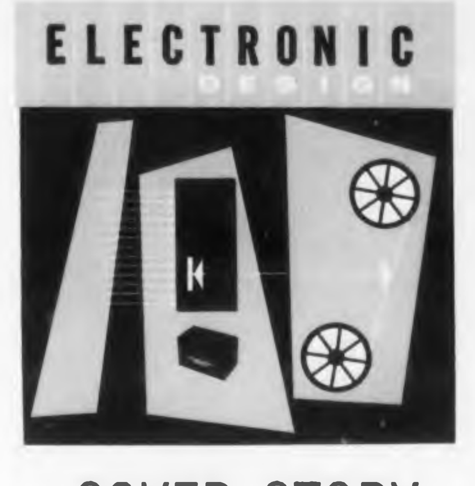
ELECTRONIC DESIGN

Multi Channel Electronic Switch .... page 40



COVER STORY

ELECTRONIC DESIGN

DATA REQUEST PROCESS CARD
Use Before March 19th, 1958

Name ____________________ Title ____________________

Company ____________________

Company Address ____________________ City __________ Zone ______ State __________

For Change of Address: Old Company Name ____________________ Old Company Address ____________________

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For Personnel Ads Only (Nos. 550-599)

ELECTRONIC DESIGN

DATA REQUEST PROCESS CARD
Use Before March 19th, 1958

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Company ____________________

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ENGINEERING REVIEW

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

Only tube used in this TV chassis is the picture-tube. Thirty-one transistors are employed, and power is provided by two nickel-cadmium batteries that give six hours of set operation, without charging. Picture is comparable to conventional portable.

Around the corner

Transistorized TV

An experimental all-transistor (except picture tube) battery-powered television receiver was recently announced by Motorola, Inc. First such set to be described, it employs 31 transistors and uses two rechargeable batteries which provide six hours of continuous operation away from commercial power. Performance is stated to be equivalent to conventional ac-powered, vacuum-tube sets.

Although the new set draws only twelve watts from its two nickel-cadmium batteries, a quarter of this is needed to supply the picture-tube filament. According to ELECTRONIC WEEK's account of this development (Jan. 13, 1958), Motorola's Neil Frihart stated that their biggest "headache" was tuner design. Special (and apparently costly, at present) transistors were required in the "head end" to get good high frequency sensitivity. Motorola wouldn't disclose tuner design or transistor types, but it is understood that a 41.25 mc sound and 45.75 mc video i-f are used and are designed to give somewhat greater gain than present commercial sets in order to compensate for lower tuner sensitivity.

Nickel-cadmium batteries are used because of their ability to hold terminal voltage about constant until discharged. This lessens problems with voltage regulation. Batteries occupy only about 250 cu in. total, with a weight of less than ten pounds. Battery life is based on about 2000 recharging cycles minimum. A total charge takes just two hours while the set is connected to commercial power.

High voltage is supplied to the picture tube anode at 20,000 volts. Originally designed as a square wave oscillator, Motorola engineers found that the high voltage supply worked better driven. The oscillator is now driven from the horizontal output at the scanning frequency of 15,750 cps. First, 12 volts ac is stepped up to 2500 volts, then quadrupled to the anode operating voltage. Horizontal scanning is accomplished by a switching type circuit with power fed to the yoke during retrace.

So far, only two sets have been built. Both were displayed in January at Chicago's Merchandise Mart. While Motorola's aim is to produce a production model of a battery-portable TV, they don't expect to have a model available at a practical price until about 1960.

ENGINEERING REVIEW

Large-Screen Long-Range Rada Display Pin-Point Targets

A radar indicator that has the ability to pin-point targets of interest, through expansion of the display in azimuth and range, has been developed at the Research and Development Division of Allen B. DuMont Labs. Inc., of Paterson, N. J. for Lincoln Labs.

The presentation is made on a 16-inch cathode-ray tube with a P7 phosphor and utilizes a conventional 13 scan (range versus azimuth). The equipment will operate with pulsed radar systems of a limited frequency range. With an azimuth display of 350 deg. the range display is zero to 4,000 miles. Expansion of a range sector is variable from a 50 to a 500 nautical-mile sector, and azimuth sectors can be 10 deg minimum and 350 deg maximum. The amount of expansion is selectable. The area to be expanded is automatically intensified on the screen when the equipment is operating in its normal mode.

Inputs to the indicator include radar video, system trigger, and antenna positioning by means of a Land 36-speed synchro system. The range and azimuth calibration markers are generated within the indicator.

New Magnetic Oxides

A new class of magnetic oxides, structurally distinct from ferrite, has recently been discovered. These rare-earth-iron garnets are transparent and permit the internal magnetic domain structure to be seen with a polarizing microscope.

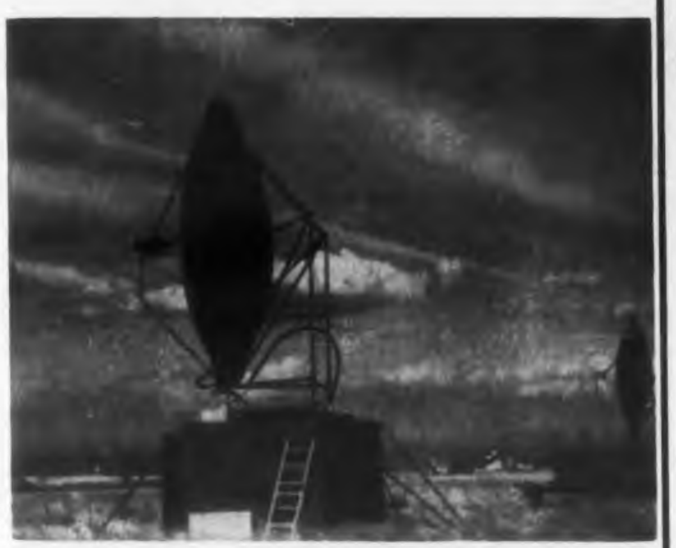
The discovery of ferromagnetism in these garnets was first made in France, and then, independently by S. Geller and M. A. Gilleo of Bell Telephone Laboratories, 463 West St., New York City, where the optical and magnetic resonance behavior of the garnets is being studied.

◄ CIRCLE 4 ON READER-SERVICE CARD

Electronic Device Aids Delicate Eye Operation

Surgeons making the delicate operation of re-attaching retinas are aided by a new electronic device called the Ophthalmo-Electrotome. Detachment of the retina, the innermost coat of light-sensitive cells located in the back part of the eye, can be caused by a blow on the head or other common injury. Retinal detachment rivals the cataract as a cause of blindness. Electronic engineers of Ford Instrument, Div. of Sperry Rand, worked closely with doctors of the New York Hospital-Cornell Medical Center to develop the new electrosurgical control equipment which attaches retinas.

Electrosurgery is a medical operating technique utilizing the electrical knife, which is basically electrodes connected to an electrical power supply. The electrode issues a fine radio frequency current when the power is turned on. It is employed for such ordinary purposes as removing warts to complex, delicate brain operations. Unlike conventional electrosurgical equipment, the Ford device enables the surgeon to control both voltage and frequency and thus prevent burning delicate tissues. This instrument is now being used on research animals at the New York Hospital-Cornell Medical Center.



Nutshell Communication Terminal: A compact uhf communication terminal can be packed up, moved by air, and quickly put in operation by a few men. Designed by Collins Radio Co., Cedar Rapids, Iowa, the system is on trial at the U.S. Army Electronic Proving Ground, Ft. Huachuca, Ariz. Called the Transhorizon, it has blower-inflated antennas and two metal huts into which all equipment can be packed. These double as shelters when the station is erected. Using tropospheric scatter propagation, the terminal achieves reliable multichannel communication, without intermediate relays, for ranges of 50 to 150 miles. It operates in the 1000 mc band.

ENGINEERING REVIEW

Electronics Spending for Missiles

Who gets what percentage of each dollar being spent for guided missiles? What proportion of the total funds expended takes care of electronics, engines, missile frames, etc.? Some of the answers are now forthcoming from USAF sources. As published in a recent Aircraft Industries Association release, all the money spent by the USAF on both research and production of guided missiles between fiscal 1946 and fiscal 1958 is proportioned as follows: Airframes 35 per cent; propulsion systems 20 per cent; guidance and control 20 per cent; military construction 10 per cent; nose cones 8 per cent; industrial facilities used by contractors 6 per cent; and miscellaneous 1 per cent.

Projecting USAF figures against estimated missile spending by all the services during the 13-year period shows that guidance and control have cost $1,500,000,000. On the basis of one type of air-to-air missile, one prime contractor divides his production costs as follows: non-nuclear warhead, 3.5 per cent; mechanisms (including gyros, accelerometers, hydraulic servo units, switches, actuators, safety and arming units, etc.) 33 per cent; electronics 43 per cent; electric power source 1.5 per cent; airframe 12.5 per cent; and 6.5 per cent for the solid propellant rocket engine. These costs exclude R & D.

Tiny Chemical Memory

A chemical memory system which may be able to store 1,000,000 bits of information on a square inch surface is under development at the National Cash Register Company, Dayton, Ohio. Microscopic droplets of photosensitive "solid liquids" are coated on a sheet of paper. When exposed to blue light, they turn a brilliant blue. When exposed to yellow light, they become colorless again.—Thus they can serve as chemical switches, or bistable devices. NCR hopes to have a working model of a chemical memory computer by mid-1959.

◄ CIRCLE 6 ON READER-SERVICE CARD

Missile Takes A Bromo

Bromo Seltzer can be used to cure missile headaches, too, it was disclosed today by General Electric missile engineers, 3198 Chestnut Street, Philadelphia, Pa. The company is developing nose cones for the top priority Air Force Atlas ICBM and the Thor IRBM at its Missile and Ordnance Systems Department in Philadelphia.

To house recording instruments during test flights of these missiles, GE engineers developed a spherical capsule which is carried in the missile nose cone and is ejected before the nose cone hits the earth. Electrically operated markers help engineers locate the sphere. However, to function properly, these markers must be delayed for a few minutes before operation.

This is where the Bromo Seltzer comes in. Bromo Seltzer, packed around electrical wires, delays completion of the electronic circuit for the few minutes required for operation. Engineers had spent considerable time perfecting various mechanical switches, none of which worked satisfactorily. The engineering headaches involved were extremely annoying until Bromo Seltzer stepped in and cured them.

Device Counts Fog Particles

A new device to count and measure fog particles has been developed at the U.S. Army Chemical Corps' Chemical Warfare Labs., Army Chemical Center, Md. It is portable, electronically operated and semi-automatic. With this counter, one man can measure and record, with one hand, at an average rate of 3300 particles per hour —as compared with 1250 particles per hour for previous methods. Faster automatic devices are available, but they do not distinguish between fog and other particles. Using electronic "calipers," the operator measures greatly magnified particle images flashed on a screen. Operation of a foot pedal records the size.

CIRCLE 7 ON READER-SERVICE CARD ➤

"Teletac" Sense-of-touch communicator for the deaf. It provides instant message transmittal when the "sender" places his hand on the vibration sending piano-type keyboard (right) with the "listener's" fingers impressed on the five sensitive diaphragms on the receiving unit (left).

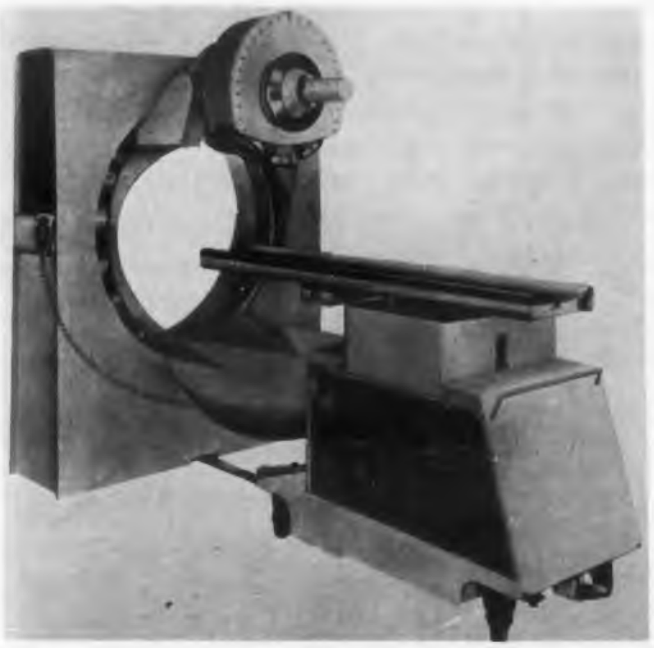
New Vibration Sender Gives the Deaf Word Symbols

A new tactile stimuli device for communicating with the deaf has been designed by a Ramo-Wooldridge Engineer, Joseph Hirsch. With Hirsch's device the speaker works five vibration-sending piano-type keys, and the listener gets the message by resting five fingers on sensitive receiving diaphragms. Immediate reception is accomplished, reports the John Tracy Clinic of Los Angeles; and a duplicate system allows the listener to become the speaker.

Employing two frequencies, the system called Teletac, enables a deaf person to transmit 637 words or symbols. However, the problem of optimum coding is one which will have to be solved. The John Tracy Clinic expects to learn about optimum coding by studying the learning rate of deaf children as they respond to codes prepared by linguists.

Army Must See Over Thousands of Square Miles

The Signal Corps has just awarded Cornell Aeronautical Laboratory, Inc., a contract to study how to keep an eye on the enemy spread out over thousands of square miles. Combat surveillance, the continuous and systematic watch over a combat area under all conditions of weather, both day and night, has long been a neglected area regarding its capability for both large scale and limited war. It is expected the study will indicate how improvements in systems of surveillance of a battlefield by radar, infrared, sonic, meteorological, reconnaissance, photographic, and televisional means can be made. Mobility and wide dispersal are aspects of modern combat tactics that require much information quickly. For example, a profitable target for a guided missile might exist only a brief period at a distance of hundreds of miles. A commander of the future must be able almost instantly to scan a large battle area if he is to take appropriate action.



Cobalt 60 Therapy Unit Treats Deep Cancer: A new Cobalt 60 therapy unit is now available from the Westinghouse Electric Corp., P. O. Box 416, Baltimore, Md. A source of higher energy radiation is provided to get appreciable doses to deep lying lesions without exceeding the tolerance of the skin and overlying tissues.

The source head can be rotated completely around the patient; the beam being continuously aimed at the axis of rotation. By turning the ring to the desired position, the operator can select any one of the seven cones located in the source head. Six semi-permanent cores are contained in the ring. The seventh position accommodates small interchangeable cones.

Patient contact protection stops rotation immediately if the source head should touch either the patient or table. The device operates without any contact pressure.

Only the arc of travel of the head, and the time of patient exposure are specified by the operator; a speed calculator automatically regulates the speed of rotation of the source head.

A safety device employed by the unit moves the Cobalt 60 capsule along the axis of the treatment head to the "on" position when treatment begins. When treatment is finished the capsule automatically returns to the "off" position.

ENGINEERING REVIEW

Large Annunciator System With No Moving Parts Except the Bell

An annunciator system with no moving parts will get its first application in 1958 when the Public Service Electric and Gas Company of New Jersey employs it to monitor 560 critical quantities. Developed by Westinghouse Electric Corp., the system will use modular plug-in magnetic elements rather than relays. In over-all design it will be similar to Cypak static control systems for industrial control applications. Static annunciator systems house several information processing components in a single plug-in module. The unit functions over a voltage range of 75 to 140 volts. Although our source of information didn't so state, we're sure the bells and buzzers still use moving parts.

New machine test memory plates: A machine, developed at Radio Corporation of America's research laboratories at Princeton, N.J., tests accuracy of "memory plates" used in electronic computers. Tiny RCA aperture plate in foreground, containing 256 bits of information, enables computers to store more than a million facts in a space little larger than a shoebox and to recall any or all of them in a few millionths of a second. Machine in background, with lights corresponding to tiny holes in the memory plate, can instantly test plate for any flaws.

More Work for MASER

Harvard University's Gordon McKay Laboratory of Applied Science has developed a three-level, solid state maser. The experimental device, it is hoped, will extend the range of the best radio telescopes. In addition to its potential applications in certain radar systems, it is hoped that the new maser, the first to run successfully in the 21 cm band, will confirm or deny the existence of hydrogen gas, suspected of hovering between the galaxies.

The first maser, a gas type, rather than a crystal type, was proposed and constructed in 1954 by Prof. C. H. Townes at Columbia University. The word stands for "microwave amplification by stimulated emission of radiation."

Printed-Circuit Institute Formed —Previously Reported by *ED*

As reported almost a year ago in ELECTRONIC DESIGN (Jan. 15, 1957), the then forthcoming association of printed-circuit manufacturers has now been announced as a reality. Among various things the association is expected to accomplish are recommendations for industry-wide printed-circuit standards.

The association is to be known as the Institute of Printed-Circuits and has established headquarters at 27 E. Monroe St., Chicago 3, Illinois. Elected officers are: president—W. J. McGinley, President, Methode Manufacturing Co., Chicago; vice-president —A. R. Hughes, Electralab Inc.; and treasurer—R. L. Swiggett, V.P., Photocircuits Corp. Directors include Karl Clayton, Tingstol Co., and R. G. Zens, V.P., Printed Electronics Corp.

Mr. McGinley, in announcing the formation of the association, stated that "the objectives of the group will be to develop standards and other educational material to aid the user to purchase and use printed circuits more efficiently and more economically, and to provide an organization for manufacturers in the industry to work together toward common goals." The association has already completed preliminary specifications for standard dimensional tolerances, and has prepared a preliminary draft of a new brochure on *How To Design and Spe-*

cify Printed Circuits.

The 1958 activities of the IPC are expected to include a comprehensive survey of the size, facilities, and problems of the industry. It will also include special programs of industry promotion and publicity, and a continuation of the work to develop both commercial and precision tolerances for printed circuits.

New Integrator Speeds Accurate Color Matching

A new machine that determines how the average human eye will see a color under various lighting conditions has been developed by William E. White and Dr. David L. MacAdam of Kodak Research Laboratories. It is called a universal digital tristimulus integrator.

Built for use with a spectrophotometer, the device which traces the reflectance curve of the color sample, converts the analogue motion of the spectrophotometer into digital pulses. The pulses are then sent to a digital integrator, which sums them according to a program fed into it by means of a punched tape.

Kodak color research scientists have found that the machine eliminates human error in ordinarily tedious integrations involving thirty computations per curve for each of three tristimulus values. The integrator uses the selected ordinate system. It simultaneously adds up three sets of 200 or more reflectances per sample, thus reducing error inherent in the integration process. It provides a faster, more accurate means of matching color under given physical conditions.

In addition to the sensitivity curves of the human eye, sensitivity of TV receptors or color film can be fed to the machine to provide color matching for a variety of "viewers."

Programs can be fed into the machine to correspond to various lighting conditions, such as fluorescent light, sunlight, and tungsten light. At the same time, reflectance values of the color sample are read by the spectrophotometer.

◄ CIRCLE 12 ON READER-SERVICE CARD

A Deadhead Pays Its Way: During tests on a transistorized microphone, response curves were plotted using this artificial life-size head. Because acoustic measurements on microphones require near real conditions, the head was covered with skin-like plastic. Shure Bros., Inc., 222 Hartrey Ave., Evanston, Ill., made "Oscar" to test their 505T magnetic microphone for mobile radio transmitters. The microphone houses a tiny transistorized amplifier which improves sensitivity so much that the 505T can often replace a carbon microphone with no transmitter changes.

Traveling-Wave TV Antenna: A unique, advanced type of television antenna will be initiated by Station KGHL-TV in Billings, Montana. Designed at RCA, Gibbsboro, N. J., the antenna has a gain of 15 for high-power TV broadcasting in the vhf-TV band (316000 watts from a 25 kw transmitter). Its unusual electrical design permits transmitted television signals to travel the length of the sectioned antenna as complete waves. This traveling-wave characteristic makes for ideal shaping of vertical patterns, improved circularity and uniform signal distribution, and simpler mechanical construction. The antenna needs no external feed lines. It is available with gains ranging from 8 to 18.

Operator checking out the electronic equipment aboard a fighter plane with the portable spectroscope built for Republic Aviation Corp. by Applied Research Inc. of Flushing, New York.

Spectroscope Checks Out Aircraft Electronic Gear

A radio-frequency spectroscope has been developed at Republic Aviation Corporation which reduces to one-sixth the time it has previously taken to check aircraft electronic equipment on the production line. The checkout makes certain that a pilot will be able to hear his radio clearly and that there is no electrical interference with the operation of his radar equipment.

The spectroscope is basically a hypersensitive radio set that is plugged into an aircraft's antenna and "hears" any interference or static when the ship's various electrical systems are operating. The interfering signal is detected and changed into a wavering line that can be seen on the "glass eye" of the tester.

The spectroscope saves time by being able to check an entire radio-frequency band at once rather than having to check each channel separately as previously required. It is compact and light enough to be moved from location to location and has a remote control device that can be used for testing aircraft in the field. Other applications have been suggested for the device including use as a noise interference analyzer, spectrum analyzer, search receiver and as monitoring equipment.

First International Conference On Physics of Electronic and Atomic Collisions

Physicists from the United States and abroad, including a group from the Soviet Union, met at New York University on Jan. 27 and 28 for a conference on the physics of electronic and atomic collisions. The five-session meeting was sponsored jointly by the Office of Naval Research, and NYU. It was the first conference in this country devoted solely to electronic and atomic impact phenomena.

Included in the program were papers by both American and foreign physicists on topics basic to the study of the flight and reentry of missiles and the study of thermonuclear reactions.

Metallic Chamber: In the precisely controlled "climate" of a specially constructed chamber attached to an intricate maze of recording and analyzing instruments, scientists and physicians of the National Institute of Arthritis and Metabolic Diseases, are studying various influences on the metabolism of man.

Constructed by Tenney Engineering, Inc., Union, N. J., the metabolic chamber is an airtight room 13 x 9 x 8 ft high with two windows and an outer additional space of 4 x 9 ft to house heaters, cooling coils, and circulation fans. The air circulation in the room is 1300 cfm, allowing complete exchange in less than one minute, with an air velocity less than 50 ft per min due to an entirely louvered ceiling. Through considerable effort, the noise level has been reduced to less than 40 db. Temperatures between 40 F to 120 F and relative humidities of 10 to 95 per cent bring to the chamber climatic conditions as would be encountered in desert, jungle, temperate or semi-arctic zones, which would affect the metabolic changes in man. Sealed passages through the walls are designed to allow for many wires and tubes for physiological measurements, intercommunication, ports for periodic blood sampling, etc.

WASHINGTON REPORT

Herbert H. Rosen

FCC at Year End

As is customary at the close of the year, the Federal Communications Commission has looked inwardly and summed up its past, present, and future. From the technical standpoint, the Commission has had a busy, although not entirely successful year in terms of missions accomplished.

It is still re-examining its frequency allocations to radio services throughout most of the radio spectrum in light of present and future needs and technical developments. But as these needs and developments advance, this area requires continuing re-examination.

The FCC continues to deal with new spectrum-saving techniques such as offset carriers, single sideband, and split channel transmission. Also tropospheric and ionospheric scatter techniques, and expanding microwave operation. The Commission can look forward to a strong plea from the Electronic Industries Association for some conclusion to the problem of "saving the spectrum." EIA's VP Secrest advises that with all of these techniques at hand, a way should be found in which all of the users of the spectrum will be happy with their allocations. He expects to call for a Government-sponsored study of the problem, and hints that EIA has a scheme up its sleeve that will be a virtual panacea to it.

The growth of the telecommunications industry has further compounded the problems of the FCC. The Commissioners estimate the administrative load they must handle has doubled since WW II. However, there has been little change in the amount of appropriations or the number of people assigned to the job. So, 1958 will bring some new problems. Among these are:

- Service expansion and technical developments which require continuing consideration and keep rules and regulations in a constant state of flux.
- Dearth of frequencies in particular parts of the usable radio spectrum to meet the demand for new or extended services.
- Growing interference and enforcement problems which practically overwhelm the Commission's limited staff.
- Backlogs in processing due to sheer volume of applications.
- Increasing competition for radio facilities extending to nonbroadcast business interests.
- Procedural tactics by parties which delay the providing of new services.

It's going to be a long year.

CIRCLE 217 ON READER-SERVICE CARD ➤

Army Accepts Missile Master

Simple computers; thousands of tubes, parts, and pieces; miles of wire; manpower, and Nike-Ajax missiles are now coordinated into a single operating system called the Missile Master. The production of this target selection and fire distribution system was under the management of The Martin Company. Major contributions were made by Airborne Instrument Laboratories, American Machine and Foundry, Western Electric and hundreds of subcontractors. As a single unit, the Missile Master cost the Army about $7 million. The land on which it and the Nike battalions sit, roughly $3 million. And it will be about 18 months before units other than the one at Fort George Meade are made operational elsewhere in the United States.

Missile Master also has a built-in failure detection and prediction system. To be effective, the system must have phenomenal reliability. Therefore, many information paths are duplicated. Elements in which bottlenecks may occur are paralleled. And although some parts may fail, Missile Master can still perform its job at reduced capacity.

AMB Awards First Contract

What is hoped to be the first award in a long chain of contract awards by the Air Modernization Board has been made to the General Precision Laboratories. The multimillion dollar contract calls for the first part of a three-part program that will ultimately become a semi-automatic data processing and display system for New York's LaGuardia Airport. When the three parts are completed in 1961, the installation will be the model for similar installations in other major airports across the country.

The GPL data processing and display system is the key element in a strand of five. The other four are communications, navigation, data acquisition, and airport improvement.

When combined into one complete system, the air traffic control equipment will embody the most modern and technically advanced concepts available. A deadline date of 1963 has been set for its completion at LaGuardia. Once proven, the individual parts of the system will become the basis for production specifications for similar equipment to be installed in the national air traffic control system. Other systems, however, will not be as extensive as the New York operation, since they handle a much smaller amount of traffic. Therefore, the model system will have to have inherent flexibility to allow reduction in size and complexity with decreasing traffic demand.

Letters to the Editor

Hasten Intelligently on Russian Translations

Dear Editor:

I have read with interest your editorial in the Dec. 1, 1957, issue, "Sputnik Should Spark Translations." Since our firm has experience in this field, I should like to comment on your editorial.

. . . you are absolutely on the mark when you say that the individual must assume responsibility for keeping abreast of foreign technology and especially Russian technology. Yet, this does not quite get to the heart of the matter, which is that many research scientists and research librarians would like to have these translations while industrial management has not seen fit to include them in its budgets. The fact that you "get an urgent plea for advice on how to get a complete translation," despite the fact that existing translation agencies continue to bombard industry with notices of translations they have made, is amazing. Yet, it is not really a surprise to us, because we have been advertising translations for eleven years and still get queries such as: "Do you mean you translate thus and so?" and "Is it really available in English?" Evidently, many of us don't read very carefully or don't assimilate what we read.

Somehow I find an implied blame laid upon the Government in your editorial, and this I feel to be unfortunate and unfair. We have been publishing cover-to-cover translations of Soviet scientific journals for over eight years. Yet, American industry, with the notable exception of a comparative handful of forward-looking firms, has ignored and still ignores the availability of this material. In sharp contrast, the Government and especially the National Science Foundation since mid-1955 has supported and strengthened this program, and through grants to scientific societies has further expanded it.

I also feel worried about your recommendation for a "crash" program. In spite of the apathy, smugness, and miserliness of American industry, there are currently being published some three dozen Russian scientific journals in complete English translation, available on a subscription basis—a program steadily being expanded with Government assistance. The last thing America needs at this point is a badly conceived "crash" program of translation, begun in haste and panic and without the expertise which has been developed over the past ten years.

What is needed is a realistic evaluation by American industry of the importance of basic research and foreign research-in-translation for which it must ultimately foot the bill.

The fact that the USSR has a central translation agency should hardly come as a surprise since they also have a central book publishing house, a central committee and a central many other things. We do not operate in that fashion in this country. The way such a program must be shaped here, it would seem to me, is precisely the way in which it has been moving; namely, the seizing of the initiative by people in the translation industry backed up by Government assistance but never forgetting that since industry benefits most largely from any such program, it must loosen its purse strings and make more extensive purchases of existing translations.

Earl M. Coleman, President
Consultant Bureau Inc., NYC

■ Mr. Coleman's company, without subsidy, translates *Automatika i Telemekhanika*. Electronic engineers can subscribe by the year or buy single copies. We congratulate such initiative. Until recent grants by the National Science Foundation for translating electronic journals, ELECTRONIC DESIGN was the only organization to publicize regularly what the USSR is doing in electronics.

We do not now propose a crash program for translating journals. We do suggest that there be a crash program to find out what the Russians have written. This includes Soviet books, transactions of symposia, and monographs which are in the U.S., but which no one can read. We feel a scientific and engineering advisory board should be set up to evaluate what should be translated. Where industry obligation ends and government responsibility begins is hard to say. A good part of the electronics industry is supported by government funds. The government determines what industry costs and overhead are allowable. This is just one factor. We do feel that the individual engineer must first press his own management to get translations. It goes without saying that we feel the professional man should be as technically informed on this subject as he can. This means knowing what engineers in the rest of the world are doing.

MEETINGS

Feb. 20-21: 1958 Transistor and Solid State Circuits Conference

University of Pennsylvania and Sheraton Hotel, Philadelphia, Pa. Sponsored by the IRE, AIEE, and University of Pennsylvania. Papers will deal with high speed circuits, analytical techniques for system integration, device characterization, high and low power circuits, memory, magnetics, and related topics. For further information send to J. H. Milligan, Jr., Dept. of E. E., New York University, New York 53, N. Y.

Feb. 20-24: 1958 EIA (formerly RETMA) Industrial Relations Conference

Town and Country Hotel, San Diego, Calif. Collective bargaining in the electronics industry, and technical manpower development and utilization are among the topics to be discussed. For information write to D. H. Stover, Industrial Relations Dept., Electronic Industries Assoc., 1721 De Sales St., N.W., Washington 6. D. C.

Mar. 16-21: 1958 Nuclear Congress

Chicago Amphitheatre and Palmer House, Chicago, Ill. Sponsored by the AICE, AIEE, IRE, and many others. The congress will include five separate conferences: The Fourth Nuclear Engineering and Science Conference (Mar. 17-21), The Fourth International Atomic Exposition (Mar. 16-21), The Sixth Atomic Energy in Industry Conference (Mar. 17-19), The Sixth Hot Laboratories and Equipment Conference (Mar. 19-20), and The American Power Conference (Mar. 17-19). For more information write to the American Institute of Chemical Engineers, 25 W. 45th St., New York 36, N. Y.

March. 18-19: Conference on Extremely High Temperatures

Air Force Cambridge Research Center, L. G. Hanscom Field, Bedford, Mass. Sponsored by AFCRC. The purpose of the Conference is to further the exchange of information among those interested in research into temperatures above 30,000 Kelvin. Emphasis will be placed upon theoretical and experimental aspects although the Conference will also cover applications. Write Dr. Heinz Fischer, AFCRC, L. G. Hanscom Field, Bedford, Mass. for details.

Mar. 24-27: IRE National Convention

Coliseum and Waldorf-Astoria, New York City. A comprehensive program of 275 papers, covering the most recent developments in the fields of all 27 IRE Professional groups, will be presented in 55 sessions. The high point of the program will be two special symposia on "Electronics in Space" and "Electronic Systems in Industry," to be held Tuesday Evening, March 25. The complete program will be announced sometime in January.

Mar. 27-29: Ninth Biennial Electrical Industry Show and Fifth Electrical Maintenance Conference

Shrine Exposition Hall, Los Angeles, Calif. Some of the topics to be discussed are maintenance to prevent breakdown, maintenance of electrical and electronic equipment, and maintenance of lighting to assure peak output. For more details write Paul H. Henrichs, Southern California Edison Co., P.O. Box 351, Los Angeles, Calif.

Mar. 31-Apr. 2: Instruments and Regulators Conference

University of Delaware, Newark, Del. Sponsored by the IRE, ASME, AIChE, and ISA. For details send to E. M. Grabbe, P.O. Box 45067, Airport Station, Los Angeles 45, Calif.

Apr. 2-4: ASME Conference on Automatic Optimization

University of Delaware, Wilmington, Del. AIEE, IRE, ISA, AIChE with professional groups analogous to the RE will participate in the conference by sponsoring technical papers centered around the theme, "Automatic Optimization." For details write W. E. Vannah, Control Engineering, 330 W. 42nd St., N. Y. 36, N. Y.

Apr. 8-10: Symposium on Electronic Waveguides

Auditorium of Engineering Societies Bldg., 33 W. 39th St., New York. Sponsored by IRE, PGED and PGMTT, and the Department of Defense Research Agencies. The symposium will deal with the interaction of electromagnetic fields and electron or plasma beams in general waveguide regions. The symposium covers the fields of electron beams, plasmas, and electromagnetics to compare the rather widely disparate theories and techniques employed to describe the wave phenomena encountered in the interaction of such fields. For further information contact the Polytechnic Institute of Brooklyn, 55 Johnson St Brooklyn 1, New York.

MEETINGS

Apr. 22-24: 1958 Electronic Components Conference

Ambassador Hotel, Los Angeles, Calif. Sponsored by the IRE, AIEE, EIA, and WCEMA. With "Reliable Application of Component Parts" as its main theme, the conference has been planned to cover the following general topics: resistors, capacitors, and dielectrics; transistors and solid state devices; component reliability; electron tubes and their application; and progress with materials. For complete information write to David M. Knox, Packard-Bell Electronics Corp., 12333 W. Olympic Blvd., Los Angeles 64, Calif.

Apr. 24-26: URSI Spring Meeting

Willard Hotel, Washington, D. C. Sponsored by the PGAP, PGMT&T, PGCT, PGIT, PGI, and URSI. For information, contact John P. Hagen, Naval Research Lab., Washington 25, D. C.

