ELECTRONIC DESIGN

JULY 1, 1956

Co-Publishers James S. Mulholland, Jr.
T. Richard Gascoigne

Advertising Representatives

New York: Owen A. Kean
Lawrence Conover
Bryce Gray, Jr.
James P. Quinn
19 East 62nd St.
New York 21, N. Y.
TEmpleton 8-1940

Chicago: Thomas P. Kavooras
Berry Conner, Jr.
644 No. Michigan
Chicago 11, Ill.
SUperior 7-8054

Los Angeles: Robert E. Ahrensdorf
Earl W. Wilken
1140 Wilshire Blvd.
Los Angeles 17, Calif.
MAdison 9-2681

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 title; your company's name, address, and main product. Electronic, research, development, project, electrical, and chief engineers are typical qualifying titles.

If you have a design responsibility not indicated by your title, describe those responsibilities. Job changes require requalification.

Subscription rate for non-qualified subscribers—$12.00 for 1 year only.

Hayden Publishing Company, Inc.
19 East 62nd Street
New York 21, New York

◄ CIRCLE 1 ON READER-SERVICE CARD

ELECTRONIC DESIGN

Vol. 4, No. 13

Contents

July 1, 1956

NBP BPA

ELECTRONIC DESIGN is published semi-monthly by Hayden Publishing Company, Inc., 19 E. 62nd Street, New York 21, N. Y., T. Richard Gascoigne, President; James S. Mulholland, Jr., Vice-President & Treasurer and David B. Landis, Secretary. Printed at Hildreth Press, Bristol, Conn. Acceptance under section 34.64 P. L. & R. authorized. Copyright 1956 Hayden Publishing Company, Inc., 27,000 Copies this issue.

RETMA MEMBER

2

75 INCHES PER SECOND

3 MSEC STARTS AND STOPS

Model 905 Digital Magnetic Tape Handler

The Ultimate in Digital Tape Handlers for High-Speed Computers, Electronic Business Machines, Industrial Control and Other EDP Applications.

Regardless of cost, many features are exclusive with Potter

Speed and ease of operation—Up to 75"/sec in a variety of dual speed combinations, with 3 msec starts and stops. Tape widths from ¼" to 1 ¼" are accommodated. Automatic threading, fast rewind, end-of-tape sensing, and front panel or remote control provide unmatched flexibility and ease of operation.

Standard 19" Rack Mounting—Hinged front panel provides quick access to mechanical parts and plug-in electronic components. Transparent dust cover protects tape and moving parts without hindering visual observation of tape track.

Auxiliary Equipment—A complete line of digital data-handling accessories is available, including *record-playback heads* (Model 6400) in numerous channel number and tape width combinations. *Record-playback amplifiers* can be furnished as individual plug-in units (Models 52, 53) or in *complete systems* (Model 920) for return-to-zero or non-return-to-zero recording. *Shift registers, high speed printers and other data-handling components* are available separately or in integrated systems for solving specific data-processing problems.

WRITE FOR INFORMATIVE BULLETIN . . . and feel free to consult Potter engineers on your data-handling problems. No obligation, of course.

POTTER INSTRUMENT COMPANY, INC.
115 Cutter Mill Road Great Neck, L. I., N. Y.

CIRCLE 2 ON READER-SERVICE CARD FOR MORE INFORMATION

Editorial

You Can't Escape

You can't escape transistors. They are influencing design thinking in practically all branches of the electronic industries. Their small size, low weight, long life, low power consumption, and high efficiency have captured the imagination of many equipment designers. Transistorizing electronic equipment seems to be the order of the day.

Transistors have already found a place in many types of military electronic equipment. Guided missiles, telemetering equipment, portable communication equipment, and airborne electronic devices are typical examples.

Transistors are also making rapid inroads in test equipment designs. A wide variety of portable measuring instruments for use in field testing as well as laboratory instruments like the VTVM have been successfully transistorized.

The prospect of making computers with a low power consumption and high reliability which transistors seem to afford is certainly keeping the computer lads interested. We can expect an increased use of transistors in computers as time goes on.

Transistors have literally invaded the consumer electronics field. Every hearing aid on the market is transistorized. Every major radio receiver manufacturer has announced a transistor portable. Soon practically all table model radios will be transistorized. Automobile radios are apparently headed the same way. Transistorized all wave portable receivers are being developed, and it's no secret that the battery operated transistorized portable TV receiver is getting a lot of design attention these days. Even the usually conservative hi-fi field now boasts of a transistorized preamplifier-equalizer.

Component designers were probably the first to feel the influence of transistors on their designs. The growing list of components specifically designed for use with transistors indicates the results of this influence. As more of these components become available, we can expect even greater transistor application activity.

In spite of these examples, the transistor is far from being a panacea for all electronic design problems. Much work remains to be done on circuit development, components, and the transistor itself before it can be a real threat to the vacuum tube, especially in high power and high frequency applications. This is sometimes given as a reason for ignoring the transistor in its present state of development.

On the other hand, consider this: The cost of transistors has steadily gone down, quality and frequency range have gone up, and transistor circuit knowledge has increased. There is no doubt that much of the future of the electronic industries is tied up with the transistor. It's a wise man who prepares himself for the future . . . while it still is the future.

Engineering Review

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

Positive Temperature Coefficient Thermistors . . . Successful fabrication of thermistor materials having large positive temperature coefficients was revealed recently by two Bell Telephone Laboratories engineers.

Speaking at the IRE-RETMA-AIEE-WCEMA Electronic Components Symposium in Wash., D.C., Harold A. Sauer and Steward S. Flaschen discussed the preparation of one material having a positive temperature coefficient from about –50°C to 110°C, with the coefficient reaching a value as high as 9%/°C. Another material of slightly different composition was found to have a positive temperature coefficient from about 50°C to 225°C, with a maximum coefficient of 14%/°C.

These materials in general consist of barium titanate or barium-strontium titanates to which small amounts of lanthanum have been added. By properly proportioning the various components, a wide variety of characteristics can be obtained.

Air Force Awards Contract For "White Alice" Network . . . The operation and maintenance contract for the "White Alice" communications network in Alaska has been awarded by the U.S. Air Force to Federal Electric Corp. of Lodi, N.J., a subsidiary of I.T.&T. Corp.

The "White Alice" (Alaskan Integrated Communication Exchange) network is under construction to fill the communications needs of the U.S. Government and commercial enterprises in Alaska. When completed, it will consist of a group of "over the horizon" and "line of sight" microwave links, in addition to the necessary terminal equipment for telephone and telegraph service.

The system will interconnect isolated cities and defense installations which currently are isolated or inadequately linked to already established networks.

New Loudspeaker Telephone Introduced At British Industries Fair . . . A new loudspeaker telephone has been developed which is said to operate successfully loud-to-loud or loud-to-soft in locations having an ambient noise level of 75 phons of "white" noise.

Called the Tellaloud, the device, manufactured by Winston Electronics, Ltd., Shepperton, Middlesex, England, can be used with systems of two, three, or four wires, and needs no alteration for use with private automatic, automatic branch, magneto or branch exchanges. The microphone will pick up speech when the speaker is up to 25 feet away, and the voltage across the line does not exceed the output of an ordinary handset when used at a speaking distance of two feet.

Speech clipping does not occur even when the set is arranged for "no hands" loud-to-loud conversation and the interchange of speech is rapid. This is due to the time constant of the switching circuit which is less than 3 milliseconds.

There is a special "break-in" feature by which any user wishing to break in on a loud-to-loud conversation in which he is taking part can do so by merely raising his voice a little as he would do in normal conversation.

Language Translating Machine Can Be Made . . . No insurmountable problems appear to exist in the realization of a mechanical translating machine.

According to R. E. Wall, Jr., of the Univ. of Washington, Seattle, Wash., speaking at a computing symposium of the AIEE in San Francisco, research has progressed sufficiently to allow the formulation of a detailed program which should result in a commercially practical machine in a reasonable time.

Mr. Wall observed that translations would be confined to technical data and to make the machine competitive in cost with human translation, it would have to operate very rapidly. He feels that such a machine will cost as much as a modern large-size digital computer, which has a per-hour cost of about $250. This means that a $250 per hour machine would have to produce about 25,000 words per hour, or in round numbers, about 10 words per second, in order to have a same per-word cost.

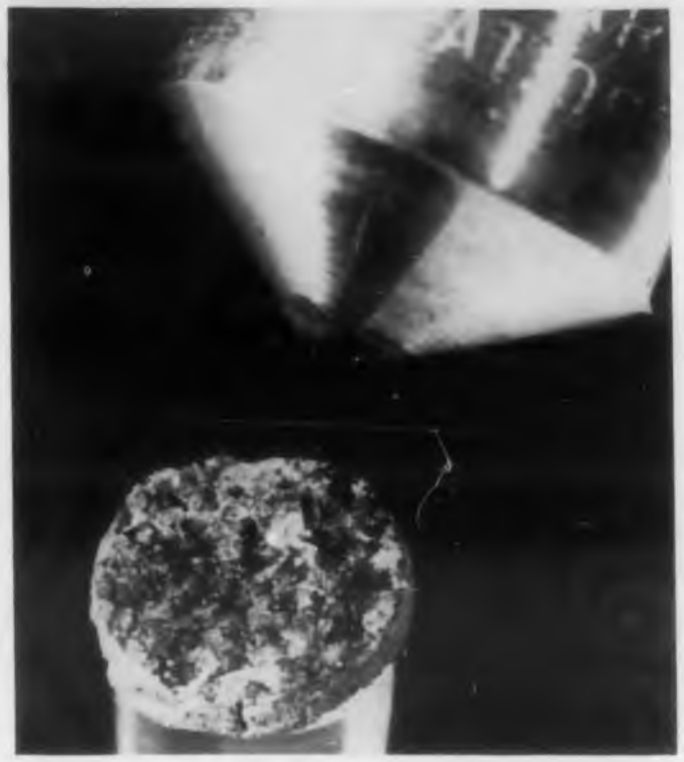
TV Equipped Aerial Drone Aids Ground Commanders . . . A TV pickup from an experimental aerial drone system has been designed to aid combat commanders in getting an immediate ground evaluation.

The pilotless system, developed at the Army Signal Corps Engineering Laboratories, Fort Monmouth, N.J., consists of an L-17 modified for TV photo-drone operation; an auto-pilot which provides effective remote control by means of on-off type radio signals; and a ground control station that can be carried in a jeep.

Signals transmitted from the ground station to the L-17's 42 lb auto-pilot regulate stability, altitude, and airspeed. Complying with remote commands, the plane will perform a scheduled climb or glide. Special control provisions prevent stalls, over-speeding, excessive loss of altitude, and other hazardous conditions.

When the drone's mission is completed, the ground controller flicks an approach switch which automatically positions landing gear, flaps, prop pitch and power in proper sequence for landing.

Soldiers operate radio remote controls that can pilot a TV robot plane up to 40 miles away. Soldier at left operates the plane's ground remote control box, while soldier at right works levers that point and focus aerial camera.



Man-Made Diamonds

Diamonds in industry were highlighted recently as the General Electric Co., Schenectady, N. Y., presented some of its earliest man-made diamonds to the Smithsonian Institution. The cluster shown above, about 1/4" diam., is being compared with a Rockwell hardness tester. This cluster consisted of some of the first man-made diamonds produced in the GE Research Laboratory.

Halogen Leak Detector

Used for the location of leaks in pressure vacuum systems or for the detection of small concentrations of the halogens in other gases, this instrument is so sensitive that it can detect a leak of Arcton at the rate of 1/50th of an ounce per year. The detector is manufactured by British Thomson-Houston Co., Ltd., of Rugby, England.

Electronic Device Controls Exposure In Motion Pictures . . . Designed to adapt to any motion picture camera and to be used with any lenses, this electronic device has been developed for the automatic control of exposure in motion pictures.

The heart of the unit, developed by Flight Research, Inc., Richmond, Va., is a light-sensitive device which actuates a motor to turn any number of lens aperture rings. Lenses can be changed readily because the flexible tape drive can be adjusted to fit many different lenses.

The entire unit is completely self-contained and weighs only about 3-1/2 lb, including the flashlight cells which drive it. The drive unit weighs only a little over a pound, less than many telephoto lenses. It is approximately 4-1/2" long and 2" diam.

An important feature called the "accent control" permits the photographer to intentionally change the aperture setting from the correct value for the average lighting of the scene, in order to produce the best exposure for the object of most interest.

Response speed can be varied to meet different requirements. Speeds which provide full travel from F-2 to F-22 in as little as 1 second can be achieved.

Ultrasonic Tire Tester

Silent, invisible, non-destructive beams from an ultrasonic tester are being used to locate and measure flaws in new or used automobile, bus, truck, and aircraft tires. Developed by the Industrial and Scientific Products Div. of Curtiss-Wright Corp., Caldwell, N. J., it reports on an indicator such obscure imperfections as minute blisters and tread separations.

Injection Molded Battery Washers

Three hundred washers at a time are formed of red Tenite polyethylene by rapid injection molding for use as seals in Ray-O-Vac pencil-size batteries. The multiple molding job is processed at the rate of over a hundred castings—some 30,000 washers—per hour.

Mobile Air Traffic Control Tower . . . A mobile air traffic control tower has been developed that performs the same function as a permanent airport installation. The equipment has the strategic advantage of being easily moved or flown by aircraft to forward areas and quickly put into operation.

The tower, developed and manufactured for the Air Force by Craig Systems, Inc., Danvers, Mass., is part of "Project Four-Wheels," a highly mobile communications and navigation system that is being sponsored by the Airways and Air Communications Service and the Rome Air Development Center. Designated Air Traffic Control Central AN/MRN-12, the unit may be hauled over rough terrain or flown by C-119 or larger cargo aircraft to forward areas of operation. It is designed to operate either independently or in conjunction with other airport facilities, such as radio direction finders and message centers.

At the operator's finger tips is a console with instruments to give him radio communications with aircraft taking off and landing, as well as with base

This mobile tower performs the same function as a permanent airport installation.

operational facilities. Telephone communications are also provided. A second man with identical controls sits at a "standby" position in the trailer and operates the GCA indicator and handles incoming phone calls.

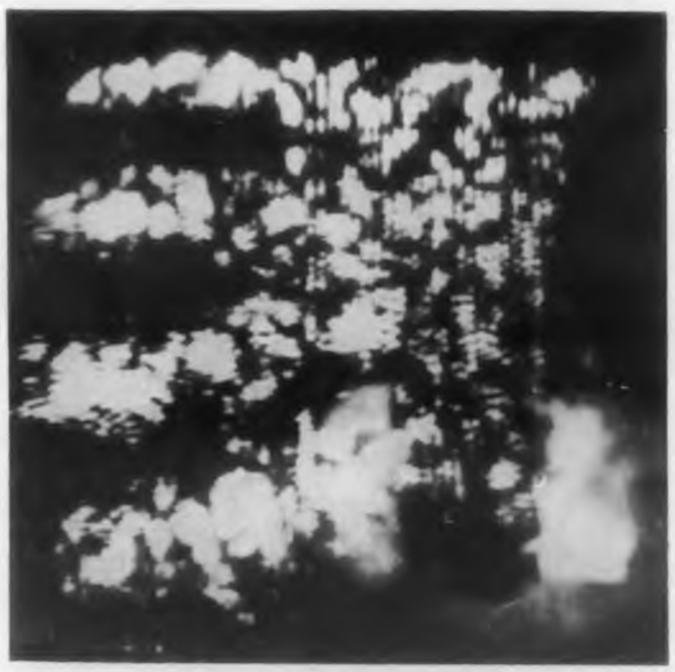
Enclosed in a trailer approximately 13′ long, 8′ wide and 7′ high, the facility has an observation dome that gives the operator 360° visibility of the airfield. The dome, fitted with special glass panels to prevent fogging and icing, lowers into the van body when the unit is being transported.

Sonic Photography Technique Makes Progress . . . A research team at the Polytechnic Institute of Brooklyn, using ultrasonic waves in the same way that a photographer uses light, have evolved a method for translating the waves reflected from the object being "shot" into pictures on a TV-like screen.

The technique was developed by Eustace E. Suckling, a doctoral student in electrical engineering and Prof. William R. MacLean. At the present time, the pictures taken with sound show with relative clarity the outline of such delicate structures as a fish skeleton, a cat's kidney, and the bone structure in the human hand.

The 1/50″ high-frequency wave being used by the research team has the capacity to be reflected, and therefore translated into a picture by an object of that relative size, either in width or depth. As a result, the possibilities for picturing nerves, veins, arteries, and small lesions are also definitely present.

The 1/50″ of h-f sound employed in the process as compared with the 2″ or so of ordinary audible sound, must be transmitted through water. When sent through the atmosphere, it disappears among the oxygen atoms. Objects being photographed by sound at the present time must be immersed in water.



Picture of hand bone structure taken by sound.

Ceramic Coating Spray Gun

A thermocouple tube is being sprayed with zirconia using the Type P Thermospray Gun. The zirconia coating, while somewhat softer than alumina, has superior heat insulating properties. The gun, developed by Metallizing Engineering Co., Inc., Westbury, N. Y., can apply these ceramic materials at a very fast rate—up to 15sq ft/hr (0.010" thick)—with deposit efficiencies usually in excess of 95%.

Hands Free Telephone

The Tel-O-Master telephone loudspeaker allows both hands to be completely free to take notes, look up data, or refer to rate, price schedules or files. The handset is placed on this unit, with the result that the incoming conversation is amplified to a normal conversational tone. Return conversation is automatically directed into the handset by the Tel-O-Master. Developed by Fisher Research Laboratory, Inc., Palo Alto, Calif., the device is completely portable and amplification is provided by 4 hermetically sealed transistors.

High-Speed Printer

This special-purpose, miniature high-speed printer can turn out more than 2500 lines a minute. Applied to printing results of numerical calculations of fast analog computers, the technique, developed by the General Electric Co.'s Engineering Laboratory, Schenectady, N. Y., can be used for facsimile reproductions of pictures, line drawings, and lettered characters.

Midget TV Camera Used In Flight Testing . . . A TV camera weighing only 1-1/2 lb and measuring 1-3/4" x 2" x 5" has been developed to aid in flight testing the new Lockheed Electra prop-jet airliner. A standard box camera is 8 times as large and a network-type TV camera is 300 times larger.

With the remotely controlled "eye," developed by Lockheed Aircraft Corp., Burbank, Calif., research and flight test engineers will be able to view operations which would be impossible to see without it. The camera can see into inaccessible areas. It can give a close-up view of tests a man could not safely watch.

As an example, it can fit inside a landing gear housing and relay a continuous picture to a 27" screen inside the plane. Observers can watch the gear being raised and lowered against the force of the slipstream. They can study gear doors to make sure they work smoothly in bumpy air, climbs or dives.

If a problem is detected, pilots and engineers can maneuver the plane to maintain a desired test condition and explore all its characteristics immediately.

Motion Analysis Camera

A typical application of the Fairchild Camera and Instrument Corp., Syosset, L.I., N.Y., new high-speed "Motion Analysis" camera, capable of taking high quality pictures at the rate of 5000 per second. Here, an electronic tone wheel is tested for chatter.

Foreign TV: Czechoslovakia, Venezuela, Germany, Japan, Africa, Belgium . . . The second TV transmitter in Czechoslovakia was put into operation in Ostrawa, shortly after the first of the year, and now a third transmitter is under construction in the neighborhood of Bratislawa. By means of relays all TV transmitters will be linked. A direct relay with the Soviet and Polish TV networks will be possible, via Prague, site of the first Czech station . . . According to La Electronica Venezolana, the first electronic plant to be set up in Venezuela, the manufacture of TV picture tubes was scheduled to start recently in full production . . . Underwater TV cameras have been developed jointly by two German TV manufacturers. Tests have been conducted successfully on the Rhine River and Lake Konigsee. They are aiming at the development of TV techniques for industrial and professional applications where it is desirable to have a camera operating efficiently while submerged in water or other liquids . . . Production of TV receivers in Japan more than quadrupled in 1955, when 134,700 sets were produced . . . Introduction of TV to South Africa continues to be a matter of considerable speculation. The Afrikaner Nationalist Govt. is not presently in agreement . . . Two TV transmitters in Brussels and one each in Antwerp and Liege are broadcasting 50 hours per week. In addition, Brussels has an experimental v-h-f transmitter.

Sylvania Expands Microwave Tube Laboratory . . . Plans were recently announced for a new 18,000 sq. ft. addition to Sylvania's Microwave Tube Laboratory in Mountain View, Calif. The new wing will be devoted to increased research and development in traveling-wave tubes and other microwave devices.

G. C. Rich, laboratory manager, said that 15,000 sq. ft. of the new addition will be used for engineering laboratories and offices and 3000 sq. ft. for experimental tube construction. The laboratory presently has 40,000 sq. ft.

CIRCLE 10 ON READER-SERVICE CARD ➤

Private Eye (Electronic) Analyzes Aircraft Engines . . . Electronic "detectives" are being used by the Air Force to speedily detect and pinpoint, both on the ground and in flight, hidden troubles in aircraft engines.

Developed by Sperry Gyroscope Co., Great Neck, N.Y., the device continuously and instantly provides a picture of what is happening in the inner mechanical recesses and electrical systems of engines.

The 75 hours it takes normally to check intake and exhaust valves in the engine of a B-36 bomber has been reduced 15 times to as little as 5 hours with the analyzer. Similar reductions have been made on transport planes with 18-cylinder engines on which time requirements went from 25 hours to three.

CBS-Columbia To Decide Future By July 1st . . . Pres. Frank Stanton of CBS said recently that the future of CBS-Columbia would probably be decided by July 1st. In a memo to all officers of CBS and its operating divisions, he stated that some of the alternatives for CBS-Columbia are: (1) a merger with or an acquisition of another TV manufacturer; (2) greater concentration on special types of sets, such as color and small-screen; (3) expansion of manufacturing activities by acquiring a modern facility in place of the present Long Island City plant; (4) having another manufacturer produce its TV and radio sets; (5) halting TV set manufacture altogether; (6) operating on a minimum basis until the situation clarifies itself.

Peroxide Powers British Submarine . . . The Explorer, Britain's latest experimental submarine, is using high-test peroxide as fuel to power it. The Explorer will carry no armament, nor will she take part in operations. However, she will be capable of high underwater speed and long endurance, and will be used for training anti-submarine forces.

One of the principal advantages of peroxide for underwater propulsion is that no exhaust bubbles reach the surface, adding a safety factor to the submarine's operation.

In the above test, "Ernie" will shake the specimen horizontally.

"Earthquake Ernie" Shakes It Up, Down and Sideways . . . A new midget test device has been designed which is capable of generating the same force as an automobile crashing into a brick wall at a speed of 60 mph during 1/10 of a second.

Known as "Earthquake Ernie," the shaker is about the size of a soapbox, and uses no more current than a common household electric iron. It can apply a force of 55g's to guided missile electronic components weighing more than 1000 lb.

Developed by Northrop Aircraft, Inc., Hawthorne, Calif., the device is less than 1 cu ft in volume and is used to test the effects of frequency vibration ranging from 5 to 600cy on airframe sections housing sensitive electronic equipment.

"Ernie" was invented to simulate conditions encountered on a missile launch so that vibration effects on full-system components could be recorded prior to actual flight. It was built to assure the continued high performance of Northrop's Snark SM-62 intercontinental guided missile.

Heart of the device is a 2-stage electro-hydraulic servo valve built for Northrop by the Bertea Products Co., Pasadena, Calif. This valve allows the needed precision control of the hydraulic power.

Giant "Dish" Antenna Aids Community Antenna System . . . A giant TV paraboidal antenna sitting atop two 100 ft steel towers in Ventnor, N.J. is being used for experimental pickup of New York channels.

The "dish," which beams in signals from over 100 miles away, was built by Jerrold Electronics Corp., Philadelphia, Pa. Experiments are being conducted in conjunction with the South Jersey TV Cable Co., community antenna system serving Ventnor.

The antenna was hung 100 feet up in the air so that it wouldn't bend or turn in the Atlantic gales of the Eastern seaboard. It can withstand 80 mph winds with 1/2" ice coating.

The Ventnor system now receives three channels from Philadelphia (3,6, and 10 and one (12) from Wilmington, Del. These signals are picked up on an antenna tower outside the city and are carried to subscribers houses by means of coaxial cables strung along telephone poles. The "dish" is also located at this site.

Flight Information Board

This unusual electronic flight information board at Cleveland's Hopkins Airport uses 14,200 bulbs to report the arrival and departure of some 250 flights daily. The board was built at a cost of $96,000 by Spencer Displays, N.Y. Photo is by United Air Lines.

Electronic Transmission System

A WAC pfc is at work on a transceiver similar to those used in the Logistical Reporting Network now in operation between four key signal depots and the Army Signal Supply Agency in Philadelphia. Information on stock levels of Army signal supplies is electronically interchanged between depots through transceivers, using ordinary telephone circuits, that transmit and receive data on punched cards.

Alloy Plate Steel Observed

Speedier production of alloy plate steel at Lukens Steel Co., Coatesville, Pa., is made possible by RCA closed-circuit TV installation of 9 separate cameras. They enable attendants to peer around corners for remote observation and control of processing operations. Here, furnace-line operator studies monitor for guidance in switching alloy plate to next processing operation.

Admiral Producing 1,500 Portable TV Sets A Day . . . Admiral Corp., Chicago, Ill., is ahead of schedule in its production of 10.375" portable TV receivers and is assembling them at the rate of 1,500 a day. The sets will be introduced on a market-by-market basis.

TV In The Baltic Countries . . . On March 2, a new broadcasting station serving Stockholm was put into operation by the Swedish Broadcasting Co. Located in the southeastern portion of the city, it has 150kw power and can simultaneously transmit one middle wave and two ultra-shortwave programs, as well as a TV program.

A Norwegian TV committee is to make its report on TV possibilities in the country this spring. Parliament must then consider when and how a regular TV service will be introduced, so a final decision cannot be expected until the spring of 1957, according to the RETMA International TV Handbook. The Norweigian State Broadcasting System operates an experimental TV station in Oslo. There were approximately 300 receiver sets in use as of Jan. 1, 1955, RETMA reports.

The Finnish Radio Co., (Yleisradio), is reported as being ready to install a TV transmitter in Helsinki on an experimental basis. The local receiver manufacturing industry there is prepared to produce about 5,000 TV sets a year, if there is the demand. It will be installed in the Stadium Tower, while studio facilities are scheduled to be located in the radio station at Fredriksberg. Programming will be initially limited to about one hour per day.

