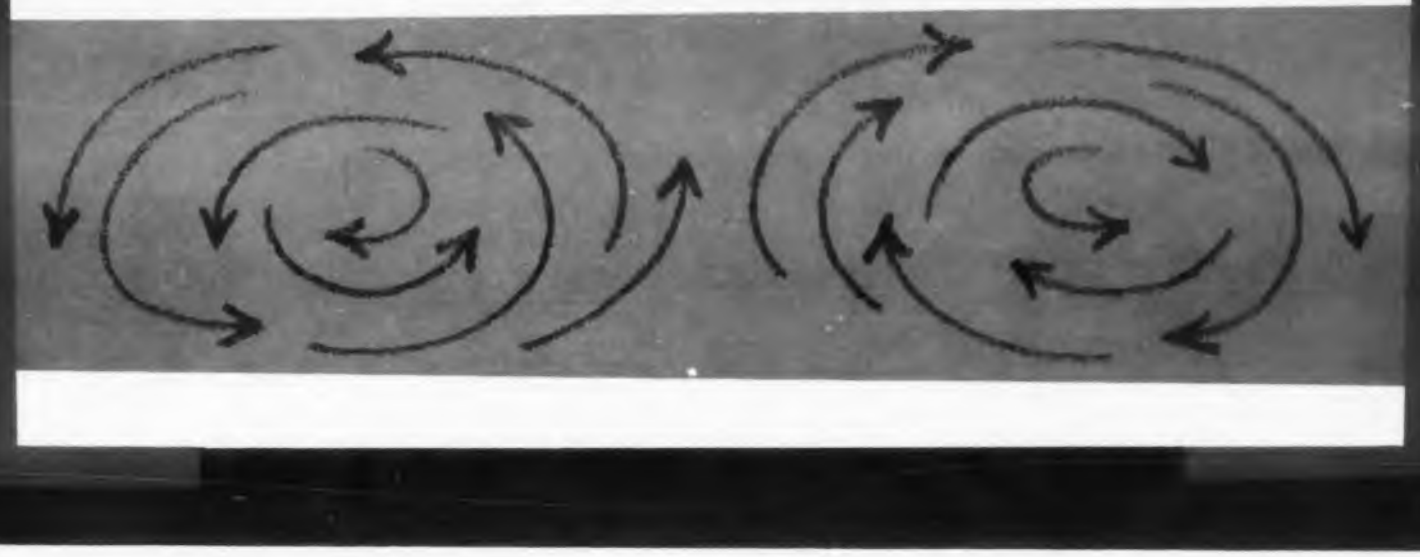
ELECTRONIC DESIGN



Sealed-in Gas Shrinks Resistor's Size . . . 30

HIGHLIGHTS OF ISSUE

November 26, 1958 Vol. 6
Number
24

SUBSCRIPTION POLICY

ELECTRONIC DESIGN is circulated only to qualified electronic design engineers of U. S. manufacturing companies, industrial consultants, and government agencies. If design for manufacturing is your responsibility, you qualify for subscription without charge provided you send us the following information on your company's letterhead: Your name and engineering title, your company's main products, and description of your design duties. The letter must be signed by you personally.
ANY ADDRESS CHANGES FOR OLD SUBSCRIBERS NECESSITATES A RESTATEMENT OF THESE QUALIFICATIONS.
Subscription rate for non qualified subscribers—$15.00 for 1 year only.

Hayden Publishing Co., Inc., 830 Third Avenue, New York 22, N.Y.

CONTENTS

NBP BPA

ELECTRONIC DESIGN is published bi-weekly by Hayden Publishing Company, Inc., 830 Third Avenue, New York 22, N.Y., T. Richard Gascoigne, President; James S. Mulholland, Jr., Vice-President & Treasurer; and David B. Landis, Secretary. Printed at Hildreth Press, Bristol, Conn. Accepted as controlled circulation publication at Bristol, Conn. Additional entry, New York, N.Y. 32,000 copies this issue.

STAFF

Editor Edward E. Grazda
Managing Editor J. A. Lippke
Associate Editors L. D. Shergalis, G. H. Rostky, H. Bierman
Assistant Editors T. E. Mount, D. S. Viebig, L. N. Tolopko, M. M. Robinson, B. Patrusky, A. E. Takacs, F. Muehleck
Contributing Editors S. H. Hubelbank, J. G. Adashko, E. Brenner, B. Bernstein
Editorial Assistants M. S. Buckley, J. R. Feder
Art Director R. A. Schulze
Technical Illustrator B. L. Armstrong
Art Assistant C. Bank
Production Manager T. V. Sedita
Asst. Prod. Manager M. P. Hedrick
Production Assistant M. C. Alexich
Business Manager M. C. Young
Circulation Manager N. M. Elston
Asst. Circ. Manager A. C. Lovett
Reader Service J. Medina

CO-PUBLISHERS

T. Richard Gascoigne
James S. Mulholland, Jr.

ADVERTISING REPRESENTATIVES

Advertising Sales Manager
Bryce Gray, Jr.

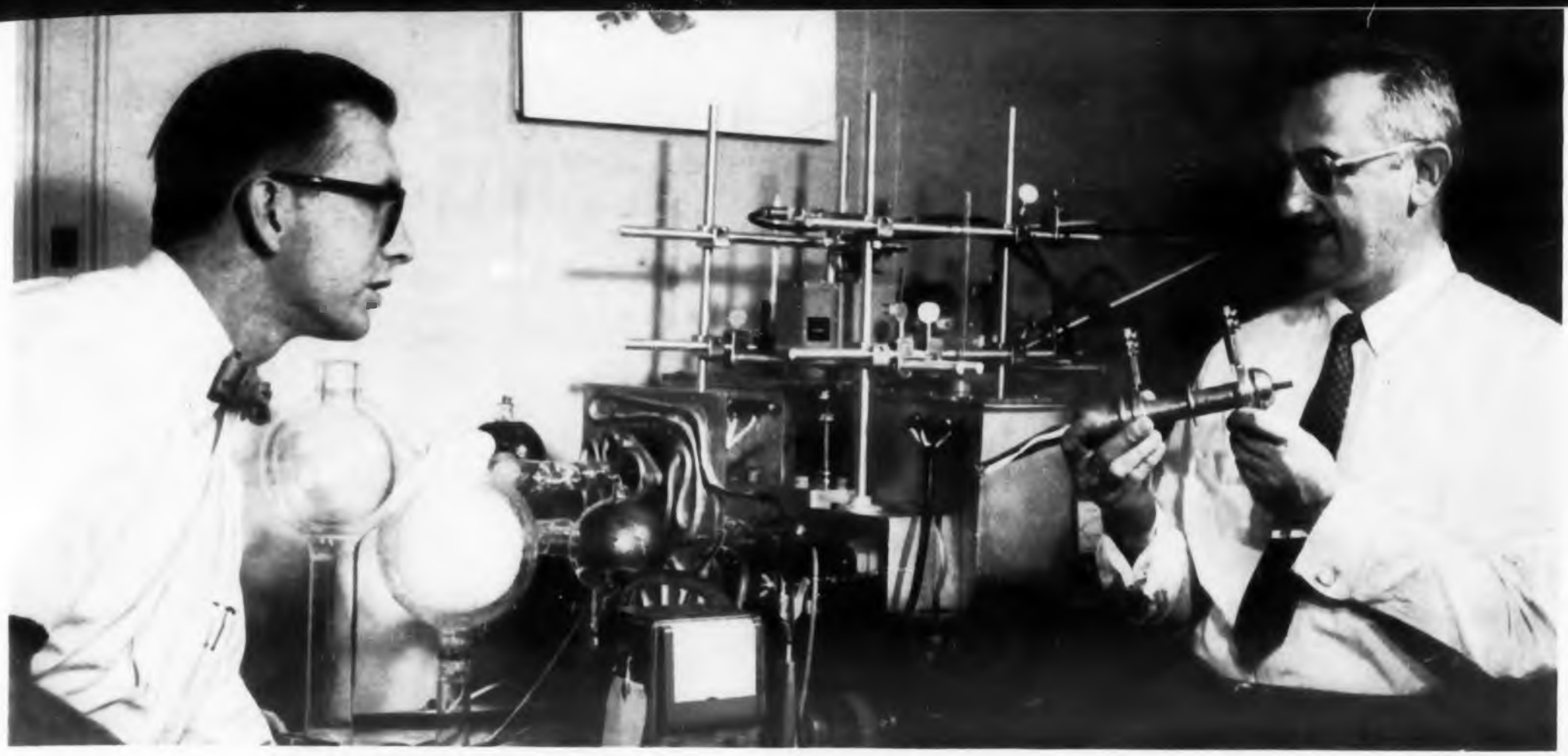
New York: 830 Third Avenue, PLaza 1-5530 — Owen A. Kean, Robert W. Gascoigne, Richard Parker, Blair McClenachan, James P. Quinn, Charles C. Wadsworth

Chicago: 664 N. Michigan Ave., SUperior 7-8054 — Thomas P. Kavooras, Berry Conner, Jr., Fred T. Bruce

Los Angeles: 3275 Wilshire Blvd., DUnkirk 2-7337 — Robert E. Ahrensdorf, John V. Quillman, Stanley I. Ehrenclou

Southeastern: 2808 Middle River Dr., Ft. Lauderdale, Fla., LOgan 6-5656 — Lucien Neff

London, W. 1: 24 Baker Street, England — Michael B. Horne



Bell Labs scientist holds 55,000 mc TWT. In the background is equipment for evacuating and testing the tube.

DESIGN

BEHIND THE NEWS

New TWT Gives 100 mw Output at 55 kmc

A TRAVELING-WAVE tube which provides cw powers of 100 mw or more at 55,000 mc with a band-width of 10,000 mc, is in an early stage of development at Bell Telephone Laboratories. It has produced ten times more cw power output than has previously been reported for any other amplifier at this frequency.

Interest in frequencies in this range has been sparked by the possibility of long distance transmission at millimeter wavelengths using a circular electric mode in round wave guide pipe buried in the ground. The tube is intended for use as a power amplifier in such a communication system.

In the Bell Labs' tube, a 7000 v. 3 ma electron beam is projected through a 4 in. long helix having a bore of only 15 mils. This helix is made from copper-plated molybdenum wire wound at 110 turns per inch. With a magnetic focusing field of about 1500 gauss, the beam current intercepted by the helix is held to 5 per cent or less. A converging electron gun is used so that cathode current density is held to about 1 amp per sq. cm. This value should make a cathode lifetime of thousands of hours possible.

Although similar in principle to helix type TWTs used at lower frequencies, the mm wave tube required a completely new design approach because of the small sizes involved.

The helix is glazed to a single support rod of low-loss ceramic instead of the more conventional three rods. This rod is spring-loaded against a heat sink which has a direct heat conduction path to the outside of the vacuum envelope. The required degree of precision is obtained by a combination of optical alignment techniques and specially selected machining operations. In this manner, tolerances of the order of 0.0001 in. can be maintained.

Experimental tubes have been tested at 55 kmc and have given cw output powers ranging from 125 to 200 mw. Gain at maximum output is 19 db and at low level is 25 db. Thus the basis has been

(Continued on following page)

BEHIND THE NEWS

laid for a practical broadband TW amplifier with cw power outpu of 200 mw or more at 55 kmc.

Unconventional Sources of Electrical Power Surveyed

Most practical unconventional power sources for converting solar, thermal, chemical, and mechanical energies into electricity, appear to be the oscillating electromagnetic generator, thermopile generator, ion exchange membrane, fuel cell, and photovoltaic battery. This was the conclusion of an Air Force-sponsored survey which has just been released to industry through the Office of Technical Service, U. S. Department of Commerce, Washington 25, D.C. The study involved the theoretical and practical limitations and capabilities of power generation by means other than rotating machinery, conventional batteries, or radioactivity. The data, drawn from the literature and limited laboratory work, was intended to determine where emphasis should be placed in a possible development program. A. L. Betts and P. A. McCollum, of Oklahoma A & M College, conducted the survey for Wright Air Development Center, U. S. Air Force. The report is *Unconventional Power Sources* divided into two parts (PB 131411 and PB 131218) each selling for two dollars.

AM Stereo Radio System Uses Sidebands

An experimental radio broadcasting system is providing full stereophonic sound through a single receiver and dual speakers on the regular a-m broadcast band. The RCA Laboratory stereo a-m system works this way:

Two separate sound channels, picked up by two separate microphones or by a stereo disk or tape pickup at the studio, are trans-

mitted on the regular broadcast frequency. Each of the stereo channels is carried by one sideband.

In the stereophonic a-m receiver, the two sidebands are separated and fed to two speakers, left and right, to reproduce the stereo effect picked up at the studio. In a present conventional a-m receiver, there would be no separation of the two sidebands, so that the program would be heard in conventional fashion without the stereo effect. The stereophonic receiver also can pick up nonstereo broadcasts and play them through either speaker or both, without any stereophonic effect.

Advantages and . . .

. . . om a Report on Instrument Sticks—a new packaging concept by James B. Lindgren, Lind Corp. in Princeton, N. J.

"In very unusual cases the addition of beryllium oxide filler to the casting epoxy may be considered. This material is an electrical insulator, with a thermal conductivity comparable to brass. (Its disadvantage is that if one were to attempt repair of a stick, the dust generated in cutting—if not contained—would, when inhaled, prove fatal.)"

Ed. Note. Hold your breath.

Rapid ASCAT

This new electronic tester, designated ASCAT (Analog Self-Checking Automatic Tester), can check aircraft and missile systems in a fraction of the time normally required. Developed by Bell Aircraft Corp., Buffalo, N. Y., the ASCAT accomplishes in only two minutes the same number of checkout operations requiring more than an hour by a crew of six to ten men working with conventional equipment. High speed results from Go-No Go type of equipment.

BEHIND THE NEWS

In one minute this sheet of paper was printed by the new Army teleprinter.

Teletypewriter Prints 3000 Words Per Minute

A teletypewriter which prints at a rate of 3000 words per min was announced. The device, reportedly the fastest general purpose message printer, was developed jointly by the U. S. Army Signal Corps and the Burroughs Corp., Paoli, Pa.

In its essentials, the electrostatic recording process uses a controlled source of electricity to form small charged areas on a high-resistivity surface such as a coated paper.

The electrostatic latent image formed by the charged areas is made visible by application of powdered ink, permanently fixed by the application of heat.

The recording head comprises 35 tiny wires leading into and through a triangular-shaped piece of plastic. The wires are polished flush with one corner of the triangle, or printing head, to form a rectangle seven wires high by five wires wide.

This is the matrix—72 of them in a row to form a printing line. They do not touch the paper but are maintained at a fixed distance from the paper surface.

Electric pulses will selectively charge all 35 wires or any combination of those wires in each head. A normal line of type, such as appears on this page, is made possible by setting up the first

GENERAL ELECTRIC

TUBE DESIGN NEWS

FROM THE RECEIVING TUBE DEPARTMENT OF GENERAL ELECTRIC COMPANY

New Fast, Sure G-E Impulse Test Method Safeguards 5-Star Tube Performance under Vibration Conditions

IMPULSE-TESTING G-E SUBMINIATURES. R. W. Field, Manager, Finished Tube Quality Control, General Electric Owensboro tube plants, watches test operator take peak and integrated output readings as 5-Star 6111's are tapped by pendulum (circle). To assure accurate readings, the meter pointers remain in indicating position until operator presses the reset button.

Rapidly being applied to 5-Star Tubes — miniatures and subminiatures—General Electric's new impulse test method for measuring vibrational output gives a lower-noise tube in military applications where shock and vibration are definite hazards.

Missile circuits, for example, may incur any one of three kinds of vibration — impulse, random, and periodic. All three can result in tube resonance and variations in output.

In order to weed out those tubes with high output variations caused by vibration, General Electric tube engineers developed a new, fast, and positive method of impulse-testing which interprets tube output in terms of both peak and *integrated* values. Integrated output figures have a close correlation to swept-frequency test results (see chart below).

G.E.'s test thus protects against periodic and random, as well as impulse-type, vibration, insofar as these conditions affect tube performance.

For 6829 5-Star Twin Triode: Most Advanced General-Purpose MIL Tube Spec Ever Written!

Thirty-nine MIL-spec performance tests for General Electric's 6829 military tube are followed by seven different life tests. Important among these is a special cut-off life test to assure emission capabilities after long periods of cut-off operation.

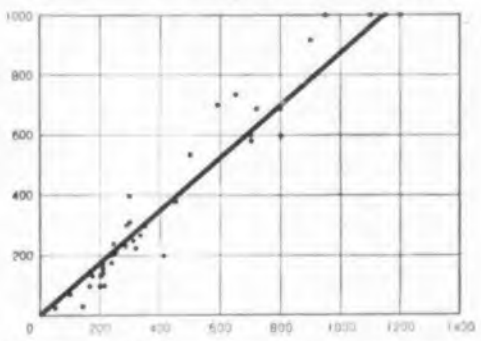
Other 6829 MIL-spec life tests cover: 100-hour survival rate, heater cycling, and a stability check for early-life variations in tube characteristics; also long-term reliability tests conducted under Class-A, zero-bias, and pulse conditions.

Proved by these stringent factory tests, General Electric 5-Star 6829's are going into circuits that demand the utmost in tube reliability.

The 6829 has high perveance; uniform, controlled cut-off; high mu and high transconductance. These custom-fit the tube for use as a counter in computers, or as a line or core driver in cathode-follower circuits.

In addition, the versatile 6829 is directly suited to amplifier or pulse-generator applications in military controls, communications equipment, and detection systems. Ask any General Electric Receiving Tube Department office listed on the following page for additional information!

Showing Close Correlation Between Impulse and Swept-Frequency Tests



Horizontal: integrated output of impulse excitation, in microvolt-seconds. Vertical: swept-frequency vibration (100 to 10,000 CPS, 10 G peak acceleration), max output in peak-to-peak millivolts. Tube tested, Type 6021. 10 sections. E_f:6.3 v. E_b:100 v. R_k:150 ohms. R_l:10,000 ohms.

Tear off and keep this sheet for reference. It contains useful tube-application data.

TO MINIMIZE TV DISTORTION, ALLOW FOR VIDEO REFERENCE SHIFT!

Avoid White Compression and Other Picture Faults by Designing for a Video-Amplifier Grid Voltage Range in Excess of Peak-to-Peak Drive!

Study of the diagram at right will show how essential it is for the television designer to provide a linear transfer characteristic with significantly greater dynamic range than apparently is required for a given peak-to-peak video-detector output. This applies when AC coupling is used between video detector and video amplifier.

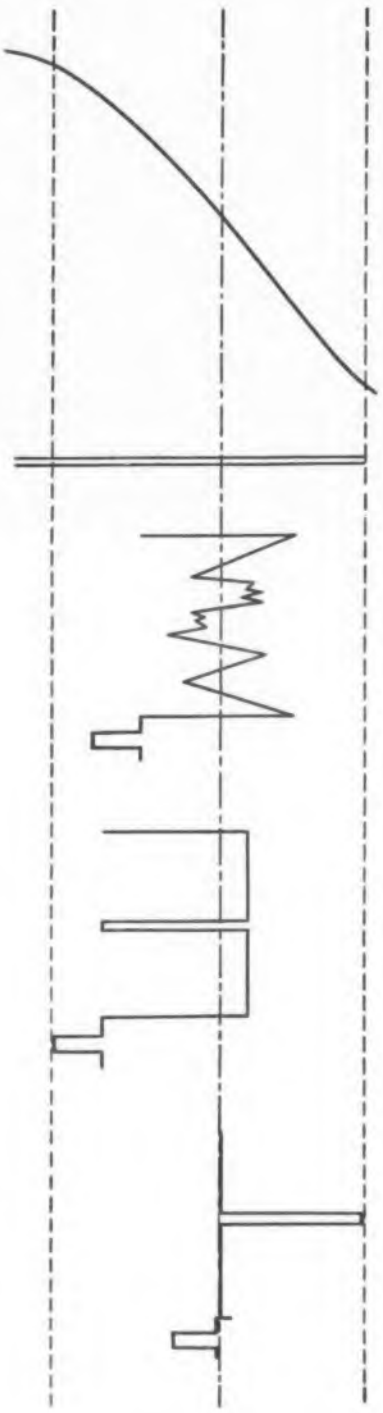
In order to include the two extremes of the picture tone scale—a predominantly white screen image or a predominantly black image—the grid-voltage swing called for is approximately 1.6 times that of the peak-to-peak detector-output voltage.

These two picture extremes are not commonly encountered in home set operation. However, their existence shows that a safety factor should be used when choosing video-amplifier tubes or establishing detector level, in order to assure good picture reproduction over a wide range of image content. The amount of safety factor will depend on the degree of compromise chosen by the designer. A factor between 1.24 and 1.4 times the detector-output voltage might be considered practical.

Tube Characteristics Vital—Select the Right Type!

Depending on individual circuit requirements, the TV designer should carefully consider a video-amplifier tube's cut-off characteristics and amplification factor insofar as these affect the tube's ability to cover the full desired grid-voltage range efficiently.

General Electric's wide selection of video-amplifier types helps the designer choose exactly the right tube for his circuit. Among G-E types are the popular 6AU8-A . . . 6/8AW8-A . . . 6/8CX8 . . . 6/8EB8 . . . 12BY7-A. Ask any G-E receiving tube office below for expert application counsel!



Curve at left plots plate voltage (vertical axis) against grid voltage (horizontal axis) for a video-amplifier tube with typical plate load.

Outer vertical lines show extremes within which constant peak-to-peak drive shifts. Middle line represents bias with no signal.

Average picture: mixed blacks, grays and whites. Waveform represents one horizontal scan line.

Scan line for a predominantly white picture, with vertical black bar at center.

Scan line for a predominantly black picture, with vertical white bar at center.

For further information, phone nearest office of the G-E Receiving Tube Department below:

EASTERN REGION
200 Main Avenue, Clifton, New Jersey
Phones: (Clifton) GRegory 3-6387
(N.Y.C.) WIsconsin 7-4065, 6, 7, 8

CENTRAL REGION
3800 North Milwaukee Avenue
Chicago 41, Illinois
Phone: SPring 7-1600

WESTERN REGION
11840 West Olympic Boulevard
Los Angeles 64, California
Phones: GRanite 9-7765; BRadshaw 2-8566

Progress Is Our Most Important Product

GENERAL ELECTRIC

12-11-206

character in the line across all 72 heads. The only head that prints is the one selected by a coincident pulse to the back plate, or "anvil." The electrostatic charge can be deposited in one millionth of a second.

The second character in the word would be set up across the line and printed serially in a similar manner. Obviously, a line of 72 characters wide would require only a small fraction of a second.

During the recording stage, the electrical discharge from the printing head to a metal plate—grounded or of polarity opposite that of the printing head—is used as the source of charge to form the electrostatic latent image on the paper surface.

The size of the image depends mainly upon the polarity, the electric field strength and the surface coating on the paper. A relatively low negative voltage applied to the point electrode gives small, round dots.

Operating at a lower speed of 750 words a minute to meet Army Signal Corps requirements, the new electronic messenger will be the major unit in the Army's new family of teletypewriter devices, all operating at 750 words a minute.

Sized-Down Seismograph

This is the first all-transistorized seismic amplifier system. It reportedly yields weight, power and size savings ranging from 50 to 80 per cent over conventional vacuum tube systems.

The entire 24-channel seismograph—complete with control and test circuitry—is contained in one waterproof case weighing only 57 lb. An all-transistorized regulated power supply and lightweight 12-v aircraft battery both are contained in another case weighing 45 lb. Vacuum tube seismic amplifier systems weighed in the order of 200 lb. Operator here holds an experimental silicon solar convertor charging 12 v battery. An all-transistorized regulated power supply at left, powering the seismograph in center, feeding recording oscillograph at right. Dubbed Explorer, the seismograph was designed and manufactured by Texas Intsruments Inc., Houston, Tex.

CIRCLE 7 ON READER-SERVICE CARD

BEHIND THE NEWS

Declassify 40 Year Accumulation of Military Documents

More than one million c . ft. of classified military documen s were wrenched from the National Archives and Federal reco d centers last month. This amount of paper represents most of the letters, reports, films, books, and memorabilia classified and collected by the military services between 1907 and Jan. 1, 1946. Even with this grand sweep, there still remains nearly 10 million cubic feet of paper collected within the last 12 years.

This mountainous accomplishment is made possible through a Defense Department Directive downgrading the tremendous backlog of documentation—with certain exceptions. Among the comparatively short list of exceptions are several of interest to the electronic design engineer: radar scope photography; documents describing electronic countermeasures or counter-countermeasures; those giving structural or performance data concerning Naval vessels or Naval armament and equipment, i.e. proximity fuses, fire control systems having designation MK 37 and numerically higher, including their associated computers and radars.

While the directive brings into the open many old documents, its very existence has tended to make military classifiers more keenly aware of the problems. Under the "needling" of declassification policy-maker Vice Admiral John M. Hoskins, USN (Ret.), guide lines may be established that will make the job of classifying that of the person who knows most about the document.

Meanwhile, in an attempt to stem the tide of classification, Hoskins' office has set up a periodic reporting system with the services. Certain criteria have been set up on an experimental basis. If they do not appear to be doing the job, then others will be developed to do it better.

NEWS BRIEFS...

. . . MI-AUTOMATIC DATA PROCESSING SYSTEM development for military and civil air traffic control proceeding "on schedule," General Precision Laboratories reports. Contracts with the MAB totalling $8 million awarded earlier this year specify 1960 target date for initial model completion. System will handle both in-route and terminal phases of flight, performing non-decision making functions.

. . . EYEGLASS HEARING AID features magnetic pickup in front frame. Sound and visual reception are thus coordinated. Pickup measuring 1/2 x 3/8 x 1/5 in. is of balanced armature variable reluctance variety. Feeds either monoaurally or binaurally. Acoustic gain is 50-60 db. Developed by Otarion Listener Corp. who are now going after military contracts in subminiature components.

. . . WIRE-GUIDED TORPEDO developed for the Navy's Bureau of Ordnance by Vitro Laboratories; Silver Spring, Md. Weapon is connected to its launching vessel by a wire that is paid out from the torpedo as it drives through the water. Operators aboard the launching vessel send electrical signals over the wire to guide the torpedo to a "kill." Range of Mark 39 was not disclosed.

. . . ION AND OTHER ELECTRICAL PROPULSION for space flight applications will be jointly developed by Marquardt Aircraft Company, Van Nuys, Calif., and Applied Radiation Corporation, Walnut Creek, Calif. Formal agreement was recently made by both companies who bring extensive complementary experience to the union.

. . . NEW SUPERSONIC AIR-TO-AIR GUIDED MISSILE climbs higher, flies faster and has a greater range than any of its predecessors. Fourth in the family of Falcon missiles produced by Hughes, the GAR-3 is scheduled to go into operational service as principal firepower of advanced all-weather jet interceptors of the Air Defense Command. White ceramic nose cone is longer and more pointed than the stubby, rounded radomes of earlier birds. Other external changes include greater length (slightly over seven feet), increased wing span, and extension of stabilizers so that they reach beyond the center of the airframe.

WASHINGTON REPORT

Herbert H. Rosen

The Poor, Poor Army

Depending on when you listen to their spokesmen, the Army is the greatest, best equipped, most knowledgeable organization in the world—or it is the most logistically starved, down-trodden, sinned-against collection of soldiers anywhere. Recently, the Association of the U. S. Army (AUSA) provided a forum for its members that was singularly blessed with a rather high degree of truth.

General L. L. Lemnitzer, Vice Chief of Staff—and probably Gen. Taylor's successor—set the stage with a reflection on modernization. "In terms of dollars," he said, "approximately 60 per cent of the Army's inventory today was procured during WW II or the Korean War." There's even more pre-WW II equipment still in use. Ancient equipment means serious drain on maintenance resources, besides the more important aspect that such equipment prevents the Army from fighting much of a battle.

But replacement equipment and new items are expensive. And a good proportion of the Army's money is being spent on missiles and missile support. Not the least for consideration is communications-electronics. Here, too, the spectre of too-little-too-late hangs over the Signal Corps. In proudly displaying its latest concept of mobility, the Signal Corps was forced to admit that much of its new equipment is still under development. A new Army Area Communications System requires an automatic electronic switching system—still under development. Tropospheric scatter radio terminals are still under development. So are a "push button" electronic telephone and belt-type pouch combat radio.

In combat surveillance, the Signal Corps is striving to "stitch" the battlefield with all-seeing drones. But, according to R & D Chief, Lt. Gen. A. G. Trudeau, the Army's ability to collect intelligence has not improved in the past few years, especially at jet speeds. He cited the vital need for more drones provided with IR, radar, and TV to keep the battlefield commander constantly aware of enemy troop movements.

Trudeau's outspoken remarks affirmed similarly annoying comments—annoying to the Army, that is—made by the Chairman of the Joint Chiefs

of Staff, Gen. Nathan Twining. The nation's top soldier hit at the Army for seeking too glamorous equipment to do an immediate job. The Army mobility concept was attacked. In this context Twining was directing his comments at "rapid and reliable communications, accurate target acquisition, and simple supply procedures." "Every aspect of modern technology should be used to improve these areas," he said.

Unnecessary Complexity

Twining went on to point out that "much of our equipment today is unnecessarily complicated. Are we making equipment so technical because it is supposed to be so today? I think we have introduced too many refinements and comforts into much of our equipment with resulting problems of maintenance under field conditions and training, not to mention the factor of cost . . ."

AUSA was shocked at this public rebuff, but could do little about it when its own people—Trudeau and Medaris—hit at the same areas. The R & D Chief called the requirements set by the military too high. He suggested that rather than seek perfection all the time, the services should be satisfied with, say, 90 per cent of the goal.

Trudeau also called for more decentralization of decision in light of rapid transportation and virtually immediate communications. He also advised that industry should be given greater authority over its projects. But, in being granted this authority, the companies must accept the responsibility of success and failure of the project.

This same kind of approach was reiterated by the Army's missile boss, Maj. Gen. J. B. Medaris. Furthermore, he thought that the military procedures for selecting contractors via open competition is too time consuming. Part of the long lead time between concept and operational capability can be attributed to this system.

Medaris also felt that industry's red tape is no more cumbersome than the military and is partly responsible for industry's inability to respond fast enough to the customer's changes in direction. He further chastised some elements of industry that have a "tendency to make a lifetime career out of a military project."

This same line was cast at industry by E. P. Quesada at a recent NSIA luncheon. Neither the new Federal Airways Agency director nor the AIMA chief gained many friends by these remarks. However, both have great influence on the kind and amount of work the electronics industry will be doing over the next few years. Quesada's FAA is expected to let many far-reaching contracts in air traffic control equip-

WASHINGTON REPORT

ment happen. And Medaris' part in missile activities need not be elaborated on.

But their influence goes even deeper than these indicators. Deputy Defense Secretary Donald Quarles expects to request a $42 billion budget for FY '60. In doing so, several large programs will have to be cancelled. Washington circles believe that missile and aircraft projects will be the hardest hit. And among these will be those conducted by companies giving every indication of making them "lifetime projects."

With all this great cry of an inadequate air defense, why is there such a delay in installing more missile masters for point defence typified by the Nike batteries? Rumors prevail that four such installations are now sitting in warehouses waiting for the Army and Air Force to decide who will have housekeeping responsibility and who will supply the bricks and mortar.

There should be quite a repercussion in the industry when—and if—ITT receives the award for the SAC global communications modernization program—456L. Although teamed with Hughes and Hoffman, ITT still carries a major share of the burden as well as having prime responsibility for SAC's command system, 465L. Many hundreds of millions of dollars are involved.

Without any illumination by publicity, it appears that the land-based Talos is slowly sinking into the ground. Pentagon Deputy Boss, Dr. Donald Quarles, admitted that there are now plans to discontinue its development—this, in spite of highly successful tests at White Sands.

Growth factor of Sperry Rand's Utah laboratories surprisingly high in light of recent recession. Officials claim the staff of Utah Engineering Laboratory will be more than 2000 by end of 1958. Big contract in laboratory is Sargeant solid-propellent guided rocket for the Army. Preliminary work on new antiballistic rocket, Vigilant, is also in progress. However, it is rumored that the work is only the first stage for a still highly classified follow-on missile of advanced design.

Complaints about too little applied R & D in electronics are refuted in EIA report that $1.4 billion was spent in 1956. Estimate is based on National Science Foundation survey. However, the figures are a reflection of a total cost of $6.4 billion for all basic research and applied R & D by all industries. According to former Defense R & D chief, Frank Newbury, about $12 billion is actually spent on R & D. If true, electronics R & D should rise accordingly. Further, since figures are based on the 1956 survey, 1958 estimates should be considerably higher.

EDITORIAL

Seek Ye Not The Truth

"You are doing a disservice to the nation when you try to find out how good our weapons stock-up against the Russian's." So spake Maj. Gen. John B. Medaris last month at a NEC news conference. What the nation as a whole will know about our security will come from official communiques only. Official communiques in the past have been too often half-truths. Acting on incomplete facts, newspapers and magazines have often drawn erroneous conclusions, and we have editors confessing, "Why My Newspaper Lied" (*Saturday Review of Literature*, April 5, 1958). Engineers are often no better informed. Your source of information of our weapons' capabilities is often the newspaper or magazine. Despite your secret security classification, you often don't qualify as having a "need-to-know" requirement. As a consequence, few people know our real position. The rest of us apparently can do little more than have faith in those entrusted to decide what is good for us.

How you can get this faith is difficult to say. You usually know men not by their words but by their deeds. We see some deeds like Nike missiles and atomic submarines in sufficient quantities to impress us. Perhaps many of the words said impress us too until we remember words or symbols only and not the things they represent. Words are no good by themselves and as for the deeds of the military, we have no reference by which we can judge them. Do we then judge by the character of those who speak the words?

To judge a person's character is not easy. There are catalogs of virtues to be used: most of them suspect when one speculates on the possible motivations that drive a person. Motivations quite accidentally create results recognized as virtues. Vested interests are certainly motivations which raise havoc with a person's rationale.

Two virtues do stand out: selflessness and honesty. The selflessness of the kind shown by Heinrich Hertz who was too busy doing new things to bother to file patents for his own welfare is no doubt too much to expect in today's society. Scrupulous honesty would demand that we don't get any misleading information that either scares us too much or comforts us too much. This requires courage. And such courageous persons may easily expend their usefulness in official circles as did J. Robert Oppenheimer.

As most of us are thwarted in seeking the whole truth, let us ask that those with higher responsibility put truth above self-interest. Let's ask that skeptics be part of our top team as thinking starts with skepticism.

James C. Tippett

Graphical shortcuts can make the design of transistor circuits easier.

Graphical Design of Transistor Bias Circuits

G. V. Woodley
Raytheon Mfg. Co.
Waltham, Mass.

DESIGNING transistor bias circuits can be simplified by representing the following considerations graphically:

- the relative magnitudes of the resistors involved;
- the power consumed in the bias circuit;
- the stability of the chosen bias current for various conditions of temperature and for different transistors of the same kind.

Here is a method by which these three considerations can be represented graphically, making the design of the bias circuit easier. Two biasing schemes will be examined—one rather thoroughly. A design problem illustrates the method of determining the bias circuit of an ac transistor amplifier.

Two Biasing Schemes

Two schemes of biasing are shown in Fig. 1. Here i_c is the desired collector bias current; i_t is the base current necessary to achieve this ($i_c \cong \beta\, i_t$), and R_t is the input impedance of the transistor ($R_t \cong \beta\, R_e$). Let us examine these two schemes one at a time.

Common Method of Biasing

To determine the impedance level relationships which hold for any given bias current desired, the transistor circuit of Fig. 1a is approximated by passive circuit of Fig. 2.

In this circuit

$$\left(i_t = \frac{R_b}{R_b + R_t}\right)\left(\frac{E}{R_f + R_b\, R_t}\right) \tag{1}$$

from which

$$\frac{R_f}{R_t} = \frac{K^1 \dfrac{R_b}{R_t}}{\dfrac{R_b}{R_t} + 1} \tag{2a}$$

$$K^1 = \frac{E - i_t\, R_t}{R_t\, i_t} \tag{2b}$$

The stability consideration is as follows. Assume that the steady-state collector current is made up of two parts:

$$i_c = \beta\, i_t + (\beta+1) I_{co} \tag{3}$$

Here I_{co} is defined as the common-base-circuit collector-cutoff-current. This is the standard definition, and hence the multiplier $(\beta + 1)$. Defining the stability factor S as,

$$S = \left.\frac{\partial i_c}{\partial I_{co}}\right|_{V_c = \text{const.}} \tag{4}$$

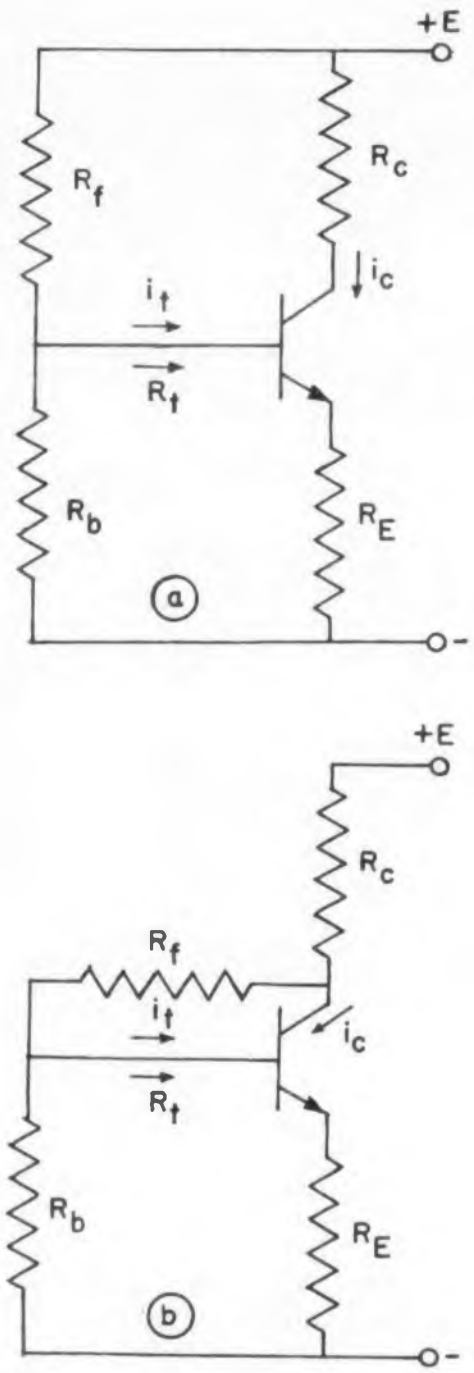


Fig. 1. Two biasing circuits. Fig. 1a shows a common method of biasing transistors by the use of one battery. Fig. 1b shows a feedback method of biasing transistors by use of one battery.