Apr. 30-May 1-2: 7th Region Technical Conference & Trade Show

Hobbies Bldg., State Fair Grounds, Sacramento, Calif. Write Ewald W. Berger, 3421 58th St., Sacramento 20, Calif. for information.

May 1-8: ASTE Tool Show

Convention Center, Philadelphia, Pa. A complete integrated technical program of papers, panels, seminars, plant tours, and related activities will be offered. For further information, write Richard Gebers, Public Relations Manager, 10700 Puritan, Detroit 38, Mich.

May 4-7: 4th National Flight Test Instrumentation Symposium.

Park-Sheraton Hotel, New York City. Sponsored by the Instrument Society of America. Theme of the Symposium is "More Data Per Dollar." For details write P. O. Box 113, Bethpage, N. Y.

May 5-7: AIEE Great Lakes District Meeting

Michigan State University, East Lansing, Mich.

May 5-7: PGMT&T National Symposium

Stanford University, California. For details, write to Dr. K. Tomiyasu, GE Microwave Lab., 601 California Ave., Palo Alto, Calif.

EDITORIAL

Public's View of Engineer Shapes U.S. Destiny

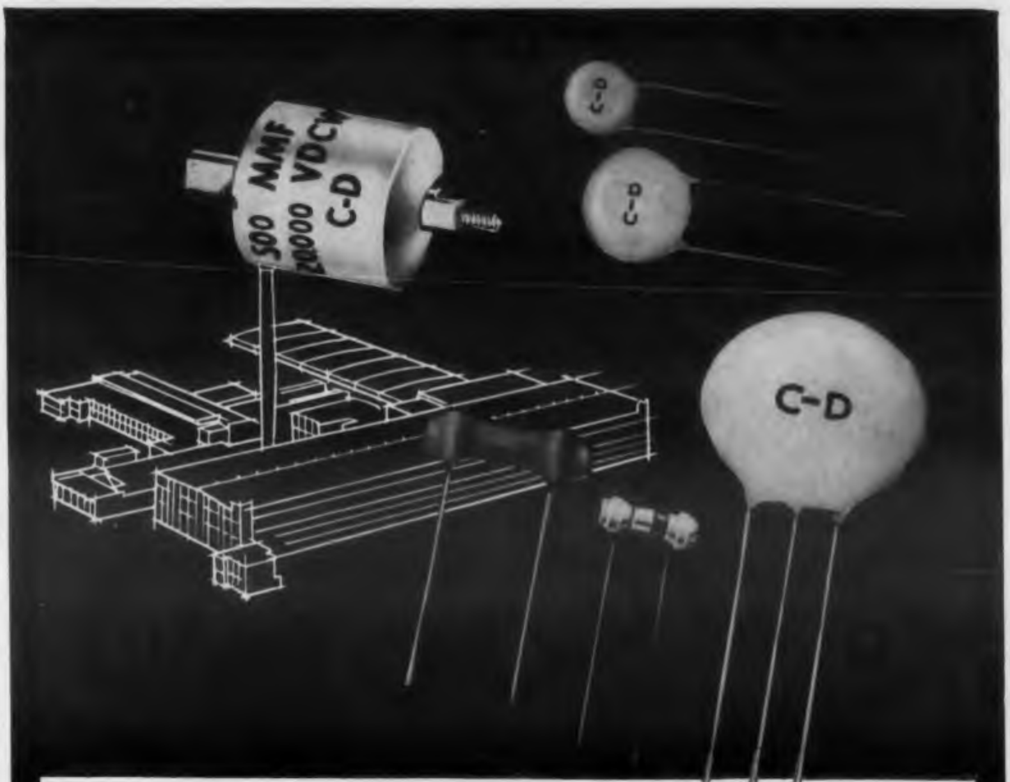
The man in the street's idea of the role of science and technology, until Sputnik, was that they produce miracle pills for piles and more TV's, autos and refrigerators. In case of war, or for defense, we thought mostly in terms of how many planes and ships we would have to buy. Now practically everyone realizes that the quality of the products, not only quantity, is a determining factor.

Scientists and engineers must play one of the most predominant roles in future society. Our destiny depends on engineering and engineers being understood by our government leaders (there are no more than 2 or 3 engineers in the legislature) and by the people at large, who shape public policy. This calls for public relations by the engineer.

In advocating a program of public relations, T. E. Garrigan, in the September issue of the *Pulse of Long Island* (published by the Long Island Section of the IRE), says "... the future of our nation depends, to a great extent, on the public's understanding of how the engineer fits into our economy. A lack of understanding can lead to a deterioration of the quality and quantity of engineers for the future; it can lead to lowering the engineer's social prestige, his monetary remuneration and other factors whose cumulative effect would be harmful to the whole nation."

There is a need for communicating technical information to the layman. Recent surveys report that by and large the public's understanding of science and engineering comes from newspapers. Very few newspapers have science editors who know anything at all about science. As a result, the layman has no deep appreciation or clear picture of what science and engineering is. In some respects he's too gullible; he assumes science can do anything once they set their minds to it. Of course, if he reflects he may become skeptical when he realizes that pills for curing insanity and frustration have been publicized for two years, yet the number of insane and neurotic keeps growing. And where is that color TV set that he read that he was going to have in 1957? We think engineers can do something about this themselves. We congratulate The Long Island IRE members who are, among other things, giving programs for the non-technical public—John R. Pierce packed the auditorium with his fascinating yet informative discussion "Fancies and Fallacies of Space Travel" and planning meetings, tours, and demonstrations for community leaders. They are also slanting publicity releases concerning members and activities to the average citizen. Each engineer is encouraged to actively participate in at least one community activity.

Garrigan says, be a good citizen and you will be a better engineer. We agree.—JAL



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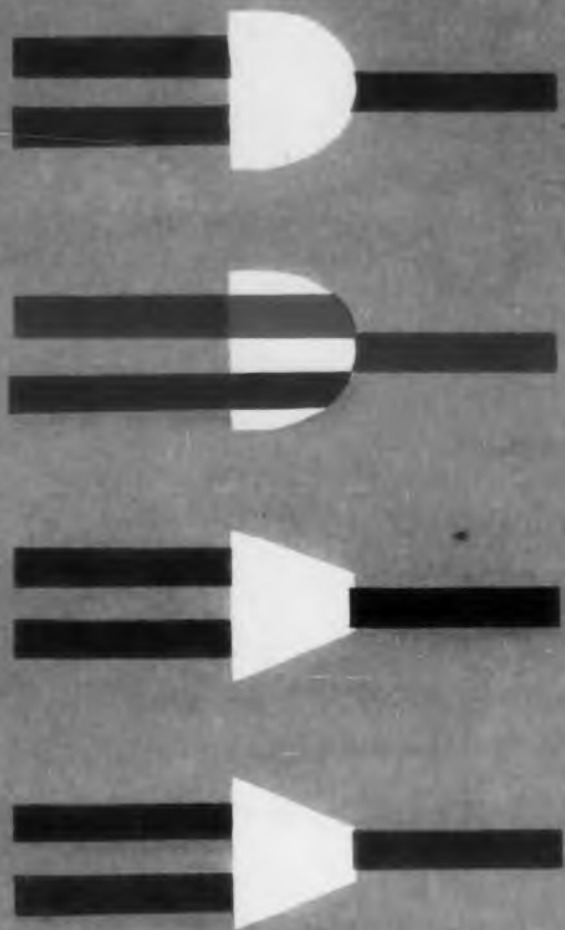
CIRCLE 23 ON READER-SERVICE CARD



Transistor NOR Circuit Design

W. D. Rowe

Westinghouse Electric Corp.
Buffalo, N. Y.

Transistor NOR logic can express all logical operations using only one basic logic circuit. This logic was designed specifically to use the advantages offered by transistors. Fifteen hundred NOR circuits can be packed into a cubic foot.

THE TRANSISTOR NOR circuit was designed specifically to take advantage of transistors with their low power requirements, diminishing cost, and increasing regularity of properties. This logic makes use of a reliable transistor circuit, forming an exceptional combination into a new and powerful tool.

Basic Transistor NOR Circuit

The basic circuit, shown in Fig. 1, employs a junction transistor in the common emitter configuration—not as a linear device, but as a two position switch. An npn transistor may be used in place of the pnp shown if polarities are reversed. When the input voltage exceeds a certain minimum, of the correct polarity, the transistor switches from its normal cutoff state to saturation.

During cutoff, collector to emitter impedance is extremely high. The supply voltage sees the transistor as an open circuit, so the output is substantially at the supply voltage level.

When the transistor is saturated, its impedance is very low, so the ouput is held essentially at ground potential. Thus a voltage appears at the output when there is no signal at the input, and conversely there is zero ouput when there is a signal at the input.

Basic NOR Logic

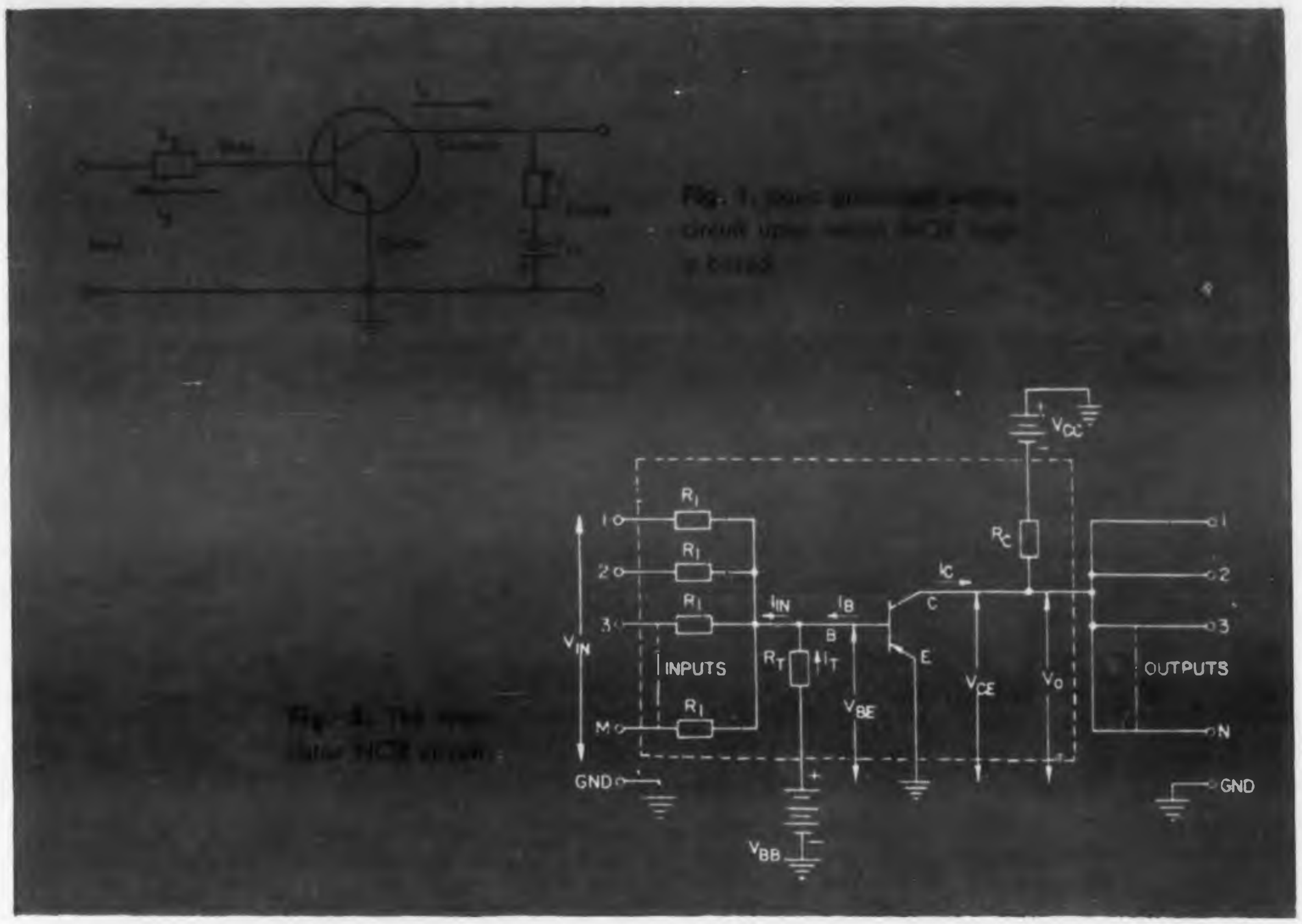
In general, a logic device has more than one input. A multi-input circuit is constructed by simply adding more inputs and input resistors to the transistor base, as in Fig. 2. Here, a signal on any or all inputs will cause the output signal to be absent, while the output is present only if NO inputs are present.

If a voltage signal represents a one, and its absence represents a zero, this transistor circuit can express binary logic. In the binary system, only two numbers, zero and one, can combine to represent all numbers.

Combinations of NOR circuits can express all combinations of logic except time delays. The usual AND, OR, and NOT may be expressed entirely with NOR circuits. Furthermore, a compound logical function does not necessarily require more NOR circuits than so called English circuits.

NOR Circuit Design

Fig. 2 shows a transistor NOR circuit with an arbitrary number of *M* inputs and *N* outputs. The equivalent output loading for each prior stage is a resistor, *R1* to ground through the base impedance of the transistor. The total output impedance is $R1/N$. V_{cc} is the collector supply voltage. V_{bb} through R_t biases the transistor to reduce leakage current, I_c, to a minimum when the transistor is cut off. *R1*, the input current limiting resistor, prevents feedback between inputs. With pnp transistors, the output is a negative signal.



In designing NOR circuitry for a particular transistor type, many transistors should be tested. Test results should provide limits on the design parameters so that few transistors will lie outside these limits. This allows an economical choice of operating parameters with reliability.

Loading Limitations

The number of outputs is limited by the loading of the output voltage down to a point where there is insufficient signal for the following stages. The number of inputs is limited by a crosstalk factor which becomes important if *R1* becomes very small.

Fig. 3 shows the circuits to be considered for both input and ouptut loading. In the cutoff condition, the input to transistor *T1* is zero, or certainly no more than —0.25 v. At the maximum operating temperature the cutoff collector current is highest and is $I_c = \beta(I_{cbo} + I_b) + I_{cbo}$ (1) where I_{cbo} is the base to collector leakage with the emitter open circuited, and β, the base to collector current gain. If the base current is negative and equal to the magnitude of I_{cbo} the first term of the expression is zero, and the collector current is reduced to I_{cbo}. Eq (1) is not valid when $|I_b|$ exceeds I_{cbo}. I_{cbo} is the lowest value of collector current attainable.

Since the transistor is to remain cut off at the highest operating temperature with zero or slightly negative input voltage, the base current required must be supplied from the bias source I_t, which can be considered a current source in most cases. This bias current should equal the maximum value of I_{cbo} at the maximum operating temperature for highest leakage transistor used.

Input Loading

Maximum marginal loading on the input of a NOR element occurs when a minimum input voltage $V_{o\,min}$ is applied to one input while all other inputs are grounded by a saturated transistor as shown in the lower right section of Fig. 3. For this case, I_{in}, the current supplied by the preceding transistor can be calculated.

$$I_{in} = (V_{be} - V_{o\,min})/R1$$
$$= SI_{b\,min} + \frac{V_{bb} - V_{be}}{R_t} - \frac{V_{be}\,(M-1)}{R1} \qquad (2)$$

$I_{b\,min}$ is determined by the minimum gain of transistor *T2* for the value of I_c to be chosen. S is a factor for a margin of safety to allow for future decrease in transistor gain, as well as other circuit parameter tolerances. V_{be} is a function of base current. For the low minimum voltage, minimum current case under consideration, SI_b is less than 300 μa, and V_{be} will not exceed —.25 v. Using these maximum values, the expression for I_{in} reduces to

$$I_{in} = SI_b + I_t + \frac{.25\,(M-1)}{R1} \text{ at } V_{o\,min} \qquad (3)$$

Output Loading

The output loading case is most extreme if all *N* outputs load *T1* simultaneously. Then

$$V_{o\,min} = V_{cc} + (NI_{in} + I_{cbo})\,R_c = I_{in}\,R1 + V_{be} \quad (4)$$

If V_{be} is much less than V_{cc}, and R_c is chosen to allow maximum collector current flow, and if I_{cbo} is much less than I_c then

$$N = I_c\left[\frac{1}{SI_b + I_t + .25\,\dfrac{M-1}{R1}} + \frac{R1}{V_{cc}}\right] \qquad (5)$$

This gives the number of succeeding NOR circuits which may be connected to *T1* under the worst case of loading. The number of outputs, then depends on I_c, the corresponding I_b, I_t (or I_{cbo}), V_{cc}, the safety factor S, the input resistor *R1*, and *M*, the number of inputs desired.

A high negative value reduces the negative second term of *N*. *M* and S can be specified so the expression for *N* is a function of only the transistor to be used and *R1*. The results of Test 2 and common emitter characteristic curves provide corresponding values of I_b and I_c and the safety factor. Test I_c gives the maximum design value for I_{cbo}.

I_t is designed to be equal to or somewhat greater than the maximum I_{cbo} to be encountered with a particular transistor. A family of curves of *N* vs I_c may be calculated from eq (5). Different values of *R1* influence the curves. The maximum value of *N* occurs at different values of I_c. Final choice of *R1* and I_c involves a compromise of desired values of *M* and *N*, the power dissipation in the transistor, and the total power dissipation.

Power Dissipation

Transistor dissipation is maximum when a lightly loaded transistor has a signal from each input, and each input supplies only this transistor. For this case

$$I_{b\,max} = M - V_{cc}/(R_c + R1) \text{ and}$$
$$P_{diss} = P_{base} + P_{coll} + V_b\,I_{b\,max} + V_{ce}\,I_c \quad (6)$$

The maximum power supply dissipation per NOR circuit occurs when the transistor is saturated.

$$P_{supply} = V_{cc}\,I_c + V_{bb}\,I_t \qquad (7)$$

Final choice of supply voltages is guided by keeping all power levels much less than the maximum allowable transistor dissipation.

Crosstalk

Crosstalk is another type of loading which can occur between NOR circuits as shown in Fig. 4. *T1* is saturated, maintaining a low value of V_{ce}. *N*-1 of the outputs are connected to other transistors such as *T2* which has the rest of its inputs at full signal. The base voltage of *T2* is high because of the high base current. This high base voltage V_{be} can cause a current I_o to flow from the collector of *T1* to the base of *T2*. A total crosstalk current $I_{ct} = (M\text{-}1)\, I_o$ could flow through the collector of *T1* in addition to the normal collector current I_c; I_{ct} should be limited to a small percentage of I_o to prevent *T1* becoming unsaturated and having V_{ce} rise on the *N*'th output of *T1* which must still be at zero signal. An upper limit for I_{ct} is found by calculating $I_b = (M-1)\,(-V/_{cc})\,(R_o + R1)$, finding V_{bo} from Fig. 3, and using this in $I_{ct} = (N-1)\,(-V_{bo})\,R1$.

If I_{ct} is less than I_c the safety factor margin in SI_b can allow some additional collector current under these extreme crosstalk conditions.

Reliability

Five thousand NOR elements were subjected to an aging cycle of 24 hours at 70 C with supply voltages applied, 24 hours at room temperature with voltage, and 48 hours at 70 C with supply voltage and a square wave input signal. Only 5 failed during aging. None failed in service. Power supply fluctuations of 30 per cent and high ripple did not cause malfunction.

Operating Frequency

In a typical design, using RCA 2N109 transistors, the NOR circuit operated well up to 40 kc. For many slower control processes this speed is sufficient. Certain means of increasing frequency response have been considered.

The first, the use of speed up capacitors in parallel with the input resistors allows a rapid drain for stored holes when coming out of saturation, increases the complexity of the crosstalk and loading conditions by requiring transient analysis; and in actual circuits limits the number of inputs and outputs.

The second method uses diode networks to prevent transistor saturation, but does not allow enough speed up to warrant the extra circuitry.

The third method allows the emitter diode to break down to bring the transistor out of saturation. Although this improves frequency response, insufficient experience with this technique does not yet assure its reliability.

Use of high frequency transistors, driven to saturation, in place of the low frequency units is quite satisfactory. Drift type transistors have been operated easily in the two mc range, and selected units have operated at five mc and higher.

Advantages and Disadvantages

The NOR circuit is a highly compatible, highly reliable circuit that promises advantage in complex control circuit logic. Here is a summary of the properties.

Reliability

When transistors are used correctly within specified margins and limits they are extremely reliable. Since the NOR circuit uses a simple transistor circuit, it is easy to express all the margins and limits. Since only one logic element is used throughout, these margins and limits hold for every circuit in a compound array. Since NOR circuits connect, in general, to other NOR circuits, loading and coupling conditions are easily expressed.

Since the circuit operates as a switch with wide circuit tolerance, most of the disadvantages of linear operation are eliminated.

Every transistor should be completely tested and aged before and after assembly to assure maximum reliability. Marginal checking may be used to detect faulty units long before failure.

Since each circuit is an individual module, a failure in one circuit does not cause operational failure in other circuits.

Compatibility

Except for three simple rules, these circuits may be connected to each other indiscriminately.

1. Use no more inputs to a circuit than are allowed by the design.

2. Use no more outputs than are allowed by design.

3. Never connect the outputs of two NOR circuits directly together.

Since within the limits of these rules all impedances and loading mechanisms are known, and since each circuit is an amplifier, these circuits are easily compounded.

Furthermore the logic is such that each circuit is independent of preceding or succeeding logic as far as interconnection is concerned.

Power Requirements

Without special means to limit power supply requirements, typical units with high collector supply voltages require less than 100 mw for operation, while units with power dissipation as low as one mw have been used at lower voltages. A thousand typical units will work on 100 w of unregulated, poorly filtered power. This may not be desirable, but it does work.

Simplicity of Design

NOR circuits are simply transistor switches coupled together with closely observed margins. Only resistors and transistors are used.

Logic

All logical functions can be synthesized using only NOR circuits and time delays. In a complex circuit, the final design using these circuits may possibly be simpler than with English circuits. NOR circuit logic techniques are somewhat harder to comprehend at first, but after working with this logic for a short time, one becomes very adept at its application.

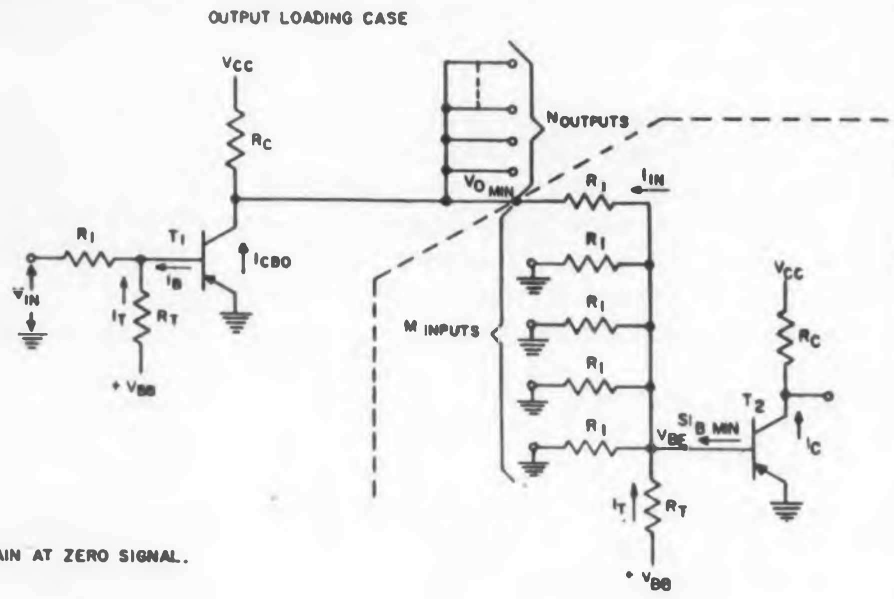


Fig. 3. NOR circuit conditions for calculation of input and output loading.

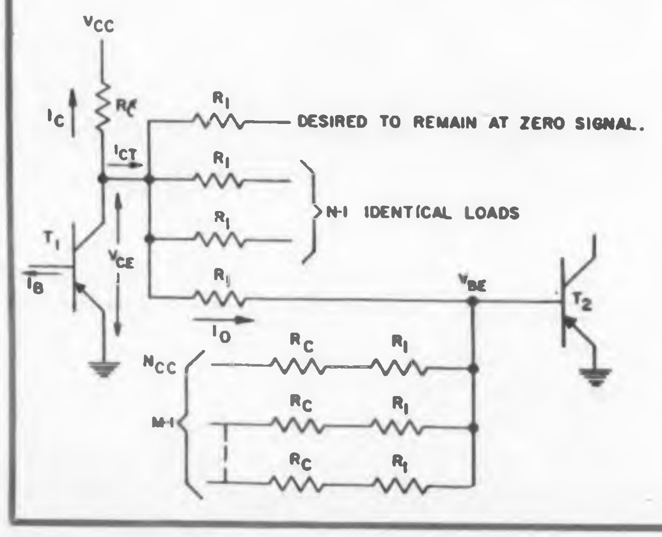


Fig. 4. NOR circuit conditions for calculation of crosstalk loading.

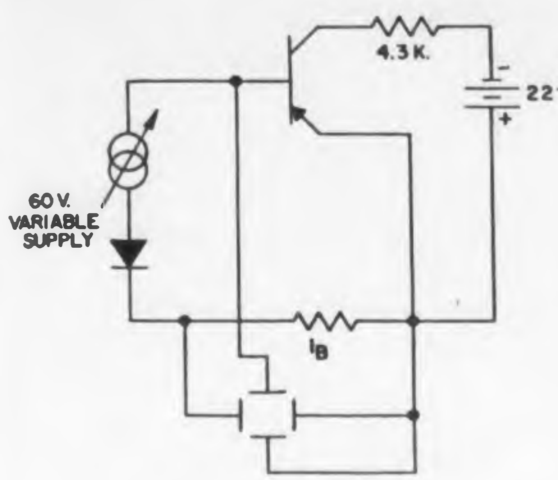


Fig. 5. Test circuit for V_b/I_b curves.

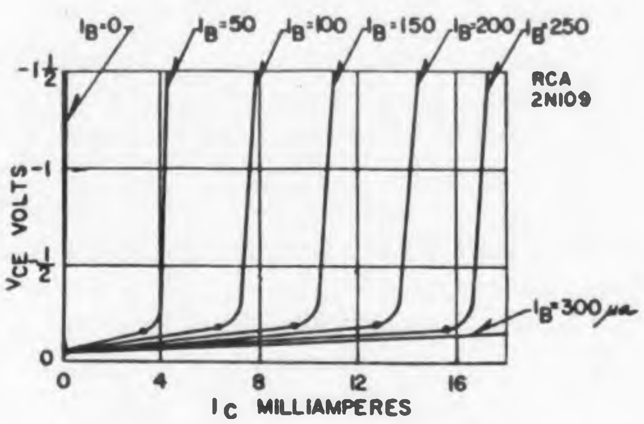


Fig. 6. Common emitter collector characteristics for an RCA 2N109 transistor.

Physical Embodiment

Several physical structures have been used, all of which seem suitable. One such embodiment consisting of a printed circuit, dipped in epoxy resin, requires a single package for each logic circuit. This allows easy compounding of circuits by dip soldering the units into an epoxy glass printed circuit board with copper interconnections. Using this method, it is possible to pack 1500 NOR circuits into one cubic foot of space, allowing for 150 w dissipation. This is by no means a minimum space factor.

Components

All resistors are printed, using highly proven materials. Tolerances may be kept to two per cent, though 10 per cent is entirely suitable. Transistors are tested and aged during the entire construction process for maximum reliability.

Frequency Response

Many of the units constructed with ordinary transistors have a fairly low frequency response; 20 kc seems to be the upper limit. Other types of transistors and some circuit modifications have increased this limit to as high as four mc. Further increases are expected as new transistors are perfected for this application.

Cost

The cost of individual units compares very favorably with other types of logic circuits.

Transistor Test Methods

Test 1. Back Collector Current—I_{cbo}

a. Find I_{cbo} at 25 C at a specified collector supply voltage V_{cc}. Set a maximum limit on I_{cbo} for this test.

b. Determine the rise in temperature required to double I_{cbo}, or

c. Test I_{cbo} at the high temperature limit to determine stability of back current at this temperature. This test is related to Test 4.

Test 2. Base to Collector Current Gain—(DC β)

a. Fig. 5 shows a plot of transistor characteristics. The horizontal portion of the collector current curves are for the saturated "switch-on" condition of operation. On each curve read the highest value of I_c just before the transistor becomes unsaturated. These points, on Fig. 6, give values of I_c, I_b, and the resultant current gain.

b. Set a minimum limit on β at a specified collector current.

Test 3. Forward Saturation Volt Drop—V_{ce}

The voltage drop from collector to emitter at saturation is obtained from the same indicated points. This saturation voltage will become the maximum OFF signal and should be held to less than .25 v.

Test 4. Noise Figure—NF

A noise figure measurement is made at maximum allowable collector voltage. The noise figure is defined as noise above thermal noise at 1000 cps with a one cycle band pass, and is expressed in db. A standard noise test meter is used. This test is made at a high collector voltage so the majority of the noise occurs in the collector junction. A high noise figure indicates high points on the collector that can cause failure and/or unstable I_{cbo} at both low and high temperatures. This test is a measure of reliability.

Test 5. Base Input Characteristics— I_b vs V_{be}

Using the test circuit of Fig. 5, a curve of I_b vs V_{be} may be plotted.

Acknowledgment

The author wishes to acknowledge the work of G. H. Royer who helped with the work in the design of the NOR circuit, and L. F. Stringer who has done considerable work in the application of the logic.

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From a paper delivered at the 1957 *WESCON* show, San Francisco, California.

Practical RC Differentiator Design

Lester Saporta, James Rarity
New York University

This article considers the design of practical RC differentiators which are driven by a source with finite internal resistance and operating into a load having a finite shunt capacitance

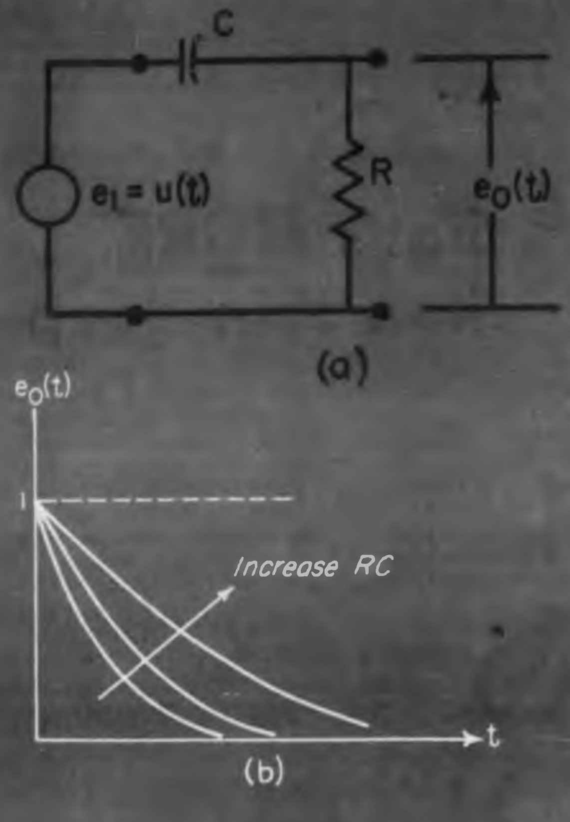

Fig. 1. a—Simple RC Differentiator with zero generator impedance and zero load capacity, b—Step function response for simple differentiator.

THE STEP function response of the simple differentiator of Fig. 1a is the well-known exponential decay function shown in Fig. 1b. The peak output is always equal to the amplitude of the input step. The output spike may be made as narrow as desired by decreasing either R or C or both.

This simple situation holds only under the assumptions that the driving source has zero impedance and that the output drives a zero capacity load. When these assumptions cannot be made the more complex circuit of Fig. 2a must be invoked to describe the operation. Fig. 2a represents a situation often met in practical design problems where a voltage source of internal impedance R_1 and a load represented by the capacitor C_1 are given and it is desired to interpose a differentiator between them. In this case, as illustrated in Fig. 2b, the peak output of the network and the duration of the output spike cannot be independently specified with complete freedom. If an attempt is made to narrow the output spike by reducing R_2 a point is reached where the voltage divider action of R_1 and R_2 becomes excessive. A similar situation occurs if the output spike is narrowed by reducing C_2. Then a loss in output voltage takes place due to the voltage divider formed by C_2 and C_1.

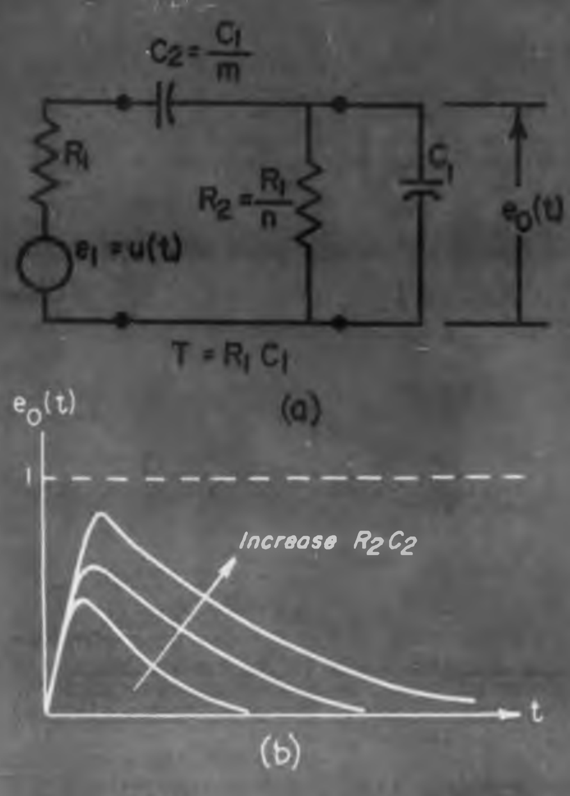

Fig. 2. a—Practical RC Differentiator with finite generator impedance and load capacity, b—Step function response for practical differentiator.