Washington Report

Albert Warren

Washington Trends & Briefs . . . ***Nation's air traffic*** control needs for next 20 years are object of study initiated by President Eisenhower with $300,000 contract awarded to Airborne Instruments Laboratory, Mineola, N.Y., which will cooperate with Cornell Aeronautical Laboratory of Buffalo and Aeronautical Research Foundation of Boston. Work will be supervised by special presidential asst. Edward P. Curtis. "The basic objective of this contract," White House announcement stated, "is to determine for the next 2 decades the requirements for those aviation facilities commonly used by all air-space users, both civil and military, including navigation aids, communications, air traffic control, airways, and airports" . . .***Worldwide Transceiver Control*** Station will be established in Tulsa, Okla. by Air Materiel Command for purpose of handling requests for supplies from air commands anywhere in the world. Station will employ punch card machines to record information obtained via radio, telephone and teletype circuits . . . ***New radio-paging service*** for institutions such as hospitals is sought by Stromberg-Carlson in petition filed with FCC, seeking use of 27.31, 27.35, 27.39, 27.43 & 27.4Mc . . .

U-H-F TV Translators . . . ***Mountain-locked hamlets*** now have final FCC go-ahead to build TV "translators," tiny 10w stations on u-h-f Channels 70 to 83—and there are predictions that the little repeaters will spring up by the hundreds, producing a market for 1,000,000 or more u-h-f sets. Commission proposed the translators as a substitute for the illegal v-h-f radiators which have been operated clandestinely—having no Govt approval. However, with u-h-f having a very difficult time generally, it was believed little use would be made of the translators even if finally approved by FCC. It now appears that considerable demand will develop. The leader in translator experimentation, Ben Adler, of Adler Communications Labs, New Rochelle, N.Y., reports he now has orders for 100 of the transmitters at $2750 each. Operating a Ch. 80 translator experimentally at New Rochelle, he says it picks up Ch. 4 from New York, rebroadcasts it without a hitch—including faithful rendition of color. The Ch. 4 signal is attenuated to levels expected at 150 miles for typical translator operations. As set up by FCC, translators will merely pick up regular stations' signals, convert them to u-h-f, rebroadcast them. Directional antennas permitting gains of 10 or more are allowed—to concentrate signals in direction of towns to be served. Minimum operating requirements are imposed. Stations need be checked only once every 6 hours, may be operated by remote control. Frequency tolerances are less stringent than for regular stations.

Meetings

Aug. 20-21: National Telemetering Conference, Biltmore Hotel, Los Angeles, Calif. Sponsored by the IRE, AIEE, Institute of the Aeronautical Sciences, and the Instrument Society of America. Papers will be presented on novel industrial or military applications of telemetering in remote measurement systems, flight test data, remote guidance systems, remote monitoring, and air traffic control. New component developments such as transducers, multiplexers, data recorders, transmitters and receivers, pickoffs, and telemetering filters will be discussed. For information, write to IRE, 1 E. 79th St., New York, N. Y.

Aug. 20-24: Conference on Scientific and Technical Writing, Philadelphia, Pa. Sponsored by the University of Pennsylvania Institute for Cooperative Research. The conference, open to scientists, engineers, editors, writers, and administrators, will provide advanced study and experience-sharing in the art of making technical literature readable. The fundamental problems involved in the communication of technical information will be analyzed, and current systems for handling these problems will be evaluated. For information and applications, write to Dr. Harry F. Arader, 3400 Walnut St., Philadelphia 4, Pa.

Aug. 21-24: Western Electronics Show and Conference, Los Angeles, Calif. Sponsored by the Los Angeles and San Francisco Sections of the IRE and the West Coast Electronics Manufacturers Association. For information, write to Mrs. Jeanne W. Jarrett, WESCON, 344 N. La Brea Ave., Los Angeles 36, Calif.

Sept. 16-22: Second Pacific Area National Meeting and Apparatus Exhibit, Hotel Statler, Los Angeles, Calif. Sponsored by the American Society for Testing Materials. For information, write to American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

Sept. 24-25: Industrial Electronics Conference, Cleveland, Ohio. Sponsored by the Professional Group on Industrial Electronics, IRE. For information, write to G. P. Bosomworth, Firestone Tire & Rubber Co., Engineering Laboratory, Akron 17, Ohio.

Sept. 26-30: New York High Fidelity Show, Trade Show Building, New York, N. Y. Sponsored by the Institute of High Fidelity Manufatcurers. The Audio Engineering Society will hold its annual meeting at the show. For information, write to Jack Gilbert Associates, 1186 Broadway, New York 1, N. Y.

Oct. 1-3: Twelfth Annual National Electronics Conference, Hotel Sherman, Chicago, Ill. Sponsored by the AIEE, IRE, Illinois Institute of Technology, University of Illinois, and Northwestern University. More than 100 technical papers and 240 commercial exhibits will be featured. For information, write to Victor J. Danilov, Illinois Institute of Technology, Chicago 16, Ill.

Oct. 1-3: Canadian Institute of Radio Engineers Convention, Automotive Building, Exhibition Park, Toronto, Canada. Technical papers are planned on medical electronics, scatter propagation, application of electronics to atomic energy projects, use of computers in automation and engineering problems, and transistors. An exposition will include many of the latest improvements in radio, radar, TV, control mechanisms, computers, and other electronic items.

For information, write to Grant Smedmor, Convention Manager, 745 Mount Pleasant Road, Toronto 12, Canada.

Oct. 1-5: AIEE Fall General Meeting, Chicago, Ill. For information, write to AIEE, 33 W. 39th St., New York 18, N. Y.

Oct. 3-5: Fifth Annual Meeting of the Standards Engineers Society, Hotel Willard, Washington, D. C. Theme of the meeting is "Standards—Guides for Tomorrow." Sessions are scheduled on standardization in the chemical industry, standards and the atomic energy field, the future trend of standards in the metals field, and creative engineering and standards. For information, contact the Standards Engineers Society, P.O. Box 281, Camden, N. J.

Oct. 8-9: Second Annual Symposium on Aeronautical Communications, Hotel Utica, Utica, N. Y. Sponsored by the IRE Professional Group on Communications Systems. The symposium will stress communication requirements in support of present and future aeronautical activities. The submission of papers on associated topics is invited. Titles, authors, and a brief abstract of 200 words should be submitted to Fred Moskowitz, 1014 N. Madison St., Rome, N. Y., before July 1. For information, write to R. C. Benoit, Jr., 138 Riverview Parkway N., Rome, N. Y.

Oct. 16-18: Conference on Magnetism and Magnetic Materials, Hotel Statler, Boston, Mass. Sponsored by the AIEE, IRE, American Physical Society, Amercian Institute of Mining and Metallurgical Engineers. Authors should submit titles of proposed papers by June 15 and abstracts by August 1. For further information, write to T. O. Paine, Measurements Laboratory, General Electric Co., W. Lynn, Mass.

Oct. 18-19: Third Annual International Meeting of the Institute of Management Sciences, Statler Hotel, Los Angeles, Calif. Theme of the conference is "Management Sciences—A Progress Report." Program plans include the presentation of technical papers on the latest developments in the application of advanced sciences to business and industrial management. For further information, please contact Al N. Seares, Vice President Remington Rand, Sperry Rand Corp., 315 Fourth Ave., New York 10, N. Y.

Oct. 22-24: AIEE Machine Tool Conference, Sheraton Gibson Hotel, Cincinnati, Ohio. For information, write to AIEE, 33 W. 39th St., New York 18, N. Y.

Oct. 25-26: Second Annual Technical Meeting of the IRE Professional Group on Electron Devices, Shoreham Hotel, Washington, D. C. Titles and abstracts of 100-200 words on papers to be offered for presentation should be submitted to R. L. Pritchard, Research Laboratory, General Electric Co., Schenectady, N. Y., before August 1. For other information, contact Prall Culviner, Sylvania Electric Products, Inc., 1740 Broadway, New York, N. Y.

Oct. 29-30: Third Annual East Coast Conference on Aeronautical and Navigational Electronics, Fifth Regiment Armory, Baltimore, Md. Sponsored by the Baltimore Section and Professional Group on Aeronautical and Navigational Electronics of the IRE. Theme of the conference is "Electronics in the Jet Air Age." For information, write to W. D. Crawford, Publicity Chairman, Westinghouse Electric Corp., Air Arm Div., Friendship International Airport, Baltimore 27, Md.

Nov. 7-9: Conference on Electronic Technology in Medicine and Biology, Governor Clinton Hotel, New York, N. Y. Sponsored by the AIEE, IRE, Instrument Society of America. For information, write to AIEE, 33 W. 39th St., New York, N. Y.

Nov. 26-30: Third International Automation Exposition, Trade Show Building, New York, N. Y. Clinic sessions will be offered in electronic computers, process automation, machine tool automation, office automation, automatic materials handling, servomechanisms, electromechanical components, and electronic components. More than a hundred exhibitors will participate in the clinics. For information, write to Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 22, Pa.

Oct. 29-Nov. 2: Convention on Ferrites, London, England. Sponsored by the Institution of Electrical Engineers. Program will include sessions on theory, preparation, and properties of ferrites, microwave application, square loop applications, radio and TV applications, and carrier frequency applications. For further information, write to W. K. Brasher, Secretary, Institution of Electrical Engineers, Savoy Place, London W.C. 2, England.

Dec. 5-7: Second IRE Instrumentation Conference, Biltmore Hotel, Atlanta, Ga. Sponsored by the Professional Group on Instrumentation and the Atlanta Section of the IRE. Sessions will be devoted to industrial applications, missile range instrumentation, and the application of solid state devices. Prospective authors are invited to submit abstracts of 200 words or less not later than Sept. 1 to the program chairman, M. D. Prince, Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Ga. For further information, contact the IRE, 1 E. 79th St., New York, N. Y.

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

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

What's Inside Transac — I

A Transistorized Automatic Computer

A. L. Cavalieri, Jr.

Philco Corp., Government & Industrial Div.

DIRECT coupling, low power requirements, and high speed operation are features and characteristics of the Transac, a transistorized automatic computer using surface barrier transistors. The result has been a highly portable, low cost unit capable of performing about 416,000 additions per sec. It can multiply two six-digit numbers in about 48μsec.

Because of direct coupling, the transistor base and collector are operated at the same potential. Terminal impedance and gain are similar to those existing under more common operating conditions.

Surface barrier transistors possess the advantage of higher speed performance than alloy-junction transistors under these direct-coupled conditions. To exploit this higher speed switching performance of surface-barrier transistors, a family of circuits for use in binary digital computers have been developed. Basic circuits and arithmetic units for basic operations are discussed in this article. Four of the simplest and fundamental of these, Fig. 1, show a comparison of relay and transistor circuits for performing simple, logical operations.

Basic Circuits

Four sections comprise the basis of a simple digital computor. They are (1) input, (2) output, (3) memory, (4) arithmetic and control section. The input section processes the input signal into a form which is acceptable to the arithmetic and control section. This may be an amplification or a conversion of the input to digital form.

The output section operates on the result of the arithmetic computations that have been carried out.

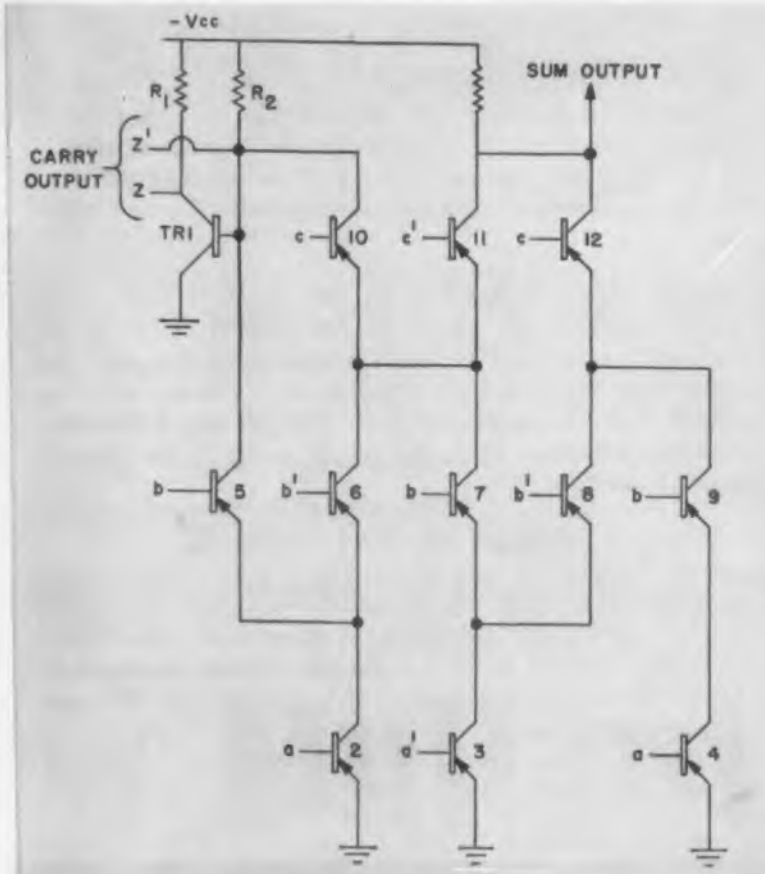


Fig. 2. Transistor binary adder circuit.

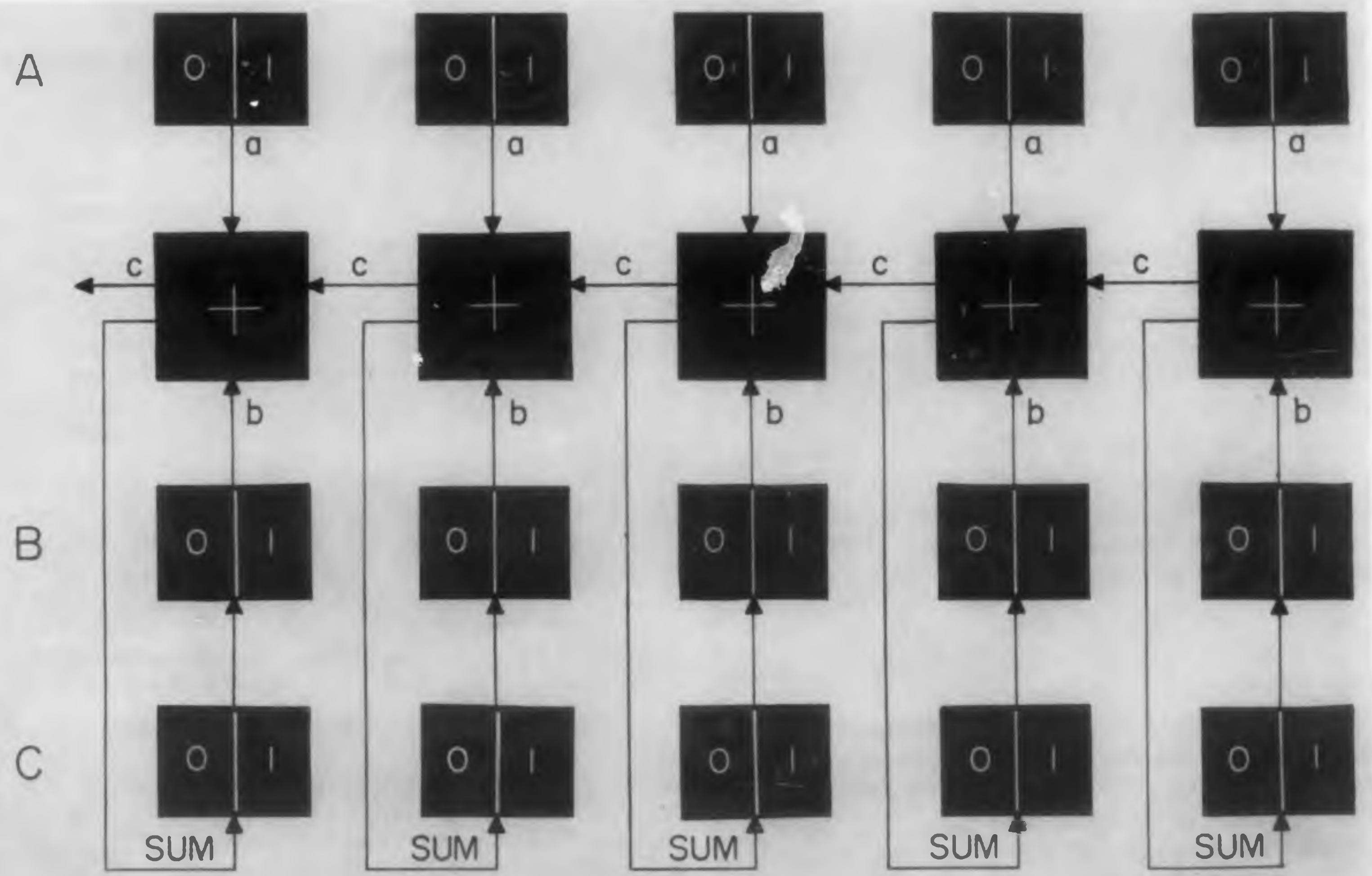


Fig. 3. Block diagram of an arithmetic unit for addition.

It modifies or adjusts the output to fit the requirements of the device which is to be actuated by this signal.

The memory contains two types of information in two subsections. One of these sections contains the program for sequences of operation; the other, the data section, retains and will make available upon demand, data to be processed or compared with the input.

The arithmetic and control section is sometimes called the "brain" of the computer. It is more nearly the slave of the input and the memory, responding to orders more or less instinctively by virtue of the built-in control. Transistors fit best into this section.

Binary Addition

One of the simpler circuits in the arithmetic and control section is the binary adder. It requires provision for 3 inputs, and addend, augend, and carry. It produces 2 outputs, a sum, and a carry. Circuit of a Transac binary adder is shown in Fig. 2. Inputs are *a*, *a'*, *b*, *b'*, *c*, and *c'*. If a *one* is present at input terminal *a*, for example, the corresponding transistor conducts. If a *one* is absent, then the transistor at input *a'* conducts.

To illustrate addition, suppose that inputs *a* and *b* are *ones*, and *c* is a *zero*. If we define an output as that condition in which a conducting path exists between the output terminals and ground, the inputs specified produce zero output, since no conducting path exists. However, transistors *2* and *5* are conducting and cause transistor *1* to be cut off. The negative pulse at the terminal Z is defined as a carry output. Should input *C* also have been a *1*, the only change in the result is that a sum output would have been produced.

Actual condition is carried out as shown diagrammatically on Fig. 3. The blocks identified by the plus signs are adders of the sort shown in Fig. 2. The other blocks are flip flop and are divided into three ranks. These are: input *A*, slave *B*, and the accumulator *C*. These ranks store the addend, augend and sum, while the carry is propagated from adder to adder along the wires marked *c*. Only a five digit adder has been shown.

In the addition process, the three ranks are first cleared or set to zero. A number is entered in *A* and at a given command given to *B*. The sum is then transferred to *C*. If the *A* rank is cleared and the new number read in, and if *C* is transferred to *B*, then the sum of *A* and *B* will appear in *C* upon an add command. Thus, four distinct operations are required: clear, transfer, clear, and add. In fact, if numbers are stored in *A* and *C*, a four-cycle operation is required such that *B* is cleared, *C* is transferred to *B*, *C* is cleared, and *A* and *B* are added with the sum entered back in *C*.

Clearing requires setting the flip flop to a zero condition. This can be accomplished by setting the ground base of the transistor to be cut off. An example of how this can be done in one digit of the *B* and *C* ranks, Fig. 4, also shows means for transferring between ranks.

Note that upon command, "transfer *C* to *B*," transistor *4* is caused to conduct. If transistor *6* is in a state of

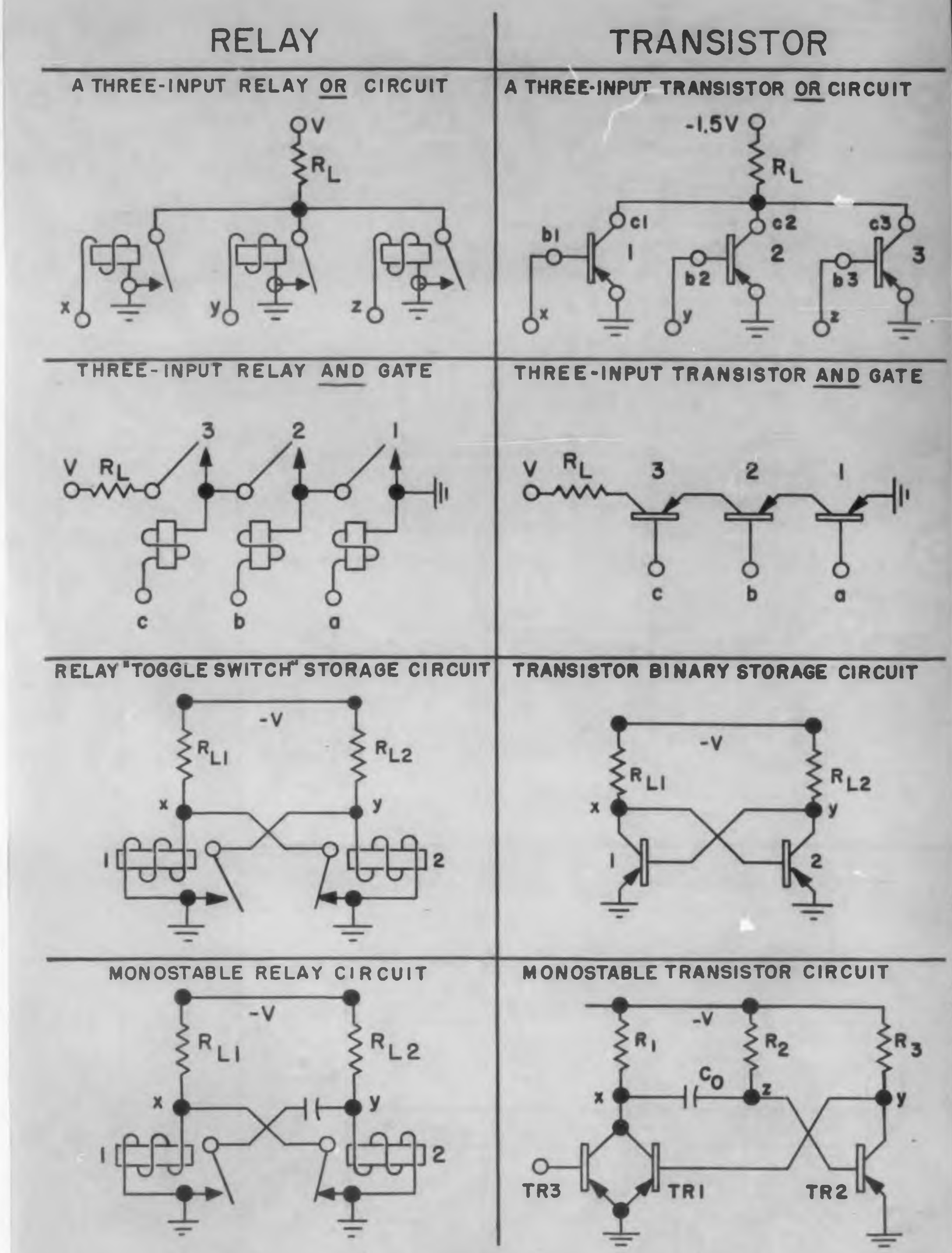


Fig. 1. Comparison of relay and transistor basic computer circuits.

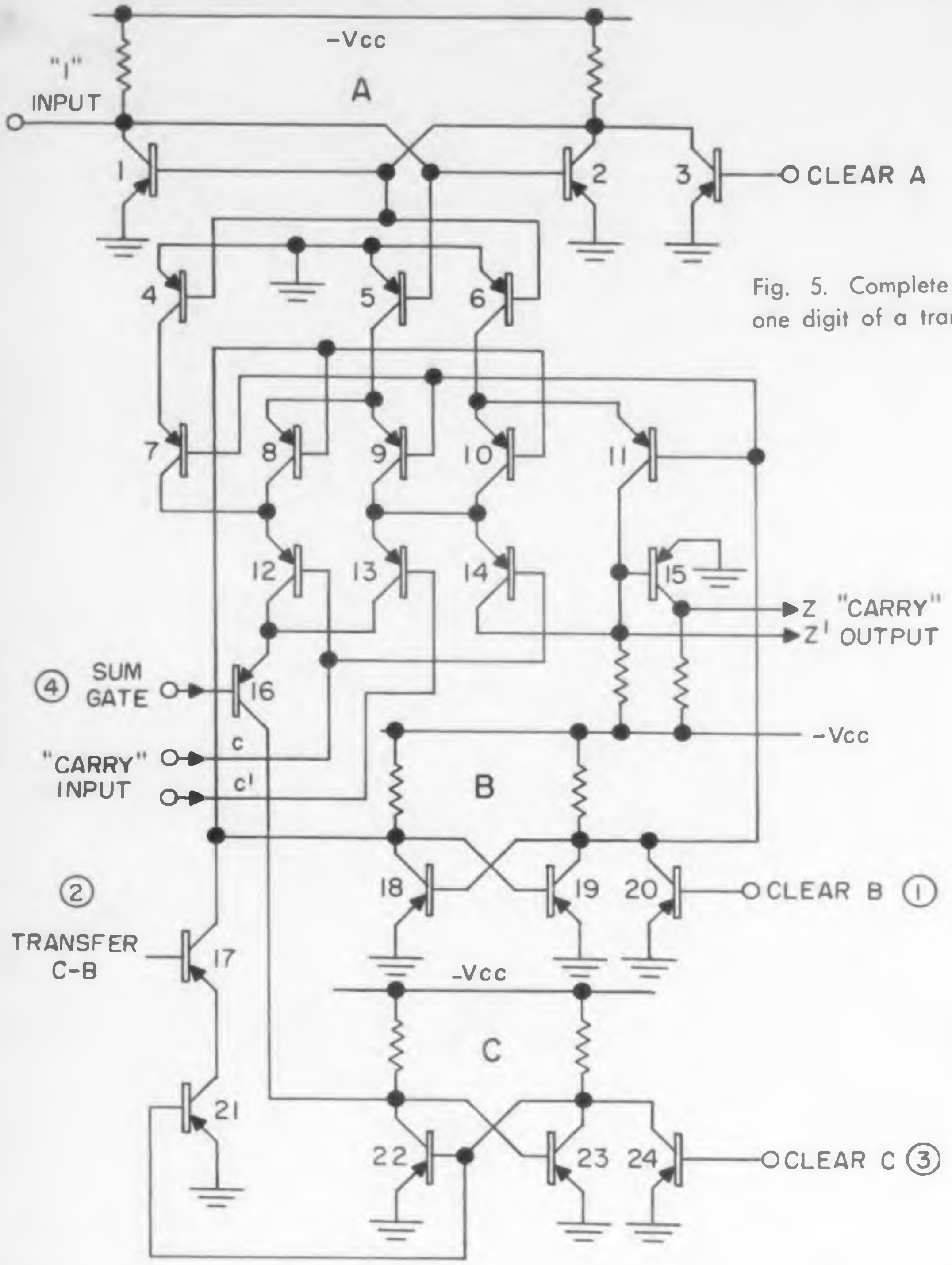


Fig. 5. Complete adder section for one digit of a transistorized computer.

conduction, its base, as well as that of *5*, will be high. Transistors *4* and *5* provide a path between the base of transistor *2* and ground causing it to be off and *1* to be on. Thus the state of the flip flop in the *C* rank has been set up in the *B* rank. Were *C* in the opposite state, no transfer would have taken place. Using this clearing and transferring circuit, and the adder, a complete one digit adder section, Fig. 5, can be built.