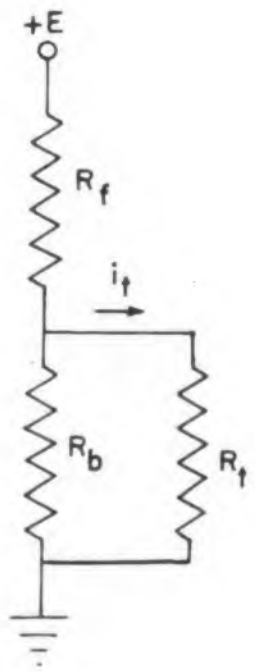


Fig. 2. Passive approximation to the bias circuit of Fig. 1a.

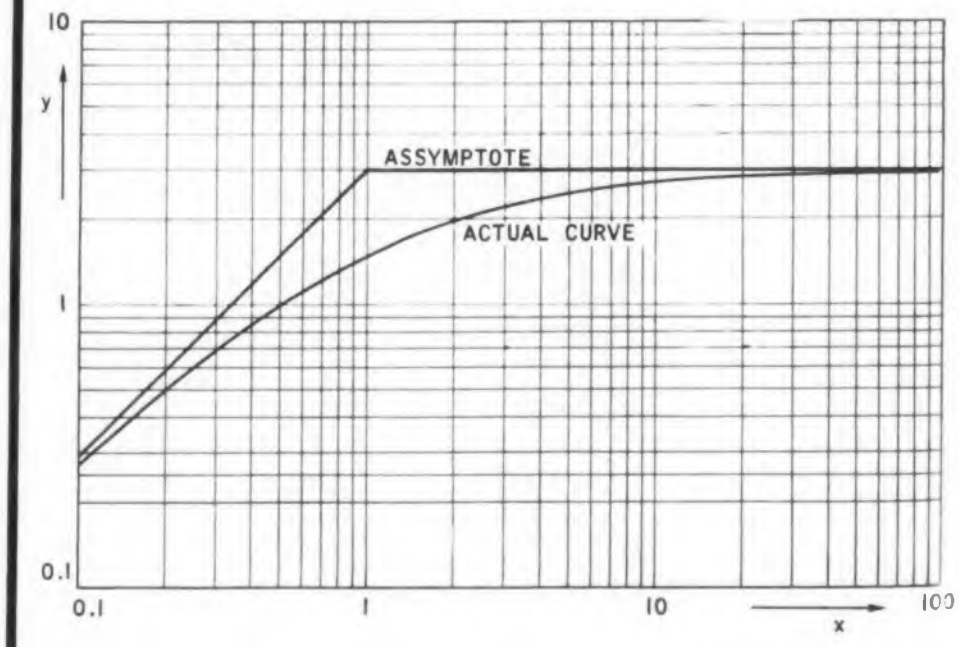


Fig. 3. Assymptote and actual representation of the equation $y = Kx/x+1$ for $K = 3$.

ne as a figure which expresses the change in he collector current due to the change in the cut-off current. The larger this figure is, the more unstable is the bias. Writing the necessary equations for Fig. 1a and solving them for i_o as expressed in Eq. (3), we differentiate the expression obtained with respect to I_{co} and obtain Eq. (5).

$$S = \frac{1 + \frac{R_e}{R_f} + \frac{R_e}{R_b}}{1 - \alpha + \frac{R_e}{R_f} + \frac{R_e}{R_b}} \tag{5}$$

Note that R_t/β is substituted for R_e, and $1/\beta$ for $(1-\alpha)$.

Substituting Eq. (2a) into Eq. (5), we get

$$S = \frac{\frac{R_b}{R_t}\left(\frac{\beta K^1 + 1}{K^1 + 1}\right) + 1}{\frac{R_b}{R_t} + 1} \tag{6a}$$

$$S = \frac{\frac{R_b}{R_t}\left(\frac{\beta K^1}{K^1 + 1}\right) + 1}{\frac{R_b}{R_t} + 1} \tag{6b}$$

As an approximation Eq. (6b) is justified if $\beta K^1 >> 1$, which is usually the case.

To determine the bias power, the approximation in Fig. 2 is used. From this,

$$P_b = \frac{E^2}{R_f + R_b R_t} \tag{7}$$

Again substituting Eq. (2a) into Eq. (7),

$$P_b = \frac{P^1}{K^1 + 1} \frac{\frac{R_b}{R_t} + 1}{\frac{R_b}{R_t}} \tag{8a}$$

$$P^1 = \frac{E^2}{R_t} \tag{8b}$$

Eqs. (2), (6), and (8) are the three important considerations of a bias circuit expressed as a function of the base resistor, nondimensionalized with respect to the input impedance of the transistor.

A graphical method of expressing these relationships can be found, if one examines these relationships and notices their similarity to frequency-domain representations of passive compensating networks. These expressions have asymptotes and correction factors, and can be drawn very easily by the use of a template. The equation and graph of such a template is given in Fig. 3. The template can be constructed out of cardboard or plastic from the graph.

(Continued on following page)

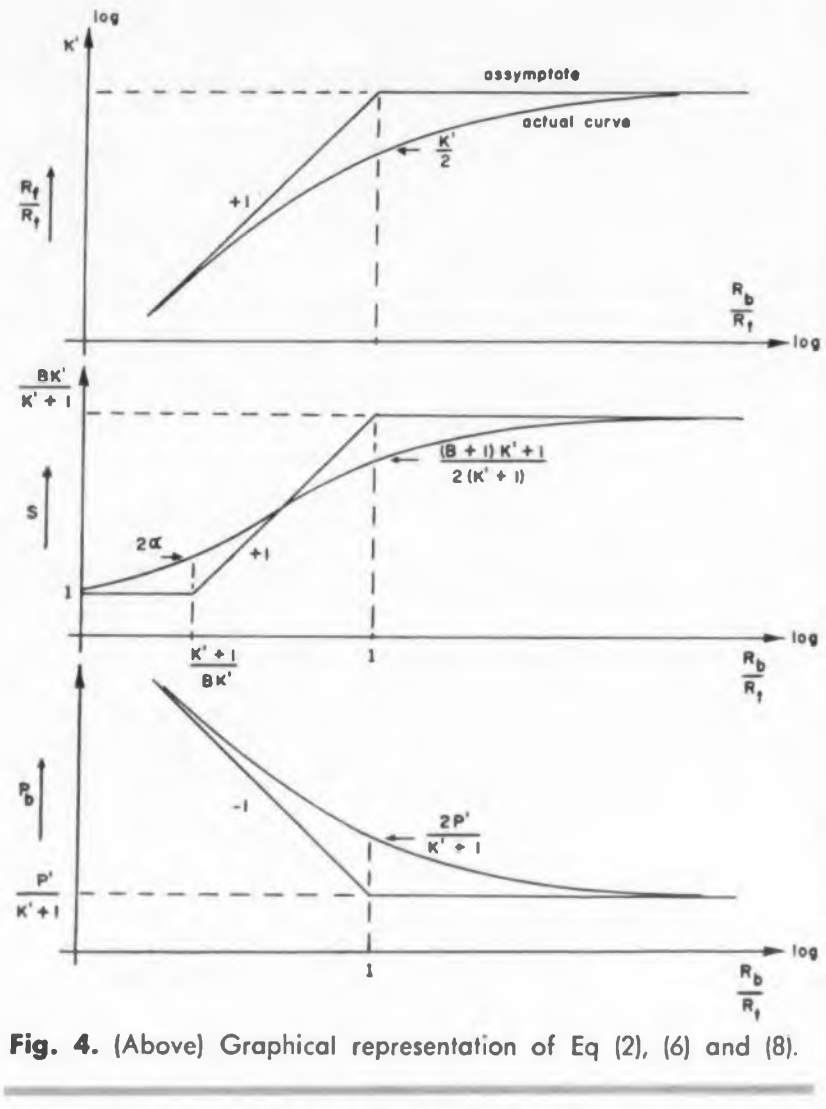


Fig. 4. (Above) Graphical representation of Eq (2), (6) and (8).

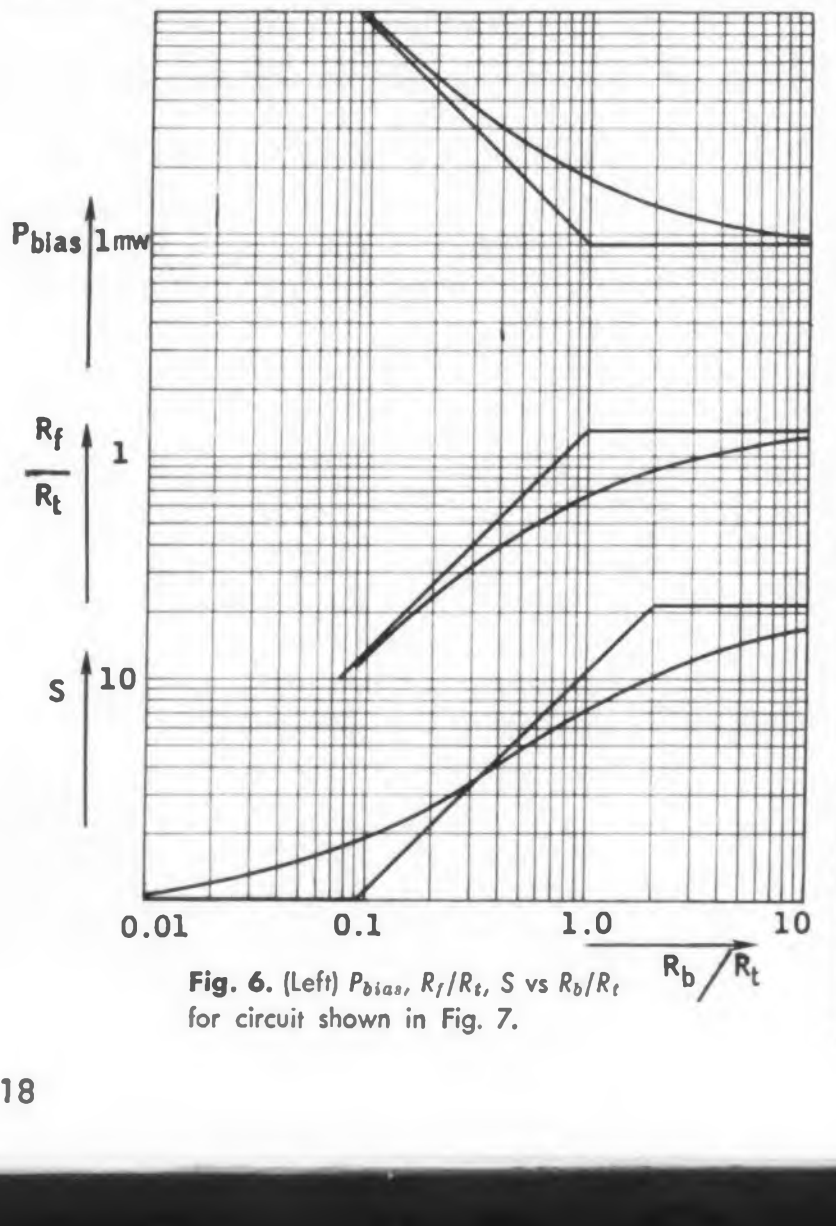


Fig. 6. (Left) P_{bias}, R_f/R_t, S vs R_b/R_t for circuit shown in Fig. 7.

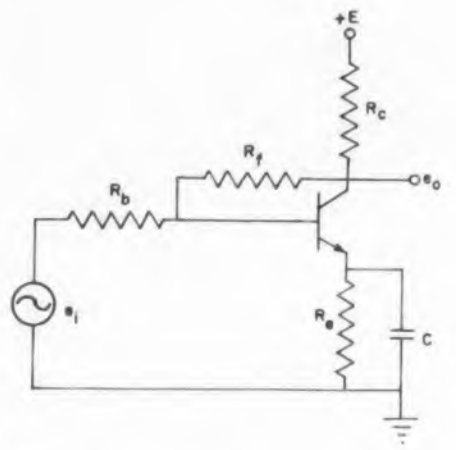


Fig. 5. (Above) Common emmitter feedback amplifier.

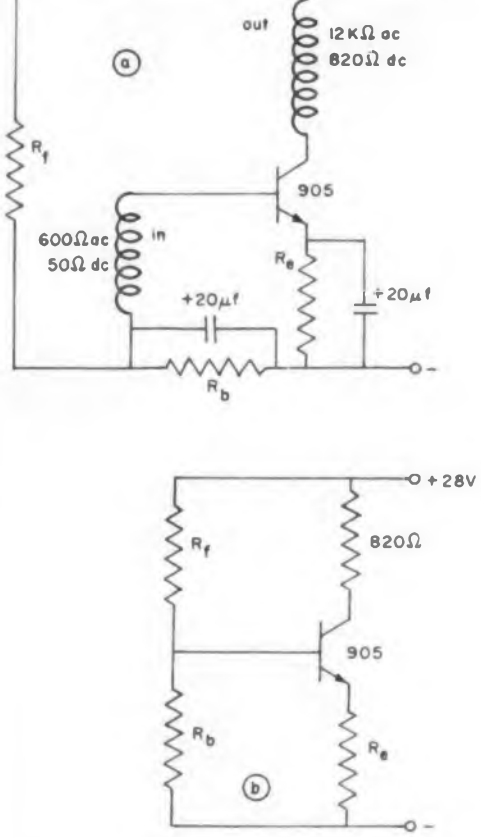


Fig. 7. (Above) Circuit of an ac amplifier. Fig. 7a shows the ac circuit and Fig. 7b shows the dc equivalent.

Eqs. (2), (6), and (8) are graphically represented in Fig. 4. Note that,

$$P^1 = \frac{E^2}{R_t} \quad K^1 = \frac{E - i_t R_t}{i_t R_t}$$

The representation of Fig. 4 can be drawn easily for any particular case with the help of template. Whenever one quantity is varied, the effect on any of the others can be determined at a glance. The illustrative example presented later, shows a typical procedure using Fig. 4.

Feedback Method of Biasing

Here the situation is more difficult. Some of the equations of interest have been derived, however, and are presented here.

In this case one additional consideration becomes important—that of gain. A common-emitter circuit is used as shown in Fig. 5. If C is large enough, then

$$\left.\frac{e_o}{e_i}\right|_{ac} \cong \frac{-R_c R_f}{R_b\left[\frac{R_f}{\beta+1} + R_e\right]} \tag{9a}$$

The dc gain is:

$$\left.\frac{e_o}{e_i}\right|_{dc} = \frac{-R_c\,[(\beta+1)\,R_f - R_t]}{R_b R_f + R_t R_f + R_t R_b + R_c\,[(\beta+1)\,R_b + R_t]}$$

The bias current i_c is given by,

$$i_c = \frac{\alpha\, E/R_f}{1 - \alpha + \frac{R_e}{R_f} + \frac{R_e}{R_b} + \frac{R_c\,(R_e+R_b)}{R_b\,R_f}} \tag{10}$$

The stability factor is,

$$S = \frac{1 + \frac{R_e}{R_f} + \frac{R_e}{R_b} + \frac{R_c\,(R_e+R_b)}{R_b R_f}}{1 - \alpha + \frac{R_e}{R_f} + \frac{R_e}{R_b} + \frac{R_c\,(R_e+R_b)}{R_b\,R_f}} \tag{11}$$

Note that Eqs. (10) and (11) have the same denominator.

A point of interest is the similarity of Eqs. (5) and (11). In Eq. (11) the term $\frac{R_c\,(R_e+R_b)}{R_b\,R_f}$ is added to both the numerator and denominator of Eq. (5). This term has the effect of increasing the stability of bias current.

An important special case of Eq. (11) exists when $R_e = 0$.

If $R_e = 0$,

$$S = \frac{1 + \frac{R_c}{R_f}}{1 - \alpha + \frac{R_c}{R_f}} \tag{12}$$

The stability is not a function of R_b, but the gain, Eq. (9a), is, making it possible to adjust

gain without affecting the stability. Eq. (12) can be adopted to graphical methods very easily. This sort of bias can be used most effectively in the last stage of an ac amplifier.

Illustrative Example

The methods of Fig. 4 will be used to determine the biasing circuit of an ac transistor amplifier.

The following is the synthesis procedure. Since the max voltage swing of the 905 is 30 v and the ac load is 12.0 K, we wish to bias the transistor in the middle of a 30 v —12.0 K load-line, or at $i_c = 1.25$ ma, $v_c = 15$ v. The emitter voltage should be

$$V_e = 12 \text{ v} = 1.25\, R_e$$

Assuming that $i_e = i_c$. From this, $R_e = 10\ k_r$. One measurement is necessary for the accurate determination of K^1. Opening R_6 and substituting a decade resistor for R_f, this decade resistor is varied until the desired emitter current is obtained. In this case this produces an emitter voltage of 12 v with a 10 K emitter resistor. This value of R_f, which shall be referred to as $R_{f\infty}$, because it was measured with $R_6/R_t = \infty$, was 500 K in this case.

From the voltage divider relationship, assuming no drop between base and emitter, $R_t = 375$ K and $\beta = 37.5$.

Since $$K^1 = \frac{R_{f\infty}}{R_t},\ K^1 = \frac{500}{375} = 1.33.$$

Also, $P^1 = E^2/R_t = 2.1$ mw, and $P^1\,(K^1 + 1) = 0.9$ mw. The additional bit of information we need before drawing Fig. 4 for this case is that

$$\frac{K^1}{K^1 + 1} = 21.4.$$

Using this information, Fig. 6 is constructed. A special template constructed for 2-1/4" x 2-1/4" cycle log-log paper was used.

In this case, the bias power is inconsequential.

Choosing $S = 2$, we read: $\frac{R_b}{R_t} = 0.12$; $\frac{R_f}{R_t} = 0.15$;

P bias $= 8$ mw. From which $R_b = 47$ K, using resistors in the 5 per cent rma values.

Summarizing then for the circuit in Fig. 7,

$$R_e = 10\ K_n$$
$$R_b = 47\ K_n$$
$$R_f = 56\ K_n$$
$$S = 2$$
$$P_b = 8 \text{ mw}.$$

This network was constructed and checked experimentally. The emitter voltage for a group of six different 905 transistors varied from 12.2-12.6 v, against a calculated value of 12 v.

Reflectionless Bead for Symmetrical Strip Transmission Line

K. S. Packard
Airborne Instruments Lab.
Mineola, N. Y.

The design of a reflectionless bead for supporting the center conductor of a strip transmission line is described. The design and fabrication are simple and the SWR is extremely low over the full useful frequency range of most practical symmetrical strip transmission lines.

IN ANY multiconductor transmission line some means for maintaining the spacing of the conductors is required. In the symmetrical strip transmission line, comprising a rectangular center conductor equally spaced between two parallel ground planes, one may usually use a continuous dielectric sheet to perform this function. There are applications, however, where it is desirable to use a bead-supported center conductor. In such cases one could use any of the common bead design techniques used for coaxial lines. But all the more practical ones suffer from some degree of frequency sensitivity.[1] Symmetrical strip transmission line has a property not possessed by coaxial line. It is the possibility of constructing a simple, series inductive-discontinuity. This property permits the design of a simple reflectionless bead.

Designing the Bead

Consider the symmetrical strip transmission line shown in Fig. 1. The plan view shows an undercut in the strip width to compensate for the relative dielectric constant of the bead and maintain the characteristic impedance constant. The discontinuity reactance introduced by this undercut is pure series inductive.[2] If the bead is allowed to overlap the undercut, a pure shunt capacitive reactance will be introduced at this point. Providing that the extent of these discontinuities is small compared with a wavelength they will not be sensitive to frequency. Then by making the ratio of inductance to capacitance equal to the square of the characteristic impedance of the line, the bead will be reflectionless.

In any specific case the required overlap may be found as follows. For a given characteristic impedance, Z_o, and dielectric constant, ε, the width, W', of the undercut portion of line may be found from curves of the characteristic impedance.[3] The discontinuity inductance is given by,[2]

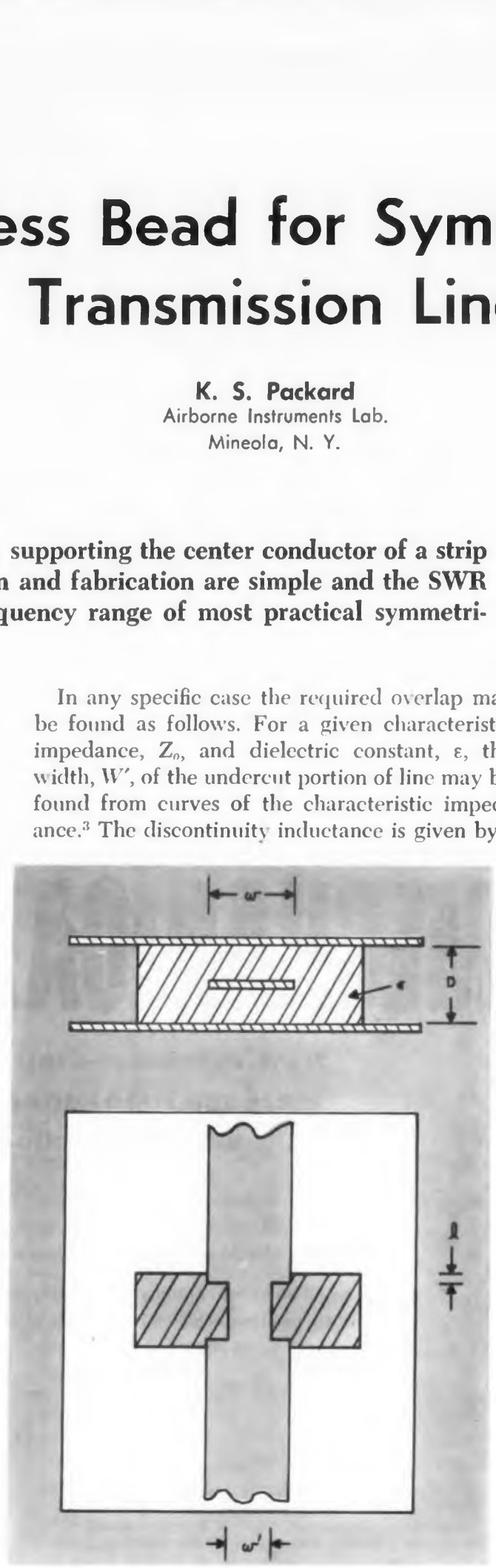


Fig. 1. Reflectionless bead for strip transmission line.

$$L = Z_o \frac{2W}{\omega\lambda} \ln \csc\left(\frac{\pi W'}{2W}\right) \qquad (1)$$

where

$$W = D\,K(k)/K'(k),\ k = \tanh\left(\frac{\pi w}{2D}\right)$$

K and K' are complete elliptic integrals of the first kind. In most practical cases where $w/d > 0.5$, an adequate approximation is

$$W = w + \frac{2D}{\pi} \ln 2.$$

The quantity W' is defined similarly. The discontinuity capacitance for small l is given by,

$$C = \frac{l\,(\epsilon-1) \times 10^{-10}}{3\,Z_o} \qquad (2)$$

where l is measured in cm.

For no reflection, the characteristic impedance in the vicinity of these discontinuities, which are considered to be of infinitesimal extent, must be made equal to Z_o. Thus

$$L/C = \frac{6\,Z_o^2\,W \ln \csc\left(\frac{\pi W'}{2W}\right)}{(\epsilon-1)\,l\,\omega\,\lambda \times 10^{-10}} = Z_o^2 \qquad (3)$$

Noting that $\omega\lambda = 2\pi c/\sqrt{\epsilon}$

where $c = 3 \times 10^{10}$ cm per sec, we find that the required overlap is,

$$l = \frac{W \ln \csc\left(\frac{\pi W'}{2W}\right)}{\pi \frac{\epsilon - 1}{\sqrt{\epsilon}}}\ cm \qquad (4)$$

It remains to be shown that l is small compared to a wavelength.

In a practical transmission line of this type, $D < \lambda/4$, and for a dielectric constant of about

we will find that

$$ln\ csc\left(\frac{\pi W'}{2W}\right) \approx 0.2,\ \frac{\epsilon - 1}{\sqrt{\epsilon}} \approx 1$$

and

$$l \approx 0.07\ W.$$

In the region of 50 ohms,

$$W \approx 1.5\ D$$

so that

$$l \approx 0.03\ \lambda$$

which is sufficiently small for the tangent of the electrical length to be approximated by the length to a 1 per cent accuracy. Even at the maximum usable frequency of the line, where $D = \lambda/2$,

$$l \approx 0.06\ \lambda$$

which is still sufficiently small for good compensation.

It should be noted that in the case of a thick strip, a truly infinitesimal capacitive discontinuity may be obtained by decreasing the thickness in the bead region.[4] The combined change in both thickness and width would, however, prove difficult to analyze.

Design Problem

To indicate the order of magnitudes involved, let us consider a 50 ohm line with a ground plane spacing of 0.5 in., a strip thickness of 0.025 in. and a polystyrene bead ($e = 2.56$). We have then

$w = 0.648$ in., $W = 0.868$ in. $= 2.20$ cm.

$w' = 0.318$ in., $W' = 0.538$ in.

and

$$l = \frac{2.2\ ln\ csc\left(\frac{0.538\pi}{1.296}\right)}{0.975\ \pi}$$

$$l = 0.137\ \text{cm.} = 0.054\ \text{in.}$$

A line of these dimensions is normally used in the 10 cm wavelength region so that the electrical length of the overlap is only 0.014 λ. The overlap is, however, of sufficient size so that it can be machined accurately.

It is quite likely that, in any practical application of this design technique, the chief source of residual reflection will be the fabrication tolerances.

References

1. Microwave Transmission Circuits, G. L. Ragan, McGraw-Hill, 1948.
2. Equivalent Circuits for Discontinuities in Balanced Strip Transmission Line, A. A. Oliner, *Trans. IRE*, Vol. MTT-3, pp. 134-143, March 1955.
3. The Characteristic Impedance of the Shielded Strip Line, H. T. Bates, *Trans. IRE*, Vol. MTT-4, pp. 28-33, January 1956.
4. Equivalent Circuits for Discontinuities in Transmission Lines, J. R. Whinnery and H. W. Jamieson, *Proc. IRE*, Vol. 32, pp. 98-114, February 1944.

Simulated Doppler Effects For Radar System Testing

J. E. Toffler
Hughes Aircraft Co.
Los Angeles 45, Calif.

MANY types of conventional fire control and missile radar systems employ a gated receiver. A gated receiver is one which receives signals only during the time that the reflected signal pulse from the desired target is being received. This prevents random noise from saturating the receiver and also provides a method of selecting one target out of many. Due to the Doppler effect, the echo pulses and hence the receiver gating pulses will generally not be at the same frequency as the transmitted pulses, and may be varying in frequency. This article explains how to calculate the frequency shifts involved and suggests a method of simulating these shifts to test receiver tracking capability (the ability to remain in synchronism with the echo pulses).

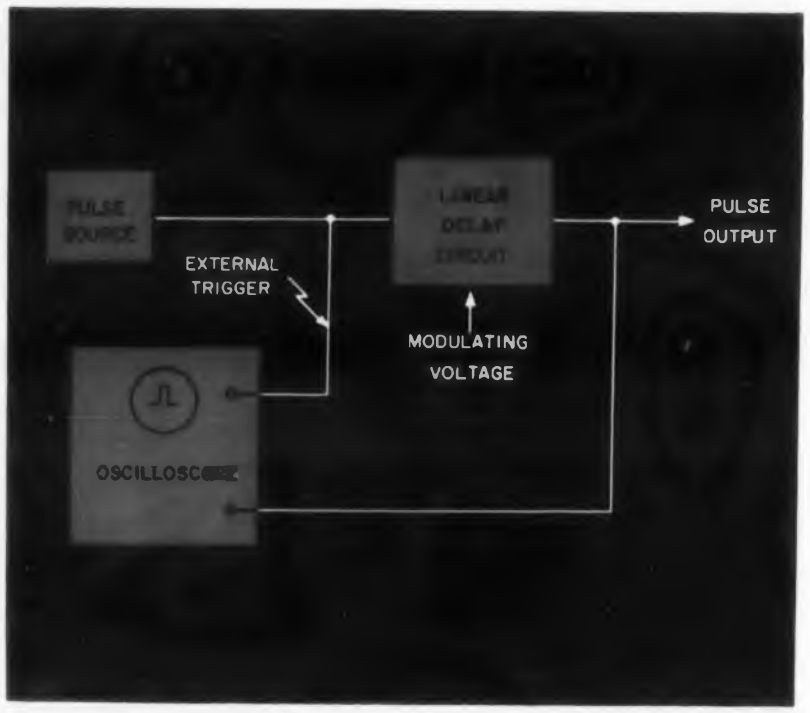


Fig. 1. Monostable delay circuit. The delay is almost proportional to the applied voltage.

Calculating Doppler Frequency Shift

The usual formula for calculating Doppler frequency shift is,

$$f_1 = f_o\left(1 \pm \frac{v}{c}\right) \tag{1}$$

where

f_1 = observed frequency

f_o = actual source frequency

v = relative velocity between source and observer

c = velocity of transmitted energy (980 ft. per μsec for light)

The above formula is exact only for the case of a stationary source of sound waves and a moving observer. In the case of light, unlike sound, it is immaterial whether the relative velocity is due to the source or to the observer. Neglecting second order effects, however, eq (1) is accurate enough for most purposes.[1]

To find the fractional change in frequency required, eq (1) can be written,

$$\frac{f_1 - f_o}{f_o} = \frac{\Delta f_o}{f_o} = \pm\frac{v}{c} \tag{2}$$

The rate of frequency shift due to a relative acceleration can be found by differentiating,

$$\frac{d}{dt}\left(\frac{f_o}{f_o}\right) = \pm\frac{1}{c}\frac{dv}{dt} = \pm\frac{a}{c} \tag{3}$$

where

a = acceleration

In radar systems the source is usually a reflecting target. For the most general case, it is necessary to consider three-point Doppler theory involving a true source, a reflector, and an observer. Based on these considerations, a suitable apparent velocity and acceleration can be selected to use for v and a in eqs 2 and 3 to determine the required frequency shift.

As an example, assume that test equipment is needed to test the tracking capability of a receiver for a simulated signal representing a maximum acceleration of 400 g, or 0.0129 ft/μsec/sec. Using eq 3, it is seen that the required rate of frequency shift is 13.1 parts per million (ppm) per sec.

It is difficult to design a precision crystal oscillator which will provide a constant rate of frequency shift and also difficult to check or calibrate the oscillator to verify that the frequency shift is correct. An alternate approach is to use a modulated time delay system. This method allows the designer freedom in the design of the precision oscillator, is relatively easy to design and test, and allows for "programs" of accelerations and decelerations or velocities of any magnitude.

If recurrent pulses are all delayed by a certain fixed time interval, the resultant pulse train will represent a condition of zero velocity and zero acceleration. By changing the time interval linearly, a constant velocity can be simulated; by changing in a "square-law" manner, a constant acceleration is simulated.

Measuring Doppler Frequency Shift

The frequency shift can be readily measured with an oscilloscope having a time base calibrated in microseconds, due to the simple relation that the frequency shift in parts per million is numerically equal to the output pulse velocity across the face of the oscilloscope in microseconds per second; or the total displacement in microseconds equals the time integral of the frequency shift:

$$S = \int_{T_1}^{T_2} \frac{f_1 - f_o}{f_o}\,dt \tag{4}$$

where $T_2 - T_1$ is the time interval over which the displacement is measured. The time modulation of the output pulse can be obtained with a monostable delay circuit, such as a phantastron or a cathode coupled multivibrator, in which the delay is very nearly proportional to an applied voltage.[2]

This system is illustrated as a block diagram in Fig. 1. To observe displacement of the output pulse, it is necessary to trigger the oscilloscope externally with the original undelayed pulse. An

expanded sweep is very helpful in making accurate measurements.

A simple plan is to choose a sinusoidally varying acceleration, causing velocity and displacement also to be sinusoidal. A sinusoidal voltage for modulation of the delay can be obtained from a low frequency oscillator, a function generating potentiometer, or a synchro.

Example

Assume that a sinusoidal acceleration is desired with peak amplitudes ±400 g, and a period of 2 secs. As shown above, 400 g corresponds to a rate of frequency shift of 13.1 ppm/sec. Therefore the acceleration and rate of frequency shift are,

$$a \text{ (in g units)} = 400 \sin \frac{\pi}{2} t$$

$$\frac{d}{dt}\left(\frac{\Delta f_o}{f_o}\right) = 13.1 \sin \frac{\pi}{2} t$$

The frequency shift is obtained by integrating,

$$\frac{\Delta f_o}{f_o} = \frac{f_1 - f_o}{f_o} = \int 13.1 \sin \frac{\pi}{2} t \, dt$$

$$= \frac{-2}{\pi} \times 13.1 \cos \frac{\pi}{2} t$$

Finally, the displacement observed on the oscilloscope is obtained by using eq (4).

$$S = \int_1^3 -8.34 \cos \frac{\pi}{2} t \, dt$$

$$= 10.6 \ \mu\text{secs}$$

It is thus very easy to check or adjust the acceleration to 400 g merely by adjusting the total pulse displacement on the oscilloscope to 10.6 μsecs. The simulated velocity in this case can be found by integration of the acceleration. As mentioned previously, 400 g equals 0.0129 ft/μsec/sec. Therefore,

$$V = \int a \, dt$$

$$= 0.0129 \sin \frac{\pi}{2} t \, dt$$

$$= -0.0082 \cos \frac{\pi}{2} t$$

This represents a maximum apparent velocity of 0.0082 ft per μsec or 5,600 mph.

References

1. Fundamentals of Optics, Jenkins and White. McGraw-Hill Book Co., 1950, Pages 190-195.
2. Pulse and Digital Circuits, Millman and Taub. McGraw-Hill Book Co., 1956. Pages 193-194, 225-228.

Comparing

Illuminated In-Line Readouts

DIGITAL presentation of data has three advantages over the analog method. They are:

- Elimination of human estimating error.
- Speed in observing data.
- Reduced fatigue of human operator.

Most popular of the digital presentations are the illuminated digits arranged in a horizontal row: In-Line Readouts. They are currently available in many sizes and digit combinations. Five of the more common types of illuminated readouts are compared in the table appearing on the opposite page. These units represent a sampling of the market and include representatives of major design concepts.

How Accurate?

Accuracy of the digital readouts are dependent on three factors. One is the ability of the instrument to reproduce exactly the data presented to it. Most readout designs are such that mistakes on the part of the display unit are next to impossible. This is because the actuating signals either directly activate the display digits, or are processed through decoding units which are highly reliable. Another factor upon which accuracy depends is the nature of the display. It must not lead to faulty recognition of the digits. The third factor is the manner of forming the characters. Some displays form characters from bars, segments or dots of light. Failure of certain of these elements can sometimes cause characters to be misread.

Visibility

Effective visibility of the digital display is an important aspect of performance. All units analyzed in the table depend on the contrast between the digits' own luminescence and that of the surroundings for effectiveness of visibility. In general, the poorer the ambient lighting conditions, the greater the visibility of the Readout.

Maintenance

The major portion of Readout maintenance is centered in lamp replacement. Regardless of precautionary measures, lamps eventually burn out. Most Readouts examined have been constructed to permit replacement of the lamps easily and quickly.

Five Illuminated In-Line Readouts Compared

Features Compared	Edge-Lighted Lucite Plates	Multi-Lens Projection	Glow Discharge Tube	High Intensity Lamps	Lighted Segments
Character construction	Characters are engraved on separate lucite plates which are arranged one behind the other.	Characters are photo engraved on concave surfaces of condensing lenses which are molded on one lucite plate.	Numerals stacked into gas-filled, cold cathode tube and act as glow discharge cathodes.	Many neon lamps placed directly behind the viewing screen to form characters.	Combinations of straight-line segments form the characters.
Method of Illumination	Each plate edgelighted with individual lamp. Light reaching engraving is reflected out.	Light passes through lens and is focused on a screen. There is one lamp per lens.	Cathode corresponding to desired numeral is energized. Glow results from ionization.	Lamps corresponding to points in a character's shape are energized and projected on screen.	Light from proper segments produce desired characters.
Visibility	1 in. high character on 2 in. sq plate visible to 40 ft within angle of 45 deg. (NLS).	100 per cent intensity viewing of all characters for 90 deg. included angle (IEE).	0.8 in. characters visible up to 40 ft (Burroughs HS).	2.25 in. numerals visible up to 200 ft viewing angles of 150 deg. included angle (CMC).	1.25 in. numerals provide visibility over 40 ft through viewing angles of 150 deg. included angle (Beckman).
Other factors	Characters can be changed by removing plates. Lamps are available over wide voltage range, are easily replaced. Each unit can hold 12 characters.	Data from two lenses may be projected on screen. Using colored lenses a character may be overlayed with a colored spot of light. This technique used with go-no-go gage readings.	Ten numerals, 0 to 9 available. Units are low in cost, consume little power.	A lamp failure does not lead to recognition error. At least 3 lamps must fail before error can occur.	As with some other units, there is no masking of characters by unused elements.
Manufacturers	Non-Linear Systems, Inc., Delmar, Calif., Millman Engineering Co., Los Angeles, Calif.	Industrial Electronic Engineers, North Hollywood, Calif.	Burroughs Corp., Plainfield, N.J.	Computer Measurements Corp., North Hollywood, Calif.	Beckman Instruments Inc., Berkeley Div., Richmond, Calif.

Fig. 1. This edge-lighted display is manufactured by Non-Linear Systems, Inc., Del Mar, Calif. Lighting both numeral and the decimal point simultaneously provides a combination of two symbols.

Fig. 2. Display units combining several projection systems in horizontal rows. Manufactured by Industrial Electronic Engineers, North Hollywood, Calif.

Fig. 3. This "Nixie" numerical indicator tube is produced by Burroughs Corp., Plainfield, N.J.

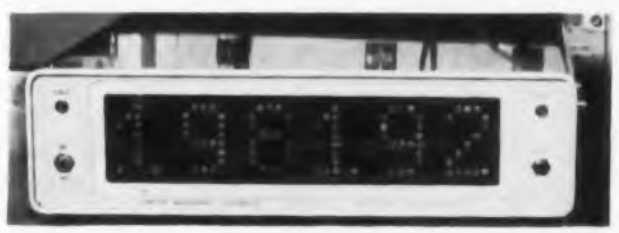


Fig. 4. High-intensity lamps form the characters in this Readout unit. Manufactured by Computer Measurements Corp., North Hollywood, Calif.

Fig. 5. Seven lighted characters form the numerals 0 through 9 in this unit, manufactured by Beckman Instruments Inc., Berkeley Div., Richmond, Calif.