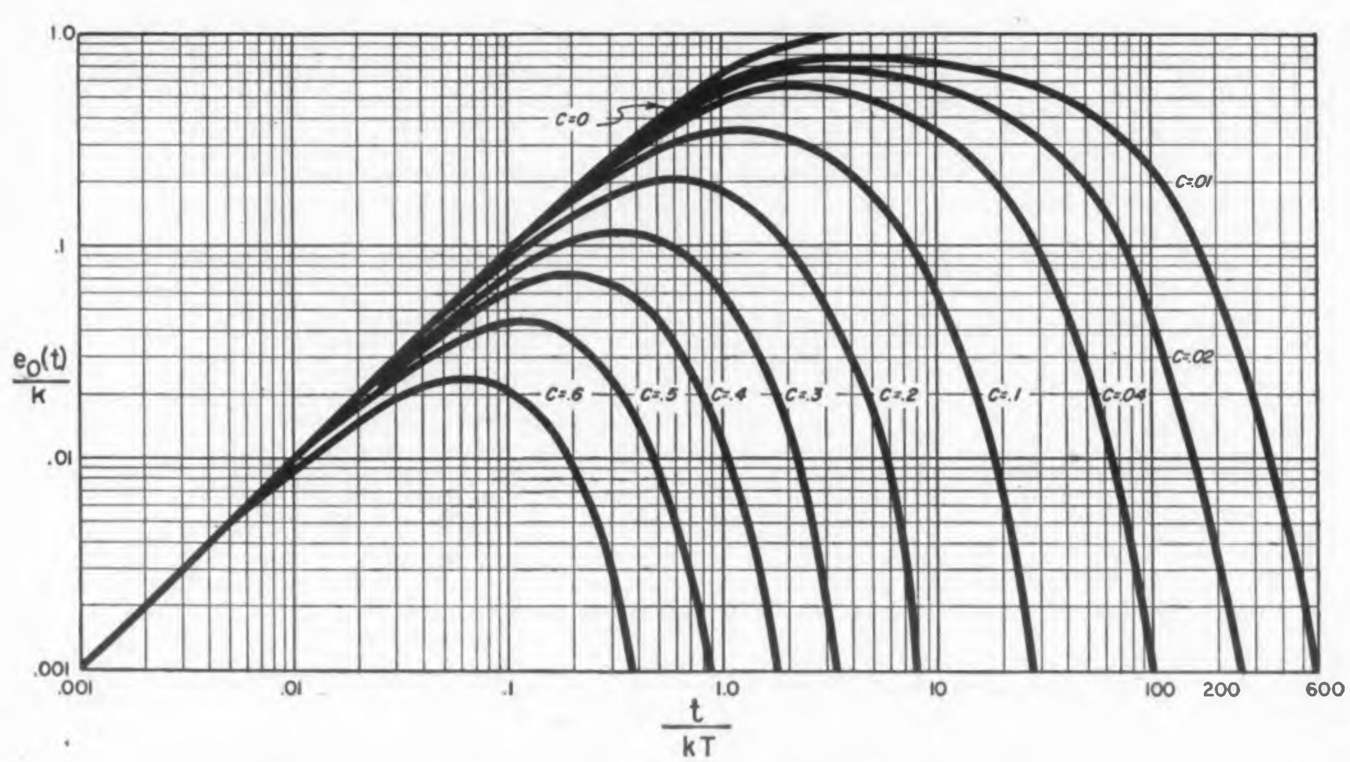

Fig. 3. Normalized step function response of practical differentiator.

It is therefore necessary to establish the relationship between output amplitude and width (or more generally shape).

Network Response

The response of the circuit of Fig. 2a to a unit step input can be expressed as follows:

$$\frac{e_o}{k} = \frac{1-\sqrt{c}}{1+\sqrt{c}}\left[\epsilon^{-\frac{c}{(1-\sqrt{c})^2}\left(\frac{t}{kT}\right)} - \epsilon^{-\frac{1}{(1-\sqrt{c})^2}\left(\frac{t}{kT}\right)}\right] \quad (1)$$

$$\text{where } c = \frac{(n+m+1) - \sqrt{(n+m+1)^2 - 4nm}}{(n+m+1) + \sqrt{(n+m+1)^2 - 4nm}}, \quad (2)$$

a parameter which determines the shape of the curve.

$$k = \frac{1}{1+(\sqrt{n}-\sqrt{m})^2}, \text{ a normalizing factor.} \quad (3)$$

Since m, equal to C_1/C_2, and n, equal to RE/R_2 are positive real numbers, k and c are positive real numbers subject to the following restrictions:

$$0 < c < 1 \text{ and } 0 < k < 1$$

Eqs (2) and (3) may be inverted to express the physical parameters m and n in terms of k and c:

$$m = \frac{1}{2}\left[\frac{c+1}{k(1-\sqrt{c})^2} - 1\right] \pm \frac{1}{2}\sqrt{\left[\frac{c+1}{k(1-\sqrt{c})^2} - 1\right]^2 - \frac{4c}{k^2(1-\sqrt{c})^4}} \quad (4)$$

$$n = \frac{1}{2}\left[\frac{c+1}{k(1-\sqrt{c})^2} - 1\right] \mp \frac{1}{2}\sqrt{\left[\frac{c+1}{k(1-\sqrt{c})^2} - 1\right]^2 - \frac{4c}{k^2(1-\sqrt{c})^4}} \quad (5)$$

For the case when $k = 1$ eq (4) and (5) reduce to

$$m = n = \frac{\sqrt{c}}{(1-\sqrt{c})^2} \quad (6)$$

Design Curves

The parameters c and k are useful in obtaining normalized curves of the response. Normalization is accomplished by plotting e_o/k as a function of t/kT. This is done in Fig. 3. It is evident that in a plot of this type, the parameter c determines the shape of the curve while k is a normalizing factor which multiplies both the time and voltage scales. A value of k equal to unity results in the largest realizable expansion of e_o and t/T for any particular value of c.

A particular peak output can be achieved with many combinations of k and c, if k is always

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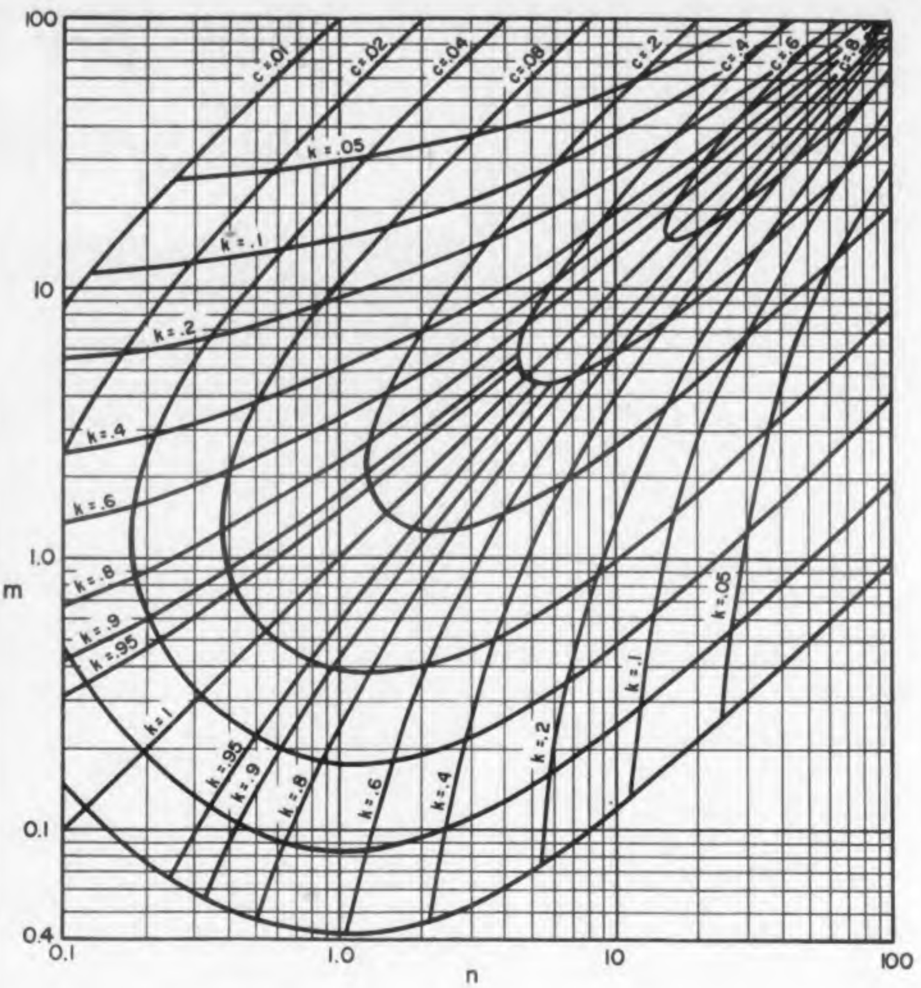

Fig. 4. Parameters k and c mapped on the m = n plane.

chosen less than unity. Referring to Fig. 3 for example, a peak output of 0.205, can be realized with $c = 0.2$ and $k = 1$. The same output of 0.205 can be achieved with $c = 0.1$. Since the peak of this curve is .355, k is .205/.355 or .577. At the same time, the time scale to be applied for $c = 0.1$ is reduced by the same factor k, giving a narrower response than that illustrated. This narrowed response, however, is not as narrow as the response achieved with $c = 0.2$ and $k = 1$. For a given output the sharpest response is achieved when $k = 1$ and, for a given sharpness, the maximum peak output is realized when $k = 1$.

Fig. 4 relates k and c to the physical parameters m and n. The special case where $m = n$ ($k = 1$) is plotted as a function of c in Fig. 5.

The curves of Figs. 3, 4, and 5 permit the solution of many analysis and design problems.

Sample Problems

Example 1. Given the circuit of Fig. 2a with $R_1 = 1000$ ohm, $R_2 = 5000$ ohm, $C_1 = 250$ μμf, and $C_2 = 100$ μμf. Find the time of occurrence and the amplitude of the response peak. Find the time at which the response has decayed to one tenth its peak amplitude.

$$T = R_1 C_1 = 1000 \times 250 \times 10^{-12} = 0.25\ \mu\text{sec}.$$

$$m = \frac{C_1}{C_2} = \frac{250}{100} = 2.5$$

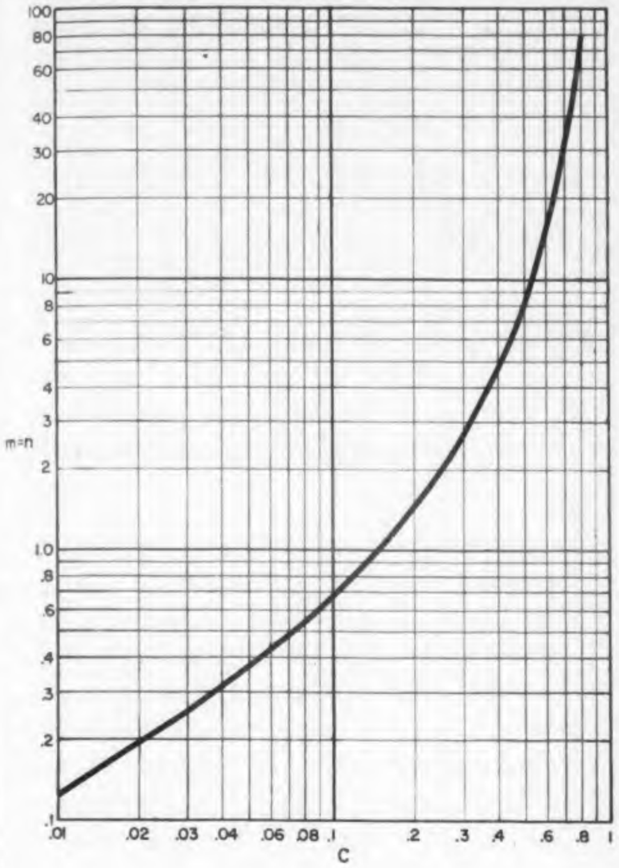

Fig. 5. Parameter m (or n) vs c for the case where $m = n$ ($k = 1$).

$$n = \frac{R_1}{R_2} = \frac{1000}{5000} = .2$$

From Fig. 4, $c = .04$; $k = 0.45$.

The shape of the response is represented by the curve marked $c = .04$ in Fig. 3. This curve has a peak value of 0.56 and since $k = 0.45$ the peak output of the network as a result of an input unit step is 0.56 x 0.45 = .25 volt. The curve peaks at $t/kT = 2.15$ or at $t/T = 0.968$. Since T is 0.25 μsec the peak occurs at $t = 0.968 \times 0.25 = .242$ μsec. The curve has decayed to one tenth its peak value (0.056) at $t/kT = 38$ or $t = 38 \times 0.45 \times 0.25 = 4.28$ μsec.

Example 2. Given the circuit of Fig. 2 with $R_1 = 1000$ ohm and $C_1 = 100$ μμf. Find the values of R_2 and C_2 which result in the largest realizable peak output consistent with the restriction that the output be less than 0.06 v at $t = 1$ μsec.

Since the maximum peak output for a given shape of response is required, the condition $k = 1$ must be used. $T = R_1C_1 = .1$ μsec so that at $t = 1$ μsec, $t/kT = 1/1\text{x}.1 = 10$. The curve which decays to 0.06 v at $t/kT = 10$ is represented in Fig. 3 by $c = 0.1$. This curve peaks at 0.36 v (since $k = 1$). Fig. 5 shows that $m = n = 0.68$ for $c = 0.1$. Thus $C_2 = C_1/m = 100/.68 = 147$ μμf and $R_2 = R_1/n = 1000/.68 = 1470$ ohm.

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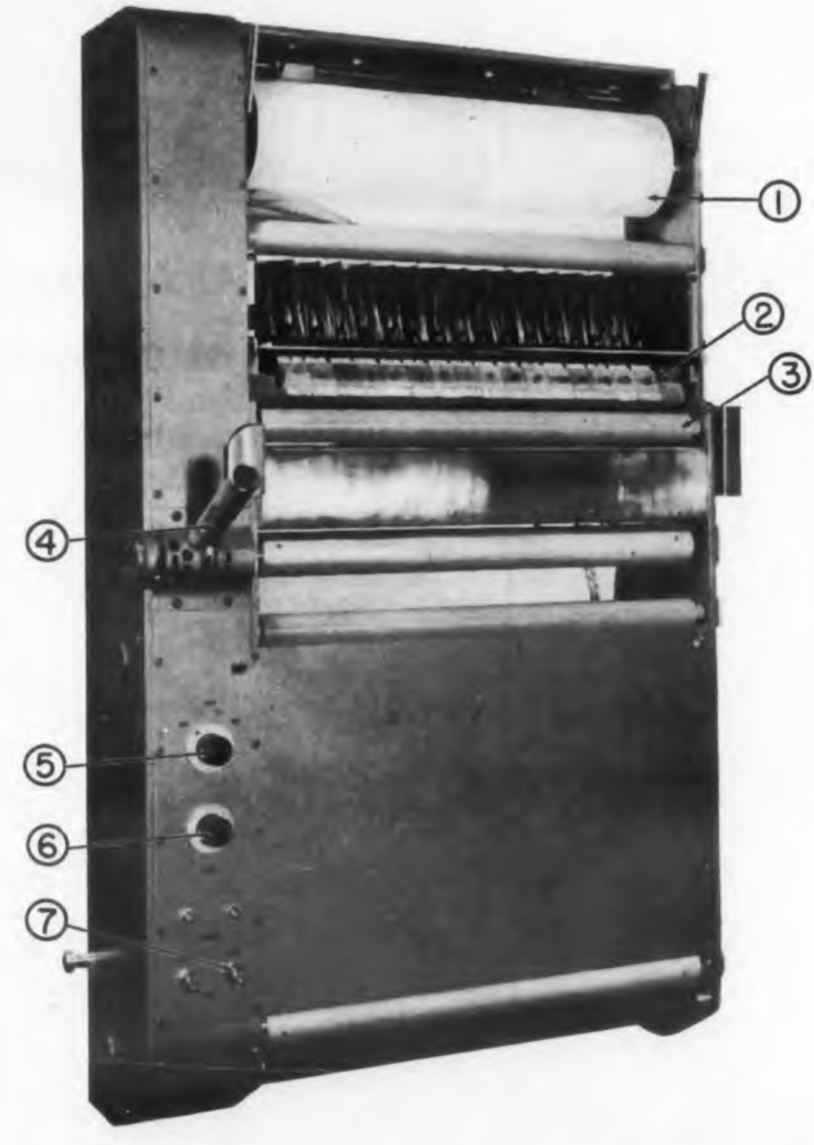

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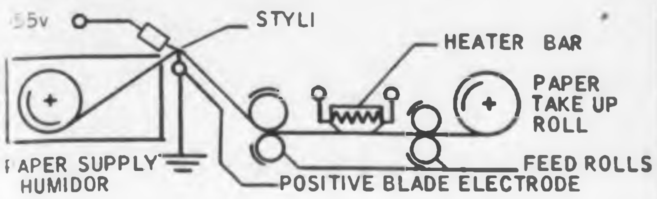

Simplified schematic representation of the visual recorder.

tinuously, thereby drawing scale lines on the paper. These lines can be positioned at any intervals.

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Feedback Circuit Analysis Using Impedance Concepts

Gustave Pellegrino, Jr.
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White Plains, N. Y.

In the usual analysis of feedback circuits it is difficult to visualize what is taking place in the circuit. The mathematics beclouds the actual circuit operation. The solution obtained with impedance concepts, while no simpler, helps to explain what is happening in the circuit. It simplifies the choice of design parameters and allows one to see how any term affects the overall design.

IT IS SIMPLER to interpret the gain or transfer function of a feedback amplifier by obtaining the solution in measurable quantities. These quantities are the open circuit gain of each stage and the feedback factor. When these are known, the closed loop gain is easily found from

$$G = \frac{A}{1 - A\beta} \tag{1}$$

where G is the closed loop gain, A, the open look gain and β, the feedback factor.

This method is always applied when the feedback factor is well defined, as in a simple divider network. It is usually overlooked when feedback is applied in a complex manner.

In a two stage, plate to cathode feedback amplifier, (Fig. 1), the feedback resistor R_f, looks directly into the low impedance cathode of the first stage. In order to apply eq (1), the complex quantity Z_k must be found. Then the feedback factor is determined from

$$\beta = \frac{Z_k}{Z_k + R_f}$$

Mesh analysis of the equivalent circuit reveals the closed loop gain. The drawback is that every component and tube constant enters the solution. A comparison of the results obtained using mesh analysis and those obtained by solving for Z_k shows the advantage of the latter.

Mesh Analysis

Fig. 2 is the equivalent circuit of the plate-to-cathode feedback amplifier. The mesh analysis reveals

$$\text{Gain} = \frac{E_{out}}{E_{in}}$$

$$= \frac{\mu_1 R_{k_1} R_{L_2}\left[\mu_2 R_{L_1}\left(1+\frac{R_f}{R_{k_1}}\right)-r_{p_2}+(\mu_2-1)\,R_{k_2}\right]}{\Delta} \qquad (2)$$

where Δ is the system determinant.

$$\Delta = \begin{vmatrix} R_{L_1}+r_{p_1}+R_{k_1}(\mu_1+1) & -R_{k_1}\,(\mu_1+1) & R_{k_1}\,(\mu_1+1) \\ -R_{k_1} & R_{k_1}+R_f+R_{L_2} & -(R_{k_1}+R_f) \\ R_{k_1}+\mu_2 R_{L_2} & -(R_{k_1}+R_f) & R_{k_1}+R_f+r_{p_2}+(1-\mu_2)\,R_{k_2} \end{vmatrix}$$

Equation (2) is the gain solution. The problem still remains, though. It is still necessary to interpret the result and to use it as a tool to obtain the required performance of the amplifier. This equation can certainly be simplified, but the circuit performance is still well obscured.

Analysis by Solving for Z_k

Fig. 3 is a different representation for the same amplifier. If the open loop gain of each stage is known, the only parameter lacking for a closed loop gain solution is the cathode imped-

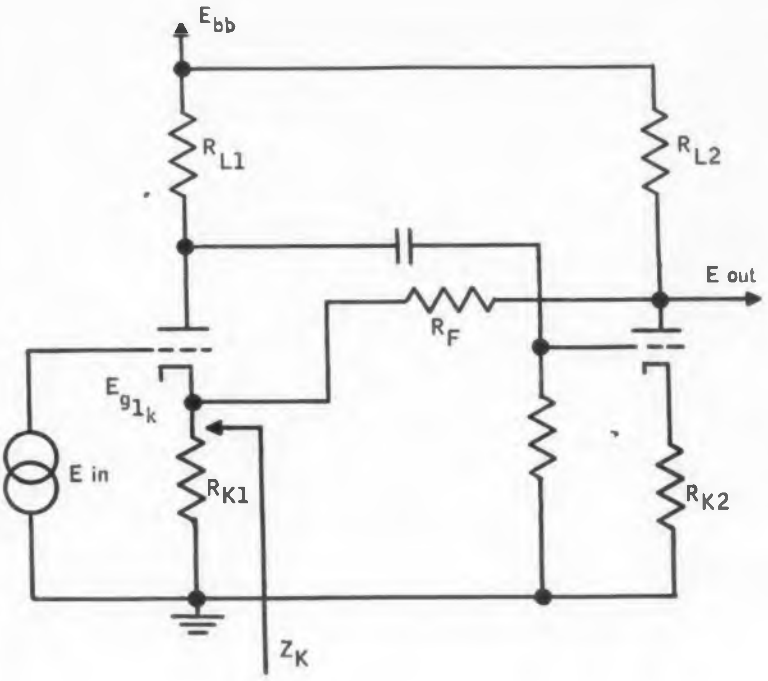

Fig. 1. Plate to cathode feedback amplifier.

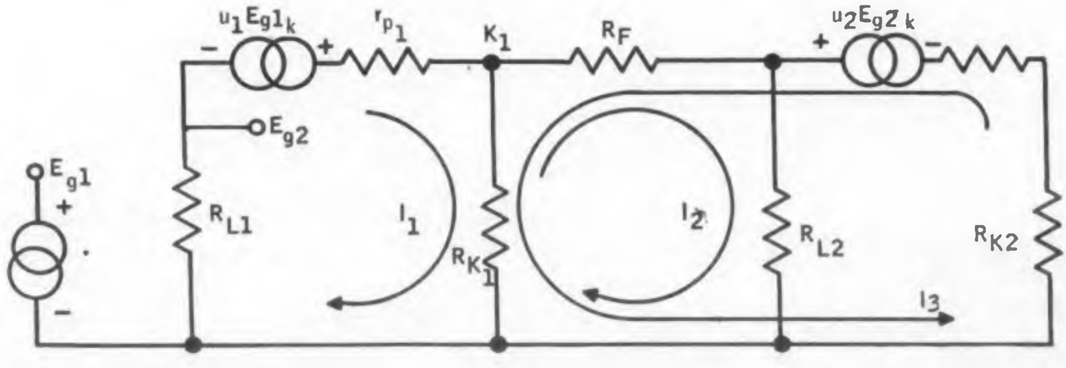

Fig. 2. Equivalent circuit of the feedback amplifier of Fig. 1

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ance. If the feedback resistance R_f, is large compared with Z_k, one may assume a small voltage change applied across the cathode impedance and calculate the incremental current flow Δi. Then $Z_k = \Delta e/\Delta i$, and referring to Fig. the equivalent circuit, one finds

$$\Delta i = \frac{\Delta e}{R_k} + \Delta ip$$

where Δi_p = change in plate current

$$\text{and} \qquad \Delta e + \mu_1 \Delta e_{gk} = \Delta i_p (R_{L_1} + r_{p_1}) \qquad (3)$$

From basic feedback theory

$$\Delta e_{gk} = \frac{\Delta e_{in}}{1 - A\beta} \qquad (4)$$

with A, the overall open loop gain, and β, the feedback factor, is negative for negative feedback.

From the circuit of Fig. 3,

$$\Delta e_{in} - \Delta e_{gk} = \Delta e \qquad (5)$$

Solving for Δe_{gk} in terms of Δe,

$$\Delta e_{gk}(1 - A\beta - 1) = \Delta e$$

$$\text{Hence} \qquad \Delta e_{gk} = \frac{\Delta e}{-A\beta} \qquad (6)$$

Substituting (6) into (3),

$$\Delta e\left[1 + \frac{\mu_1}{-A\beta}\right] = \Delta i_p (R_{L_1} + r_{p_1})$$

$$\text{and} \qquad \Delta i_p = \frac{\left[1 + \frac{\mu_1}{-A\beta}\right]\Delta e}{R_{L_1} + r_{p_1}}$$

$$\text{Hence} \qquad \Delta i = \frac{\Delta e}{R_{k_1}} + \frac{\Delta e}{\dfrac{(R_{L_1} + r_{p_1})}{1 + \dfrac{\mu_1}{-A\beta}}}$$

$$\text{and} \qquad Z_k = \frac{\Delta e}{\Delta i} = R_{k_1} /\!/ \frac{R_{L_1} + r_{p_1}}{1 + \dfrac{\mu_1}{-A\beta}} \qquad (7)$$

The first stage gain is

$$A_1 = \frac{\mu_1 R_{L_1}}{R_{L_1} + r_{p_1} + (\mu_1 + 1) R_{k_1}}$$

The second stage gain is

$$A_2 = \frac{\mu_2 R_{L_2}}{R_{L_2} + r_{p_2} + (\mu_2 + 1) R_{k_2}}$$

The open loop gain is $A = A_1 A_2$

The general feedback equation (1) can now be applied directly. The gain of the amplifier, then, is

$$G = \frac{A_1 A_2}{1 - A_1 A_2 \beta} = \frac{A_1 A_2}{1 - \dfrac{A_1 A_2 Z_k}{Z_k + R_f}}$$

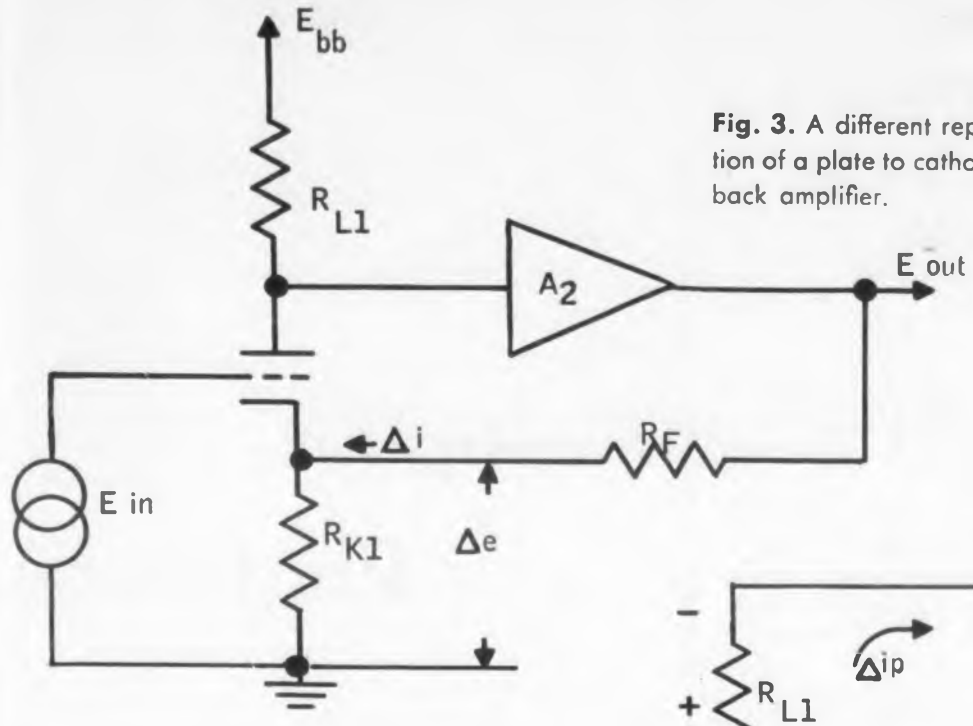


Fig. 3. A different representation of a plate to cathode feedback amplifier.

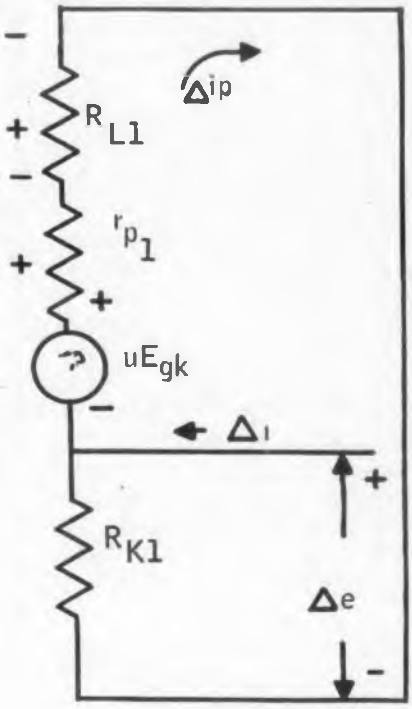


Fig. 4. An equivalent circuit for the representation of Fig. 3.

This expression appears to be superior to that of eq (2), since all the parameters are easy to recognize. For design purposes, it is easy to see how any one term affects the overall gain.

Illustrative Problem

In the feedback amplifier of Fig. 3, it is necessary to find the feedback resistor R_f, for a closed loop gain of 20. The following data are given.

$$R_{k1} = 1000 \text{ ohm}$$
$$R_{l1} = 20 \text{ k}$$
$$r_{p1} = 40 \text{ k}$$
$$\mu_1 = 70$$
$$A = 400$$

Solution for β

From $G = A/(1 - A\beta)$ one finds

$$\beta = -\frac{A - G}{AG} = -\frac{400 - 20}{8000} = -.0475$$

Solution for Z_k

From (7)

$$\frac{R_{L_1} + r_{p_1}}{1 + \frac{\mu_1}{-A\beta}} = \frac{(R_{L_1} + r_{p_1})(-A\beta)}{\mu_1 - A\beta}$$

$$= \frac{(60{,}000)(-400)(-.0475)}{70 + (-400)(-.0475)} = 12{,}800 \text{ ohm}$$

$$Z_k = R_k /\!/ 12{,}800 \text{ ohm}$$
$$= 1000 /\!/ 12{,}800 = 928 \text{ ohm}$$

Solution for R_f

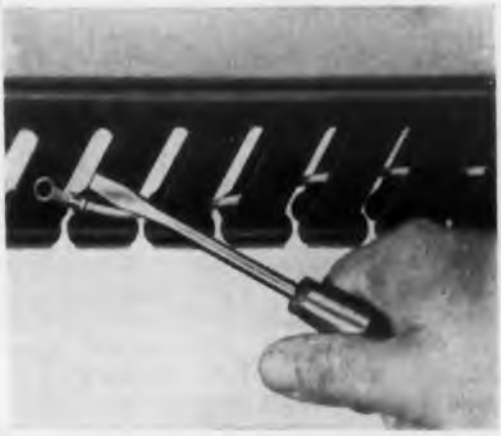
From $\beta = Z_k/(R_f + Z_k)$

$$R_f = \frac{Z_k(1-\beta)}{\beta} = \frac{928(.9525)}{.0475} = 18{,}560 \text{ ohm}$$

newest addition to Panel Chanel's line of wiring raceways . . LOK-SLOT

WIRES INSERT EASILY

Single wires slip into Lok-Slot quickly. Connectors can be placed on wires *before* assembly, simplifying wiring procedure. Need to change a wire's location? Just lift it out and slip it into the new slot.



STAY PUT . . .

Once in place, wires don't pop out. They *can't*, for Lok-Slot's slim throat is a deliberately designed "bottleneck" —for wires you *don't* want out.

AND COME OUT WHEN YOU WANT THEM

Slanted slot design permits lateral as well as vertical wire movement for precise alignment with desired terminal. Just pick your wire and lift. Out it comes, without bringing a scramble of leads with it. The others remain securely in place — until you want them.

Lok-Slot has all the other fine features of Panel Chanel® wiring raceways. It reduces panelboard wiring time and costs by eliminating bundling and lacing. Made of tough, reinforced phenolic, Lok-Slot won't warp and is fire retardant. It can be cut simply with ordinary tools, requires no special fastening hardware, and comes in a variety of sizes. What's more, the finished job is neat and professional looking, and lasts the life of the equipment.

For full details on Lok-Slot and other Panel Chanel styles, write for your copy of Bulletin S-302.

Lok-Slot and Panel Chanel are tradenames.

