z_b}; \qquad (11)$$

$$Z_{ib} = Z_c + Z_b - \mu_b Z_b = Z_c - Z_b(\mu_b - 1)$$

By analogy similar results can be obtained for common-emitter, grounded-emitter, or grounded-collector amplifier circuits.

The equivalent circuit of Fig. 3 makes possible calculation of the phase, frequency, and transfer characteristics for a transistor stage, using the same equations that are applicable to vacuum-tube circuits. The values of Z_i from (11) are used as required in the equations.

The characteristics derived in this manner relate the output and input voltages in the same manner as for a vacuum-tube stage. The frequency and phase characteristics of multistage amplifiers at the load of each stage is the input impedance of the following stage. The input impedance is calculated from (4) in which the values of Z_{11}, Z_{12}, Z_{21}, and Z_{22} are used for the particular transistor circuit and the load impedance Z_H. (*Abstracted from an article by G. S. Zyskin, in Radiotechnika, No. 2, 1956.*)

What the Russians are Writing

—Continued

Radiotekhnika, No 5, 1956

Propagation of UHF Waves at Large Distances Beyond the Horizon, V. N. Troitski, (18 pp, 13 figs).

Discussion of tropospheric propagation of UHF signals assuming this phenomenon to be due to both turbulent and laminar inhomogeneities in the dielectric constant. The mean value of the field intensity of the tropospheric wave is computed. Fading and distortion are discussed briefly and theoretical data are compared with experiments.

An appendix is devoted to the validity of the 2/3 law for tropospheric inhomogeneities and to a summary of experimental data obtained by various workers on the inhomogeneities of the dielectric constant. Many references to American articles.

Effect of Distance between Elements on the Resonant and Directivity Properties of a "Wave Channel" type of Antenna Array, D. M. Vysokovski, (5 pp, 3 figs).

The amplitudes and phases of the currents in such arrays are calculated for element separations ranging from 0.1 to 0.4 times the wavelength.

Noise Stability of the Correlation Method of Reception, A. E. Basharinov, (9 pp, 1 table).

Statistical study, with references to work by Lee, Chatham & Wiesner (*Proc. IRE*, Oct. 1950), Tucker & Griffith (*Wircless Engineer*, Nov. 1953), Peterson Birdsall & Fox (*Proc. IRE*, April 1954), and Davenport, Johnson, & Middleton (*Journ. Appl. Physics*, Apr. 1952).

Transients produced in Linear Networks by Irregular Voltages. Iu. I. Samoilenko, (7 pp, 2 figs).

The stationary parameters of the noise produced at the output of linear filters by stationary random input voltages have been discussed by many authors. This article employs statistical theory to determine the transients produced by such voltages.

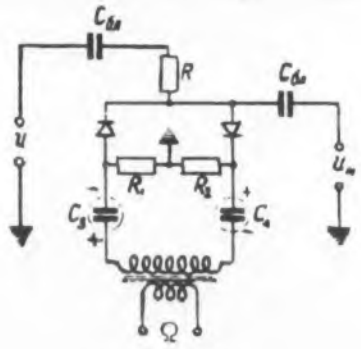
Amplitude Modulation with Diodes, A. D. Artym, (9 pp, 9 figs).

A simple method, essentially a modification of the double limiter, makes possible modulation up to 95 per cent and detection at frequencies approximating the carrier frequency. The circuit diagram is quite simple. Its principal elements are two diodes (crystal or vacuum-tube), a limiting impedance, and two RC networks.

The non-linear distortion of the carrier envelope does not exceed 1 per cent when the hf voltage is limited by five times; greater limiting reduces the distortion substantially. All the odd harmonics are modulated simultaneously with the carrier. The harmonic distortion can be kept low by suitably limiting the hf voltage.

Modulation is possible at frequencies up to that of the carrier. With slight modification, the conventional amplitude detector can be used to demodulate such a signal.