Transistor Variable Gate with High Stability

Everett R. James
Motorola Inc. Research Lab.
Riverside, Calif.

WITH JUST a few minor changes the stability and accuracy of the basic gating circuit can be increased by a factor of ten. A simple feedback arrangement and the use of improved products such as the Sensitor (a silicon resistor with a well defined temperature coefficient) make this improvement possible. Now many circuits that previously were put aside as unsatisfactory become acceptable.

Compensation of the voltage controlled monostable multivibrator circuit described in this article is only one example. The compensation scheme used to stabilize this circuit is certainly applicable to other forms of the multivibrator circuit. Investigation show that compensation is also possible in the bistable flip-flop circuit.

Design Requirements

A gating signal is required which could be varied from 10 μsec to 120 μsec by a dc analog voltage while holding an accuracy of 1 per cent

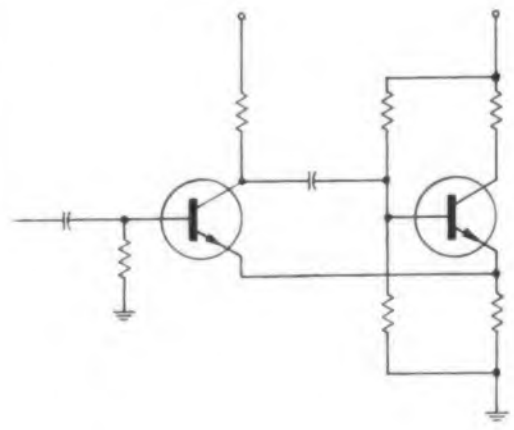


Fig. 1. (Above) Basic circuit.

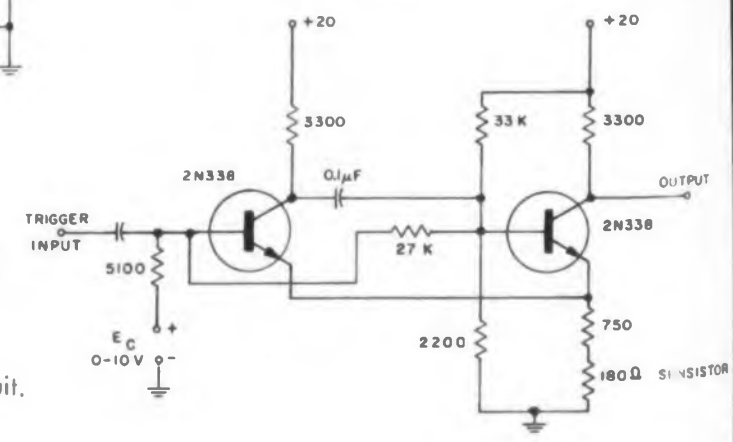


Fig. 2. (Right) Final circuit.

1 per cent accuracy must be maintained at an operating temperature of 75 C. The basic circuit selected to satisfy the first requirement is a monostable multivibrator. The multivibrator because of its sensitive trigger level is most adaptable to voltage control. The transistor version of this circuit has been thoroughly discussed in numerous publications.[1,2] Therefore, the design of the basic circuit will not be covered in this article.

It is of interest, however, to discuss the reason for selecting the particular configuration shown in Fig. 1. Because of the temperature performance of the circuit, it is desirable to use silicon transistors. The present state of silicon transistors restricted the circuit to a configuration using two npn transistors. The cathode coupled arrangement is selected to facilitate stability and temperature compensation.

Selecting The Proper Transistor

Once the basic configuration is established, it is necessary to select the transistors. The 2N338 is selected because of its low I_{CBO} and high speed response. The output waveform must have a 1 μsec rise time in order to preserve 1 per cent tolerance limits. Standard design procedure was used to select the component values.[1] The best location for the control voltage was on the triggered base as better range was obtainable at this point. A positive control voltage was available from an analog computer and the operational voltage range was selected to be 1-10 v, although this value is arbitrary and may be varied by changing the resistance in the base lead. A significant improvement in performance was noted when high stability resistors were used for bias and collector load: a prototype of the basic circuit was constructed and complete performance checks were made to determine the degree of stabilization required.

Improving Linearity

The uncompensated circuit (Fig. 1) showed a control linearity of about 10 per cent at room temperature and drifts another 10 per cent in going from room temperature to 70 C. The first problem is to improve linearity at room temperature. To accomplish this, feedback is inserted first from collector to base and then from base to base. An improvement is noted in both cases, but only with base to base feedback is it possible to achieve 1 per cent accuracy. The next problem is to maintain this accuracy at elevated temperature.

Investigation of several temperature compensation schemes shows little promise that 1 per cent linearity could be maintained to 75 C. However, the development of the Sensistor

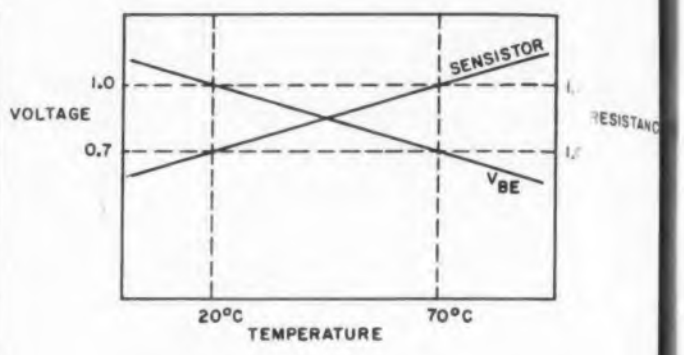


Fig. 3. Temperature characteristics.

opens a new possibility. The Sensistor (silicon resistor) produced by Texas Instruments is a temperature compensating device that has a temperature characteristic closely approximating the reciprocal of the V_{BE} curve of the transistor. Since the firing point of the multivibrator is directly a function of V_{BE}, Sensistor is a logical choice for temperature compensation. Fig. 3 shows the V_{BE} and Sensistor curves for comparison.

The curves are merely illustrative and do not have quantitative data since at the time of writing accurate data was not available. Experiments show that V_{BE} increases approximately 30 per cent in going from 20 C to 70 C. To better understand the effect of the Sensistor compensation, it is advantageous to study the total bias voltage in the configuration of Fig. 2. The composite voltage base to ground (V_B) may be broken into three separate voltages: V_{BE} transistor threshold voltage, V_R drop across emitter resistor, and V_S drop across Sensistor. Therefore, $V_B = V_{BE} + V_S$ where, for the purpose of our present analysis, V_B and V_R are constant. Solving the above equation for V_{BE}, $V_{BE} = V_B - (V_R + V_S)$ or $V_{BE} = \text{Constant} - V_S$ for a constant value of I_{BE}. If the latter equation is to be satisfied as V_{BE} decreases with temperature V_S must increase. From the Sensistor data sheets it is possible to select the proper Sensistor value which will satisfy the equation within the limits desired. In the circuit shown in Fig. 2, a 220 ohm Sensistor was selected as the proper value but later temperature cycling showed 180 ohms to be more satisfactory.

Obtaining High Stability

The final circuit with complete stabilization is shown in Fig. 2. Extensive tests were performed on the completed unit and are shown in the curves Fig. 4 and 5. Fig. 4 demonstrates the effect of feedback to improve linearity. Fig. 5 shows temperature drift for the uncompensated, overcompensated and properly compensated circuit. With the 180 ohm Sensistor it was possible to hold drift to 1 per cent over the operating temperature range. Temperature cycling

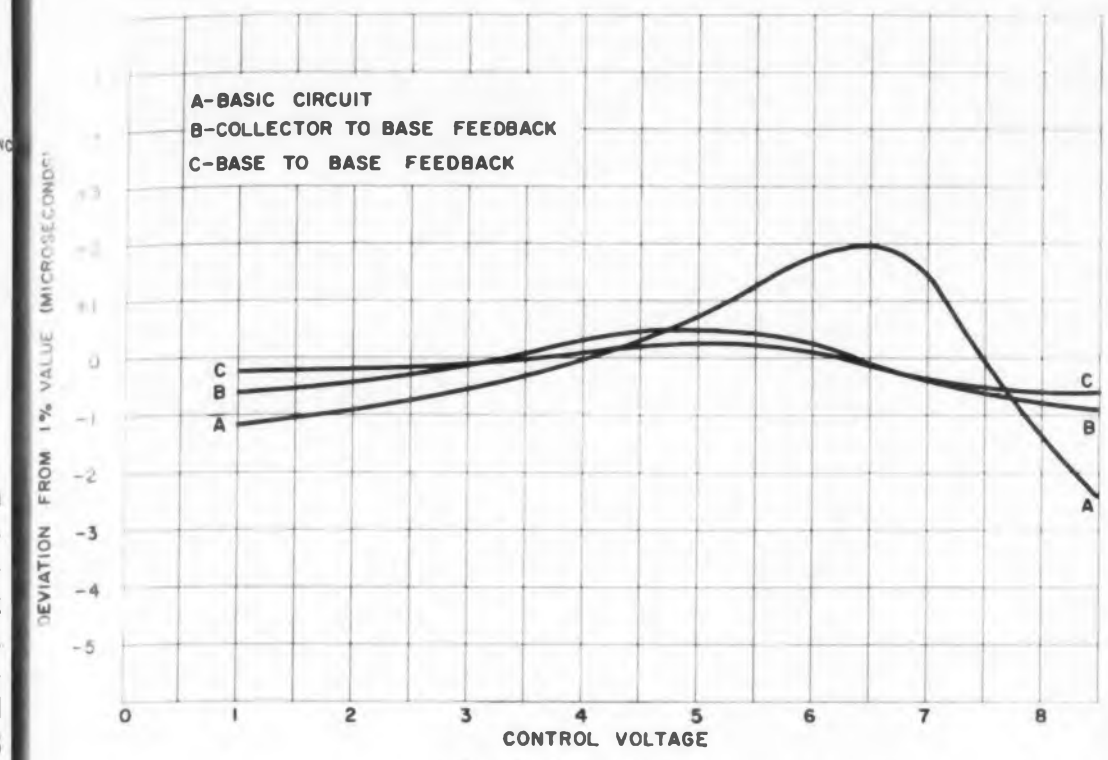


Fig. 4. Linearity.

is necessary to optimize the Sensistor value, for only by periodic measurement can the overall compensation be observed.

Temperature cycling discloses a slightly different value than did the calculations. The output waveform exhibits a rise time of 0.7 μsec and a fall time of less than 2 μsec.

References

1. Transistor Circuit Engineering, Shea et al.

2. Design of a Transistor Monostable Multivibrator, H. E. Schaurecker, *Electronic Equipment Engineering*, December 1957, page 40.

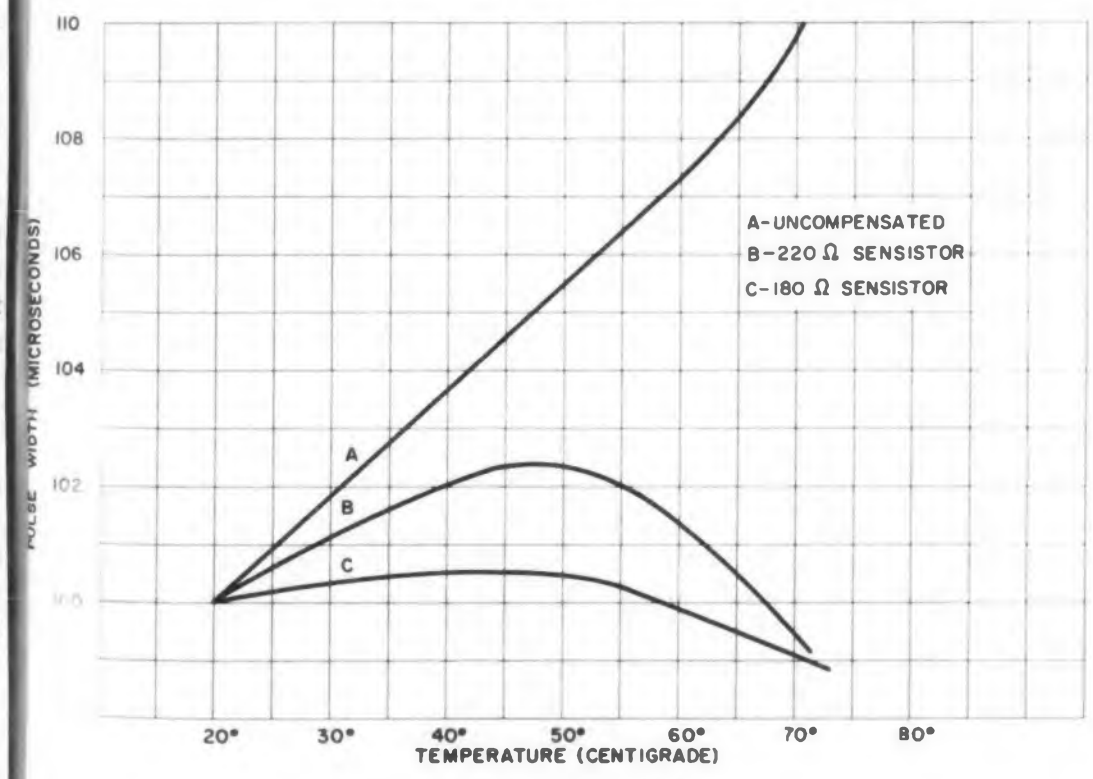


Fig. 5. Drift characteristics.

Sealed-in Gas Shrinks Resistor's Size

SEALED-IN gas reduces the size of these metal film resistors. The gas helps dissipate the heat produced inside the unit. Thus more watts can be handled in a smaller package. Given the same volume and ohmic value, the gas-filled metal film resistors can stand four times as many watts as its wirewound counterpart.

The Inside Story

The resistive element of the unit is formed on the inside of a steatite tube. Take a look at Fig. 1 which shows a resistor sliced in half. A moisture dispersing epoxy coating is molded over the tube. Formerly, air was contained inside the resistor. But now, during manufacturing, air is removed and replaced with an inert gas. The inert gas (undisclosed by the maker) is better than air for two reasons. First, it prevents oxidation of the resistive element. Second, it conducts heat better. Heat produced within the unit is conveyed by the inert gas to the terminals where it is carried out.

Called the Vamistor Missile Line, the units are made by Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J.

Sizes Available

Two models of the Vamistor Missile Line are available. Model 9854 has ohmic values ranging from 100 ohms to 2 megohms. Wattage ratings are variable, depending on ambient temperatures. See Fig. 1. At 40 C they will handle 4 w and at 175 C the limit is 0.25 w. Length of the unit is 0.866 in., and the diameter is 0.312 in.

Resistance range for the model 9855-4 starts at 100 ohms and ends at 500 K. Again, wattage ratings depend on ambient temperatures. See Fig. 2. At 100 C they'll stand 1 w. But at 175 C they're derated to 1/8 w. Length of this model is 0.650 in., and the diameter is 0.235 in.

Test Results

The gas filled Vamistor has been tested for thousands of hours. It has an estimated life of 10,000 hours. Noise of the unit is comparable to

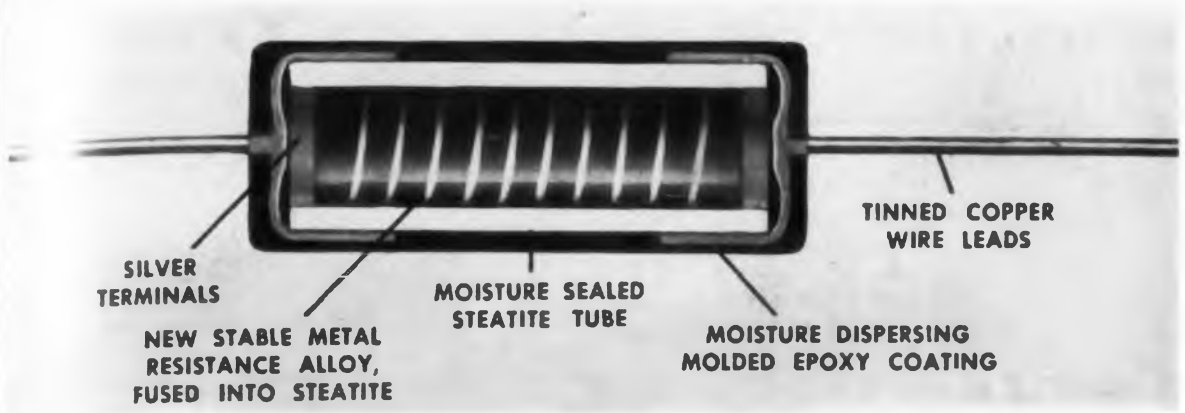


Fig. 1. Cross section of the Vamistor

wirewound units: –200 db. Its voltage coefficient is 1 ppm per volt. Temperature coefficient is 50 ppm per degree C. For 10 sec it will handle about 6.25 w with an average resistive value change of 0.01 per cent. Insulation is 10,000 megohms and dielectric strength is 900 v rms with 0 per cent change. The unit will in most cases do better than specified by MIL-STD-202.

For more information on this gas-filled Vamistor, turn to the Readers Service card and circle number **106.**

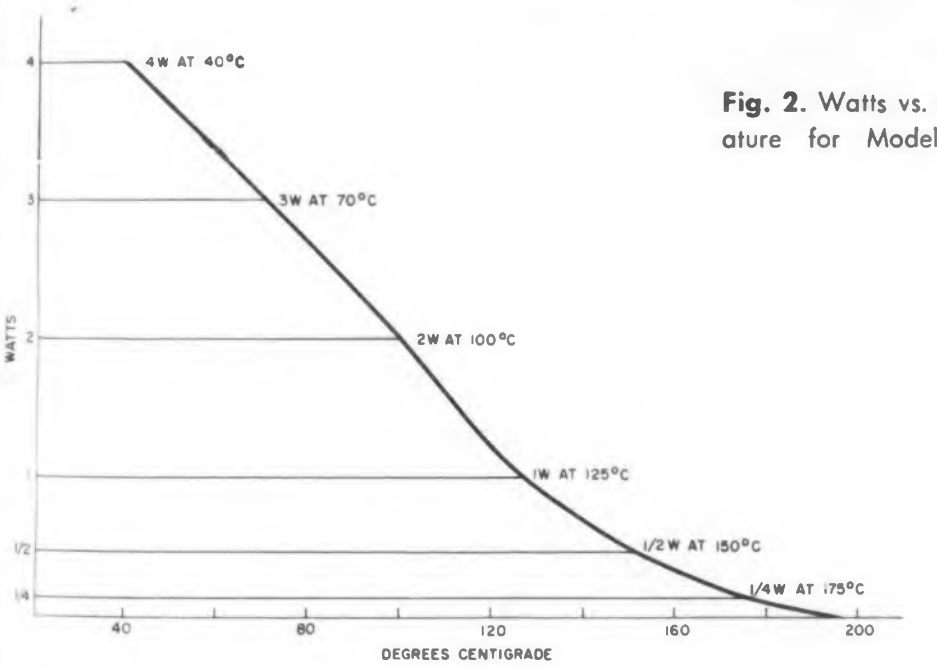


Fig. 2. Watts vs. temperature for Model 9854.

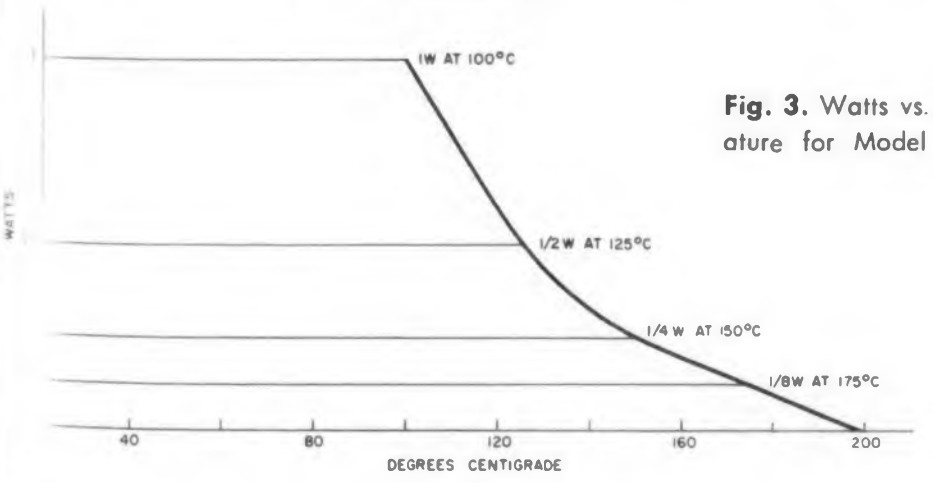
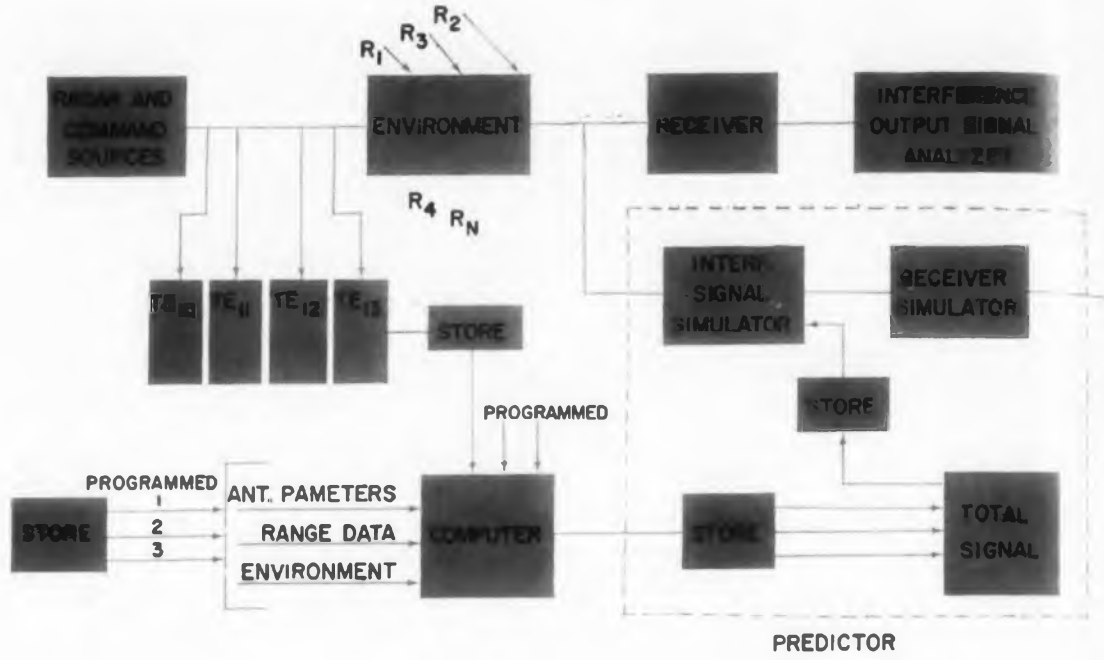


Fig. 3. Watts vs. temperature for Model 9855-4.



Functional block diagram of an interference prediction system described by Mr. Berliner. Necessary parameters shown at left can be retained in a storage device or programmed into a computer as required. Output of computer would then be fed to a storage device and then, to a simulator, shown on right in dotted rectangle. Computer output would be total signal environment or desired portion of total signal environment. Computer should also be capable of providing answers to factors which are causing interference and other answers to particular problems. These data, in proper form, would then be fed into interference simulator. Output of simulator would feed to receiver under test and then to interference output analyser.

CONFEREES SAY

Reduce RFI With Education

Ben Patrusky
Assistant Editor

RIDDING electronic equipment of interference sources by the "shotgun" technique has "got to go." Designers must consider the radio frequency interference (rfi) problem right from the foetal pencil-sketch stage to equipment baptism. More often they don't consider it at all. The result: brute force application of suppression devices after the equipment has been installed—a task that's uneconomical, not always effective, and often catastrophic.

That's the immediate problem most delegates at the Fourth Conference on Radio Interference Reduction and Electronic Compatibility were eager to see solved. Most advocate: make the designer aware of the rfi problem.

"Many designers are sorely lacking in any understanding of the rfi," C. W. North of the Martin Co. declared. "They just don't concern themselves with the fact that equipment may be placed in environments where there is concentrated electromagnetic radiation. Equipment which proved operational at home may be incompatible with other equipment in an electronic complex like Cape Canaveral. They've got to be made aware of the fundamental importance of interference-free equipment."

Missile "Buggings" Cited

To emphasize the validity of these observations, here are some recent results of ineffective interference suppression Mr. North cited in a conference address.

- Missiles have taken erroneous paths.
- Missiles have failed in later stages and were either destroyed or failed in flight.
- Missiles were blown up from internal signals while in flight. (It was discovered that in one case, relay transients produced a "dump" signal.)
- Missile flights were delayed for hours and frequently cancelled.
- Complete design changes had to be made before a successful launching could be attained.

Leonard Thomas of the Navy Bureau of Ships suggested a capsule initial solution.

"Before a hand is laid on the drawing board, the designers must consider all potential sources of rf energy. When these are determined they should investigate where this energy will be used. If locally, they must take all available steps to isolate the stuff."

Admittedly a large percentage of engineers have not been obliged to live with the rfi problem. "In fact they've consistently ignored it," one would-be educator commented. They are not entirely to blame, however.

Merely getting an operational piece of equipment can be a harrying task—especially when time limits are imposed. It is, therefore, understandable that engineers cannot devote themselves to rfi. And certainly in some areas the knowledge which many educators would like to bequeath to the designers just doesn't exist at some of the higher frequencies. Some radars are

now working at 10 kmc. Others are being built for n[illegible] higher frequencies.

"H[illegible] many engineers know about basic propagation [illegible] 20 kmc; it's really brand new to many of u[illegible]," Mr. Thomas stated. "We just don't know enough about the 'plumbing' requirements in that range," he said.

Need Vertical Education

Furthermore, as some delegates suggested, this educational renaissance must be of a vertical nature. Not only must the designer be educated. There has to be a re-orientation of administrative thinking in this area. "If the top guys make it their business, it will surely rub off all the way down the line," one representative observed.

He, along with several others, cited the fact that some companies have hired rfi consultants to work closely with the designers. He noted that the programs are generally meeting with excellent results. It is the way of thinking which has been adopted from manufacturers of nonelectronic interference equipment.

The nonintentional radiating devices—vehicles, internal-combustion engine, commutating devices, etc.—were until fairly recently the worst offenders. This broadband interference problem has for all intents and purposes been brought under control. How? The manufacturers took the initiative and obtained expert assistance from rfi specialists. The narrow-band rfi problem must now be licked.

Allergic To Aid

People working in electronics don't appear quite as receptive to hiring these people, was one criticism. "They're allergic to outside assistance; they believe bringing in outsiders is a snide criticism of their work." Another caustic observation went this way: "They feel as if someone is telling them how to make love to their wives."

But another conferee commented:

"Sure, there are rfi specialists. But it's expertese gained by cut-and-try. A number-knowledge of interference parameters is needed.

"Their [rfi specialists] guess is probably better than ours, as to how a piece of equipment will fare in some heavy electronic network. But they don't know either. The military wants high power and high gain antennas, highly sensitive receivers. All these equipments are placed close together. Then you have a vast number of modulation systems bugging each other. Result: chaos."

In his address, J. Berliner of Rome Air Development Center described RADC's projected planned approach of analysis and control of electromagnetic interference.

(Continued on page 34)

"First we must obtain necessary and sufficient information and data on all parameters which contribute to the interference problem, e.g. transmitter spurious output, receiver vulnerability, environmental factors," Mr. Berliner explained.

Once this data is obtained, he said, corrective measures can be undertaken. Accumulation of this data, however, emphasizes the need for data reduction techniques and field intensity meters for frequencies beyond 10 kmc.

"We must begin evaluation of spurious outputs while in early design stages," Mr. Berliner asserted. He commented further that a means to determine what type of signals will be experienced by the equipment "prior to equipment installation" is needed.

The second phase of the program is interference prediction.

"Once various parameters which contribute to interference are obtained, it is then possible to apply this information to predict interference occurring with: (1) planned introduction of new equipment into operating environment, (2) planned establishment of a new site," he stated.

Mr. Berliner then described an interference prediction system which is illustrated here.

Specific problems uncovered by analysis techniques could then be eliminated or reduced during equipment research and design, Mr. Berliner explained.

"What cannot be accomplished through specs must be accomplished through suppression techniques," he added.

And these are the techniques he listed: time sharing, shielding, spectrum conservation, frequency channelization, spurious control, antenna improvement, special circuit techniques, modulation techniques, receiver improvement.

Where The Specs Fail

Meanwhile, military specs also came in for some lashing. Though it is generally agreed that the specs governing rfi up to 10 kmc are "pretty good" when calling out radiation levels, there are many aspects which don't make the vendor's task any easier.

As Bill Jarva of the Filtron Co. put it in his address:

"The specs give a general estimate of undesirable radiation. But they do not provide information to solve practical physical problems. In fact, the information given is often misleading and measurements indicating intense interference emission may be obtained where none exists and vice versa. Numerous variables exist which can cause large inconsistencies in measuring interference emission from a given source."

There have also been instances in which military enforcement of these specs have been lax and so contractors have just ignored them.

built some equipment without bothering to meet the spec," one company official reported. "The spec wasn't enforced and sure enough when the equipment was installed at the test site it created a hell of a lot of interference. The equipment had to be shut off and a costly, time-consuming program of suppression had to be initiated. We piled junk upon more junk. And you can bet there still are times when the test site control board makes us shut down because of the rfi the equipment still generates. I'm sure much of our problem could have been eliminated way back in design."

"We'll Never Lick RFI"

"Many of the specs have been updated," Mr. Thomas commented. The levels prescribed are those which have been determined after careful consultation and are attainable. These levels, if they're not exceeded, should result in a satisfactory system.

"The drawback is that we have to work with off-the-shelf equipment which are often rfi offenders. Getting up field changes to render the field equipment usable makes for a great many problems."

He cited the example of one piece of equipment which required 40 field changes.

"It's just a matter of time. We must wait for equipment attrition," he said.

When asked if he thought the rfi problem would ever be licked, Mr. Thomas uttered an unqualified no.

"In fact we'll ultimately be forced into lower levels of interference tolerability," he stated.

The Armour Research Foundation, Chicago, Ill., is publishing the proceedings. They will be available shortly. All thirty-one technical papers will be included. These areas covered include: missile systems, communications and radar techniques, instrumentation techniques, radiating devices, interference control, nonlinear devices, and computer techniques. In addition, the various keynote and luncheon addresses will be reprinted.

This Interference is Poison

As if the rfi problem weren't complicated enough, another source of interference crawled into the picture recently at Cape Canaveral. It seems C. W. North of the Martin Co., explained, that while inspecting a test hangar whose floor was crawling with cables, he noted one wire doing just that—crawling. The crawling wire turned out to be a rattlesnake. Admittedly it was an electrifying experience.

Ed. note. Talk of snaking wires.

Transistorize

measures microwa

PORTABILITY is the unique feature of this new microwave power bridge. Light in weight and as precise as most laboratory units, this battery-powered device is completely transistorized. It is suitable for making checks where larger, heavier units are too inconvenient to hook up.

Made by Airborne Instruments Laboratory, 1345 New York Ave., Huntington Station, L.I., N.Y., this Type 50 Power Bridge is self-balancing and permits direct reading of power in watts and dbm. Its frequency range is from 10-40,000 mc using a thermistor as the detector. Power ranges are 0-1 and 0-10 mw.

Power bridges using vacuum tubes are usually heavier, weighing as much as 25 lb. Type 50 weighs about 4 lb. Vacuum tube units require about 100 watts of ac power to operate 5 or 6 vacuum tubes. AIL's unit operates from two 9 v mercury cells.

Basic principle of operation is the substitution of audio for rf power. While this technique is not new, the major circuit feature is the design of the transistorized voltmeter circuit (Fig. 1.).

Type 50 consists basically of an audio oscillator and a bridge in a closed-loop circuit. The amplitude of the audio signal is variable and is dependent upon and controlled by the condition of balance of the bridge. The balance of the bridge is in turn dependent upon the total power in a thermistor which, through the action of the closed loop, is maintained at a constant value. As rf power is applied to the thermistor, the bridge is unbalanced and the unbalanced voltage is impressed across the input of the audio oscillator. Audio power is thereby decreased until the cumulative power in the thermistor is restored again to its constant value.

At this point, the bridge is balanced and no further change occurs in the audio signal. The output of the audio oscillator, which is then a function of the rf power applied to the thermistor, is displayed on the meter.

Printed wiring is utilized in the bridge, along with commercial components to facilitate repairs if necessary. The case is watertight, but

...ridge . . .

...wer anywhere

the instrument is easy to remove. Its design permits mounting the working portion in a panel if desired.

Quick readings at remote locations may be taken to check aircraft equipment, radar, TV, microwave links or rf leakage.

For more information on this transistorized microwave power bridge, turn to Readers Service Card and Circle **100**.

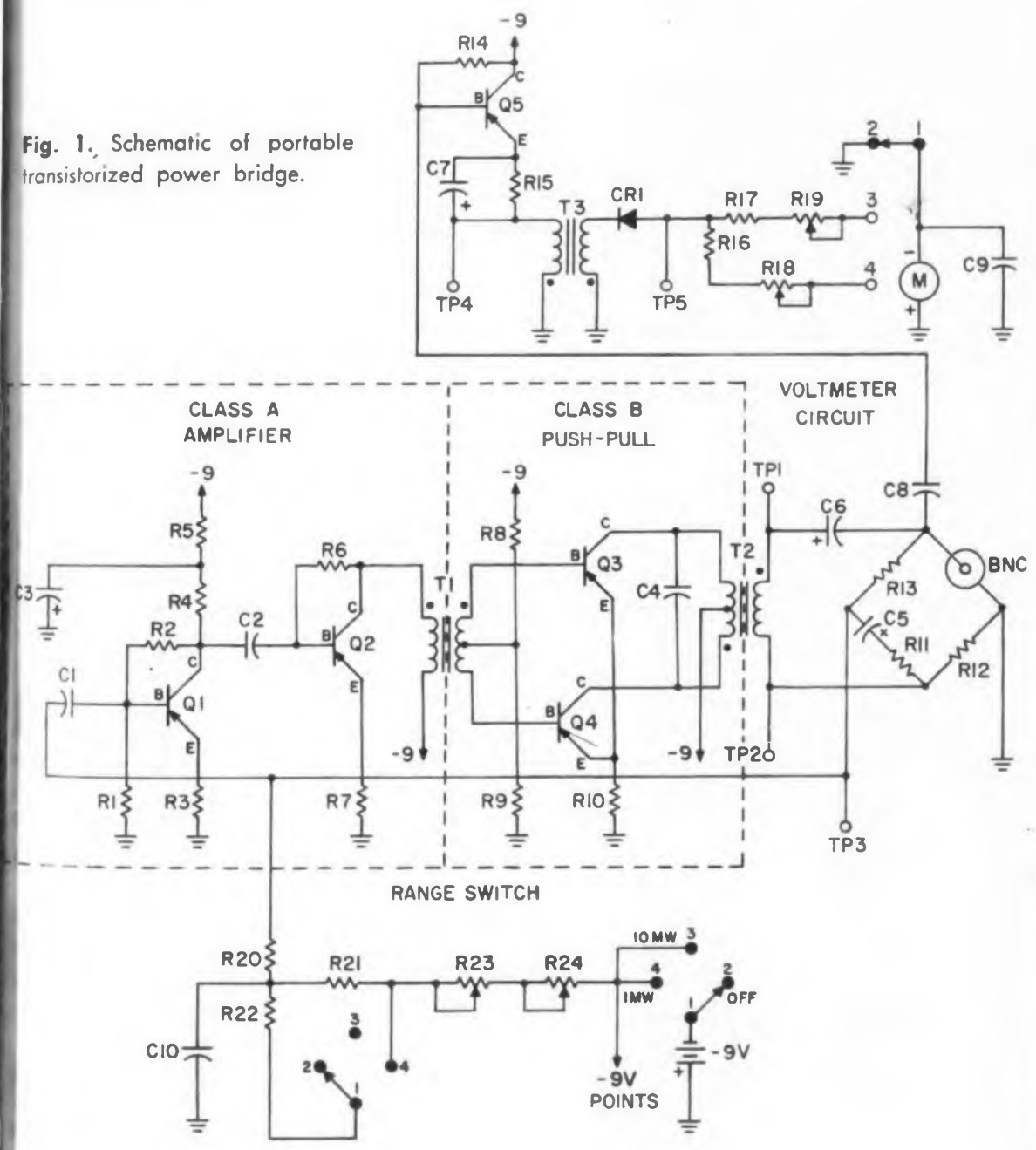


Fig. 1. Schematic of portable transistorized power bridge.

Use Mil Components in Miniaturized Circuits

Gustave Pellegrino, Jr.
Belock Instrument Corp.
Great Neck, N. Y.

MANY Mil components are compatible with miniaturized circuitry. Using them has advantages often overlooked. One advantage is the elimination of detailed descriptions when ordering. For example, the design engineer specifying a 1/2 in. potentiometer must consider style, bushing, shaft length, resistance, tolerance, etc. In many cases the callout would vary for different component makers. But a 12 digit Mil-designation, such as RV6LAYSA501B, completely specifies a particular 1/2 in. potentiometer from any manufacturer.

Saves Time and Money

In the design of operational military equipment the government usually requires that all nonstandard components be justified. This leads to additional cost in time and money for the equipment manufacturer using nonstandard components.

When considering smaller, nonstandard parts, factors such as reliability and availability must be evaluated.

Reference Chart

The accompanying reference charts cover nine fixed and variable resistor Mil specifications. The styles represent only a small number of the total available. They are, however, the more commonly used units and easily procured. A subminiature rating was given those resistors whose largest dimension is about 1/2 in. or less. Components about 1 in. or less are called miniature. The rest are labeled standard.

Three Mil specifications covering fixed composition and film resistors.

Specification	MIL-R-11B				MIL-R-10683A			MIL-R-10509B			
Description	Fixed, Composition				Fixed, Composition Film			Fixed, Film			
Characteristic	Insulated				Very High Frequency			High-Stability			
Max. Ambient, Full Watts	70°C				40°C			70°C			
Shape	Tubular				Tubular			Tubular			
Stability	Poor				Good			Good			
Tolerance	±5%				±5%			±1%			
High-Freq. Operation	Good				Excellent			Good			
Style	RC09	RC20	RC32	RC42	RF50	RF40	RF30	RN60	RN65	RN70	RN75
Rating (Watts)	¼	½	1	2	¼	½	1	⅛	¼	½	1
Size	SM	SN	Min	Min	SM	Min	Std	SM	Min	Min	Std
Leads	Axial	Axial	Axial	Axial	Axial	Tab	Tab	Axial	Axial	Axial	Axial
Minimum Resistance	10Ω	10Ω	2.7Ω	10Ω	20Ω	20Ω	20Ω	10Ω	10Ω	10Ω	10Ω
Maximum Resistance	22M	22M	22M	22M	1M	1M	1M	1M	2M	5M	10M

Three Mil specifications covering fixed wirewound resistors.