Panel Chanel®

STÄHLIN BROTHERS, INC. • 103 MAPLE STREET
Belding, Michigan

CIRCLE 36 ON READER-SERVICE CARD

Multiplier Phototube

INTENDED for use in the detection and measurement of low-level red and near-infrared radiation, type 7102 multiplier phototube covers the range from about 4200 to 11,000 A, with a maximum response occurring at approximately 8000 A, as shown in Fig. 1. Along with this response, the tube achieves a very short time resolution. For an input pulse having a duration of 1 mμsec or less, the time spread of the pulse at

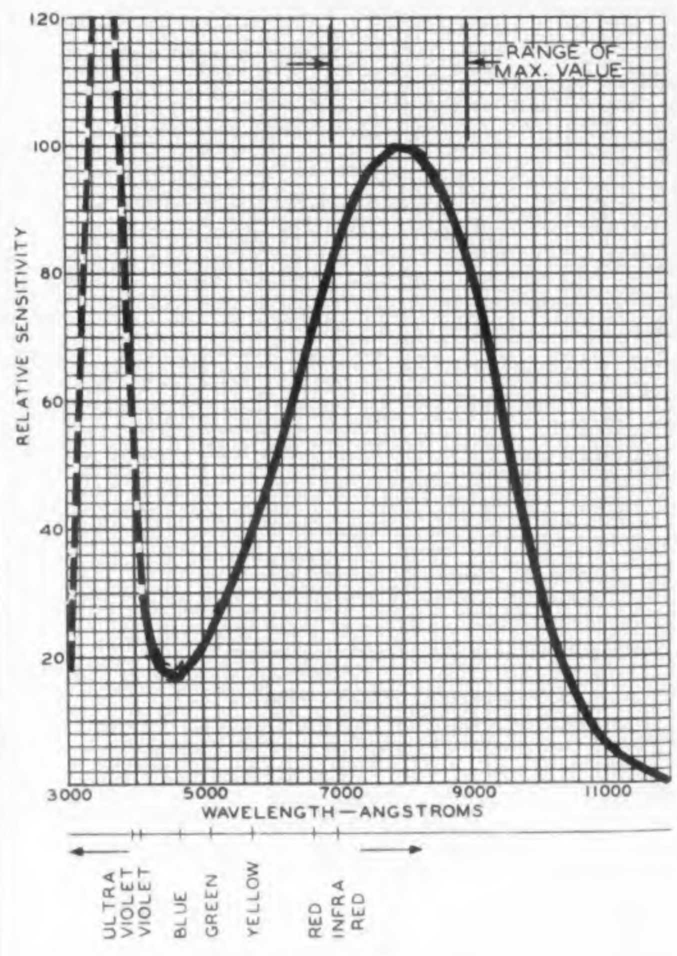


Fig. 1. Spectral response of the phototube achieves its maximum at about 8000 A. The curve is shown for equal values of radiant flux of all wavelengths.

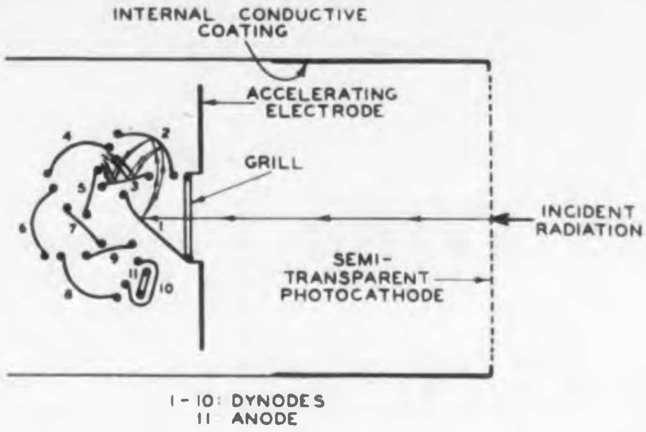


Fig. 2. Construction of the multiplier phototube shown schematically.

... high red to near-infrared response

the anode is about 5 mμsec, measured at 50 per cent of the maximum pulse height. This time spread corresponds to an electron transit-time spread of about 5 mμsec. The transit-time spread can be reduced to about 2 mμsec by irradiating only a small central area of the photocathode.

The phototube, built by RCA, is basically a ten-stage, head-on type with a semitransparent cathode having a minimum diameter of 1.24 in. This relatively large cathode permits efficient collection of the radiation from sources of scattered radiation. Ten electrostatic dynode stages utilize the phenomenon of secondary emission to amplify signals composed of electron streams. As shown in Fig. 2, the electrons emitted from the irradiated cathode are directed by fixed electrostatic fields to the first dynode (secondary emitter). This process continues until the electron streams emitted from the last dynode (dynode no. 10) are collected by the anode, providing the current utilized in the output circuit.

Dynode no. 10 is so shaped that it partially encloses the anode, thus serving as a shield to prevent the fluctuating potential of the anode from interfering with electron focusing in the interdynode region. Actually, the anode consists of a grating which allows the electrons from dynode no. 9 to pass through it to dynode no. 10. The spacing between dynode no. 10 and the anode creates a collecting field such that all the electrons emitted by dynode no. 10 are collected by the anode. Therefore the output current is substantially independent of the instantaneous positive anode potential over a wide range. As a result of this characteristic, this multiplier phototube can be coupled to any practical load impedance encountered.

For more information on this phototube, turn to the Reader's Service Card and circle 38.

RCA Subminiature Relays are designed to give maximum reliability and superior performance in missile and airborne applications, as well as critical industrial uses.

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CIRCLE 39 ON READER-SERVICE CARD

CRYSTAL-CASE SIZE! PERMANENT MAGNET DESIGN.
SHOCK: 100g. VIBRATION: 30g 55 TO 2000cps. NO CONTACT OPENINGS.

SC NON-LATCHING TYPE—This micro-miniature relay sets new standards—in design, in performance, in reliability. Yet the SC conforms to standard dimensions and circuitry and may be used to replace ordinary crystal-case relays. A permanent magnet in the structure provides *at least twice the contact pressure found in relays of comparable size.*

SL LATCHING TYPE—Unique magnetic latch assures exceptional contact pressure. A 1 watt, 3 ms. pulse to either coil transfers contacts. Transfer time is only 0.5 ms. Has the same exceptional shock and vibration characteristics as the SC.

GENERAL: Insulation Resistance: 10,000 megohms, min.
Breakdown Voltage: 1,000 V. RMS.
Shock: 100g.
Vibration: 30g 55 to 2000 cps.; 0.195" max. excursions from 10-55 cps.
Temperature Range: -65°C. to +125° C.
Weight: 17.5 grams (5/8 oz.).

SC and SL Series Engineering Data

Operate Time: 3 MS. max. with 550 ohm coil @ 24 V. DC. (SL: 630 ohm coil at 24 V. DC).
Transfer Time: 0.5 MS max.
Terminals: (1) Plug-in for microminiature receptacle of printed circuit board. (2) Hook end solder for one #20 AWG wire.
Enclosure: Hermetically sealed.

CONTACTS: Arrangement: 2 Form C.
Material: Gold flashed palladium.
Load: 2 amps @ 28 V. DC, resistive; 1 amp @ 115.V. AC, resistive.
Pressure: SC—13 grams min.; SL—16 grams min.

COIL: Power: Approx. 1.0 watt at Nominal Voltage.
Resistance: SL—40 to 1400 ohms; SC—35 to 1250 ohms.
Duty: Continuous.

MOUNTINGS: Bracket, stud and plug-in.

P&B Standard Relays are available at your local electronic, electrical and refrigeration distributors

Potter & Brumfield, inc.

PRINCETON, INDIANA · SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY
Manufacturing Divisions also in Franklin, Ky. and Laconia, N.H.

CIRCLE 41 ON READER-SERVICE CARD

Read and Write Transistor Circuits for Magnetic Drums – 1

This article discusses the integration of transistors in magnetic drum read-write circuits. A general approach to the design of these circuits for high reliability is outlined.

Part I, presented here, will deal with the design of writer circuits. Part II, which will appear in an early issue of ELECTRONIC DESIGN, will cover read preamplifier design.

B. A. Mangan
International Business Machines Corp.
Kingston, N. Y.

Writer Configurations

FOR our purposes, a discrete-pulse type of recording shall be used in adapting the drum writer to transistors. Fig. 1 depicts a simplified transistor writer capable of operating at a 400-500 kc repetition rate. The prime consideration in designing this circuit is the selection of a transistor that will withstand the back voltage developed across the head and will still be capable of supplying the required current. If a trapezoidal or sinusoidal pulse is utilized, the induced voltage for a specified pulse amplitude will be a minimum. Sufficient voltage therefore exists across the transistor to allow the peak current to be drawn.

Introducing these pulses prevents the transistor from being driven to saturation. Hence, turn-off delay is eliminated. However, since saturation is not reached, the output current depends on the forward current transfer of the transistor. In a vacuum-tube circuit, this same condition is alleviated to a considerable degree through cathode degeneration.

The same result is accomplished with emitter degeneration, to a much greater extent, by virtue of the low impedance of the

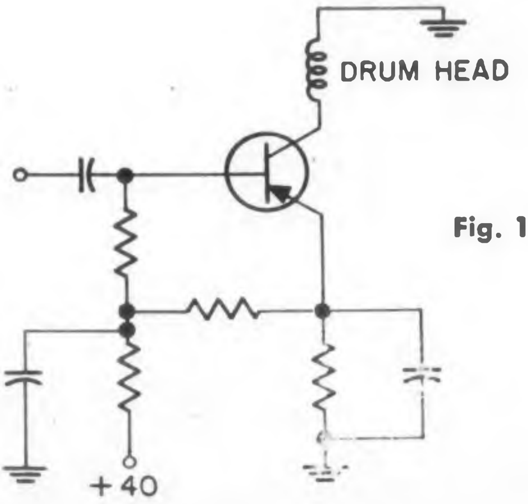

Fig. 1. Simplified transistor writer (magnetic drum).

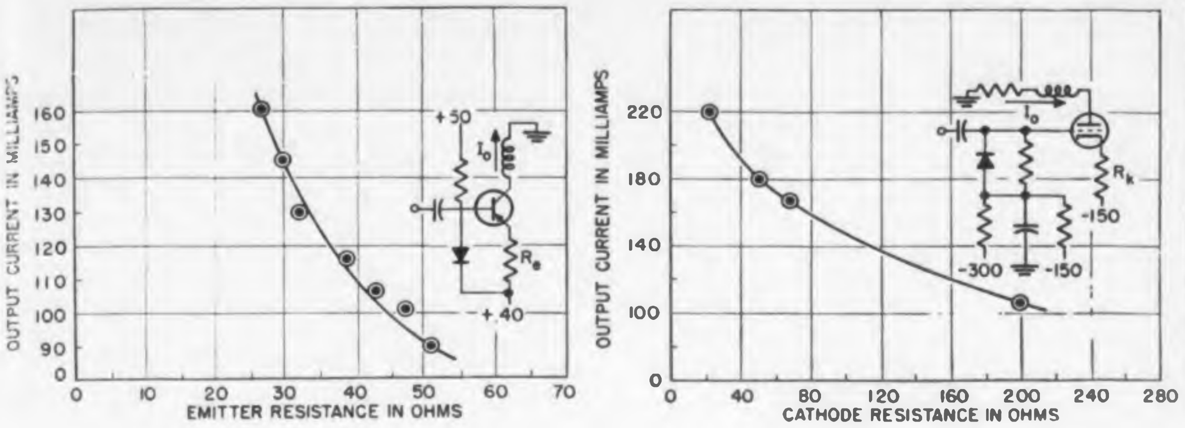

Fig. 2. Comparison of emitter and cathode degeneration.

transistor. Fig. 2 illustrates, by comparison, the amount of degeneration that can be built in. In addition, an emitter resistor tends to stabilize the operating point by reducing the effect of variations in the forward resistance of the emitter-base junction. In transistors of this type, common emitter current ratios (beta) of about 10 are normal. This value of beta helps to minimize the variation in output current since the range of beta must then also be small.

Fig. 3 indicates two methods of obtaining bias for the writer. The first arrangement (a) makes use of the voltage drop across the forward impedance of a diode. This has the advantage of establishing a rather stiff reference for the incoming signal. The selection of *R* depends on the bias voltage required and the input impedance of the transistor which it effectively shunts. Since the range of beta is not great, the required bias should be calculated for the value which tends to turn the transistor on. The presence of the diode essentially removes the I_{co} from bias consideration.

The second bias arrangement (b) has the advantage of using a single power supply. However, I_{co} must be considered. The proper selection of voltage divider ($R_2 + R_3$) and a bias resistor (R_1) will compensate for the worst I_{co} at the highest expected temperature.

The two major advantages of utilizing a single power supply are:

- Fluctuations in the power supply will be seen at both the base and emitter; hence the effect on the circuit will be a minimum.
- In the event of a power failure, no voltage exists across the transistor, thus preventing damage to the transistor.

A further consideration regarding the general reliability of the circuit is the placement of the head at ground potential. This arrangement results in the elimination of accidental grounding and its consequent catastrophic effects on circuit components.

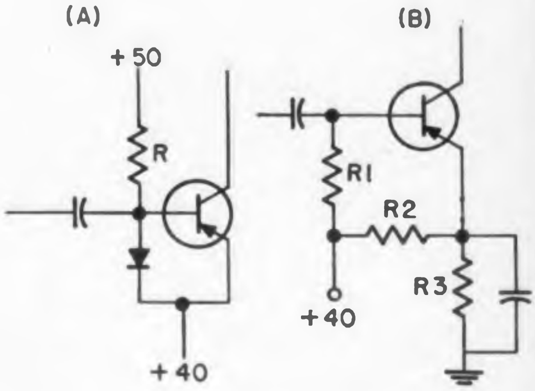

Fig. 3. Two methods of obtaining bias.

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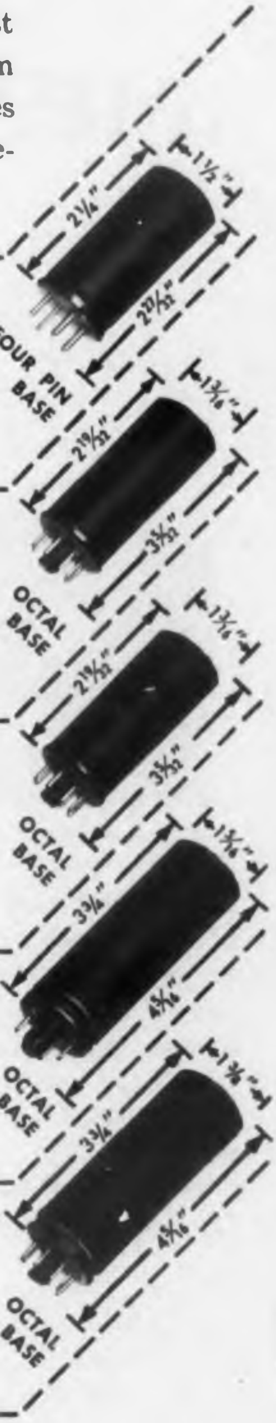

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Peak Inverse Voltage per Section . . 1600 Volts Max.
Peak Rectifier Current per Section . . 8000 MA Max.
DC Output Current . . . . 750 MA Max.
Ambient Temperature . . . . 100°C Max.
Replacement for Types 80, 82, 83, 83V, 5Z3

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Peak Rectifier Current per Section . . 8000 MA Max.
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DC Output Current . . . . 750 MA Max.
Ambient Temperature . . . . 100°C Max.
Replacement for Types 5AU4, 5AW4, 5AZ4, 5T4, 5U4, 5V4, 5W4, 5Y3, 5Z4

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MAXIMUM RATING

Peak Inverse Voltage per Section . . 2800 Volts Max.
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DC Output Current . . . . 500 MA Max.
Ambient Temperature . . . . 100°C Max.
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Send for data sheets on any of the above types.

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CIRCLE 42 ON READER-SERVICE CARD

NEW PRODUCTS

To provide a complete coverage of ALL new products generally specified when designing electronic original equipment, the New Product section has been extended. To include the larger number of items, products which are best suited to a brief description have been noted at the end of the section.

GERMANIUM PHOTODIODE

An Integral Lens for focussing light on the junction area of this photodiode eliminates the external optics usually necessary. The hermetically sealed germanium device can be used in either the visible or infra-red portions of the spectrum. Typical applications include punched-card or tape reading. Sensitivity is approximately 30 ma per lumen at an ambient temperature of 20 C. Dark current is less than 3.5 μa. The sensitive surface measures approximately 1 mm^2.

Nucleonic Products Co., Inc., Dept. ED, 1601 Grande Vista Ave., Los Angeles, Calif.

CIRCLE 43 ON READER-SERVICE CARD

DIGITAL TAPE SYSTEM

150-Inch-Per-Sec tape speed enables the FR-300 tape system to transfer six-bit alpha-numeric characters at rates up to 90,000 characters per sec, using a 1-in. tape width and 300 bits per in. density. This tape speed, plus the tape's width and packing density, cuts search time to 1/6th of the time previously required. Another feature is the reduction of start and stop times to 1.5 msec. These times are built-in characteristics, allowing a predictable time of response to command. The quick control of the reel motors is provided by a thyratron servo system responding to air-column pressure changes.

Ampex Corp., Dept. ED, 934 Charter St., Redwood City, Calif.

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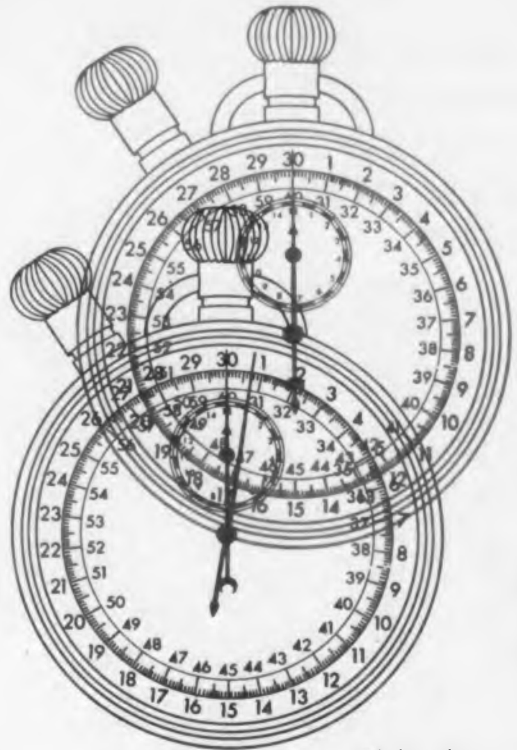

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LABORATORY ACCURACY. The Model 301 is an extremely compact and accurate variable DC power supply and calibrated null voltmeter. It employs KIN TEL's proved chopper circuit to constantly compare the output voltage against an internal standard cell. As a DC voltage standard, it combines the stability and accuracy of the standard cell with the current capabilities and excellent dynamic characteristics of the finest electronically regulated power supplies. The self-contained null voltmeter indicates the voltage difference between the supply in the 301 and the DC source being measured, affording simple and rapid measurement of DC voltages to an accuracy of 0.02%.

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VERSATILITY. The KIN TEL Model 301 is ideal for rapid and accurate production calibration of precision measuring instruments and DC power supplies . . . design of DC amplifiers and complex electronic circuitry . . . computer reference . . . versatile precision reference for calibration and measurement laboratories.

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0.01% stability

0.02% accuracy

1 to 501 volts at 20 ma

4 accurate null ranges

0.002% regulation

Less than 100 μv ripple

IMPORTANT SPECIFICATIONS

Output Voltage & Current 1 to 501 volts at up to 20 ma
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DC Output Range . . . . ±500, 50 volts
DC Input Range . . . . ±500, 50 volts
DC Null Meter Range . . ±50, 5, 0.5, 0.05 volts
Long Time Stability . . . . ±100 parts per million
Output Voltage Calibration . . . . . . ±0.02% or 2 mv
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Response Time . . . . 0.2 millisecond
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CIRCLE 45 ON READER-SERVICE CARD

NEW PRODUCTS

Strain Relief Bushing
Thick Housings

Type SR-5L strain relief bushing is designed especially for SV, HPN, HPD and SPT wires and will anchor the wire to housings with 1/8 in. thick walls. Snapping into chassis hole, the bushing absorbs pull, push and torque.

Heyman Manufacturing Co., Dept. ED, 100 Michigan Ave., Kenilworth, N.J.

CIRCLE 47 ON READER-SERVICE CARD

Molded Transformers
for Metering Applications

Type CPE molded transformers are for use with watthour meters or other applications where high accuracy at low burdens is required. The unit is a windowtype transformer, but can be supplied with round or flat bar primary conductors, or mounting brackets.

Standard Transformer Co., Dept. ED, Warren, Ohio.

CIRCLE 48 ON READER-SERVICE CARD

Seismic Data Processor
Central Portable System

The VIP variable Intensity plotter offers central processing office advantages while preserving mobility for the quick processing and

◄ CIRCLE 46 ON READER-SERVICE CARD

interpretation of seismic data. Components of the system consist of a visual display unit weighing 65 lb, and a computing unit weighing 85 lb.

Texas Instruments, Inc., Dept. ED, 3609 Buffalo Speedway, Houston 6, Texas.

CIRCLE 49 ON READER-SERVICE CARD

Plastic Wiring Duct
Overlapping Closed-Slot

Type C plastic wiring duct features overlapping closed slots over the full length of the duct. Quick access is possible with a cover which snaps or slides in place directly on the duct. Another model, type B, has individual snap-in slots which allow wires to be laid after terminals have been attached.

Panduit Co., Dept. ED, 14461 Waverly Ave., Midlothian, Ill.

CIRCLE 50 ON READER-SERVICE CARD

Nylon Screws
for Miniature Assemblies

This 2-56 round-head nylon screw, precision-molded to American Standard Thread Specifications, is especially suitable for miniature assemblies where nylon can be used to advantage. Insulation without special washers or bushings, and resistance to corrosion and fungus are featured.

Weckesser Co., Dept. ED, 5701 Northwest Highway, Chicago 30, Ill.

CIRCLE 51 ON READER-SERVICE CARD

CIRCLE 52 ON READER-SERVICE CARD ➤

Telemetering Simplified with

Angular Position Transducer

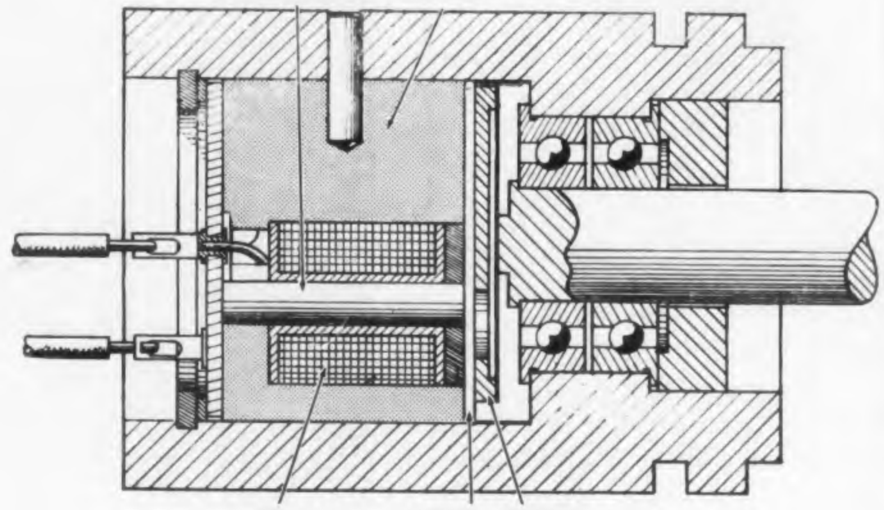


Fig. 1. Cross section of transducer. The grey area is a stator cylinder of magnetic material in which the coil is imbedded.

INFINITE resolution and insensitivity to vibration and shock characterize a new type of angular position transducer. Operating on the variable reluctance principle, the transducers are designed for use in telemetering systems where measurements are transmitted as signal frequencies. Rotation of a magnetic rotor varies the amount of ferro-magnetic material in a fixed air gap, and due to the shape of the rotor, a change in the magnetic reluctance varies the frequency of an oscillator in a linear manner.

Developed by Ultradyne Inc., P. O. Box 3308, Albuquerque, N. M., the new transducers function through the use of a single electrical coil and an associated magnetic circuit. A magnetic rotor, which is actuated by the movement of the object being tested, varies the cross-sectional area of a non-magnetic gap which is part of the magnetic circuit. As this area varies, a change occurs in the coil impedance, causing a change in the frequency of the signal generated by the oscillator which contains the coil as a frequency-determining element.

The transducer is housed in an outer shell. A cylindrical magnetic stator is rotatably mounted within the shell. A coil is wound around pole piece, mounted within the stator, and held in position by potting compound. The end of the pole piece opposite the potting compound is in intimate contact with the stator, providing good magnetic conductivity. A tetrafluorethylene resin wafer, several mils thick, provides lubrication between the facing surfaces of the rotor and stator.

A magnetic circuit, consisting of the following elements, is created: pole piece, main body of the stator, the non-magnetic gap between rotor and stator occupied by wafer, rotor, the non-magnetic gap between the pole piece and the rotor—also occupied by the wafer. Variation of the cross-sectional area of this last-named gap while the shaft rotates is one of the basic principles behind the patent applications for the new instruments. In Fig. 2 the rotor is seen to have a number of holes. These holes are located equidistant from the center of the rotor, within close tolerances. This distance is such that pole piece lies fairly well within a projection of any of the rotor holes onto the stator when the rotor is in a position slightly clockwise from that shown. When the rotor is in such a position, any magnetic flux leaving the pole piece must traverse a considerable space gap in order to reach the rotor. This, then, is the position of maximum reluctance of the magnetic circuit and the position which gives the coil its minimum impedance. The shape of the non-magnetic portion of the rotor can be chosen to compensate for the non-linear effects on coil inductance usually noticed when the size of the gap is varied.

The transducer is supplied in two models, the T-2-TA and T-4-TA, the latter being temperature

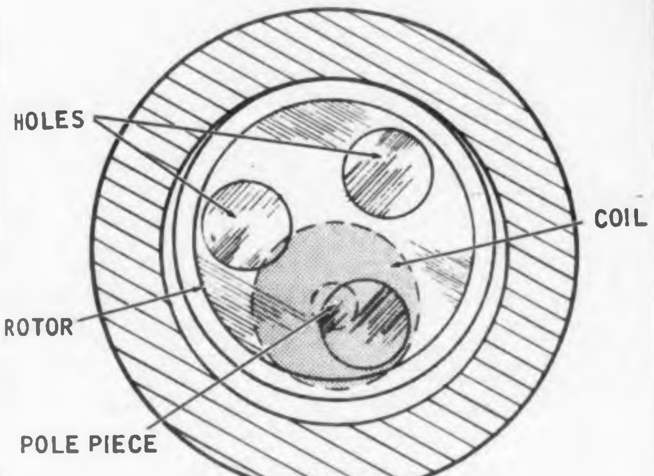


Fig. 2. Diagram showing position of rotor over pole piece. The holes in the rotor compensate for non-linear effects in coil inductance.

compensated over the range of 0 F thru ±250 F. Specifications include an angular range of ±4 deg to ±10 deg, an inductance mid-range value matched to oscillator and tapped at 60 per cent of full inductance. They withstand 18 impact shocks of 30 g's, without damage and without exceeding normal operating tolerances. Operating temperature range is −65 F through ±250 F. Error will not exceed ±3 per cent of full range output from best straight line.

Sensitivity adjustment is permitted by varying the thickness of the wafer employed, since this dimension controls the length of both the non-magnetic gaps in the circuit. The particles cause a sort of hysteresis in the calibration curves, decreasing instrument accuracy. The tetrafluroethylene wafer is consequently used as a form of lubrication which will maintain constant length gaps by eliminating the end play caused by particles and compensating for any surface irregularities.

For more information circle 54 on Reader Service Card.

Economy and Quality with

NEW 22 Circuit Centralab.

MINIATURE SWITCHES

2X MAGNIFICATION

ACTUAL SIZE

These new switches are designed for application where costs must be kept to a minimum without compromising rigid electrical specifications. New laminated construction allows up to 22 separate switch points on a 1$\frac{1}{16}$" diameter.

- Voltage breakdown, 1000 volts R.M.S. Back to back insulated clips, 500 volts R.M.S. Laminated phenolic sections type PBE per specifications MIL-P-3115.
- Current rating 2 amp. at 15 volts DC; 150 milliamps at 110 volts AC (resistive load).
- Minimum life, 10,000 cycles.
- Supplied as single section, double section, or single section with line switch. 2-12 positions per switch.
- AC line switches for single section units in SPST, DPST and SPDT switching arrangements.

For detailed specifications, write for Bulletin EP-90 or contact your Centralab representative.

Centralab

P-5808

A DIVISION OF GLOBE-UNION, INC.
900A E. KEEFE AVE. • MILWAUKEE 1, WIS.
In Canada: 804 Mt. Pleasant Rd. • Toronto, Ontario

VARIABLE RESISTORS • PACKAGED ELECTRONIC CIRCUITS • ELECTRONIC SWITCHES
CERAMIC CAPACITORS • ENGINEERED CERAMICS • SEMI-CONDUCTOR PRODUCTS

CIRCLE 56 ON READER-SERVICE CARD

Multichannel Ele

THIS NEW switch is entirely electronic and overcomes many of the shortcomings of mechanical types which are plagued by a short life span at high sampling rates. It is the newest answer to the need for reliable telemetering switches.

The need for reliable switches to sample large quantities of data is a real one. It is surprising that in spite of a pressing need, there are so few highly reliable sampling switches on the market. (See ED, July 15, 1957, p 32.)

This new switch, tradenamed Electrocom, has no moving parts so it can withstand high vibration and acceleration environments and can meet many other military requirements. Manufactured by General Devices, Inc., of Princeton, New Jersey, models are available to provide up to four accurately synchronized poles, sampling rates to 24,000 samples per minute per channel, and up to 24 non-shorting channels with insulation resistance to 100 megohms between any two channels.

The Electrocom accepts inputs in the 0-5 v range with source impedances up to 10 kilohms, and provides output voltages in the same range into load impedances of 25 K or greater. When properly operated, the input-output linearity is about 0.2 per cent. One of its beauties lies in its size. One model weighs less than one pound and measures only 2 x 2 x 3 in.

The block diagram shows how the switch works. A series of sequential gate control pulses establishes the required channel time slots. Input signals are gated to a common output in sequence. The channel on-time can be varied by electrical blanking at the common output point.

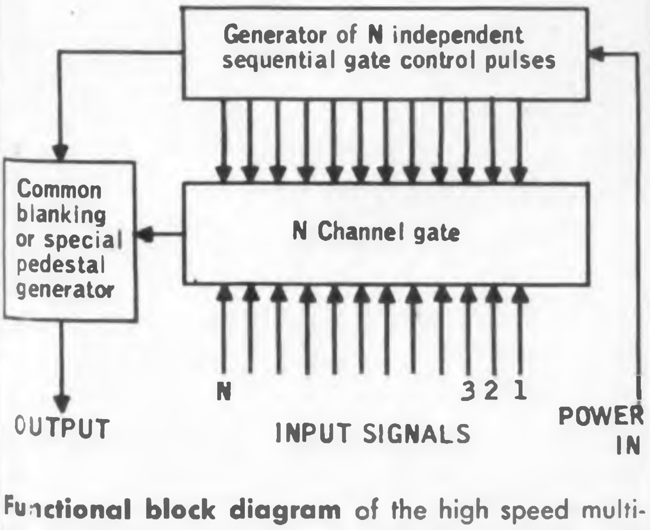
ne Electronic Switch

If required, voltage pedestals can be introduced at the output.

The gate pulse generator can use delay lines, polyphase signals, an open ring multivibrator chain, a closed ring counter, a binary matrix, a gas tube chain, or other circuitry depending on the system requirements. The choice depends on temperature, shock, vibration, power, size, weight, speed, switching voltage level, and synchronization requirements.

Models are available which use only simple passive elements, while others use solid state devices, gas tubes, magnetic cores or other active elements, depending on the scanning principle employed. The output, always in the form of pulse amplitude modulation (PAM), can be converted to other forms.

For more information on this high speed switch, circle 57 on the Reader-Service Card.



Functional block diagram of the high speed multichannel switch. One of several principles can be used for sequential switching.

offman Micro-Miniature

ZENER Silicon Junction DIODES

with GOLD ALLOY Ohmic Contacts

The GOLD CONTACT at the Heart of this Diode assures long life

TYPICAL CHARACTERISTICS
LOW VOLTAGE MICRO-MINIATURE ZENER DIODES

Hoffman Type Number	GZ1	GZ2	GZ3	GZ4	GZ5	GZ6
Zener Voltage Range: Volts @ Iz = 5 mA dc	2.0 to 3.2	3.0 to 3.9	3.7 to 4.5	4.3 to 5.4	5.2 to 6.4	6.2 to 8.0
Zener Impedance: Avg. *@ Iz = 10 mA dc	45	40	30	25	10	5
Max. @ Iz = 10 mA dc	60	55	45	35	20	10

Hoffman Micro-Miniature ZENER Silicon Junction Diodes are made with GOLD ALLOY Ohmic Contacts in order to withstand higher operating temperatures. This line of Hoffman Zener Diodes was developed for *Clipping, Limiting* and *Regulating* and similar applications where physical mounting *space* is at a minimum.

Rated at 250 milliwatts at 25°C (ambient temperature) and derated at one (1) milliwatt per degree centigrade above 25°C.

Operating and storage temperature range: −65°C to +200°C.

Special selections from Types GZ1 thru GZ6 are available with a tolerance of ±5%.

Units with ZENER voltages from 8 volts thru 51 volts are available at tolerances of ±10% and ±5%. From 56 volts thru 100 volts at ±10% tolerance.

Write for Hoffman Technical Information Bulletin No. 27-58 for detailed data on this new line of Micro-Miniature Zener Diodes.

CIRCLE 58 ON READER-SERVICE CARD

Transistor Socket

For use with 3 and 4 pin Jetec 30's

This socket is molded from mica-filled phenolic per Mil M-14, type MFE and is for use with 3 and 4 pin Jetec 30 transistors. The beryllium copper contacts are wrap-around style, silver plated and gold flashed for good contact as well as corrosion resistance.

Grayhill, Inc., Dept. ED, 561 Hillgrove Ave., LaGrange, Ill.