Timing these operations requires a cascade of monostable circuits of the type shown in Fig. 1. Furthermore, it requires a knowledge of the time required for the various phases of the addition cycle. Clearing and transferring requires about 0.25μsec. However, to this must be added the time required for "carry" sig-

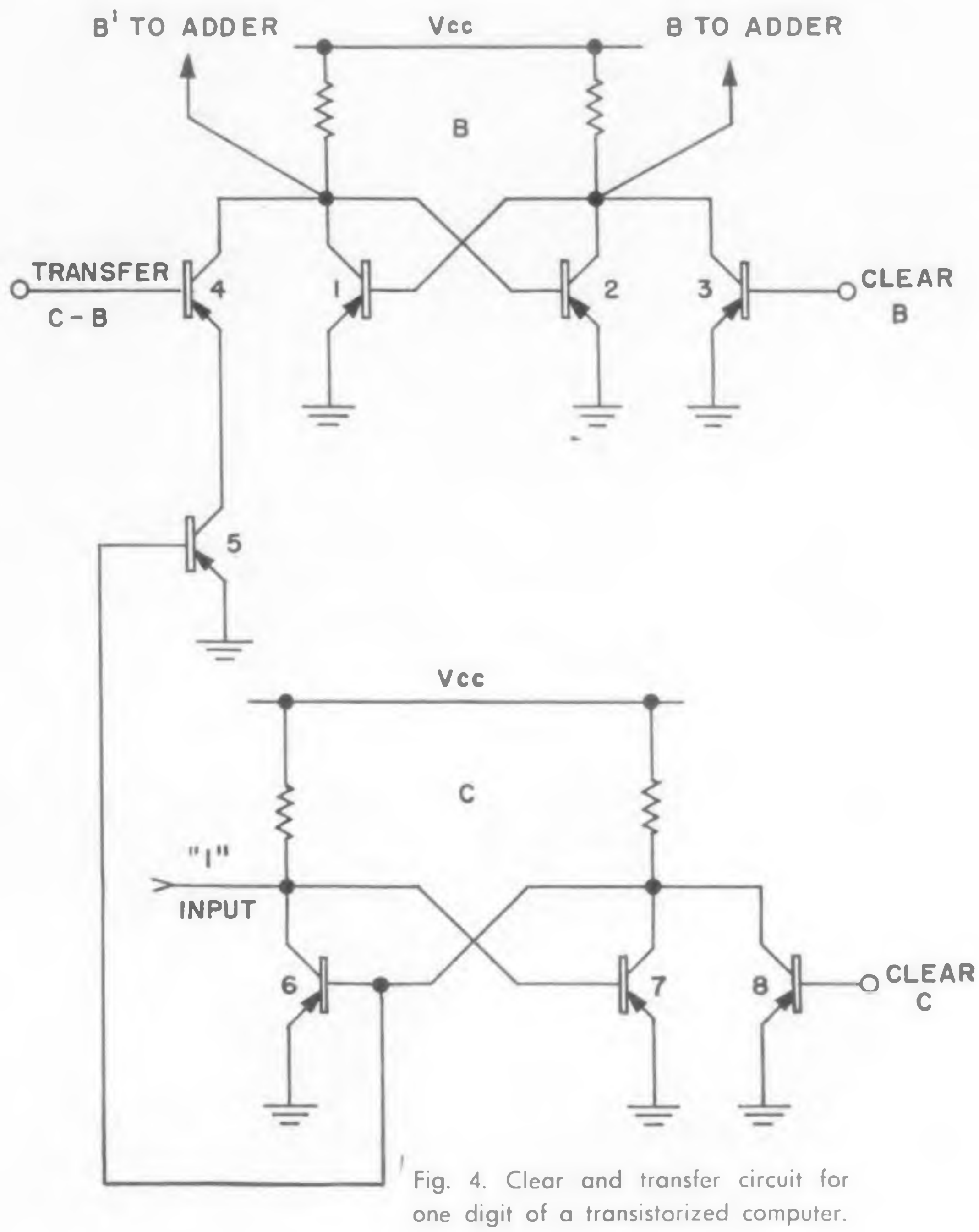


Fig. 4. Clear and transfer circuit for one digit of a transistorized computer.

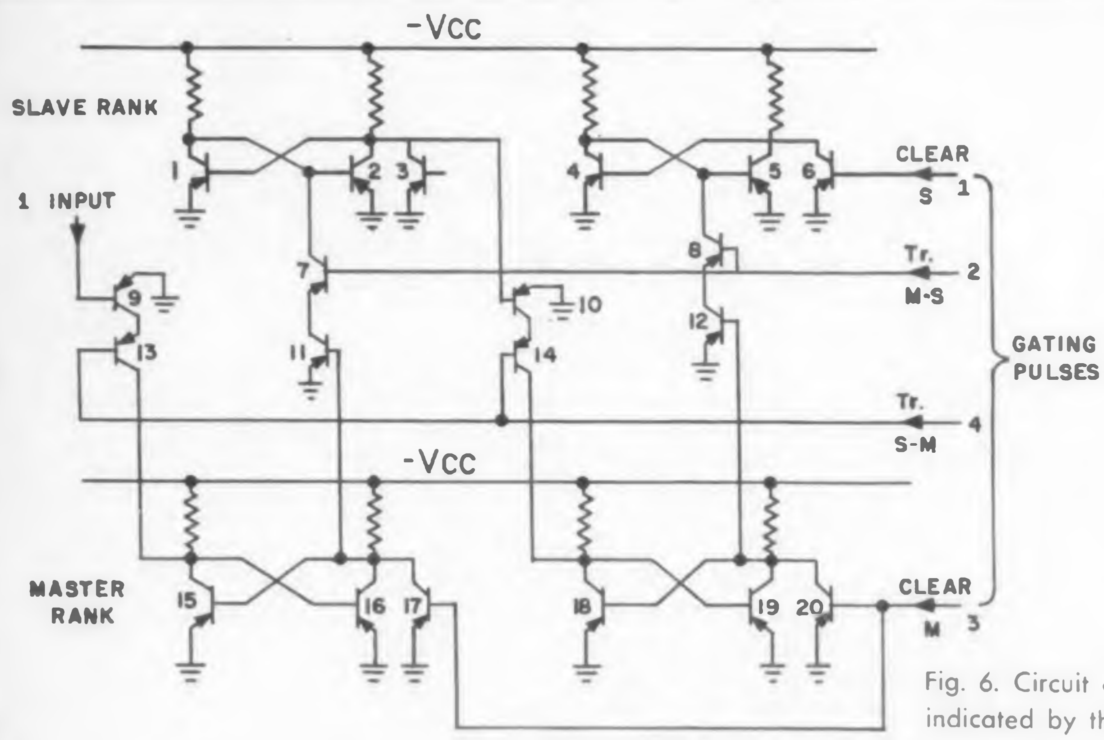


Fig. 6. Circuit of a two shifting register for multiplication. Order of operations involved is indicated by the numbers of the gate pulse input terminals at the right.

nals to ripple through the adder from the least to the most significant digit. Typical maximum addition time in a twenty digit Transac computer has been measured to be 2.5μsec, of which approximately 2μsec was due to this ripple effect.

Binary Multiplication

Multiplication consists essentially of the formation of particle products which must be added to previously formed and shifted partial sums. Two operations are required over and above those involved in the addition. These are the shift of a given number to the right by one digit position at a time, and counting to determine the end of multiplication.

One approach used in Transac computers involves an input rank, an adder, an accumulator register, a multiplier-quotient register, and a step-counting register. These three registers are identical to each other and are similar to the register made up of ranks *B* and *C*, Fig. 5. However, they include provisions for shifting diagonally up and down as well as straight up. In multiplication, shifting straight down and diagonally up to the right is of importance.

Counting to determine the end of a multiplication involves inserting a *one* into the step-counting register through which it propagates at the same rate as the digits involved in the multiplication itself. Its appearance at a certain position in the step-counter causes an inhibiting signal which might open the feed-back loop around the timing generator allowing it to complete its cycle but not to recycle.

One type of two-digit register used in the Transac is shown in Fig. 6. Shifting and clearing are initiated by providing paths of low resistance either for grounding certain points or connecting points to be set at the same potential. Since multiplications is really a series of additions, the maximum multiplication times is simply the product of the number of digits in the multiplier and the "add" time of 2.5μsec. In the 20-digit computer, a maximum of 50μsec is required for multiplication.

Other Arithmetic Operations

Transac is also capable of subtracting, dividing, and taking square roots. The circuits involved either bear great similarity to those already described or require a small additional section. As an example, an adder-subtracter is made up of an adder and an additional subtracter section. Division requires shifting left and subtracting as opposed to the routine in the multiplication cycle. These processes require methods of handling and identifying negative numbers which can become quite complicated. These details have been avoided since they require introduction of subjects beyond the scope of this article.

Method of control, the memory circuit, and the methods of transmitting information to the computer will be discussed in Part II of this article.

TRIAD

QUALIFIES FOR UNITED STATES ARMY SIGNAL CORPS

RIQAP

(Reduced Inspection Quality Assurance Plan)

The U.S. Army Signal Corps officially recognizes that TRIAD TRANSFORMER CORPORATION'S quality control and inspection system equals or exceeds the quality levels set by RIQAP (Reduced Inspection Quality Assurance Plan), and is qualified to manufacture under provisions of the program.

Triad's adherence to the highest standards in the production of military items is carried throughout the entire line of Triad Transformers — assuring you the ultimate in quality in every Triad transformer.

Write for General Catalog TR-55G

TRIAD TRANSFORMER CORP.

4055 Redwood Avenue • Venice, California

CIRCLE 21 ON READER-SERVICE CARD FOR MORE INFORMATION

3-D Flux Meter

This unusual and versatile flux meter, made in West Germany, is marketed by Federal Telephone and Radio Co. in Clifton, N. J. The rotating pick-up coils, which provide for 3-dimensional flux measurement, are located at the end of the head, shown enlarged above.

THIS flux meter can be used to measure the strength of a three-dimensional magnetic field in terms of its space components along each of the three rectangular axes. Its long thin probe makes it particularly suitable for taking measurements in narrow cylinders such as are used in focusing solenoids for travelling-wave tubes. It can be used any place for measurement of magnetic flux intensity in the range from 2 to 1000 gauss and its range can be extended to greater limits through the use of external meters.

A recent addition to a number of interesting and useful instruments made in Germany and marketed in this country by Federal Telephone and Radio Company, this 3-D flux meter has some interesting features. It is extremely compact and light weight (2.6 lb) with the "business end" out at the tip of the probe. Yet, it is "mighty" in the information it supplies.

In operation, the instrument is basically a d-c generator. The sensing elements are armatures rotating in a magnetic field. The voltage induced into each rotating coil is directly proportional to the intensity of the magnetic field in which it rotates; or, strictly speaking, proportional to one of its components only, which is determined by the axis of rotation and the commutation plane.

In this 3-D Flux Meter, two armatures in the form of small measuring coils located at the end of the probe, are driven by a synchronous motor back in the case at 3600rpm. These coils rotate about two perpendicular axes, a special commutator arrangement making possible the separate measurement of three field components. To minimize internal noise generation and maintain low contact resistance at the commutator, spring type bronze wire is used for brushes and silver graphite for the collectors.

The magnetic flux intensity range of this instrument is from 2 to 1000 gauss. Two ranges are provided: 200 and 1000 gauss full scale for each of the three space components. Both larger and smaller full scale values can be obtained with external meters; with a sufficiently sensitive galvanometer, the earth's magnetic field can be detected. Measuring coil sensitivity is approx. 0.2 millivolts per gauss. Controls include: power, on-off meter range and flux direction. Power required for operation is 110v, 60cy at 10w. Case size is 6-3/4" x 3-1/4" x 4", and the probe is 12-3/4" long x 0.435" dia.

For additional information on this product fill out the Reader's Service Card and circle No. 22.

Automatic Curve Tracing Aids Transistor Circuit Design

Norman H. Goldich
Development Engineer
American Electronic Laboratories, Inc.
Philadelphia, Pa.

CURVE tracers can be effectively used to evaluate transistors in circuit design. They are particularly useful in analyzing changes in transistor characteristics with load, operating time, and environmental conditions. They can also be used to compare various transistors of a given type for uniformity. An understanding of the elements that make up such equipment should help designers to use it effectively. Therefore, this article is a delineation of a typical curve tracer and explains how it can be used as a design tool.

To produce a family of transistor curves two basic parameters are required: a stepped constant-current source, and a unidirectional sweep voltage. While sweep currents and stepped voltages may also be used for curve plotting, such factors as intrinsic high collector resistance and low base resistance make constant currents and sweep voltages more desirable as independent variables. The constant current provides bias for the transistor under test and should in addition to increasing in equal increments, cover a wide range of amplitudes of either polarity. The sweep voltage should also be reversible in polarity and must be synchronized with the constant current steps.

To generate a typical set of transistor collector characteristic curves, the bias current must be applied to the base or emitter and the sweep voltage to the collector. The collector voltage (V_c) is then plotted against the current produced by the sweep voltage (I_c), and thus produces a V_c-I_c curve for each increment of input bias current.

The cathode-ray oscilloscope is most useful for displaying the family of curves since it can be used for visual monitoring or photographic recording. Since it is a voltage measuring device, the sweep current can be measured by passing it through a small precision series resistance to produce a voltage proportional to the current. To make quantitative measurements, screen calibration voltage should be provided, either in the oscilloscope or in the curve tracer.

A typical curve tracer is shown in Fig. 1. It consists of three rack mounted units: power supply, oscilloscope, and main chassis. The block diagram, Fig. 2, shows the general circuit arrangement.

The stepped constant current or "staircase" output is produced by means of three stages: counter, staircase generator, and staircase amplifier.

The counter consists of three cascaded binary counters driven by the 60-cycle line voltage. It may be optionally operated by a single-step push-button switch, which permits presentation of single transistor curves on screen for individual study.

The staircase generator consists of three pairs of diode-triode switches which are operated by the three binary digits from the counter. The switches control six currents derived from two regulated voltages—one positive, the other negative. These currents, which are weighted in the ratios of 1, 2 and 4, are added to produce a staircase output of either polarity as shown in Fig. 3. While both polarities of staircase outputs are present, only one is used at a time, the one used being dependent on the output current polarity selected.

Because of the wide range of output currents (1μa to 120ma) which are required to test a variety of transistors, the staircase amplifier circuits are divided into two basic ranges. The lower range consists of staircase outputs of 1, 2, 5, 10, 20, 50, 100 and 200μa per step; the upper range will deliver outputs of 0.5, 1, 2, 5, 10 and 20ma per step.

In the lower range, the input staircase currents are converted to constant voltage steps by means of a feedback amplifier. The voltage waveform is then converted into output-current steps by one of a set of calibrated resistors. The low-range feedback amplifier

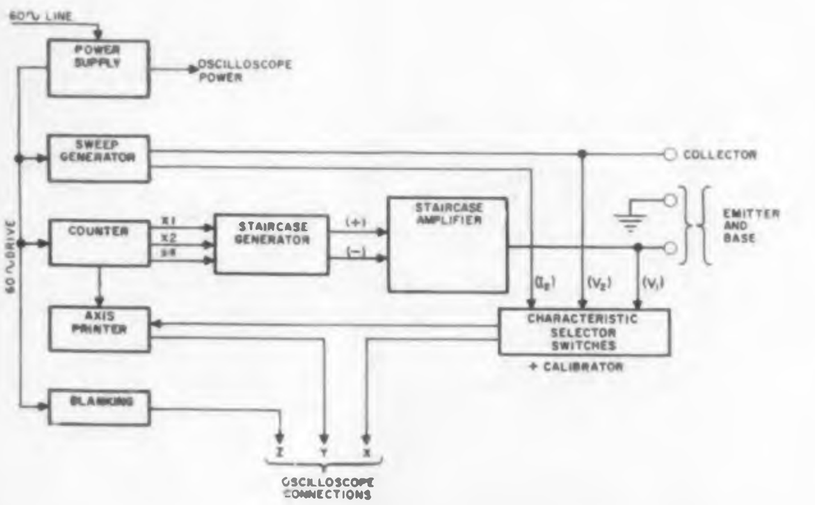


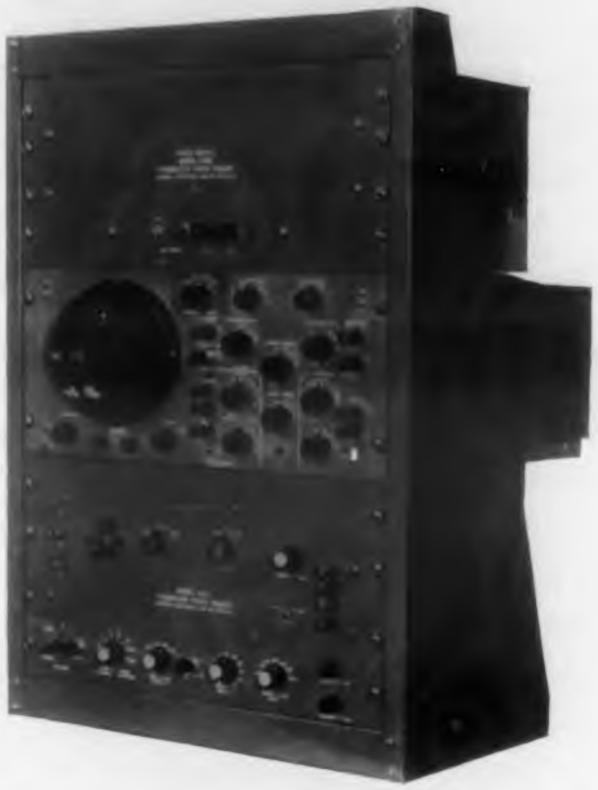
Fig. 2. Block diagram of circuit employed in American Electronics Labs, transistor curve-tracer Model 126H.

Fig. 3. Output from "staircase generator".

Fig. 4. P-n-p collector characteristics for common-emitter connection.

Fig. 5. P-n-p collector characteristics for common-base connection.

Fig. 1. Rack mounted curve tracer; includes modified commercial oscilloscope (center), power supply (above) and auxiliary control cricuits (below).



performs two useful functions: It provides a low output impedance which permits the use of standard precision resistors for controlling the current to the transistor; and by having a low effective input impedance, it permits linear current addition in the staircase generator.

In the upper or milliampere range the circuit of the amplifier must be entirely different, since the output impedance of a simple resistor would be too low to be a constant current supply for a common-emitter transistor configuration. In the milliampere range the staircase amplifier produces a constant output voltage across a series calibrated resistor and the load. However the actual load voltage is subtracted from the feedback signal (which is derived from the amplifier output voltage), thus producing a new feedback signal proportional to the voltage drop across the calibrated

Fig. 6. Common-base emitter voltage vs collector current curves.

resistor. Since this voltage drop is proportional to the load current, the output is current regulated. The magnitude of the regulated current is determined by the value of the precision resistor which is selected.

The sweep generator delivers a unidirectional half-sinusoidal waveform to the transistor. The amplitude range and polarity can be selected, and by use of an adjustable autotransformer, the sweep amplitude can be varied within the range selected.

A germanium power rectifier is used on the lowest sweep range to provide very low forward impedance at high sweep currents (three to five amperes). On higher sweep ranges a silicon junction diode is used to provide low forward impedance (relative to a hard tube diode) and high back resistance.

As shown on the block diagram, also incorporated are an X-axis printer, a blanking circuit, and a characteristic selector. The axis printer places an X-axis on the oscilloscope screen by switching the Y-axis to ground when the counter stage is in seventh or last step. The blanking pulse, which is derived from the line voltage, blanks out the residual spot during the off half cycle of the sweep waveform when the counter and staircase generator are in the process of changing to the subsequent step. The blanking of this bright spot prevents halation of photographs and eliminates transients from the display which may occur due to sharp counter pulses.

Referring to Fig. 3, curve tracer action can be summarized as follows: During the horizontal portions of the staircase output, the sweep half-sinusoids are present at the other output. Axis printing occurs on the seventh step. Blanking occurs during the vertical portions of the staircase and the non-conducting portions of the sweep voltage. This cycle produces a set of 8 curves: a zero bias curve, 6 active current curves, and an X-axis, and is repeated 7-1/2 times per sec.

The curve tracer provides three output variables for curve plotting: current (I_2) through the transistor due to sweep voltage. Sweep voltage (V_2), and voltage (V_1) across the transistor produced by the constant current. For most curve tracer applications with the sweep applied to the collector and the constant current to the base or emitter, I_2 and V_2 are the collector current I_c, and voltage V_c, respectively while V_1 is the base V_b, or emitter V_e, voltage. Possible curve families which may be viewed for a swept collector are as follows:

V_e vs I_c; I_b (or I_e) constant

V_b (or V_e) vs I_c; I_b (or I_e) constant

V_b (or V_e) vs V_c; I_b (or I_e) constant

A family of collector characteristics is shown in Fig. 4 for a p-n-p- transistor with common-emitter connection. The collector characteristic for the same transistor with common-base connection is shown in Fig. 5. Curves of emitter voltage versus the collector current with common-base connection are shown in Fig. 6. From the collector family, output characteristic (r_{22}) can be measured from the slopes of the V_c-I_c curves. In a similar fashion, feedback characteristic (R_{12}) may be determined from the V_b-I_c curves. If the feedback characteristic, h_{12}, is desired, the slopes of the V_b-V_c curves can be used for the determination of this parameter.

By the artifice of shunting a small resistance across the constant current staircase output, a voltage staircase can be produced. If this staircase is applied to the output, and the sweep is applied to the input of the transistor, the h_{11} input characteristic can be displayed. With the latter parameters reversed in application to the transistor, the g_{21} characteristic can also be determined.

The collector characteristic is generally the most useful, since it can be used to evaluate the magnitude and variation of current gain with respect to collector current.

Viewing and Recording

To observe and record curve data, it is best to use an oscilloscope with a flat faced cathode-ray tube. The P-1 phosphor is the easiest to observe for extended periods and is adequate for photographic purposes. A flat-faced tube lends itself to a graticule which, if properly made, can minimize parallax between the oscilloscope screen and the scale. The type camera employed will depend on the users' ultimate application of the data obtained. By taking double exposures, such curves as the output and feedback characteristics can be superimposed.

Application

The collector characteristic obtained on the curve tracer has some of the same uses as the plate characteristic for vacuum tubes. If duality is applied to a transistor, and if currents are substituted for voltages and voltages for currents in a collector family, an analogy to vacuum-tube plate characteristics may be readily seen. Once the collector characteristics are recorded, load lines can be drawn and the curves can be used to establish optimum operating points either for fixed or self biased circuits. A maximum dissipation hyberbola can be drawn on the collector family to further aid the circuit designer. In the design of power amplifiers or large signal circuits, graphical techniques are often an excellent approach. As in the case of vacuum tubes the collector characteristic can be used to construct a dynamic transfer curve for such design problems.

Since n-p-n and p-n-p transistors may be used to great advantage in push-pull circuits by the principle of complementary symmetry, the curve tracer can be used to check the degree of symmetry of a given pair by comparison of their collector curves. In certain networks such as switching, modulation and detection circuits, transistors possessing symmetrical characteristics have many applications. To measure the symmetry of such devices the curve tracer can easily be employed, either directly by shorting the sweep rectifier or by separate plots of collector families for each polarity of collector voltage.

Wire Lacing With Plastic Tubing

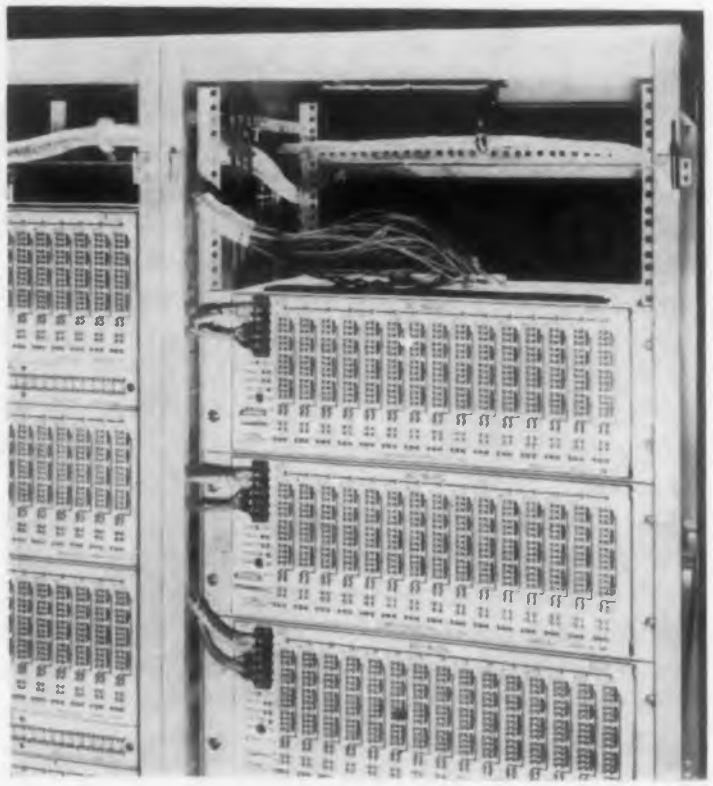


Fig. B. Typical application of Spirap in a computer wiring installation.