Specification	MIL-R-93A			JAN-R-184			MIL-R-26C		
Description	Fixed, Wirewound			Fixed, Wirewound			Fixed, Wirewound		
Characteristic	Accurate			Low-Power			Power		
Max. Ambient, Full Watts	85°C			40°C			25°C		
Shape	Tubular			Tubular			Tubular		
Stability	Excellent			Good			Good		
Tolerance	±.1%			±5%			±5%		
High-Freq. Operation	Poor			Poor			Poor		
Style	RB09	RB15	RB17	RB52	RU3	RU4	RU6	RW59	RW55	RW56
Rating (Watts)	⅛	¼	½	¼	½	1	2	2.5	5	10
Size	SM	Min	Min	Min	Min	Std	Std	SM	Std	Std
Leads	Tab	Tab	Tab	Axial	Axial	Axial	Axial	Axial	Axial	Axial
Minimum Resistance	.1Ω	.1Ω	.1Ω	.1Ω	.24Ω	.51Ω	1.0Ω	.1Ω	.1Ω	.1Ω
Maximum Resistance	.185M	.225M	.75M	.12M	.47K	2.2K	3.3K	2K	9K	16K

Three Mil specifications covering variable composition and wirewound resistors.

Specification	MIL-R-94B		MIL-R-19A			MIL-R-22A	
Description	Variable, Composition		Variable, Wirewound			Variable, Wirewound	
Characteristic			Low Operating Temp.			Power	
Max Ambient, Full Watts	70°C		40°C			25°C	
Shape	Circular		Circular			Circular	
Stability	Poor		Good			Good	
Tolerance	±10%		±5%			±5%	
High-Freq. Operation	Good		Poor			Poor	
Style	RV6	RV4	RA10	RA20	RA30	RP10	RP15
Rating (Watts)	⅓	2	1	2	4	25	50
Size	SM	Min	Min	Min	Std	Std	Std
Leads	Tab	Tab	Tab	Tab	Tab	Tab	Tab
Minimum Resistance	100Ω	100Ω	15Ω	3Ω	3Ω	2.0Ω	2.0Ω
Maximum Resistance	5M	5M	2.5K	15K	25K	5K	10K

One Size Relay

It's not the small one this time. Babcock's BR-7 is somewhat larger than the crystal can relay shown in this photo, but has a capacity ranging from dry circuit to ten amperes.

A SINGLE subminiature can gives relay users the option of dry circuitry or a 10 amp contact load. Somewhat larger than a crystal can type, which many reliability engineers distrust, the new relay can be used throughout a piece of electronic gear.

One size fits all applications. While the contact assembly for switching vacuum tube grids, thermocouples or piezoelectric devices necessarily differs from the one used for output applications and switching control circuits, the remainder of the relay configuration stays the same.

Babcock Relays, Inc., 1640 Monrovia Ave., Costa Mesa, Calif., conducted a survey aimed at learning what relay characteristics were most in demand by industry. They found the largest proportion of users specified contact loads under 10 amp, and conformance to MIL specs. They wanted sensitivity and reliability, too.

Babcock settled on a can size of 1.26 x 1.07 x 0.56 in. This permitted them to use a larger wire size and be reasonably assured of mechanical reliability in production; it is also well below the 1 x 2 x 2-1/2 in. size of telephone-type relays. The double coil design shown in Fig. 1, a torqued magnetic structure (for a straight armature, helpful in production) and optimum pole faces (with reluctance to match the reluctance of the magnetic circuit) are standard for all relays.

Dpdt contact configuration, shown in the drawing, is basically the same for high power as dry circuit work, the only difference being that the contact spacing for 10 amp is 0.025 in. (1.5 to 2 msec transfer time) while for dry circuit applications the spacing and pressure is less. The spring-like curve of the static contacts gives a longitudinal "wipe" to avoid arcing.

The BR-7—no model number differentiation is made for relay contact heads operating up to 5 amp and those operating from 5 to 10 amp—is rated for a life of 100,000 actuations minimum over a temperature range from —65 to 125 C.

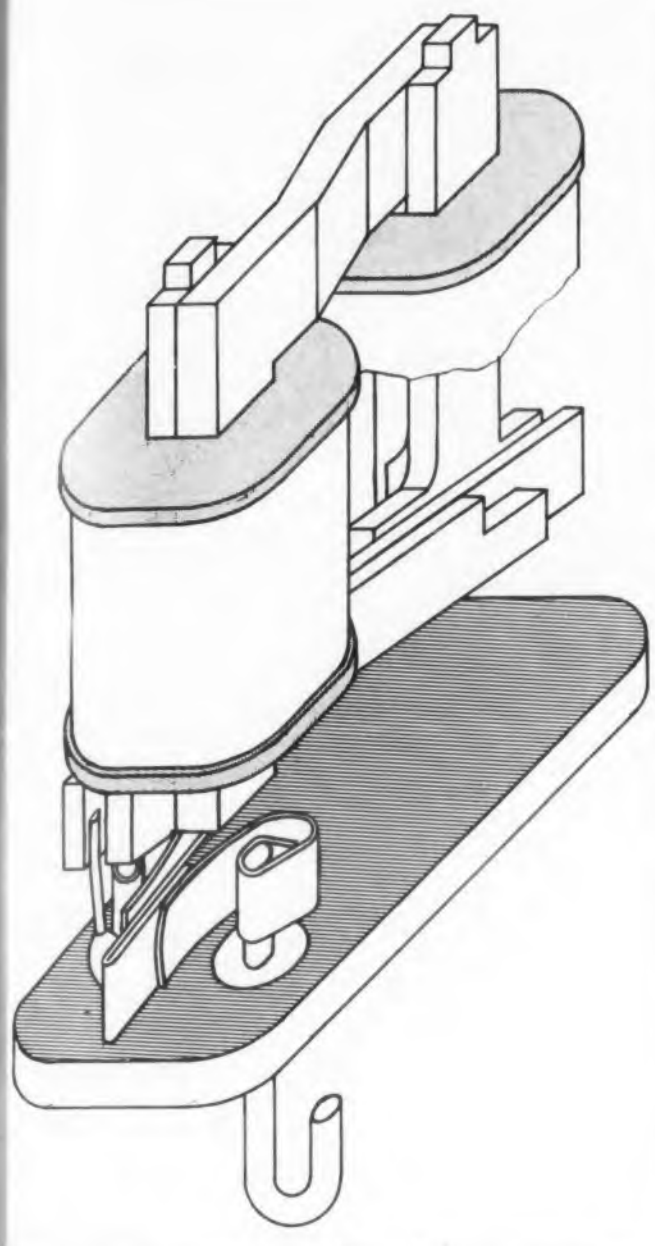


Fig. 1. Relay construction. "Wipe" is caused by the slide-and-deflection of the dpdt contact assembly, as the glass bead shoves the contact over. Arcing is kept to a minimum. Use of a torqued frame for the double coil assembly permits a straight armature—good news for the production quality control department.

Pull-in power is 480 mw for 10 amp contacts; 80 mw for 2 amp contacts; lower for spdt and special adjustments.

Coil resistance is 20 K maximum; insulation resistance 1000 meg; dielectric strength 1500 v rms. The relay will withstand 0.4 in. double amplitude vibration over a 10 to 40 cps frequency range, 30 g from 40 to 2000 cps.

For use with printed circuits, the BR-7 has a standard 0.2 in. grid spacing header, though hooked headers are provided for applications above 5 amp: the 0.05 in. pin diameter is too large for available sockets.

For further information about this one-size relay turn to the Readers Service Card and circle 104.

Digital readout to 0.1 per cent accuracy from this

Minified Millivoltmeter

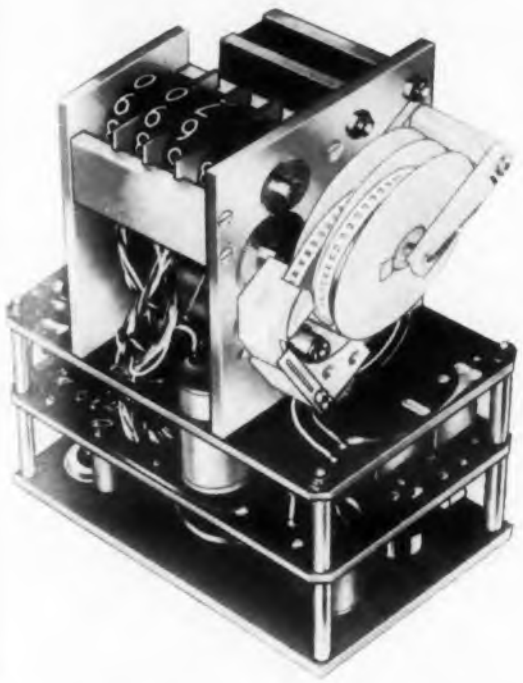
WHEN AN analog/digital converter packs a transistorized amplifier, a chopper, an input filter, a slidewire pot, a servo motor, a digital readout, and a zener reference in a small can, measuring only 3 x 5 x 5-3/8 in.—that takes a lot of packing. And when the converter weighs less than three pounds, provides 0.1 per cent accuracy, and 0.05 per cent conformity, with an infinite resolution potentiometer, it bears looking into.

In response to our "How come?", the B & H Instrument Co., Inc. of 3479 West Vickery Blvd., Forth Worth, Tex., explained it this way.

The heart of the instrument is a tape-slidewire, formed by bonding a resistance wire within the edge of a laminated Mylar tape.* The tape, 12 feet long, is calibrated against a 60 foot long master tape. During calibration, digital values as specified, are automatically printed on the face of the tape for linear or nonlinear readout through a window in front of the case. This way, linear, parabolic, hyperbolic, or logarithmic functions can be presented in any scale.

If the printed readout is not desirable, a digital in-line counter is geared to the slidewire drive shaft. In this case, variations in resistance slope, up to 15 per cent, are accomplished by varying the sprocket hole spacing.

*This novel potentiometer is shown in the New Products section of this issue. A larger and somewhat different version was featured in *ED* September 1955, p. 50.

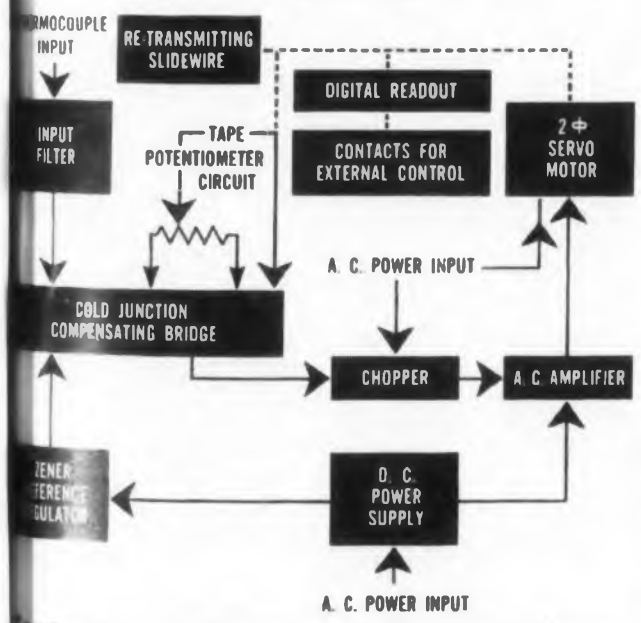


With room to spare, this very small A/D converter provides infinite resolution with a 12 foot long, servo-driven slidewire.

The slidewire, available with resistance from 100 ohms to 100 K, is driven between two concentric spools by the sprocket drive, which in turn, is driven by a null-balanced servo motor.

Available for 60 or 400 cycle operation, the entire instrument takes only 20 va from a 115 v line. The two models, one for temperature measurements, the other for rpm, can be equipped with 100 ma, 115 v contacts to provide a signal for programming and control. They even have space left for a retransmitting slidewire.

For more information on this very small A/D converter, turn to the Reader-Service Card and Circle **105**.



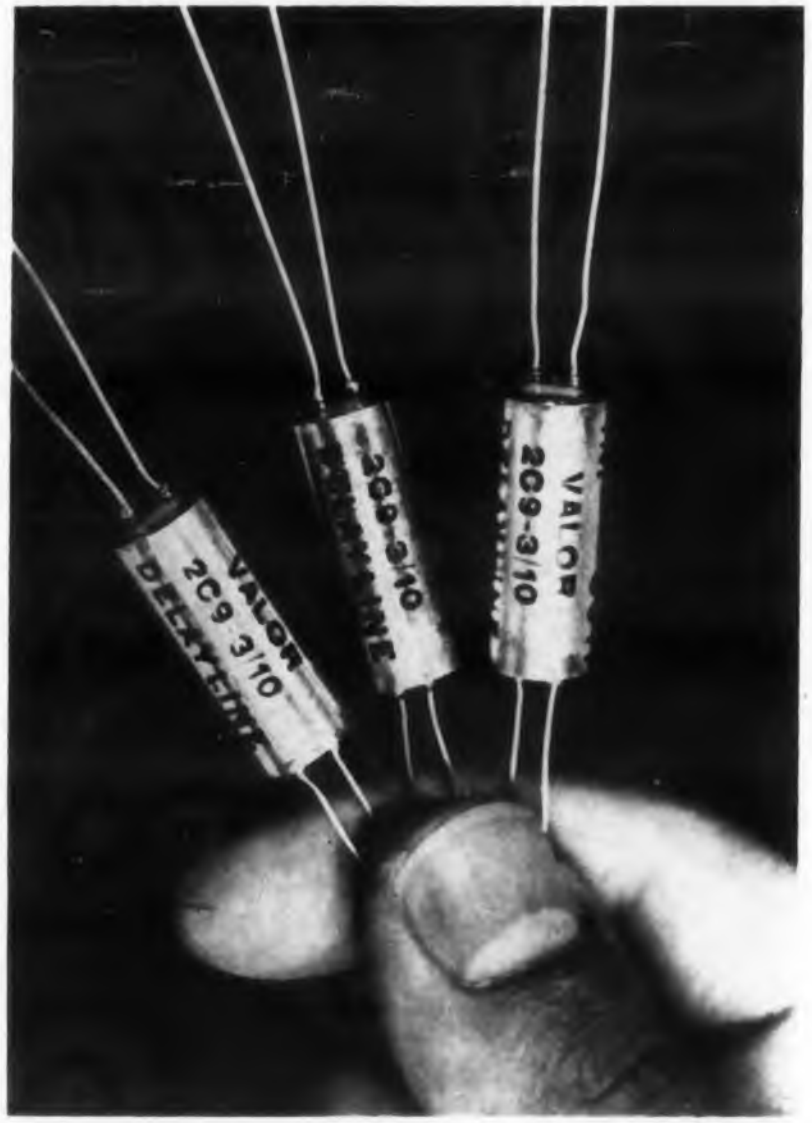
Temperature indicating unit. The block diagram shows the components in the instrument. The dotted lines refer to optional features which can be built in.

NEW PRODUCTS

Covering all new products that might generally be specified by an electronics engineer engaged in the design of original equipment.

SMALL STUFF

An old engineering dictum states that equipment must be designed so that it costs nothing, requires no maintenance, lasts forever, and occupies no space. Here are some of the latest items developed with the last requirement in mind.



DELAY LINES

Designed for transistor and printed circuit applications, these lumped constant delay lines (left) are packaged in a 1 x 0.4 in. metal tube. The delay lines consist of powdered iron toroidal inductors and temperature compensating ceramic disk capacitors. The unit is phase and frequency compensated for best pulse response. There are seven units in the series. Characteristics range from 0.1 μsec delay, 0.03 μsec rise, and 500 ohm impedance (Type 1C9-3/5) to 0.7 μsec delay, 0.23 μsec rise, and 1600 ohm impedance (Type 7C91-3/16).

Valor Instruments, Inc., Dept. ED, 13214 Crenshaw Blvd., Gardena, Calif.

CIRCLE 37 ON READER-SERVICE CARD

POINT-CONTACT DIODES

These miniature germanium point-contact diodes (right) are encapsulated in hermetically sealed glass cases. Eleven types are manufactured for both general purpose and computer applications. They have a maximum length of 0.265 in., and a maximum diameter of 0.105 in. Lead length is 1.25 in.

Erie Resistor Corp., Dept. ED, Erie, Pa.

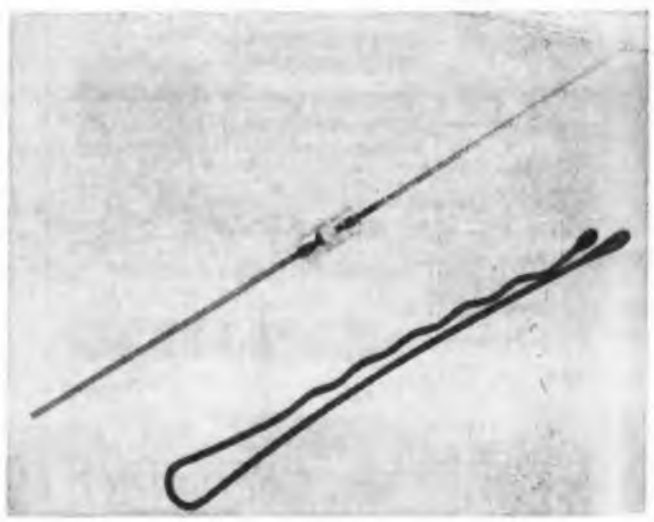
CIRCLE 39 ON READER-SERVICE CARD

TANTALUM CAPACITORS

Case size of these sintered anode electrolytic capacitors is less than 1/16 in. in diameter and a little over 1/8 in. in length. Designated type HAT, the units were developed for miniature transistorized devices. Dc leakage is less than 1 μa. They are available in ratings from 1 to 10 μf and 1 to 10 v.

P. R. Mallory & Co., Inc., Dept. ED, 3029 E. Washington St., Indianapolis 6, Ind.

CIRCLE 38 ON READER-SERVICE CARD



SLIDEWIRE-TAPE POTENTIOMETER

A resistance wire bonded to a Mylar tape forms the heart of this unit. The wire is available in lengths of 120 in., and resistance ranges are from 100 ohms to 100 K. Labeled Ta'pot H5600, the calibration may be either linear or nonlinear. Conformity between true resistance and specified function is 0.05%. Resolution is better than 0.01%. Total resistance tolerance is 0.25%. Unit will handle 2 w at 25 C. Operating temperature range is −55 to +70 C. Two or more units may be ganged together. Case dimensions are 2 x 2.25 x 2.75 in.

The Howell Instrument Co., Dept. ED, 3101 Trinity St., Fort Worth 7, Tex.

CIRCLE 40 ON READER-SERVICE CARD

MAGNISTOR

The Magnistor is a solid state magnetic component. Designated MPT-1, the unit is constructed of four coils: set, reset, interrogation, and signal output. Coils are on a ferrite core. With associated circuitry, the Magnistor can function as a differentiating detector with a permanent or erasable storage capability. Sealed in an epoxy plastic, it operates over a wide frequency range. The unit has both data processing and industrial control applications.

Ilter Instrument Co., Inc., Dept. ED, Sunnyside Blvd., Plainview, N.Y.

CIRCLE 41 ON READER-SERVICE CARD

Silicon Solar Cells

Conversion efficiencies of 10%

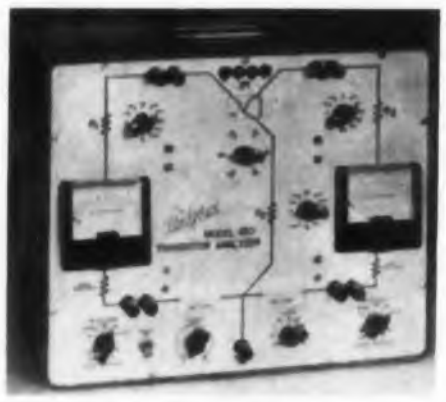
For both commercial and military use, these rugged silicon solar cells can convert 10% and more of the radiant energy falling on their surface. Rectangular in shape, they can provide an output of approximately 9 w per sq ft of active cell area in bright sunlight. Their efficiency is due in part to alloying techniques which permanently bond the contact to the silicon wafer. The contact is thus made an integral part of the cell itself, while still allowing individual cells to be soldered. Besides increasing efficiency, this bond minimizes series resistance. Individual cells are obtainable with or without color-coded pigtail leads. They measure 0.5 x 1 cm, 0.5 x 2 cm, and 1 x 2 cm.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.

CIRCLE 43 ON READER-SERVICE CARD

Transistor Analyzer

Has wide range of applied voltages



Accuracy of the 850 transistor analyzer is ±2 per cent of full scale. The tester has a wide range of applied voltages available by substitution for breadboard configurations—common base, common emitter, and common collector.

The Hickok Electrical Instrument Co., Dept. ED, 10525 Dupont Ave., Cleveland 3, Ohio.

CIRCLE 44 ON READER-SERVICE CARD

Tantalum Capacitors

Have sintered anodes

In tubular cases, type 109D tantalum capacitors have sintered anodes and can be furnished with insulating sleeves. They offer higher capacitances than shouldered cup units of the same size.

Sprague Electric Co., Dept. ED, 347 Marshall St., North Adams, Mass.

CIRCLE 46 ON READER-SERVICE CARD

Aircraft Power Transformers

Withstand extreme shock

For aircraft and missiles, these power transformers withstand extreme acceleration and shock. Models are 1 or 3 phase in ratings from 10 va to 5 kva.

Westinghouse Electric Corp., Dept. ED, P.O. Box 2099, Pittsburgh 30, Pa.

CIRCLE 47 ON READER-SERVICE CARD

Accelerometers

40 mv per g sensitivity

Sensitivity of 40 mv per g is provided along with high resonant frequencies up to 30 kc in the A-380 and A-395 accelerometers. The units provide a flat response over temperatures ranging from −70 to +250 F, with an accuracy of ±5 per cent. Both series are available in grounded or integrally ungrounded designs. The A-380 series has a range of 0.05 to 500 g, and a useful frequency range of 3 to 2500 cps. The A-395 series covers 0.1 to 800 g, useful within 3 to 9000 cps.

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

CIRCLE 48 ON READER-SERVICE CARD

NEW PRODUCTS

Precision Fine Wire

Temperature Stable

This precision fine wire maintains virtually constant resistance from −65 to +250 C. It is made of Moleculoy, a nonmagnetic 75/20 nickel chromium alloy modified with additions. Diameters range from 0.01 to 0.0004 in.

Molecu-Wire Corp., Dept. ED, Scobeyville, N.J.

CIRCLE 50 ON READER-SERVICE CARD

Program Timer

Has glow transfer tubes

Originally developed for annealing turbine blades, this program timer operates from 115 v, 60 cps and comes in a standard relay rack housing. It produces a series of pulses which are initiated by a momentary contact closure. Any number of pulses from 1 to 30 may be selected by the controls. The duration of the pulses, as well as the spacing between, can be adjusted from 0.1 to 10 sec. Glow transfer tubes indicate the progress of the sequence.

G. C. Wilson & Co., Dept. ED, Huntington, W. Va.

CIRCLE 51 ON READER-SERVICE CARD

Power Pentode

Low distortion

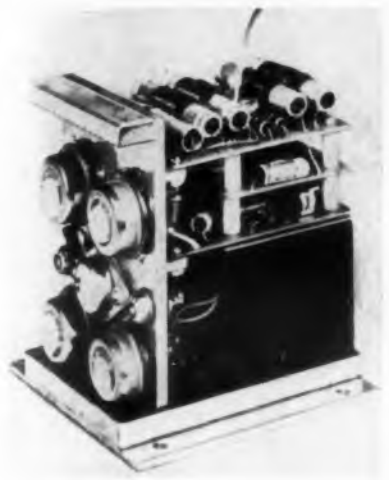
A 9-pin miniature power pentode, the 6/8BQ5 vacuum tube is designed for low-distortion TV and high fidelity use. As a class A amplifier, it delivers 5.7 w with a maximum of 10% distortion. In class AB push-pull operation, it will deliver 17 w with a maximum of 4% distortion. A relatively small signal produces high output. In class A operation with 4.3 v on one tube, it is possible to obtain 5.7 w. Rated plate dissipation is 12 w. A long bulb is used to provide the needed radiation area.

Westinghouse Electric Corp., Electronic Tube Div., Dept. ED, Route 17, Elmira, N.Y.

CIRCLE 52 ON READER-SERVICE CARD

Inverters

Ac or dc to dc or ac



Static Power sources, these transistorized converter-inverters may be used in aircraft radio, radar, missile instrumentation, and remote radio telephone and telegraph. Converting ac or dc to dc and ac, they offer up to 5 w cubic inch output. Efficiency is 80% for input voltages greater than 23 v dc. Series 760 units have 6.3 to 32 v dc input; 1 to 10 kv dc output; up to 1 kw output power; and 0.01% regulation. Series 770 units have 6.3 to 440 v ac inputs at 60 to 2000 cps; 1 v to 10 kv dc output; up to 1 kw output power; and 0.01% regulation. Series 780 units have 6.3 to 32 v dc input; 0 to 440 v ac output at 60 to 400 cps; up to 200 w output power; and 0.5% regulation. Series 790 units have 6.3 to 440 v ac input at 60 to 2000 cps; 1 to 10 kv ac output at 60 to 2000 cps; up to 1 kw output power; and 0.5% regulation.

Spectrol Electronics Corp., Dept. ED, 1704 S. Del Mar Ave., San Gabriel, Calif.

CIRCLE 53 ON READER-SERVICE CARD

Solenoid

Stands high temperature

The SD-225 solenoid was designed for reactor control systems in atomic submarines. It withstands high internal pressures and high temperatures.

ASP Engineering Co., Dept. ED, 6[illegible] Walker Ave., Maywood, C[illegible]f.

CIRCLE 54 ON READER-SERVICE CARD

CIRCLE 55 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Volt-Ohmmeter

For explosive circuits

A high sensitivity, low energy unit, the Igniter volt-ohmmeter is for circuits where explosive or sensitive contacts and components are involved. It can measure continuity, resistance, and stray dc voltage. It is safe for testing explosive cartridges, missile and missile firing circuits, TNT detonators, and circuits with current sensitive components such as platinum contacts and conductive liquids. In a shock resistant plastic case, the unit has an encapsulated power supply and a 5-position selector switch. It has a resistance scale for accurate readings from 0 to 100 K. The voltage scale has two ranges: 0 to 50 and 0 to 500 mv. Maximum current and power available at the terminals are 0.5 ma and 170 μw. Open circuit voltage is 1.35 v. Maximum power is delivered when a 2700 ohm load is applied across the terminals.

Borg-Warner Corp., Pesco Products Div., Dept. ED, Bedford, Ohio.

CIRCLE 56 ON READER-SERVICE CARD

Integrator Drive Assembly

With changeable components

This integrator drive assembly can have its components varied to meet a wide range of design requirements. Motor-generator used operates on 115 v, 400 cycles. Stall torque rated at 0.63 oz in. and rotor inertia of 1.3 gm cm.^{2} Unit can be used where electrical output corresponding to shaft input is desired.

Helipot, Dept. ED, Newport Beach, Calif.

CIRCLE 57 ON READER-SERVICE CARD

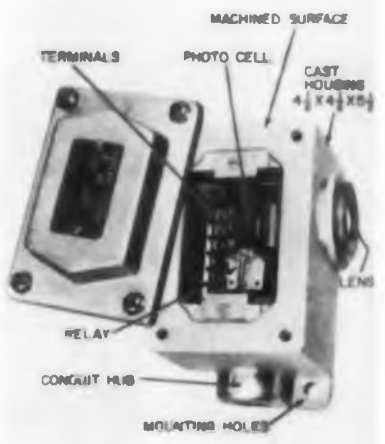
Microwave Tester

For radar systems

An X-band microwave radar test set, the MTG 100X provides a delayed target to a pulse radar at its microwave frequency. An afc loop locks the target pulse to the radar frequency. This unit and the company's RP 175 video target simulator form the RTS-100 microwave radar target simulator system, which offers target speeds to 500 ft per sec, accelerations to 30 g, and ranges to 30 nautical miles. The MTG 100X power output is adjustable from —10 to —80 dbm.

Remanco, Inc., Dept. ED, 1630 Euclid, Santa Monica, Calif.

CIRCLE 59 ON READER-SERVICE CARD



Photorelay

Explosion proof

Housed in a cast explosion proof case, type RPFE1 photorelay needs minimum maintenance. For machinery, production, and process applications, it is resistant to wetness, dirt, shock, vibration, and temperature extremes. Operation is from 100 to 130 v at 25 to 60 cps. The unit is controlled by the 8 ft-c type RPPFE115 light projector, also explosion proof, which can be placed up to 20 ft away. Factory speed tests are made at 1000 per min, and the maximum recommended counting rate is 600 per min. The contacts are rated at 5 amp spdt. The photorelay and projector are each 4.5 x 4.5 x 5.5 in.

Photobell Co., Inc., Dept. ED, 43 Vesey St., New York 7, N.Y.

CIRCLE 60 ON READER-SERVICE CARD

NEW PRODUCTS

Digital Indicator

Has 1 in. characters

In response to four bit binary oded decimal input, this 1 in. haracter digital indicator displays through 9 and two blanks in se- uence. The motor driven unit op- ates on an open circuit principle, hecking code agreement of both nary ones and zeros to assure rrect positioning. Operating ne is 0.1 to 0.8 sec.

Union Switch & Signal, Div. of Vestinghouse Air Brake Co., Dept. D, Pittsburgh 18, Pa.

CIRCLE 61 ON READER-SERVICE CARD

Linearity Testers

For potentiometers

As a production inspection gage, e LT-2 tester checks potentiom- ers for predetermined linearity lerances. As an analytical tool, it n be used to evaluate the linear- characteristics of 1, 3, and 10 rn potentiometers in detail. It n also find the angular position end terminals and taps. Once mmed and set, the tester will easure continuously and auto- atically, stopping when nonlin- rity exceeds a preselected value. rcentage deviation from linearity indicated directly on a panel ter. The unit includes power pply, test voltage supplies, dc plifier, master potentiometer, l angular position scale. Connec- ns are provided for auxiliary ta recording. Power requirements 105 or 125 v ac, 60 cps, 300 w. Boller & Chivens, Inc., Dept. ED, 3 Meridian Ave., South Pasa- na, Calif.

CIRCLE 62 ON READER-SERVICE CARD

3-Inch Storage Tube

2.6 in. diameter useful target

For use in computers, the WL-7225 is a rugged, 3-in. storage tube with a useful target 2.6 in. in diameter. The electron gun beam focuses to a fine spot. A coaxial connector for the output terminations permits compact mounting.

Westinghouse Electric Corp., Electron Tube Div., Dept. ED, P.O. Box 284, Elmira, N.Y.

CIRCLE 63 ON READER-SERVICE CARD

Insulated Printed Circuits

Imbedded in base material

Imbedded Circuitry is printed circuitry imbedded in the base material with an insulating cover. Locked in place, it is not disturbed by severe conditions. Extra thick, conductors and terminals can be narrow and close together.

Beck's Inc., Dept. ED, 300 E. Fifth St., St. Paul 1, Minn.

CIRCLE 64 ON READER-SERVICE CARD

Linear Encoder Systems

Measure lengths of 0 to 100 ft

LE-100 encoder systems measure and automatically record linear lengths from 0 to 100 ft in 1/8, 1/16, or 1/1000 in. steps. Accuracy is ±1 count of the least significant digit.

G. M. Giannini & Co., Inc., Datex Div., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

CIRCLE 65 ON READER-SERVICE CARD

◀ CIRCLE 66 ON READER-SERVICE CARD

Capacitors

For energy storage

Stock ratings of these tubular capacitors range from 0.1 μf at 150 kv with 0.1 μh inductance to 0.25 μf at 50 kv with 0.04 μh inductance. Low-cost energy storage units, they are designed for fast discharge applications requiring high peak energy within a short time constant. They are also suited for blocking and bypass service, power supply filters, and similar uses. The precision rolled, aluminium foil electrodes are separated by polyester film dielectric and assembled in a hermetically sealed, liquid filled, phenolic case. The metal end caps have no. 1/2-13 x 11/16 in. threaded studs. The capacitors have minimum magnetic flux, low impedance, and high ringing frequency. Removable corona shields can be provided for either end.

Axel Bros., Axel Electronics Div., Dept. ED, 134-20 Jamaica Ave., Jamaica, N.Y.

CIRCLE 67 ON READER-SERVICE CARD

Differential Transformer Accelerator

Infinite resolution

A differential transformer accelerator with infinite resolution model 7-34 features ultimate output ratio—to 60 v in a range from ±1 g to ±50 g. It is temperature compensated within 0.1 per cent of critical during damping. The unit is 3.3 x 1.9 x 1.6 in.

Edcliff Instruments, Dept. ED, P.O. Box 565, Monrovia, Calif.

CIRCLE 68 ON READER-SERVICE CARD

Pressure Transducer

Variable reluctance diaphragm type

The S-90 temperature compensated, single coil, variable reluctance diaphragm type pressure transducer can be used as the variable inductor in inductance and reactance controlled fm/fm subcarrier oscillator systems. Differential, gage, and absolute models are offered with numerous pressure ranges from 0 to 10 through 0 to 5000 psi. The unit has low sensitivity to shock, vibration, and acceleration.

Ultradyne, Inc., Dept. ED, P.O. Box 3308, Albuquerque, N. Mex.

CIRCLE 70 ON READER-SERVICE CARD

Phase Shifter

Has two direct-reading scales

Phase shifter type Q-4 is a 400 cycle unit with two direct-reading scales. It provides any phase shift from 90 deg leading to 90 deg lagging in the testing of electronic equipment, control circuits, components, and instruments. Rated at 1000 va, continuous duty, the Q-4 has a 120/240 v input and 120 or 240 v, 3 phase output.

Knopp Inc., Dept. ED, 1307 66th St., Oakland 8, Calif.

CIRCLE 71 ON READER-SERVICE CARD

Synchronous Timing Motor

Has internal solenoid

The 450 synchronous timing motor has an internal solenoid to assure instant starting and stopping. In speeds between 1 and 180 rpm, the unit is 2 in. in diameter and 1-21/64 in. deep. Output torque is 9 in.-oz at 1 rpm.

Bristol Motors, Dept. ED, Old Saybrook, Conn.

CIRCLE 72 ON READER-SERVICE CARD

NEW PRODUCTS

Mercury Rectifier Tester

Handles all types

All types of mercury vapor rectifiers can be tested with this one instrument. Self contained, the tester reads ionization voltage for the determination of tube condition and life. Tubes are tested in their sockets.

Teletronix Engineering Co., Dept. ED, 4695 Eagle Rock Blvd., Los Angeles 41, Calif.

CIRCLE 74 ON READER-SERVICE CARD

DC Power Supply

Transistorized

Model 7PVR20 transistorized power supply produces 100 v dc at 40 ma from an input of 11[illegible] v ±10% at 400 cps. Output voltage variation is ±0.5%. The unit is 2.5 x 2.5 x 3 in. and weighs 17 oz. It operates from —40 to +165 F.

Western Gear Corp., Dept. ED, P.O. Box 182, Lynwood, Calif.

CIRCLE 75 ON READER-SERVICE CARD

Function Generator

Tests pneumatic components

Functionair model 100A is a function generator for testing pneumatic components and systems. It converts electrical signals into pneumatic pressure signals and responds to frequencies from 0 to 50 cps when used with volumetric loads up to 20 cu in.

Palisades Engineering Co., Inc., Dept. ED, P.O. Box 22, Pacific Palisades, Calif.

CIRCLE 76 ON READER-SERVICE CARD

CIRCLE 77 ON READER-SERVICE CARD

Electron Tube News
—from SYLVANIA

Anticipating the circuit designer's needs—everywhere in electronics

TELEVISION . . .

New Tripotential Electron gun takes another 2-inch slice off picture tube length

Sylvania, pioneer in 110° picture tube development, introduces another basic design innovation in cathode ray tubes—the short tripotential focus electron gun. It reduces picture tube length up to 2 1/8 inches, yet permits use of standard design centering magnets, yokes and other associated components.

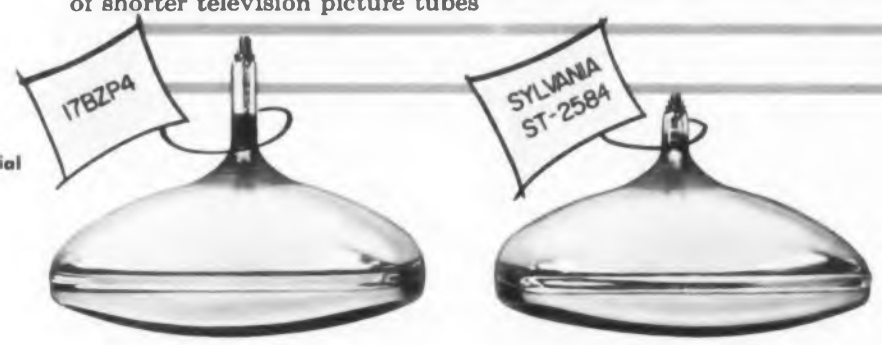
Voltages required to operate tripotential focus picture tubes are available in ordinary TV receiver circuit designs.

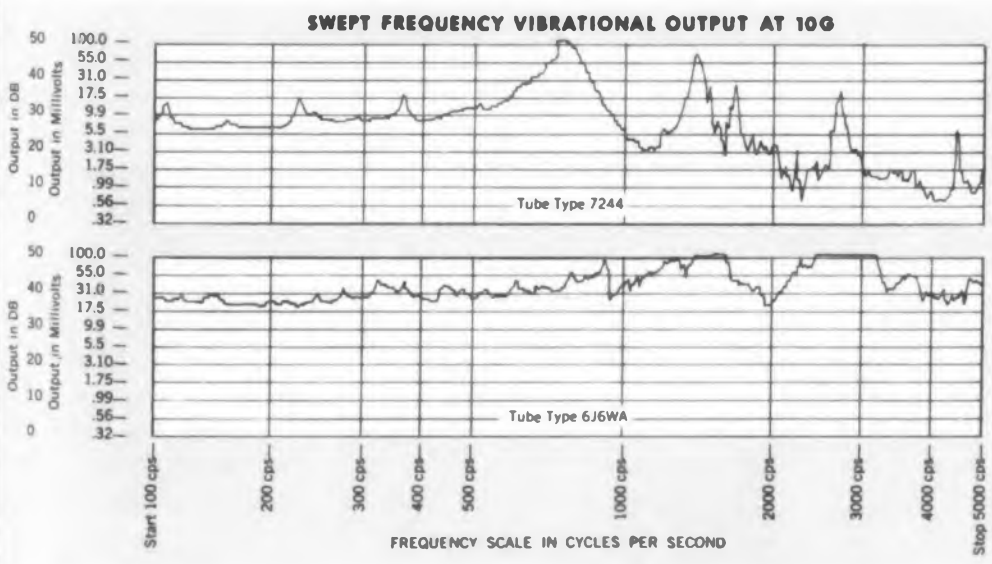
The new gun is much less complicated than conventional types. Its simplicity of design not only makes the gun inherently more rugged but allows for greater uniformity in manufacturing and assembling. This means less arcing, fewer shorts and better over-all performance throughout life.