CIRCLE 59 ON READER-SERVICE CARD

Magnetic Storage Drum

Stores 15,000 binary bits in a small unit

A total storage of 15,000 binary bits in a drum measuring 15 in. in diam and 14 in. high is the primary feature of this unit. Called the HD (high density) file drum, the unit consists of the drum, driving and lubrication system, track-selection mercury relay matrix, linear readout preamplifier, and final writing amplifier. Average random access time provided to any data is 180 msec. The complete drum has 320 tracks, 20 of which are used as spares. The recording heads are assembled in pairs. Mating surfaces of the head pole pieces are optically lapped, and a lubrication system is provided to insure a very small uniform separation between the heads and the drum surface, and therefore very high recording density. The matrix of relays used for track selection are a pressurized, mercury-wetted contact type.

Laboratory of Electronics, Inc., Dept. ED, 75 Pitts St., Boston 14, Mass.

CIRCLE 60 ON READER-SERVICE CARD

Humidity Cabinet

Provides temperature uniformity

Counter-flow controlled relative humidity cabinets are available with dry bulb temperatures from 32 to 185 F and controlled per cent relative humidity from 20 to 98 per cent. Air is mechanically convected horizontally across test chamber by alloy turbo blower. A vapor pressure system used to control humidity assures high temperature uniformity and control of humidity with no wet bulb control-wick to change. True point programming utilizes an automatic dual Microtrol plus a 24-hr timer and wet and dry bulb recorder.

Blue M Electric Co., Dept. ED, Blue Island, Ill.

CIRCLE 62 ON READER-SERVICE CARD

Solenoid Valve

Entirely enclosed moving parts eliminate leakage

Type SV solenoid valve is specifically designed for high vacuum servicing and features freedom from leakage and high flow conductance. Stem leakage is eliminated, since the moving member is entirely enclosed within the valve body. The seat seal is made by a non-metallic O-ring set into one of two units that comprise the valve disc. When the valve is closed, these units are forced apart by a wedge action, pressing the O-ring against the smoothly machined brass bar body. Leak-proof tightness is tested with a mass spectrometer leak detector. High conductance is the result of straight-through design, very short flow path, and completely unimpeded ports.

Veeco Vacuum Corp., Dept. ED, 86 Denton Ave., New Hyde Park, N.Y.

CIRCLE 63 ON READER-SERVICE CARD

R-F Test Set

Combined signal generator, dc voltmeter and r-f field strength indicator

A portable test set that functions as a signal generator, dc voltmeter, and rf field strength indicator has been announced. With appropriate adapter plugs, the set will test all two-way radio equipment and will meter 16 transmitter-receiver-exciter functions as well as several functions within the test set. As a crystal-controlled r-f signal generator, the test set covers r-f, hf, vhf, and uhf frequency ranges. Four internal crystal positions are provided. As a 20,000-ohms-per-v dc voltmeter, the set has ranges of 0-3, 0-60, and 0-600 v. When used as a field strength indicator, the set has a 10,000 μv sensitivity.

Bendix Aviation Corp., Bendix Radio Div., Dept. ED, Baltimore 4, Md.

CIRCLE 65 ON READER-SERVICE CARD

Oscillograph

Designed for routine laboratory test work

Type 542 Dynograph, is a two channel direct writing oscillograph designed to be a practical routine test instrument for laboratory work. Applications include vibration and transient recording beyond the range of the usual direct recorder, geophysical recording, and direct recording of action potentials and electromyograms. The unit features 2 msec deflection time and a sensitivity of 5 mv/cm made possible by combining the Dynograph writing unit with a transistorized amplifier.

Offner Electronics, Inc., Dept. ED, 5320 N. Kedzie Ave., Chicago, Ill.

CIRCLE 66 ON READER-SERVICE CARD

Telemetry Multicoupler

Operates nine receivers from one antenna

Model 1104 multicoupler provides a means for connecting as many as nine telemetry receivers into a single antenna output. By cascading two couplers, 17 outputs are provided. It was designed for and has been used in the TLM-18 telemetry-antenna. Interchannel isolation is 55-85 db, frequency 216 to 255 mc, bandwidth 30 mc, and gain is 2 db nominal.

Radiation, Inc., Dept. ED, P. O. Box 37, Melbourne, Fla.

CIRCLE 67 ON READER-SERVICE CARD

Current Transformer

A laboratory type measuring low power factors down to 3 per cent.

This laboratory type current transformer measures power of extreme low power factors down to 3 per cent. It has a phase angle error to 2.4 min leading. Accuracy is 99.5 per cent. The current rating is 500/5 amp and the instrument can be made with ratings from 1 to 10,000 amp. Each transformer is tested for core loss, polarity, voltage, corona, insulation breakdown and aging characteristics.

Nothelfer Winding Laboratories, Inc., Dept. ED, P. O. Box 445, Trenton, N.J.

CIRCLE 68 ON READER-SERVICE CARD

CIRCLE 69 ON READER-SERVICE CARD ➤

CIRCLE 71 ON READER-SERVICE CARD

Triaxial Connectors

Hold noise radiation to minimum

These connectors are designed for use in high-voltage pulsed circuits where noise radiation must be kept at an absolute minimum. Included in the available type are air-to-air and air-to-oil receptacles, right angle receptacles, double end adapters, and both field assembled and molded-to-cable type plugs. Corona ratings range from 9 kv dc through 15 kv dc and from 12 kv rms through 15 kv rms.

H. H. Buggie, Inc., Dept. ED, Box 817, Toledo 1, Ohio.

CIRCLE 72 ON READER-SERVICE CARD

Vector Potentiometer

Output voltage has adjustable vector orientation

Model VP-101 Vector-Pot is a 400 cps potentiometer which, when excited from a reference line, develops an output voltage of adjustable vector orientation. The output voltage may be developed in either polar or rectangular coordinates, based on the line voltage as reference. The output components are direct reading. It is principally designed to null out error signals in precision test circuits for servomechanisms, resolvers, potentiometers, synchros, and similar devices. It is widely applicable as an element in custom test rigs designed to measure accuracy of precision components. The company's phase-sensitive null detector is a companion piece of equipment, which, in combination with the Vector-Pot, permits quick assembly of special-purpose test sets for precise measurements.

Dynamic Development Co., Dept. ED, 59 New York Ave., Westbury, N.Y.

CIRCLE 73 ON READER-SERVICE CARD

High Voltage Capacitors

Ratings from 25 kv to 200 kv

Designed for high-voltage dc filtering, pulse network, voltage doubler, and dc energy-storage applications, this series of uhv capacitors are available in voltage ratings from 25 to 200 kv. Employing the company's standard double-end design, with cast aluminum end caps serving both as mounting means and electrical terminals, these tubular capacitors permit easy installation in compact banks. This type of construction provides a long creepage path, and eliminates terminal flashover. Seven end-cap style combinations are offered to meet various requirements.

Cornell-Dubilier Electric Corp., Dept. ED, S. Plainfield, N.J.

CIRCLE 74 ON READER-SERVICE CARD

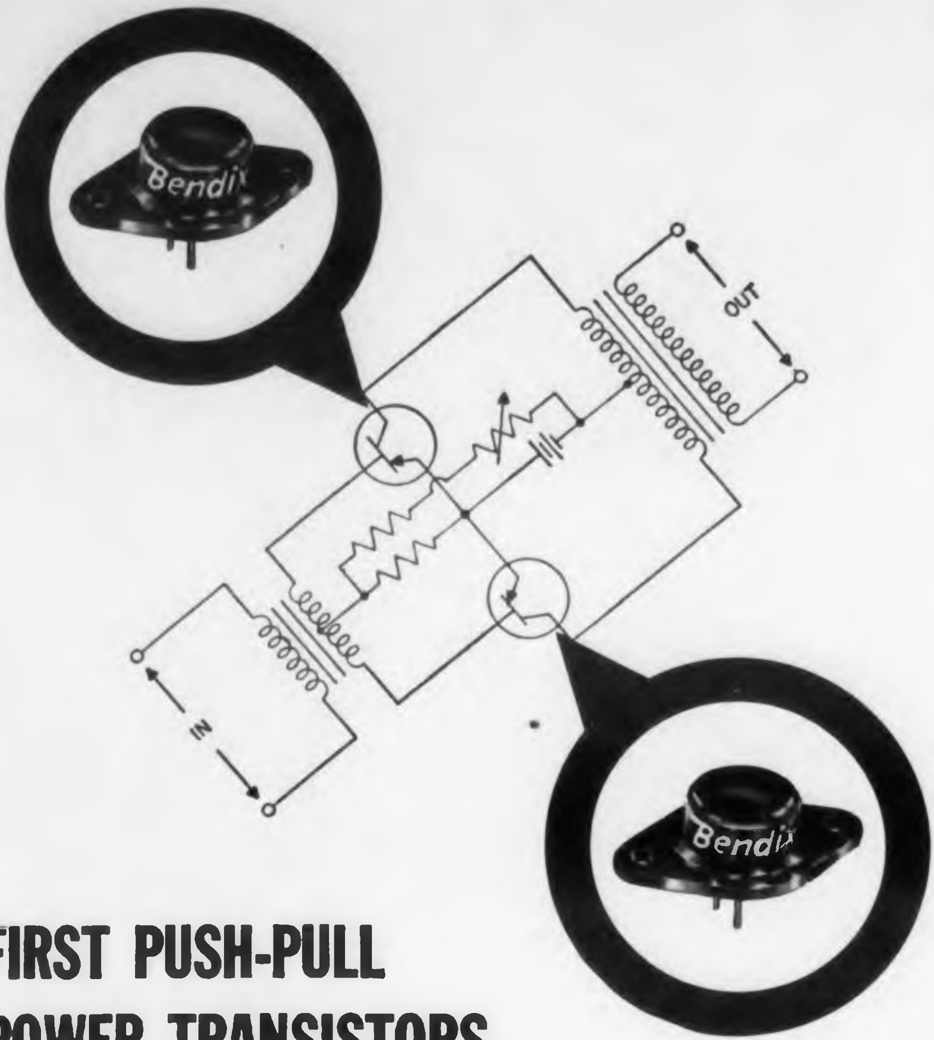
Power Relay

Switches large loads with low coil power

This polarized relay is designed to switch 1 to 2 kw loads in response to momentary 1/4 to 1/2 w signals. Series 61-relay uses a permanent magnet latch in place of mechanical latching devices. This eliminates all but one moving part and thus lengthens the life of the relay. The relay is a dpdt type with four separate contact circuits, and is available in two forms: 61Y (single coil only), two-position, magnetic bias; 61Z (single or dual coil), two-position, magnetic latch-in. Nominal contact rating is 20 amp (resistive) at 28 v dc or 120 v ac, with standard sensitivities of 225 or 450 mw. Minimum life is 100,000 operations when operated not more than once per second.

Sigma Instruments, Inc., Dept. ED, 48 Pearl St., S. Braintree 85, Mass.

CIRCLE 75 ON READER-SERVICE CARD



FIRST PUSH-PULL POWER TRANSISTORS ANNOUNCED BY BENDIX

More big news from Bendix in the power transistor field!

Here—in the new Bendix models 2N399 and 2N401—are *the first power transistors specially designed for such push-pull applications as push-pull amplifiers and servo-amplifiers.*

Both Bendix transistor types are supplied in matched pairs for high efficiency, low distortion, high-power output (up to 25 watts), low battery drain, low idling current, and low heat production.

Both are in volume production and ready for your application.

In fact, whatever your need, the complete Bendix power transistor line is designed to provide extra quality at no extra cost on a wide variety of applications. For full details, or for help with circuitry problems, write SEMICONDUCTOR PRODUCTS, BENDIX AVIATION CORPORATION, LONG BRANCH, NEW JERSEY.

West Coast Office: 117 E. Providencia Ave., Burbank, Calif.
Export Sales & Service
Bendix International, 205 E. 42nd St., New York 17, N. Y.
Canadian Affiliate: Computing Devices of Canada, Ltd., P. O. Box 508, Ottawa 4, Ont.

BENDIX PUSH-PULL TRANSISTOR PERFORMANCE CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS

Vc Vdc	Ic Adc	Pc W	Ib mAdc	T storage °C	Tj °C
−40	3.0	25	−150	−60 to +90	+90

TYPICAL APPLICATION
(Supply Voltage: 14 Vdc—Quiescent Supply Current: 120 mAdc)

	Load Imped'ce Collector-to-Collector	Source Imped'ce Base-to-Base	Power Output (No Clipping)	Circuit Gain	Efficiency
2N399	40 Ω	40 Ω	8 W	36 db	55%
2N401	48 Ω	40 Ω	5 W	33 db	55%

Red Bank Division

Bendix
AVIATION CORPORATION

CIRCLE 77 ON READER-SERVICE CARD

Power Amplifier
100 W Output

Model A-3052 rf amplifier provides up to 100 w output from standard 2-w telemetry transmitters. The amplifier uses a stacked ceramic tube for reliable operation. Temperature range is −55 to +75 C, shock 100 g, vibration 20 g to 2000 cps, altitude to 70,000 ft, and frequency range is 215-235 mc.

Radiation, Inc., Dept. ED, P. O. Box 37, Melbourne, Fla.

CIRCLE 78 ON READER-SERVICE CARD

Mica Capacitors
Can be assembled in decade box to provide steps of 0.001 μf

An assembly of type 980 decade capacitance units in a decade box is available as the type 1419-K decade capacitor. This unit, with a maximum capacitance of 1.11 μf in steps of 0.001 μf, replaces the older type 219-K. Dissipation factor of the new decades is one-third that of the older units and the long-term stability of capacitance values is better than 0.1 per cent.

Also available are type 505 mica capacitors, of which the decade units and assemblies are comprised. Although using the same construction as the standard capacitors, the type 505's are adjusted to ±0.5 per cent and are packaged in a less-expensive case. They are available in a 1-2-5 series extending from 100 μμf to 0.5 μf. Dissipation factor for the 1000-μμf and higher sizes does not exceed 0.0003. They are housed in low-loss molded-phenolic cases and are equipped with both screw-and-lug-type terminals and mounting flanges.

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

CIRCLE 79 ON READER-SERVICE CARD

DC to DC Converters

Provide up to 500 v at 165 ma from a 12 v supply

These transistorized units are designed to convert 12 v dc to high voltage dc. Transistor reliability is 95 per cent for 10,000 hr of use. A typical receiver supply, shown, produces 250 v dc at 130 ma or 290 v dc at 130 ma from either 12 or 13.6 v dc input. Size of the unit is 3-3/8 x 1-7/8 x 3-1/4 in. A typical transceiver supply produces three outputs of 500 v dc at 165 ma, 270 v dc at 150 ma, and —55 v dc at 10 ma from a 12 v dc input and comes in a 3-1/2 x 5 x 3 in. package.

Universal Transistor Products Corp., UAC Electronics Div., Dept. ED, 36 Sylvester St., Westbury, N.Y.

CIRCLE 81 ON READER-SERVICE CARD

Variable Resistor Assembly

Plug-in two-in-one and three-in-one units reduce assembly costs

Two and three unit variable resistor assemblies equipped with plug-in mounting brackets have been announced. Available in twelve basic types, each with 17 shaft lengths, the controls eliminate many of the production operations needed to mount separate units. Dipped soldered printed wiring terminals and snap-in metal mounting brackets provide firm support. The controls have been designed with sufficient clearance to allow wires or small cables to pass under them. The solder dipped printed wiring terminals on all types are spaced in accordance with proposed EIA standards.

Stackpole Carbon Co., Electronic Components Div., Dept. ED, St. Marys, Pa.

CIRCLE 82 ON READER-SERVICE CARD

◀ CIRCLE 85 ON READER-SERVICE CARD

NEW PRODUCTS

Multi-Turn Potentiometer

High Resolution

A 7/8-in. diam multi-turn precision potentiometer, series 55 provides up to 20 per cent more winding length in a given 10-turn od. Rated at 3 w, the unit is available in several resistance values up to 100,000 ohms. Low noise level is attained by controlled techniques. Runout and end resistance are at a minimum.

Clarostat Mfg. Co., Inc. Dept. ED, Dover, N.H.

CIRCLE 86 ON READER-SERVICE CARD

Counting Device Booster

Extends Life and Speed

The SD-1 booster is designed to increase the life and speed range of electro-mechanical counting devices as much as 15 times. The booster can be placed several hundred feet from switch contacts and registers in counts of 10 while counting up to 50 units per sec. Equipped with a visual totalizer if desired.

Post Electronics, Products Div., Dept. ED, Beverly, Mass.

CIRCLE 87 ON READER-SERVICE CARD

Symbols Template

0.25 In. Grid

The No. 315 MIL-STD-15A Template is being manufactured as an adjunct to the recently announced No. 314 MIL-STD-15A Template. The No. 315 MIL-STD-15A adheres to all military symbols, but is predicated on the established grid of 0.25 in., while the previously announced No. 314 is predicated on a 0.1 in. grid.

Rapidesign, Inc., Dept. ED, P. O. Box 429, Burbank, Calif.

CIRCLE 88 ON READER-SERVICE CARD

VHF Transceiver

360 Channels

The DTR-360A is a 360-channel vhf communications transceiver conforming to the requirements of TSO C37 and C38. Transmitter section provides 15 w output on any channel from 118 to 135.95 mc. A double conversion receiver has a sensitivity of 2 μv or better on every channel. Single channel simplex, double channel simplex or any cross channel duplex operation can be provided.

Dare, Inc., Dept. ED, Troy, Ohio.

CIRCLE 89 ON READER-SERVICE CARD

Dipped Mica Capacitors

125 C Rating

Type ADM dipped-mica capacitors are designed for printed-wiring and general purpose applications, and meet requirements of MIL-C-5A and RETMA RS-153. The units feature small size, temperature range of —55 C to 125 C, and narrow temperature coefficient.

Aerovox, Applications Engineering Dept., Dept. ED, New Bedford, Mass.

CIRCLE 90 ON READER-SERVICE CARD

CIRCLE 91 ON READER-SERVICE CARD ➤

a-c small motors

reversible

Barber-Colman reversible motors are adaptable to a variety of control circuits and speed and power requirements. Compact construction and low-inertia rotors make these motors ideal for applications requiring fast reversing. Used extensively in servo-mechanisms, remote switching and positioning, recording instruments, voltage regulators, etc. Available with or without reduction gearing, open or enclosed types. Electronic control of Barber-Colman reversible motors is accomplished by controlling the magnitude and phase of the shading circuit current with respect to the field coil current. Thus, the reversible motor functions as a two-phase motor, with the field coil being connected to one phase of the power supply and the shading coil circuit to the amplifier or second phase. Directional control is achieved by causing the phase of the shading circuit current to lead or lag the field current. Torque is controlled (and indirectly, the speed) by varying the magnitude of the shading circuit current.

geared

Barber-Colman a-c shaded pole reversible and unidirectional motors are available with both enclosed and open gear reductions. (Model shown is designed for overhanging loads.) Wide choice of models with wide variety of gear ratios for such applications as vending and office machines, rotisseries, TV tuners, program switches, etc.

unidirectional

Designed for applications requiring long life and high starting torque. Low-inertia rotors for quick, positive starting. Well suited for driving pumps, vending machines, vaporizers, antenna rotators, fans, blowers, office machines, and the like. Rugged construction, low cost. Synchronous and non-synchronous types available.

FREE CATALOG HELPS SELECT MOTOR NEEDED

Get the helpful condensed catalog of Barber-Colman shaded pole small motors. Contains complete descriptions of above motors, shows typical specifications, performance characteristics, control circuit diagrams. Write for your copy.

BARBER-COLMAN COMPANY

Dept. B, 1283 Rock Street, Rockford, Illinois

Small Motors • Automatic Controls • Industrial Instruments • Aircraft Controls
Electrical Components • Air Distribution Products • Overdoors and Operators
Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

CIRCLE 228 ON READER-SERVICE CARD

Pulse Modulator

Three operating modes

Model 63M hard-tube, high voltage pulse modulator is a flexible instrument for experimental tube testing. It is capable of three distinctly different modes of operation: cathode pulsing, modulating-anode pulsing, and grid pulsing. In all modes, it operates anywhere in the range from 30 cps to 12,000 cps and with pulse lengths continuously variable from 0.5 to 30 μsec. As a cathode pulser it will pulse from 0 to 50 kv up to 35 amp. As a modulating-anode pulser, it will pulse from 0 to 50 kv into a 25 μμf load. As a grid pulser, it will pulse from 0 to 5 kv into a 25 μμf load. The equipment has a 55-kv, 0.5-amp power supply with less than 0.1 per cent peak-to-peak ripple.

Levinthal Electronic Products, Inc., Dept. ED, Stanford Industrial Park, Palo Alto, Calif.

CIRCLE 92 ON READER-SERVICE CARD

Amp-Volt-Ohmmeter

Pocket-size unit measuring down to 0.3 ma

The Elavi-2 meter has a total of 26 measuring ranges. Current ranges are 0.3 ma to 1.5 ma and voltages from 0.15 v (6 v for ac) to 600 v. The instrument has two resistance ranges of 0-1000 ohms and 0-100 k. Frequency range is 15 cps to 10 kc. The meter uses germanium diodes.

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

CIRCLE 93 ON READER-SERVICE CARD

Synchro System

115-v input rating eliminates stepdown transformer

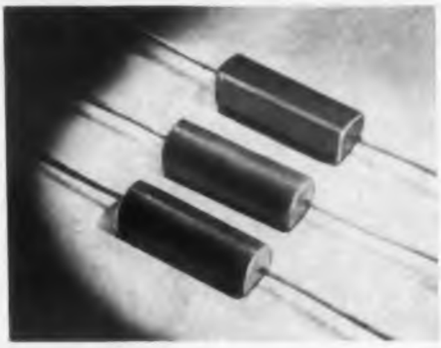
A more adaptable size 10 115 to 11.8 v 400 cps transmitter and receiver synchro system has been made available. The rated input voltage of the synchro eliminates a stepdown transformer, thereby reducing both system size and weight. Type 10-4081-01 synchro transmitter has an angular accuracy of ±15 min. Type 10-4085-07 receiver synchro has 45 min. accuracy error and 1 deg friction error. Transmitter-receiver system has torque gradient of 2900 mg per mm per deg.

John Oster Mfg. Co., Avionic Div., Dept. ED, 1 Main St., Racine, Wis.

CIRCLE 95 ON READER-SERVICE CARD

Deposited-Carbon Resistors

Flat side provides automation index



The latest of the series of encapsulated Fixtohm deposited-carbon precision resistors is equipped with a flatted area to serve as an index surface for automation, permitting orientation of marking and leads. The surface may be used as an adhesive mounting for unusual vibration, shock and power requirements.

Type CMF style RN70B 1/2-w Fixtohm is available in a resistance range of 10 ohms to 2.5 meg, ±1 per cent tolerance. Power rated at 1/2 watt at 70 C, derated to zero power at 150 C. Insulation resistance is in order of 100,000 meg. Moisture resistance is in order of 1 per cent. Temperature coefficient, maximum, is 500 ppm or 0.05 per cent per ohm degree C.

Clarostat Mfg. Co., Inc., Dept. ED, Dover, N.H.

CIRCLE 96 ON READER-SERVICE CARD

THE MARK OF QUALITY

BARBER
COLMAN

d-c small motors

compact, powerful – up to 1/10 hp

permanent magnet

Only Barber-Colman permanent magnet motors feature *the patented symmetrical, progressive lap winding* which provides true electrical balance, higher efficiency, superior commutation, and low radio noise output. Motor characteristics range from 6 to 115 volts d-c, 5,000 to 20,000 rpm, outputs up to 1/10 hp. Various mountings and shafts available. Ideal for many aircraft or industrial equipment applications.

split-series

Barber-Colman split-series motors are available in two frame sizes with continuous duty outputs up to nine millihorsepower. Outstanding efficiency due to excellent magnetic design and symmetrical lap-type armature winding. Electromechanical brakes can be supplied for these motors.

gearhead

Barber-Colman gearhead motors can be used as small actuators to drive switches, programing devices, camera mechanisms, autopilots, and for remote positioning in industrial automation. Standard EYLM motor with gearhead, illustrated, provides up to 10 lb-in. torque output. Gear ratios from 9.5 to 55,446/1.

with blowers, filters

Barber-Colman d-c motor-blower units quickly dissipate heat from hot tubes, circuit components, and other confined equipment. Air volume for a typical 1½-in. centrifugal unit is 20 cfm at 0 static pressure and 70°F. Voltages range from 6 to 115 volts d-c.

Barber-Colman permanent magnet motors also available with lightweight, compact, integrally mounted radio noise filters.

TECHNICAL BULLETINS ON COMPLETE LINE OF BARBER-COLMAN ELECTRICAL COMPONENTS

Detailed specifications, performance data, product and circuit drawings on polarized relays, resonant relays, d-c motors, tach generators, choppers. Write for your copy on any or all products.

BARBER-COLMAN COMPANY

Dept. B, 1883 Rock Street, Rockford, Illinois

Small Motors • Automatic Controls • Industrial Instruments • Aircraft Controls
Electrical Components • Air Distribution Products • Overdoors and Operators
Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

CIRCLE 97 ON READER-SERVICE CARD

Alternator

A 4-oz. unit developing 14 v, 80 ma at 350 cps

This permanent magnet alternator measures less than 1-in. od and weighs 4 oz. The unit is available in one, two, or three phase output with various frequency ranges. A 6-pole model develops 350 cps, 14 v, and 80 ma at 7000 rpm with less than 5 per cent distortion. A two pole version develops less than 3 per cent distortion.

Eastern Air Devices, Inc., Dept. ED, 385 Central Ave., Dover, N.H.

CIRCLE 99 ON READER-SERVICE CARD

Ferrite Load Isolator

Handles 50 kw peak from 2.8 to 3.2 kmc

Models S-131 and S-132 ferrite load isolators operate over the frequency band of 2:8 to 3.2 kmc and handle a minimum of 50 kw peak power and 50 w average power transmitted. The vswr is 1.15. Model S-131 has an insertion loss of 1db, an isolation of 22 db and a length of 8 in. Model S-132 has an insertion loss of 0.8 db, isolation of 13 db and length of 6 in.

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

CIRCLE 100 ON READER-SERVICE CARD

◀ CIRCLE 98 ON READER-SERVICE CARD

Molded Transformers

Miniature units for transistor applications

Designed for transistor, audio and servo applications, these transformers are molded of high temperature epoxy to provide protection against extremes in ambient. Weighing 1/2 oz, the dimensions of the MM-M series is 3/4 x 7/8 x 1/2 in. high. Mounting is by means of standard channel ears, threaded studs, or inserts. Terminal pins are arranged for use with dip soldered printed circuitry.

Microtran Co., Inc., Dept. ED, 145 E. Mineola Ave. Valley Stream, N.Y.

CIRCLE 101 ON READER-SERVICE CARD

Cathode Ray Tubes

Feature gradient type of post acceleration

Types 5BGP- (T5IP) and 5BHP- (T54P) cathode ray tubes have 5-in. flat faceplates, employ both electrostatic focus and deflection, and incorporate post acceleration by use of a spiral band resistance winding which extends from tube faces to the vicinity of the deflection plates. This type of post acceleration provides good deflection plate linearity and minimum pattern distortion can be obtained. Type 5BGP is 17-1/2 in. long and type 5BHP is 18-1/4 in. long. Both tubes are available with either P1, P2, P7 or P11 flourescent screens.

Electronic Tube Corp., Dept. ED, 1200 E. Mermaid Lane, Philadelphia 18, Pa.

CIRCLE 102 ON READER-SERVICE CARD

CIRCLE 103 ON READER-SERVICE CARD ➤

Quiggle Quells the Query

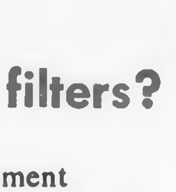
...where to get the best bandpass filters?

Major Quiggle*, KC, AC, DC, MC, fixed his procurement manager with a withering stare. "So now our whole production line is held up," he barked, "while you try to find a good bandpass filter with a flat response between 17 and 20 kcs. And you also insist that it have sharp low and high frequency cut-off," he added.

The manager reeled with the outburst. Never had he seen the old man in such a fury over a simple question of where to get the best bandpass filters.

Quiggle continued, "Haven't you been reading the trade paper advertisements? Why don't you call Barker & Williamson! They've been making filters of all types such as Band Elimination, High-Pass and Low-Pass for years . . . must be experts on the subject, they'll have the answer."

And B&W did have the answer. The Model 360 torroidal bandpass filter was perfect. With a flat response between 17.2 and 20.2 kcs, Quiggle's engineers found many other favorable characteristics when they obtained a spec sheet on the unit by the simple expedient of calling B&W.



*Now a confirmed customer and friend, name is withheld intentionally

B&W

Barker & Williamson, Inc.
Canal Street & Beaver Dam Road, Bristol, Penna.

B&W also design and manufacture filters for: ANTENNAS • RADIO INTERFERENCE • RADIO RANGE • UHF and VHF as well as many special types designed to performance specifications. Available to commercial & military standards.

CIRCLE 104 ON READER-SERVICE CARD

NEW PRODUCTS

Frequency Time Counter

A versatile instrument which includes preset internal generating as one of its functions

Frequency time counter, model 860, provides present interval generating, timing and counting functions in a compact package. The unit is a completely transistorized instrument with in-line read-out. It contains the shaping, gating, switching, counting and crystal-controlled time base circuitry required to perform counting, timing, frequency measuring, and interval generating functions in a compact package. The unit is a mits direct reading of results without considerations of transducer conversion factors.

Characteristics of the unit include direct measurement of frequency from 0 to 150 kc, frequency ratio determination, period measurements for 1 or 10 cys and time interval measurements for intervals from 10μsec to 100 sec.

Potter Instrument Co., Inc., Dept. ED, Sunnyside Blvd., Plainview, L. I., N.Y.

CIRCLE 105 ON READER-SERVICE CARD

Meters

1 per cent accuracy achieved on a production line basis.

Featuring 1 per cent or better accuracy, these meters are being manufactured on a production line basis. Spring mounted jewel bearings and infinite point suspension system provide ruggedness. High stability is achieved from +85 to —55 C. Military types exceed MIL-M-10304A specifications and withstand shock and vibration specifications of MIL-T-945. Commercial meters are available in 2-1/2, 3-1/2, 4-1/2 in. Square styles, 4-1/2 in. rectangular style in black phenolic plastic cases, and military meters in 2-1/2, 3-1/2, and 4-1/2 in. round steel cases with acrylic plastic windows and front zero adjusting screws, are also available. Military meters are sealed and ruggedized. All meters have a normal overload characteristic of 5000 per cent.

American Metrix Corp., Dept. ED, 40 Haddon Ave., Camden 3, N. J.

CIRCLE 106 ON READER-SERVICE CARD

CIRCLE 107 ON READER-SERVICE CARD

Motor Alternator

Two outputs with waveform distortion of less than 2 per cent

Model MA-3 motor alternator incorporates a conventional hysteresis type synchronous motor driving a pair of permanent magnet alternators through appropriate gearing. The relationship to line frequency of the two output frequencies is determined by proper selection of gearing. Model MA-3 can develop both 90 and 150 cps outputs from a 400 cps input. Outputs are matched to within 0.1 per cent over the temperature range of —55 to +65 C. Wave form distortion is less than 2 per cent. Separate outputs can be synchronized so that the waves have a definite phase relationship to ± 2 deg of one another.

Eastern Air Devices, Inc., Dept. ED, 385 Central Ave., Dover, N.H.

CIRCLE 109 ON READER-SERVICE CARD

Recorder

Traces information instantaneously with 1 per cent accuracy on electrosensitive paper

Model 260 instrumentation recorder presents instantaneously up to eight 11-in. scale traces within 1 per cent accuracy with a transient response of up to 3000 cps. The recorder traces a permanent record of electronic signals on electrosensitive paper which requires no processing and can be reproduced by standard duplicating methods. Recorder accuracy is unaffected by line voltage variations and paper stretch since calibration marks are recorded simultaneously with input signals. Coordinate markers are generated internally and provide 5 per cent amplitude lines and time markers at 1, 0.1, or 0.0167 sec intervals. Provisions are also made for external frequency standards and additional recorder channels if required.

Consolidated Avionics Corp., Dept. ED, Westbury, L. I., N.Y.

CIRCLE 110 ON READER-SERVICE CARD


.924
.540 DIA
.314 DIA

INERTIAL GUIDANCE SYSTEMS IN PRODUCTION

INERTIAL PLATFORM

Lightweight and compact, Kearfott four gimbal inertial platforms are characterized by rapid warm-up and alignment. Suitable for manned aircraft or missile applications.

COMPUTER-AMPLIFIER

For analog or digital data processing. Available with fully transistorized amplifier modules.

PANEL

Display and control panel for pilot reference or ground support equipment.

Other Kearfott systems feature 18 pound, all attitude platforms with 2 minute warm-up time. Examples of compass systems are conventional or roll stabilized directional gyros and all attitude platforms with 0.25°/hour maximum drift rates.

KEARFOTT COMPANY, INC.
LITTLE FALLS, N. J.

Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J. Midwest Office: 23 W. Calendar Ave., La Grange, Illinois. South Central Office: 6211 Denton Drive, Dallas, Texas. West Coast Office: 253 N. Vinedo Avenue, Pasadena, California.

Kearfott

GENERAL PRECISION EQUIPMENT CORPORATION GPE

Shock Tester

Vertical Drop Type

This shock tester will generate with repeated uniformity the 100 g shock test specification over a frequency of 100 to 700 cps. Designated type 1500, the machine will produce a variety of acceleration pulse wave forms, pulse amplitudes, and pulse durations such as saw-tooth, and half sine wave forms. Useful test load is 400 lb max, and drop distance is up to 30 in. The load platform accommodates equipment 30 x 67 in. high.

Barry Controls, Inc., Dept. ED, 935 Pleasant St., Watertown 72, Mass.

CIRCLE 219 ON READER-SERVICE CARD

Clutch System

Mechanical amplification coupled with an electrical transducer provides fast transmission of very large torques.