How spirally-cut plastic tubing is applied to a bundle of wires. Hand lacing with cabling twine is avoided.

CABLING a group of wires with twine is both time consuming and tedious. One solution to the lacing problem is advanced by a new, easily applied, spirally-cut polyethylene tubing that provides insulation and protection of the bundle. Individual wires may be brought out of the cable or entered as desired.

Called "Spirap," the tubing is available in 1/4" initial diameter and is capable of handling wire bundles up to 2" in diameter. Cable clamps may be used without damaging critical wire insulation. Both production and experimental or prototype wiring may be facilitated.

One of the advantages cited by the manufacturer, Computer Control Company, Inc., Babson Park, Wellesley, Mass., is that the tubing can be removed as easily as it is put on. Standard lengths are available ranging from 50' to 1000'. Although polyethylene is the standard material from which Spirap is made, it can also be obtained in nylon, Teflon or other materials on special order. For further information on this plastic wire lacing turn to Reader's Service Card and circle No. 28.

Transistor Circuit Design with Intermediate Connections Terminal

Alfred Jorysz*

Chief Development Engineer
Presto Recording Corp.
Paramus, N. J.

Transistor circuits in which the base, the emitter, or the collector are common to both input and output, have been studied extensively, and complete design information is available for them.[1,2,3] Recently, however, a new, more general, class of transistor circuits has been developed, which exhibits interesting and quite useful properties.[4,5] The new circuits are more general and allow better control of impedances and amplification properties of the transistor.

The present article will be limited to low frequency applications of junction transistors, which will permit the use of purely resistive equivalent circuit parameters. Applications at higher frequencies may be based on the same circuits and methods of analysis.

The most general form of the new circuit may be considered as a parallel-series or series-parallel combination of a transistor and an impedance bridge. Since there are three basic types of transistor circuits, a total of six combinations appears possible. Figs. 1 and 2, for instance, show the common emitter transistor circuit with the two possible bridge combinations. Restriction of this discussion to a few special bridge configurations will yield a group of three simple circuits, which are to be examined in detail. In their final form they can best be described as follows: In each one of the resultant four-pole structures, three terminals are connected directly to the transistor. The fourth is a point intermediate between any two transistor terminals. In accordance with the location of this fourth terminal, the circuits will be referred to respectively as "intermediate emitter-base," "intermediate emitter-collector" and "intermediate base-collector."

* Now with Otis Elevator, Electronics Div.

Intermediate Emitter-Base Circuit

The circuits of Figs. 1 and 2 are most easily analyzed with the aid of matrix algebra (Chapter 15 of reference 1 contains a lucid introduction to this subject). The details of this analysis will not be presented here, but it should be pointed out that by selecting the proper matrix for both the transistor and the bridge circuit, it is possible to obtain the matrix elements of the complete circuit by the simple process of addition.

Since we are not interested in the most general bridge circuit, which contains a total of six elements, special values will be assigned to some of its impedances. By assuming Z_1, Z_2 and Z_5 to be infinite and Z_4 zero, Fig. 3 results. In its redrawn simplified form (Fig. 4) we obtain the final configuration of the intermediate emitter-base circuit. Consistent with established terminology, divider Z_3-Z_6 is connected between emitter and base, and one output terminal of the final four-pole circuit is the "intermediate" point.

The matrix representation of the circuit equations of Fig. 4 can be shown to be:

$$\begin{vmatrix} i_1 \\ e_2 \end{vmatrix} = \begin{vmatrix} g^*_{11} & g^*_{12} \\ g^*_{21} & g^*_{22} \end{vmatrix} \begin{vmatrix} e_1 \\ i_2 \end{vmatrix} \qquad (1)$$

The g parameters relate the input current and output voltage as dependent variables to the input voltage and output current as independent quantities (Ref. 1, p 314).

In developed form Eq. (1) becomes:

$$\begin{aligned} i_1 &= g^*_{11} e_1 + g^*_{12} i_2 \\ e_2 &= g^*_{21} e_1 + g^*_{22} i_2 \end{aligned} \qquad (1a)$$

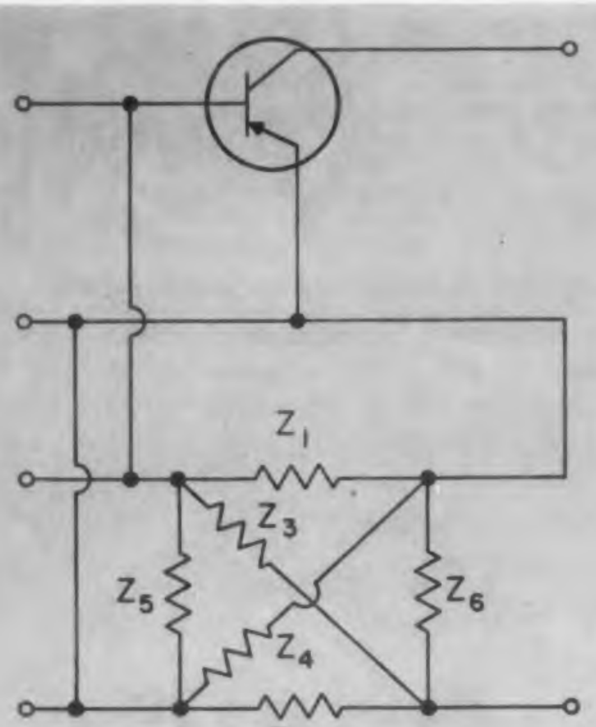


Fig. 1. Basic intermediate circuit for transistor-bridge combination with common-emitter connection.

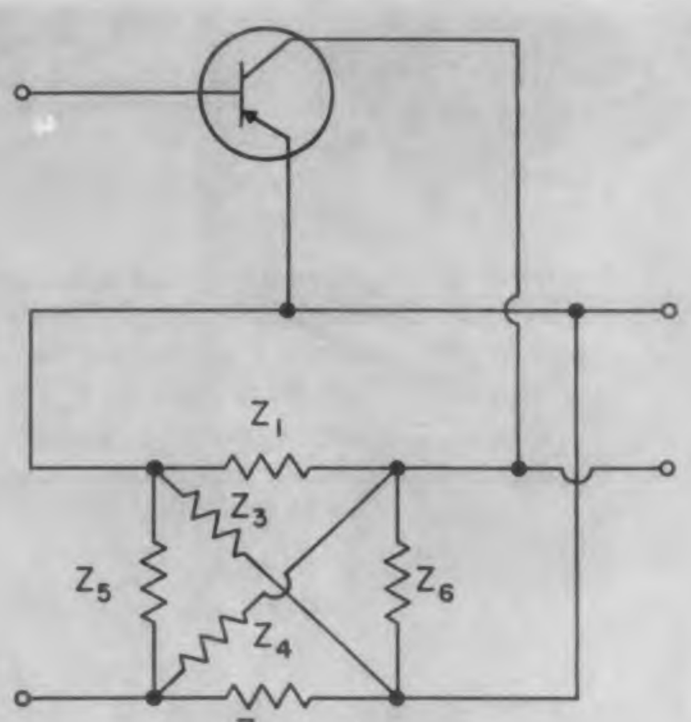


Fig. 2. Alternative circuit to Fig. 1.

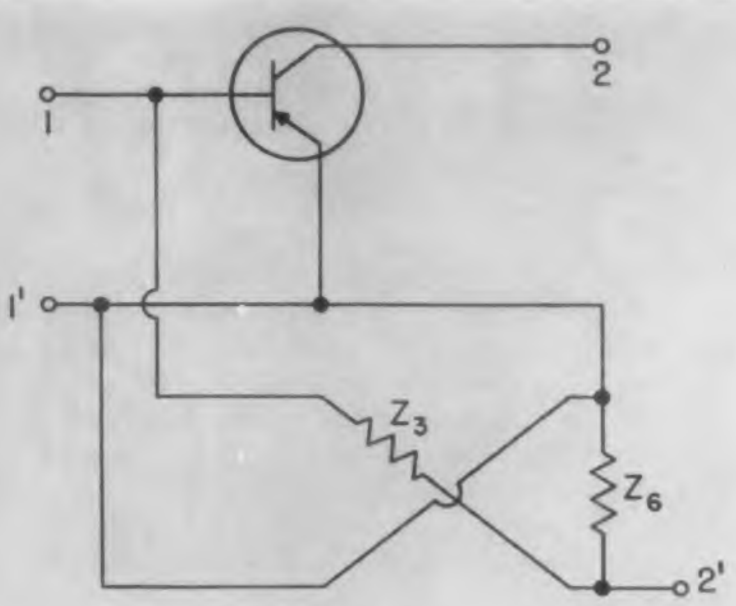


Fig. 3. Resulting circuit with Z_1, Z_2, Z_5 ∞ and Z_4 0.

The complete expressions for the g's are:

$$g^*_{11} = \frac{h'_{22}}{\Delta^{h'}} + \frac{1}{z_3 + z_6} \quad (2)$$

$$g^*_{12} = -\frac{h'_{12}}{\Delta^{h'}} + \frac{z_6}{z_3 + z_6} \quad (3)$$

$$g^*_{21} = -\frac{h'_{21}}{\Delta^{h'}} - \frac{z_6}{z_3 + z_6} \quad (4)$$

$$g^*_{22} = \frac{h'_{11}}{\Delta^{h'}} + \frac{z_3 z_6}{z_3 + z_6} \quad (5)$$

with

$$\Delta^{h'} = h'_{11} h'_{22} - h'_{12} h'_{21} \quad (6)$$

In equations (2) to (5) the g parameters are expressed in terms of the transistor common emitter hybrid parameters. The latter are easily measured and available to designers in transistor data sheets published by most manufacturers. Hybrid parameters referred to the common emitter circuit are usually primed. This notation will be used here. Hybrid quantities without prime will refer to the common base circuit.

The expression for each g parameter consists of two parts, the first originating in the transistor, and a second determined by the external network. Examination of Fig. 4 shows that shorting out Z_6 results in the common emitter circuit with Z_3 only shunting the input. The common base connection is obtained if Z_3 vanishes and Z_6 becomes infinite. In the first circuit the g parameters reduce to their common emitter values. When Z_3 is zero, however, g^*_{12} and g^*_{21} differ from their common emitter values by one. It can be shown without difficulty that these new g expressions are the common base g parameters. In proving this, one has only to remember that, compared to the conventional common base circuit, both i_1 and e_1 are reversed in Fig. 4.

Example: We shall now discuss various properties of the intermediate emitter-base circuit with the aid of a practical example. Assume a transistor with the following common emitter hybrid parameters: $h'_{11} =$ 1000 ohms, $h'_{12} = 0.0009$, $h'_{21} = 19$ and $h'_{22} = 0.00002$ ohm. Use of equation (6) yields for Δ', 0.0029. If Z_3 and Z_6 are both resistive and their sum is designated as R, Z_6 can be expressed as a fraction bR, where $0 \leqq b \leqq 1$. Equations (2) to (5) are now simply:

$$g^*_{11} = 69 \times 10^{-4} + \frac{1}{R} \quad (2a)$$

$$g^*_{12} = -0.31 + b \quad (3a)$$

$$g^*_{21} = -6550 - b \quad (4a)$$

$$g^*_{22} = 34.5 \times 10^{4} + b\,(1-b)\,R \quad (5a)$$

For a load resistance r_e of 10,000 ohms and a total divider R of 100,000 ohms, Table I shows the variations in input resistance, voltage amplification and current gain for $b = 0, 0.5$, and 1. This table was computed using the following formulae (Ref. 1, p. 336):

Input resistance:

$$r_i = \frac{g^*_{22} + r_e}{\Delta g^* + g^*_{11} r_e} \tag{7}$$

Voltage amplification:

$$A_v = \frac{g^*_{21} r_e}{g^*_{22} + r_e} \tag{8}$$

Current amplification:

$$A_i = \frac{g^*_{21}}{\Delta g^* + g^*_{11} r_e} \tag{9}$$

Table I

	b=0	b=0.5	b=1.0
r_i (ohms)	859	96.3	50.9
A_v	—184.5	—184.5	—184.5
A_i	— 15.9	— 1.77	— 0.94

It is obvious from Table I that by shifting the tap of the voltage divider R, a range of 17:1 in input resistance values can be covered and an almost equal variation in current gain is obtained. Control of one or the other quantity is therefore possible in a simple way. Note that the voltage amplification remains constant for the range of b values assumed.

Equations (2a) to (5a) show that both g°_{11} and g°_{21} are very little affected by changes in b, while g°_{12} is effectively controlled by it. The influence of b on g°_{22} is governed by the magnitude of R. Notice that g°_{12}, the backward current transfer ratio with shorted a-c input, can be made zero by proper choice of b.

In practical applications it may be required to obtain a certain current amplification using a given transistor and load resistance. This is accomplished by plotting A_i as a function of b for a fixed value of R, then read off the b value required for the desired A_i.

Intermediate Emitter-Collector Circuit

Starting from Fig. 2 and choosing Z_3 zero, while Z_5, Z_6, and Z_1 are assumed infinite, Fig. 5 is obtained. The divider is now connected between emitter and collector. This circuit shows characteristics intermediate between the basic common emitter and common collector circuits. The analysis will be restricted to a purely resistive divider R. The fraction bR of R, $0 \leqq b \leqq 1$, is then Z_2; and Z_4 equals $(1\text{-}b)$ R.

The matrix best suited for analysis of this circuit is the hybrid parameter matrix in which input current and output voltage are the independent variables. This choice becomes obvious if one considers that input currents and output voltages are identical for both the transistor and the impedance bridge. Since the common emitter circuit was used for the transistor, common emitter hybrid parameters will appear in all equations. The intermediate emitter-collector circuit equations are therefore:

$$\begin{vmatrix} e_1 \\ i_2 \end{vmatrix} = \begin{vmatrix} h^*_{11} & h^*_{12} \\ h^*_{21} & h^*_{22} \end{vmatrix} \begin{vmatrix} i_1 \\ e_2 \end{vmatrix}$$

or in developed form with the proper h° values substituted:

$$e_1 = [h'_{11} + b\,(1-b)\,R]\,i_1 + [h'_{12} - b]\,e_2 \tag{10}$$

$$i_2 = [h'_{21} + b]\,i_1 + \left[h'_{22} + \frac{1}{R}\right] e_2$$

If b equals zero and R infinity, equations (10) describe the common emitter circuit, while the choice of $b=1$, $R=\infty$ produces the common collector equations.

In practical designs the procedure to be followed is quite similar to the one outlined in the previous section. The expressions (7) to (9) have to be replaced, however, by (11), (12) and (13) respectively:

$$r_i = \frac{\Delta^{h^*} + h^*_{11} y_e}{h^*_{22} + y_e} \tag{11}$$

$$A_v = \frac{-h^*_{21} z_e}{h^*_{11} + \Delta^{h^*} z_e} \tag{12}$$

$$A_i = \frac{-h^*_{21} - y_e}{h^*_{22} + y_e} \tag{13}$$

Example: An example will illustrate their use. Assume the same transistor as in the previous example. If the total divider between collector and emitter is 100,000 ohms again, and the load resistance is 10,000 ohms, Table II shows the variations of r_i, A_v, and A_i for three different locations of the tap.

Table II

	b=0	b=0.5	b=1.0
r_i (ohms)	868	101000	162500
A_v	—168.5	— 1.49	— 0.995
A_i	— 14.6	—15.0	—15.4

Inspection of this table shows that for a given load a wide range of input resistances can be obtained, which is of a different magnitude than the one computed for the intermediate emitter-base circuit. The current gain remains practically constant, while the voltage amplification changes over wide limits. The change in power gain is therefore directly proportional to A_v.

Intermediate Base-Collector Circuit

The third circuit to be discussed is the intermediate base-collector circuit. It can also be derived from a series-parallel combination of a transistor and an impedance bridge. We shall proceed directly to the circuit containing a voltage divider between base and collector terminals of the transistor (Fig. 6). The final circuit matrix is based again on the hybrid parameters. It is not identical with the matrix appearing in equa-

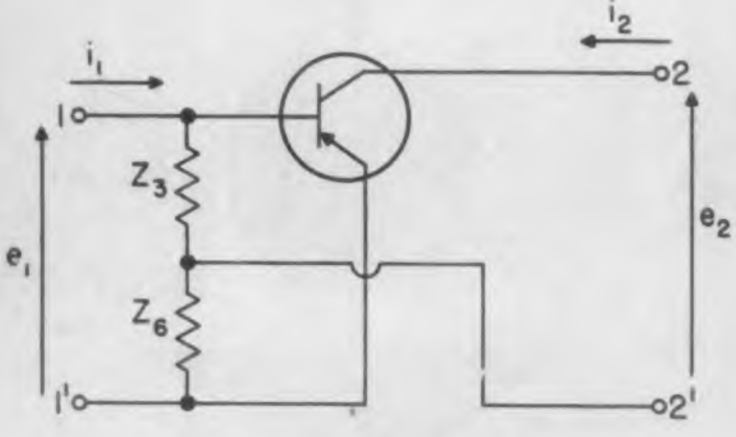


Fig. 4. Redrawn, simplified form of Fig. 3.

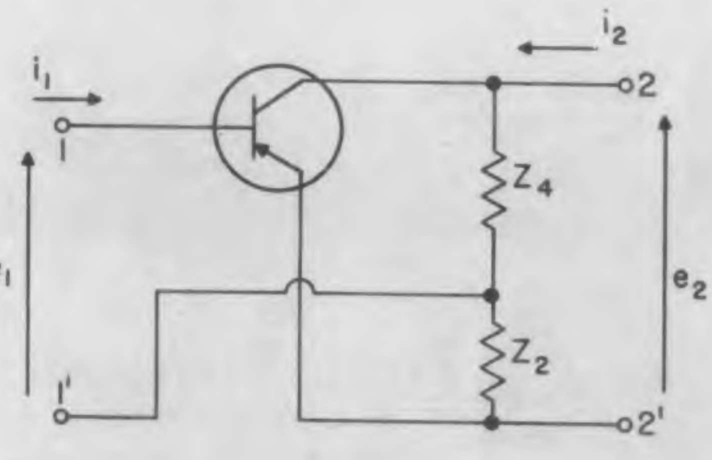


Fig. 5. Intermediate emitter-collector circuit.

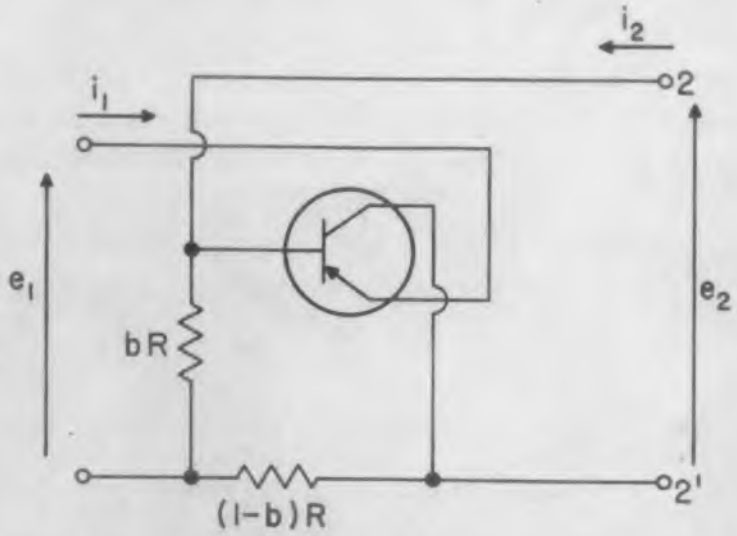


Fig. 6. Intermediate base-collector circuit.

tions (10), however, since in the present case the hybrid parameters are referred to the common base circuit. They therefore appear without a prime in equations (14).

$$e_1 = [h_{11} + b\,(1-b)\,R]\,i_1 + [h_{12} - b]\,e_2$$
$$i_2 = [h_{21} + b]\,i_1 + \left[h_{22} + \frac{1}{R}\right]e_2 \qquad (14)$$

By setting b zero and R infinity, (14) reduce to the common base circuit equations. If b equals unity, on the other hand, we have the common collector circuit in which the emitter is the input and the base the output terminal.

Circuit with Equal Input and Output Resistances

After having discussed the three types of intermediate circuits, it is interesting to examine the possibility of devising a transistor circuit with equal input and output resistances based on an image impedance match. Such a match is accomplished for a four-terminal network if the generator impedance equals the input impedance and the load equals the output impedance.

The intermediate emitter-base circuit shows only relatively low input resistances, and, as can be shown by assuming a generator, fairly high output resistances. The intermediate emitter-collector circuit, on the other hand, shows a wide range of both input and output resistances. In this circuit it is therefore possible to equate the expressions given below for image matched input and output, (15) and (16), (Ref. 3, p. 105) and determine b from the resultant equation (17).

$$r_{im} = h^*_{11}\sqrt{1 - \frac{h^*_{12}\,h^*_{21}}{h^*_{11}\,h^*_{22}}} \qquad (15)$$

$$\frac{1}{r_{om}} = h^*_{22}\sqrt{1 - \frac{h^*_{12}\,h^*_{21}}{h^*_{11}\,h^*_{22}}} \qquad (16)$$

$$h^*_{11}\,h^*_{22} - h^*_{12}\,h^*_{21} = 1 \qquad (17)$$

The h^* parameters to be used are those appearing in expression (10).

A graphical solution can be obtained very simply by plotting both (15) and (16) as functions of b. The intersection of the two curves yields the value of the required tap location. By using this value for b it is possible to connect two transistors directly, as far as ac is concerned, and obtain optimum power gain.

References

1 Principles of Transistor Circuits, R. F. Shea, J. Wiley & Sons, 1953
2 Transistor Audio Amplifiers, R. F. Shea, J. Wiley & Sons, 1955
3 Transistor Electronics, A. W. Lo et al., Prentice-Hall, 1955
4 "Active Four-Poles in Intermediate Terminal Connections," H. Beneking, *Archiv der elektr.* Uebertragung, September 1955
5 "High Frequency Amplification with Triodes," R. Cantz, *Telefunken Roehre,* 30, 1953.

Transistors in 1956

Norman B. Saunders
Circuit Engineering Consultant

PRICES have come down. This has meant more and more transistors have been used—3-1/2 million in 1955. Almost 2 million have been sold already in the first quarter of 1956. As transistorized products hit the market, competitors are forced to redesign their equipment and the demand for transistors rises sharply. Between 10 and 11 million are expected to be sold by transistor manufacturers in 1956 according to industry experts. From a technical viewpoint transistors have improved in quality. The current gain of alloy types now holds up for much higher current levels. The spread of characteristics within any one type has been narrowed. Further, several new general classes of transistors based upon application as well as structure have come about. Advances in the art of applied solid state physics such as "grown-diffused" units have been announced but are not yet available commercially.

The work on solid state diffusion and the advances in micro-techniques have been most significant. However no one technique for producing very-high-frequency transistors is ahead as of now. Perhaps this will come in the next year. The most important matter otherwise was the government's antitrust suit resulting in many A.T.&T. patents being made royalty free.

The price of transistors today extends from $0.50 for low-quality units in lots of hundred thousands (for toy use only), through $5 for computer units, and to $50 for new experimental units. The $1 special offered by the jobbers for the amateur is all too often so widespread in its characteristics from one to another as to lead to disgust with transistors. One manufacturer however sets and holds reasonable limits and puts them on the specification sheet supplied with the dollar transistor. Most others will probably follow suit this next year.

The long standing demand by radio manufacturers for transistors that approach tubes in cost is being met. Now a radio manufacturer is considering replacing a tube with a transistor on the basis of cost alone. At the beginning of the year some transistorized computer packages were found to be cheaper, all things considered, than the vacuum tube packages that they were replacing. A rough rule of thumb for today is that a transistor will cost about $1.00 for each unit of value measured as the product of *a* power dissipation in watts at 55°C, *b* frequency of alpha cut-off in megacyles, and *c* common emitter current gain. Improvement of these qualities has been impressing design engineers but this is not the entire story. The tetrode, which has a high figure of merit on the above basis, has been largely neglected. Tetrodes are proving desirable as r-f stages in all-band receivers.

The current gain of the alloy types has been sustained over longer periods by double emitter doping and other techniques so that power types with a current gain of 60 at 1 to 2amps are now obtainable. In the smaller deciwatt class, the sustained current gain now gives push-pull class B audio output up to more than 100mw with less than 5% distortion at any level. In the high frequency p-n-p's the current gain varies as little as between 60 and 80, for example, from tens of microamperes to tens of milliamperes collector current.

A year ago only one manufacturer offered standard units with a maximum current gain spread of as low as 2 to 1. Now it is almost mandatory to keep within that range. That same manufacturer is now offering units with $\pm 20\%$ current gain spread and even some rated at $\pm 10\%$. This achievement of closer tolerance units is more superficial rather than real. Production line units are simply divided into groups or types with smaller ranges, though the production spread is always being lowered. The problem is mostly one of designation and stocking of types.

Although the practice of dividing up production into more types is going on, the total number of types is increasing because users are demanding transistors with current gains as high as 200. The author predicts, however, that the maximally desired current gain will not go much beyond 100 because at 100 the common emitter input and output impedances are nearly equal. Note that the beta spreads now obtainable are comparable to the transconductance spreads in tubes.

Variation in external shapes structure is still much greater than that of tubes. In the near a watt class, the choice appears to be between the cartridge type with its large base ring contact, introduced last year, and a type about to be announced in which the leads come out at three corners of a square (one tenth inch on a side) protruding from the base. The overall package is derby-like in shape about 1" in diameter (with no pipe on top) and might go to one or two watts. Another factor in physical non-interchangeability is grounding of an electrode to the shell. This procedure is ideal for the particular circuit for which it was designed. It has given headaches to circuit designers who try to use the unit in other circuits. In the last year the tendency appeared to be toward such connection to the shell thus multiplying the already too large number of types.