Distortion in the hf carrier and nonlinearities in the internal resistance of the diodes do not distort the demodulated signal, but reduce the possible depth of modulation. This effect can be minimized by proper choice of modulator elements. The modulated voltage does not contain even harmonics if the carrier is free from them. This facilitates filtration of the carrier and sideband frequencies.



Harmonic Synthesis and its Application to Radio Engineering Problems, A. M. Zaezdnyi, (12 pp, 6 figs).

Essentially this is a method of transforming the standard Fourier series expansion

$$f(x) = A_o + \sum_k (A_k \cos kx + B_k \sin kx)$$

into a polynomial

$$f(x) = a_o + \sum_n a_n \cos^n x \text{ or } f(x) = b_o + \sum_i b_i \sin^i x$$

The author shows that this transformation often simplifies the computations required in transient or non-linear analysis and discusses several advantages of this method.

Application of the Regeneration Method to the Design of Transistor Circuits, A. A. Rizkin, (9 pp, 2 figs, 3 tables).

To be abstracted in a future issue of ELECTRONIC DESIGN.

Design of Selenium Rectifier with Capacitive Filter, Iu. E. Nosovitski, (8 pp, 5 figs).

The design of vacuum-tube rectifier circuits with capacitive (RC) filters involves several simplifying assumptions, which must be modified if selenium rectifiers are used, principally because of the greater non-linearity of the forward current-voltage characteristic of the latter. The author employs piecewise linearization of this characteristic to improve the accuracy of the computations.

ACOUSTIC JOURNAL, Vol 2 No 2, Apr.-June 1956

None of the articles in this issue contain material that is of primary interest to electronic engineers. We translate, however, the table of contents for the benefit of our readers with interest in acoustics. The editor will be glad to supply further information about these articles.

PROPAGATION OF WAVES IN A MEDIUM HAVING A REFRACTION COEFFICIENT WITH RANDOM INHOMOGENEITIES (REVIEW), V. A. Krasil'nikov & A. M. Obukhov.

MECHANISM OF CAVITATION DAMAGE TO SURFACE FILMS IN SONIC FIELD, A. S. Bobchuk, L. O. Makarov, L. D. Rozenberg.

EXPERIMENTAL INVESTIGATION OF RELAXATION PROCESSES OCCURRING IN THE PASSAGE OF ULTRASONIC WAVES IN LIQUIDS, Iu. N. Bormosov, V. F. Nozdrev, V. D. Sobolev, A. M. Sultanov.

FOCUSING OF SOUND WAVES BY INHOMOGENEOUS MEDIA, L. M. Brekhovskikh.

ON THE PROBLEM OF GUIDED SOUND PROPAGATION IN INHOMOGENEOUS MEDIA, Iu. L. Gazarian.

ON CERTAIN NEW METHODS OF MEASURING HUMAN HEARING AND THE RESULTS OBTAINED, G. V. Vershunin.

MODULATION METHOD OF MEASURING THE DISPERSION OF ULTRASOUND, V. A. Zverev.

SCATTERING AND RADIATION OF WAVES BY STATISTICALLY INHOMOGENEOUS AND STATISTICALLY FLUCTUATING SURFACES, M. A. Isakovich

APPLICATION OF LAYERS THAT ELIMINATE THE PRODUCTION OF TANSVERSE WAVES IN THE REFLECTION OF A LONGITUDINAL WAVE FROM THE BOUNDARIES OF SOLID BODIES, M. A. Isakovich.

EXPERIMENTAL INVESTIGATION OF ULTRASONIC TRANSITION LAYERS, G. I. Kaminir, B. D. Tartakovski.

FIXED-DISTANCE PULSE ECHO-RANGING PROCEDURE, ITS PHYSICAL FOUNDATIONS AND PRACTICAL APPLICATIONS, N. I. Koshkin, V. F. Nozdrev, V. D. Sobolev, N. G. Shirkevich, V. F. Iakovlev.

VELOCITY OF SOUND IN LIQUIDS, LIQUID MIXTURES, AND SOLUTIONS, B. B. Kudriavtsev.