Tripotential Electron gun is a major advance in the evolution of shorter television picture tubes

Mechanical Dimensions Comparison Chart
Over-all Dimensions (Inches)

Screen 110° types, 1 1/8" neck dia.	Conventional Tubes	Sylvania Tripotential
17"	12 9/16	10 7/16
21"	14 11/16	12 9/16
24"	15 7/8	13 3/4





Over a frequency range of 100 to 5,000 cps at a 10 G level the type 7244 produced a vibrational output in the range of 6 millivolts average while the 6J6WA averaged 60 mv or higher

RELIABILITY . . .

Stacked tubes in glass set new standards for reliability in shock and vibration tests

Production of Sylvania's new stacked tubes in glass, types 7244 and 7245, is being stepped up to meet the increasing demands of military and industrial customers. Fast growing acceptance is based on the inherent reliability of the stacked mount structure:

Reliability

Actual vibrational test data of the stacked structure compared with a conventional tube indicates as much as 2 to 1 improvement in vibrational output at 6 times the G level.

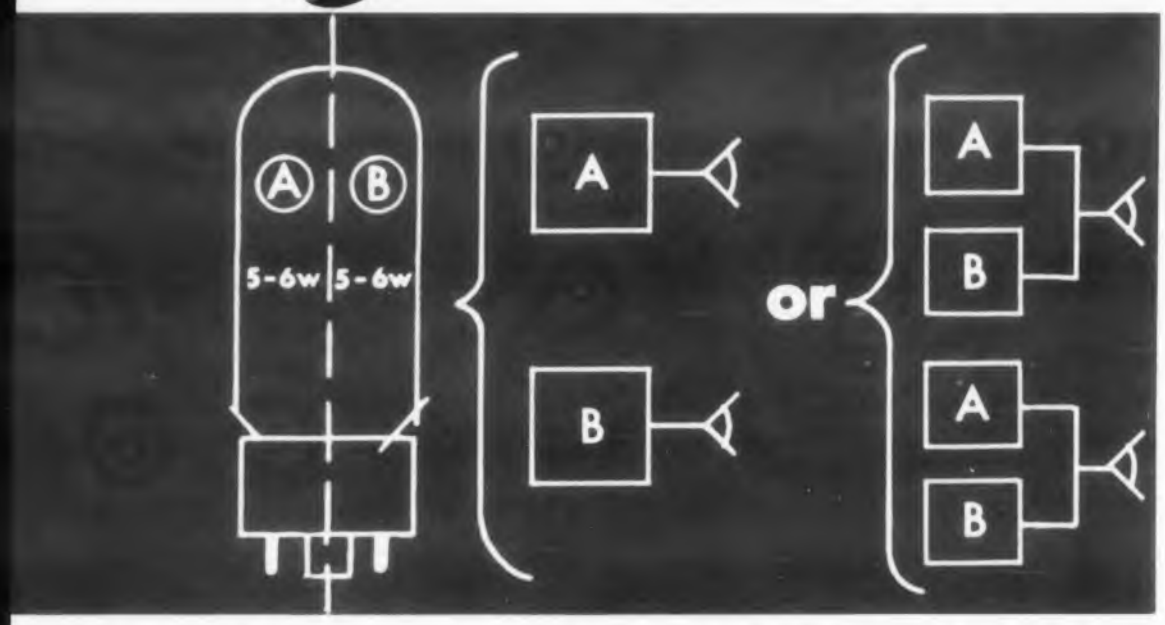
New dual-pentode for STEREO

Sylvania Framelok construction is adapted for greater circuit flexibility, better performance and new economy

A new tube design which takes advantage of the symmetry of the Sylvania Framelok tube construction is being developed specifically for application for the output stages of stereophonic sound circuits. Because it incorporates two identical pentodes in one envelope this new Framelok tube provides design flexibility and can introduce substantial circuit economies.

This new design concept now makes possible the use of a single Framelok tube—common cathode and screen grid—that will supply 5 to 6 watts usable audio output in each channel. Its unusual flexibility also permits application in push-pull in each stereo channel or two tubes push-pull, parallel in high power monaural systems.

In addition to its potential cost advantages there are the many benefits inherent only in the Framelok design: • Greater uniformity of electrical characteristics in tube after tube • Greater stability of electrical characteristics during tube life • Less change in electrical characteristics due to element temperatures at high dissipation levels • Better control of cutoff • Less chance for shorts, microphonism and noise • Better plate-to-screen current ratios • Less arcing.



New Framelok dual pentode type designed for stereo can supply 5 to 6 watts audio output single ended at the voice coil for each channel. High flexibility allows one tube to provide push-pull operation for each channel

RELIABILITY (Continued)

	Type 7244	Type 6J6WA
Frequency	40 cps	25 cps
G Level	15 G's	2.5 G's
Vibrational Output	15 MV	25 MV

Stability and Uniformity

The planar structure of the stacked tube in which all elements are arranged in parallel planes insures optimum stability of operation and uniformity of characteristics.

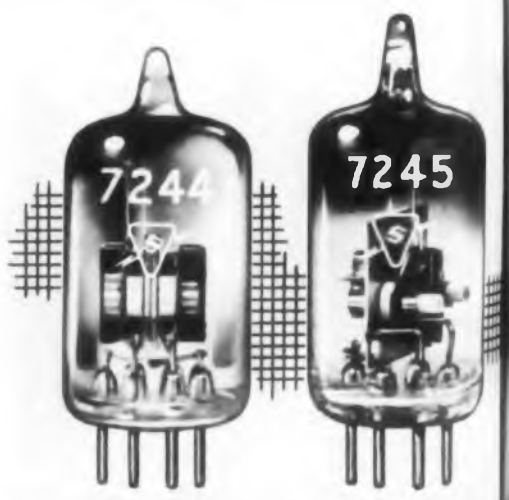
Fewer dimensions need to be controlled, providing a major simplification and reduction in the number of critical tolerances in parts fabrication.

Increased Mechanical Life

The ceramic mount structure is solidly integrated and relative motion between elements is negligible. The entire mount is displaced with shock and vibration as one solid entity, and parts or elements will not react independently. In fact, ceramic stacked mount tubes in glass have survived several hundreds of hours on 15 G, 40 cycle vibration fatigue with no significant change—a test which usually destroys conventional tube types in less than a hundred hours.

Lower Costs for Customers

The stacked tube in glass means less equipment maintenance. In-plant tube selection can be eliminated or reduced. Missile flights and other military operations have a higher probability of success with the rugged stacked tube. No major circuit redesign is necessary since the types are basically retrofits. The 7244 and 7245 can go in present equipment where 6J6WA and 6J4WA types are used with only slight compensations.



AUDIO

Beam power audio pentode for quality amplifiers

Better power output and less distortion than comparable types are the chief attributes of the new 6BQ5. It maintains initial peak performance standards throughout life. Throughout life tests the tube exhibits no "slumping" due to excessive screen dissipation. It delivers 5.6 watts at 9.2 percent distortion single ended under 4.30 v. signal input and 5.95 watts with a 4.70 v. signal. In push-pull at 250 v. plate & screen, the 6BQ5 delivers 10. 65 w. at 3.4 percent distortion; at 300 v. plate & screen, 16.5 w. at 4.16 percent distortion.

Improved high-mu twin triode serves as audio amplifier or phase inverter

As a result of Sylvania's continuing tube improvement program, a superior 12AX7 is now available with sharply reduced hum and noise. Through improved aging and processing schedules Sylvania engineers have been able to maintain the output advantages of the tube while at the same time minimizing the hum and noise characteristics.

Designed primarily for quality audio circuits, the improved 12AX7 has a center tapped heater for operation at 12.6 or 6.3 volts. It has separate cathodes and is packaged in a T-6½ envelope.

New double triode for extremely critical audio applications

Wherever extreme limits on hum and noise must be met, Sylvania's new 7025 will fill the requirements. Its special design incorporates a folded coil heater that improves over-all performance. The new high mu twin triode has an equivalent noise and hum voltage of 1.8 microvolts rms average and 7 microvolts rms maximum.

Low hum-low noise triode-pentode for hi-fi

Sylvania's new 7199 is a 9-pin miniature medium mu triode and sharp cutoff pentode designed particularly for high-quality audio applications. The triode is normally used as a phase inverter, although many other possibilities exist, while the pentode is used as a high-gain audio amplifier.

Folded coil heaters, separate cathodes and an internal shield to reduce electrical coupling combine to provide a pre-amplifier tube with low noise, low micro and high reliability, as required in high-performance audio systems.

New rectifier for hi-fi audio equipment

Double anode, indirectly heated, common cathode rectifier type 6CA4 is now available from Sylvania. The new tube can handle two 6BQ5 output tubes. It delivers 150 ma. maximum DC output current.

RATINGS (Design Center Values)

Peak inverse plate voltage	1000 volts max.
D. C. output current	150 ma. max.
Peak plate current per plate	450 ma. max.
Peak voltage between cathode and heater (cathode positive with respect to heater)	500 volts max.
Transformer voltage	2x250 2x300 2x350 volts, rms.
Total effective plate supply resistance per plate	150 200 240 ohms min.

SYLVANIA

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 2833 Sec. 34.9 P.L.&R., Buffalo 9, N.Y.

SYLVANIA ELECTRIC PRODUCTS INC.
1100 Main St.
Buffalo 9, N.Y.

MOBILE COMMUNICATIONS...

Sylvania introduces four new receiving tubes designed to meet the specialized requirement of mobile radio equipment

Now manufacturers of commercial and industrial mobile transceivers can select from a new line of rugged Sylvania receiving tubes designed with the special conditions of mobile radio in mind. The new tubes, types 7054, 7056, 7059 and Sylvania original type 7258, operate from B supply voltages ranging from 100 to 250 volts. The heater voltages of the line are centered at 13.5 volts—the midpoint of heater voltage range for vehicular equipments. This allows a full 3.52 volt safety margin for the tubes to take care of the fluctuating power supply that may occur in such mobile equipment.

In the Sylvania original type 7258, the pentode section may be used as an RF or IF tube. The triode section can serve as a low frequency oscillator or general purpose amplifier.

Type 7054—a 9 pin sharp cutoff pentode
Type 7056—a 7 pin sharp cutoff pentode
Type 7059—a 9 pin medium mu triode, sharp cutoff pentode
Type 7258—a 9 pin medium mu triode, sharp cutoff pentode

Characteristics and typical operation for Sylvania original type 7258

	Triode Section	Pentode Section
Plate Voltage	150	125 Volts
Grid No. 2 Voltage		125 Volts
Grid No. 1 Voltage	−3	0 Volts
Cathode Bias Resistor		56 Ohms
Plate Current	15	12 Ma
Grid No. 2 Current		3.8 Ma
Transconductance	4500	7800 umhos
Amplification Factor	21	
Plate Resistance (Approx.)	4700	170,000 Ohms
Grid No. 1 Voltage for Ib=20 ua (approx.)	−17	−6 Volts
Plate Current at Ec1 = −3 V Rk = 0		1.6 Ma

INDUSTRIAL & MILITARY C-R TUBES

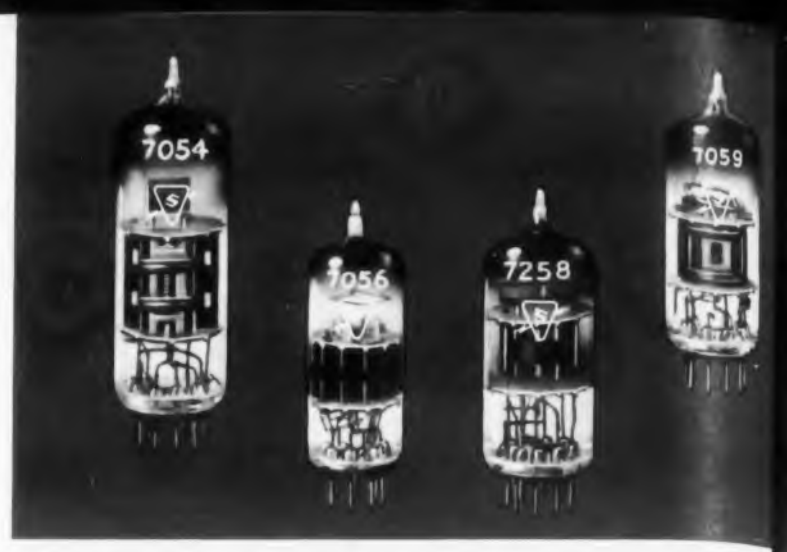
Sylvania introduces a brand-new special purpose 12″ CRT designed particularly for radar and medical applications

Now, an economical 12″ 'scope tube, type SC2558, with fast response time, high impedance input and post deflection acceleration is available from Sylvania. The new tube, which will sell for approximately ½ as much as comparable types, incorporates both electrostatic deflection and focus. Its lower operating voltage eliminates the need for an elaborate power supply. With post deflection acceleration, greater deflection sensitivity is possible with increased brightness.

The large screen size of type SC2558 is especially convenient for group viewing of medical and radar displays. The new tube incorporates an aluminized screen, standard base and is available in any phosphor coating specified.

Typical Operating Conditions

Anode No. 3 Voltage	10,000 Volts D.C.
Anode No. 2 Voltage	5,000 Volts D.C.
Deflection factor	
Deflecting Plates 1-2	105 to 145 v/in.
Deflecting Plates 3-4	80 to 115 v/in.



SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
P. O. Box 1190, Station "O," Montreal 9.

LIGHTING • TELEVISION • RADIO • ELECTRONICS • PHOTOGRAPHY • ATOMIC ENERGY • CHEMISTRY-METALLURGY

Please send additional information on the items checked below:

☐ New tripotential gun

Stacked tubes in glass:
☐ Type 7244
☐ Type 7245

Industrial & Military Cathode Ray Tubes:
☐ Type SC2558

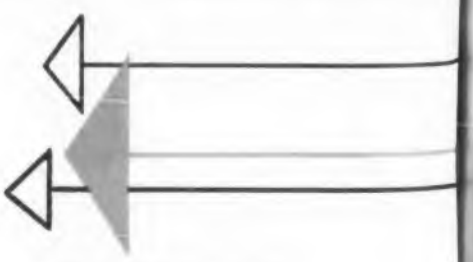
Audio Tubes:
☐ New Framelok tube for stereo
☐ Type 6BQ5
☐ Type 12AX7
☐ Type 7025
☐ Type 6CA4
☐ Type 7199

Mobile Radio Tubes:
☐ Type 7054
☐ Type 7056
☐ Type 7059
☐ Type 7258

Name_____

Address_____

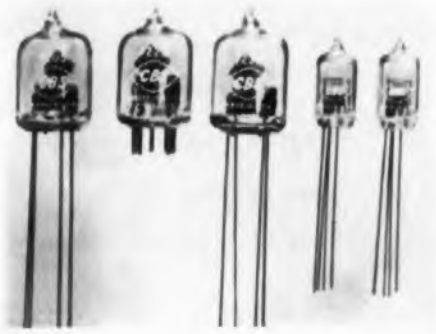
Company_____



Use this handy business reply card to request additional information on these important new Sylvania developments

Trigger Tubes

1.6 to 4 μsec anode delay times



Krytrons are accurate, fast switching cold-cathode trigger tubes which replace relays, thyratrons, and other devices in simplified circuits. Types 7205 and 7229 through 7232 control up to 500 amp with input currents of less than 20 μa. The miniature units operate from —55 to +85 C and under extreme shock and vibration. Anode delay times are from 1.6 to 4 μsec.

CBS-Hytron, Dept. ED, Danvers, Mass.

CIRCLE 78 ON READER-SERVICE CARD

Voltage Stabilizers

1/30 sec response

These redesigned constant voltage stabilizers correct fluctuations in 1/30 of a second and operate within ±1% of nominal output voltage. Inputs are 95 to 130 v and 190 to 260 v. Outputs are 6.3, 120, and 240 v.

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

CIRCLE 79 ON READER-SERVICE CARD

Sweep Generator

Measures to 0.01 db

The entire sweep of model 1099 is level to 0.1 db. Its lower limit is locked to 100 kc; the upper limit is variable to 20 mc. Input and output probes allow a differential method of measurement and eliminate errors due to frequency/level changes.

Marconi Instruments, Dept. ED, 111 Cedar Lane, Englewood, N.J.

CIRCLE 80 ON READER-SERVICE CARD

CIRCLE 77 ON READER-SERVICE CARD

Oscilloscope

Up to 24 channels

Using a persistent cathode ray tube 17 in. long, the RM-24 oscilloscope displays up to 24 channels of information at once. The instrument can be used to study time and motion, stress, strain and vibration, pressures, analog functions, and biological phenomena. It has individual plug-in channel amplifiers with individual control for Y position, beam intensity, gain, and balance. A position for switching a high gain channel amplifier for external X input is incorporated on the time rate switch. The calibrated time base features recurrent as well as triggered sweep. Time is calibrated from 100 μsec per cm to 1 sec per cm. The unit has a frequency response from dc to 3500 cps and requires 26.25 in. of panel space. An external power supply with regulated dc sources is provided for external mounting or internal mounting in a console.

Railway Communications, Inc., Rycom Instruments Div., Dept. ED, 9351 E. 59th St., Raytown 33, Mo.

CIRCLE 82 ON READER-SERVICE CARD

Subcarrier Discriminator

In all standard IRIG frequencies

Available in any standard IRIG frequency, the 951 subcarrier discriminator provides single ended output from ±1 to ±10 v for full bandwidth deviation at currents to ±200 ma. Output noise is under 0.1% for full deviation. Power consumed is 180 w. Special units with frequencies to 250 kc and outputs to 25 kc may be ordered.

Midwestern Instruments, Dept. ED, 41st and Sheridan, Tulsa, Okla.

CIRCLE 83 ON READER-SERVICE CARD

Sharpening

Vibration Meter

Portable

The T-1 vibration meter is a light, portable, battery-operated unit designed for use with the company's TD-series vibration pickups. Accurate measurements of acceleration, velocity, and displacement are selected from the function switch and read directly. Four transducers may be connected at once.

Southwestern Industrial Electronics Co., Dept. ED, 2831 Post Oak Rd., Houston 19, Tex.

CIRCLE 84 ON READER-SERVICE CARD

Computer Module

Static flip-flop

A digital computer module, the T-Pac model FS-10 static flip-flop contains two dc coupled Eccles-Jordan flip-flop circuits using surface barrier transistors. To permit its use as a standard logical element, the unit has diode gated inputs to set and reset the flip-flop. It can drive sensitive relays requiring up to 10 ma, and, in shift register applications, it can shift at rates up to 1.5 mc. The output has an inherent 0.5 μsec delay. The inputs accept normal T-Pac assertion and negation signals, and each output can be connected to 30 gates. Output levels switch between —0.1 and —16 v. The etched circuit layout is designed so that simple wiring changes can readily be made to modify the gating structures.

Computer Control Co., Inc., Dept. ED, 92 Broad St., Wellesley, Mass.

CIRCLE 85 ON READER-SERVICE CARD

NEW PRODUCTS

Transistorized Power Supply
Has 0.01% regulation

Without switching, the SC-32-2.5 transistorized power supply delivers a continuously variable output of 0 to 32 v at 0 to 2.5 amp. Stability for 8 hours and regulation for line or load are both 0.01% or 0.002 v, whichever is greater. Ripple is less than 1 mv rms. The unit has a recovery time of less than 50 μsec, an output impedance under 0.01 ohm, and a temperature coefficient of less than 0.01% per degree C. Power requirements are 105 to 125 v, 50 to 65 cps.

Kepco Labs, Inc., Dept. ED, 131-38 Sanford Ave., Flushing 55, N.Y.

CIRCLE 87 ON READER-SERVICE CARD

RF Power Resistors
For severe environments

Noninductive NH resistors are miniature, wire-wound power units for severe environments. In 10, 25, 50, and 250 w sizes, they operate from −55 to +275 C. Tolerances range from ±0.05% to ±3%; resistances, from 1 ohm to 37 K.

Dale Products, Inc., Dept. ED, Columbus, Nebr.

CIRCLE 88 ON READER-SERVICE CARD

Insulation Tester
For uhf dielectric measurements

Type 874-LM dielectric measuring line tests solid insulation over the 200 to 5000 mc range. It measures dielectric constants from 1 to 10 within ±2%, and dissipation factors from 0.0001 to 0.05 within ±(5% +0.0001).

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

CIRCLE 89 ON READER-SERVICE CARD

Miniature Servomechanisms

In kit or assembled form

Supplied assembled or as kits, model 20-200 servomechanisms are versatile sets of parts which can be put together as pre-engineered 1-7/8 in. components. They fit into standard MS cases 2 in. in diameter. The parts may be made into aircraft instruments, panel indicators, control mechanisms, actuators, computer elements, or a variety of electromechanical components. Seven shafts operating in ball bearings are available for gearing, and as many as three servo loops can be accommodated in a single unit. Up to six size 8 rotating components may be installed, or two size 8 and two size 10. Length varies according to application. Outputs may consist of electrical synchros or potentiometers, torque shafts, dials and pointers, counters, or combinations. Antibacklash gears, clutches, and integrally lighted dial assemblies are also available.

Servo Development Corp., Dept. ED, 567 Main St., Westbury, N.Y.

CIRCLE 90 ON READER-SERVICE CARD

Power Supply

High voltage

Transistorized model 59 power supply operates from 6 v dc. Its output can be adjusted from 1000 to 1500 v dc. The unit is suited for use with photomultiplier tubes, geiger tubes, and other gas filled detectors.

Consolidated Electronics Corp., Dept. ED, Denville, N.J.

CIRCLE 91 ON READER-SERVICE CARD

NEW PRODUCTS

Linear Amplifier

Gain of 50 to 1600

For amplifying small pulses to measureab or visual levels, model LA-100 linear amplifi can be used with proportional or scintillati counters, with ionization chambers, and checking radioactive isotopes. It has a uniq circuitry that completely does away with any cps effects from the pulsations being analyze Fine gain with its inherent instability is eli inated. Temperature stability is good. The u has gains of 50 to 1600 in six switchable po tions. Resolving time at 100 times overload 10 μsec; usable signal is 200 μv to 1 mv; linear is 0.5%; and input impedance is 4 K. Output from a cathode follower. The minimum discri inator pulse height is 600 mv and the maxim pulse height is 100 v.

Gyra Electronics Corp., Dept. ED, 518 Spring Ave., La Grange Park, Ill.

CIRCLE 94 ON READER-SERVICE CARD

Double Pulse Generator

10 μsec rise time

Optimum rise time of pulse in the Na type 5002 is 10 μsec and independent of p width. Square wave output ranges from 0.25 2.5 x 10^7 cps. Dial calibration is accurate wi 5%. External trigger signals can be as low as 0 and have frequencies up to 2.5 x 10^7 cps. P pulse delay: variable from 0.2 μsec to 2 sec. A plitude of main pulse: 20 mv to 50 v, positive negative.

Jackson Edwards Co., Dept. ED, 4101 Lank shim Blvd., North Hollywood, Calif.

CIRCLE 95 ON READER-SERVICE CARD

Flight Data and Control Engineers

Cross new frontiers in system electronics at The Garrett Corporation.

High-level assignments in the design and development of system electronics are available for engineers in the following specialties:

1. **ELECTRONIC AND FLIGHT DATA SYSTEMS AND CONTROLS** A wide choice of opportunities exists for creative R & D engineers having specialized experience with control devices such as: transducers, flight data computers, Mach sensors, servomechanisms, circuit and analog computer designs utilizing transistors, magamps and vacuum tubes.
2. **SERVO-MECHANISMS AND ELECTRO-MAGNETICS** Requires engineers with experience or academic training in the advanced design, development and application of magamp inductors and transformers.
3. **FLIGHT INSTRUMENTS AND TRANSDUCERS**
   1) **DESIGN ANALYSIS** Requires engineers capable of performance analysis throughout preliminary design with ability to prepare and coordinate related proposals.
   2) **DEVELOPMENT** Requires engineers skilled with the analysis and synthesis of dynamic systems including design of miniature mechanisms in which low friction freedom from vibration effects and compensation of thermo expansion are important.
4. **PROPOSAL AND QUALTEST ENGINEER** For specification review, proposal and qualtest analysis and report writing assignments. Three years electronic, electrical or mechanical experience required.

Forward resume to:

Mr. G. D. Bradley

THE GARRETT CORPORATION

9851 S. Sepulveda Blvd.
Los Angeles 45, Calif.

DIVISIONS:
AiResearch Manufacturing—Los Angeles
AiResearch Manufacturing—Phoenix
AiResearch Industrial
Rex • Aero Engineering
Airsupply • Air Cruisers
AiResearch Aviation Service

CIRCLE 550 ON READER-SERVICE CARD

...supplying the following major airplane subsystems: Autopilot, Air Induction, Armament Control, Navigation, Surface Controls, Cockpit Indication and Pneumatic Static Pressure Correction.

The AiResearch centralized air data computing system integrates pneumatic, electronic, electrical and mechanical components on one of the Navy's fastest jets. It senses, measures, and automatically corrects all air parameters affecting flight. It supplies air data information to the pilot and all major airplane subsystems.

This centralized combination of transducers, computers and indicators is the most complete air data computing system ever devised. It enables aircraft to operate at maximum efficiency continuously.

Eliminating duplication of components, the AiResearch centralized air data computing system cuts down space and weight requirements over decentralized systems by many times. Its principal functions: angle of attack, true static pressure (electrical and pneumatic), true air speed, true Mach, altitude, rate of climb, total temperature, dynamic pressure and altitude and Mach error.

AiResearch has been the leader in the development of centralized computing systems. The F4H-1 installation is the first, single package air data computer possessing completely interchangeable, modular construction.

Your inquiries are invited.

ENGINEERING REPRESENTATIVES: AIRSUPPLY AND AERO ENGINEERING, OFFICES IN MAJOR CITIES

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

CIRCLE 96 ON READER-SERVICE CARD

NEW PRODUCTS

Ribbon Cable
Up to 3 in. wide

This improved Tempbraid cable comes in widths from 0.25 to 3 in. It consists of Teflon lead wires woven with Teflon and other yarns into a flat, flexible ribbon. The cable has many advantages where motion is involved. It can be pulled over rollers, coiled on drums, and passed between chassis and panel doors. With the yarns impregnated, the ribbon can be slit to make small inexpensive harnesses. The harness construction is square or rectangular, permitting more conductors to be placed in square or rectangular channels.

Hitemp Wires, Inc., Dept. ED, 1200 Sharon Dr., Westbury, N.Y.

CIRCLE 98 ON READER-SERVICE CARD

Transistorized Indicator
For linear displacement

Portable and battery powered, the Microtron type 170 transistorized indicator is an electronic gaging unit. It is suitable for surface plate height gage work, checking setups, runout, alignments of parts and machines. The unit has two full scale sensitivity ranges: 0.006 in. with 770X magnification, and 0.0006 in. with 7700 magnification. There is a single zero adjust control for both ranges. Graduations on the 4.6 in. high-magnification scale are 10 millionths of an inch.

Airborne Instruments Lab, Dept. ED, 160 Old Country Rd., Mineola, N.Y.

CIRCLE 99 ON READER-SERVICE CARD

Data Recorders

Automatic typewriter readout

With these data loggers, analog signals from temperature, strain, flow, pressure, level, vibration, and other transducers are converted to typewritten data. The systems incorporate a strip chart potentiometer recorder where data may be scanned and printed versus time. Two models are available: the 166 with a 48 point scanning system and a single range typewriter readout; and the 167, which has circuitry for multirange selection.

Gilmore Industries, Inc., Dept. ED, 13015 Woodland Ave., Cleveland 20, Ohio.

CIRCLE 107 ON READER-SERVICE CARD

Cable Connector

1.15 to 1 vswr

Type 2075 captive pin connectors are approved for use with RG-117/U cable. They have captivated center conductors and dimensionally stable Teflon dielectrics. A slip nut feature allows complete mechanical insertion and good electrical contact prior to engaging the threads so that the nut may be easily rolled on and fitted into position. Capable of handling 500 w, the units have a frequency range of 350 to 5000 mc. Vswr 1.15 to 1; insertion loss, 0.1 db maximum. These UT male connectors are 1-3/4 x 3-5/8 in. They are qualified according to MIL-E-5272.

Tann Electronics, Inc., Dept. ED, Box 1217, Culver City, Calif.

CIRCLE 108 ON READER-SERVICE CARD

NEW PRODUCTS

Coaxial Double Slug Tuners

Cover 300 to 5000 mc

For mounting in a 50 ohm transmission line, type SF coaxial double slug tuners cover the frequency range from 300 to 5000 mc. The two slugs may be adjusted from contact to a quarter wavelength apart and locked in position. The tuners are available for standing wave ratios of less than 2 to 1 and less than 10 to 1. They are 10.7 or 19.1 in. long and have a power rating of 100 w. The units have type N male and female connectors.

Microlab, Dept. ED, 71 Okner Parkway, Livingston, N.J.

CIRCLE 112 ON READER-SERVICE CARD

Standard Frequency Multipliers

Generate 1 to 1000 mc signals

With crystal-controlled standards, type 1112 multipliers provide accurate measurements at microwave frequencies. The multiplier chain consists of two units. The first provides 20 mw at 1, 10, and 100 mc from three phase-locked quartz-controlled oscillators. The second provides 50 mw at 1000 mc from a phase-locked klystron oscillator. Input to the first unit, type 1112-A, is normally 100 kc, but alternatively 2.5, or 5 mc can be used. The second unit, type 1112-B, is driven from the 100 mc output of the first. The multipliers have low noise and are almost completely free from submultiple-frequency spurious signals.

General Radio Co., Dept. ED, West Concord, Mass.

CIRCLE 113 ON READER-SERVICE CARD

Coaxial Cable Switch

Under 1.5 vswr

A small, dependable 115 v ac actuator, model C6N2DB coaxial switch will operate from 60, 400, 1600, and 2400 cps power sources. It meets airborne specifications and features low insertion loss and high crosstalk. At 10,750 mc, vswr is less than 1.5.

Thompson Products, Inc., Tapco Group, Dept. ED, 23555 Euclid Ave., Cleveland 17, Ohio.

CIRCLE 114 ON READER-SERVICE CARD

Electrical Insulation Tape

Class H

Unsupported silicone rubber, tape X-1070 is class H and inorganic. Pressure-sensitive, it has 700 v per mil dielectric strength, and 1 million meg insulation resistance.

Minnesota Mining and Mfg. Co., Dept. ED, 900 Bush St., St. Paul 6, Minn.

CIRCLE 115 ON READER-SERVICE CARD

Magnetron Test Kit

For X and C band units

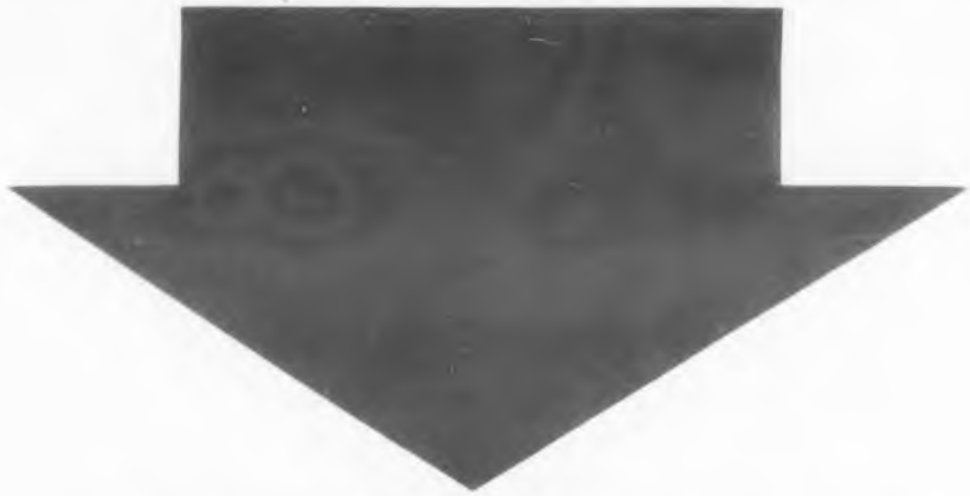
To be used in the field or on the production line, this portable kit tests X and C band 100 and 400 w magnetrons. It comes with or without a power meter and spectrum analyzer.

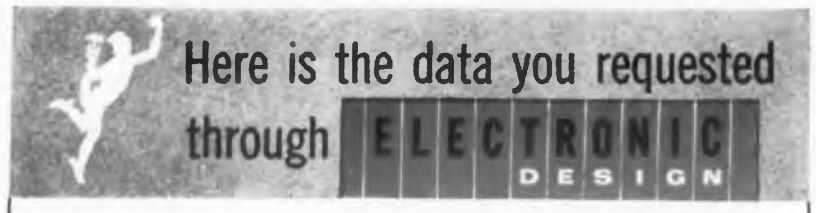
Boonton Labs, Inc., Dept. ED, 1 Salem Rd., Beverly, Mass.

CIRCLE 116 ON READER-SERVICE CARD

CIRCLE 117 ON READER-SERVICE CARD ➤

WATCH FOR THIS LABEL





Thomas J. Whiteside
Senior Project Engineer
Wilson Electronic Enterprises
4th Avenue
Canfield, New Jersey

POSTMASTER: This parcel may be opened for postal inspection if necessary. Return postage guaranteed.

A NEW, FASTER, ONE DAY SERVICE TO SPEED THE INFORMATION YOU REQUEST

Look for this label on your incoming mail . . . it signals the material you have inquired about . . . and helps to bring it to you faster.

Recenty, *Electronic Design* adopted a completely new system to speed and simplify communication between reader and advertiser.

When you make an inquiry on your reader service card, your name and address is typed directly on this label (a separate label for each item you have inquired about). As a result we are now able to process your card within one day of receipt. Your inquiries will be separated, recorded, labels typed, and on their way to each manufacturer by AIR MAIL (1st. class within one day delivery zone) within twenty-four hours. No delay for batch mailing or complicated tabulation.

Although the new system involves considerable extra clerical effort and expense for *Electronic Design*, it means that there is less work for the advertiser, saves typing and the cost of a transmittal letter, enables him to answer your request quickly and easily.

New faster reader inquiry handling is one more step in *Electronic Design's* continuous program to improve its services for both reader and advertiser.

ANOTHER SERVICE . . . ONLY IN ELECTRONIC DESIGN

a HAYDEN publication, 830 THIRD AVE., NEW YORK 22, N. Y. • PLaza 1-5530

NEW PRODUCTS

AUTOMATIC TUBE TESTER.—Model 1128 for large-scale vacuum tube testing. Performs complete dynamic tests on up to 25 tubes at once at rates of 7 to 10 sec per tube. Handles pentodes, triodes, diodes, and neon regulators.

Jackson Electronic & Mfg. Co., Dept. ED, 65 Johnston St., Akron, Ohio.

CIRCLE 118 ON READER-SERVICE CARD

ELECTRONIC TEMPERATURE CONTROL.—Responsive to thermocouple output fluctuations of 1 μv. Applicable to laboratory test ovens and glass fiber drawing dies. Three ranges: 0 to 800, 800 to 1800, and 1800 to 2800 F.

Hagan Chemicals & Controls, Inc., Controls Div., Dept. ED, Box 1346, Pittsburgh 30, Pa.

CIRCLE 119 ON READER-SERVICE CARD

HEAVY DUTY SLIDE.—A pair of series 80 slides handles 300 lb with wide safety factor. In any length from 6 to 60 in. Variety of locking mechanisms and mounting hole patterns. Meets all military specifications.

Jonathan Mfg. Co., Dept. ED, 720 E. Walnut Ave., Fullerton, Calif.

CIRCLE 120 ON READER-SERVICE CARD

TRANSISTOR TRANSFORMERS. — Transistor driver and output transformers hermetically sealed to MIL-T-27A specifications. Molded construction. Tabs, inserts, or studs on special order.

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

CIRCLE 121 ON READER-SERVICE CARD

BERYLLIUM COPPER SEAMLESS TUBING. Complete line of seamless tubing from no. 25 alloy. OD's range from 0.1 to 0.625 in. Wall thickness from 0.042 to 0.001 in.

Uniform Tubes, Inc., Dept. ED, Collegeville, Pa.

CIRCLE 122 ON READER-SERVICE CARD

CHASSIS SLIDES.—Thinline ball bearing slides under 1/2 in. wide, handle 150 lb per pair. In any length from 6 to 36 in.

Jonathan Mfg. Co., Dept. ED, 720 E. Walnut Ave., Fullerton, Calif.

CIRCLE 123 ON READER-SERVICE CARD

ENCLOSURES.—Pressurized aluminum cases custom-built for missile and aircraft electronic equipment. Cooled by built-in blowers.

Northeastern Engineering, Inc., Dept. ED, P.O. Box 150, Manchester, N. H.

CIRCLE 124 ON READER-SERVICE CARD

ALARM SYSTEMS.—Series ST Annunciators with completely self-contained static switching circuits. Variety of models and sizes.

Scam Instrument Corp., Dept. ED, 1811 W. Irving Park Rd., Chicago 13, Ill.

CIRCLE 125 ON READER-SERVICE CARD
CIRCLE 126 ON READER-SERVICE CARD

Just off the press:

NEW

GENERAL ELECTRIC TRANSISTOR MANUAL

Greatly expanded 3rd edition contains latest applications, circuit diagrams and specifications

Never before has so much vital information about transistors — facts you'll use every day in your work — been gathered between the covers of one book!

Whether you're looking for basic information like how to interpret parameter symbols, or are about to design a complex switching circuit, you'll find what you need in General Electric's big new Transistor Manual.

Throughout its more than 160 pages are described the very latest advances in the art of transistors and rectifiers. There are 50% more pages . . . expanded applications sections including new Unijunction Transistor circuits and transistor switches, including Flip-Flop Design Procedures . . . all the latest G-E transistor specifications . . . a list of over 175 new Registered JETEC specs with interchangeability information . . . many new circuits, . . . and a new circuit index to make them easy to find. There's a chapter on General Electric's revolutionary new silicon controlled rectifier, a device which opens up whole new fields of application for semiconductors, but is still so new you won't find it in any other reference.