How to Classify

Transistors seem to be fundamentally classifiable on the basis of power dissipation level. Power dissipation is proportional to size which, in turn, directly limits frequency response. This natural restriction on the number of basic types is partially offset by the occasional use of a low-power transistor structure in a shell of greater power handling capability or vice versa.

The choice of semiconducting material and further adaption of the transistor to application has resulted in a settling down to certain broad types and subdivision as follows:

Audio
a. General purpose
b. Low voltage
c. Low noise
d. Subminiature
e. Deciwatt
f. Watt

Computer
a. Low frequency
b. Medium frequency
c. High frequency
d. High voltage
e. Bidirectional

Radio
a. R-f
b. Mixer
c. I-f

Servo, Control, etc.
a. High impedance
b. High temperature

Special
a. Photo transistor
b. Avalanche
c. Hook collector
d. Point contact
e. Double-base diode
f. Field effect transistor
g. etc.

[This year's ELECTRONIC DESIGN Transistor Data Chart follows this general breakdown using as major heads, general-purpose, l-f; high-frequency and switching; power transistor and special units as photo transistors and tetrodes.] This breakdown shows about twenty natural classes most of which could be subdivided into about twenty-six sub-classes by dividing current gain into $\pm 20\%$ segments between the values of ten and two hundred (why not use standard color-coding to indicate current gain?). With transistors achieving clean and stable surfaces, a further breakdown into sub-sub-classes is probably superfluous. A classification along some scheme is urgently needed.

The low noise audio units will probably become of lesser importance as the noise level of all units con-

tinues to decrease and as more circuit designers become aware of the fact that collector voltage is a major factor determining circuit noise. The small size class is now led by the 0.160 x 0.130″ audio unit. This is an order of magnitude smaller than last year's smallest but is still an order of magnitude larger than need be. At the other extreme, power units are now available with 12w and 60v ratings. Auto radio use has forced standardization of the 2-w package which has been followed by price competition resulting in, to date, a price of $2.50 to set manufacturers. This trend has involved mostly germanium units. Silicon power units will have the fore next year.

Computer types continue to be sold to the customer's specifications. Each customer not only specifies different values but also different coefficients to be measured and his own way of measuring them. Lamp switching transistors are audio types of relatively low current gain, low collector cut-off current, and high collector voltage ratings and are now available in grown n-p-n and alloy p-n-p. Competition is such that a second manufacturer is producing alloy p-n-p bidirectional units even though no real market has been created as yet. There are several companies making the alloy n-p-n bidirectional units. Here there is a present demand because of the superior high frequency response. This type can be expected to take an increasingly larger share of the market.

The high-frequency alloy p-n-p is a staple item with more manufacturers entering the market. It is now also available with a restricted collector capacitance range for i-f work. The usable i-f gain is increased from perhaps 26 to 32 to 33db compared with the maximum available gain of 35db. The off capacitance units are sold as mixers. Selection by capacitance and gain had been offered last year by a grown junction manufacturer. This selection is fortunately being reduced. However the low capacitance units now supplied are obtained by a decrease in cross-section and hence are operated very near to thermal and electrical maximum.

Alloy silicon units are now available in the servo, or power class, to increase the designer's freedom in high impedance and high temperature circuits.

A photo-transistor with all three electrodes brought out is again available. Other special types continue to become available and improved upon. An emitter-to-base direct-coupled pair in one can is now available, but at five times the price of the equivalent transistors. When such construction, because of a saving of one header can and seal, results in a reduced price over separate transistors it will become more significant.

The basic data for this article is not necessarily complete since but about one fifth of the manufacturers were personally communicated with to get information. The statements and conclusions set forth are therefore the author's responsibility. Gratefulness is expressed to Frank Dukat and Nicholas DeWolf for their suggestions.

FOR ADVANCED-ENGINEERED

VR tubes

IT'S CBS

Have you an exacting requirement for stable voltage? Try the reliabilized CBS 6626 and 6627. There are no better VR tubes made. They represent the most advanced engineering concepts in gaseous voltage-regulator tubes. They eliminate sudden discrete voltage shifts in voltage-reference circuits.

It's only natural that CBS VR tubes should be the finest. CBS-Hytron specializes in VR tubes . . . has made over 20 millions of them. CBS-Hytron has originated many VR types; for example, the OB2, USN-OA2WA, USN-OB2WA, 6830, 6831 . . . as well as the 6626 and 6627. CBS-Hytron offers the widest line of 105-volt and 150-volt VR tubes: commercial and military . . . miniature and GT . . . for voltage regulation and voltage reference. And inquiries are solicited for production quantities of specialized VR types, like the flying-lead 6830 and 6831.

It makes good sense to think of CBS when you think of VR tubes. Be sure of up-to-the-minute design and tightly controlled quality. Follow the leaders, specify the leader. For stable, reliable, advanced-engineered VR tubes . . . always make it CBS.

Seen the new CBS VR Tube Manual? A complete, informative, easy-to-read eight pages. Includes data, theory, and application on voltage regulation and voltage reference. Write for free Bulletin E-267 today.

CBS-HYTRON, Danvers, Massachusetts

A Division of
Columbia Broadcasting System, Inc.

Transistor Contour Curves

including new surface barrier type

Keats A. Pullen, Jr.
Ballistic Research Laboratories
Aberdeen Proving Ground, Md.

CONDUCTANCE curve techniques, recently developed for data presentation of vacuum tubes, have also been found useful in transistor circuit design (ELECTRONIC DESIGN, July 1955, p. 22). Additional data has recently been compiled, with particular attention being given to grounded emitter characteristics. Included in this article are transistor contour curves using *g* parameters on the *SB-100*, *L-5117*, and the *2N96*. Also, an experimental curve using *h* parameters is included for the *2N96*.

Since a study of the conductance parameters satisfies the basic physical principles, this recent data is based on g_{11}, g_{22} and $g_c = g_{22} - g_{12}\, g_{21}/g_{22}$. One set of curves based on *h* parameters has been prepared.

The g parameters for grounded-base or grounded collector operation may be obtained from the grounded emitter data. A substitution may be made of appropriate combinations of parameters for the grounded emitter parameters in the amplification equation of the grounded emitter amplifier. The substitution is valid since the exact configuration of the transistor is not considered in the derivation of the equation. These substitutions are given in the accompanying table.

Analysis has shown that of the two frequency limit equations used with the transistor current gain, ω_α and $\omega_\beta, \omega_\alpha$ has special significance. The ω_β results from the finite base input impedance on transistors, and controls the frequency at which the input capacitance of the transistor must be considered. The current gain in tubes, as in transistors above ω_β, is inversely proportional to frequency.

The ω_α frequency is the frequency at which the input susceptance of the transistor equals the forward transconductance. The parameter α may therefore be defined as, approximately:

$$\alpha = \frac{g_{21}}{g_{21} + g_{11} + j\omega C_{11}}$$

Since only the g_{11} contains a large susceptance component, and $g_{11} << g_{21}$, follows that $\omega_\alpha = g_{21}/C_{11}$.

Amplification for a transistor operating in the grounded emitter connection Fig. 3, left, is given by Eq. 1, where K_e is the common emitter voltage gain, R_{in} is the series input resistance of the source and r_b' is the base spreading resistance.

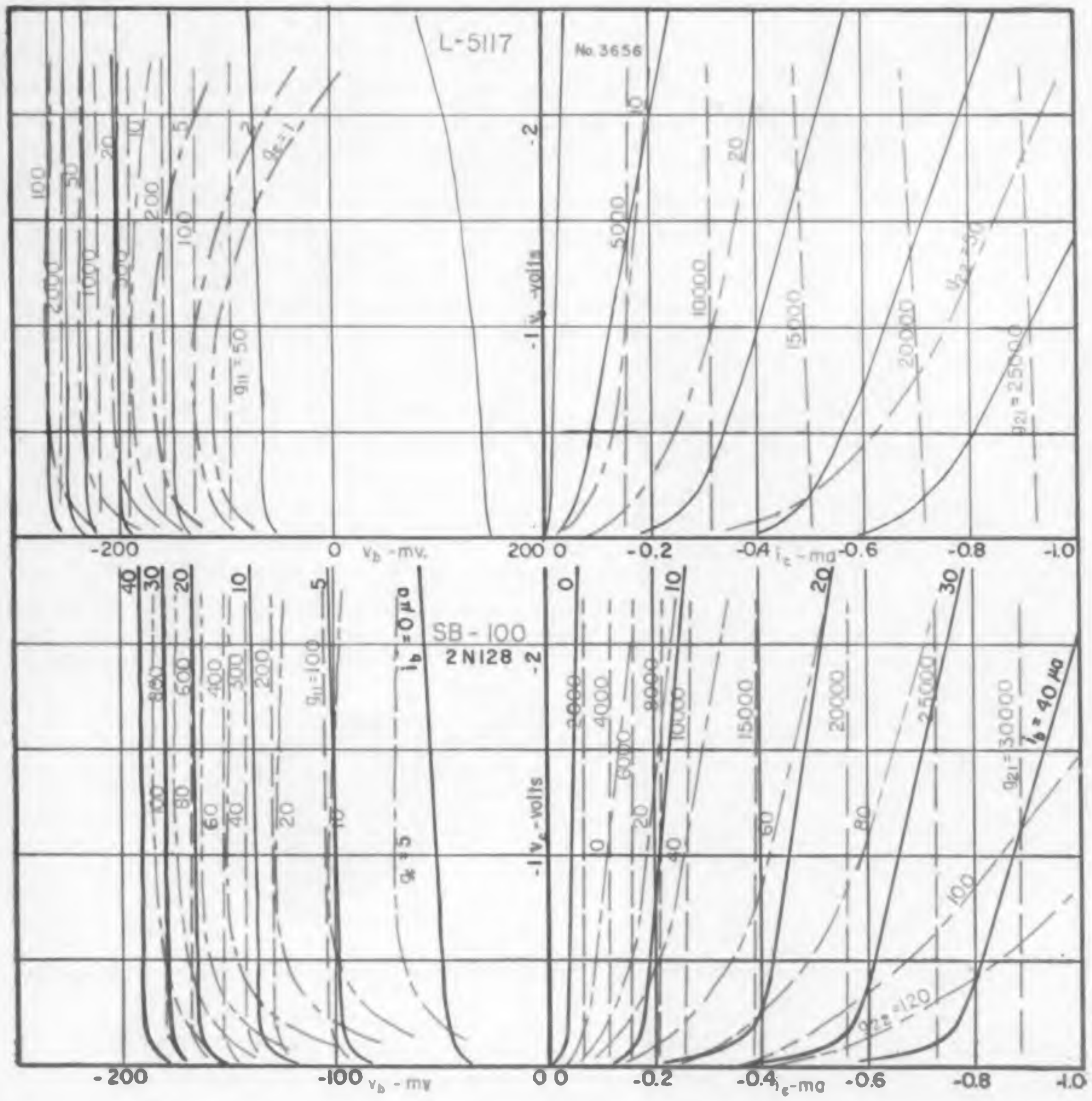


Fig. 1. Contour curves for *L-5117*, top, and *SB-100*, bottom.

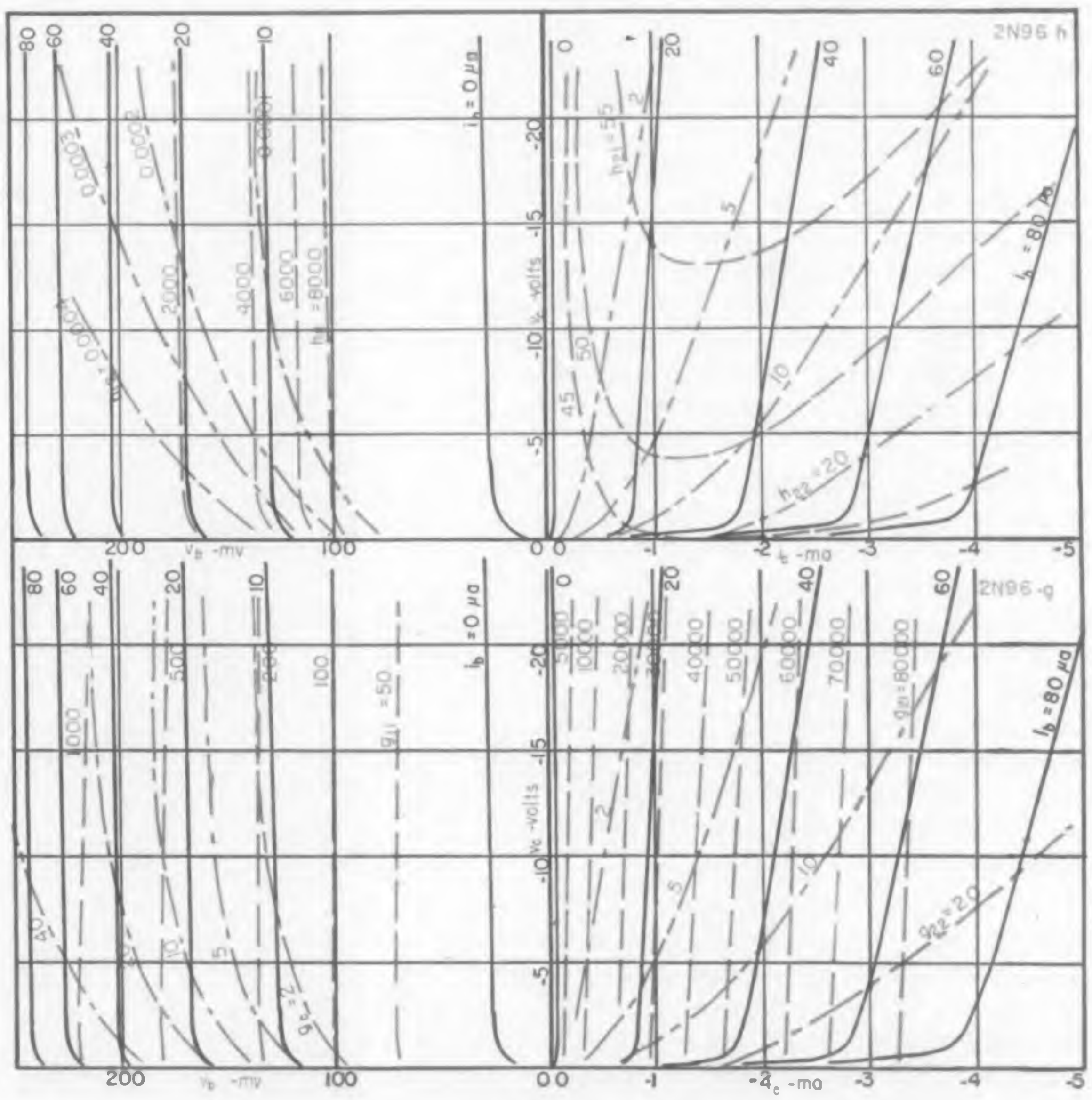


Fig. 2. Contour curves for *2N96* using *h* parameters, top, and g parameters, bottom.

Eq. 1 may be modified into Eq. 2 to include the effect of emitter degeneration, Fig. 3, right.

Calculation of the small-signal amplification of the transistor amplifiers in a completely analogous manner to the corresponding calculations for the tubes is possible using Eq. 1 and 2.

The first step in design is the selection of a supply voltage and a maximum collector current. The maximum collector current should be as small as possible, consistent with either power or impedance limitations. It should not, however, be small enough to make the variation of I_{co} important. Collector voltage should be selected to be between 1/5 and 3/5 maximum collector rating. Transformer-coupled amplifiers use the lower values, resistance-coupled the higher. Values of voltage and current should be adjusted to be consistent with any limitations on load resistance resulting from frequency response requirements.

After the supply voltage and load resistance (or maximum collector current) have been selected, the load line may be drawn on the collector family (right) of the chart. It connects the supply voltage point E_c and the maximum current point of I_c. Then the load line must be replotted on the emitter family (left) on the chart. This is accomplished by reading the E_e at each intersection between a base current contour and the load line on the right, and locating the corresponding points on the left. A curved line may then be sketched through the successive points.

After the two load lines have been plotted on the emitter and the collector families, the values of the small-signal parameters for the transistor at the respective intersections between the base current contour and the load lines may be tabulated. From these, amplification may be calculated directly. Distortion is then obtained from Eq. 3.

The input and output voltage conditions may be found from Eq. 4 and 5. Total input voltage change may be found by introducing first one extreme of the values of e_b, i_b and i_c, and the other. Total change in output may be found similarly.

Eq. 1 may be converted to the form required for either grounded-base or grounded collector operation by the use of the relations in the conversion table. To make certain that base spreading resistance, r_b' is taken into account, the equations may be rederived into Eq. 6 for the grounded base connection, and Eq. 7 for the grounded collector connection. The usual forms of the equations for triode grounded-grid or grounded-plate amplifiers are obtained by setting all g_{11} and r_b' equal to zero and g_c equal to g_{22}.

Input impedance for the general degenerative amplifier is given by Eq. 8. For emitter followers, R_L is zero; for ordinary amplifiers, R_e is zero. Eq. 9 is the ratio of the input conductances of the ordinary amplifier to that of the degenerative amplifier. With this equation, since values of g_{21} of about 0.03 are readily obtainable, an R_e as small as 100 ohms can reduce the input conductance of an amplifier to a quarter or less of that for the straight amplifier. As a consequence, construction of amplifiers using r-c coupling and stage gain of about 25db is possible, even when several amplifiers are coupled in a cascade.

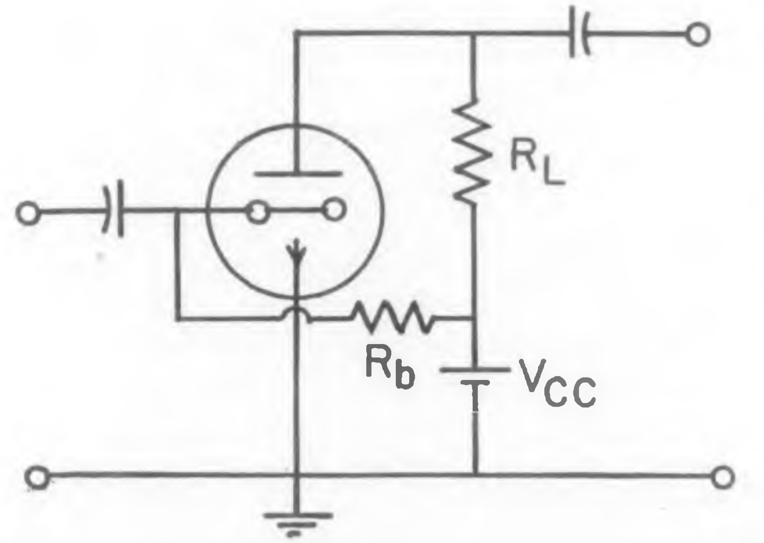
In several of the equations, g_{12} has been neglected when it appeared in the sum: $g_{11} + g_{12} + g_{21} + g_{22}$. Since g_{12} has a value near 10^{-7} compared to the values of g_{11} about 10^3, g_{21} about 10^2 and g_{22} about 10^5, it is evident that, unless a differencing occurs in the use of numbers, neglecting g_{12} is justified.

Sets of experimental curves on the 2N96 transistor, one set using g parameters, the second h parameters, have been prepared. Using the h parameters, voltage amplification is given by Eq. 10.

The main defect so far noted with Eq. 10 is the presence of the term $(h_{11}h_{22} - h_{12}h_{21})$ in the expression. Since the magnitude of $h_{11}h_{22}$ is nearly the same as $h_{12}h_{21}$, rather stringent requirements on the accuracy of measurement for the four components results. No such requirements are necessary with the g expressions, since the term $(g_{11}g_{22} - g_{12}g_{21})$ is measured directly in the form $g_{11}g_c$.

It would appear, therefore, that the h parameters should be modified if they are to have maximum usefulness. The modification would consist of using either $(h_{22}-h_{12}h_{21}/h_{11})$ or $(h_{11}-h_{12}h_{21}/h_{22})$ instead of h_{12} as is common practice.

Some loss of physical significance appears to result from the use of h parameters as compared to the g parameters. Also, some of the complications are introduced into the presentation of high-frequency characteristics when the h parameters are used. When these deficiencies are added to the comparative precision required of the basic data for the two systems, a tentative decision may be reached that the modified g parameters are probably better than the h parameters as currently used.



Equations used with Transistor Contour Curves

$$K = -\frac{g_{21} R_L}{1 + g_{11} (r_b' + r_{in}) + g_{22} R_L + g_{11} g_c (r_b' + R_{in}) R_L} \tag{1}$$

$$K_d = -\frac{R_L (g_{21} - g_{11} g_c R_e)}{1 + g_{11} (r_b' + R_{in}) + g_{11} + g_{21} + g_{22}) R_e + g_{22} R_L + g_{11} g_c \left[(r_b' + R_{in}) (R_e + R_L) + R_e R_L\right]} \tag{2}$$

$$D = 25 \frac{K_1 - K_2}{K_1 + K_2} \tag{3}$$

$$e_{in} = e_b + i_b R_{in} + (i_b + i_c) R_e \tag{4}$$

$$e_o = - i_c R_L \tag{5}$$

$$K_b = \frac{R_L (g_{21} + g_{22} + g_{11} g_c r_b')}{1 + (g_{21} + g_{22}) R_{in} + g_{22} R_L + g_{11} (r_b' + R_{in}) + g_{11} g_c (R_{in} + R_L) (r_b' + R_{in})} \tag{6}$$

$$K_e = \frac{R_e (g_{21} - g_{11} g_c R_e)}{1 + g_{11} (r_b' + R_{in}) - (g_{11} + g_{21} + g_{22}) R_e + g_{11} g_c (r_b' + R_{in}) R_e} \tag{7}$$

$$g_{in} = \frac{g_{11} \left[1 + g_c (R_e + R_L)\right]}{1 + g_{11} (r_b' + R_{in} + R_e) + (g_{21} + g_{22}) R_e + g_{22} R_L + g_{11} g_c \left[(r_b' + R_{in}) (R_e + R_L) + R_e R_L\right]} \tag{8}$$

$$\frac{g_{ie}}{g_{id}} = \frac{(g_{11} + g_{21} + g_{22}) R_e + g_{11} g_c \left[R_e (r_b' + R_{in}) + R_e R_L\right]}{1 + g_{11} (r_b' + R_{in}) + g_{22} R_L + g_{11} g_c (r_b' + R_{in}) R_L} + 1 \tag{9}$$

$$K = -\frac{h_{21} G_{in} R_L}{1 + h_{11} G_{in} + h_{22} R_L + G_{in} R_L (h_{11} h_{22} - h_{12} h_{21})} \tag{10}$$

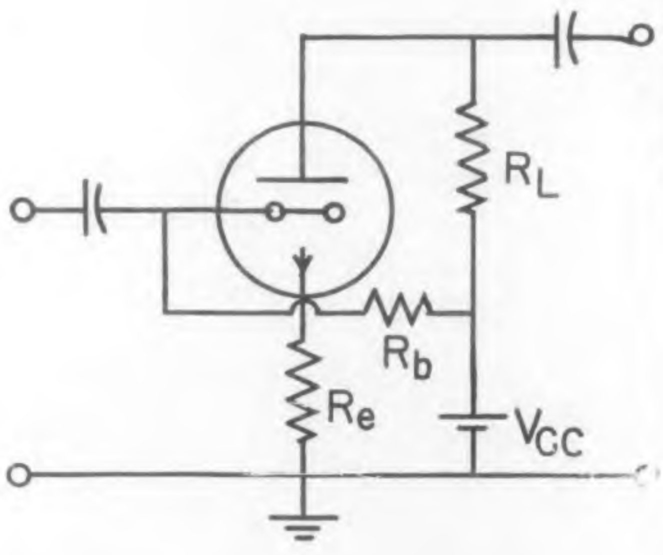


Fig. 3. Circuit, left, for measuring amplification of a transistor operating in the grounded emitter connection, and above, modification to include effect of emitter degeneration.

Table of Substitutions for finding grounded base and grounded collector parameter from grounded emitter parameters.

Grounded Emitter	Grounded Base	Grounded Collector
g_{11}	$g_{11}+g_{21}+g_{22}$	g_{11}
g_{21}	$-g_{21}-g_{22}$	$-g_{11}-g_{21}$
g_{22}	g_{22}	$g_{11}+g_{21}+g_{22}$
g_c	$\dfrac{g_{11}+g_c}{g_{11}+g_{21}}$	g_c

$$g_{12} = \frac{g_{11}}{g_{21}} (g_{22} - g_c)$$

ONE... or ONE THOUSAND

Safeway

WOVEN HEAT ELEMENTS

are specially made

to fit your individual needs

A Safeway representative writes, phones, or if possible, visits each customer before blueprints are drawn to ascertain that we have all essential information. As a result, every order, no matter how large or small, is filled according to individual specifications . . . tailor-made to meet your most exacting requirements.

An unceasing research program is further assurance that every unit produced by Safeway, the pioneer in woven heat elements, is keeping pace with development in industry.

Typical applications are for *helicopter rotors, aerial cameras, heated pipes, and propeller blades.* Many more include *heating and de-icing units in aircraft and a variety of heating elements for molds, dies, trays, tanks, ovens and dryers in industry.*

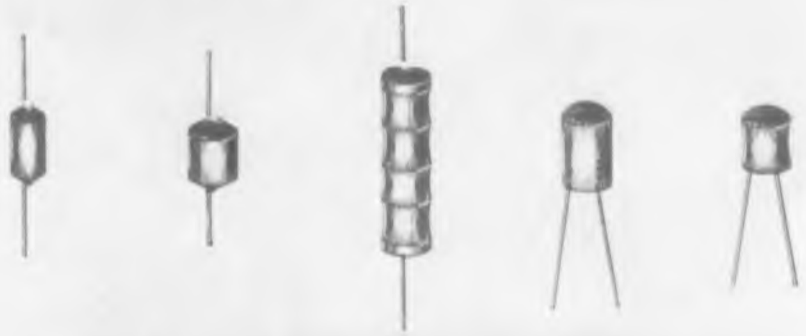
For your copy of a fact-filled folder, write to:

Safeway HEAT ELEMENTS INC.

680 NEWFIELD STREET • MIDDLETOWN, CONNECTICUT

CIRCLE 35 ON READER-SERVICE CARD FOR MORE INFORMATION

For maximum resistance in minimum space:



Daven's new winding technique cuts giants down to size

Inside these fully encapsulated miniature precision wire wound resistors, Daven furnishes the solution to problems presented by space limitations. A new winding technique permits the use of extremely fine sizes of resistance wire to obtain two or three times the resistance value previously supplied on a miniature bobbin. This new development more firmly establishes DAVEN'S leadership in the field of miniature and standard size precision wire wound resistors.