CHANGEOVER TO GEOMETRIC APPROXIMATION IN THE THEORY OF ELASTICITY, M. L. Levin & S. M. Rytov.

SCATTERING OF SOUND WAVES BY SINUSOIDAL AND SAWTOOTH SURFACES, A. N. Leporski.

CONCERNING ONE APPROXIMATE SOLUTION TO THE PROBLEM OF SCATTERING OF SOUND WAVES BY UNEVEN SURFACES, Iu. P. Lysanov.

NON-MIRRORLIKE REFLECTION OF SOUND BY A THIN CYLINDRICAL SHELL, L. M. Liamshev.

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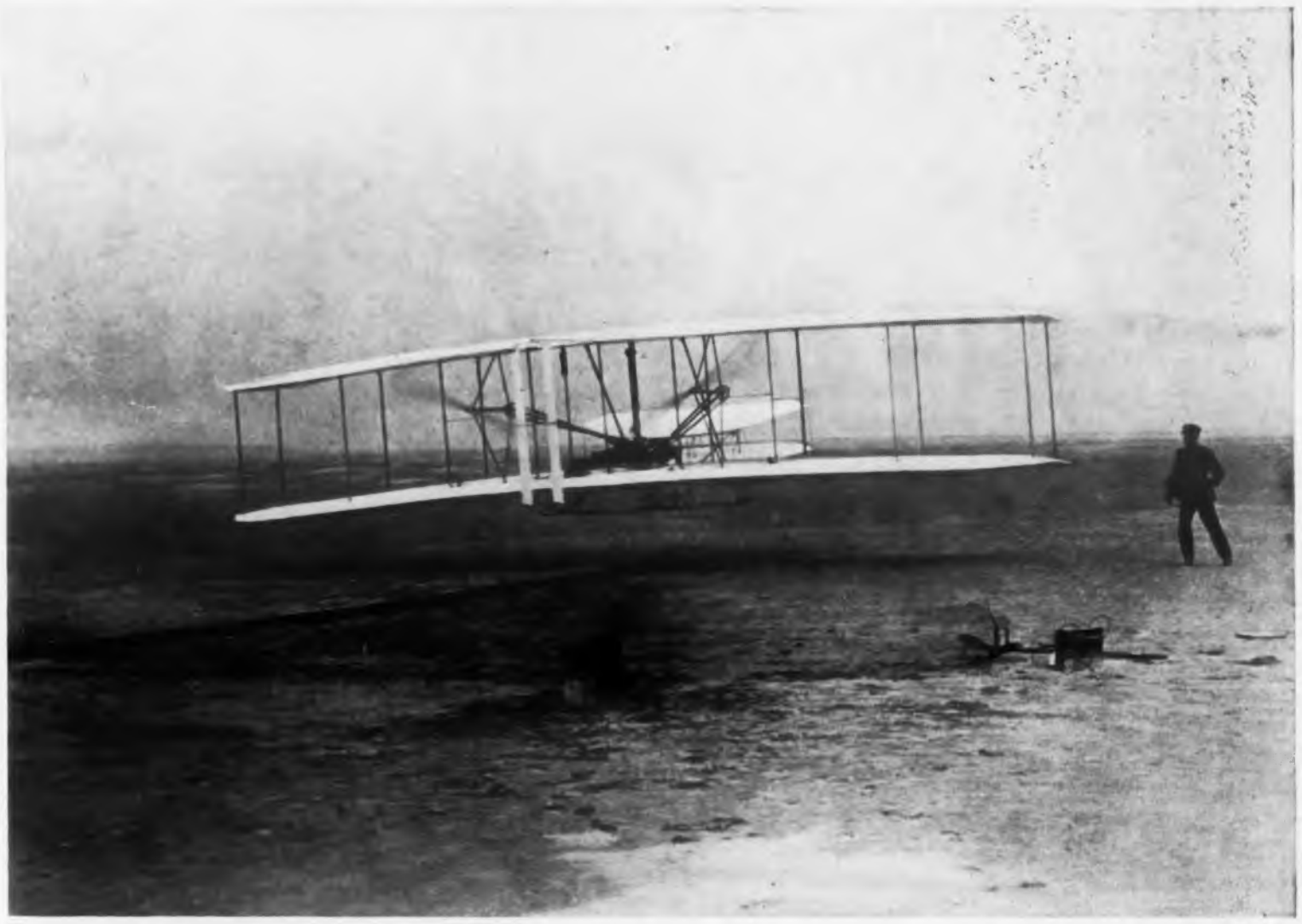