The General Electric Transistor Manual is already the most widely used book in the transistor field. You won't want to miss this tremendously improved new 3rd edition. Your G-E Tube Distributor has copies now, or mail the coupon on the reverse side with one dollar.

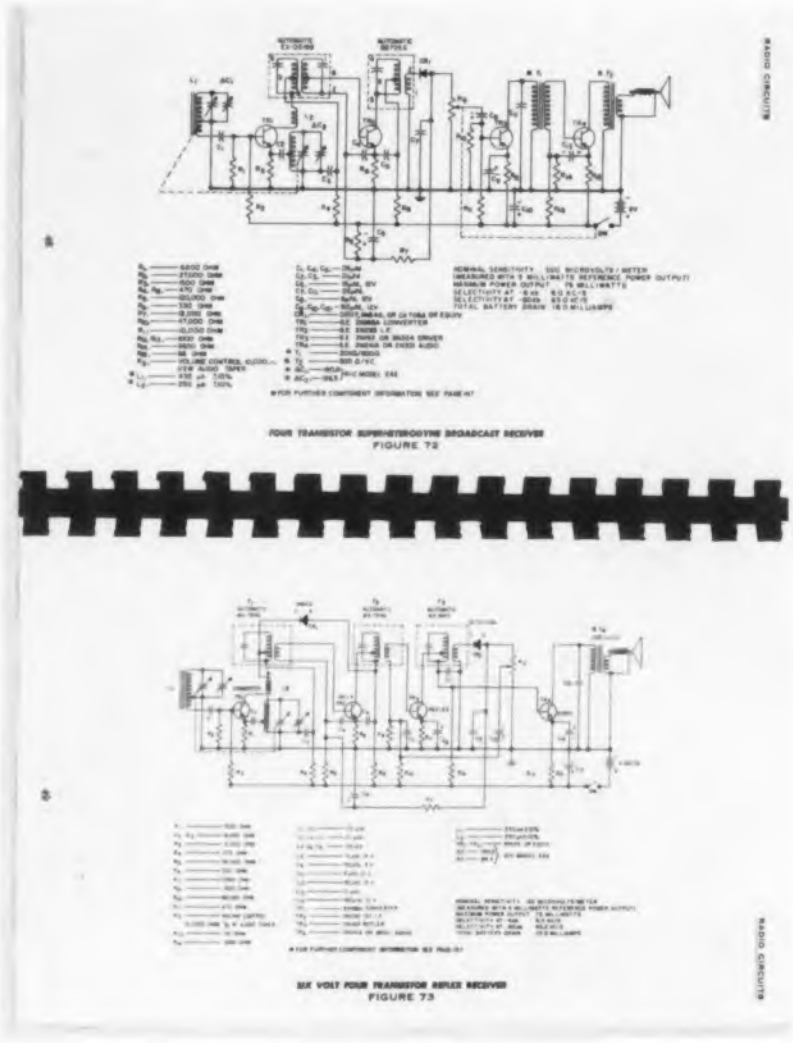
Get your copy from your G-E Tube Distributor, or mail coupon on back.

MAIL COUPON TODAY! ——————▶

NEW GENERAL ELECTRIC TRANSISTOR MANUAL

It's all here!

THEORY • CIRCUITS LOGIC • SPECS



FOUR TRANSISTOR SUPERHETERODYNE BROADCAST RECEIVER
FIGURE 72

SIX VOLT FOUR TRANSISTOR RADIO RECEIVER
FIGURE 73

In the fabulous field of semiconductors, with new products coming onto the market almost every day, there is an urgent and continuing need for sound, basic information. As part of OPERATION UPTURN, we offer the expanded new 3rd edition of the Transistor Manual in the hope it will increase understanding and use of transistors and help build sales and jobs in '58.

TABLE OF CONTENTS

GENERAL ELECTRIC

OPERATION upturn GENERAL ELECTRIC

General Electric Company
Semiconductor Products Dept.
Section S23118
Electronics Park, Syracuse, N. Y.

Rush me the new enlarged 3rd edition of G. E.'s Transistor Manual. I enclose $1.00. (No stamps, please.)

NAME _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

ECG-360

TEL PHONE JACKS.—In two long frame designs. Con ts of silver or palladium. Military types in acco ance with MIL-J-641 specifications. Meet all stan rd circuit requirements.

R hards Electrocraft, Inc., Dept. ED, 4432 N. Ked Ave., Chicago, Ill.

CIRCLE 127 ON READER-SERVICE CARD

CAMERA INTERVAL TIMER.—Battery powered timer-actuator for use with the Eastman Kodak K-100 camera. Attaches to camera through carrying strap mounting holes. Provides any interval within these ranges: 0.5 to 40, 50 to 70, and 110 to 130 sec.

Meteorology Research, Inc., Dept. ED, 939 E. Union St., Pasadena, Calif.

CIRCLE 128 ON READER-SERVICE CARD

DRAFTING TEMPLATE.—No. 52 dimensioning and tolerancing template. Contains cut-outs for symbols recommended by MIL-STD-8A. Includes standard sizes of rectangles and circles for use with the symbols.

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

CIRCLE 129 ON READER-SERVICE CARD

EPOXY TUBING.—For containers and coil forms in the encapsulation of components. Eliminates need for molds. In OD's from 0.2 to 2 in. Made of same epoxy resin or compound as that used for encapsulation.

Resdel Corp., Dept. ED, Wildwood, N. J.

CIRCLE 130 ON READER-SERVICE CARD

GERMANIUM TRANSISTOR.—Type 2N331 pnp alloy-junction unit for audio-frequency amplifier service. Typical power gain of 44 db; typical noise factor of 9 db. Hermetically sealed.

Radio Corporation of America, Semiconductor and Materials Div., Dept. ED, Somerville, N. J.

CIRCLE 470 ON READER-SERVICE CARD

TRITIATED TITANIUM TARGETS.—Thin films of tritiated titanium on stainless steel or molybdenum. Suitable as a neutron source or as an ion producer in static eliminators, current regulating tubes, and vacuum gages.

Radiation Research Corp., Dept., Dept. ED, 1114 First Ave., New York 21, N. Y.

CIRCLE 131 ON READER-SERVICE CARD

TEMPERATURE SENSOR.—Thermal-Ribbon in tape-on or self-adhering types. For monitoring or control. Resistance of 676 ohms per deg C at 25 C. Thermal time constant of 0.5 sec. Temperature range of −60 to +160 C. Thin and flexible for irregular surfaces; 3/8 x 2 x 0.02 in.

Minco Products, Inc., Dept. ED, 740 Washington Ave. N., Minneapolis 1, Minn.

CIRCLE 132 ON READER-SERVICE CARD

CIRCLE 126 ON READER-SERVICE CARD

NEW PRODUCTS

HELIX MONITORS.—T-shaped units for monitoring helix interception current in, or applying modulation to, traveling wave tubes. Cover octave frequency ranges from 250 to 12,000 mc.

T.E.M., Inc., Dept. ED, 71 Okner Parkway, Livingston, N.J.

CIRCLE 134 ON READER-SERVICE CARD

REVOLUTION COUNTER.—Model 1523 quick-reset, geared counter accepts speeds up to 6000 rpm or 8000 counts per minute. Unit is 5 x 2-5/8 x 2-13/16 in.

Veeder-Root Inc., Dept. ED, Hartford 2, Conn.

CIRCLE 135 ON READER-SERVICE CARD

GALVANOMETER TESTER.—Model GA-201 for complete check of mirror type galvanometers as used in recording type oscillographs. Tests units of any impedance.

North Atlantic Industries, Inc., Dept. ED, 603 Main St., Westbury, N.Y.

CIRCLE 136 ON READER-SERVICE CARD

FORCED AIR DUCT HEATERS.—For heated air blasts, ovens, and dryers. Parallel rows of finned strip elements mounted in steel frame. Two models with either three or six rows of heaters. Range of lengths from 7-3/8 to 38-7/8 in. Optional thermal controls for 60 to 250 or 100 to 550 F.

Vulcan Electric Co., Dept. ED, 88 Holten St., Danvers, Mass.

CIRCLE 137 ON READER-SERVICE CARD

MACHINE SAFETY CONTROL.—"Missing Parts Detector" shuts off a power press when stamped part fails to eject. With the company's Circuit Master Mark III, the control also provides overload protection, buckling control, end of material shutoff, and misfeed control. Self-adjusting.

Wintriss, Inc., Dept. ED, 20 Vandam St., New York 13, N. Y.

CIRCLE 138 ON READER-SERVICE CARD

PERMANENT MAGNET SPEAKERS.—High fidelity three-way units. KN-812 12 in. model has 30 cps to 20 kc frequency response and 35 w power capacity. KN-815 15 in. model has 25 cps to 20 kc response and handles 50 w.

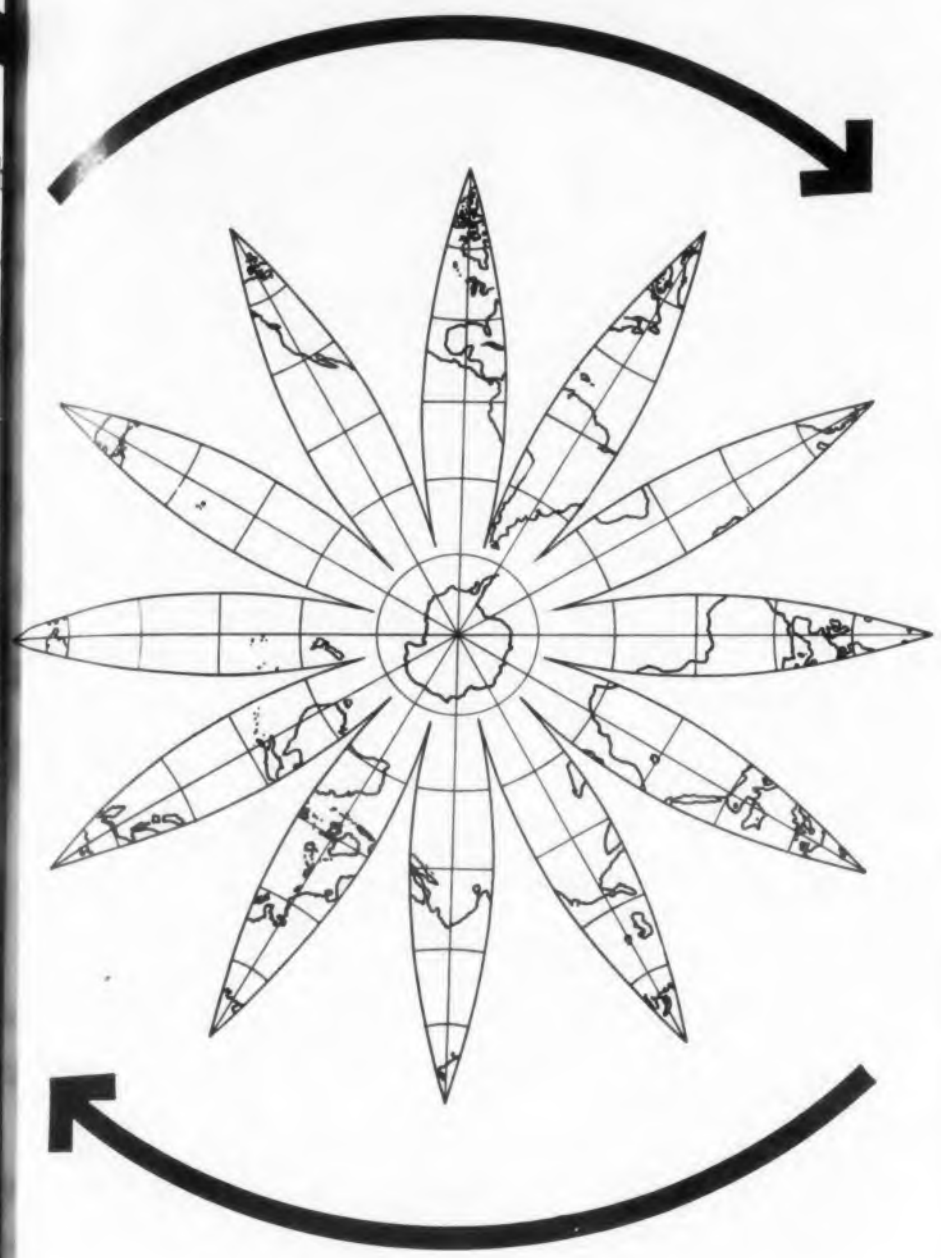
Allied Radio Corp., Dept. ED, 100 N. Western Ave., Chicago 80, Ill.

CIRCLE 139 ON READER-SERVICE CARD

FLAME-RETARDANT LAMINATES.—Grade FR-1 paper-base laminate has maximum constant operating temperature of 275 F. NEMA flammability test: ignition time 120 sec and burning time, 30 sec. Standard sheet sizes: 36 x 36 and 36 x 72 in.

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

CIRCLE 140 ON READER-SERVICE CARD



MICROWAVE TESTER.—Expanded range of model TSA-W is 10 to 44,000 mc. Unit permits visual analysis of 0.1 usec pulses and provides frequency dispersion to 70 mc. Provides narrower display bandwidth with 7 kc resolution for wide pulse analysis.

Polarad Electronics Corp., Dept. ED, 43-20 34th St., Long Island City 1, N.Y.

CIRCLE 142 ON READER-SERVICE CARD

MINIATURE WELDING HEAD.—Model 1032 for resistance welders. Makes exactly repeatable welds at electrode pressures of 4 oz. Electrode pressure is continuously adjustable from 4 oz to 15 lb. Unit weighs 4 lb.

Unitek Corp., Weldmatic Div., Dept. ED, 380 N. Halstead Ave., Pasadena, Calif.

CIRCLE 143 ON READER-SERVICE CARD

SELF-LOCKING INSERTS.—One piece, all metal inserts press into drilled holes. Have resilient segments that provide a spring grip. With threaded or plain bore. Shock and vibration resistant.

J. B. Plevyak Mfg. Co., Dept. ED, 19 Jefferson St., Newton, N.J.

CIRCLE 144 ON READER-SERVICE CARD

MEMORY SYSTEM.—Type 1092-BQ8A digital buffer storage unit synchronizes systems of differing speeds. Stores up 1092 characters of 8 bits each. Operates at 100 kc rate.

Telemeter Magnetics, Inc., Dept. ED, 2245 Pontius Ave., Los Angeles 64, Calif.

CIRCLE 145 ON READER-SERVICE CARD

BOBBINS.—Glass silicone for Class H; glass melamine for Class B; glass phenolic for Class A. All can be run from one set of low cost tooling.

Stevens Products Inc., Dept. ED, 86-88 Main St., East Orange, N.J.

CIRCLE 146 ON READER-SERVICE CARD

AUTOMATIC TV CAMERA.—Model 63A accommodates light range of 120 to 1 with 50% change in video output level. Self-adjusts beam, target, and electrical focus circuits to optimum values. Weighs 10 lb.

Thompson Products, Inc., Dage Television Div., Dept. ED, Michigan City, Ind.

CIRCLE 147 ON READER-SERVICE CARD

SHIELDED RADIATION COUNTER.—Model NC-2 neutron monitor. Neutron sensitivity is 560 cpm per nv for a PoBe neutron flux. Ratio of front to side sensitivity is about 2 to 1 for 4.5. Counting rate meter has full scale ranges from 20 cps to 10 kc in 8 steps.

Tullamore Electronics Lab, Dept. ED, 6055 S. Ashland Ave., Chicago 36, Ill.

CIRCLE 148 ON READER-SERVICE CARD

NEW PRODUCTS

SCINTILLATION DETECTOR.—Model DS8 probe for counting fast or slow neutrons, gammas, and betas. Has 10 stage, 3/4 in. photomultiplier tube and transistorized circuit. Weight, 5 oz; diameter, 1 in.

Nuclear-Chicago Corp., Dept. ED, 229 W. Erie St., Chicago 10, Ill.

CIRCLE 151 ON READER-SERVICE CARD

SERVO MILLIVOLTMETER.—SBI-200 self balancing indicator is a miniature panel mounted dc positioning servo. Provides a direct reading proportional to input ratio or millivolts.

North Atlantic Industries, Inc., Dept. ED, 603 Main St., Westbury, N.Y.

CIRCLE 152 ON READER-SERVICE CARD

HEAVY-DUTY FASTENER.—Type U securely retains parts on plain round shafts, rods, and axles. No notches or grooves required. Replaces cotter pins and drilling of holes. Removal resistance of 1000 lb.

The Palnut Co., Dept. ED, Glen Rd., Mountainside, N.J.

CIRCLE 153 ON READER-SERVICE CARD

SELF-LOCKING NUT.—All-metal unit for sheet metal fastening. Has a clinching ring which, when squeezed, causes the sheet metal to flow around a back-tapered shank, locking the fastener in the sheet

Penn Engineering and Mfg. Corp., Dept. ED, Doylestown, Pa.

CIRCLE 154 ON READER-SERVICE CARD

GYRO TESTER.—Model T 856 control panel for measurement of critical gyro parameters. Incorporates all basic switches and meters for control of gyro inputs.

Sterling Precision Corp., Instrument Div., Dept. ED, 17 Matinecock Ave., Port Washington, N.Y.

CIRCLE 155 ON READER-SERVICE CARD

STROBOSCOPE.—Model WE-1-D high intensity stroboscopic light for analyzing high speed mechanical motion or vibration. Flashing rate may be manually varied from 10 to 400 cps in three ranges. Frequency is read on 4-in. meter which also serves as a vtvm.

Westport Electric, Dept. ED, 149 Lomita St., El Segundo, Calif.

CIRCLE 156 ON READER-SERVICE CARD

RATIO COMPUTER.—Scintillation detector of 4 pi geometry. Determines energy level of radiation, identifies the radioactive isotope, and measures the amount. Counting time of 100 sec per subject obtains a sensitivity of 5 x 10^{-10} curies for 1.5 Mev gamma rays.

Radiation Counter Labs, Inc., Dept. ED, Skokie, Ill.

CIRCLE 157 ON READER-SERVICE CARD

TITANIUM WIRE CLOTH.—From 4 to 120 mesh with wire diameters from 0.08 to 0.001 in.

Newark Wire Cloth Co., Dept. ED, 351 Verona Ave., Newark 4, N.J.

CIRCLE 161 ON READER-SERVICE CARD

MULTIPLIER PHOTOTUBE.—Model 6342-A for use in scintillation counters. Supersedes model 6342. Minimum cathode-luminous sensitivity, 50 μa per lumen; spectral response, 3000 to 6500 angstroms.

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

CIRCLE 471 ON READER-SERVICE CARD

ADJUSTABLE-SPEED DRIVES.—"Precision" series drives have 0.5% regulation and can operate continuously at full torque. In various horsepowers up to 3/4 hp.

Servo-Tek Products Co., Dept. ED, 1086 Goffle Rd., Hawthorne, N.J.

CIRCLE 162 ON READER-SERVICE CARD

ADHESIVES.—R-81001, 81002, and 81114 synthetic rubber, phenolic resin base adhesives. At 600 F, shear strength is 495 psi. For rubber-to-metal, plastics-to-metal, metal-to-metal, and friction materials bonding.

Raybestos-Manhattan, Inc., Dept. ED, Bridgeport 2, Conn.

CIRCLE 163 ON READER-SERVICE CARD

HEAVY-DUTY ANTENNA TOWER.—Self-supporting to height of 130 ft. Modular construction. Suited for microwave, radio, and other communication use.

Rohn Mfg. Co., Dept. ED, 116 Limestone, Bellevue, Peoria, Ill.

CIRCLE 164 ON READER-SERVICE CARD

PLASTIC INSULATION.—Plastisol for plating, patching, or protective maintenance. Applied by spraying, painting, or dipping, it forms an adherent insulation surface on any metal or coating.

Sel-Rex Corp., Dept. ED, 75 River Rd., Nutley 10, N.J.

CIRCLE 165 ON READER-SERVICE CARD

POWER TETRODE.—The 12DS7 for use in hybrid automobile receivers where tube and transistor electrode voltages are obtained directly from a 12 v storage battery. Miniature 9-pin unit has two diodes and a high-perveance power tetrode in one envelope.

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

CIRCLE 472 ON READER-SERVICE CARD

PULSE DELAY GENERATOR.—Model 10-K provides a positive pulse delay variable in 0.1 μsec steps over 1 to 10,000 μsec range. Accuracy, 0.01%; jitter, 0.005 μsec.

Orbitran Co., Inc., Dept. ED, Lakeside, Calif.

CIRCLE 166 ON READER-SERVICE CARD

NEW LITERATURE

Transformers 169

Four-page brochure describes transformers and related magnetic components designed for airborne electronics applications. Minitran Corp., 5 Oliver St., Newark 2, N.J.

Configuration, Voltage Chart 170

This chart simplifies the identification, selection, and ordering of the correct types of plug caps and electrical receptacles for specific amperage and voltage requirements. Diagramming the approved and standardized receptacle openings and plug blade arrangements of 28 different types of polarized, non-polarized, and grounding devices for 2-, 3-, and 4-wire installations, these charts are offered in 17 x 22 in. wall size and 8-1/2 x 11 in. catalog page size. Arrow Hart & Hegeman Electric Co., Hartford, Conn.

Aircraft, Missile Switches 171

Ten switches for aircraft and missile application are described and illustrated in the 2-color, 6-page brochure. Results of environmental tests conducted for resistance to severe vibration, shock, temperature extremes, long periods of dormancy, etc. are reported. Photographs are supplemented by schematic drawings and specifications. Airtron, Inc., 1096 W. Elizabeth Ave., Linden, N.J.

25-Year Batteries 172

Bulletin CP-540 covers the use, design, and construction of the firm's line of lead-calcium grid batteries. These batteries have a life-expectancy of 25 years in control, switchgear, auxiliary power, and other stationary battery applications. Included is complete cell data on the line from 40 to 1650 amp hour ratings, curves on discharge characteristics, rack data, and accessory details. C & D Batteries, Inc., Washington & Cherry Sts., Conshohocken, Pa.

Transistor Circuits 173

Subject of Radio Brochure G-120. This booklet provides circuit diagrams and technical specifications on transistors for radios. Also included are specifications and circuitry for a new line of drift transistors for very high frequency, small signal applications. General Transistor Corp., 91-27 138th Pl., Jamaica, N.Y.

Magnetic Laminations 177

This lamination catalog includes variations of standard designs and several new shapes. Also included is a design and performance section. It is 140 pages long and written to simplify lamination procurement. Webcor, Inc., Lamination Div., 3912 W. McLean Ave., Chicago 47, Ill.

Thermocouple Tables 178

Ten-page spiral-bound booklet of thermocouple tables has two "front covers" and no "back cover" (is turned over for changing from "mv to deg" to "deg to mv") and is indexed for further convenience. Tables are based on 150 F reference temperature. Pace Engineering Co., 6914 Beck Ave., N. Hollywood, Calif.

Insertion Loss Tester 179

Application Notes No. 4 describes a dual channel insertion loss test set and emphasizes the development of a differential null detector. This device, when used with the recommended accessories, permits measurements to 20 db. Arranged in tabular form are additional instruments involved in the test set. Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md.

Mammoth Waveguide 180

A giant waveguide rotary joint—three times larger than the previous largest joint—is described in this 4-page bulletin. It furnishes details and specifications on the 6-ft high, 4-ft diameter joint produced for a new high-power low frequency Air Force radar. I-T-E Circuit Breaker Co., Special Products Div., Philadelphia 30, Pa.

Digital Processing 181

Bulletin No. 3017 provides information on the operation, construction, and features of the 210 Data Processing System. Six pages long, the bulletin contains illustrations, typical applications, and brief theory. Beckman Instruments, Systems Div., 325 N. Muller Ave., Anaheim, Calif.

Environmental Testing 182

This brochure describes and illustrates the facilities of environmental testing at the manufacturer's plant. The tests include temperature extremes, sand and dust, humidity, fungus, salt spray, shock, vibration, altitude, explosion, and others. Bowser-Morner Testing Labs, Inc., 141 Bruen St., Dayton 1, Ohio.

NEW LITERATURE

Digital Indicators 185

Principles and applications of servo null-balance digital indicating instruments are discussed in Bulletin No. 1758. The literature describes the common types of transducer pickups used with this type of indicator and illustrates applications. Illustrations include measurement of compression, tension, torque, pressure, flow, and temperature. Performance Measurements Co., 15301 W. McNichols, Detroit, Mich.

Pressure Measurements 186

Technical brochure on gage, absolute and differential pressure measurements, describes the performance, application, mechanical and electrical specifications, compatibility in installations, and instructions for ordering the instruments. Also included are circuit diagrams, a typical installation, and a basic explanation of the operation of the equipment. Gulton Industries, Inc., Instrumentation Div., 212 Durham Ave., Metuchen, N.J.

MIL Test Procedures 187

Brochure describes the system of test procedures and reporting methods for tests including vibration, shock, life, electrical measurements, etc. It includes test circuit diagrams, drawings of test fixtures, photographs of test setups, and other media which contribute to obtaining results. A cross reference between the procedures and applicable MIL specifications is included to aid the user in interpretation of military requirements. System of Procedure Specifications, 11916 W. Washington Blvd., Los Angeles 66, Calif.

Absorption Analyzers 188

This 12-page catalog of test equipment provides descriptions of three models of absorption analyzers and accessory equipment available for use with these instruments. It also discusses the equipment incorporating electrostatic pickup for wave form analysis in electronic circuits having periodic wave forms between 3 and 240 mc. Kingston Electronic Corp., Medfield, Mass.

Precision Resistors 189

Bulletin GR-20 catalogs bobbinless precision wire wound resistors, containing technical specifications of company's components, and basic engineering theory on precision bobbinless resistors. General Transistor Corp., 91-27 138th Place, Jamaica 35, N.Y.

Lead Sulfide Detectors 194

This 8-page report is to provide industry with a description of performance characteristics of a range of lead sulfide detectors. The study further shows how the detectors can be produced with long wavelength response and with close control of such meters as resistance, time constant, responsivity, S/N, and NEP. Infrared Industries, Inc., 163 Highland Ave., Needham Heights 94, Mass.

Transient Filters 195

Catalog sheet covers descriptive material on new line of transistor transient filters, including technical description, specifications, model numbers, and prices. These filters are connected at the dc input of transistorized inverters-converters, frequency changers and switching circuitry and eliminate line conducted transients to the circuits and spurious noise transmission to the line. ERA Electrical Corp., 67 East Centre St., Nutley, N.J.

Oscillographs and Amplifiers 196

New 8-page bulletin provides detailed engineering specifications, electrical characteristics, and construction of the wide variety of direct-writing oscillographs and associated amplifiers. Rectilinear and curvilinear recording oscillographs using ink-writing pens, electric stylus and heat sensitive stylus are described in Bulletin 210. Photron Instrument Co., 6516 Detroit Ave., Cleveland 2, Ohio.

Batteries 197

Use, design and construction of PlastiCell lead-antimony grid batteries for telephone, carrier and microwave service, are detailed in a 16-page bulletin. Complete cell data on the entire line from 10 to 1680 ampere hour ratings, curves on discharge characteristics, rack data, accessory details, and sales and service offices of company, are compiled in Bulletin T-533. C & D Batteries, Inc., Conshohocken, Pa.

Folded Hybrid T's 198

Up-to-date guide for the selection of precision cast and fabrication E Plane and H Plane Folded Hybrid T's included chart of physical and electrical characteristics. Catalog No. 850 available from Microwave Development Laboratories, Inc., 92 Broad St., Babson Park 57, Wellesley, Mass.

NEW LITERATURE

Air Moving Units 202

A 16-page, two-color brochure (Bulletin 5412) describes line of special purpose air moving units for original equipment manufacturers. More than 50 designs are illustrated and described including packaged centrifugal blowers, vaneaxial fans, tubeaxial fans, propeller fans, pressure blowers and fluid coolers. Specifications given include capacity range, operating speed, construction features and typical applications of each unit. American Standard, American Blower Div., Detroit 32, Mich.

Indicator Lights 203

Catalog A-58 details complete line of subminiature incandescent indicating lights and accessories. 55 different body and type configurations (including receptacle for low voltage, low current series 344 bulbs) are available for all panel illumination applications. Product now being used by aircraft, missile test stand, laboratory and production line equipment manufacturers because of low cost and versatility. The Sloan Co., 4101 Burbank Blvd., Burbank, Calif.

Transmitting Tubes 204

Recommended types and selection chart of all electron tubes currently available for transmitting and allied applications listed in comprehensive guide. Publication lists lighthouse and planar types, magnetrons, television camera tubes, Klystrons, triodes, tetrodes, diodes, reference cavities, and gas discharge devices. Data for all tubes includes frequency, plate power output, ratings and operating conditions in Bulletin PT-24. General Electric Co., Schenectady 5, N.Y.

Electronic Clocks 205

Graphs for computing cumulative errors in electronic clocks are available in a 4-page brochure, which discusses theory and provides 2 examples on the use of the graphs. Timing equipment is also included. Hycon Eastern, Inc., 75 Cambridge Pkwy., Cambridge, Mass.

Transistor Diode 206

Data for circuit designers interested in computers, telephony, control and pulse circuitry is provided in a new technical bulletin describing four-layer bistable transistor diode. Circuit properties, action of the four-layer diode, switching times, characteristics and test circuits are described in this "file-type" publication. Shockley Transistor Corp., 1117 California Ave., Palo Alto, Calif.

Flow Switches 209

Devices which respond to the flow of liquid in a pipeline to make or break an electrical circuit are discussed in Bulletin FS-1. Typical application of these flow switches are listed, and their use in an air conditioning system is shown in detail. The bulletin introduces the new FS4 series flow switches, suitable for pressures up to 100 lb., and also covers the E-2 series flow switches, designed for heavy duty pressures up to 50 lb. McDonnell & Miller, Inc., 3500 N. Spaulding Ave., Chicago 18, Ill.

Servo Valves

Catalog 210 contains a series of curves and schematics which highlight the design and performance characteristics of low flow servo valves for military, industrial and research applications. The 3 color, 6-1/2 page brochure features a detailed glossary of servo valve terms, as well as a cutaway photograph of a typical valve in this series. *For a copy of this catalog, write on company letterhead to Moog Valve Co., Inc., East Aurora, N. Y.*

Sealants and Moldings 210

Technical data chart features polyurethane, Thiokol and silicone base electronic sealants and molding compounds. These materials, according to the chart, have good electrical properties, high temperature, fuel and cold flow resistence. Coast Pro-Seal & Mfg. Co., 2235 Beverly Blvd., Los Angeles 57, Calif.

Crystal Filters 211

The 4 pages of Bulletin CF 10.7 discuss the 10.7 mc family of crystal filters. Vacuum tube and transistor circuitry is shown, in addition to pulse and impulse response photographs, attenuation vs. frequency curves, and block diagrams. Hycon Eastern, Inc. 75 Cambridge Pkwy., Cambridge, Mass.

Electro-Mechanical Glossary 212

Electro-mechanical actuation and control terminology listed in glossary. Eight pages of definitions are included. Hoover Electric Co., 2100 S. Stoner Ave., Los Angeles 25, Calif.

PATENTS

Microwave Transmission Line

Patent No. 2,810,892. Daniel Blitz (Assigned to Sanders Associates, Inc.)

In the transmission line of this invention, the lamination sections commonly used in association with hf electronic devices are each composed of an outer conductor, an insulating panel, and an inner conductor. When used as a unitary, composite, transmission line, the two sections are assembled with the inner conductors connected together. By constructing a sandwich transmission line in this manner the inner-conductor-to-outer-conductor spacings are preserved and maintained constant, regardless of limited relative motion between the inner conductors and, hence, between lamination sections.

Nonsaturating Transistor Circuits

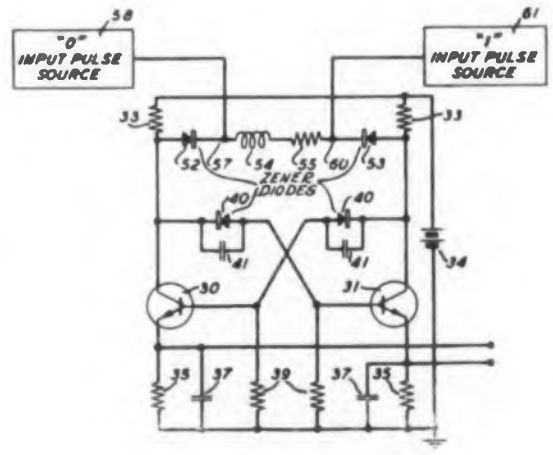
Patent No. 2,840,728. George Haugk and Kenneth K. Kennedy (Assigned to Bell Telephone Labs. Inc.)

Back-to-back zener diodes in series with an inductance connected between collectors prevent saturation of either transistor in a bistable transistor multivibrator. Response time to control triggers is thereby reduced. Transistors switch rapidly from "on" to "off" when the current is less than saturation because the magnitude of minority carrier current is decreased.

Transistors *30* and *31* are shown in a bistable circuit. Zener diodes *52* and *53* with inductance *54* are tied in series to the collector electrodes.

Assume transistor *30* conducts minimum current. Then transistor *31* carries maximum current-less then saturation current-fixed by the breakdown of diode *53*. A trigger from the "0" pulse source is isolated from transistor *31* by inductance *54*. The multivibrator flips and transistor *30* conducts at a level determined by the clamping effect of diode *52*.

Transistor *31* carries a minimum current. A trigger from the "1" input source will cause the circuit to flip over to its original state where transistor *31* again carries maximum current.



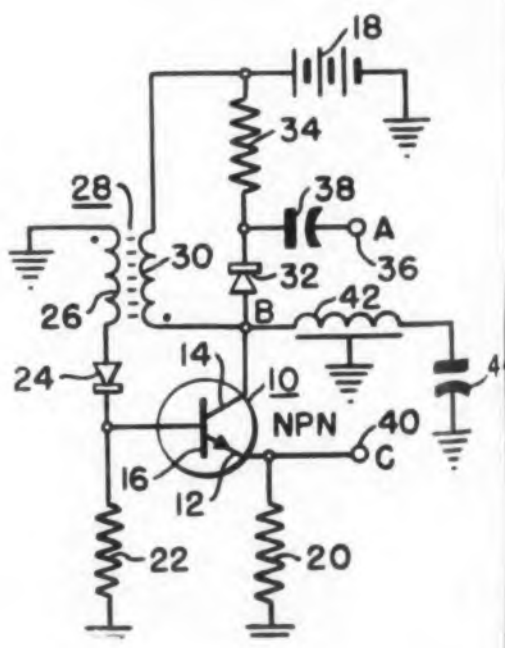
Transistor Blocking Oscillator

Patent No. 2,848,613. Elberson D. Green and Martin G. Woolfson (Assigned to Westinghouse Electric Corp.)

This patent consists of a blocking oscillator which is locked to the frequency of the trigger source. Pulse width is fixed by a delay line.

In a very simple form of the circuit the transistor is cut off in the quiescent state since the base-emitter voltage is zero. A negative impulse coupled through capacitor *38* makes the collector negative. The transformer reverses the polarity causing the transistor to conduct its saturation current.

The negative impulse travels down transmission line *42*. The short circuit effect created by capacitor *44* reflects back a positive pulse which switches the circuit back to the quiescent state.



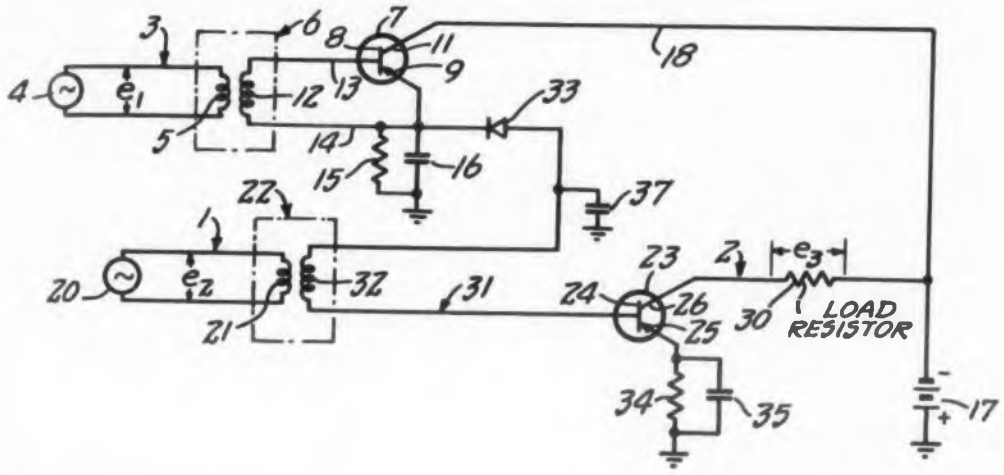
Proportional Gate Circuit

Patent No. 2,837,740. Robert L. Riddle. (Assigned to Haller, Raymond and Brown, Inc.)

Provision is made for effecting by means of auxiliary signals, a substantially linear gating and amplifying control of the primary signal between a source and receiving circuit.

The auxiliary signal from source *4* is amplified by transistor *7* and rectified by diode *33* to set the emitter-base bias voltage on transistor *23*. The current passed by transistor *33* to load resistor *30* through the emitter-collector path of transistor *23* is determined by the instantaneous bias developed by the auxiliary signal source.

In the auto-call portable receiver, a communication channel is established only when two modulated carriers are simultaneously transmitted to produce sufficient auxiliary signal output and are tuned to the frequency of the primary signal channel.