Types and Specifications

Type	Dia.	Length	Max. Res.	Wattage Rating	Terminals
1273	1/4	5/16	400K	.1	One End #22 Gauge
1283	1/4	5/16	400K	.1	Axial #22 Gauge
1274	3/16	3/8	100K	.1	Axial #22 Gauge
1284	1/4	27/64	.5 Meg.	.25	One end #20 Gauge
1192	1/4	1	1.0 Meg.	.75	Axial #22 Gauge

- Fully encapsulated.
- Meet and exceed all humidity, salt water immersion and cycling tests as specified in MIL-R-93A, Amendment 3.
- Operate at 125°C continuous power without de-rating.
- Can be obtained in tolerances as close as ± 0.05%.
- Standard temperature coefficient is ± 20PPM/°C. Special coefficients can be supplied on request.

Write for complete resistor catalog.

THE DAVEN CO.
524 West Mt. Pleasant Ave.
Route 10, Livingston, N. J.

WORLD'S LARGEST MANUFACTURER OF ATTENUATORS

CIRCLE 36 ON READER-SERVICE CARD FOR MORE INFORMATION

Transistorized

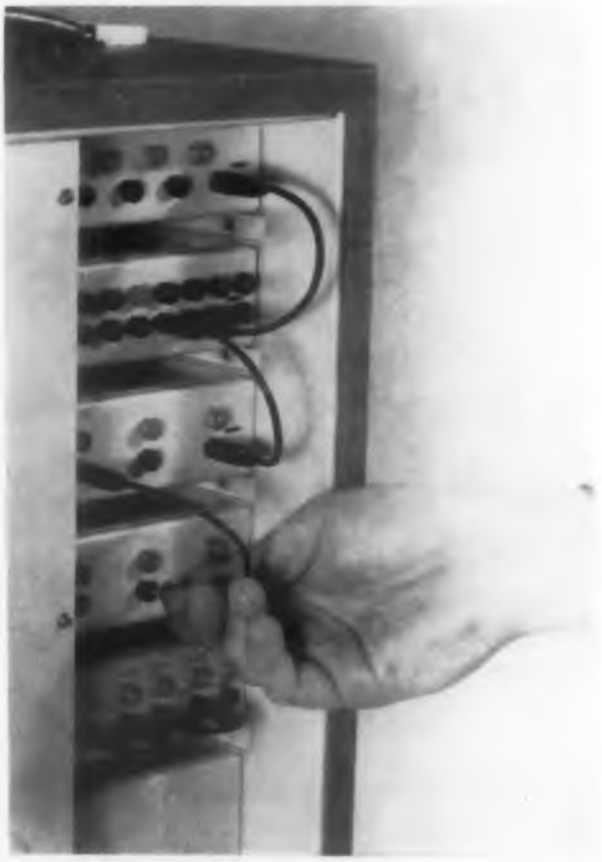
Pulse Programming

THIS transistorized pulse programming system is light enough and compact enough to be hand-carried and set on the laboratory work bench. It is designed for the development engineer who is working with transistor switching circuits, and magnetic core logic circuits: programmed pulses at the voltage and current levels that are required for driving transistorized circuits are provided. The system is made up on miniaturized building blocks. Power drain is low.

Probably most important of the design features of the 100A logic units, made by the Navigation Computer Corp., 29th & McKean Sts., Philadelphia, Pa. is the ease of programming them. All of the unit interconnections are made with small "patch board" plugs, at the rear of the cabinet, as illustrated. This simple means for interconnection is made possible by the use of very low impedance outputs, with careful control of ground currents. A miniaturized power supply is completely contained in the bench top cabinet, which is made to house up to twelve plug-in logic units. Since the power supply need only to provide two voltages, and a total of 15w, it allows an extremely simple test set-up.

Some of the most commonly used test set-ups are shown in the accompanying diagrams.

Diagram 1 shows the signal generator and the tri-delay unit being used to create a spaced pulse pair—such as may be used for driving magnetic core shift registers. One set of outputs are d-c coupled; going from 20 to 0v during the pulse duration. Hard tube constant current drivers, like the 6197, can be coupled directly to these outputs. Several of the triple delay units can be connected in series for the sweeping of magnetic core memory matrices. The individual variable delay sections can also be used for pulse standardization or inver-



Patching or programming is made at rear of units.

Equipment

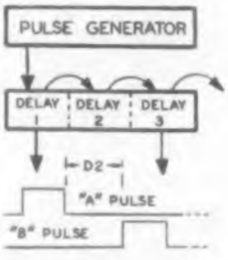
Bench-top pulse program equipment is made up of transistorized building block units.

sion, from low level trigger pulses of any shape.

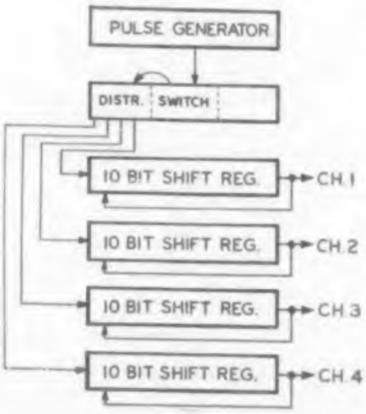
In diagram 2 the cycle distributor section of the programming unit is being used to alternately advance information from four indicating shift register units. The pulse program of "1"s and "0"s can be introduced from the front panel, and are visible in lights. High frequency clock pulses are turned on by the electronic switch to eliminate switch transient interference. The channels, which can be any multiple of 10 bits, are re-entered on themselves to perpetuate the pulse patterns.

The versatility of the building block units is shown further by the counting system in diagram 3. Here the indicating shift registers have been connected, cycle re-entrant, with the serial output being used as the advance pulse for each succeeding decade. With all the registers pre-set to "one"; they are connected in series with the "and" gate unit. An external gating pulse is used as one of the "and" gate inputs. Clock pulses from the pulse generator are then accurately counted and registered in the shift registers during the gating pulse period.

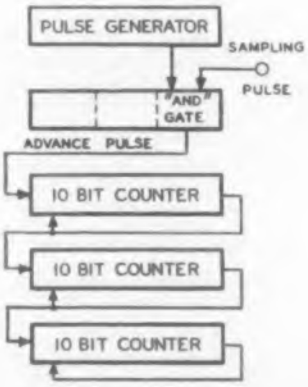
Some of the features of the new miniature units include: temperature compensation of all timing circuits; constant voltage low impedance outputs of both polarities for driving up to ten p-n-p or n-p-n transistor stages into the saturation; "hole clearing" pulses to accelerate fall time transients; and visual indication of pulse programming. For more information, turn to the Reader's Service Card and circle No. 37.



Producing a pair spaced pulses.



Sequenced cycle distribution.



Counting applications.

RADAR ANTENNA DEVICES

by Bendix

Advanced Design and Packaging Techniques Cut Down on Size and Weight

As you can see, we make a wide range of radar antenna devices, including an extremely small one that's classified. And, because of our vast experience in servo-mechanisms . . . and in latest packaging techniques . . . Bendix Radar Antenna Devices are *smaller* and *lighter*.

THE GROUND ANTENNA PEDESTAL (left) is air transportable. Total unit weight is *about half* that of previous models. Segmented parabolic reflector can be *quickly dismantled for transit*. Accuracy is 1.5 minutes at normal temperature and loading. Operational requirements cover ambient temperature range of $-65°$F. to $+150°$F. and wind loading up to 50 mph.

THE AIRBORNE WEATHER RADAR ANTENNA (right) is designed for circular azimuth scanning at 15 rpm on all modern commercial aircraft. Available in both X-band and C-band. 22″ X-band version weighs less than 25 lbs.

For complete details on our line of radar antenna devices, write Department E, ECLIPSE-PIONEER DIVISION, BENDIX AVIATION CORPORATION, TETERBORO, NEW JERSEY.

West Coast Offices: 117 E. Providencia Ave., Burbank, Calif.
Room 114, Administration Bldg., Boeing Field, Seattle 8, Washington
Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.

Eclipse-Pioneer DIVISION

Bendix AVIATION CORPORATION

CIRCLE 38 ON READER-SERVICE CARD FOR MORE INFORMATION

Designing Transistorized Test Equipment

T. E. Lommasson and K. D. Hardin

Quantum Electronics Inc.
Albuquerque, N. Mex.

REPLACING vacuum tubes with transistors requires particular consideration of temperature effects, drive and impedance matching requirements, and frequency response. Designing transistorized test equipment, especially equipment to test other transistors, often accents these problems. Some of the design problems encountered in the design of a small transistorized test set are discussed in this article.

Since the instrument was to be a piece of general purpose test equipment, also for the field man, it was desirable that only the most pertinent characteristics of a junction triode transistor were to be measured. These characteristics should indicate whether the transistor is good or bad, and furnish the operator with reliable quantitative data on how good or how bad, for most cases normally encountered.

Two measurements meet the above requirements: h_{21}, the short circuit current gain, and I_{co}, the base collector leakage current. By making these measurements, and properly interpreting them, most of the causes of failure of transistors may be detected. H_{21} or β, the short circuit current gain in the common emitter connection, is a small signal measurement which can be made with good resolution, and is a basic indication of how well a transistor is operating as a device.

Leakage current I_{co} across the base to collector junction when reverse biased by a d-c voltage is a measure of the material properties of a transistor, the care with which it was manufactured and the ease with which it may be applied to circuitry. Measurement of I_{co} is made by simple d-c techniques and involves no particular problem.

Measurement of h_{21}

Short circuit current gain, h_{21e}, may be measured to an approximation as the ratio of a small change in collector current to the change in base current causing it. The smaller the base current swing, the nearer the conditions for measurement of true h_{21e} are approached. In the design of this transistor test instrument, a peak-to-peak base current swing of approximately 5μa was chosen for the lowest h_{21e} meter scale. As the full-scale readings increase in value, the input current swing decreases, and may become as small as 0.25μa peak-to-peak on the highest range. Smallest signal swing feasible, Fig. 1, must be used to avoid an "integrated" h_{21e} reading. With small signal swings, the shape of the h_{21e} vs I_e curve can be easily ascertained.

Errors caused by measuring values on two h_{21e} vs I_e curves of different shapes, but with the same h_{21e} at a common test point are avoided using measurements made with small signal swings.

A second condition to be met in measuring h_{21e} is that the d-c collector voltage remain constant for changes in current through the source. In other words, the a-c impedance of the supply should be zero ohms. Practically, it is possible to lower this value to less than one ohm by the use of large electrolytic by-pass capacitors. Collector current swing must be measured. Therefore, series collector circuit impedance must be added for the current to develop a measurable voltage swing. This value should be kept as low as possible, certainly less than 100 ohms. With an R_L of 100 ohms and the transistor's output admittance of 400×10^{-6} mhos, as sometimes occurs in common emitter connection of high gain transistors, an approximate error of 4% is realized from this source alone.

The 100 ohm a-c load in the collector circuit of the test transistor should be as nearly zero ohms to d-c as possible. Any d-c drop due to collector current flowing through the load gives rise to an actual collector voltage operating point which is dependent upon the I_e bias chosen for the measurement. As h_{21e} is voltage sensitive in some transistors, this situation is undesirable. Use of a transformer to couple the signal from the collector circuit to the metering amplifiers, Fig. 2, avoids this difficulty.

Proper a-c collector load conditions must be estab-

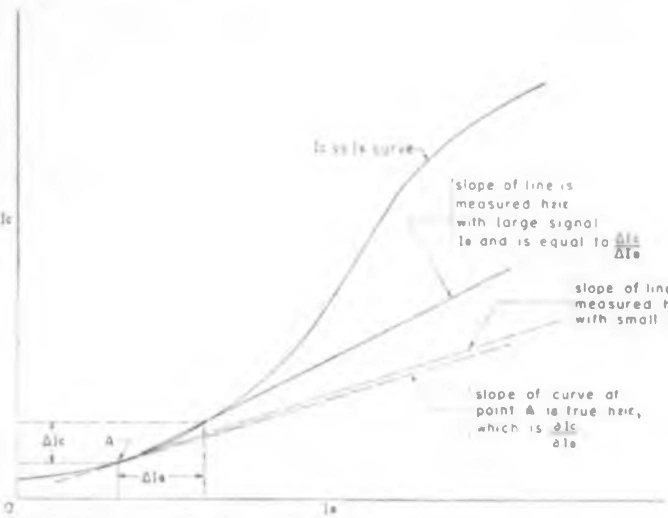


Fig. 1. Base current vs short circuit current gain for a typical junction triode transistor. Smaller base current swings result in reduced error in h_{21e} measurement.

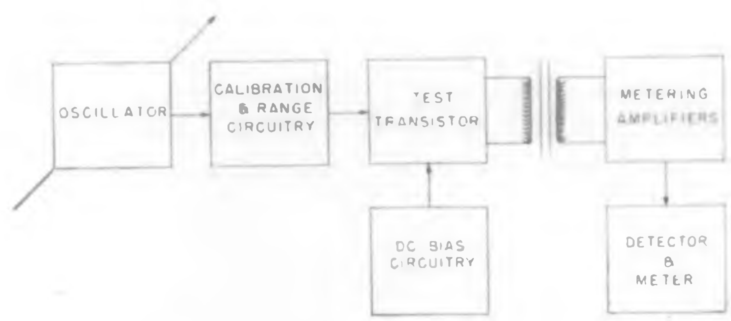


Fig. 2. Block diagram of ihe transistorized transistor tester.

Definitions of Common Emitter Hybrid Parameters

h_{11e} = Input impedance with output shorted.

h_{12e} = Reverse open-circuit voltage amplification factor.

h_{21e} = Forward short-circuit current amplification factor.

h_{22e} = Output admittance with input open.

lished through the transformer. Input impedance of the first amplifier stage must be controlled to an allowable maximum, which means that a controlling specification must be placed on the h_{21b} and h_{11b} of this transistor. Otherwise, a high h_{11b} and h_{21b} transistor could cause several hundred ohms or more to appear as reflected load in the collector circuit, causing appreciable measurement error.

Calibration

Transistor oscillator output voltage, Fig. 2, is made variable so that the instrument may be calibrated before use. Calibration consists of adjusting the meter to full scale. This calibration-range determination allows expansion of the ranges to any desired full scale h_{21e} reading between 50 and 1000 merely by changing the calibration procedure.

Oscillator waveform must be amplitude stable with time, at a given temperature. This can be accomplished using known approaches in oscillator design, but care must be taken to provide enough feedback margin so the oscillator will function properly over wide temperature and battery voltage ranges.

Calibration and range determination circuitry must, by the definition of h_{21e}, by high impedance circuitry so that I_b is independent of the test transistor input impedance. The effective signal source impedance must be high compared to the input impedance of the test transistor. Care must be taken to minimize the effects of capacity across the signal source impedance. Shunt capacitance to ground from the base terminal of the test transistor is less of a problem, unless the input impedance of the test transistor is unusually high. Very high-gain transistors with h_{21e} in the neighborhood of 500 or more may exhibit input impedances in the test circuit of 40,000 ohms or more.

One requirement of the bias circuit arrangement is that it shunt a minimum of the signal away from the test transistor input terminals. Fortunately, high input impedance test transistors nearly always exhibit high gain, a condition making it easy to meet the requirement of a high-impedance bias circuit.

Calibration and range determination circuitry, metering circuit amplifiers, detector, and meter were required to be linear to well within the desired limits of accuracy for the instrument. Amplifier circuits using a-c and d-c degeneration were found to yield good linearity. Care must be taken not to operate too far down on the nonlinear portion of the detector characteristic, as error becomes appreciable in this region. The meter movement itself, must, of course, be linear within narrow limits.

Amplifier circuits are Class A, while the detector is a peak-to-peak circuit. Peak-to-peak swing is preserved from test transistor input to the meter presentation. This technique essentially removes possible sources of error due to curvature of I_e vs I_b curve causing waveform distortion, and error in measuring only one-half of the resultant non-symmetrical waveform.

New Products

R-F Q-Meter

Has Overload-Proof Indicator

The new Q-Meter, Model T-1, incorporates an overload-proof VTVM indicator. This instrument provides a convenient method for making r-f measurements of Q, inductance, capacitance, and power factor at frequencies between 100Mc, in six frequency ranges.

Outstanding specifications of the model T-1 are: oscillator frequency: 100kc to 100Mc, accurate to ±1%; vernier capacitor: calibration, ±2.5μμfd; Q: two ranges: 10 to 100, and 40 to 400, ±5% (+5% FSD); accuracy of inductance measurement: ±5% (Residual inductance, 0.03uh); power supply; 117v, 60cy a-c, 20w.

Fisher Radio Sales Co., Inc., Dept. ED, 21-21 44th Dr., Long Island City, N. Y.

CIRCLE 40 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Transistors

For 12 and 28v Operation

Six new germanium power transistors are available for handling up to 20w input. The transistors are p-n-p power junction type, and were originally developed to meet U. S. Signal Corps specifications. Types are available for nominal 12 and 28v operation, making them suitable for direct use in battery powered equipment.

They are particularly suitable for class A operation in the audio output stage of automobile radios. The collector is electrically connected to the metal housing, but where it must be insulated from the chassis, a large mounting flange permits rapid heat flow through the insulating material.

Clevite Transistor Products, Dept. ED, 241 Crescent St., Waltham 54, Mass.

CIRCLE 41 ON READER-SERVICE CARD FOR MORE INFORMATION

Miniature Pulse Transformers

For Service From −70 To +130° C

This is a new series of miniature pulse transformers hermetically sealed by the vacuum mold epoxy process. These units are suited to a wide variety of blocking oscillator, interstage, and low level modulator applications. They are designed for service from −70 to +130°C and fully meet MIL-T-27 specifications.

Thirteen types cover the range from 0.05 to 25μsec pulse width with exceptionally low rise time. All units are three winding 1:1:1 for maximum flexibility of application.

United Transformer Co., Dept. ED, 150 Varick St., New York, N. Y.

CIRCLE 42 ON READER-SERVICE CARD FOR MORE INFORMATION

Miniature Power Resistor

In Die-Cast Aluminum Housing

Type RH-250 miniature power resistor is made with a die-cast aluminum housing. Small in size and made in accordance to applicable JAN and MIL specifications, the three resistors are completely welded from terminal to terminal and are silicone sealed inside the black anodized radiator finned housing. They are 100% impervious to moisture and salt spray.

They have a temperature coefficient of 0.00002/°C and are available in tolerances of 0.05% to 5%. The RH-25 resistor has resistance values of 0.1 ohm to 15,500 ohms; the RH-50 has resistance values of 0.3 ohm to 55,000 ohms; and the RH-250 has resistance values of 0.3 ohm to 35,000 ohms.

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

CIRCLE 43 ON READER-SERVICE CARD FOR MORE INFORMATION

Transistorized Power Supplies

High Conversion Efficiency

The Series 50T, 100T, 200T power supplies are semi-conductor, transistorized, regulated power supplies which are intended to replace vacuum tube equivalents wherever used. These transistorized units feature high conversion efficiency, light weight and small size, instant warm-up time, freedom from microphonics, low heat dissipation, and continuous output voltage adjustment, zero-max.

The units are designed for all regulated voltage applications including laboratory experimentation, incorporation into equipment, and general industrial use.

Electronic Research Assoc., Inc., Dept. ED, Nutley, N. J.

CIRCLE 44 ON READER-SERVICE CARD FOR MORE INFORMATION

Delay Lines

In Four Delay Times

This is a series of standard delay lines available from stock, presently manufactured in four delay times of 0.5, 0.25, 0.1, 0.05 μsec. Any number of these lines may be used in series to provide any given delay for either laboratory or production use.

The building block technique permits a flexibility of immediate assembly for special and changing requirements. The delay lines are available in several impedance levels and several tolerance groupings.

Essex Electronics, Dept. ED, Berkeley Heights, N. J.

CIRCLE 45 ON READER-SERVICE CARD FOR MORE INFORMATION

4-Position Switch

For Airborne and Other Applications

This is a new momentary switch which actuates 4 separate spdt contacts. Designed primarily for use as an up-down right-left control for airborne systems, type S1001's versatility will permit many other applications.

A spring-centered, dynamically balanced toggle lever is employed to actuate the 4 snap-action switches, located at 90° to each other. Radial movement of the lever up, down, left, or right engages the corresponding snap switch without affecting the three others. Similar motion in any other quadrant will actuate the switch located in a corresponding direction. Release of the lever automatically returns all four switches to their normal closed position.

The entire unit has been designed to meet stringent military specifications for shock, vibration and environmental conditions. Dimensions of the assembly are 1-5/16″ sq, 2-1/2″ deep with the toggle lever protruding 1-3/8″. Contact rating is 5amp at 250v a-c and 4amp at 30v d-c. The 12 stud terminals are plated for ease of soldering.

Marsh-Theiss, Inc., Dept. ED, 184 New York Ave., Huntington, L. I., N. Y.

CIRCLE 46 ON READER-SERVICE CARD FOR MORE INFORMATION

Test Probe

Used With Cathode-Ray Oscillographs

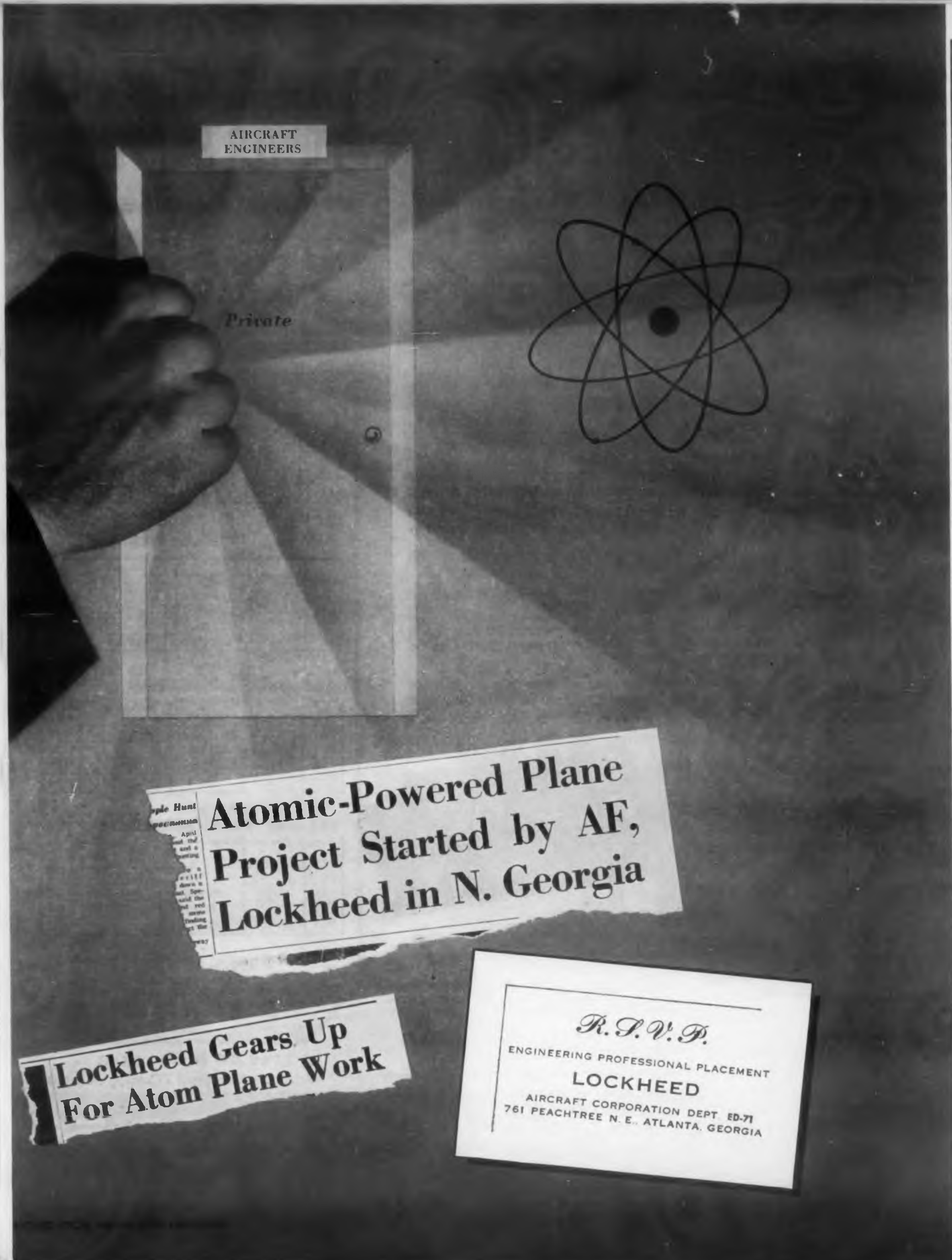
A fixed-ratio test probe has been developed which permits observation of signals in circuits with high source impedance without loading the circuit. Together with the probe, a 3″ rubber viewing hood for cathode-ray oscillographs is available.

Offering 10 megohms input impedance, the type 2613 fixed-ratio test probe has a frequency range from d-c to 10Mc/sec. The attenuation ratio is 10 to 1.

A capacitive trimmer adjustment on the probe permits frequency compensation by matching input impedances of oscillographs having inputs within the range of 10 to 80μμf.

Allen B. DuMont Labs., Inc., Dept. ED, 760 Bloomfield Ave., Clifton, N. J.

CIRCLE 47 ON READER-SERVICE CARD FOR MORE INFORMATION



Tubular Heaters

With Ceramic-To-Metal Seal

This new ceramic-to-metal seal on tubular and tubular finned heaters offers hermetic protection against moisture and fumes. The seal consists of impervious alumina ceramic. A special process bonds the ceramic to the metal parts, and the entire seal is brazed to the tubular sheath. Because the expansion coefficient of the ceramic matches that of the metal parts, the seal flexes with the metal as it heats.

The seal is designed to prevent contact of oil, moisture, carbonaceous fumes, halogen gases, and other chemical fumes with the heating element. It is recommended for use in temperatures up to 750°F in air and 1000°F in inert atmospheres.

The seal will withstand up to 4000-psi, liquid pressure. Torque resistance in the 0.315" diam heater is rated up to 35 in lb, and up to 75 in lb on the 0.496" diam heater.