Experiment by two bicycle mechanics, Kitty Hawk, 1903

BETTMANN ARCHIVE

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Abstract

Report On

RELIABILITY of electronic systems is of vital concern to the military services and, accordingly, transistor reliability studies were started as early as 1951. Two questions are now uppermost: How much has transistor reliability improved? Can transistorized equipment be designed now and be reliable?

Tests conducted in 1954 demonstrated that transistors "aged" even when on the shelf and not used. The aging was found to be an unstable surface condition. Corrective measures in manufacture were taken and by 1955 the condition was appreciably improved.

To answer the second question realistically, two other facts must be obtained first: What is the reliability required from the system using the transistor and what does the system require from the transistor in order to fulfill its mission reliably?

It is reasonable to state that the reliability required for a new transistorized system is the reliability now accepted for equipment using electron tubes. Studies have been made and Tables 1 and 2 are representative of the findings. Note that for the telephone carrier and computer applications analyzed, it is possible to generalize and state that the percent failure rate per 1000 hours of operation was in the range of 0.1 to 1 for electron tubes. The transistor failures were lower proportionately, in the range of 0.1 to 0.6 for somewhat comparable equipment. It would seem that transistors enjoy a longer life than electron tubes.

Generally, transistor failures are classified as catastrophic failures and aging failures. A transistor may also burn out, but the circuit must protect the transistor from that. Catastrophic failures are instantaneous and cause complete malfunctioning of the transistor. Internal shorting or breaking of leads are examples of this. Aging failure is the gradual drift of an electrical parameter with time. Today, only aging trends are known. Additional study is required; the answer to the entire problem is not simple. *Abstracted from A Review of Transistor Reliability, D. E. Barnes, Bureau of Ships Journal. Supt. of Documents, U.S. Printing Office, Washington 25, D.C., November 1956, pp 28-32. 15 cents.*

Transistor Reliability

TABLE 1
Electron Tube and Transistor Failure Rates of Well-Known Classes of Services

Class of service	*Electron tube type*	*Failure rate %/1000 hours*	*System interval unit-hours/failure*
Computer service	6SN7 6J6	1 to 2	0.5 to 1 x 10^5
Computer service	IBM-special	0.14 to 0.7	1.4 to 0.7 x 10^5
Telephone carrier	- - -	0.2 to 0.1	0.05 to 1.0 x 10^6
Submarine cable	- - -	0.006	- - -
	Transistor type		
Rural carrier	130 junction	0.6	1.5 x 10^5
Card translator	- - -	0.1	10^6
Computer (1)	700 Pt. Ct.	0.1	10^6
Computer (2)	615 junction	0.1	- - -
Hearing aid	- - -	0.2 to 0.5	- - -

TABLE 2
Comparison of Transistor and Electron Tube Removal Rates for Same Equipment Failure Interval

Removal rates %/1000 hours	*Unit hours per failure*	*No. of tubes or transistors*	*Equipment failure interval*
47	2,130	6 12AT7	354
15	6,666	6 12AT7	1,111
5	20,000	6 12AT7	3,333
3	33,333	10 transistors	3,333
9	11,111	10 transistors	1,111