The model A-100-CP clutch pack is the third component released for production of this company's line of speed clutches and brakes. The one-package combination consists of a mechanical pulse amplifier indexing clutch and an electrical transducer. Operating at high shaft speeds and transmitting a minimum torque of 10 in.-lb, the unit features a predetermined delay of very low value. Mechanical delay is as low as 0.001 sec; and electrical delay is 0.0035 sec, providing a combined delay of 0.0045 sec.

The pack consists of indexing clutch, power pack, servo bracket with mounting hardware, and a nylon link. Choice of an index rate of one, one-half or other fraction of a revolution with the option of clockwise or counterclockwise rotation is possible. High shaft speeds and high speed pulsing of 60 cps in standard units are available with higher speeds available in special designs. The frequency of pulses is determined by the angle for which the clutch is set and the shaft speed, allowing for the known delays.

Digitronics Corp., Dept. ED, Albertson Ave., Albertson, Long Island, N.Y.

CIRCLE 220 ON READER-SERVICE CARD

BREADBOARD KIT.—Uni-chassis kit consists of a heavy gauge chassis of double deck construction prepunched with mounting holes on the upper deck and with a large number of bolt holes on the lower deck. In addition 22 Unileads of plug-in construction are furnished together with 93 assorted terminations.

Kibbey Instrument Co., Dept. ED, P. O. Box 50, Perkins, Calif.

CIRCLE 114 ON READER-SERVICE CARD

SLIP CLUTCH.—A 2-in. long in-line slip clutch has been added to the company's existing line of clutches. Requiring no lubrication, this latest clutch is easily adjusted to transmit from zero to four in.-lb of torque.

Precision Specialties Inc., Dept. ED, 1342 E. 58th St., Kansas City 10, Mo.

CIRCLE 115 ON READER-SERVICE CARD

TERMINAL BOARDS.—Three basic sizes, from 5/16 to 1-1/8 in. wide, of boards scribed for easy separation into fifths have been announced. They are available in paper-base phenolic, a cloth-base phenolic, or in an epoxy glass material.

Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass.

CIRCLE 226 ON READER-SERVICE CARD

INTERNAL TIMER.—The 430 can be supplied with a variety of circuit arrangement, an audible signal, or a hold feature. This particular series is best suited for ranges below 6 hr.

Paragon Electric Co., Dept. ED, Two Rivers, Wis.

CIRCLE 227 ON READER-SERVICE CARD

POWER TRIODE.—Having a plate dissipation of 3 kw, type S736 is designed for use as a modulator, amplifier, or oscillator in a-m, f-m, and TV broadcasting, in high-frequency communications systems, and in induction and dielectric heating equipment.

Central Electronic Mfg. Inc., Dept. ED, Denville, N.J.

CIRCLE 116 ON READER-SERVICE CARD

COOLING FAN.—Model 1H60 is a rack mounted propeller type, measuring 7 in. high, and 9-1/2 in. wide. Equipped with stainless steel grille, the unit delivers 225 cfm.

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

CIRCLE 117 ON READER-SERVICE CARD

MOTOR-GENERATOR LINE.—Available in both portable and stationary models, a typical unit has an input of 220 or 440 v 60 cps, and an output of 37.5 kva, 30 kw, 200/115 v, 3-phase, 4-wire, 400 cps, or 500 amp, 28 v dc.

Ideal Electric and Mfg. Co., Dept. ED, Mansfield, Ohio.

CIRCLE 118 ON READER-SERVICE CARD

MAGNETIC SHIELDING CAPSULES.—Co-Netic shielding capsules have been designed for miniature reactors and transformers used in transistorized and printed circuits. Closer grouping of components is possible due to shielding effectiveness. Shields can be pretinned for soldering.

Perfection Mica Co., Magnetic Shield Div., Dept. ED, 1322 N. Elston Ave., Chicago 22, Ill.

CIRCLE 119 ON READER-SERVICE CARD

UHF-MICROWAVE TELEMETERING EQUIPMENT

by CANOGA

Canoga Corporation has recently developed and is now manufacturing a complete line of transmitting and receiving antennas for communication and telemetering in the 2200 mc region.

The compact blade antenna has been designed for missiles and supersonic aircraft. It is less than 1 inch high, has very low drag, an all metal leading edge, and provides an omni-directional pattern.

The 8 foot diameter horn fed paraboloid weighs only 82 pounds and provides a 4 degree pencil beam for high gain requirements. Polarization is readily changed from horizontal to vertical. The pedestal includes angle scales, a dual speed drive in azimuth and a single speed drive in elevation.

The conical scanner shown below is installed in 6, 8 or 10 foot diameter paraboloids. Optimum reception of telemetering signals even at long range is obtained by automatic tracking with the narrow beam provided. Horizontal, vertical and circular polarization are available.

FOR ADDITIONAL INFORMATION COMPLETE THE COUPON BELOW AND RETURN TO CANOGA.

CANOGA
CORPORATION OF CALIFORNIA
5955 SEPULVEDA BLVD
VAN NUYS, CALIFORNIA

- ☐ ANTENNAS
- ☐ RECEIVERS
- ☐ RADAR SYSTEMS
- ☐ TEST EQUIPMENT
- ☐ MICROWAVE COMPONENTS

NAME AND TITLE ____________________

COMPANY ____________________

ADDRESS ____________________

CITY ____________ STATE ____________

DESIGN, DEVELOPMENT AND MANUFACTURE TO YOUR SPECIFICATIONS

CIRCLE 225 ON READER-SERVICE CARD

TWIN TRIODE.—The 6021 medium-mu type is designed for oscillator and amplifier service in industrial and communications equipment operating at frequencies up to 400 mc. The 6021 can be operated at full ratings at altitudes up to 60,000 ft without the use of pressurized chambers.

Radio Corporation of America, Tube Div., Dept. ED, Harrison, N.J.

CIRCLE 471 ON READER-SERVICE CARD

PHOTO ELECTRIC CONTROL.—The MEK-5500 series is offered as a general purpose control. Specifications include an operating range of 15 ft, relay contacts rated dpdt 5 amp 115 v ac non-ind, and max operations per min of 600.

Machinery Electrification, Inc., Dept. ED, 56 Hudson St., Northboro, Mass.

CIRCLE 124 ON READER-SERVICE CARD

PRESSURE RECORDING SYSTEM.—Model 5770 is designed for applications such as production testing of pressure switches. The system sweeps through a pressure range of 0 to 375 psi and prints out the digital value of pressure at which the pressure switches operate.

Beckman Instruments, Inc., Dept. ED, 325 N. Muller Ave., Anaheim, Calif.

CIRCLE 125 ON READER-SERVICE CARD

MOTOR ANALYZER.—Model 1061 is designed to produce an efficient system for production quality control of electric motors, solenoids, coils, and magnetic materials. Tests are made for opens, shorts, winding errors, reverse connections, hi-spot to ground, and commutator position.

Automatic Development Co., Dept. ED, 2530 N. Naomi St., Burbank, Calif.

CIRCLE 126 ON READER-SERVICE CARD

TRANSIT CASE.—Incorporates a high-strength pressure hinge which provides a means of applying pressure along the hinge-line. Particularly applicable for instrument containers and as pressure-tight shipping cases.

Simmons Fastener Corp., Dept. ED, N. Broadway, Albany 1, N.Y.

CIRCLE 127 ON READER-SERVICE CARD

GEAR KITS AND WORM WHEELS.—Spur gear kits and anti-backlash worm wheels have been included in the company's line of precision gears. The anti-backlash worm wheels are designed to run with stock worms.

Pic Design Corp., Dept. ED, 477 Atlantic Ave., E. Rockaway, N.Y.

CIRCLE 128 ON READER-SERVICE CARD

UHF BLADE ANTENNA.—Type DM-C7 is designed to operate in the 225-400 mc band for use with communication and data link equipment. The antenna is a high-strength swept-back aluminum blade, with height of of 7-3/4 in. from aircraft skin.

Dorne & Margolin, Inc., Dept. ED, 30 Sylvester St., Westbury, L.I., N.Y.

CIRCLE 129 ON READER-SERVICE CARD

GERMANIUM SWITCHING TRANSISTOR.—The MN-19 is designed specifically for high reliability requirements. Typical alpha cutoff is 8 mc, and typical rise time is 0.1 μsec.

Motorola Inc., Dept ED, 4545 W. Augusta Blvd., Chicago 51, Ill.

CIRCLE 132 ON READER-SERVICE CARD

FIXED COMPOSITION CAPACITORS.—Available in 49 different EIA values, series JM cover the range from 0.1 to 18μμf. The capacitors feature operating stability, a moderate Q characteristic, and also design simplicity.

Speer Carbon Co., Jeffers Electronic Div., Dept. ED, DuBois, Pa.

CIRCLE 133 ON READER-SERVICE CARD

CATHODE RAY TUBES.—Type 5AHP7 is a 5 in. round glass, nearly flat face, magnetic deflection oscillograph tube suitable for visual presentation of low speed, non-recurring phenomena, and featuring electrostatic focus. An aluminized version, type 5AHP7 is also available.

Sylvania Electric Products, Inc. Dept. ED, 1740 Broadway, New York 19, N.Y.

CIRCLE 134 ON READER-SERVICE CARD

TOGGLE SWITCHES.—Integral terminal construction and a new step-design case offer ease of wiring and stronger terminals. Series TL include single-pole and two and four-pole circuitry, rated at 20 amps, 30 v dc, resistive load.

Minneapolis-Honeywell Regulator Co. Inc., Micro-Switch Div., Freeport, Ill.

CIRCLE 135 ON READER-SERVICE CARD

COMPOSITION RESISTORS.—Coldite 70+ is a series developed for long load life and moisture resistance. The units are available in 1/2, 1 and 2 w models.

Stackpole Carbon Co., Electronic Components Div., Dept. ED, St. Marys, Pa.

CIRCLE 136 ON READER-SERVICE CARD

CONNECTORS.—A line of connectors for Foamflex and Styroflex cables has been announced. Complete adapters from Foamflex to RG-8A/U, including feed-thru and bulkhead are available. All connectors are pressurized.

Kings Electronics Co., Dept. ED, 40 Marbledale Rd., Tuckahoe, N.Y.

CIRCLE 137 ON READER-SERVICE CARD

CERAMIC POWER TETRODE.—An all ceramic-metal version of the 4X250B, the 4CX250B has greater immunity to damage by mechanical shock and high temperature, lower rf dielectric losses, and greater dimensional stability.

Eitel-McCullough, Inc., Dept. ED, San Bruno, Calif.

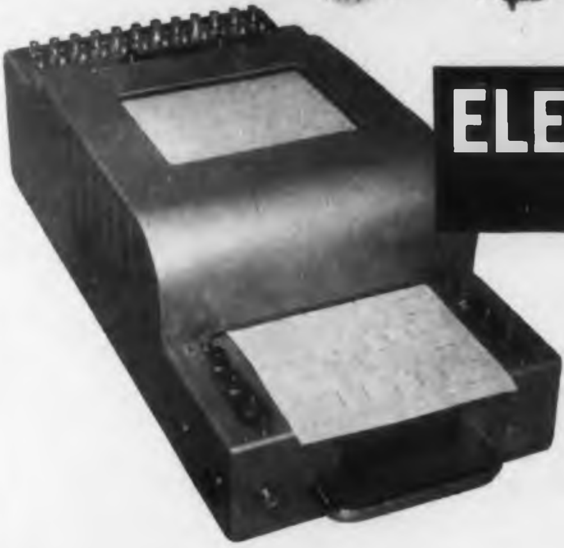
CIRCLE 138 ON READER-SERVICE CARD

MOMENTARY CONTACT SWITCH.—Designed for high-speed, low force switching, Unimax type 2MJK provides dpdt control with application of approximately two-ounce force. The unit is designed for panel mounting in a single 13/32 in. diam hole.

W. L. Maxson Corp., Unimax Switch Div., Dept. ED, Wallingford, Conn.

CIRCLE 139 ON READER-SERVICE CARD

computer time saved with



ELECTROGRAPH

MODEL 420

Visual editing of tape-recorded intelligence through use of Electrograph records saves many hours of valuable computer time.

24-channel Electrophotographic Recording Oscillograph

Now you can edit telemetered tape-recorded information and select the data to be fed into the data reduction computer. As many as 24 channels of tape signals connected to the Electrograph galvanometers through appropriate discriminators may be recorded simultaneously. The analog record is instantly readable as it is discharged from the recorder. Proper keying of the permanent record to the tape permits visual selection of the data to be placed into the computer.

Records produced by the Electrograph are permanent, requiring no further processing, and may be stored indefinitely without loss of trace definition.

For further information regarding the Electrograph, you are invited to write, wire or call for bulletin CGC-311.

Century Electronics & Instruments, Inc.

1333 No. Utica, Tulsa, Oklahoma

CIRCLE 140 ON READER-SERVICE CARD

LOOK TO TOBE FOR PROGRESS

electronic interference filters

TOBE brings unequalled experience to the solving of your filtering problems. TOBE'S advanced design-techniques, and the technical data accumulated by TOBE filter specialists over the years, meet your problems with solutions that are quicker, more efficient, and more reliable. For all your filtering needs, look to TOBE DEUTSCHMANN, the oldest name in interference filters.

TOBE FILTERETTES, available in wide range of ratings, sizes and mounting styles, are engineered to operate under the most severe environmental conditions.

Tobe Exclusives:

Feed-thru capacitor construction in filterettes.

Miniaturization with maximum quality.

Guaranteed attenuation characteristics—under full-load operating conditions.

We invite inquiries on specific applications. The services of our engineers are always available. Write TOBE-DEUTSCHMANN Corporation, Norwood, Mass., the acknowledged authority on electronic interference—manufacturers of "FILTERETTES".

specify TOBE FILTERETTES

TOBE DEUTSCHMANN • CAPACITOR PIONEERS SINCE 1922

CIRCLE 141 ON READER-SERVICE CARD

NEW LITERATURE

Ceramics 142

A 16 page, two color ceramic catalog highlighting high alumina bodies in addition to Steatite, Cordierite, and Zirconite ceramics is available. Included are special sections on standard extrusions, ceramic properties and specifications, and metalizing, plus a clear-cut method of ordering ceramic pieces. Centralab, 900 E. Keefe Ave., Milwaukee 1, Wis.

Repeat Cycle Timers 143

Bulletin sheet AWH RC-301, describes a line of sub-miniature hermetically sealed repeat cycle timers. These timers meet various military specifications such as MIL-E-5272A and can be supplied with radio interference filtering for dc units when required. The bulletin sheet is clearly illustrated, including charts on cycling times, outline and mounting dimensions, approximate weights, and tabulation of the military specifications. A. W. Haydon Co., Waterbury, Conn.

Airfoil Centrifugal Fans 144

This publication is illustrated with photographs showing construction details of airfoil fans for all types of ventilating and air conditioning installations. Comparative performance graphs show why greater efficiency and quieter operations are obtained with fans designed on the "Airfoil" principle than with those having conventional blades.

Capacity tables, dimensional drawings, and suggested arrangements are given for each model of fan. Also included in Bulletin 257 are rating tables on "Long-Life" motors, sample fan specifications, the laws of fan performance, and other data useful in engineering ventilator installations. Ilg Electric Ventilating Co., 2850 N. Pulaski Rd., Chicago 41, Ill.

Reliability Controls 145

This publication is a check list for reliable controls and contains capsule information on a line of relays, thermostats, rotary switches, range switches, motor controls, and "snap-ins." It is designed to provide engineers and purchasing agents with facts about controls for air conditioning, aircraft, appliances, automation, electronics, guided missiles, machine tools, panel boards, and similar applications. The check list also contains a business reply card for the use of those who would like more complete information. Hart Manufacturing Co., 110 Bartholomew Ave., Hartford, Conn.

Stainless Fasteners 148

An eight-page condensed guide to stainless steel fasteners normally carried in stock is now available. Thirty-seven different types of standard fasteners are illustrated in the comprehensive two-color brochure. Screws, nuts, bolts, washers, rivets, and government specification "AN" fasteners are included. Allmetal Screw Products Co., Inc., 821 Stewart Ave., Garden City, N. Y.

Printout Frequency Indicator 149

Frequency Indicator, model 7341B, with printout, provides the first economical answer to frequency, velocity, and rpm measurement problems requiring continuous monitoring and printed readings. It is described in a catalog sheet now available. The sheet gives the design operation data, plus complete specifications. Electro Pulse, Inc., 11861 Teale St., Culver City, Calif.

Panel Meters 150

The styles and ranges of panel meters in sizes from 2-1/8 to 7-1/4", are shown in 4-page catalog C-22 now available. The catalog is well-illustrated and has complete specifications on all dc types, includes dimensional diagrams, typical scales and data charts. Featured are three clear plastic models: 212P, 250P, 725P. Ideal Precision Meter Co., Inc., 126 Greenpoint Ave., Brooklyn 22, N. Y.

Relay Symposium Papers 151

Papers presented at the Fifth National Conference on Electromagnetic Relays, Oklahoma State University, Stillwater, Oklahoma, have now been made available in a 132 page booklet. The papers were presented by authors representing relay users, manufacturers, universities, and government agencies, and are complete with tables, graphs, diagrams, and illustrations. Potter & Brumfield, Inc., Princeton, Ind.

Paper Capacitors 152

Now available is a copy of the Engineering Bulletin No. 2000 on series AG paper tabulars made to preferred number capacitance values of the EIA. As a result of an improvement in end seal design construction, we have found it possible to shorten the length of all capacitors of this general design. The new sizes are shown in Bulletin No. 2000. Sprague Electric Co., North Adams, Mass.

DELAY LINES

standard or specially designed

BY TECHNITROL

These extra-compact delay lines assure a minimum of pulse distortion with maximum stability under ambient temperatures . . . and in a minimum of space. They can be had pencil-thin in plug-in, pig tail or fuse-clip mounting. Available cased or dip-coated in epoxy resin as well as hermetically-sealed units for military application . . . with any desired characteristics of impedance or frequency response. Typical are:

- **Delay: 0.01 to 6 μs**
- **Characteristic Impedance: 400 to 5600 ohms**
- **Band Pass Characteristics: Unique windings furnish maximum band width for given delay per inch.**

We are prepared to design lumped constant or distributed constant delay lines for your particular circuit applications.

Write today for Bulletin ED 174

TECHNITROL
ENGINEERING COMPANY
1952 E. Allegheny Ave., Phila. 34, Pa.

CIRCLE 153 ON READER-SERVICE CARD

LAPP ENTRANCE INSULATORS

. . . moderate and heavy duty types
. . . low voltage and apparatus types

A design which uses air as major insulation, with leakage path lengthened by forming porcelain into a bowl, eliminates losses which occur in ordinary types of bushings at radio frequency.

Lapp moderate duty insulators, suitable for a variety of low or medium voltage applications, are the standard type bowls for carrying leads through shields, equipment cases, walls, etc., and practically any indoor use where duty is not too severe.

Outdoor units are designed with corrugated surfaces which provide extra leakage distance for use in contaminated atmosphere. Corrosion-resistant hardware.

A wide variety of types of these insulators is now available as catalog items . . . or where requirements necessitate, on special design—for which Lapp engineering and production facilities are excellently qualified. Write for complete descriptive data and specifications. Lapp Insulator Co., Inc., Radio Specialties Division, 104 Sumner Street, Le Roy, N. Y.

Lapp

CIRCLE 154 ON READER-SERVICE CARD

NEW LITERATURE

Cabinet Racks 155

A catalog which contains illustrations, descriptions, technical specifications, and prices of universal cabinet racks and utility desk assemblies is now available. This 28-page catalog describes the 30 in. wide panel racks which are furnished with solid side walls, with open side walls, with front and rear doors, or with rear door only. Par-Metal Products Corp., 32-62 49th St., Long Island City, N.Y.

Resistance Thermometers 156

A 15-page booklet, entitled "How to Use Platinum Resistance Thermometers in Temperature Measurement, Telemetry, and Control," is now available. This report is believed to be the first compilation of information on platinum resistance thermometers into a single booklet. The basis for temperature measurement with platinum and some of the reasons why platinum has been adopted as an international temperature standard are set forth. Various types and characteristics of specific resistance thermometers are described. Trans-Sonics, Inc., Burlington, Mass.

Electronic Components 157

A 12-page catalog and a price list of an entire line of imported and American-made miniaturized components plus specialty and audio items is being made available. The catalog lists transistor transformers, miniature broadcast frequency tuning capacitors, a large group of transistor antenna, rf, oscillator, and i-f coils, electrolytic capacitors, and many other items. Argonne Electronics Mfg. Corp., 165-11 South Rd., Jamaica 33, N.Y.

Plastic Properties Chart 158

Comparative properties of Lexan polycarbonate resin and other thermoplastic molding materials are outlined in a Plastics Properties Chart. Other test data listed includes electrical and physical properties, as well as molding characteristics. General Electric Company, One Plastics Ave., Pittsfield, Mass.

Telemetering Equipment 159

This 30 page catalog describes and pictures a product line of transducers, telemetering oscillators, digital strain gage indicators, servo converters and automatic data logging instruments. Included are specifications and applications data useful both in military and commercial activities. Datran Electronics, 3615 Aviation Blvd., Manhattan Beach, Calif.

Gold Plating Electronic Parts 162

Reprints of an article recently published by William F. Boyle, Chief Metallurgist, tell how a patented gold plating process has affected savings in the finishing of various electronic parts, over methods previously used. According to Mr. Boyle's article, the gold plating process prevents corrosion, gives an extremely hard surface, is a fine electrical conductor, and is relatively inexpensive to apply. Also discussed are the results of various destructive tests to which the gold plate was subjected, costs as compared to other precious metals electro-plate, equipment required and a step-by-step procedure for bath preparation, operation, maintenance and control. A section treating a typical plating cycle lists the chronological steps which assure best possible results. Sel-Rex Corp., Nutley 10, N.J.

Shield Grounding Samples

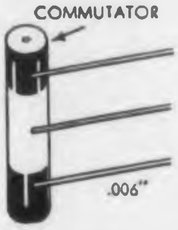
This sample board was planned to provide actual samples of various standard sizes of braid. Samples range in size from 1/8 in. to 11/16 in., plus samples of military braid in widths from 1/16 in. to 1/2 in. *To obtain this sample board, write on letterhead stationery to Lenz Electric Mfg. Co., 1751 N. Western Ave., Chicago 47, Ill.*

Electrolytic Grinding 163

Copies of a speech describing the electrolytic grinding of high grade alloys have been made available. The speech was given by Lynn A. Williams before the Metal Removal Seminar of the 1957 SAE Aircraft Production Forum held in Los Angeles on Sept. 30, 1957. Mr. Williams groups the problems of machining the high alloys into three general classes: problems resulting from heat or cold working; problems caused by tearing the metal apart or by not presenting a rigid machining surface, and cutter and tool problems. Exploration of these problems in the light of the applications of electrolytic grinding to the high alloy materials is made. Anocut Engineering Co., 631 W. Washington Ave., Chicago 6, Illinois.

Tape Wound Cores 164

Illustrated and described in a two-color, 8-page catalog are tape wound cores of high uniformity produced in commercial quantities. The catalog describes the three types of core materials from which the precision-made tape wound cores are manufactured. Test procedures are illustrated and described, standard test limits are given in chart form and graphs. The catalog also contains information on protective boxes, vibration and shock procedures, standard and special core sizes. G-L Electronics, 2921 Admiral Wilson Blvd., Camden 5, N.J.



COMMUTATOR
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Silicon Rectifier Circuit Protects DC Meter up to 1000 Times Rated Current

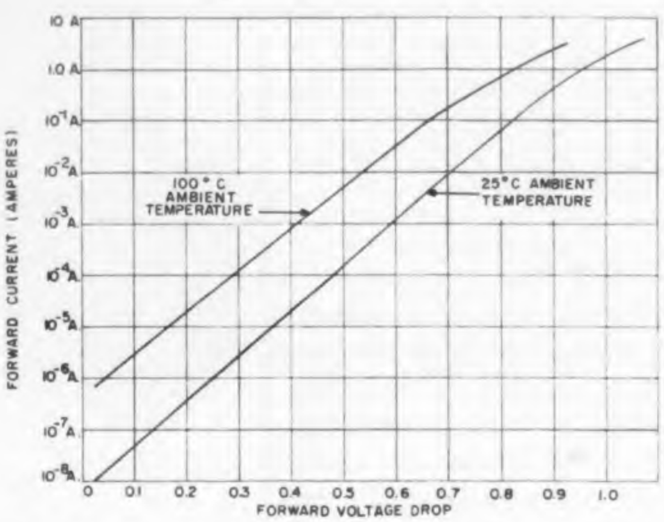


Fig. 1. Typical forward characteristic of G. E. IN536 silicon rectifier.

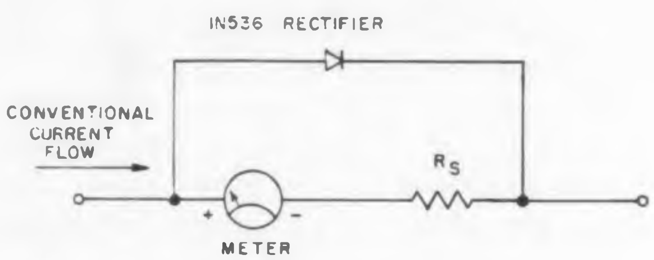


Fig. 2. Ammeter protective circuit employing silicon rectifier.

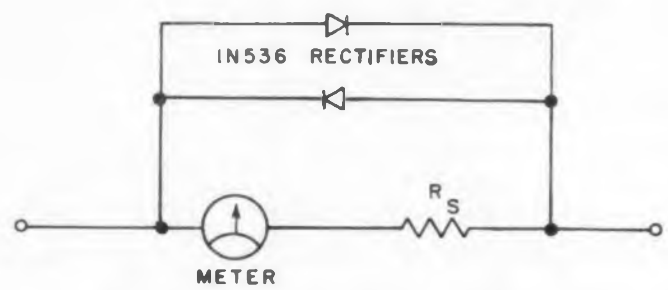


Fig. 3. Protective circuit for zero-center galvanometer.

THE SIMPLE combination of a low voltage silicon rectifier and a resistor can eliminate expensive dc meter burnouts and a plague of bent indicating pointers. In control circuits and in test equipment where the frequent possibility of shorted load circuits exists, this protective circuit clamps meter current to two or three times normal at overloads up to thousands of times full scale current. The effect on meter accuracy is 1 per cent or less at full scale, considerably less at lower currents.

The Circuit

The circuit employs the unique forward characteristic of a typical silicon rectifier, the 1N536, as shown in Fig. 1. The forward voltage drop below one ampere for this particular rectifier is essentially proportional to the logarithm of the current over a range of approximately 100 million to one.

A rectifier of this type is shunted across the ammeter in the direction of easy conduction, and a proper resistance is inserted in series with the meter to bias the rectifier for optimum protection as shown in Fig. 2.

The value of series resistor R_s is determined as follows:

$$R_s = \frac{V_{RI}}{I_{FS}} - R_M \qquad (1)$$

Where: V_{RI} = Forward voltage drop of rectifier at shunted current permissible at full scale meter reading (volts).
I_{FS} = Full scale meter current (amperes)
R_M = Internal resistance of meter (ohms)

Design Example

For example, assume the meter has a full scale deflection of 1 ma, that its internal resistance is 80 ohms, that the circuit will operate in room ambient, and that the maximum error that the rectifier may introduce on the meter is 1 per cent. Since the maximum percentage error introduced will be at full scale, the maximum shunted current allowable through the rectifier will be 0.01 x 1 ma or 10^{-5}a, V_{RI} at 10^{-5}a is 0.37 v at room temperature on Fig. 1. Using Equation 1, R_S = 0.37/0.001-80 = 290 ohms. With this resistance inserted in the circuit, 99 per cent of the load current will flow through the meter when 1 ma total flows in the circuit. At load currents less than 1 ma, accuracy will be considerably better than 99 per cent. Where necessary, increased accuracy can be attained by selecting a lower V_{RI} in the above equation. This will lower the degree of protection somewhat.

At 1000 times full scale current, or 1, the rectifier will draw practically all of the current. The current flowing through the meter, I_{OL}, under these conditions can be very closely approximated with the following equation:

$$I_{OL} = \frac{V_{R2}}{R_M} + R_s \qquad (2)$$

Where: I_{OL} = Current through meter under overload conditions (amperes)
V_{R2} = Forward voltage drop of rectifier at overload current (volts). Determine from Fig. 1.

At 1 a, V_{R2} is 0.95 v. Using Equation 2, I_{OL} = 0.95/80+290 = 2.57 ma, or slightly over 2-1/2 times full scale current. Thus, even at a 1000 fold

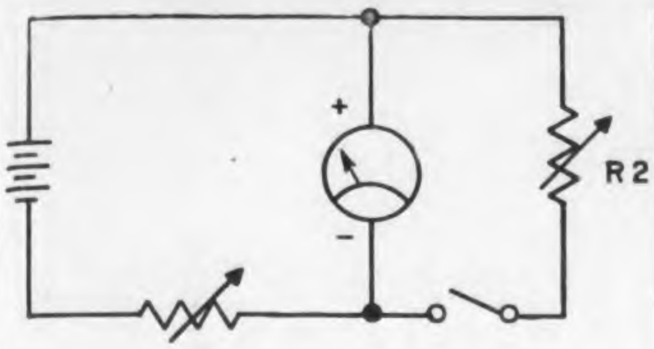


Fig. 4. Circuit for determining internal resistance of ammeter.

overload, meter current does not reach destructive proportions.

Broad Applications

Because of its broad current range, the 1N536 may be used to protect current indicating instruments from the microammeter range through into the hundreds of milliamperes. The upper current limit on use of a silicon rectifier is based on the maximum temperature rise of the junction. Thus, the 1N536 is limited to 900 ma continuous dc current at 25 C ambient and 600 ma at 100 C ambient. The worst overload condition that can be satisfactorily handled will be limited by these values. Above this limit, silicon rectifiers of higher ratings are available with similar characteristics so that even high current meters using shunts can be protected at costs very reasonable when compared to the cost of the meters being protected, provided that 0.4 to 0.5 v additional circuit drop is not objectionable. For shunt-type meters, the rectifier and resistor should be connected outside of the shunt and meter connections if maximum accuracy is to be achieved.

Illustrated in Fig. 3 is how zero-center galvanometers may be protected by shunting two rectifiers in opposite directions across the meter and series resistor.

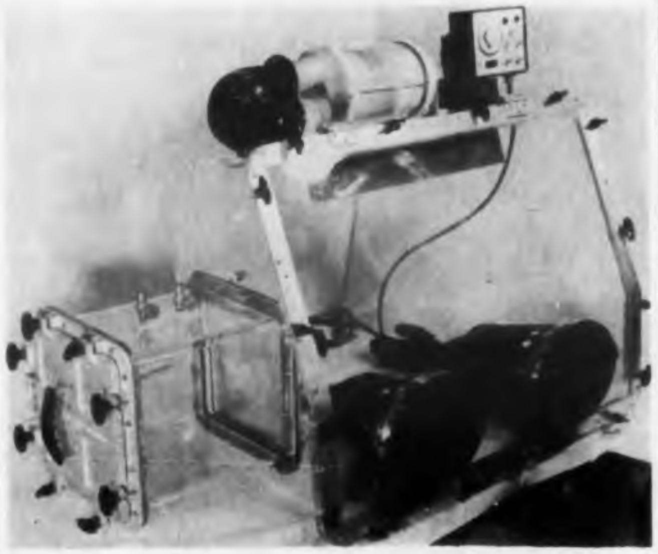
For ambient temperatures between 25 and 100 C, linear interpolation of the characteristics in Fig. 1 may be satisfactorily used.

When the internal meter resistance is not given on the face of the meter or in meter catalog information, it may be satisfactorily determined for these purposes by the following time-honored method illustrated in Fig. 4.

1. Connect the meter in series with adjustable resistance *R1* across a constant dc voltage 6 v or higher.
2. Adjust *R1* so that the meter reads full scale.
3. Connect adjustable resistance *R2* across meter terminals.
4. Adjust *R2* so that meter reads half-scale.
5. Resistance of meter will then be equal to *R2*.

F. W. Gutzwiller, Application Engineer, General Electric Co., Semi-conductor Products Dept., Syracuse, N.Y.

Materials Change Cuts Costs by Two-Thirds



Controlled atmosphere enclosures manufactured by Controlled Atmosphere Enclosures Corp. as redesigned from stainless steel to cast acrylic plastic sheet. This not only reduced cost but achieved functional advantages as well.

By substituting cast acrylic sheet and tube for stainless steel, a Long Island manufacturer of scientific equipment cut his costs by two-thirds. He improved the performance and utility of his product in numerous respects and was better able to maintain delivery schedules.

Controlled Atmosphere Enclosures Corporation, 230-11 141st Avenue, Springfield Gardens 13, Long Island, New York, manufactures hermetically sealed dry boxes and research enclosures for research and assembly operations where an atmosphere protected from humidity, dust or other contaminants is required (see figure).

Redesign Cuts Cost

Hitherto most such apparatus has been made from stainless steel, with the exception of the detachable front panel which was of glass. This involved a problem of material scarcity, high initial cost of the stainless sheet and high fabrication costs. In addition, the stainless steel seams were soldered, presenting the possibility of a leak during the life of the apparatus.

The Long Island firm now forms its enclosures from a single sheet of 3/8 in. clear Plexiglas cast acrylic. In the same operation, a shallow groove is formed in the front edges of the enclosure walls. Into this groove fits the unique gasket which assures the absolute sealing of the enclosure—a continuous length of vinyl tubing inflated to 20 lb pressure. The detachable front plate of the enclosure, also of 3/8 in. clear Plexiglas, is clamped over the tubing by phenolic clamps. The pressure of the clamps is distributed uniformly by the inflated tube to assure an even seal along the entire edge.