General Electric Co., Dept. ED, Schenectady 5, N.Y.

CIRCLE 49 ON READER-SERVICE CARD

TV Check Tube

Parallel-Mounted Electron Gun

This is a versatile new TV receiver check tube which can be used to test virtually any TV receiver or picture tube from 10 to 27". Designated the *8XP4*, the tube is an 8-1/2" rectangular tube featuring automatic self-focusing and parallel-mounted electron gun, thereby eliminating the need for an ion trap.

The *8XP4* has automatic self-focusing, eliminating the need for external focusing adjustments. The tube may be used in receivers designed for either magnetic or electrostatic focus picture tubes. It may be used in almost any electromagnetically deflected receiver, regardless of the deflection angle of the tube for which the receiver was designed.

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

CIRCLE 50 ON READER-SERVICE CARD

Transistor Data Chart

General Purpose, Low Frequency

Manufacturer and Type	Class and Application	Maximum Ratings W_c (mw)	T_j (C)	(a)mw/C (b)C/mw	V_c (volts)	I_c (ma)
Amperex Electronic Corp., Hicksville, N. Y.						
OC65	p-n-p fused, submin. hearing aid	35	65	0.65 (b)	−10	10
OC66	p-n-p fused, submin. hearing aid	35	65	0.65 (b)	−10	
OC70	p-n-p fused, hearing aid	50	60	0.4 (b)	−15	
OC71	p-n-p fused, hearing aid	50	60		−15	
OC73	p-n-p fused, audio, high tol.	100	65		−30	
Z-OC72	p-n-p fused, audio, matched pr.	100[1]	65	0.3 (b)	−18	125
CBS - Hytron, Danvers, Mass.						
2N180	p-n-p alloy, audio	150	75		−30	
2N181	p-n-p alloy, audio	250	75		−30	
Clevite Transitor Prod., Waltham, Mass.						
1032, 1320[2]	p-n-p alloy, audio	50	55		−25	40
1033, 1330[2]	p-n-p alloy, audio					
1034, 1340[2]	p-n-p alloy, audio					
1035, 1350[2]	p-n-p alloy, audio					
1036, 1360[2]	p-n-p alloy, audio					
General Electric Co., Syracuse, N. Y.						
2N43	p-n-p fused, audio	150	100		−45	50
2N43A[4]	p-n-p fused, audio			2.0 (a)		
2N44	p-n-p fused, audio					
2N44A[4]	p-n-p fused, audio					
2N45	p-n-p fused, audio					
2N186	p-n-p fused, audio output[5]	200	85		−25	
2N186A	p-n-p fused, audio output[5]	75		1.33 (a)		
2N187	p-n-p fused, audio output[5]	200				
2N187A	p-n-p fused, audio output[5]	75				
2N188	p-n-p fused, audio output[5]	200				
2N189	p-n-p fused, audio driver	75				
2N190	p-n-p fused, audio driver					
2N191	p-n-p fused, audio driver					
2N192	p-n-p fused, audio driver					
ZJ12	n-p-n silicon, hi-temp amp.	150	200		45	30
General Transitor Corp., Richmond Hill, N. Y.						
GT14/2N63	p-n-p alloy, audio	125	85	3.5 (a)	−25	
GT14H/2N130	p-n-p alloy, audio[2]	90		2.8 (a)	−12	
GT20/2N64	p-n-p alloy, audio	125		3.5 (a)	−25	
GT20H/2N131	p-n-p alloy, audio[2]	90		2.8 (a)	−12	
GT24H/2N133	p-n-p alloy, audio[2]	90		2.8 (a)	−12	
GT34/2N38A	p-n-p alloy, audio	125		3.5 (a)	−25	
GT81/2N65	p-n-p alloy, audio	125		3.5 (a)	−25	
GT81H/2N132	p-n-p alloy, audio[2]	90		2.8 (a)	−12	
GT109/2N109	p-n-p alloy, audio p-p[6]	125		3.5 (a)	−25	
GT222/2N107	p-n-p alloy, audio	90		2.8 (a)	−12	
Hughes Aircraft Co., Culver City, Calif.						
HA5001	n-p-n alloy, med. pwr. amp. and sw.	500	85	8.3 (a)	30	100
HA5002	n-p-n alloy, med. pwr. amp. and sw.				20	
HA5003	n-p-n alloy, med. pwr. amp. and sw.				30	
HA5011	n-p-n alloy, med. pwr. amp. and sw.				40	
HA5014	n-p-n alloy, med. pwr. amp. and sw.				40	
National Aircraft Corp., Burbank, Calif.						
J1	p-n-p alloy, low power audio	150	55		−40	10
P21	p-n-p alloy, low power audio	350	55		−40	50
Nucleonics Products Co., Inc., L. A., Calif.						
OC32/320[2]	p-n-p alloy, audio	50[25]			−25[25]	10
OC33/330[2]	p-n-p alloy, audio					
OC34/330[2]	p-n-p alloy, audio					
OC360	p-n-p alloy, submin. audio	35			−20	
GFT20	p-n-p alloy, audio	50[25]			−7.5	10
Philco Corp., Philadelphia, Pa.						
2N47	p-n-p alloy, low power audio	50	65		−35	20
2N49	p-n-p alloy, low power audio	50	65			
2N207	p-n-p alloy, low power audio[2]	25		0.7 (b)	−20	
2N207A	p-n-p alloy, low power audio[2]					

Characteristics				
β or α	I_{co} (μa)	NF (db)	C_c (μμf)	f_{co} (Mc)
30	5	9		9
47	4.5	9		9
30	5	10		10
47	4.5			
40	3.5			
55	4.5	12		12
60	10			0.7
60	10			0.7
9-16	10	<12		0.6
16-32				0.8
32-50				1.0
50-72				1.2
72 min.				1.2
54	16[3]	10	40	1.5
40				1.0
23				0.8
23				0.8
12				0.7
24	16			0.8
24				
36				1.0
36				1.0
54				1.2
24		15		0.8
36				1.0
54				1.2
75				1.5
20	0.01	20	15	6.0
28	6	16		
28		12		
45		16		
45		12		
30		12		
15		16		
90		16		
		12		
		16		
20	15	30		
39	10	35		2.0
19	20	18		0.5
39	15	18		1.0
	20	35		1.0
	20	35		2.0
65	15			0.4
25				0.2
0.94	6	17		0.6
0.97		17		0.8
>0.97		17		1.1
>0.95		9		0.8
25	5	<20		0.8
40	10	10		0.8
40		5		
65		12		
		7		

Transistor

PICKING the proper transistor for a particular circuit is a difficult job. We have selected the most significant guides for evaluating transistors based on information available to us, consistent with making a convenient-to-use chart. The extent to which this data can be relied upon will be discussed briefly in the following paragraphs.

Transistor type numbers are no help, and actually confusing, as different manufacturers use groups of numbers differently. For example, one manufacturer may use a consecutive block of numbers to describe transistors (of the same production run) with different betas. Another may use the difference between *2N180* and *2N181*, for example, to refer to different collector dissipation ratings, betas being the same. Likewise, numbering may be based on frequency of alpha cutoff instead. RETMA numbers are no reliable guide to similar transistors since almost any transistor can be registered. If it is not clearly identical with the previously registered type, it is quite likely a new number will be assigned.

Maximum ratings are more reliable guides than average or typical values since the spread of, for example, beta, or frequency of cutoff for any given production line varies widely. Some manufacturers show the design center and the maximum and minimum values of these spreads, and thus render a real service to the designer. Test setup used to determine such values as I_{co} and noise are specified. Unfortunately some data sheets have only wishful data on them. In any event, manufacturers data should be consulted for all possible clues as to how transistors are rated. No comprehensive transistor data chart can list all explanatory notes without becoming so unwieldly as to be virtually worthless. For that reason we are presenting mainly types being made by various manufacturers and the most significant characteristics.

Footnotes

1. With heat sink.
2. Subminiature.
3. Measured at 45v.
4. Military approved.
5. Matching not required for class B push-pull.
6. Matched pair.
7. Push-pull Class B, 160mw both units. Large signal B given.
8. Maximum.
9. Typical operating conditions.
10. At 150° C, I_{co} is 50μa.
11. Military use only, generally rated at 60° C.
12. Power gain approx. 30db at 455kc.

Data Chart

How This Year's Chart is Organized

Transistors are divided into the following tables: General Purpose, L-F; High Frequency, Switching; Power; and Tetrodes and Photo Transistors. Only data which is most helpful in determining the difference between types is listed. W_c, beta, or current gain, and frequency of alpha cutoff are entered next to vertical rules so that the eye can spot them quickly. The fact that transistor ratings vary with temperature is highly significant, especially to designers accustomed to working with vacuum tubes which, within limits, are insensitive to temperature variations. For this reason maximum junction temperature and a derating gradient is given.

The fundamental structure of transistors determines maximum power ratings and frequency and is a basic guide to classification. Beta is largely determined by the manufacturing technique and varies more than any other characteristic. I_{co}, and noise factor are indications of overall quality. C_c, related to structure—alloy, grown, fused, etc., and external configuration determines how well the transistor will behave at high frequency.

Ratings, as mentioned depend on the testing conditions. Maximum collector dissipation is generally at 25° C, I_{co} at 6 to 12v reverse bias unless otherwise noted. Always bear in mind that values for characteristics are average, and the spread may vary tremendously. Most of the characteristics were specified for common emitter connection, collector voltage in the vicinity of -6v, emitter current 1 ma. Notable exceptions are hearing air types and auto radio and other power types which were rated at a lower and higher V_c, respectively. Noise figure (NF) generally refers to a one frequency (mostly 1Kc) measurement. C_c was measured at average collector voltage.

General Purpose, Low Frequency

Manufacturer and Type	Class and Application	Maximum Ratings					Characteristics				
		W_c (mw)	T_j (C)	(a)mw/C (b)C/mw	V_c (volts)	I_c (ma)	β or α	I_{co} (μa)	NF (db)	C_c ($\mu\mu f$)	f_{co} (Mc)
Philco Corp., (continued)											
2N207B	p-n-p alloy, low power audio[2]	25	65	0.7 (b)		20	65	10	3		0.8
2N223	p-n-p alloy, audio driver	100	65	0.2 (b)	−18	60	60	20	10		0.8
2N224, 2N225[6]	p-n-p alloy, audio out, p-p	│	│	│	−25	150	60	50			0.2
2N226, 2N227[6]	p-n-p alloy, audio out, p-p	│	│	│	−25	150	35	50			0.2
Radio Corp. of America, Harrison, N. J.											
2N77	p-n-p fused, low power audio	35	50		−25	15	55	10	6.5		0.7
2N104	p-n-p fused, low power audio	50	70	0.4 (b)	−30	50	44	10	6.5		0.7
2N105	p-n-p fused, low power audio	35	50		−25	15	55	5	7.5		0.75
2N109	p-n-p fused, low power audio	50[7]	│		−25	70	70[7]				
2N175	p-n-p fused, audio preamp.	20	│		−10	2	65	12	6[8]		0.85
Radio Dev. & Research Corp. (Germanium Prod.) Jersey City 4, N. J.											
2N97	n-p-n grown, audio	50	75	2 (a)	30	10	15	2	15	14	1.0
2N98	n-p-n grown, audio	│	│	│	40	│	40	│	│	10	2.0
2N99	n-p-n grown, audio and switching	│	│	│	40	│	40	│	│	10	3.5
Raytheon Mfg. Co., Newton, Mass.											
2N63	p-n-p fused, audio	160	85	2.7 (a)	−22	10	22	6	25	800	0.6
2N64	p-n-p fused, audio	│	│	│	−15	│	45	│	22	1700	0.8
2N65	p-n-p fused, audio	│	│	│	−12	│	90	│	20	3000	1.2
2N106	p-n-p fused, audio preamp..	│	│	│	−6	│	45	│	6[8]	1700	0.8
2N130	p-n-p fused, audio[2]	130	│	2.2 (a)	−22	│	22	│	25	800	0.6
2N131	p-n-p fused, audio[2]	│	│	│	−15	│	45	│	22	1700	0.8
2N132	p-n-p fused, audio[2]	│	│	│	−12	│	90	│	20	3000	1.2
2N133	p-n-p fused, audio preamp.[2]	│	│	│	−15	│	45	│	10	1700	0.8
2N138	p-n-p fused, audio output[2, 6]	│	│	│	−12	20		│			
CK790	p-n-p silicon, audio	200	150	2.0 (a)	−45	50	24	0.2	18	30	0.3
CK791	p-n-p silicon, audio	│	│	│	−30	│	45	│	18	│	0.45
CK793	p-n-p silicon, audio preamp.	│	│	│	−30	│	30	│	13	│	0.4
Sylvania Electric Products, Inc., Woburn, Mass.											
2N34	p-n-p fused, audio	50	75	1.0 (a)	−40	50	0.975	−10	20	35	0.8
2N35	n-p-n fused, audio	│	│	│	40	│	0.975	10	│	35	│
2N213	n-p-n fused, audio driver	│	│	│	25	│	40	200[3]	│		│
2N214	n-p-n fused, audio output	125	│	│	│	│	70	200[3]	│		│
2N228	n-p-n fused, audio output	125	│	│	│	│	70	300[3]	│		│
Texas Instruments, Inc., Dallas 9, Tex.											
2N185	p-n-p alloy, audio p-p	150	50		−20	−150	55	−8			
300	p-n-p alloy, audio	100	75	0.5 (b)	−30	50	0.95	−8	25		0.7
301	p-n-p alloy, audio	│	75	│	│	│	0.98	│	22		1.0
302	p-n-p alloy, audio	│	75	│	│	│	0.98	│	20		1.3
310	p-n-p alloy, audio driver	2[9]	60		−20			│			
903	n-p-n grown silicon, audio	150	150		30	25	0.925	1.0[10]	25	8	4.0
904	n-p-n grown silicon, audio	│	│		│	│	0.96	│	│	8	5.0
904A	n-p-n grown silicon, audio	│	│		│	│	0.975	│	│	5	8.0
9052/N119	n-p-n grown silicon, audio	│	│		│	│	0.980	│	20	6	6.0
Transitron Electronic Corp., Melrose, Mass.											
2N43	p-n-p fused, audio	150	85		−45	50	50	−4	20	40	0.8
2N44	p-n-p fused, audio	│	│		│	│	22	−4	22	│	0.5
2N45	p-n-p fused, audio	│	│		│	│	12	−4	22	│	0.4
2N195	p-n-p fused, audio	100	│	3.0 (a)	−15	30	180	−3	10	│	1.0
2N196	p-n-p fused, audio	│	│	│	│	│	65	−5	18	│	0.8
2N197	p-n-p fused, audio	│	│	│	│	│	50	│	10	│	0.7
2N198	p-n-p fused, audio	│	│	│	−30	│	40	│	18	│	0.6
2N199	p-n-p fused, audio	│	│	│	−30	│	25	│	20	│	0.5
2N200[4]	p-n-p fused, audio	│	│	5.0 (a)	−36	100	45	−4	12	│	1.0
2N204	p-n-p fused, hi reliability	│	│	│	│	│	80	│	12	│	1.2
2N205	p-n-p fused, hi reliability	│	│	│	│	│	25	│	15	│	0.6
Western Electric Co., Inc., New York, N. Y.											
2N27[11]	n-p-n grown, audio	50	85		35	100	0.995	30[8]	30[8]		1.0
2N28[11]	n-p-n grown, audio	│	│		30		│	15[8]	30[8]		0.5
2N29[11]	n-p-n grown, audio, switch	│	│		35	30	│	15[8]	30[8]		1.0
GA52609[11]	n-p-n grown, audio, switch	│	│		30	50	0.998	6	7		2.0
GA52829[11]	p-n-p alloy, audio, switch	120	│		−30	50	0.996	4.5	11.5		1.0

13. At 85° C.
14. Measured at 455kc.
15. Add suffix A for $V_{eb} > -5$ for computer use.
16. Cutoff time.
17. Power gain, db, at i-f frequencies.
18. Distortion 8.5% Class A.
19. Distortion 6% Class AB pair.
20. On mounting base at 50° C.
21. 0.5w at 100° C with 9 sq in heat sink.
22. Power gain at 400cy.
23. With mounting flange.
24. Rise time = 4μsec. Full time = 1μsec. Storage time = 3μsec.
25. At 45JC, submin units rated at 35mw, Vc-20.

New transistors are continuously being announced. However, some appear to be going exclusively into portable radios and are not indicated by manufacturers as being generally available. Based on the recentness and completeness of our canvass, the tabulation here reflects very accurately what is readily available to both industrial and military users.

Other Things to Look For

For evaluation and design purposes, small signal parameters must be considered. In addition to the familiar r and h parameters, g relations are becoming popular [see article Transistor Conductance Curves by K. Pullen, this issue]. Important g values are:

g_{21}—measure of the current control efficiency of the base. Has a value between 20,000 and 35,000 micromhos per milliampere collector current. It is almost independent of collector voltage.

g_{11}—the short-circuit input conductance (approximately equal to g_{21} divided by beta). It gives a measure of the input conductance. When it is given in the common-emitter configuration, it is almost independent of the output termination at low frequency.

Also of interest is r_b', base spreading resistance, the resistance between the base connection of the germanium and the active region of the base. It may have a value between a very few ohms and several hundred. It is important in the time constant $r_b' C_c$. The value C_c is a function of collector voltage, so only an approximate value may be given. Avalanche or punch-through voltage, and reverse breakdown voltages become important for switching applications.

For copies of this chart, turn to Reader Service Card and circle **300**.

Footnotes

1. With heat sink.
2. Subminiature.
3. Measured at 45v.
4. Military approved.
5. Matching not required for class B push-pull.
6. Matched pair.
7. Push-pull Class B, 160mw both units. Large signal B given.
8. Maximum.
9. Typical operating conditions.
10. At 150° C, I_{co} is 50μa.
11. Military use only, generally rated at 60° C.
12. Power gain approx. 30db at 455kc.
13. At 85° C.
14. Measured at 455kc.
15. Add suffix A for $V_{eb} > -5$ for computer use.
16. Cutoff time.
17. Power gain, db, at i-f frequencies.
18. Distortion 8.5% Class A.
19. Distortion 6% Class AB pair.
20. On mounting base at 50° C.
21. 0.5w at 100° C with 9 sq in heat sink.
22. Power gain at 400cy.
23. With mounting flange.
24. Rise time = 4μsec. Full time = 1μsec. Storage time = 3μsec.
25. At 45JC, submin units rated at 35mw, Vc-20.

High Frequency, Switching

Manufacturer and Type	Class and Application	Maximum Ratings W_c (mw)	T_j (C)	(a)mw/C (b)C/mw	V_c (volts)	I_c (ma)	Characteristics β or α	I_{co} (μa)	NF (db)	C_c (μμf)	f_{co} (Mc)
Amperex Electronic Corp.											
Hicksville, N. Y.											
OC76	p-n-p fused, switching, converter	100	65	0.4 (b)	−32	−250		−4.5			
CBS - Hytron											
Danvers, Mass.											
2N182	n-p-n, hf, switching	100	75	2.0 (a)	25		25	3		10	5[8]
2N183	h-p-n, hf, switching						40				10[8]
2N184	n-p-n, hf, switching						60				>10[8]
Clevite Transistor Products											
Waltham, Mass.											
1390/2N111	p-n-p alloy, rf, if	50	55		−6	−5	[12]	10	10		3
1400/2N112	p-n-p alloy, rf, if										5
1410/2N113	p-n-p alloy, rf, if										10
2N32	point contact, switch, osc.		40		−40	8	2.2				0.9
2N50	point contact, switch		50		−15	1	2				3
2N51	point contact, switch	100			−50	8	2.2	350			
2N52	point contact, rf osc., amp.	120									
2N53	point contact, switch	100					2	700			5
General Electric Co.											
Syracuse, N. Y.											
2N78	n-p-n grown, osc. converter	50	100		15	20	60	6	8	4	8
2N123	p-n-p, switch	100	85		−20	−125		−6	7	12.5	8
2N35	p-n-p alloy, rf, if					−50	20	−5			4.5
2N136	p-n-p alloy, rf, if						40				6.5
2N137	p-n-p alloy, rf, if				−10		60				10
2N167	n-p-n, switch	65	100		30			1.5	8	4	8.5
2N169	n-p-n grown, if	50			15	20	22	6			5
2N170	n-p-n grown, second det.	50			6		18				3
ZJ13	n-p-n, osc., amp.	30			15		50		5	1.8	16
ZJ14	p-n silicon dbl. base diode, regen. sw.	100[13]	200								
General Transistor Corp.											
Richmond Hill, 18, N. Y.											
GT34S	p-n-p, bidirectional, clamp, det.	100	85	3.5 (a)	−25		15	10	16		
GT34HV	p-n-p, hv neon light sw.	125			−50		15	10			
GT83	p-n-p, medium speed sw., computer				−25		45	6			0.7
GT87	p-n-p, medium speed sw., computer						38				0.5
GT88/2N7	p-n-p, medium speed sw., computer						80				1
GT122	p-n-p, medium speed sw., computer						100				1.5
GT759/2N111	p-n-p, if, computer sw.	90	75	2.8 (a)	−20		20	1			2.5
GT760/2N112	p-n-p, if, computer sw.				−15		40				5
GT761/2N113	p-n-p, rf, computer sw.				−12		75				10
GT762/2N114	p-n-p, rf, computer sw.				−6		100				20
GT763	p-n-p, rf, computer sw.				−6		120				30
Hughes Aircraft Co.											
Culver City, Calif.											
HA5001	n-p-n alloy, switching	500	85	8.3 (a)	30	100	39	10	35		2
HA5011	n-p-n alloy, lf switching				40			20			1
HA5014	n-p-n alloy, switching				40			20			2
National Aircraft Corp.											
Burbank, Calif.											
HF1	p-n-p alloy, rf	75	55		−25	8	40	5			5
HS1	p-n-p alloy, high-speed sw.		85		−20	150					3
HS2	p-n-p alloy, high-speed sw.										5
HS3	p-n-p alloy, high-speed sw.										10
HS4	p-n-p alloy, high-speed sw.										15
IF1	p-n-p alloy, if		55		−25	8	50				3
Philco Corp.											
Philadelphia, Pa.											
SB100	p-n-p surface barrier, osc., if		85		−4.5	5	20	3	12		40
2N128[4]	p-n-p surface barrier, rf, video, comp.	30					35	2			60
2N129[4]	p-n-p surface barrier, rf, video, comp.	30					20	2			40

High Frequency, Switching

Manufacturer and Type	Class and Application	Maximum Ratings W_c (mw)	T_j (C)	(a)mw/C (b)C/mw	V_c (volts)	I_c (ma)
Philco Corp. (continued)						
L5108	p-n-p surface barrier, rf		85		−4.5	5
L5121	p-n-p surface barrier, computer	10			−5	15
L5122	p-n-p surface barrier, computer	10			−6	15
Radio Corporation of America Harrison, N. J.						
2N139	p-n-p fused, if	35	70		−16	15
2N140	p-n-p fused, converter	35	70		−16	15
Radio Development and Research Corp. (Germanium Prod.) Jersey City 4, N. J.						
2N99	n-p-n grown, osc., if, computer	50	75	2 (a)	40	10
2N100	n-p-n grown, osc., if, computer	25	50	2 (a)	25	5
2N160[15]	n-p-n silicon hi temp., rf, video	150	175		40	25
2N161[15]	n-p-n silicon hi temp., rf, video					
2N162[15]	n-p-n silicon hi temp., rf, video					
2N163[15]	n-p-n silicon hi temp., rf, video					
Raytheon Mfg. Co. Newton, Mass.						
2N111	p-n-p fused, if	145	85	2.4 (a)	−30	225
2N112	p-n-p fused, if, osc., converter					
2N113	p-n-p fused, rf, computer sw.					
2N114	p-n-p fused, rf, computer sw.					
Sprague Electric Co. North Adams, Mass.						
SB100	p-n-p surface barrier, osc., if		85		−4.5	5
5A	point contact, switch	80			−50	10
Sylvania Electric Products, Inc. Woburn, Mass.						
2N94	n-p-n fused, if	50	75	1 (a)	20	50
2N94A	n-p-n fused, switch				20	
2N193	n-p-n fused, osc.				15	
2N194	n-p-n fused, mixer				15	
2N211	n-p-n fused, osc.				10	
2N212	n-p-n fused, mixer				10	
2N216	n-p-n fused, if				15	
Texas Instruments, Inc. Dallas, Tex.						
2N124	n-p-n grown, switch	50	75	0.7 (b)	10	8
2N125	n-p-n grown, switch	50				
2N126	n-p-n grown, switch	50				
2N145	n-p-n grown, 455 kc if	65			20	5
2N146	n-p-n grown, 455 kc if					
2N147	n-p-n grown, 455 kc if					
2N148	n-p-n grown, 262 kc if				16	
2N148A	n-p-n grown, 262 kc if				32	
2N149	n-p-n grown, 262 kc if				16	
2N149A	n-p-n grown, 262 kc if				32	
2N150	n-p-n grown, 262 kc if				16	
2N150A	n-p-n grown, 262 kc if				32	
2N172	n-p-n grown, 455 kc converter				16	
Western Electric Co., Inc. New York, N. Y.						
2N21[11]	point contact, switch	120			−100	40
2N67[11]	point contact, switch	100				40
2N110[11]	point contact, switch	200				50
GA52837[11]	point contact, switch	120				40
GA52996[11]	point contact, switch	250				50
GA52830[11]	p-n-p alloy, switch, mag. core drive	500[1]	80		−40	500

Characteristics				
β or α	I_{co} (μa)	NF (db)	C_c (μμf)	f_{co} (Mc)
20	3	12		60
30	2			65
30	2			65
48	6			4.7
48	6			7.0
40	2	15	10	3.5
150	2	15	10	5
0.93	0.01	25	7	4
0.965				5
0.975				10
0.98				6
25	1	10	250	3
30			300	5
45			450	10
75			750	20
20	3	12		40
		50		5[8]
6[14]	5	15	11	3
10[14]	5	15	10	5
6[14]	10			3
7[14]	5	15	10	4
6[14]	10	15	10	5
7.5[14]	10	15	11	3
	2	7	10	3
	2	7		5
	2	7		5
31.5[17]	0.2	17	6	
34.5[17]		15		
37.5[17]		13		
33.5[17]		18	8	
33.5[17]		18		
36.5[17]		14		
36.5[17]		14		
39.5[17]		12		
39.5[17]		12		
25[17]			6	
1.8	400	55		1.0
	450			
				10
3				
0.99	20			4