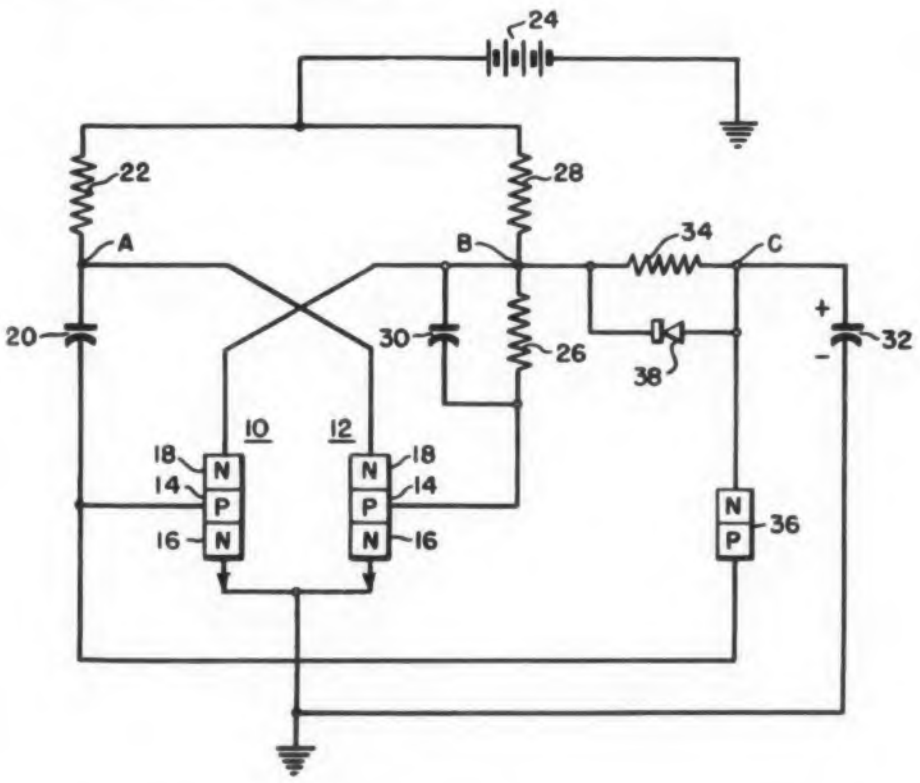


Transistor Sweep Generator

Patent No. 2,841,712. Henri R. Hoge and Douglas L. Spotten (Assigned to Westinghouse Electric Corp.)

A monostable transistor and a diode comprise the essential elements of this rugged sweep generator.

Initially, the slight negative emitter-base voltage causes transistor *12* to saturate and hold transistor *10* at cut off. Capacitor *32* charges linearly until zener diode *36* breaks down. Sufficient positive voltage is then coupled to the base of transistor *10* and transistor *12* cuts off. Transistor *10* conducts. This state is maintained until capacitor *32* discharges through transistor *10* and the voltage on capacitor *20* is insufficient to maintain conduction. Transistor *10* cuts off and the circuit flips back to the initial state.



BOOKS

Table for the Solution of Cubic Equations
Herbert E. Salzer, Charles H. Richards, and Isabelle Arsham, McGraw-Hill Book Company, 327 West 41st St., New York 36, N.Y. 161 pp, $7.50.

This new book presents a table for the numerical solution of cubic equations having real coefficients, superseding other tables in number of decimal places, range, interval, required labor finding all three roots, and convenience in use.

From it the reader can obtain all three roots of any equation in a few minutes time, using nothing more complicated than a desk calculator. Here the interval of 0.001 is fine enough for linear or quadratic interpolation, and the 7 decimal accuracy is greater than in other tables. There are completely adequate facilities for interpolation (first and second differences alongside function), and the range of argument covers every possible set of real coefficients.

The presentation provides an introduction explaining the use of the table, interpolation, and comparison with other tables.

Automatic Process Control
Donald P. Eckman, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. 368 pp, $9.00.

This book treats the important principles of automatic control, emphasizing block diagrams and frequency techniques in process control. It begins with process analysis and continues into the generalized behavior of closed-loop systems. The author incorporates numerous problems with answers and nine detailed experiments, including the analog computer. Special topics covered include: new electronic controllers; control elements and actuators; non-linear elements often encountered in process control; Nyquist and Bode diagrams; fluid and thermal process control; computer optimizing control; and direct comparison of control actions.

How To Become A Professional Engineer
John Constance, McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y. 288 pp, $5.50.

This book may serve as a guide for both unlicensed engineers-in-practice and young graduates on how to obtain a professional engineer's license. Every step of the process is covered: the seven basic requirements for licensure are clarified; various state registration laws are summarized; examples are used to show how examining boards evaluate the experience of the candidate.

The book also explains how to prepare an application; gives pointers on selecting the qualifying experience and writing it up; shows how to prepare for written and oral examinations; points out what to look for—including pitfalls—in refresher courses; and tells how to achieve multiple-state registration.

Principles and Applications of Random Noise Theory
Julius S. Bendat, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. 431 pp, $11.00.

The book develops fundamental topics explaining the basic ideas of random noise analysis and optimum filtering techniques. Physical meanings and mathematical restrictions are emphasized. The author shows how to formulate noise problems, derive their solutions, and obtain proper physical designs and interpretations.

The presentation includes discussion on probability theory, random noise analysis, random processes, engineering systems, correlation functions, power spectral density functions, and optimum filters. Other material is relative to power spectra, optimum prediction and filter theory, analog computer techniques, detailed statistical error analysis for correlation measurements, advanced optimum time-variable designs, and the zero-crossing problem.

Electronic Engineers Master Catalog

Electronic Engineers Master, 60 Madison Avenue, Hempstead, N.Y., $7.50.

The 1958 edition of the master catalog and buying directory of electronic equipment, components and materials sold direct to original equipment manufacturers and other end users is a 1000-page volume containing product information of more than 300 manufacturers. A comprehensive index directs the reader to specific catalog information. Over 4000 manufacturers and service organizations (with addresses and telephone numbers) are listed alphabetically with their respective sales representatives and/or sales offices. A Special Trade Name Directory is another aid for locating information rapidly.

Regular supplements to EEM keep this annual catalog up-to-date throughout the year.

EEM is available to qualified purchasing agents and engineers who specify, design or buy electronic equipment, components or materials.

Elementary Statistical Physics

C. Kittel, John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. 228 pp, $8.00

In its fundamental treatment of a wide range of important applications of statistical physics, the book considers kinetic methods, the principles of detailed balance, the Boltzmann transport equation, thermal noise, and the thermo-dynamics of irreversible processes and fluctuations. Mention is also made of negative temperature, magnetic energy, density matrix methods, and the Kramers-Kronig causality relations.

Problems and examples are given which are applicable to many scientific fields–nuclear physics, electrical engineering, solid state physics, metallurgy, and chemistry.

Wave Propagation and Antennas

George B. Welch, D. Van Nostrand Company, Inc., 120 Alexander Street, Princeton, New Jersey. 257 pp, $5.75.

This book presents a background of electromagnetic wave propagation and an analysis of fundamental principles of antennas. Developments in radar, forward scatter, and radio astronomy are treated. Major emphasis is placed upon the basic principles. Similarities between optical and radio waves are constantly stressed. Graphical methods for obtaining radiation patterns are based on the single principle of interference.

Techniques for Application of Electronic Component Parts in Military Equipment, Vol. II

Edited by Keith Henney and Craig Walsh, McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N.Y. 357 pp.

The book is a working manual for designers of military electronic equipment and provides essential data on component parts so that they may select the parts for end equipment with the greatest reliability.

The volume covers power sources and converters including selenium germanium, and silicon rectifiers, vibrators, dynamotors, transistorized power supplies and batteries; fuses and circuit breakers; electrical indicating instruments; printed wiring boards; solder and fluxes; choppers; blowers; and transmission lines and waveguides. Most of the emphasis is on component types for which military specifications exist.

Basics of Digital Computers

John S. Murphy, John F. Rider Publisher, Inc., 116 West 14th Street, New York 11, N.Y., 416 pp, $2.50 per volume, $6.95 all three volumes, $7.95 for single cloth binding.

This latest three-volume "picture-book" course offers a very simple treatment of electronic digital computers. Volume One reviews the development of computers, and explains the basic theory of computer arithmetic, data representation, the program, AND and OR circuitry, and control. Volume Two discusses the logical elements, circuits, typical types of signals, and magnetic cores, which are then combined to show a few units such as encoders, decoders, counters, and adders that are typical of computers. Volume Three handles the large system aspects of computers with separate discussions of types of memory, control system, and input-output equipment. Timing is also given extended treatment.

Get $10.00 plus a by-line for the time it takes you to jot down your clever design idea. Payment is made when the idea is accepted for publication.

Testing Magnets with an Oscilloscope

IT IS well known that magnetic fields deflect the electron beam in cathode ray oscilloscopes. Most people who work with scopes have proved this phenomenon, as some time, by playing with a magnet close to the tube screen.

In contrast, another useful application of the phenomenon seems to be quite unknown. An oscilloscope can serve for production test of permanent magnets, as well as of soft steel parts. Fig. 1 to 3 show practical examples of these applications.

In the arrangements of Figs. 1 and 2, the oscilloscope is placed with the screen in the horizontal plane for convenience. A thin translucent layer of plastic material (Plexiglass or celluloid, preferably not thicker than 1/32 in., or simply Scotch tape), may be attached to the glass surface, to serve three purposes:

- To save the crt from breaking by accidentally dropped objects.
- To mark a scale, or tolerance limits for the trace.
- Stop blocks can be cemented on the translucent layer, to allow magnets of the same shape to be placed always in exactly the same position.

Testing Bar Magnets

Fig. 1 shows the normal arrangement for production tests of bar magnets. A linear light trace is produced on the oscilloscope and adjusted to a marked base line. By placing a magnet on the tube face, the trace is deflected from its original position. The amount of deflection is proportional to the strength of magnetic flux around the magnet. The indication can be used for numerically comparing the strength of magnets having the same physical shape. Calibration of an absolute scale, or marking tolerance limits can be done by measuring samples of the same shape with a fluxmeter.

After calibration, the method proves superior to the usual fluxmeter method. Placing pieces and reading is faster, polarity is checked at the same time, and accuracy is even better. Though the nominal accuracy of fluxmeters is usually ± 5 per cent the positioning of pieces under test with respect to the probe often introduces larger errors, especially in production test.

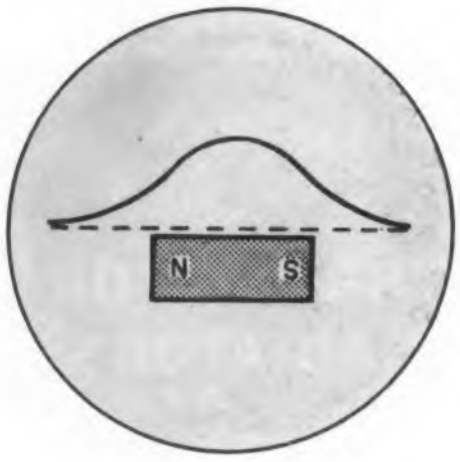


Fig. 1. Testing a bar magnet with a crt. The dotted line shows the normal trace. The solid line shows the trace deflected by a bar magnet.

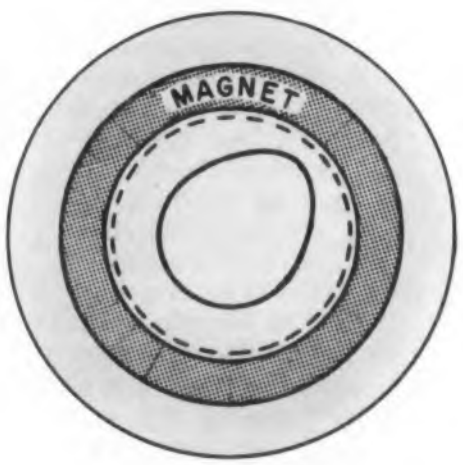


Fig. 2. A circular trace (dotted) is used for testing ring magnets. The solid line shows the trace produced by an unsymmetrically magnetized ring magnet.

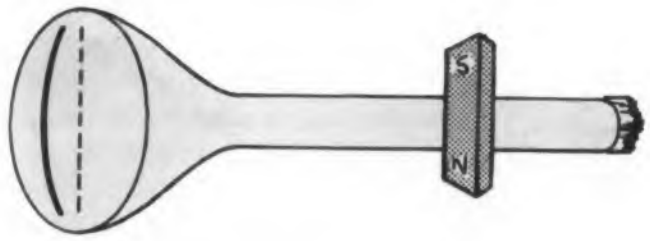


Fig. 3. Testing a mild steel bar for residual magnetism. Test piece is applied to neck of crt for higher sensitivity.

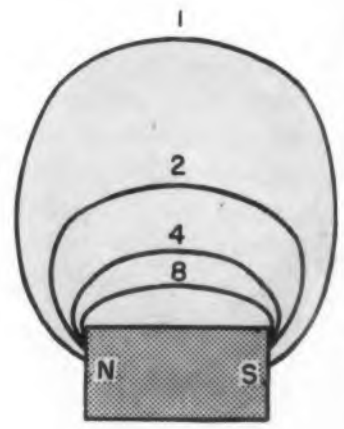


Fig. 4. Lines of gaged flux density around a bar magnet, point-by-point plotted (or photographed) on "Magnetoscope." Figures indicate relative flux density.

Testing Ring Magnets

Fig. 2 shows a special application in testing ring magnets for symmetry. A circular light trace is produced by applying sinusoidal ac in proper phase relation to horizontal and vertical input to the oscilloscope. Placing a ring magnet concentrically with the original circular trace will compress or expand the circle, depending on the polarity facing the tube screen. An unsymmetrical picture indicates unsymmetrical magnetization.

Comparative Tests

Fig. 3 shows how comparative tests can be carried out on weak magnets. For higher sensitivity, the test piece is placed on the neck of the crt. In this way, very small amounts of residual magnetism can be detected. The method can replace elaborate instrumentation in testing soft iron parts for undesirable remanent magnetism.

Gaging Flux Density

Lines of gaged flux around a bar magnet are shown in Fig. 4. These lines can be plotted point-by-point, or even directly photographed by using a special mask over the face of the crt. A patent application has been filed for this method.

Use A Sensitive Scope

It is essential to have an oscilloscope of sufficient sensitivity for magnetic deflection. By a simple experiment, one can check whether or not an oscilloscope is suitable to test a certain type of magnet.

Magnetic field deflection of the cathode ray is inversely proportional to the square root of the accelerating voltage. Earlier models of oscilloscopes usually employing lower accelerating voltages than modern types can often be used without change. By decreasing the high voltage applied to the crt, the deflection sensitivity can be further increased in most cases to about two or three times the original value.

For building up new "Magnetoscopes," only a line and dc supply are needed as major components. If the instrument is intended for testing small magnets only, the tube may be a 3AP1 (3FP7A). A dc supply of 250 v at 1 ma is sufficient to produce highest deflection sensitivity (in the order of 100 gauss per centimeter). With the same tube and a supply of 2000 v at 1 ma, a sensitivity range of 3 to 1 can be covered by normal switch positions.

The only further electrical function required is to deflect the beam in a linear trace. This can be done by applying 60 cycle line voltage to one of the deflection plates.

Thomas Rausch, Electronics Engineer, Stromberg-Carlson Co., Rochester, N.Y.

IDEAS FOR DESIGN

Stopwatch Measures Tantalum Capacitors

Tantalum capacitors often have their markings removed in use. They're normally hard to measure since most bridges have internal signals greater than the peak voltage ratings of these capacitors. It's inconvenient to use an external dc power supply for polarizing the capacitors.

The unknown capacitor can usually be identified as to manufacturer. Knowing this, and the physical size, the possible range of capacity and voltage can be narrowed down.

An easy approximation of the capacity (above 4 μfd) can be obtained with an ohmmeter and a watch. The unknown capacitor is discharged, then charged by the ohmmeter in the R x 10,000 position. The time from the initial connection to the time when the capacitor discharges to 100 on the scale is used to indicate the capacity.

A table can be made up with known capacitors. For each brand of capacitor, it should indicate the average time for the ohmmeter to read 100 (on the R x 10,000 scale).

The method doesn't work too well with capacities less than 4 μfd, since the discharge rate is too fast. The discharge time can be increased somewhat by timing the discharge to a reading greater than 100 x 10,000. This value is small enough to keep the leakage of large capacitors from giving incorrect discharge times.

James R. Zoerner, Design Engineer, Crosley Div. of Avco, Cincinnati, Ohio.

Free Running Blocking Oscillator With Equal Off-On Times

We needed a free running blocking oscillator, whose off-time was approximately equal to the on-time. With conventional techniques, the off-time is approximately two to three times the on-time.

The reason for this can be seen in Fig. 1. Capacitor C charges during a pulse, and must leak through R during the interpulse period. The transformer must also return to a non-saturated

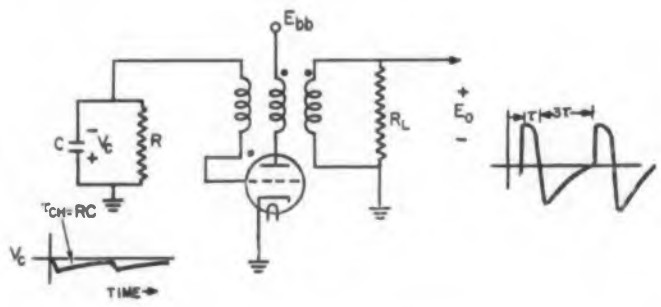


Fig. 1. Conventional blocking oscillator has an off-time about three times as long as the on-time.

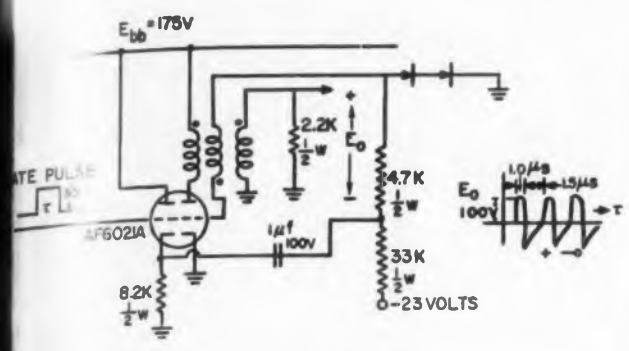


Fig. 2. In this blocking oscillator, the on-time can be made almost equal to the off-time. The transformer has a 1:1:1 ratio and uses a ferrite core.

condition, if retriggering is to yield an output. Of the two delays in recovery, the *RC* delay is usually more severe. This can be eliminated by placing zener diodes in place of, or in parallel with *C*. This prevents the capacitor from charging; therefore, the only recovery time is that of the transformer.

The circuit of Fig. 2 yields powerful pulse groups, with a short time duty cycle of 40 per cent and a long time duty factor of 0.01 at a short time rate of 400 kc. The zener dissipation may be monitored with a 1 ohm resistor in series to determine its current (I). Its voltage (E) may be monitored with a scope. $P_{average} = n\tau/T\ EI$ where n is number of pulses in a pulse group and τ/T the width of a sub-pulse divided by inter-pulse-group period. Much faster repetition rates may be accomplished with short-pulse transformers (0.05 to 0.5 μs). There should be no problem in obtaining 1 to 2 mc pulse repetition rates, and 5 mc rates may be possible.

Two or three zeners may be used in series to minimize the junction capacitance, if necessary. Some zeners work better than others in this respect. Two TI 653C's in series performed nicely in the circuit shown.

Jean A. Develet, Jr., The Ramo-Wooldridge Corp., Penetration Systems Dept., Los Angeles 45, Calif.

Easy Color Coding

In a lab breadboard it is often difficult to correlate leads and test points with the circuit diagram unless effort is taken to label points and to maintain a large supply of color coded wire. A good method is to keep a set of cheap water color paints and a small paint brush handy. Then you can color code any available leads in a jiffy for easy identification with a minimum of effort. Test points can be numbered and identified by small color dabs. Best of all, the paint takes easily to most surfaces.

Richard S. Muller, Hughes Aircraft Co., Culver City, Calif.

IDEAS FOR DESIGN

Current Measuring Adapter

In large consoles, it's not always easy to get to the right points to measure currents. In one piece of equipment, current could best be measured at the fuse holder, since the various assemblies were separately fused. But the problem remains—how to get into the fuse holder.

The gadget in the photograph solved the problem neatly. It's necessary to drill holes through the ends of a fuse and clean out the fuse. At one end, the hole must be large enough to clear the insulation on a wire which is to be inserted. At the other end, a stripped piece of wire goes through the fuse, and through a small hole and is soldered to the metal.

A hole large enough to clear two wires is drilled in the fuse holder end cap. The wires are threaded through this cap. Then the assembly replaces the regular fuse while current measurements are made. The ammeter goes at the end of the pair of wires.

James A. Fred, Dev. Engr., P. R. Mallory & Co., Inc., Frankfort, Indiana.

Adapter for measuring fused currents.

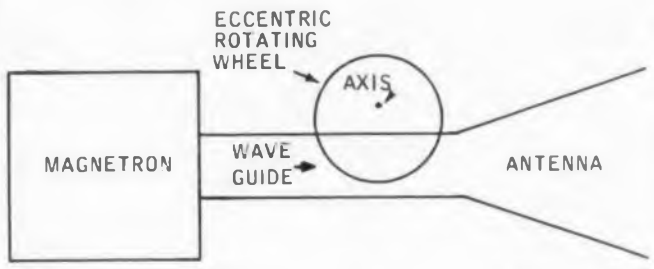
Mechanical Modulation Of Microwaves

At least two means of mechanically modulating a microwave may be conceived:

1. Amplitude modulation by a rotating resistance card attenuator in the waveguide transmission line, and
2. Phase modulation by a rotating phase shifter in the waveguide transmission line.

Both methods can prove useful in telemetry applications where amplitude modulation or phase modulation of microwave signals is desirable. High modulation frequencies cannot be used because of the mechanical nature of the systems. Certain advantages can be realized through the use of these systems.

▪ With a continuously transmitting magnetron,



Microwave modulation by an eccentric rotating wheel.

amplitude modulation is normally difficult to achieve without undesirable side effects, such as the shifting of the magnetron frequency. The figure shows the concept of an eccentric resistance card attenuator. The frequency of the amplitude modulation is determined by the speed of the rotating wheel. The modulation amplitude is determined by the depth of insertion of the wheel into the waveguide.

▪ Some fixed-frequency magnetrons are useful only with pulse modulation. The use of the rotating phase shifter permits phase modulation of the magnetron's output. Thus phase modulation may be similarly accomplished through an eccentric wheel phase shifter. The modulation frequency is determined by the speed of rotation of the wheel, while the modulation amplitude is determined by the depth of insertion of the wheel into the waveguide. The figure is also applicable for this method, except that a phase shifter rather than a resistance card will be used as the eccentric wheel.

R. S. Duggan, Jr., Lockheed Aircraft Corp., Georgia Div., Marietta, Ga.

Temporary Chassis Full of Holes

When constructing a temporary chassis for electronic equipment, a great deal of time is spent drilling and punching holes in aluminum. Often this chassis is short-lived and the effort put into the test setup is thus excessive.

A very convenient and inexpensive material for use as a test chassis, with "pre-punched holes," is heavy wire mesh. It can be obtained with any grade wire and with a specified number of wires per inch.

By folding the sides of a sheet of the mesh, a chassis can be formed. Small components can be located anywhere on the top or bottom of the mesh by securing them with screws through the mesh—and without the necessity of drilling holes. Large holes can easily be cut with tin cutters.

Aside from the simplicity of fabrication, the chassis also provides shielding and cooling.

Guenther K. Machol, IBM, San Jose, California.

IDEAS FOR DESIGN

Modify Power Supply To Save Transistors

In case of power failure, the output voltage of most vacuum tube dc power supplies increases momentarily to a high value. In most transistor work this sudden change in voltage is enough to damage the transistors.

A single pole normally open ac relay may be used to break one side of the supply at the output terminal. The coil of the relay is energized by the line voltage (after the power switch). If the power fails or the main switch is turned off by mistake, the relay opens and disconnects the terminal from the high voltage. To increase the life of the relay an arc suppression network, or a double pole relay may be used.

J. Farzan, Burroughs Corp., Electro Data Div., Pasadena, Calif.

Rapid Frequency Deviation Measurement

The measurement of frequency deviation of fm signal generators or transmitters is usually fairly bothersome and time consuming, especially when several frequencies are involved, as in telemetering or inspection of test equipment.

Here is a method for the rapid and accurate measurement of frequency deviation.

In Fig. 1, the output of the fm source under test is mixed with the rf output of a swept frequency signal generator. The sweep generator center frequency is set to match the test unit carrier frequency, and the sweep width adjusted for approximately twice the expected frequency deviation.

When the combination frequencies are detected and filtered (the low impedance bandpass detector and low pass filter normally used with the sweep generator may be used), a normal oscilloscope presentation will show a "band of birdies" corresponding to the frequency deviation of the fm source under test.

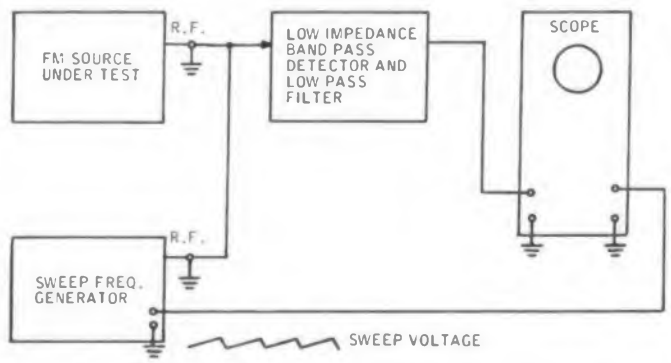


Fig. 1. Instrumentation for rapid measurement of frequency deviation.

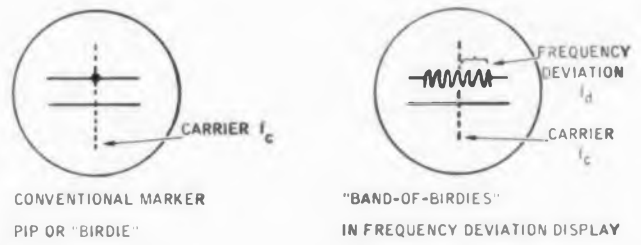


Fig. 2. Oscilloscope waveforms for the conventional marker pip or "birdie" *(l)*, and for the "band of birdies" in the frequency deviation display *(r)*.

The process involved is essentially that of producing a marker "birdie" as commonly used in bandpass alignment work. In this case however, "birdies" are produced at each instantaneous frequency correspondence between the two fm signals. Fig. 2 shows the scope presentations.

This method is faster, simpler and much less subject to ambiguities than trying to find the carrier "zeros" with a heterodyne frequency meter or calibrated receiver. The accuracy is that of the calibration of either the test source or the sweep generator, whichever is more accurate. The display is visual so rapid production testing is possible.

Michael L. Wolfe, Republic Aviation Corp., Guided Missiles Div., Mineola, N.Y.

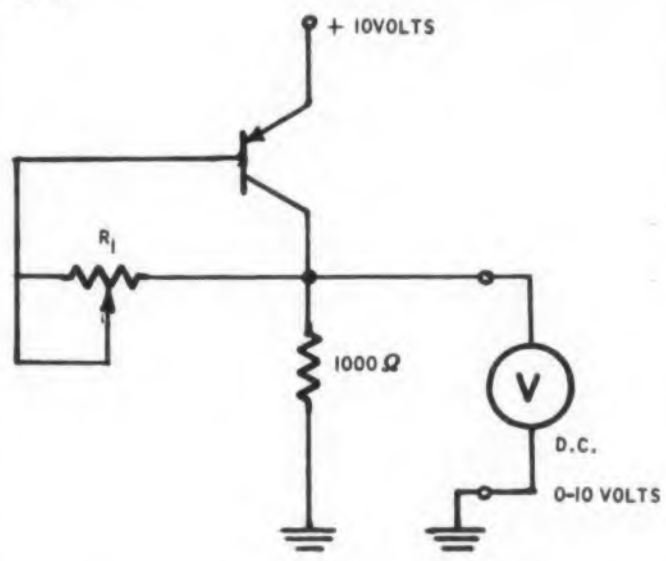
Simple Beta Tester For Small PNP's

This tester gives a value of dc beta based on the ratio of collector to base current. This is a very good measure of the ac beta also, since it is taken at a current level of 5 ma.

The procedure is simple.

1. Adjust R_1 for collector potential of 5 v.
2. The value of R_1 will then be beta times 1000 ohms. R_1 can be calibrated directly in beta.

J. M. Tewksbury, Bendix Radio, Baltimore 4, Md.



Simple beta tester for small pnp transistors.

IMPULSE

A DIGEST OF NEW DEVELOPMENTS IN ELECTRONICS AND AUTOMATION

PUBLISHED BY **ROME CABLE CORPORATION**, ROME, N. Y.

PIONEERS IN INSTRUMENTATION CABLE ENGINEERING

JUST AROUND THE TURN IN ELECTRONIC DRIVING—We mentioned in one of our previous issues an accessory that might tempt automobile buyers. This was an electronic navigational computer system being developed for the Army. Now we see in the *Wall Street Journal* where the boys from Detroit have unveiled the "General Motors Firebird III." This futuristic gas turbine-powered auto incorporates a new control system which was introduced by General Motors earlier this year. Electronic equipment in the car receives signals from a cable embedded in the highway and automatically directs the car on course along the highway. Another device on this auto of the future, says *WSJ*, provides automatic speed control. The old steering wheel and brake pedal have been eliminated and in their place is a single-stick steering device which is situated between the two passenger seats. A GM engineer said that the car has almost six times more cable and electric wiring than a conventional car of today.

$10 MILLION PER DAY!—According to the Electronic Industries Assn., defense electronic spending for fiscal year 1958 will reach about $10 million per *day!* EIA estimates expenditures of between $3.5 billion and $3.9 billion for the entire 1958 fiscal year, as compared to only $2.5 billion for the same period of 1957. More and more extensive use of instrumentation might be the reason price tags for defense missiles are so high.

IDEAS WANTED; $10 MILLION REWARD—Up to 80% of a $5 million contract is available for subcontracting to anyone in the industry with a good idea or a good product that can lead to the development of Micro-Modules for the U.S. Army Signal Corps. Army wants to make military electronic equipment 10 times smaller without sacrificing quality and reliability, and do it at less cost. Ideas, anyone?

IDEA HELPER—One way to get ideas that solve tough cable problems is to call in a cable specialist. You'll find a complete group of them at Rome Cable Corp.—men experienced in the design and manufacture of conventional and special wires and cables. One can help solve *your* tough wire and cable problems—just call your nearest Rome representative, or write Rome Cable Corp., Dept. 431-D, Rome, New York. Our phone number is Rome 3000.

TRENDS IN TELEMETRY—As missiles become more complex, more information is needed from each firing. This is putting special demands on telemetry equipment. Trend is to electronic commutation, statistical telemetry, and pulse code modulation. Major headaches in the industry today: obsolete standards, limited frequency spectrum, lack of coordination.

CABLEMAN'S CORNER—As mentioned in one of the paragraphs above, one of the bugaboos in the procurement of electronic equipment is the lack of up-to-date standards. In order for a major contractor to properly evaluate his suppliers' quotations, a definite set of regulatory standards must be established and adhered to by the suppliers themselves.

Up-to-date standards are equally as important when evaluating test procedures. A reliable wire and cable manufacturer (such as Rome Cable Corporation) will have a series of standard checks and tests in force on every product that is produced in the plant. When *special* quality control is necessary, this manufacturer is prepared to do the job with a minimum of additional effort.

The rapidly expanding electronics field is constantly pressuring the individual manufacturer to produce special equipment. Not too much thought is given to the minimum quality requirements of this equipment except for that well-known phrase: "It's *got* to work!" Phooey! Unless the contractor realizes that making this equipment work involves adherence to proper testing and quality checks, chances are we'll still have exploding busts instead of rocketing successes.

Some of us may be inclined to be penny-wise and pound-foolish. Doesn't it make more sense to spend a few dollars on the order line to make sure that all is dependable on the firing line?

IDEAS FOR DESIGN

Diode Protects Tube During Grid Bias Changes

A cathode ray light source tube (DuMont K1388P16) was to be used in conventional circuitry. But the grid bias was to be varied to determine the operating characteristics. To prevent operating the tube with a positive grid, a TI 1N647 silicon diode was placed between grid *1* and the cathode.

The extremely high back resistance of the diode does not interfere with the normal negative voltage operation of the tube, while the low forward resistance limits positive grid excursions to very low voltages.

Neil Wotherspoon, AEC Computing and Applied Mathematics Center, New York University, New York, N. Y.

Simple Continuous No-Loss Phase Shifter

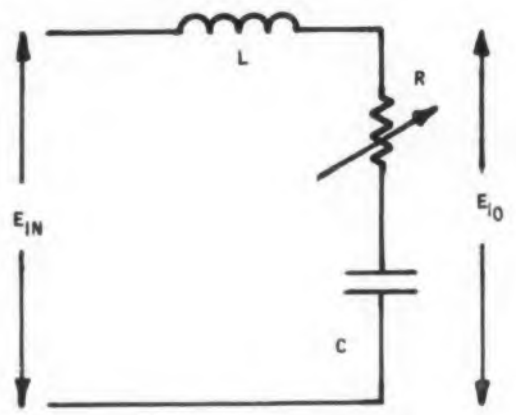
Here's a simple phase shifter whose phase can be varied continuously at a given frequency with no attenuation.

If, at any given frequency, L and C are properly chosen, e_o may be varied in phase over most of the range 0 to 180 lagging by simply adjusting R. E_o will remain equal to E_{in} for all values of R.

The important values are as follows $L = 2/\omega^2 C$, and the phase shift angle is twice the angle whose tangent is $1/\omega CR$.

The magnitude of R is inversely proportional to phase shift. If phase angles appreciably greater than 90 deg are required, a low impedance driving source should be used to prevent excessive loading.

David Perlman, Eastman Kodak Co., Rochester 4, N. Y.



Unity Transmission Phase Shifter

A DC Controlled Servo System

Certain control problems require the use of a servo system with a dc input signal. Generally, a vacuum tube or chopper is used for converting the input and a potentiometer is driven to obtain the proper null. The use of these components, which may be undesirable under certain conditions, can be avoided. A basic control loop is shown in the figure.

An input signal impressed on the saturable reactor produces a corresponding ac signal. The difference between the signal voltage and the induced voltage from the linear transformer *(LT)* provides the input signal to the transistor amplifier. When a signal is present, the motor is driven and in turn drives the *LT* until no signal exists at the input to the amplifier.

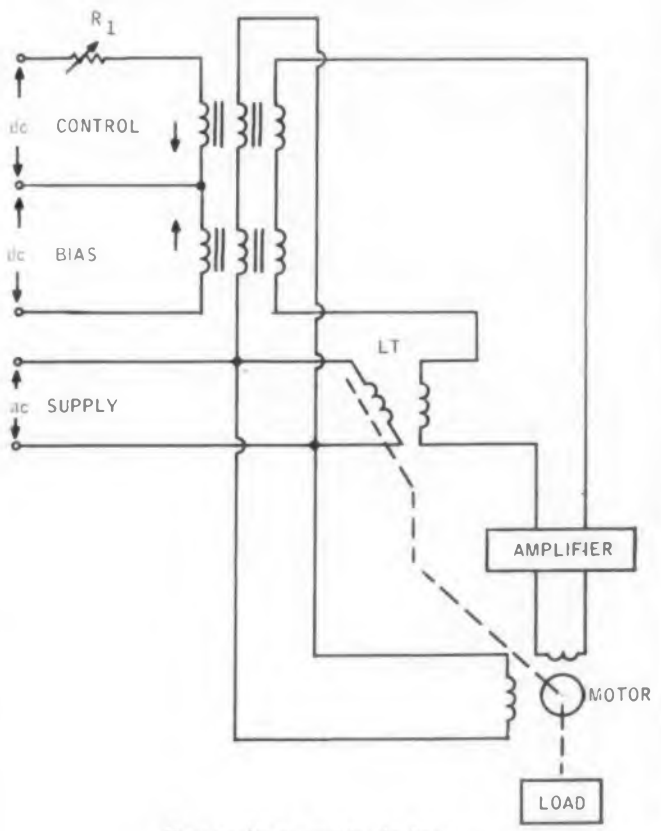
By properly matching the impedance at the input to the transistor amplifier, a reasonably sharp null may be obtained.

Sensitivity to small signals, limitation of drift and reversibility are achieved by applying a fixed voltage across the control coil and an equivalent voltage in opposition to this across a bias coil.

Linearity is roughly determined by varying the resistance R_1 in the control coil circuit. The system proves to be very linear.

The circuit appears suitable for control systems involving step type inputs and may be adaptable for use in recording type meters. The components are such that they could be packaged in a small, rugged and virtually trouble-free unit.

M. Snyder, G. Shoemaker, Aeronautical Instruments Laboratory, Johnsville, Pa.



Servo loop with dc input.

REPORT BRIEFS

Diffused Semiconductor Devices

The essential processes of blank preparation, diffusion, electrochemical machining, and micro-alloying which are utilized in the fabrication of the graded base switching transistor have been successfully demonstrated in the laboratory. The results of the study indicate that it is possible to further develop the techniques and equipment discussed in this report in order to adapt these techniques and equipment to the requirements of large-scale production methods. *Industrial Preparedness Study on Diffused Semiconductor Devices, J. D. McCotter and C. G. Thornton, Philco Corp., Philadelphia, Pa. March 1957, 64 pp, microfilm $3.90, photocopy $10.80. Order PB127428 from Library of Congress, Washington 25, D. C.*

Eliminating Radar Ground Return

Clutter cancelation indication is a simple method for eliminating radar ground return. In most applications, it is a reasonable substitute for MTI, without the system restrictions inherent in MTI. An antenna beam established slightly lower in elevation than the main radar beam delivers information to an auxiliary receiver. Fed into a difference amplifier, this information is compared with that from the main receiver to *$4.80. Order PB127036 from Library of Contion: A Method for Eliminating Radar Ground Return, John Reed, U. S. Air Force, Air Research and Development Command, Cambridge Research Center, Electronics Research Directorate, Special Systems Laboratory, Bedford, Mass. August, 1956, 22 pp, microfilm $2.70, photocopy $4.80. Order PB 127036 from Library of Congress, Washington 25, D. C.*

Amplitude and Phase Difference Fluctuations

This report presents data on 8.6 mm wavelength of phase difference fluctuations on a 10-mile path in Colorado between Pikes Peak and the Garden of the Gods and of amplitude fluctuations on this path and on a 60-mile path between Pikes Peak and Mount Evans. The mm data are compared with similar data taken using a wavelength of 3.2 centimeters. *Amplitude and Phase Difference Fluctuations of 8.6 mm and 3.2 cm Radio Waves on Line-of-Sight Paths, C. W. Tolbert, B. M. Fannin and A. W. Straiton, Electrical Engineering Research Laboratory, Austin, Tex. March 1956, 17pp, microfilm $2.40. Order PB 125571 from Library of Congress, Washington 25, D.C.*

Measurement of Ferrite Parameters

Part 1. The question is considered of measuring the magnetic permeability μ and the dielectric permeability ε tensors of ferrites by using an electromagnetic cavity resonator. The principle of perturbing the resonator is generalized to gyrotropic media and the problems of ferrite bodies of various shapes, placed in the resonant cavity, are solved by using a quasi-stationary approximation. Different vibrations are proposed of measuring μ and ε of ferrites by using a cylindrical resonator and certain experimental results are cited. Translated from Radiotekhnika i Elektronika, AN USSR, I, 447-468, 1956.