Abstracts

Report Briefs

Magnetic Properties

Measurements of the susceptibility contribution to permeability made on Elgiloy, Iconel and Colmony alloys indicated that the first two have mainly paramagnetic contributions to the permeability. Colmony has equal contributions from both paramagnetism and ferromagnetic impurities. Extrapolation of the susceptibility data to low temperatures showing both Elgiloy and Iconel ferromagnetic below room temperature. An experimental arrangement for measuring low permeabilities in fields of about 100 gauss is described. *PB 121169 Magnetic Properties of Low Permeability Alloys, T. R. McGuire and F. S. Smart, NOL, OTS, US Dept. of Commerce, Washington 25, D. C., Feb. 1954, 16 pp, $.50.*

High Electron Mobility Semiconductors

This investigation was concerned with the preparation and evaluation of semiconducting materials of unusually high electron mobility. Indium antimonide was prepared in a state of high purity and its basic electrical properties were analyzed. Studies were made of the zone-refining process for InSb and the effect of a specified number of passes on both p- and n-type impurities. Specimens of indium antimonide were prepared with impurity contents as low as 10^{14} atoms/cm^3 and with electron mobilities of 75,000 cm^2/v-sec at room temperature, and 500,000 at 80 K. *PB 121288 Research and Development Work On Semiconducting Materials of Unusually High Electron Mobility, Beer, Harman, Willardson and Goering, Battelle Memorial Institute, OTS, US Dept. of Commerce, Washington 25, D. C., July 1955, 50 pp, $-.50.*

U. S.-Owned Inventions Available

Described in this compilation are 1,915 Government-owned inventions applicable to the electrical and electronic apparatus industry, covered by patents active as of Dec. 31, 1953. For each invention, the title of the invention, the U.S. patent number, and an abstract of the patent are given. *PB 111468 Patent Abstract Series, No. 5, Electrical and Electronic Apparatus, OTS, US Dept. of Commerce, Washington 25, D. C., 160 pp, $4.00.*

Statistical Design of Lab Experiments

Navy-sponsored lectures on the philosophy and practical use of statistics in research and design are contained in this volume. Included in the report are papers on "An Example of Planning Laboratory Experiments," "Principles of Experimental Design," "The Student-Fisher Revolution in Modern Statistics," "Usable But Not Widely-Known Statistical Techniques," "Multivariate Methods in Testing Of Complex Equipment" and "Making Decisions From Experiments." *PB 121181 Collection of Papers Presented at the Colloquim in Statistical Design of Laboratory Experiments, NOL, Order from OTS, US Dept. of Commerce, Washington 25, D.C., pp 102, $2.75.*

Experiments With Thin Ferrite Films

Successful production of thin ferromagnetic films by sputtering is described. The report also reviews theories pertaining to the properties of thin ferromagnetic films and existing experimental data concerning the deviation of magnetization and other parameters of thin films from that of the bulk material. *PB 121177 The Experimental Production Of Thin Ferrite Films And A Survey Of The Magnetic Properties Of Thin Films, R. J. Miller, Naval Research Lab., OTS, US Dept. of Commerce, Washington 25, D. C., Mar. 1955, 40 pp, $1.25.*

Packaging and Materials Handling

Packaging and materials handling specialists from both the Armed Services and industry participated in a three-day exchange of information. This symposium was sponsored by the Department of the Navy with the cooperation of the Army, Air Force and Department of Commerce.

Subjects discussed were: materials handling in production; transportation and warehousing; packaging methods selection; transportation costs reduction; packaging requirements; automatic packaging; and automation in handling. *PB 121350 First Joint Military-Industry Packaging and Materials Handling Symposium, OTS, US Dept. of Commerce, Washington 25, D. C., pp 695, $6.00.*

Light Weight Ceramics Patents

World-wide patents on light weight ceramics, granted by some 14 different foreign countries, are catalogued and described briefly in this compilation. *Patents on Light Weight Ceramics, A. J. Metzger, Bulletin 111, Virginia Polytechnic Institute, Blacksburg, Virginia, July 1956, 69 pp, $.25.*

Standards and Specs

Sherman H. Hubelbank

This department surveys new issues, revisions, and amendments, covering military and industry standards and specifications. Our sources of information include the Armed Services Electro-Standards Agency (ASESA), the cumulative indexes to Military Specifications, Vols, II, IV, American Standards Association (ASA) and other standards societies.