A unique feature is a transparent square air lock, with hermetically sealed doors, for safe transfer into or out of the controlled environment. This is made from a length of 10 in. Cadco cast acrylic tube (1/4 in. wall) which has been re-formed into a square shape to provide a flat work surface.

Since the air-lock body is formed of one piece, there are no seams to check for possible leakage and the rounded corners afford ease in cleaning. The air lock is strong enough to withstand complete evaluation of the air, which is necessary to prevent contamination of the already controlled atmosphere in the hood during transfer. Contamination of the outside air is also avoided by exhaust valves on the air lock.

Other Advantages

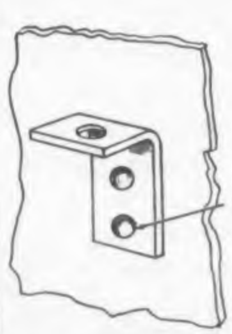
Aside from cost and availability of material, the advantages of the all-acrylic enclosures are these: there are no seams to check for possible leakage; the complete transparency is an advantage for the many minute operations which are performed within the enclosure; the rigidity and dimensional stability of cast acrylic are assurance against deforming of the flat work surfaces, even under rough treatment; the cast acrylic tube and formed sheet will withstand up to 150 psi and are resistant to most common chemicals.

In radioactive operations, the acrylic enclosure provides protection against low gamma and beta radiations.

Short Cut to Metal Fabrication

To save weight, reduce fabrication time, and cut cost of airborne sheet metal chassis or cabinets, this modification for sheet metal clips or brackets can often be made.

R. G. Clark, Mechanical Engineer, Radio Corporation of America, Camden, N. J.



Usual Method

New Method

Non-destructive Transistor "Punch-Thru" Test

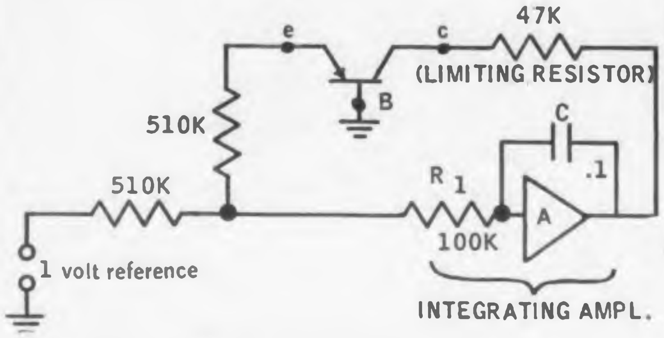


Fig. 1. Circuit for non-destructive determination of "punch-thru" voltage.

A non-destructive means of determining the punch-through voltage of transistors was needed. The circuit shown (Fig. 1) resulted.

Circuit Analysis

In this circuit an applied collector-to-base voltage is automatically brought to the punch-through value for the particular transistor under

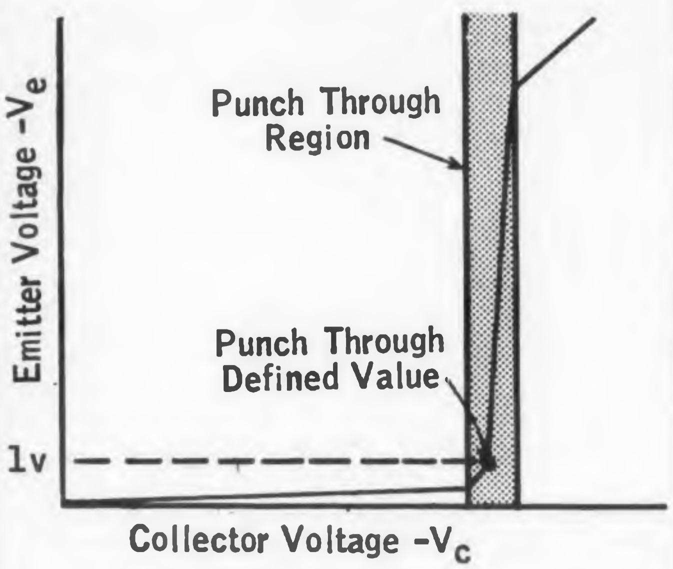


Fig. 2. Typical emitter-collector characteristic showing "punch-thru" region.

test. *Vc* is not an exact voltage but covers a slight range (due to the finite slope of *Ve* at punch-through, Fig. 2). Punch-through voltage will be defined as the collector-to-base voltage, *Vc*, (+ or — depending upon whether the transistor is n-p-n or p-n-p) for which 0.1 v (of same polarity as *Vc*) will appear across *R*.

The principle of operation is as follows: The input voltage to the integrating amplifier, *Vi*, is a function of the l-v reference (which is positive for p-n-p transistorized negative for n-p-n tran-

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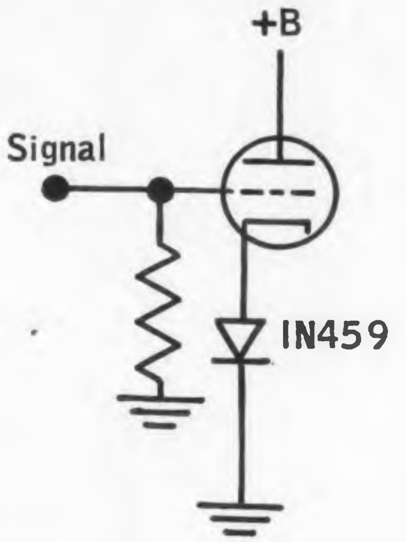
sistors) and the emitter voltage, Ve. Prior to punch-through, Vi is about 1/2 v and Ve is essentially only slightly above zero, and with the polarity of the reference voltage. As long as Vi is above zero, the output voltage of the integrating amplifier rises (with phase inverted), thereby increasing Vc until punch-through occurs. At this time $Ve = 1$ v of opposite sign than the reference voltage, and $Vi = O$. Here the integration ceases and the integrating amplifier holds Vc at the defined punch-through value.

The integrating amplifier utilizes a Philbrick K2 operational amplifier.

Manuel Bardash, Engineer, American Bosch Arma Corp., Garden City, N. Y.

A Novel Low-Frequency Cathode By-Pass Arrangement



Diode replaces cathode resistor and its associated by-pass capacitor.

By-passing was needed for the cathode resistor of a 12AT7 for very low frequencies (1 to 10 cycles). Standard capacitors were too large; tantalytics were too expensive; electrolytics were not satisfactory over the temperature range required and were not sufficiently reliable; and no negative supply was available for fixed bias.

The solution was to use a silicon diode as the cathode resistor. This arrangement approaches fixed bias and avoids all the objections to capacitors listed above. By-passing is effective down to dc. The effective degeneration resistance in the cathode is the dynamic resistance of the diode (about 5 ohms for the one used). The effective bias is approximately 0.6 v. For various bias levels, diodes may be added in series.

R. B. Hirsch, Engineer, Instruments for Industry, 150 Glen Cove Rd., Mineola, N. Y.

REPORT BRIEFS

Application of Kramers' Theorem

Kramers' theorem is discussed from the matrix point of view. A proof of the theorem is presented for a single atom. The methods of the proof are then applied to many atom systems. It is shown that lifting of Kramers' degeneracy by interatomic multiple interactions in crystals is a consequence of the enlargement of the system to include an even number of particles, rather than a consequence of the nature of the interaction. *Application of Kramers' Theorem to Many Atom Systems, by A. G. Mencher, M. Sachs and R. Satten, California University, Dept. of Engineering, Los Angeles, Calif., Apr. 1955, 20 pp, microfilm $2.40, photocopy $3.30. Order NB 124093 from Library of Congress, Washington 25, D. C.*

Diffraction by an Aperture

The diffraction of a wave by an aperture of any shape in a thin screen is treated by a new method, called "the geometrical theory of diffraction," because it is an extension of geometrical optics which accounts for diffraction. In this method new rays, called diffracted rays, are introduced. They are produced when an incident ray hits the edge of the aperture, and they satisfy the law of diffraction. A field is associated with each ray in a quantitative way, by means of the optical principles of phase variation and energy conservation. In addition "diffraction coefficients" are introduced to relate the field on a diffracted ray to that on the corresponding incident ray. *Diffraction by an Aperture, I, by Joseph B. Keller, New York University, Institute of Mathematical Sciences, Division of Electromagnetic Research, June 1956, 73 pp, microfilm $4.50, photocopy $12.30. Order PB 125232 from Library of Congress, Washington 25, D. C.*

Project Vanguard Minitrack

The "Minitrack" system for tracking an artificial earth satellite, which has been developed as a part of Project Vanguard, is described briefly, and the phase measurement portion of this system is described in detail. *Project Vanguard Report No. 18: Minitrack Report No. 1: Phase Measurement, by C. A. Schroeder, C. H. Looney, Jr. and H. E. Carpenter, Jr., U. S. Naval Research Laboratory, July 1957, 31 pp, $1.00. Order PB 131220 from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.*

Retarding-Field Oscillator Design Guide

This manual was prepared to expedite design for production of retarding-field oscillators operating over ranges of frequencies. Dimensions, construction details, and drawings of parts for the basic oscillator are included, along with discussions of operating principles and theory of the oscillator. Also treated are the Heil gun prototype, power-coupling systems, resonator structure, repeller, and other parts of the standard oscillator design. Frequency limitation is discussed, and design data for specific frequency ranges with performance characteristics at high and low frequencies are provided. Construction techniques involving hobbing methods, brazing, and preparation of cathodes by compressing properly proportioned mixtures of nickel powder and the carbonates of barium and strontium are described. It is shown that tubes with nickel matrix cathodes reduce more power output at the same beam current than the same structures using oxide-coated cathodes. *Design Guide for the Retarding-Field Oscillator, E. M. Boone, Ohio State Research Foundation, May 1957, 185 pp., $4.75. Order PB 131201 from OTS, U. S. Dept. of Commerce, Washington, D. C.*

Helicopter Instrumentation

This volume reports a phase in development of an instrumentation system which would permit precise hovering of a helicopter under adverse weather conditions. Effectiveness of three display systems in an analog simulation of the aircraft in the hovering phase of flight were evaluated. The systems were: Conventional, where helicopter attitude and groundspeed were displayed on separate indicators; Integrated, where attitude and groundspeed combined into a single display; and Quickened, where attitude and other derivatives summed to a single indication of groundspeed through feedback circuitry. The operator was to minimize translational motion while subject to simulated gust disturbances. Among the results it was indicated that the Quickened system was consistently superior in hover precision. Integration of attitude and ground rate information on a single display brought greater precision than separate display. Results of the comparative effect on each display system resulting from imposing control of heading on each test condition are also reported. *Comparative Evaluation of Three Approaches to Helicopter Instrumentation for Hovering Flight, J. S. Sweeney, A. W. Bailey, and J. F. Dowd, Naval Research Laboratory, June, 1957, 34 pp, $1.00. Order PB 121979 from OTS, U. S. Department of Commerce, Washington 25, D.C.*

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2BB-18 2BB-24 2BB-30 2BB-36	2BB-AL-18 2BB-AL-24 2BB-AL-30 2BB-AL-36	2BB-BNC-18 2BB-BNC-24 2BB-BNC-30 2BB-BNC-36	18" 24" 30" 36"	Shielded microphone cable. Polyethylene insulation. Vinyl jacket.	Gray	25
2BC-18 2BC-24 2BC-30 2BC-36	2BC-AL-18 2BC-AL-24 2BC-AL-30 2BC-AL-36	2BC-BNC-18 2BC-BNC-24 2BC-BNC-30 2BC-BNC-36	18" 24" 30" 36"	Coaxial shielded cable. Polyethylene insulation. Vinyl jacket. RG58C/U.	Black	28.5

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Beryllium copper heat treated spring contact, for long life and low contact resistance. Finish, silver plate, gold flash. Extra flexible polyvinyl insulated wire, 20 gauge. Stranding 41 x 36 T. C. Wire lead securely solder-bonded to assembly. Plug body molded with polyethylene. Compact size, extended height above jack, 7/8", diameter 1/4".

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REPORT BRIEFS

Resonance in Infinite Gratings of Cylinders

The diffraction by a grating is examined (for spacing large compared to wavelength and dimension of grating element) for wavelengths in the neighborhood of the "Rayleigh" wavelengths. The shape of the elements, and their size in wavelengths is unrestricted. The results, including the effect of interaction, are expressed in terms of quantities relating to single scattering. Some properties of certain determinants formed from single scattered amplitudes are derived. The results are compared with those obtained by other authors, using various restrictions on the parameters. *On Resonance in Infinite Gratings of Cylinders, by S. N. Karp and J. Radlow, New York University, Institute of Mathematical Sciences, Division of Electromagnetic Research, New York, N. Y., April 1956, 42 pp, microfilm $3.30, photocopy $7.80. Order PB 125225 from Library of Congress, Washington 25, D. C.*

Human Engineering Handbook

This report contains data on the size and shape of the hand covered by various Army cold-weather handwear. It was intended for use by engineers and designers in the design and sizing of hand-operated equipment. The criteria employed was the hand size of 95 per cent of Army personnel. The information is presented in illustrations with index scales, enabling measurement of dimensions on the picture and reference to the index scale to establish actual size. *Quartermaster Human Engineering Handbook Series II:—Dimensions of the Upper Limit of Gloved Hand Size, J. L. Kobrick, Quartermaster Research & Development Center, U. S. Army, Dec., 1956, 198 pp, $5.00. Order PG 131192 from OTS, U. S. Department of Commerce, Washington 25, D.C.*

Nonmetallic Ferromagnets

This report reviews a phase of the Air Force's program for development of improved electronic components in general and nonmetallic ferromagnetic materials in particular. The work described had two objectives: measurement of microwave ferrites produced earlier; and conception and initial development of applications for the materials. The theory of ferrites was treated qualitatively and semiquantitatively. Considerable attention was given to the measurement of the permeability tensor components, and a technique was developed for precise comparison of ferrite characteristics at X-band frequencies. A number of ideas were advanced for ultimate production of finished devices. These included use of a microwave duplexer with a ferrite gyrator and two 3 db hybrid couplers, and an electrically tunable cavity useful for wider range of klystrons. *Non-metallic Ferromagnetic Materials: Part VII-Microwave Ferrites, H. C. Rothenberg and E. B. Mullen, General Electric Co. for Wright Air Development Center, U. S. Air Force, Dec., 1955, 49 pp, $1.25. Order PB 131053 from OTS, U. S. Department of Commerce, Washington 25, D.C.*

Visual Changes

Problems of deterioration in performance occurring when observers are required to spend long periods of time in some form of visual observation are reviewed. The study was based on the literature on visual work, and the principles derived can be applied to problems of radar observation. Two different types of prolonged observation are contrasted and the types of impairment resulting from them are identified. One type is the vigilance task, or one involving search for infrequently occurring signals. The other is the active task, which involves the continuous use of the oculomotor system and requires more or less continuous mental operation. *Changes in Visual Performance after Visual Work, J. Deese, Johns Hopkins University for Wright Air Development Center, U.S. Air Force, Apr., 1957, 29 pp, $.75. Order PB 131258 from OTS, U. S. Department of Commerce, Washington 25, D.C.*

Industry Planning for Emergency

Proceedings of a conference of industry executives on the problems which might confront industrial management and the nation in the event of an enemy attack have just been published. The volume is available to the public through the Office of Technical Services, U. S. Department of Commerce.

At the conference, 38 high-level industry officials discussed what has been done, is being done, and should be done to insure continuity of industrial production, management, and supply during a national emergency. The meeting was held in February, 1957 under auspices of the Business and Defense Services Administration, U. S. Department of Commerce. *Industry Planning for the Continuity of Production in the Event of Enemy Attack, Business and Defense Services Administration, U. S. Dept. of Commerce, Feb., 1957, 36 pp, $.50. Order PB 131300 from OTS, U. S. Department of Commerce, Washington 25, D.C.*

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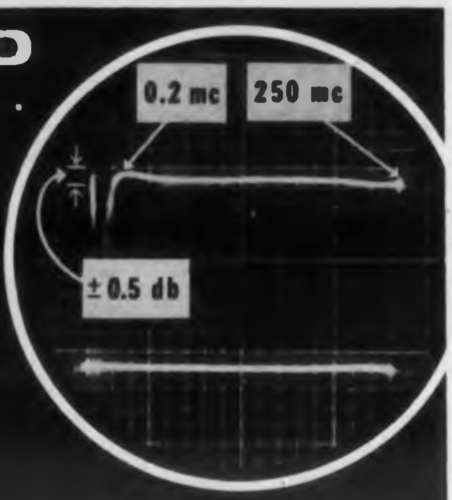

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Center frequency continuously variable from 275 MC to 900 MC. Sweep Width continuously variable from a minimum of 0.1 MC, at any center frequency setting, to a maximum of 100 MC at a center frequency of 275 MC, and to a maximum of 300 MC at a center frequency of 850 MC.

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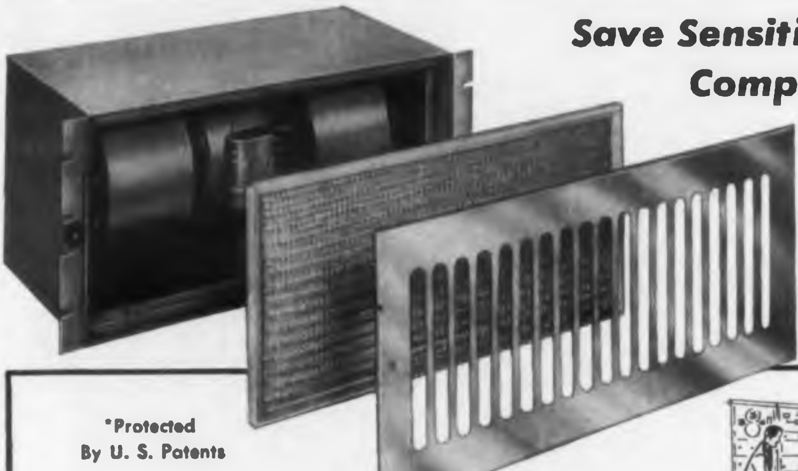

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PATENTS

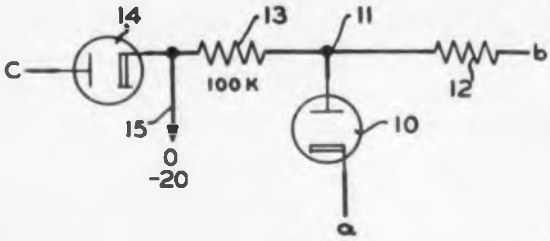
Diode Logic Circuits

Patent No. 2,797,318. Walter S. Oliwa. (Assigned to Monroe Calculating Machine Company)

Switching circuits of the type known as diode logic circuits are used extensively in electronic computers. Because of the complexity of computers, circuits which are known as building blocks have been used for performing a logical process. These building block circuits operate usually on two potentials, one of which potentials is a designation of one and the other of zero. The output of such a circuit is one of the two potentials. The diode circuits which have been used in performing such logical processes have certain advantages which have been overbalanced by the difficulty of coupling them together in order to secure a series of logical processes. In other words, the cascading of the diode circuits was made on a multi-level basis rather than on the single signal level.

The circuits disclosed in the patent uses the building block diode logic circuit which perform a large number of logical processes and on a single signal level.

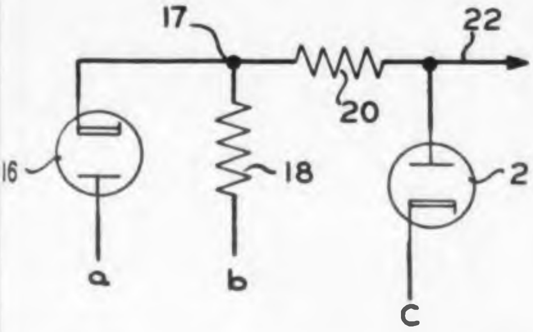
The circuit disclosed in Figure 1 is a basic diode circuit which responds to a formula which may be expressed as a and b or c results in a high potential output. In other words, this circuit results in a high output at 15 when the inputs a and b are simultaneously high no matter what the potential of c, or results in a high output at 15 when the input c is high no matter what the potential input of a and b. Diode 10 and resistor 12 constitutes an "and" circuit and diode 14 and resistor 13 constitutes



an "or" circuit. These inputs *a*, *b*, and *c* may be either zero potential or —20 potential. With this circuit the following combination of inputs of *a*, *b*, and *c* results in an output as designated where high (H) indicates zero potential and low (L) of —20 potential.

Input a	Input b	Input c	Output line 15
L	H	H	H
H	L	H	H
L	L	H	H
H	H	L	H
L	H	L	L
H	L	L	L
L	L	L	L

Figure 2 illustrates a circuit which responds to the logical equation a or b and c results in a high or low output at 22. In this basic circuit diode 16 and resistor 18 is an "or" circuit and diode 21 and resistor 20 is an "and" circuit. With this circuit the application of the following inputs at the designated points results in an output as shown in the following chart where again H is represented by high or zero potential and L represents a low or —20 potential.



Input a	Input b	Input c	Output line 15
H	H	H	H
L	H	H	H
H	L	H	H
L	L	H	L
H	H	L	L
L	H	L	L
H	L	L	L
L	L	L	L

For more complex logical equations, these basic circuits are cascaded and two circuits are illustrated which respond to more complex equations. In the basic and more complex circuits, the resistors are of equal value which is advantageous in that it permits a shorter RC time for the entire circuit then has been possible with the multilevel circuits heretofore used which consists of resistors which increase in magnitude from stage to stage. The value of the resistors are determined from the source impedance of the circuit inputs.

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THE DAY OF RADIO

In the last issue of ELECTRONIC DESIGN we reported on the All-Union Scientific Session of the A. S. Popov Scientific-Technical Society for Radio Engineering and Electric Communication. Some 2000 scientists and engineers from Russia's largest cities, and from Bulgaria, Hungary, East Germany, China, Poland, and Czechoslovakia, in addition to representatives of the IRE, attended the sessions in Moscow May 20-25, 1957.

In that issue (ED, January 22, 1957), we presented the highlights of papers of major intertest to electronic designers. We covered the sessions on Information Theory, Semiconductors, and Radio Wave Propogation.

In these pages, we are continuing our coverage of these important sessions with a presentation of the highlights of the sessions on Receiving and Transmitting Equipment, Antenna Apparatus, Wire Communication, and General Radio Engineering.

What The Russians Are Writing and Saying

J. George Adashko

SESSION ON RECEIVING AND TRANSMITTING EQUIPMENT

A paper by D. V. Ageev, V. V. Malanov, and K. P. Polov reports on an investigation of a new method of realizing the pulse principle of power amplification at audio frequencies; this method is free of the shortcomings of previously-proposed versions.

S. I. Tetel'baum noted in his paper that the optimum amplitude-phase modulation, proposed in U.S.S.R. in 1939, makes it possible to double the bandwidth of the broadcast signal compared with ordinary amplitude modulation. Normal reception is insured in this method with the aid of radio-receivers designed for ordinary amplitude modulations. It was recommended by the section that this system be tried out soon in one of the Kiev radio broadcasting stations.

A. A. Gorbachev proposed new converters, of the tuned type, for the frequency spectrum of pulse noise, and investigated conversion of the shape of the frequency spectrum of pulsed noise passing through the first linear converter and a variable-threshold amplitude limiter.

A paper by Iu. I. Medvedev was devoted to the method of suppressing pulse noise by disconnecting the low frequency channel of the receiver during the action of the noise and using linear signal spectrum converters before and after this switching operation.

In a paper by Z. I. Model', "Auto-Anode Modulation (AAM) in Short Wave Transmitters" he considered a new method for calculating frequency distortion in transmitters based on the analogy of AAM with the parallel type of anode modulation. The possibility of effecting AAM with nonlinear distortion less than 10% was considered. The use of AAM was proposed for professional shortwave transmitters. (This method, apparently a Soviet innovation, was first proposed by N. G. Kruglov.)

The paper by S. S. Geints contained a description of a balanced anode modulation circuit developed by the lecturer and put into operation in a toll-line shortwave transmitter.

Iu. K. Moiseev devoted his paper to problems of fluctuation noise in receivers, to interstation intereference, and to acoustic noise on the intelligibility of speech in telephone channels of uhf radio stations.

In a paper "Wide Band Transistor Amplifiers" I. N. Migulin indicated that a suitable discipline for the analysis of amplifier circuits is to use a single system of parameters in common with vacuum tube amplifiers. The use of the above procedure led to the development of simple amplifier circuits with maximum possible gains and bandwidths.

A paper by L. S. Berman pointed out the possibility of increasing the efficiency of a tuned amplifier operating with current cutoff, by using an additional network tuned to the third harmonic. The use of such a transistorized circuit makes it possible to obtain a useful power of 320-340 mw at an efficiency of 87-88 per cent, while the ordinary tuned semiconductor amplifier circuit yields an efficiency of 74-75 per cent and useful power of 140-150 mw.

A paper by V. M. Sidorov was devoted to the investigation of the action of sinusoidal pulses, and fluctuation noise of any level in the reception of fm signals. The effect of types of individual stages of the receiver (limiter, frequency detector, filters, etc.) on the noise attenuation was described.

A. A. Magazanik considered asynchronous modes in self-excited oscillators with two degrees of freedom. The fundamental equations of several self-oscillating systems were derived and problems of the stability of the effects of load nonlinearity were considered.

A paper by E. P. Khmel'nikski showed the advisability of detuning the tank circuit to obtain a substantial increase in oscillator efficiency. Results of the theoretical analysis of this mode of operation are given and data on engineering design of the circuit are provided. This method was recommended by the session for use in broadcast transmitters at medium and long waves with plate modulation.

A paper by S. N. Krize considered the role of approximate methods for the calculation of transients, the difficulties involved in the accurate calculations of the transients when the pulses have complicated waveforms, and methods of approximate calculations.

V. P. Shasherin showed in his paper that to obtain flat frequency characteristics in multistage amplifiers it is better to employ different gains and correction parameters in the individual stages.

Iu. V. Bogoslovski proposed a procedure for calculating the overdriven operating modes of an oscillator; the initial data used in the calculations are the intensity coefficient, the oscillation power, or the dc component of the plate current and the lower cutoff angle.

S. M. Gerasimov devoted his paper to an analysis of the dependence of transistor oscillator parameters on temperature, and to methods of temperature compensation.

A paper by V. M. Rozon "Problems of Construction of Frequency Standards for Transmitting and Receiving Radio Centers" described apparatus consisting of a central precision frequency generator and a synchronous master generator, having a long-term frequency stability on the order of $(5\text{-}10) \times 10^{-8}$.

S. A. Segal' considered a new method of modulation, from which the non-productive load of the apparatus and of the channel is eliminated, and in which no energy is consumed in the radiation of the entire frequency, so that it is possible to increase the power of the components that carry the information by at least four times. This also eliminates the need for restoring the carrier at the point of reception.

In a paper "Use of Semiconductors in Radio Broadcasting Apparatus," B. S. Semenov indicated that the Institute of Radio Instruments and Apparatus has been continuously studying for

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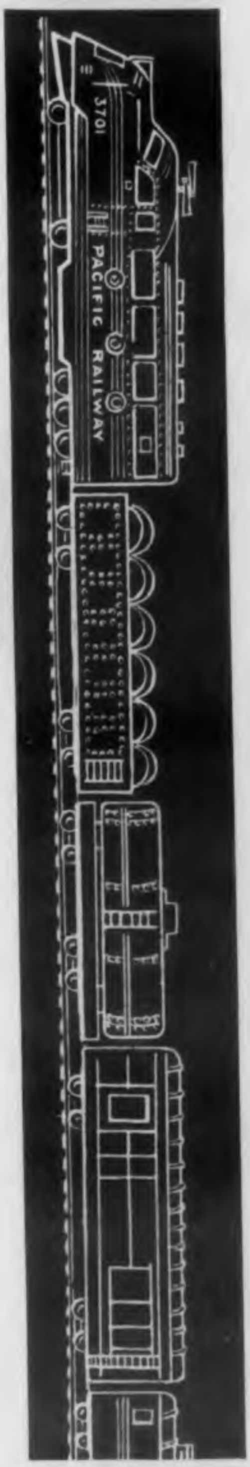

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the past few years, the characteristic parameters of all types of semiconductors suitable for radio broadcast apparatus. Engineering methods have been devised for calculating the various circuit elements of the receivers—low and intermediate frequency amplifiers, automatic gain control, etc.

SESSION ON ANTENNA APPARATUS

V. I. Zimina reported the results of a theoretical investigation of the propagation of electromagnetic waves along a tube filled with ionized gas. The conditions under which the corresponding transcendental equation can be solved were considered and the roots of this equation were determined.

A paper "Ballistic Antenna" by A. A. Pirogov considered the conditions of dynamic equilibrium of ballistic antennas, versions of devices for launching and dropping the antenna, and also methods of excitation and fields of application of ballistic antennas for long, short, and uhf waves. The lecturer pointed out that it is possible to

realize complex antenna systems with the aid of ballistic antennas.

The paper by V. I. Talanov was devoted to the method of solving problems concerning the excitation of surface waves over an impedance plane.

M. R. Zelinskaia and N. M. Tseitlin considered a method for direct measurements of losses and directivity coefficients at centimeters and meter waves with the aid of radiometers, based on the extraterrestrial cosmic radiation and on the internal noise of the antenna-feeder system.

It was shown in a paper by P. R. Cherep "Bends in Waveguides with Surface Wave" that the most important practical result of the bend is the supplementary attenuation due to the radiation from the concave bend. Several methods for eliminating the influence of the bend on attenuation have been proposed.

The problem of the passage of an arbitrary cylindrical wave through a bent waveguide of round section with ideal walls was considered in the paper by N. P. Kerzhentsev. Expressions were derived for the coupling coefficients between the waves, characterizing the phenomenon of the passage of waves of parasitic types over the bend.

A paper by N. K. Gorshkov, B. Z. Katsenelenbaum, V. V. Malin, and A. N. Sivov determined the losses of different waves, caused by coating a thin dielectric film with large loss angle on the inner surface of a round metallic waveguide.

I. A. Dombrovski lectured on the theory of regular waveguides carrying mixed types of waves; this theory is based on the method of complex eigenvalues, which extends considerably the capabilities of the classical theory, yielding many formulas for the calculation of the constant phase and of the attenuation of regular waveguides made of various materials.

A paper by V. D. Kuznetsov described a new antenna he developed, for collective reception of television over a frequency range from 48.5 to 230 mc, and also the electrical structural data on the system and the experimental results.

A paper by A. M. Model' was devoted to the choice and description of elements of the antenna-feeder system of multi-trunk radio relay lines. The fundamental requirements that the individual element of the channel must satisfy are discussed.

V. I. Krutikov described a method for broadband matching of the antenna-feeder channel of multi-trunk radio-relay lines. The matching is performed with the aid of a directional coupler and a system of reflecting filters. The method described makes it possible to obtain a very high degree of matching in the pass bands of all the trunks of radio relay lines.

M. E. Gertsenshtein and A. M. Pokras gave a theoretical analysis of the operation of a waveguide coupler, and applied the analytical results to the formulation of a procedure for the design of the coupler.

B. E. Kinber extended the theory of linear antennas to include the case of an antenna that is idealized in the form of a curvilinear filament, and also for the three-dimensional case of a plane or curvilinear antenna.

A. L. Mikaelian and A. K. Stoliarov reported the results of an experimental investigation of transverse ferromagnetic resonance in a rectangular waveguide with ferrite. The parameters of resonant valves, developed by the authors for the three and eight centimeter band and used for measurement and radio-relay line work, are listed.

A. L. Mikaelian and M. M. Koblova considered a new type of coaxial valve system for which ferrites are employed, and reported the results of experimental investigation of the non-mutual attenuation in a transversely-magnetized ferrite-dielectric plate, placed in a coaxial line.

SESSION ON WIRE COMMUNICATION

Although containing many papers on information theory and switching circuits, most papers in this section concern telegraphy, facsimile, and wired broadcasting, which are not of primary interest to ED readers.

SESSION ON GENERAL RADIO ENGINEERING

Ia. S. Itskhoki in his paper "Minimum Volume of Pulse Transformer" noted that the substantial success in the development of special magnetic alloys jointly with the use of transformer biasing has made it possible to revise the procedure previously used for transformer design. While formerly principal requirement concerned the maximum distortion of the flat portion of the pulse, the new requirement now becomes the miniaturization of the transformer. The condition for the

balance of optimum losses in the transformer leads to an expression for the volume of the transformer in the form of a function that takes into account all the structural parameters of the core.

A paper by O. N. Litvinenko considered inhomogeneous transmission lines for shaping pulses of specified forms. In particular, it is shown that it is possible to obtain a linearly-varying voltage or current by means of an inhomogeneous line.

Another paper by O. N. Litvinenko was devoted to the transformation of millimicrosecond pulses by inhomogeneous lines. Infinitely long lines, which do not distort the shape of the input current or the input voltage, are considered. It is then shown how to extend the analysis to include finite lines.

The paper by Iu. B. Sindler and A. S. Nemirovski gave design equations for the noise distribution at the output of radio-relay lines, derived by comparing the distribution of the sum of the random oscillations with the distribution of the maximum oscillation.

E. Ia. Grinberg noted that to design ladder networks one employs usually the matrix method of the theory of four-terminal networks. However, the calculations can be simplified considerably using the so-called Euler brackets. This makes it possible to establish the necessary effect during the course of calculation, and also to check both the individual stages of the calculations, as well as entire groups of these stages.

In another paper, "Formulas for the Analysis and Synthesis of Simple Multi-Network Filters" E. Ia. Grinberg determined the transfer coefficients of a resonant narrow-band filter and established the quantities that determine the shape of the selectivity curve.

A paper by M. Z. Arslanov was devoted to the investigation of dynamic resonance in a nonlinear oscillating circuit, considered the possibility of using this resonance for selection of pulse signals.