Part 2. The use of a rectangular resonator to measure the μ and ε ferrite parameters in samples of various shapes is considered. The perturbation theory developed by the author in Part 1 underlies the computations. Cited are experimental results of comparable measurements of ferrite parameters using a cylindrical and a rectangular resonator. Translated from Radiotekhnika i Eletronika, AN USSR, 1, 638-646, 1956. *Measurement of Ferrite Parameters at Microwave Frequencies, V. V. Nikol'skii, Translated by Morris D. Friedman, Part 1, December 1956, 38pp, microfilm $3.00. Order PB 127203 from Library of Congress, Washington 25, D.C. Part 2, October 1956, 18pp, microfilm $2.40. Order PB 127202 from Library of Congress, Washington 25, D.C.*

Backward Wave Oscillator

Two backward-wave oscillators have been developed which tune over the frequency ranges 35-50 kmc and 47-74 kmc, delivering power of the order of mw. Ceramic guns, stems, and output windows have been developed for use with these tubes. The tubes operate at collector currents of 3 to 5 ma, and require a focusing magnetic field o f 1200 gauss. Helix voltage is varied from 800 to 3500 v to cover the complete frequency range of oscillation. Design features are calculated and observed performance curves for these tubes are shown. In addition to the development of the tape helix tubes, theoretical and experimental investigations were made of the properties of a coiled ridged waveguide and an interdigitally loaded waveguide as slow wave circuits for use in millimeter backward-wave oscillators. Design data and calculated performance for these circuits are given. *Development of Millimeter Backward Wave Oscillator, Donald J. Blattner and Fred Sterzer, Radio Corporation of America, RCA Laboratories, Microwave Advanced Development, Princeton, N. J. February, 1958, 72 pp, $2.00. Order PB131765 from OTS, Washington 25, D. C.*

Here, in Part 6, we continue our translation of Professor Kharkevich's book with the beginning of his Section 9, Chapter 1. This section deals with detection.

Nonlinear and Parametric Phenomena in Radio Engineering

Part 6

A. A. Kharkevich

(Translated by J. George Adashko)

Chapter 1

Nonlinear Circuits and Fundamental Nonlinear Processes

9. Detection

The aim of detection is to extract the signal, i.e., the low frequency modulating oscillations, from a modulated oscillation. In this section we shall consider only the detection of amplitude modulated oscillations.

Detection and Rectification

The detection of am oscillations has much in common with rectification; the difference lies principally in the nature of the rectified signal and in the desired results. The simplest detector circuit contains a nonlinear element having the same characteristic as that of the rectifier shown in Fig. 15.

Let us first qualitatively analyze the phenomena that occur in detection. Let an am voltage act on a circuit with a nonlinear element having the broken characteristic shown in Fig. 21.

The current in the detector circuit comprises high frequency pulses. The envelope of these pulses is a replica of the envelope of the modulated oscillation. The current contains the carrier frequency and its harmonics, and a dc component in which we are usually not interested. Finally, the current contains the low frequency component, which we wish to separate.

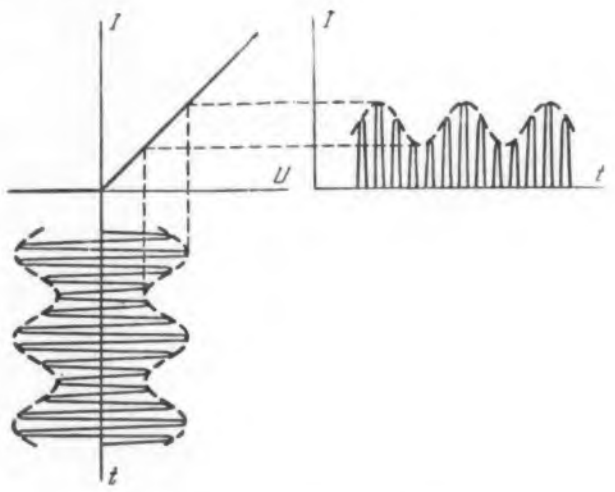


Fig. 21. An idealized detector characteristic.

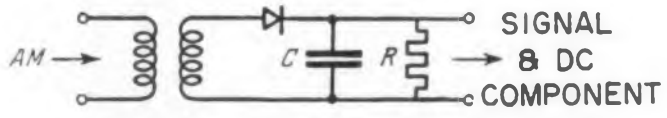


Fig. 22. A basic am detector circuit.

It must be emphasized that the modulated oscillation does not contain a low frequency component. We know, for example, that in the case of sinusoidal modulation, the modulated oscillation contains three sinusoidal components: the carrier, and the two sidebands which also have high frequencies.

To separate the low frequency component, which appears as a result of detection, it is necessary to filter out the high frequencies, and the dc component. The latter usually eliminates itself, since it will not pass through an amplifier channel containing transformers and coupling capacitances. As to the high frequencies, they can be filtered out with a simple *RC* element.

The detector then assumes the form shown in Fig. 22. It differs little in appearance from the rectifier circuit of Fig. 20. But the circuit of Fig. 22 performs still another task—it separates the low frequency of the signal, while the rectifier eliminates the ac component and produces a direct current.

This difference dictates the difference in requirements that must be satisfied by the filters. The filtering element in the detector circuit of Fig. 22 must eliminate the high frequency but retain a low frequency.

For this, it is essential that the resistance R be much greater than the capacitive reactance at the high (carrier) frequency ω_0, and much less than the capacitive reactance at the low signal frequency Ω. This condition is expressed by the inequality

$$\frac{1}{\omega_0 C} \ll R \ll \frac{1}{\Omega C}$$

One can arrive at this conclusion in a somewhat different manner. The *RC* network can be considered as an integrating circuit the purpose of which is to average the current. However, the circuit must average the high frequencies rather than the low frequencies, for averaging the latter would produce only a dc output.

The effect of integrating or averaging is determined by the time constant of the element or, more accurately, by the relation between the time constant

$$\tau = R C$$

and the period of the current. Averaging takes place only when the time constant is considerably greater than the period. If, to the contrary, the time constant is considerably less than the period, no averaging takes place, and the output voltage follows the input voltage.

With these considerations in mind, we can write the following condition for correct operation of an *RC* element:

$$T_0 \ll \tau \ll T_1$$

where T_0 and T_1 are respectively the periods of the carrier and signal frequencies. But this inequality is the same as the one written above, if we recall that

$$T_0 = \frac{2\pi}{\omega_0}, \quad T_1 = \frac{2\pi}{\Omega}$$

Frequent use is made of full wave detection. Here, the carrier frequency is subjected to full wave rectification. The frequency is then doubled and can be more readily separated.

Full Wave Detection

Let us now analyze the detection process. Assume that full wave detection is used and that the characteristic of the detector can be written in the form $I = k \mid U \mid$ as in Fig. 23. In the case of a carrier frequency ω_0 modulated by a sinusoidal voltage of frequency Ω, we have the following expression for the modulated voltage:

$$U = U_m (1 + m \sin \Omega t) \sin \omega_0 t$$

To determine the current in the detector circuit we must take the modulus (absolute value) of this expression. It is necessary to obtain the modulus of each of the factors, since the modulus of a product equals a product of the moduli of the individual factors.

Note that the modulation coefficient m is a positive quantity that does not exceed unity. Therefore the factor $[(1 + m \sin \Omega t)]$ cannot be less than 0, so we need find only the modulus of the last factor. Thus

$$I = k\, U_m (1 + m \sin \Omega t) \mid \sin \omega_0 t \mid$$

But $\sin \omega_0 t$ is the result of full wave rectification of a sinusoid. We know the Fourier series expansion of this function

$$\mid \sin \omega_0 t \mid = \frac{2}{\pi}\left(1 - 2\sum_{k=1}^{\infty} \frac{\cos 2k\omega_0 t}{4k^2-1}\right).$$

Thus

$$I = \frac{2}{\pi} kU_m (1 + m \sin \Omega t)\left(1 - 2\sum_{k=1}^{\infty} \frac{\cos 2k\omega_0 t}{4k^2-1}\right)$$

$$= \frac{2}{\pi} kU_m \left((1 + m \sin \Omega t) - 2\sum_{k=1}^{\infty} \frac{\cos 2k\omega_0 t}{4k^2-1} - 2m\sum_{k=1}^{\infty} \frac{\sin \Omega t \cos 2k\omega_0 t}{4k^2-1}\right).$$

We see that the purpose of detection has been accomplished: we obtain a current with a component $(1 + m \sin \Omega t)$, i.e., containing the modulating signal. In addition, the current contains many higher harmonics: even harmonics of the carrier with frequencies $2k\omega_0$ (first sum) and sidebands with frequencies $2k\omega_0 \pm \Omega$ (second sum). The spectra of the modulated oscillation before and after detection are shown in Fig. 24.

Linear Detection

We have considered detection involving a detector characteristic in the form of a broken line (Figs. 21 or 23). A detector with a characteristic of this kind is called "linear." It is naturally understood that the term "linear" refers not to the characteristic of the detector as a whole, but only to the form of the branch of the characteristic on one side (Fig. 21) or on both sides (Fig. 23) of the break in the line.

Examining Fig. 21, we see that only a "linear" detector leaves the form of the envelope undistorted. To show how the form of the detector characteristics influences the result of detection, let us consider the detection of an am signal by a square-law detector.

Section 9 will be continued in the Dec. 10 issue of ELECTRONIC DESIGN.

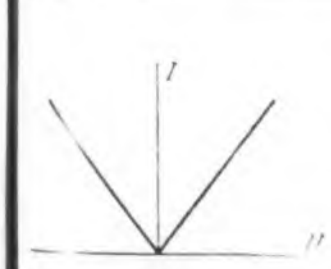


Fig. 23. Detector characteristics the form $I = k|U|$.

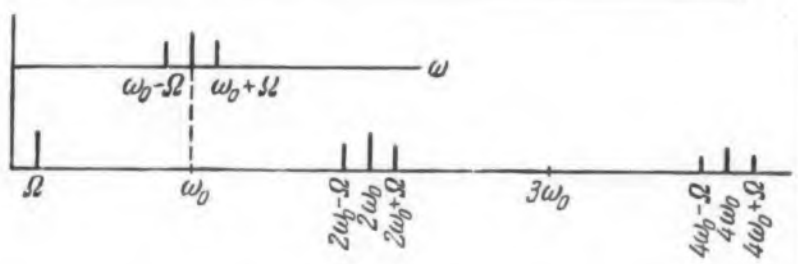


Fig. 24. Frequency spectra of modulated oscillation before and after detection.

RUSSIAN TRANSLATIONS

What the Russians Are Writing

J. George Adashko

CIRCUITS

Interaction Between Signal and Noise in an Exponential Detector by A. D. Knyazev. EC 3/58, pp 11-20, 8 figs.

The author investigates the detection conditions, under which the interaction between two signals may be accompanied by the weaker signal, becoming reinforced in the presence of a strong unmodulated or modulated noise. As a result, an improvement would be produced in the signal to noise ratio at the detector output. It is shown that for this purpose the amplitude characteristics of the detector must be a sharply rising one (for example, exponentially). Results of experiments are cited.

Increase in Useful Power of a Tuned Semiconductor Amplifier by Increasing Its Efficiency, Part II by L. S. Berman. RE 3/58, pp 71-73, 5 figs., 1 table.

The first part of the article was published in the November 1957 issue of *Radiotekhnika*. It was shown there that by using an additional tank circuit, tuned to the third harmonic, it is possible to increase the efficiency of a semiconductor tuned amplifier from 74-75 per cent to 85-87 per cent, and to increase the useful power by a factor of 2.1-2.2 (for equal dissipation power).

In this article it is shown that the use of the second harmonic instead of the third harmonic gives somewhat better results, and increases the efficiency to 90-92 per cent. This is explained by the broader "valley" of the collector voltage during the time that the collector current flow, and also by the higher coefficient of utilization of the collector voltage. On the other hand, the maximum voltage in the collector is higher when the second harmonic is used, compared with the use of the third harmonic.

Analytic Formulation of the Problem of Synthesis of Corrective Networks and Linear Systems by V. G. Segalin. AT 2/58, pp 148-161, 1 fig.

In spite of great progress made in the

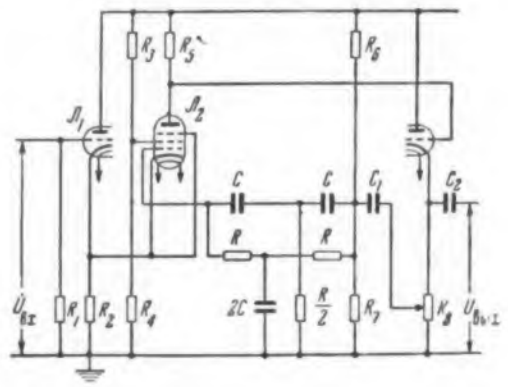


Fig. 1. Diagram of selective amplifier. It represents essentially a modification of a double-triode amplifier with cathode follower.

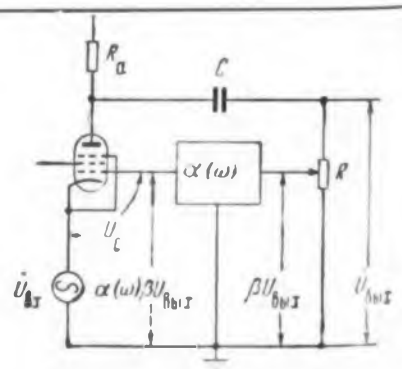


Fig. 2. Simplified equivalent circuit of Fig. It is assumed that the gain of each cathode follower is unity, the cathode coupling of the tubes is negligible, and the double T network does not load the amplifier stage.

ynthe is of linear electric networks with umpe constants and linear automatic ontrol systems, the problem of the synhesis of correcting networks has not yet been fully developed. What is still to be done at the present time is:

An analytic formulation of the synthesis problem for correcting networks;

a procedure for obtaining the optimum transfer function of the correcting system and its generalized analytic expression;

formulation of recommendations on the choice of various correcting networks, with allowance for the features of the uncorrected portion of the system under actual applications;

formulation of recommendations on the advisability of using active correcting networks, also with allowance for the actual application conditions.

Selective Resistance Coupled Low Frequency Amplifier as an Element of a Control System by Yu. G. Kochinev. AT 9/58, pp 355-359, 4 figs.

The dynamic properties of a selective RC amplifier with double *T* network are analyzed. The double *T* network is preferable over the Wien bridge circuit because less difficulty is involved in the summation of the input and feedback signals.

To obtain high selectivity, it is necessary that the open-loop gain of the amplifier be high and that the nonlinear and frequency distortions be relatively low. On the other hand, the input and output impedances of the feedback loop must be matched with the amplifier parameters. See Figs. 1-3.

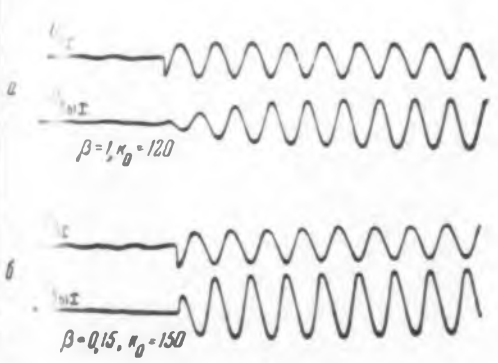


Fig. Oscillograms of the input and output volta s for two values of depth of feedback.

RUSSIAN TRANSLATIONS

AUTOMATIC CONTROL

Concerning One Type of AC Bridge with Automatic Balancing by Two Parameters by V. Yu. Kneller. AT 2/58, pp 162-173, 7 figs.

AC bridges with automatic balancing of two parameters of a single arm are frequently used in automatic control. There are various versions of such bridges. The one discussed by the author is a bridge where the unbalanced voltage is resolved into two components by means of two phase-sensitive null indicators. Its outputs are amplified and control servomotors balance automatically the bridge. The effect of coupling between the balancing networks and the effect of nonlinearity of the static characteristics of the bridge circuit on the stability of the system are analyzed. A bridge circuit is developed, for which is is possible to decouple the balancing circuits over a wide range of measured quantities.

Statistical Analysis of Nonstationary Processes in Linear Systems by Using Inverse Simulating Devices by A. V. Solodov. AT 4/58, pp 312-324, 8 figs.

The minimization of the least square error in a servo system, when the input signal is random and the system itself is nonstationary, involves considerable analytical difficulties. Simulation affords the best approach to the subject, since a simulator can be coupled with an actual regulator. The application of this method of attack to

KEY

The sources of the Russian articles and their dates of issue follow the authors' names. Here is the key to the names of the journals in which the articles originally appeared.

AJ	Acoustic Journal *(Akusticheskiy Zhurnal)*
AT	Automation and Telemechanics *(Avtomatika i Telemekhanika)*
CJ	Communications Journal *(Vestnik Svyazi)*
EC	Electrical Communications *(Elektrosvyaz)*
IET	Instruments and Experimental Techniques *(Pribori i Tekhnika Eksperimenta)*
JTP	Journal of Technical Physics *(Zhurnal Tekhnicheskoy Fisiki)*
ME	Measurement Engineering *(Izmeritel'naya Tekhnika)*
R	Radio
RE	Radio Engineering *(Radiotekhnika)*
REE	Radio Engineering and Electronics *(Radiotekhnika i Elektronika)*

statistical problems has been somewhat limited in the past to special cases. Special circuits, called inverse circuits, are developed for a general analysis of such problems.

Analysis of Quality and Synthesis of Automatic Control Systems with Time Lag by Fan-Chun-Wui. AT 3/58, pp 198-207, 18 figs.

The method of synthesis of correcting networks for servomechanisms, developed by Solodovnikov, is extended to include systems with time delay. Curves are developed for the synthesis of systems with time delay and for the analysis of their response. Several diagrams are plotted for the distortion function of the real frequency characteristic at various values of time delay.

Determination of the Parameters of a System from Experimental (Specified) Frequency Characteristics by A. A. Kardashov and L. V. Karnyushin. AT 4/58, pp 334-345, 5 figs.

A method is proposed for determining the parameters of linear elements in automatic control systems. It is based on approximating these elements by means of experimental amplitude-phase characteristics. Tentative values of the coefficients of the analytic expression for the amplitude-phase characteristics are obtained by interpolation, and are subsequently refined by the least-squares method. The method proposed is applicable for all types of polynomials in the numerator and denominator of the transfer function. It gives sufficiently good results at slight-rule accuracy. Illustrative examples are given.

MEASUREMENTS

Prototype of a Diode Compensation Voltmeter by B. M. Rabinovich and A. M. Fedorov. ME 2/58, pp 74-76, 5 figs, 1 table.

The voltmeter is intended to measure between 25 mv and 100 v at frequencies from 30 cps to 300 mc. It requires no calibration against stand-

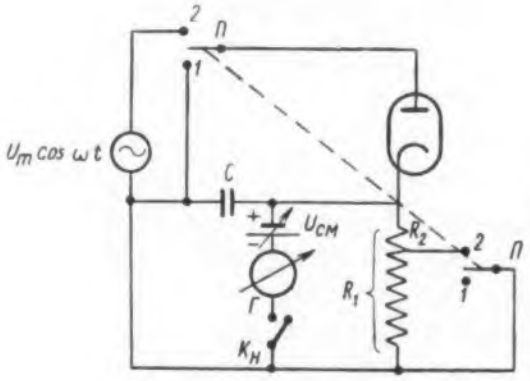


Fig. 4. Illustrating the operating principle of the vacuum tube voltmeter.

RUSSIAN TRANSLATIONS

ard ac instruments. Its accuracy depends on the accuracy of the standard cell employed and on the resistances in dc circuits. See Fig. 4.

Measurement of Small Reflection Co-efficients over a Wide Frequency Range with the Aid of a T-Bridge by V. K. Paramonov, A. A. Metrikin, and N. A. Fel'd. EC 5/58, 7 figs, 1 table.

Description of a waveguide T-bridge, intended for the measurement of small reflection coefficients (less than 1 to 1.5 per cent) at frequencies from 3400 to 3900 mc. The asymmetry of the double T-bridge and the turning off the standard terminal resistance of the bridge is carried out during each change in frequency. The fundamental elements of the bridge, the procedure of their adjustment, and the procedure of measurement with the bridge are described. See Figs. 5-7.

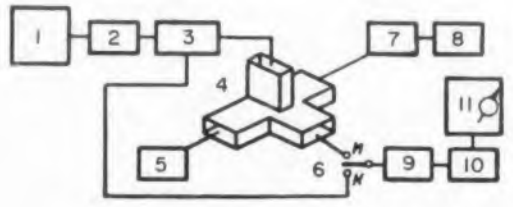


Fig. 5. Block diagram of the measuring bridge. *1*—signal generator, *2*—decoupling attenuator, *3*—directional coupler, *4*—double T, *5*—variable terminal load, *6*—waveguide switch, *7*—measured element, *8*—standard terminal load, *9*—calibrating attenuators, *10*—detector head, *11*—measuring amplifier with indicator.

Fig. 6. The matching of the *H* arm, *E* arm, and the tested arms of the *T* over the tested frequency range. Abscissas—frequency mc, ordinates—SWR.

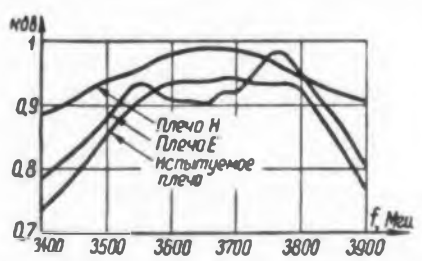
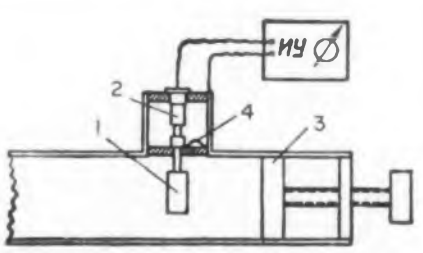


Fig. 7. Detector head. *1*—vibrator, *2*—detector, *3*—short circuiting plunger, *4*—jumper. It is used to complete the dc circuit of the detector and to adjust the Q of the resonant circuit and the form of the resonant curve.



ANTENNAS

Choice of Most Suitable Dimensions and Design of Ferrite Antennas by B. I. Ryazanov. EC 2/58, pp 25-28, 4 figs, 1 table.

Formulas and graphs are given for the calculation of the effective height and the inductance of ferrite antennas with round cores. The effect of various quantities on the parameters of the antenna, including the effective height for a constant inductance, are considered.

In-Phase Band Short-Wave Antenna with Aperiodic Reflector by G. Z. Ayzenberg, V. D. Kuznetsov, and L. K. Olifin. EC 3/58, pp 21-28, 7 figs.

This is a continuation of a general article on the same type of antenna published by the authors in the January 1958 issue of *Elektrosvyaz'*. They give here the theoretical and experimental results, which make it possible to choose the dimensions of the aperiodic reflector. The directivity patterns of the antenna in the horizontal and vertical planes were examined theoretically and experimentally. Computation curves are given for the dependence of the directivity coefficient and the gain of the antenna on the wavelength. The results of an experimental investigation of the matching of the antenna with the supply feeder, using a model, are given for a broad frequency band. Certain information on specific antennas is also given.

MAGNETIC AMPLIFIERS

Dynamic Character of Rectangular Static Hysteresis Loops (Influence of Eddy Currents) by M. A. Rozenblat. AT 1/58, pp 75-84, 7 figs, 3 tables.

The author examines the influence of eddy currents on the form of the dynamic hysteresis loop, on the value of the differential permeability and on the value of the dynamic coercive forces of cores with rectangular static hysteresis loops. Analytic expressions are derived for the dynamic hysteresis loop under sinusoidal variation of the conduction, under sinusoidal variation of the magnetic field intensity, and under reversal of magnetization of the core by dc. Experimental data confirming the results of the calculations are also cited.

Concerning a Magnetic Amplifier with Inductive Load, Connected through a Rectifier by L. V. Safris. AT 3/58, pp 228-238, 18 figs, 2 tables.

It has already been established that the duration of a transient in a magnetic amplifier feeding an inductive load through a rectifier is determined by the time constant of the load, regardless of the signal amplitude. This article provides an analysis for nonideal circuits.

E. Brenner

Design of Quartz Crystal Oscillators

IF CERTAIN, physically reasonable assumptions are made, exact solutions for the behavior of three-pole quartz crystal oscillators can be deduced easily. In the general three pole circuit shown in Fig. 1 it is assumed that the feedback factor, $Z_1/(Z_1+Z_3)$ is large compared to the reciprocal of the tube amplification factor. The condition for oscillation is then given by

$$g_m Z_1 Z_2 + Z_1 + Z_2 + Z_3 = 0$$

It is further assumed that in addition to the tube, the only energy dissipation takes place in the crystal which is used as one of the three impedances. Linear operation and absence of transit time and other hf effects are also assumed.

The quartz crystal has its electrical properties represented by the equivalent circuit shown in Fig. 2. In this circuit the impedance Z_s is taken as

$$Z_s = R_s + j2\Delta\omega\, L_s$$

where $\Delta\omega$ is the difference between the frequency of oscillations and the series resonant frequency of the crystal.

If either Z_1 or Z_2 represents the quartz crystal then the Pierce-Miller oscillator results. If the crystal is represented by Z_3 and if Z_1 and Z_2 are capacitances then the circuit is the Pierce-Colpitts circuit.

Choosing the quartz crystal as the impedance Z_1, and letting Z_2 be an inductance whose reactance is X_2, then Z_3 is a capacitance with reactance $-X_3$. Defining a parameter A through

$$2A = \frac{X_p(X_3 - X_2)}{X_p + X_3 - X_2}$$

the frequency difference $\Delta\omega$ is given by

$$2\,L_s = A \pm (A^2 - R_s^2)^{1/2}$$

Transconductance is given by

$$g_m\, X_2/(X_3 - X_2) = R_s/(4A\Delta\omega L_s)$$

If Z_1 and Z_2 are interchanged then the formulas given above apply if X_1 is replaced by X_2 and vice-versa.

When the Colpitts circuit is used and the capacitive reactances in the arms *1* and *2* are denoted by $-X_1$ and $-X_2$ respectively then a parameter B is defined where

$$2B = X_p^2/(X_p + X_1 + X_2)$$

The frequency is given by

$$2\Delta\omega L_s = X_p - (B \pm B^2 - R_s^2)$$

and

$$g_m X_1 X_2 = \frac{X_p^2\, R_s}{2B\,(B \pm B^2 - R_s^2)}$$

As indicated above, each of the expressions involves a choice of sign. Since generally the oscillator will stabilize at the condition which requires the smaller value of g_m, the plus sign is used.

In the original article both power dissipation in the quartz crystal and frequency stability of the oscillator with respect to parameter variation are considered. It is concluded that except at high frequencies (above 40 mc) the Colpitts circuit is most useful.

Abstracted from an article by F. Rockstuhl, Telefunken Zeitung, *Vol. 31, No. 119, April 1958, pp 50-58.*

Errors In Binary Transmission

Table 1 Parameter Values

Keying Method	Demodulation Method	a	b	c	Valid if the error in R is less than 0.5 db for:
Frequency Shift	Envelope	2	0	2	all values of R
	Synchronous	2.5	½	2	R≥5db; p≤0.04
Phase Reversal	Synchronous	3.55	½	1	R≥2db; p≤0.04
Amplitude	Envelope, Threshold Value k = ½	2	0	2	R≥2db; p≤0.25
	Envelope, Threshold Value opt. [F(R)]	1.9	¼	2	R≥3db; p≤0.15
	Synchronous	2.5	½	2	R≥5db; p≤0.04

IN BINARY transmission the probability, p, that a signal will be received erroneously (i.e. a 1 as a 0 or vice versa) depends both on the signal to noise ratio and the methods of keying and demodulation. It can be shown that phaseshift keying is the optimum binary transmission method.

One general formula can be used to approximate the various curves which give p as a function of signal to noise ratio, R, under the assumption of white noise and of equal probability for each binary element ($p(0) = p(1) = 1/2$). The formula has the form

$$p \approx \frac{1}{aR^b}\, e^{-R/c}$$

The values of a, b and c depend on the transmission and detection scheme and can be taken

as the constants shown in Table 1 within the limits indicated. Laboratory experiments confirm the validity of the formula.

Abstracted from an article by H. J. Held, Nachrichtentechnische Zeitschrift, *Vol. 11, No. 6, June 1958, pp 286-292.*

Operating Temperature of Transistors

OPTIMUM design of transistor amplifier stages with high transistor lifetime requires that the internal temperature be limited. Although almost all transistor parameters are temperature dependent (and can therefore be used to determine operating temperature) the simplest relationship involves the residual currents at a pn junction which have the temperature dependence $I_o = A \exp(-qV_o/kT)$. Since the values of A and V_o differ from sample to sample, constant calibration at known temperatures is necessary if this relationship is to be used directly. This method also requires that elaborate mechanical switching arrangements be used.

If in place of the residual base-collector current (with open emitter) the collector current with shorted emitter is used as shown, the sensitivity of the measurement is increased and a direct reading (i.e. in deg C) circuit can be devised. The accuracy of 0.5 C can be reached.

If V_1/V_T ($V_T = kT/q$) is small then the collector current in the figure is related to the open circuit value by

$$I_2 = I_{co}\frac{V_T + R_B I_{eo}}{V_T + R_B I_{co}(1-\alpha_c)}$$

By making a portion of R_B adjustable it is possible to match the temperature dependence of I_2 for various samples (approximately). It is then only necessary to calibrate at a given temperature and vary R_B to match the constant A in the expression for residual current.

Abstracted from an article by H. Beneking, Archiv der Elektrischen Uebertragung, *Vol. 11, No. 12, December 1957, pp 504-508.*

MEETINGS

Calendar of Events

1-5 Annual Meeting, American Rocket Society, New York, N.Y.

1-5 ASME Annual Meeting, New York, N.Y.

2-4 3rd EIA Conference on Reliable Electrical Connections, Dallas, Tex.*

3-5 Eastern Joint Computer Conference, Philadelphia, Pa.*

3-5 2nd National Symposium on Global Communications, St. Petersburg Beach, Fla.*

3-5 American Inst. of Electrical Engineers, St. Petersburg, Fla.

4-5 Annual Conference Professional Group on Vehicular Communications (IRE), Chicago, Ill.*

7-10 Annual Meeting American Inst. of Chemical Engineers, Cincinnati, Ohio

8-10 American Nuclear Society Meeting, Detroit, Mich.*

9-10 Conference on Learning Effectiveness, Philadelphia, Pa.

9-11 Tenth Annual Technical Conference IRE Kansas City Section, Kansas City, Mo.

18-20 American Physical Soc., Los Angeles, Calif.

26-31 Annual Meeting American Assoc. for Advancement of Science, Washington, D. C.

*Indicates meetings described below.

3rd EIA Conference on Reliable Electrical Connections, Dec. 2-4

Statler-Hilton Hotel, Dallas, Tex. Manufacturing point-of-view as well as Government and Military aspects will be covered. All types of electrical connections will be considered including: (a) those which are out-of-sight and within (internal) component parts, such as connections inside capacitors, and (b) those which are exposed (external) and parts of an electrical or electronic system.

One full day will be devoted to each of three general subjects: (1) Fixed connections (wrapped, soldered, crimped, and welded); (2) sliding and

wip[illegible] connections (such as encountered in poten[illegible]meters, rheostats, switches, and the like); and [illegible]3) connect-disconnect connections (plugs and [illegible]cks).

A[illegible]ttempt will be made to cover all the face[illegible] of the foregoing subjects, such as (1) choi[illegible] of materials being joined together; (2) meth[illegible]ds and equipment used to join them; (3) mate[illegible]ials and processes used to protect the connections; (4) effects of usage or environments of the finished parts or systems on the electrical connections, and (5) servicing or maintenance aspects of the parts or systems.

For information, write W. O. Richards, 224 Cedar St., Syracuse 3, N.Y.

Eastern Joint Computer Conference, Dec. 3-5

Bellevue-Stratford Hotel, Philadelphia, Pa. Sessions to be presented: Reliability and components; Computer technology (Part 1—Present research, Part 2—Speculation on future); Organization and processing information; Design techniques; New computers.

2nd National Symposium on Global Communications, Dec. 3-5

Colonial Inn and the Desert Ranch, St. Petersburg Beach, Fla. Jointly sponsored by IRE Prof. Group on Communications Systems and AIEE, Communications Div. Technical program to include 60 papers covering latest advances in radio and wire communications; data link systems; spectrum utilization, conservation, and administration; system reliability; application and utilization of military and civil systems. Fifty-four leading manufacturers of communications equipment will exhibit their latest problems. Further information may be obtained from Mr. Thomas F. Thompson, Jr., Chairman Registration Committee, Florida Power Corp., P.O. Box 4042, St. Petersburg, Fla.

Annual Conference Professional Group on Vehicular Communications, Dec. 4-5

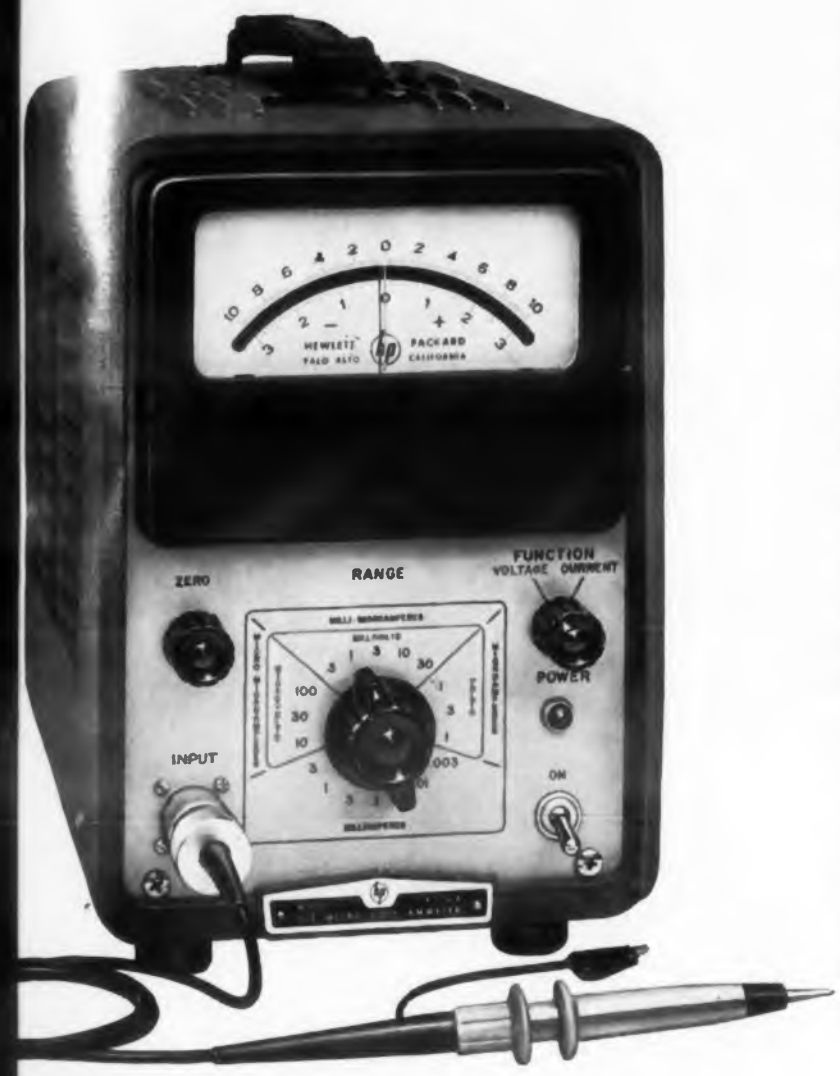
Hotel Sherman, Chicago, Ill. Fifteen papers to be pr[illegible]sented and nearly 20 leading manufacturers [illegible]f two-way radio and accessory equipment will [illegible] exhibiting.

Ame[illegible]can Nuclear Society Meeting, Dec. 8-10

Sher[illegible]ton-Cadillac Hotel. Leading nuclear scientists [illegible]nd engineers to discuss the most recent ato[illegible] energy concepts—including a package rea[illegible]r for use in outer space.

ADVERTISERS' INDEX

November 26, 1958



The all-new *-hp-* 425A Microvolt-Ammeter will provide engineers, physicists, chemists and physiological scientists with one compact, direct-reading instrument measuring minute voltages and currents with speed, simplicity and 10 times the sensitivity of the complex equipment arrays previously required.

Very careful engineering, including heavy filtering against ac signals and substitution of a unique photoelectric chopper for the conventional mechanical vibrator, has resulted in performance heretofore unobtainable. The long-term drift of the 425A is less than 2μv and internal noise is less than 0.2 μv.

Conservative electrically, Model 425A includes every conceivable assurance of safety, accuracy and dependability. For example, momentary overloads of 1,000 volts cause no damage; and the new pickup probe is specially designed to minimize thermocouple and triboelectric effects. The meter provides constant polarity indication.

The new *-hp-* 425A also may be used to measure a wide range of resistances. Milliohms may be measured by using a battery and series resistor as a constant current source. Higher resistances may be measured with higher voltages; a 100 volt supply allows the 425A to measure accurately up to 10 megmegohms.

Call your *-hp-* representative now for demonstration on your bench; or, write for details.

HEWLETT-PACKARD COMPANY
4882 K PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
Cable "HEWPACK" • DAvenport 5-4451
FIELD REPRESENTATIVES IN ALL PRINCIPAL AREAS

SPECIFICATIONS

MICROVOLT-AMMETER

Voltage Range: Positive and negative voltages from 10 μv full scale to 1 v full scale in an eleven step, 1, 3, 10 sequence.

Current Range: Positive and negative currents from 10 $\mu\mu$a full scale to 3 ma full scale in an eighteen step, 1-3-10 sequence.

Input Impedance: Voltage Ranges: 1 megohm ±5%. Current Ranges: Depends on range, 1 megohm to 0.33 ohm.

Accuracy: Within ±3% of full scale.

AMPLIFIER

Frequency Range: dc to 0.2 cps.

Gain: 100,000 maximum.

Output: 0 to 1 v for full scale reading, adjustable.

Output Impedance: 10 ohms, shunted by 1000 ohm potentiometer.

Noise: Less than 0.2 μv rms referred to input.

Drift: After 15 minute warm-up, less than ±2 μv per hour referred to the input.

Power: 115 v ±10 v, 230 ±20 v, 60 cps, 40 watts.

Dimensions: Cabinet Mount: 7½" wide, 11¼" high, 14" deep.

Weight: Net 20 lbs.

Price: $500.00.
-hp- 425AR (rack mount) $505.00.
-hp- 425A (cabinet) $500.00.

Data subject to change without notice. Prices f.o.b. factory.

basic new instruments in 1958

CIRCLE 262 ON READER-SERVICE CARD

DESIGN

HAYDEN PUBLISHING COMPANY, INC.
830 Third Avenue, New York 22, N. Y.