Impact Testing

ASTM Special Publication No. 176, Symposium On Impact Testing.

Nine papers presented at the Symposium on Impact Testing that was held at the ASTM meeting in June, 1955 and five papers which are appropriate to the theme of the Symposium are included in this recently published 170 page publication. The papers encompass impact in parts, components, and complete structures, and they are not confined to notched bar testing. Available from the American Society for Testing Materials, 1916 Race Street, Philadelphia, Pa., for $3.50 each.

Specs on Specs

MIL-S-25063 (USAF), Instructions And Requirements For Preparation Of Specifications And Engineering Data For Airborne Electrical Equipment Or Systems, 15 June 1956.

Preliminary design specs, performance specs, and detail design specs pertinent to electrical equipment and their application for piloted aircraft and guided missile weapons systems are covered in this spec.

RETMA Request for Reaffirmation

In accordance with the RETMA policy of reviewing existing RETMA Standards, REC-119, Vibrator Power Transformers, has been submitted for reaffirmation. Although the official comment period may have expired, you are encouraged to contact the RETMA Engineering Department, 11 West 42nd St., New York 36, N.Y. if you are vitally interested.

Resistors

MIL-R-14293 (Sig C), Resistors, Fixed, High Megohm (Hermetically Sealed), 19 April 1956

Fixed resistors, ranging in value from 10^8 to 10^{11} ohms, with a tolerance of 10% at 25°C are covered in this spec. These resistors are hermetically sealed and are 1-15/16 inches long and 15/16 inch in diameter.

RETMA Standards

RETMA RS-163, RF Radiation Label, August 1956

Dimensions and copy for the RF Radiation Label which is to be affixed to receivers in accordance with Part 15 of the F.C.C. rules are specified. Available from RETMA for 25 cents per copy.

RETMA RS-162, Test Standard For Ceramic Based Printed Circuits, August 1956

The standard test procedures to be used for the ceramic based printed circuits, as defined in RETMA Standard RS-161, are described by this standard. The standard specifically covers the type A unit, which is a combination in which the components are separably and individually accessible at the terminations for individual measurements. It may also be used where applicable for the type B unit, which is a combination in which some of the components are not separably and individually accessible at the termination for individual measurement, and which, in whole or part, must be considered as circuits. Copies of the standard may be obtained from RETMA, 11 West 42nd St, New York 36, N.Y. for 30 cents each.

RETMA RS-161, Unit Standards For Ceramic Based Printed Circuits, August 1956

Physical and electrical specs of ceramic based printed circuits which have been standardized are established by this standard. The physical specs include maximum overall size, lead length and size, lead number and sequence, RETMA identification number, and manufacturer's number. The electrical specs include circuit schematic, component values and tolerance, component rating, the connections to lead wires and terminations, and additional information required for test. Copies of this standard are available from RETMA, 11 West 42nd St, New York 36, N.Y. for 70 cents each.

Power Supply

MIL-P-157369 (SHIPS), Power Supplies, Metallic Rectifier, Naval Shipboard, 9 July 1956

General requirements for class HI-shockproof metallic rectifier type power supplies are established by this spec. Two basic classifications of power supplies have been established: Class R, regulated and Class NR, nonregulated.

Plastics

L-P-349a, Plastic Compounds, Molding, Cellulose Acetate Butyrate; and Molded or Extruded Parts, 30 July 1956

This revision supersedes specs L-P-349, dated 9 May 1949, MIL-P-3414, dated 15 February 1951, and MIL-P-16414 (BuOrd) dated 29 June 1951, in their entirety, and that portion of MIL-P-10407 (Ord) dated 31 July 1950 concerned with the evaluation of the cellulose acetate butyrate molding compound.

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