The analysis of the oscillator as a nonlinear self-oscillating circuit was the topic of V. S. Troitski's "Theory of Molecular Oscillator and of the Fluctuations of its Oscillations."

S. I. Averkov and L. A. Ostrovski considered non-resonant power amplification of oscillations propagating in a medium with varying parameters. They concluded that it is possible to detect this effect at radio frequencies and to make practical use of it.

N. N. Lunacharski considered an equation for behavior of the phase of oscillation in a self-oscillating system with an external driving signal.

Iu. A. Driagin described an instrument for measuring low-frequency fluctuations due to the flicker effect, instability of power supply, etc. The instrument makes possible measurement of the spectral density of fluctuations ranging from 0.2 to 2,000 cps.

In a paper "Concerning Systems of Electrical and Magnetic Units" L. B. Slepian indicated that it is possible to obtain complete compatibility between the MKS-Coulomb system and the CGS system, i.e., to establish relationships between the systems that do not depend on c. For this purpose it is necessary to introduce into the equations for the electromagnetic field a factor $1/c$, as proposed by I. G. Kliatskin.

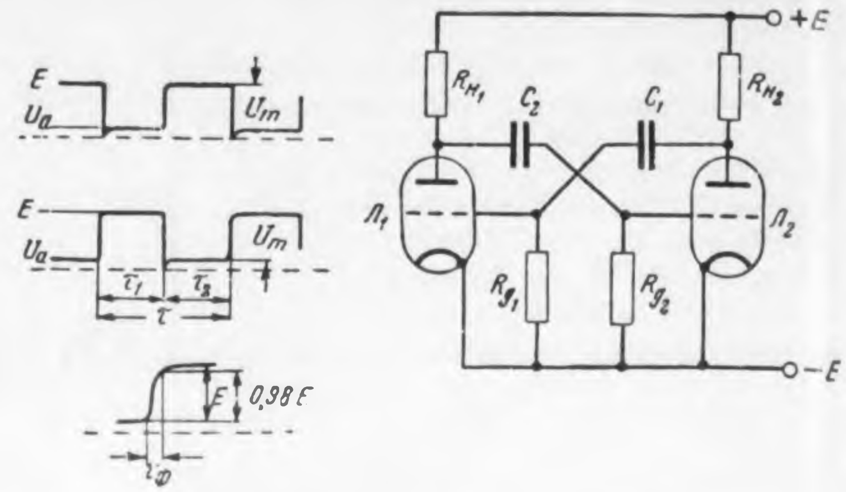
I. L. Bershtein indicated in his paper that by using a phase automatic frequency tuning system, one can obtain high frequency stability of microwaves in a relatively simple manner.

Iu. Ia. Iurov discussed a new balanced mixer for centimeter waves.

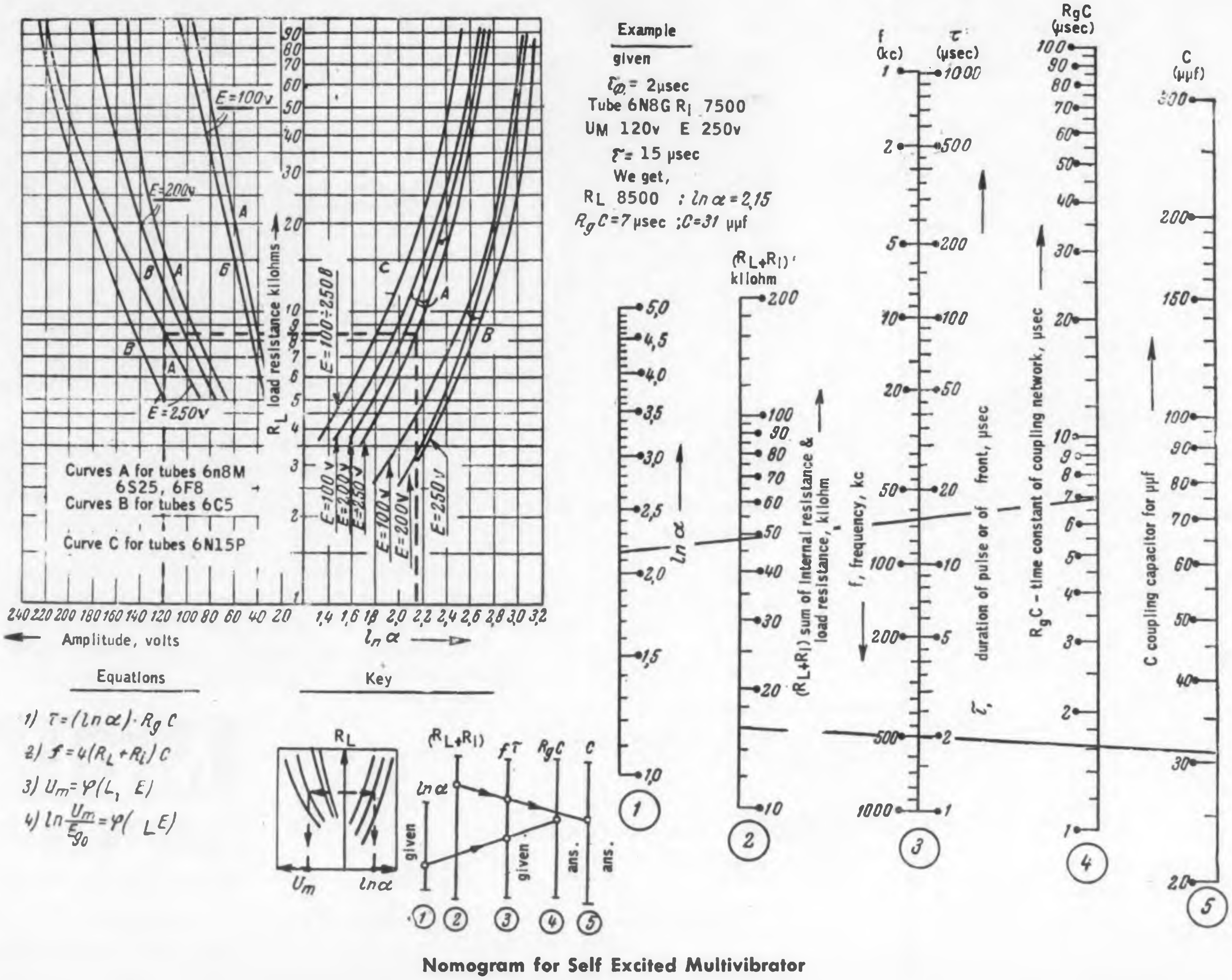
A. A. L'vovich discussed the advantages of synchronized oscillators employing thermistors. Such oscillators can be used extensively where high amplitude stability is required.

Design of Multivibrator with Self Excitation

J. George Adashko



Multivibrator with plate waveforms. The upper waveform is for plate 1.



Nomogram for Self Excited Multivibrator

THE PERIOD of a self-excited multivibrator (see Figure) can be found with sufficient accuracy, assuming $R_L \ll R_g$, from the following equation:

$$T = \tau_1 + \tau_2 = R_{g1}C_1 \ln \alpha_1 + R_{g2}C_2 \ln \alpha_2 \quad (1)$$

$$\text{where } \ln \alpha = \ln \frac{U_m}{E_{go}} = \ln \frac{E - U_a}{E_{go}} \quad (2)$$

(the symbols are identified on the figure); E_{go} is the grid cutoff voltage for a given load and given source voltage. The rise time τ_f of the pulse front is determined from the expression

$$\tau_f = 4(R_L + R_i)C. \quad (3)$$

The time is measured from the start of the pulse to the instant at which its value reaches 0.98 of the rated amplitude.

The nomogram is based on the above three equations and makes possible the determination of the half period of the oscillations. Located to the left of the nomogram is a plot with which it is possible to determine the values of ln α for certain types of tubes, and to determine the amplitude U_m. If the multivibrator employs other tubes or other voltages, Eq. (2) and the characteristics of the tubes must be used in lieu of the graph to determine $\ln \alpha$. To find the oscillation period it is necessary to know, in addition to the parameters and operating condition of the tubes, also the load R_L in each plate circuit and the time constant of the coupling networks $R_{g1}C_1$ and $R_{g2}C_2$. The nomogram can also be used to design blocked multivibrators.

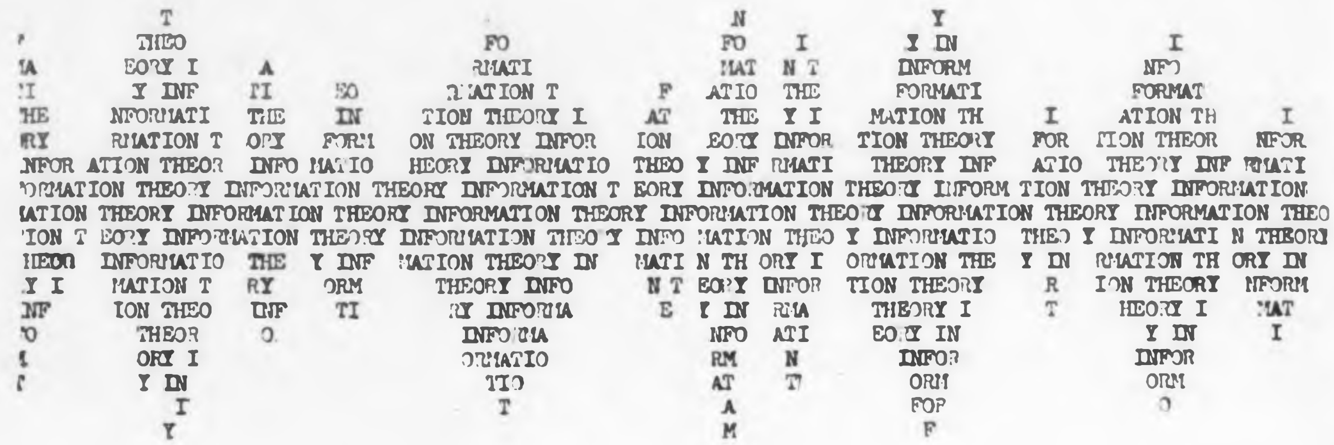
Example

A self-excited multivibrator employs 6N8S tubes (Russian equivalent of 6C8G). Data is given on the nomogram. The pulse repetition rate should be 25 kc. The pulse rise time should not exceed $\tau_f = 2$ µsec. The pulse amplitude (120 v) is marked on the left abscissa of the graph, and the curve corresponding to the 6N8S tube at 250 volt supply yields the required load resistance, 8500 ohms. Scale 3 of the nomogram is used to determine the period corresponding to the prf, $f = 25$ kc, namely $T = \tau_1 + \tau_2 = 40$ µsec. Since it is necessary to obtain pulses of duration $\tau = 15$ µsec, the remaining part of the period must be $\tau_2 = 25$ µsec. The remaining operations are shown on the key of the nomogram.

From Nomogram Collection on Radio Engineering *by V. M. Rodionov, Soviet Radio Publishers.*

Information Theory in the U.S.S.R.

Paul E. Green, Jr.
Lincoln Laboratory
Massachusetts Institute of Technology



This article is a sketch of the development of the science of information theory in Soviet Russia. For the past two years, the author has tried to follow Soviet publications, past and present, in the field of information theory. Recently he has had opportunities to speak briefly about this subject with several Soviet scientists. This paper will present a history of Soviet information theory as deduced from this material.

Mr. Green has here condensed his 1957 WESCON paper especially for ELECTRONIC DESIGN.

HERE *information theory* is taken to mean *the application of statistical notions to problems of transmitting information.* This field makes a fairly instructive case study. It is quite unusual to have a body of theory such as this spring up in a short period of several years and immediately attract the interest and activity of such diverse professions as communication engineers, economists, mathematicians, physiologists, linguists and so forth. The reaction to all this in the Soviet was rather interesting, and tells us not a little about their scientific system.

Since 1725, when the Academy of Sciences was founded by Peter the Great, the theory of probability has enjoyed a particularly high quality of attention in Russia. The present pre-eminence of the Russian school, which includes A. N. Kolmogorov, A. Ia. Khinchin, and many others, is a direct legacy from that period, when Peter invited many Westerners, including Euler and N. Bernoulli to participate in the intellectual renaissance that he and his Academy were attempting.

Most Western students of communication theory are familiar with the names of Khinchin and Kolmogorov because of two instances of parallelism with the work of Norbert Wiener.

The first of these is the extension of the notions of Fourier analysis to processes with infinite time duration and continuous spectra (such as certain stationary random processes)—the so-called Generalized Harmonic Analysis. This subject was pursued with great success during the decade 1925-1935 principally by Wiener and Khinchin themselves. The second instance—the concurrent development of optimum mean-square filtering and prediction theory by Wiener and Kolmogorov—took place in a wartime environment. Originally, Wiener's study of the subject was classified, and the existence of Kolmogorov's journal article was not known in this country until Wiener's work was substantially complete. (The difference in method of publication of these works is explained when one considers the extent to which Wiener carried his treatment through to engineering applications.)

It was the variety of technological problems presented by World War II that catalyzed this and other developments in the statistical treatment of communication, detection, and control problems. This was as true in Russia as it was here, but at the time the means at their disposal were much more limited. For example, they had no equivalent to our Radiation Laboratory where most of our early work in this field originated.

During the war the interest of Soviet engineers was attracted to the statistical nature of communication problems, but not on the *information* basis of Shannon and Wiener. This seems to be entirely a Western idea, and as such was for a time in some disrepute.

KOTEL'NIKOV'S THEORY

In place of the Shannon theory which treats information as an attribute of the signals generated and transported through a communication system, there appeared in the U.S.S.R. a different sort of statistical communication "theory." This is the study of *potential interference immunity*, enunciated by V. A. Kotel'nikov in his doctoral dissertation of 1946.

Kotel'nikov's dissertation incorporated a number of important ideas that were quite new at the time. He studied communication in the presence of gaussian additive noise. By the use of the inverse-probability or "decision theory" argument employed later by Woodward and Davies, he obtained the result that the receiver having the least probability of error in the presence of white gaussian noise uses the mean-square-difference detection criterion. He called the probability of error (the probability of one possible signal being mistaken for another) the *potential interference immunity*, and computed also the actual probability of error (interference immunity) for several types of systems.

Kotel'nikov's study was an outstanding piece of work for its time. In 1953 he was made an Academician in the Academy of Sciences and he is now director of the Academy's electronics research laboratory, the Institute of Radio Engineering and Electronics, in Moscow.

These are the main developments during the period before 1952. After Kotel'nikov's pioneering effort, Soviet communication engineers seem to have published little of real significance. Their efforts in the theory of communication during this period were mostly applications of the *results* of Kotel'nikov's original study, rather than the use of his *methods* on other problems.

Continued on next page

In the field of probability, Soviet Russia possesses, in addition to such pure mathematicians as Khinchin, Kolmogorov, Gnedenko, Linnik, etc., a very strong complement of applied mathematicians, who have successfully used statistical theories in such subjects as turbulence (Obukhov, A. M. Iaglom, Monin), scattering of waves (Krasil'nikov, Chernov, Tatarskii), and mean-square filtering and prediction (A. M. Iaglom, Pugachev). Kolmogorov himself has written many papers on applications. There are signs that both groups of mathematicians are interesting themselves in information theory.

It was probably about 1952 that Khinchin first became interested in Shannon's work, in particular the entropy expression. He published in 1953 a survey paper setting forth in clear mathematical language the properties of self- and conditional-entropy of discrete distributions and Markov chains, interpreting them in terms of information.

An active interest in information theory (in the Western sense) by the Soviets seems to date from about the time of the publication of this paper.

Several points in the original Shannon formulation have resisted a rigorous mathematical treatment, notably the fundamental theorem: that there exists a coding scheme that will encode the output of a source of rate H so that at the other end of a channel of capacity C, there will be an arbitrarily low probability of error (or "fractional information lost" in some formulations), provided H is less than C. Attempts by McMillan and Feinstein in this direction were only partially successful. Recently, Khinchin interested himself in this problem, and provided the most complete and rigorous treatment of the discrete case to date, including proof of this theorem, in a long paper published in 1956. (The two Khinchin papers have recently been republished in English by Dover under the title "Mathematical Foundations of Information Theory.")

Whether Khinchin's interest was originally self-generated and limited to himself or part of a group effort is not clear. But such a combined effort by Soviet mathematicians did evolve, apparently led by Kolmogorov. A seminar on information theory has been in progress for some time, under him. The Soviet probabilists seem to be interested in information theory as a bona-fide new branch of the theory of probabilities. A number of very high quality papers have been published extending and making more precise Shannon's treatment of self- and conditional-entropy.

The Soviet mathematicians seem to be proceeding carefully toward a rigorous, comprehensive treatment of the entirety of Shannon's work. The chances appear good that their studies will lead not only to a better understanding of existing theory but also to new extensions of it.

WORK OF SOVIET ENGINEERS

The interest in information theory of people like Khinchin does not seem to have been shared to a significant extent by communication people until about 1954 if publication of journal articles is any criterion. Then, during 1954 and 1955, official recommendation for work on a more general theory of communication came from several highly-placed authors, and from the Academy of Science. For example, in 1954, Kotel'nikov, in an article in the radio amateur magazine "Radio," defined the most important radio engineering problems as "extension of the usable frequency spectrum, semiconductor applications, and a general theory of communications."

Pronouncements such as these do not usually go ignored in the U.S.S.R. Therefore it should not be surprising to observe that a year-by-year list of the number of articles and notes on information theory in the electronics journals shows a sharp upswing beginning about this time: None during 1953, 1 during 1954, 6 during 1955, 12 during 1956, and 9 in the journals received to August 1957. In the 1957 journals received, 14 per cent of all articles and notes were on statistical applications, and 45 per cent of these were on information theory.

The subject matter of almost all these 28 papers breaks down into three fairly specific fields:

(1) Coding studies,
(2) Simple bandwidth-compression schemes,
(3) Channel capacity studies using the vector model.

A concentration of subject matter under so few topics is rather surprising. Most of the tougher and more intriguing byways have been, until recently, untouched. (For example: channel capacity and how to approach it in more difficult type of channels, new coding schemes, cascaded or networked channels, and so forth). The use of statistical decision theory has been conspicuous by its absence in the published literature, even though a form of this approach was used by Kotel'nikov and has also been available in Lawson's and Uhlenbeck's book and in the Woodward and Davies papers where it was related directly to information theory notions.

The published work on coding, which is mostly tutorial, explores the relationship between code length, average information rate, channel capacity and average error probability, in various combinations; but does not give any new insight into the problem of devising better codes. Published work on bandwidth-compression has been limited to velocity-modulated scanning systems for picture transmission.

By and large, the published information

theory work of Soviet engineers is a disappointment. On the other hand its quality is steadily increasing. And it is always possible that behind the facade of indifferent work there have already been some substantial achievements that will some day be sprung on the unsuspecting.

FILTERING AND DETECTION

The preceding sections have dealt only with Soviet work on the theory of information. This restriction has left unmentioned the progress of work in other related fields which will now be summarized.

There has been steady activity in mean-square filtering since the late 1940's by engineers (for example, V. V. Solodovnikov) and mathematicians (notably A. M. Iaglom and V. S. Pugachev). In the published literature, the use of such techniques for detection problems seems to be very much secondary to their use in automatic control systems. The Soviets have followed closely the few engineering extensions of this theory and have made several original and independent contributions of their own.

Observable work in weak-signal detection has inclined toward the weak side. Some fairly detailed studies of radiometers have been made, but on the other hand, claimed performance for these circuits in radio-astronomy work has run several years behind that attained in the U.S.A., England, and Australia. Published work on correlation detection has been limited to simple schemes for detection of pulses. Several papers on video integrators (or "comb filters") have appeared. Papers on radar detection are seldom seen, probably because of security restrictions.

CYBERNETICS

From its initial formulation in 1949 until 1955, cybernetics (which Wiener defines as "control and communication in the animal and machine") was one of the standard whipping boys of the Communist regime. The usefulness of analogy relationships betwen biological processes and electronic or mechanical ones was denied most emphatically. In the general loosening up after Stalin's death, cybernetics followed shortly after information theory in obtaining official approval. A very large number of articles, many of them in the popular magazines have followed. The subject is currently attracting wide interest, particularly on the popular level where the fascination for cybernetics seems to have somewhat the same motivation as the current popular Soviet interest in science fiction.

Some quite interesting work on mechanical translation has been done, and the same group of people have begun programming computers to play chess.

Soviet linguistics suffered a great decline in the 1940's and 1950's because of political interference (first in the name of Marr, and later Stalin). The statistical study of languages has never really come to life.

Only a passing mention has been seen of the relationship of thermodynamics and informational entropy. Very few investigations in biophysics or neurophysiology have been reported, and the present author has seen no evidence of Soviet work in the theory of games, the theory of automata, or the sociological or psychological implications of cybernetics.

CONCLUSIONS

1) There is no doubt that information theory is at present the object of great interest and activity in the Soviet Union. After a late start, they are already producing results worth studying. The time lag was a deliberate one, probably due to a combination of ideological orthodoxy and a calculated desire to wait and see what results would be obtained elsewhere.

2) Almost all these results have so far come from the pure and applied mathematicians, whose competence in probability has been a matter of historical fact for many generations.

3) Work by communication engineers is still very much exploratory, but is improving rapidly.

4) Lack of communication between mathematicians and engineers seems to have been considerable. The practice, familiar to us, of forming groups of people having a wide spectrum of talents (from the abstract to the engineering application) does not appear to have been used by the Soviets in information theory although in other fields they have applied it quite successfully. The probabilists work at their institutes and the communication people at theirs.

5) There remains the slight possibility that the low quality of observed engineering work is to a certain extent a deception, and that classification according to quality as well as according to subject is practiced in the U.S.S.R.

6) It is important to make some estimate of the possibility that behind the scenes the Soviets have used information theory or related ideas to develop sophisticated new coding, modulation or detection techniques. After due consideration of the available data, the author's feeling is "probably not—yet."

7) Finally, there is a statement often made about Soviet science: that once the top command has decided that the U.S.S.R. should excel in a given field, all that is needed is the official impetus and it is then only a matter of time. All signs indicate that in information theory the impetus has been provided. Meanwhile, it *is* taking time.

The research in this document was supported jointly by the Army, Navy, and Air Force under contract with the Massachusetts Institute of Technology.

Books

Principles of Electrical Measurements

H. Buckingham, E. M. Price, Philosophical Library, 15 E. 40th Street, New York, N.Y. 600 pages, $15.00.

Rapid progress in the field of electronics has made many new measurement techniques necessary. The aim of this book is to provide a knowledge of the principles employed in making such measurements and to explain their application. An understanding of the material in this book should prepare a degree candidate for his final examination. It is also useful for Higher National Certificate and Diploma courses.

It is sufficiently comprehensive to be a useful reference source to engineers requiring information on electrical measurements. A suitable proportion of the contents is devoted to topics on potentiometer and bridge methods, measurement which are related to power systems, and the measurements of some non-electrical quantities.

Handbook of Tri-Plate Microwave Components

Norman R. Wild, Donald J. Sommers, Jesse L. Butler, Kenneth P. Nelligan, and William J. Wilson, Sanders Associates, Nashua, New Hampshire. 152 Pages, $3.00.

This handbook serves as a scientific report of Sanders Associates, Inc. under development contracts of the National Bureau of Standards and the Air Force Cambridge Research Center.

Basic technical information on an advanced form of "flat-strip" microwave transmission line is presented in seven well organized chapters. The authors cover the evolution of flat-strip transmission line, its various forms, applications, measurements, materials, and fabrication techniques.

The book, replete with photographs, graphs, and working formulas enables an engineer to intelligently evaluate the advantages and limitations of these microwave components.

Radiation Effects on Materials—Vol. I

American Society for Testing Materials. 1916 Race St., Philadelphia 3, Pa. 190 Pages, $4.75; to ASTM members $3.50.

This book is a collection of sixteen technical papers presented at Symposiums on Radiation Effects on Materials and on Radioactive Isotopes held in Los Angeles in September, 1956. These meetings were part of the Second Pacific Area National Meeting of the American Society for Testing Materials.

The papers are broadly grouped in four principal categories: Theory, Radiation Facilities and Mechanics of Testing, Fuel and Graphite Materials, and Structural Materials Including Organics.

In the papers on *Problems of Dosimetry* and *The Effect of Radiation on Some Plastics and Elastomers*, the electronics engineer can find useful information on the damage metals, alloys, and plastics undergo from nuclear radiation. In the book as a whole, however, the electronic design engineer will find little of immediate practical value.

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German Abstracts

Analog Solution of Polynomials

E. BRENNER

THE SOLUTION of nth order algebraic equations of the form

$$f(z) = \sum_{m=0}^{N} a_m z^m = 0 \qquad (1)$$

where the coefficients a_m are real numbers is often a tedius procedure, especially when complex roots occur. Such equations are the characteristic equations of linear systems and must frequently be solved for many values of the coefficients a_m. Many schemes have been developed for the machine solution of such equations using either electrolytic troughs or especially designed electronic equipment. It is possible to solve these algebraic equations using an analog which is built with ordinary, commonly available electrical components.

The schematic diagram shown in the Figure illustrates the principle of a machine which solves equations of the form of Eq.1. For the sake of the desired simplicity, continuity of adjustment of the parameters has been sacrificed so that values can be set of the machine only to three significant figures. The values of the function are represented by ac voltages and by writing the equation in trigonometric form. The solution is obtained when voltages which correspond to both the real and imaginary parts of the solution are equal to zero. In trigonometric form these parts are

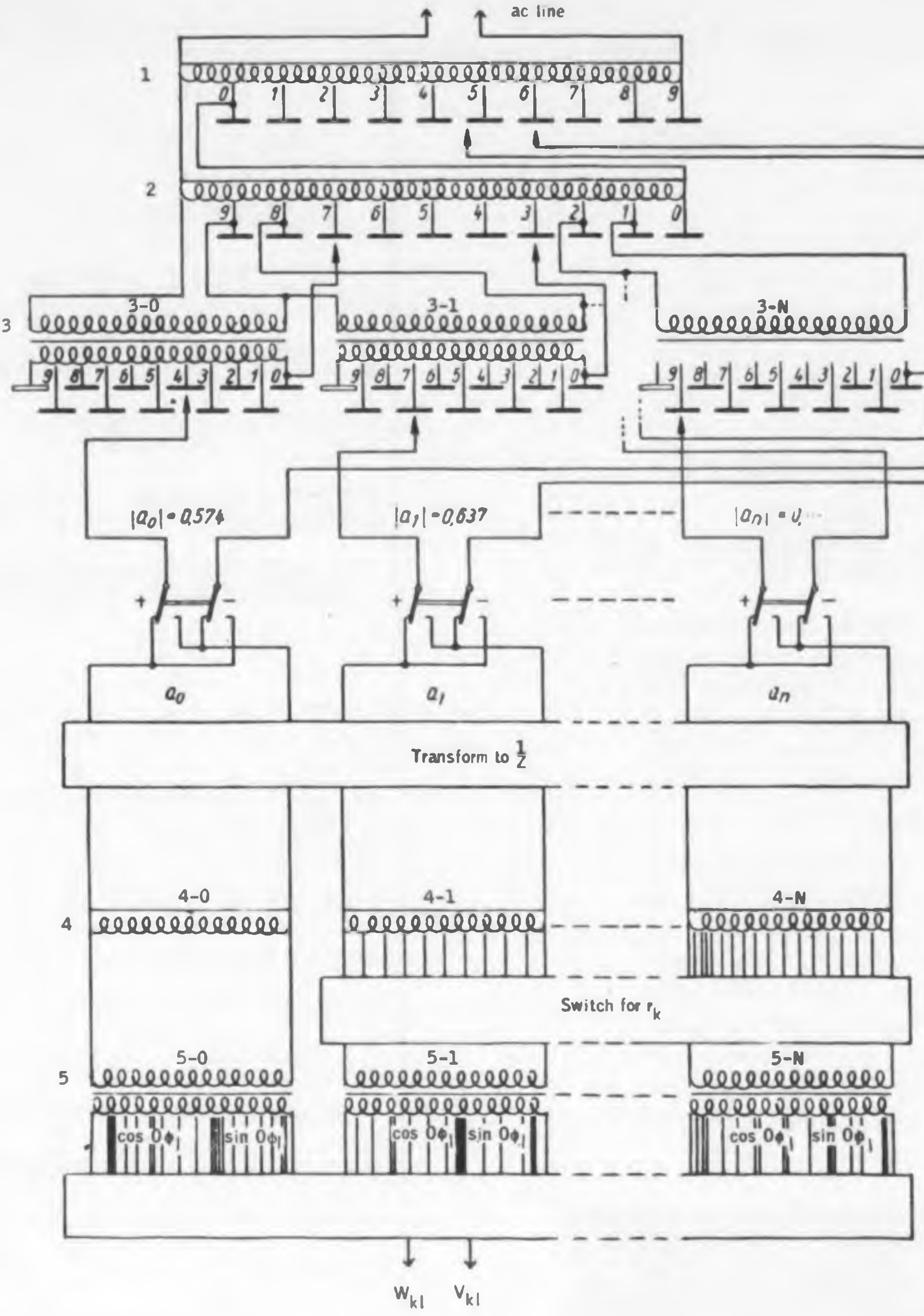
at $\quad z = z_{ke} = r_k e^{j\phi_e}$

$$\mathcal{R}_e f(z) = u_{ke} = \sum_{m=0}^{N} a_m r_k^m \cos m \phi_e \qquad (2)$$

and

$$\mathcal{I}_m f(z) = v_{kl} = \sum_{m=0}^{N} a_m r_k^m \sin m \phi_l$$

All transformers except banks 3 and 5 are autotransformers, the coefficients are set by adjusting the tap position. The Transformer bank 5



Schematic of a machine which solves equations of the form of Eq. 1. The values of the function are represented by ac voltages and by writing the equation in trigonometric form.

has the taps arranged so as to have the ratio of transformation correspond to multiplication by the desired trigonometric function (sin mφ or cos mφ). The stage which transforms to the variable $1/z$ is used when a root of the equation has an absolute value which exceeds unity. Elaborate switching arrangements are provided to perform the addition operations which are indicated by Eqs 2 and 3. An oscilloscope is used as the output indicator. A machine of this type was built to solve equations up to the order 8 ($N = 8$).

(Abstracted from an article by H. Adler Nachrichtentechnik, *Vol. 7, No. 8, August 1957 pp 335-342.)*

Abstracters Note: The arrangement which is proposed in the above abstract is particularly interesting because no unusual or precision components are required for the construction of the machine. The larger number of components which this device required as compared to other devices which fulfill the same purpose is due to the fact the number of significant figures in the solution is predetermined. While this calls for a large number of transformer banks; precision potentiometers and specially designed phase shift capacitors such as are required in another German machine are eliminated. "Machine solution of Higher Order Polynomials," Abstracted in ELECTRONIC DESIGN, Oct. 1, 1957.)—E B.

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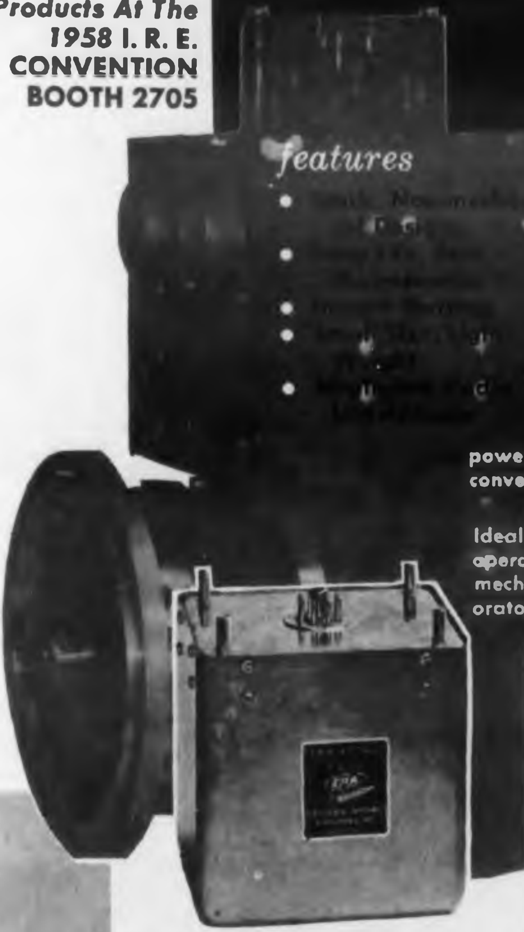

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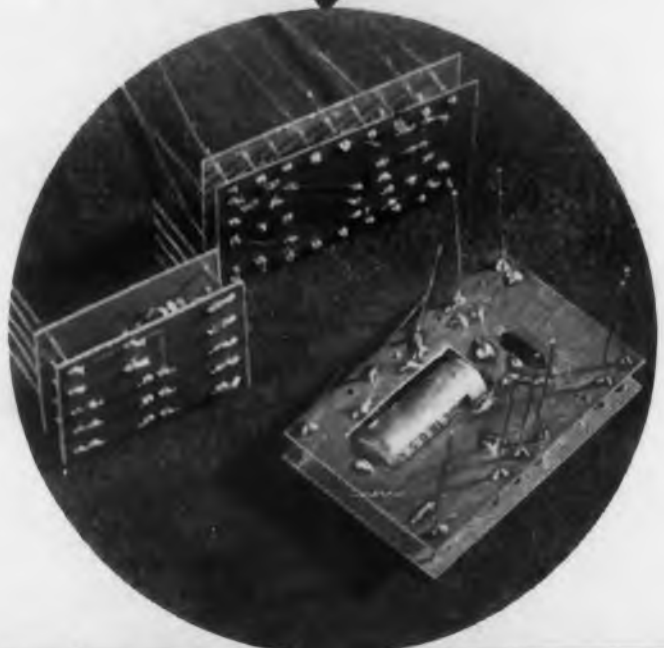

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