Typical Switching Operation

Manufacturer and Type	Time(μsec) Rise	Fall	Storage	Leak. Cur. (μa)	Sat. Volt. (v)	D-C. Beta (avg)
Amperex Electronic Corp.						
Hicksville, N. Y.						
OC76				4.5	0.25	22
CBS - Hytron						
Danvers, Mass.						
2N182	0.7	0.5	0.8		0.15	25
2N183	0.5	0.3	0.7			50
2N184	0.3	0.2	0.6			100
Clevite Transistor Products						
Waltham, Mass.						
2N51	0.1					
General Electric Co.						
Syracuse, N. Y.						
2N123	6	4	6	6	0.04	50
2N167	6	4	6	1.5	0.27	70
ZJ14	1	1				
General Transistor Corp.						
Richmond Hill 18, N. Y.						
GT83	1.4	1.4	1.8	6	0.3	9[14]
GT87	1.6	1.4	1.8			8[14]
GT88/2N77	1.1	1.2	1.6			10[14]
GT122	0.8	1.0	1.4			10[14]
GT759/2N111	0.7	0.8	0.8			14[14]
GT760/2N112	0.3	0.4	0.6			18[14]
GT761/2N113	0.2	0.3	0.5			20[14]
GT762/2N114	0.1	0.3	0.4			25[14]
GT763	0.06	0.1	0.4			30[14]
Hughes Aircraft Co.						
Culver City, Calif.						
HA5001	0.2	0.2	0.5		0.2	40
HA5011	0.3	0.3				
HA5014	0.3	0.3				
Radio Development & Research Corp.						
(Germanium Prod.)						
Jersey City, N. J.						
2N99	<0.2	<0.3				
2N100	<0.2	<0.3				
Raytheon Mfg. Co.						
Newton, Mass.						
2N112	0.8	1.0	0.5	0.25	0.15	36
2N113	0.1	0.15	0.6			54
2N114	0.05	0.10	0.7			90
Sylvania Electric Products, Inc.						
Woburn, Mass.						
2N94A	0.3	0.4	0.6	5	0.1	70
Texas Instruments, Inc.						
Dallas, Tex.						
2N124	0.15	3.5[16]			0.3	18
2N125						36
2N126						75
Sprague Electric Co.						
North Adams, Mass.						
5A	0.2	0.2				
Western Electric Co., Inc.						
New York, N. Y.						
GA52830[11]	0.5	0.3	0.95	100	0.25	50

Power Transistors

Manufacturer and Type	Class and Application	Maximum Ratings W_c (W)	T_j (C)	(a)W/C (b)C/W	V_c (volts)	I_c (amp.)
CBS - Hytron, Danvers, Mass.						
2N156	p-n-p alloy, pwr. amp.	1.5	85	0.1 (a)	−30	3
2N158	p-n-p alloy, pwr. amp.	1.5	85	0.1 (a)	−60	3
Clevite Transistor Products Waltham, Mass.						
CTP1002	p-n-p, pwr. amp., high current	25[1]	85	0.4 (a)	−60	4
CTP1003	p-n-p, pwr. amp., high current				−60	
CTP1004	p-n-p, auto radio output, 5 w Class A				−40	
CTP1005	p-n-p, auto radio output, 5 w Class A					
CTP1006	p-n-p, auto radio output, 5 w Class A					
Delco Radio Div., Kokomo, Ind.						
2N173	p-n-p alloy, V_c = 12, 16 w Class A[18]	55[1]	90	1.2 (a)	−60	12
2N174	p-n-p alloy, V_c = 12, 80 w Class AB[19]	55[1]	90	1.2 (a)	−80	12
General Electric Co., Syracuse, N. Y.						
ZJ16	p-n-p silicon, servo amp.	8[13]	200		−75	0.5
Minneapolis-Honeywell Regulator Co. Minneapolis, Minn.						
H3A	p-n-p, servo amp.	3[20]	95	0.072 (a)	−60	0.35
H4A	p-n-p, servo amp.	3[20]		0.072 (a)	−60	0.5
H5	p-n-p alloy, servo amp., converter[24]	20[20]		0.45 (a)	−80	3
H6	p-n-p alloy, servo amp., converter[24]					
H7	p-n-p alloy, servo amp., converter[24]					
XH10	p-n-p alloy, servo amp., converter	35[20]		0.83 (a)	−60	10
Nucleonics Products Co., Inc. Los Angeles, Calif.						
GFT26		6			−10	2
Sylvania Electric Products Co. Woburn, Mass.						
2N68	p-n-p alloyed, pwr. output	4	75	0.08 (a)	−30	1.5
2N95	n-p-n alloyed, pwr. output	4		0.08 (a)	30	
2N101	p-n-p alloyed, pwr. output	2		0.16 (a)	−30	
2N102	n-p-n alloyed, pwr. output	2		0.16 (a)	30	
2N141	p-n-p, pwr. output	4		0.08 (a)	−60	0.08
2N142	n-p-n, pwr. output	4		0.08 (a)	60	
2N143	p-n-p, pwr. output	2		0.16 (a)	−60	
2N144	n-p-n, pwr. output	2		0.16 (a)	60	
Texas Instruments, Inc. Dallas, Tex.						
951	n-p-n grown silicon, audio, servo amp.	1[21]	175		50	0.06
952	n-p-n grown silicon, audio, servo amp.				80	0.05
953	n-p-n grown silicon, audio, servo amp.				120	0.04
970	n-p-n grown silicon, audio, servo amp.	8.75	150		120	0.14
Transitron Electronic Corp. Melrose, Mass.						
2N83	p-n-p, pwr. amp.	10	85	0.03 (a)	−66	2
2N83A	p-n-p, pwr. amp.				−66	3
2N84	p-n-p, pwr. amp.				−50	2
2N84A	p-n-p, pwr. amp.				−50	3
Western Electric Co., Inc. New York, N. Y.						
2N66[11]	p-n-p alloy, pwr. output, converter	2[1]	80		−60	0.8
Westinghouse Electric Corp. Youngwood, Pa.						
XD5081[23]	p-n-p, audio output, switch		85	3.5 (b)	−35	2
XD5082	p-n-p, audio output, switch		85	3.5 (b)	−35	2

Characteristics B at I_c amp.	I_{co} (ma)	f_{co} (Mc)
44/0.36	0.15	0.3
46/0.18	0.7	0.3
30/2	2	0.7
20/2		0.4
20/2		0.4
25/2		0.5
30/2		0.7
55/7	0.1	0.6
22/7	0.2	0.2
20/0.5		0.1
10/0.1	0.25	
20/0.1	0.25	
30/2	0.7	
42/2		
60/2		
20/10	1.0	
0.96		0.3
50	0.1	0.4
40		
50		
40		
30[22]		
18/0.5	0.1	0.35
17/0.5	0.085	0.4
21/0.5	0.11	0.4
20/0.5	0.095	0.45
25	1	0.2
48/1.5	0.5	0.01
48/1.5	0.5	0.01

Useful Interrelations

A useful tabulation of interrelations are:

$$r_{11} = \frac{g_{22}}{g_{11}g_{22} - g_{12}g_{21}}$$

$$r_{12} = \frac{-g_{12}}{g_{11}g_{22} - g_{12}g_{21}}$$

$$r_{21} = \frac{-g_{21}}{g_{11}g_{22} - g_{12}g_{21}}$$

$$r_{22} = \frac{g_{11}}{g_{22}g_{11} - g_{12}g_{21}} = \frac{1}{g_c}$$

$$h_{11} = \frac{1}{g_{11}}$$

$$h_{21} = \frac{g_{21}}{g_{11}}$$

$$h_{12} = \frac{-g_{12}}{g_{11}} = \frac{(g_c - g_{22})}{g_{21}}$$

$$h_{22} = g_c = \frac{1}{r_{22}}$$

$$g_{11} = \frac{r_{22}}{r_{11}r_{22} - r_{12}r_{21}}$$

$$g_{12} = \frac{-r_{12}}{r_{11}r_{22} - r_{12}r_{21}}$$

$$g_{21} = \frac{-r_{21}}{r_{11}r_{22} - r_{12}r_{21}}$$

Footnotes

1. With heat sink.
2. Subminiature.
3. Measured at 45v.
4. Military approved.
5. Matching not required for class B push-pull.
6. Matched pair.
7. Push-pull Class B, 160mw both units. Large signal B given.
8. Maximum.
9. Typical operating conditions.
10. At 150° C, I_{co} is 50μa.
11. Military use only, generally rated at 60° C.
12. Power gain approx. 30db at 455kc.

$$g_{22} = \frac{r_{11}}{r_{11}r_{22} - r_{12}r_{21}}$$

$$g_c = g_{22} - \frac{g_{12}g_{21}}{g_{11}} = \frac{1}{r_{22}}$$

$$g_{12} = (g_{22} - g_c)\frac{g_{11}}{g_{21}}$$

The following are approximate relations between equivalent T parameters, r_e, r_b *and* r_c, and g parameters:

$$r_e = \frac{1}{g_{21}}\left(\frac{g_{22}}{g_c} - 1\right)$$

$$r_b = \frac{g_{22}}{g_{11}g_c} \approx \frac{1}{g_{11}}$$

$$r_m = \frac{g_{21}}{g_{11}g_c} \approx \frac{\beta}{g_c}$$

$$r_d = \frac{1}{g_c}$$

$$r_c'' = \frac{g_{11} + g_{21}}{g_{11}r_c} = \frac{1 + \beta}{g_c}$$

$$\beta = \frac{g_{21}}{g_{11}}$$

$$\alpha = \frac{g_{21}}{g_{11} + g_{21}}$$

13. At 85° C.
14. Measured at 455kc.
15. Add suffix A for $V_{eb} > -5$ for computer use.
16. Cutoff time.
17. Power gain db, at i-f frequencies.
18. Distortion 8.5% Class A.
19. Distortion 6% Class AB pair.
20. On mounting base at 50° C.
21. 0.5w at 100° C with 9 sq in heat sink.
22. Power gain at 400cy.
23. With mounting flange.
24. Rise time = 4μsec. Full time = 1μsec. Storage time = 3μsec.
25. At 45JC, submin units rated at 35mw, Vc-20.

CIRCLE 301 ON READER-SERVICE CARD ➤

Tetrodes

Manufacturer and Type	Class and Application	Maximum Ratings W_c (mw)	T_j (C)	(a)mw/C (b)C/wm	V_c (volts)	I_c (ma)	Characteristics Pwr. Gain	I_{co} (μa)	NF (db)	C_c ($\mu\mu f$)	f_{co} (Mc)
Radio Development and Research Corp. (Germanium Prod.) Jersey City 4, N. J.											
3N23	n-p-n grown, osc., converter, rf	50	75		30	5	12	10		2	>20
3N23A	n-p-n grown, osc., converter, rf	│	│		│	│	14	│		│	>35
3N23B	n-p-n grown, osc., converter, rf	│	│		│	│	15	│		│	>50
3N23C	n-p-n grown, osc., converter, rf	│	│		│	│	17	│		1	>80
Texas Instruments, Inc. Dallas, Tex.											
501	p-n-p, grown diffused, vhf osc.	25	75		−15	2	10	25	25		200
925	n-p-n, grown diffused, silicon, if amp.	125	150		30	10	15	0.2		18	12.5
926	n-p-n, grown diffused, silicon, if amp.	125	150		30	10	14	0.2		18	30
Western Electric Co., Inc. New York, N. Y.											
3N22[11]	n-p-n, video, rf	30			10			10			15

Photo Transistors

Manufacturer and Type	Class and Application	Maximum Ratings W_c (mw)	T_j (C)	(a)mw/C (b)C/wm	V_c (volts)	I_c (ma)	Characteristics
Clevite Transistor Products Waltham, Mass.							
10A	Germanium, detector, switch	100	50		15	10	4 ma at 3 v. d-c, 300 ft. c. 500 μa dark current at 3 v. d-c.
10B	Germanium, detector, switch	100	50		15	2	100 μa at 3 v. d-c, 300 ft. c. 500 μa dark current at 3 v. d-c.
General Transistor Corp. Richmond Hill, N. Y.							
GT66	p-n-p	90	75		−12		Sensitivity = 0.16 v./ft. c. Gain = 100
Texas Instruments, Inc. Dallas, Tex.							
800	n-p-n grown				22		1.7 ma @ 3 v. d-c, 100 ft. c. 275 μa dark current @ 3 v. d-c.

Books on Transistor Circuits

Bell Telephone Laboratories, Inc., *The Transistor*, Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C., 1951, $20.00.

Bevitt, W. D., *Transistors Handbook*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1956, $9.00.

Coblenz, A., and Owens, H. L., *Transistors: Theory and Applications*, McGraw Hill Book Company, New York, 1955, $6.00.

Lo, Endres, Zawels, Waldhauer & Cheng, *Transistor Electronics*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1955.

RCA, *Transistors I*, RCA Laboratories, Princeton, New Jersey, 1956.

Shea, R. F., *Principles of Transistor Circuits*, John Wiley & Sons, Inc., New York, 1953, $12.75.

Shea, R. F., *Transistor Audio Amplifiers*, John Wiley & Sons, Inc., New York, 1955, $6.50.

What's Needed in Transistor Components*

Captain W. I. Bull, U.S.N.
Assistant Chief (Electronics)
Bureau of Ships

THE military and industry in general must have a full line of parts to properly exploit the full advantages of the transistor. New transistor components will have to be scaled-down sizes of parts comparable to the size of transistors rather than to that of subminiature electron tubes. Such scaling down of part size will impose many part design and fabrication problems more acute than heretofore encountered. Here are some general requirements of components required to complement the transistor.[1]

Capacitors—For capacitors, the main differences between the types needed for transistor circuits and those presently used for electron tube circuits will be in the capacitance values required and the lower working voltage range (5 to 50v d-c) required for the transistor circuit types. Capacitors required for transistor circuits may be divided conveniently into five classes as follows:

Class 1—Low frequency (audio frequency) application types with capacitance values ranging from 1 to 20µfd with a tolerance from 0 to ±50%. The presently available tantalum electrolytic types will meet this Class 1 capacitor need up to 115° C but as temperature ranges go up new types will have to be developed.

Class 2—The Class 2 are wide tolerance capacitors similar in characteristics to the Class 1 types except that the required capacitance values will range from those exceeding 20µfd to thousands of microfarads.

Class 3—Class 3 capacitors would need to be made in capacitance values of from 1 to 10µfd with ±10% capacitance tolerance, capacitance stability to within 0.02% per degree Centigrade and capacitance retrace values within 0.5%.

Class 4—Class 4 capacitors are the low capacitance units which are required to have 1 to 2% capacitance tolerance and a stability in capacitance 3 or 4 times better than for the Class 3 capacitors. Practically all presently available mica dielectric type capacitors meeting these electrical requirements are too large for use with transistors.

. .Class 5—The final Class 5 capacitors required are precision types of the order of ±1/2% with electrical characteristics equal to, or better than presently available, silvered-mica types which are too large for use in transistor circuits.

Inductors—Inductor characteristics required for use in transistor circuits will range in inductance value from 1mh to 100h with 10 to 20% tolerance. Magnetic saturation effects will impose some limit on the degree of inductor miniaturization possible. Minimum direct current resistance requirements for the inductor wind-

* Based on a talk delivered May 1956 to the 1956 Electronic Components Symposium, Washington, D. C.

ings may impose further limitations since the resistivity of very fine wire (as fine as #50 B. & S.) required for compact windings is high.

Production of small size inductors employing such fine wire will pose problems associated with the mechanical fragility of fine copper wire and some development work may be found necessary to increase the wire tensile strength. It may even be necessary to investigate and develop inductor winding fabrication techniques based on, for example, photographic etching processes rather than wire. Different transformer types are, of course, required and most of the above criteria which apply to inductors apply equally to transformers.

Resistors—In general, transistors will require the same types of resistors as those used for electron tube circuits, except that the types required will be smaller. Three main classes are, of course, general purpose, precision, and power types. In the general purpose class what is required is resistors of 1/10w rating or less with the finished resistor having wire leads of 10mil diameter or less. In the precision type resistor class, values from 1 ohm to 100,000 ohms are required with a permissible change due to ageing of 1%. Precision wire wound resistors need extra fine wire about 5mil diameter with higher operating resistivity. In the power types the answer seems to lie in developing better heat sinks, perhaps by utilizing metal cased types. Potentiometers will have to be low wattage types with voltage ratings of 50v or less.

The small size of transistors and comparable size parts (when such parts become available) will naturally lead to "transistorized" packaged subassemblies for use in military electronic equipment and fabricated by mechanized or completely automatic means.

Such fabrication techniques will undoubtedly impose the need for changing part designs to eliminate the following undesirable mechanical characteristics:

1. Wire lead terminals which vary too widely among various part categories with respect to diameter and length and stiffness.

2. The leads of transformers and crystal diodes which are not properly polarized.

3. Parts which are not proportioned in modular steps of length.

4. The too few parts designed with rectangular cross-sections for maximum packing efficiency.

The trend is definitely toward printed circuit cards; this type of construction lends itself to automatic assembly but does put a new requirement on component configuration and construction.

The military is stepping up research of its own in these areas including that of obtaining components with higher temperature ratings. As always the teamwork of both the military and industry will be necessary to bring these developments about at the earliest date.

[1] Based on Bell Telephone Laboratories studies for the military.

Transistor Components Chart

AB .... Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 4, Wis.

AC .... Arnhold Ceramics Inc., 1 E. 57th St., New York 22, N. Y.

AM ... American Phenolic Corp., Chicago 50, Ill.

AS .... Astron Corp., 255 Grant Ave., E. Newark, N. J.

AUT .. Automatic Mfg. Corp., 65 Gouverneur St., Newark 4, N. J.

CAM .. Cambridge Thermionic Corp., Cambridge, Mass.

CEN .. Centralab, Div. of Globe Union, Inc., 914 E. Keefe Ave., Milwaukee 1, Wis.

CTC .. Chicago Standard Transformer Corp., 3580 Elston Ave., Chicago 18, Ill.

CJ .... Cinch Mfg. Corp., 10265 Homan Ave., Chicago 24, Ill.

CP .... Columbia Process Co., Inc. Columbus, Ind.

CD .... Cornell-Dubilier Electric Corp., S. Plainfield, N. J.

DA .... Dale Products Inc., Columbus, Neb.

ELC .. Elco Sales Co., 190 Glenwood Ave., Philadelphia, Pa.

ELD .. Eldema Corp., 9844 Remer St., El Monte, Calif.

FM ... Fansteel Metallurgical Corp., 2200 Sheridan Rd., N. Chicago, Ill.

FOR .. Forrest Mfg. Co., Culver City, Calif.

FL .... Fortiphone, Ltd., 247 Regent St., London, W1, England (Imported)

FTC .. Freed Transformer Co., Inc., 1736 Weirfield St., Brooklyn 27, N. Y.

GDB .. General Dry Batteries, Inc., Cleveland, Ohio

GE .... General Electric Co., Electronics Park, Syracuse, N. Y.

Three of the virtues of transistors are their extremely low voltage requirements, small size, and long life. These factors favor the development of miniature, lightweight, and more reliable electronic equipment.

Component designers, to take advantage of this feature, have been designing smaller resistors, capacitors, and associated parts to be used especially with transistorized devices. Because of the circuit characteristics of transistors, many of the components are not suitable for use in conventional electronic circuits. Specialized components presently available from manufacturer's stock are listed in this Transistor Components Chart.

GI .... General Instrument Corp., 829 Newark Ave., Elizabeth 3, N. J.
GL .... Glenco Corp., Metuchen, N. J.
GU .... Gulton Industries Inc., 212 Durham Ave., Metuchen, N. J.
HY .... Hydro-Aire, Inc., 3000 Winona Ave., Burbank, Calif.
HYC .. Hycon Eastern Inc., 1360 Soldiers Field Rd., Boston 35, Mass.
IC .... Illinois Condenser Co., 1616 N. Throop St., Chicago 22, Ill.
IH .... Industrial Hardware Mfg. Co. Inc., 109 Prince St., New York 12, N. Y.
JE .... Jensen Mfg. Co., 6601 S. Laramie Ave., Chicago 38, Ill.
KES ... Kessler Co., Frank, 41-45 47th St., Long Island City 4, N. Y.
KN .... Knowles Electronics, Inc., 9400 Belmont Ave., Franklin Park, Ill.
LE .... Lewis Co., E. B., 11 Bragg St., E. Hartford, Conn.
LF .... Lafayette Radio, 100 6th Ave., New York, N. Y.
MAG .. Magnavox Co., Fort Wayne 4, Ind.
MAL .. Mallory & Co., Inc., P. R., 3029 E. Washington St., Indianapolis 6, Ind.
MEP .. Mepco Inc., Morristown, N. J.
MT .... Microtran Co., 84-13 Rockaway Beach Blvd., Rockaway Beach 93, N. Y.
MI .... Miller Co., J. W., 5917 S. Main St., Los Angeles 3, Calif.
MU .... Mucon Corp., 9 St. Francis St., Newark 5, N. J.
MYX .. Mycalex Corp. of America, Clifton, N. J.
NC .... National Carbon Co., 30 E. 42nd St., New York 17, N. Y.
NET .. New England Transformer Co., Somerville, Mass.
OHM .. Ohmite Mfg. Co., 3683 Howard St., Skokie, Ill.
PI .... Polyphase Instrument Co., 705 Haverford Rd., Bryn Mawr, Pa.
RC .... Radio Condenser Co., Camden, N. J.
RCA .. Radio Corp. of America, Tube Div., Harrison, N. J.
REM .. Remco Electric Co., Maynard, Mass.
REN .. Reon Resistor Corp., 117 Stanley Ave., Yonkers, N. Y.
REP .. Resistance Products Co., 914 S. 13th St., Harrisburgh, Pa.
SI .... Sickles, F. W., Div., General Instrument Corp., 165 Front St., Chicopee, Mass.
SPR ... Sprague Electric Co., 125 Marshall St., N. Adams, Mass.
SUP ... Superex Electronics Corp., 4-6 Bradford Pl., Yonkers, N. Y.
TE .... Telex, Inc., Telex Park, St. Paul, Minn.
TI .... Texas Instruments, Inc., 6000 Lemmon Ave., Dallas 9, Texas
TM ... Thordarson-Meissner Mfg. Div., Mt. Carmel, Ill.
TT .... Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif.
UL .... Ultra-Temp Transformer Inc., Groton, Conn.
UT .... Utah Radio Products Co., Inc., 1123 E. Franklin St., Huntington, Ind.
VO .... Vokar Corp., 7300 Huron River Drive, Dexter, Mich.

Components Designed for Transistor Circuits

Component	Use/Characteristic	Manufacturer
Batteries		
Zinc-carbon	Transistor power supplies	*BB, GDB, NC, RCA*
Mercury	Transistor power supplies	*GDB, MAG, MAL, NC, RCA*
Capacitors		
Ceramic	Subminiature coupling type	
	25 wvdc	*MU*
	75 wvdc	*GU*
Electrolytic-tantalum or aluminum	Bypass, filtering; high capacity—low voltage	*AS, BI, CD, FM, GE, GL, IC, MAG, MAL, OH, SPR*
Variable	Broadcast tuning	*GI, LF, RC, TM*
Coils*		
Antenna	Loop, broadcast	*LF, MI, SUP, TM*
I-F transformer	Tapped for impedance matching, adjustable, 262 and 455 kc	*AUT, MI, SI, TM, VO*
Oscillator	For broadcast superhetrodyne receivers	*MI, SI, TM, VO*
Toroids	To 2h	*FOR, REM*
Crystals		
Quartz	Oscillator, 100kc	*LE*
	Filters	*HYC*
Hardware		
	Battery clips for one or two cell mercury batteries	*CAM*
	Indicator light, neon	*ELD*
Loudspeakers		
PM	Low impedance	*JE, LF, RCA*
	High impedance, 800 ohms, center-tapped coil	*UT*
Microphones		
Magnetic	Hearing-aid type, 1000-2000 ohms	*KN*
Resistors**		
Deposited carbon	Stable type, 1/8 watt and less, 10 ohm to 500 k ohms	*AC, DA, MEP*
Molded composition	Gen. purpose 1/10 watt	*AB*
Thermistors	Temperature compensating	*GE, GU*
Trimmer, printed ceramic	Volume control, to 625 k ohms	*CEN*
Wirewound	Precision type 0.1 watt, 1 ohm to 600 k ohms 5/16" long by 1/4" diam.	*REN, REP*
Sockets		
5 pin, and polarized	General purpose & special mounting	*CJ, ELC, HY*
4 pin, and polarized	General purpose & special mounting	*CJ, ELC*
3 pin, and polarized	General purpose & special mounting	*CJ, ELC, IH, MYX*
3 pin	Printed circuit	*ELC, IH*
Assorted types	General purpose & special mounting	*AM*
Transformers*		
Chokes	General purpose	*MT, TI*
Driver	Single-ended or push-pull	*CP, FL, FTC, MT, TM, UL, UT*
Input	High-impedance primary	*CTC, CP, FTC, NET, MT, TI, TM, UL*
	Low-impedance primary	*TM, UL*
Interstage	500 ohm to 100,000 ohm primary	*CTC, CP, FTC, KES, NET, MT, TE, TI, TM, TT*
Output	48 ohm—500,000 ohms primary	*CTC, CP, FL, FTC, KES, NET, MT, TI, TM, UL, UT*
Power	For junction transistor oscillator	*FL*
Pulse	Pulse width range from 0.2 μ sec to 100 μ sec	*PI*

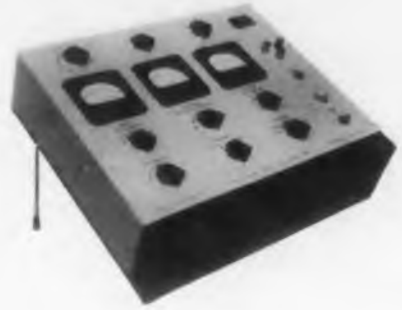
*Code numbers indicate manufacturers stocking these items. Other types may be made to customer specifications.

**Consult also manufacturers of MIL-R-10509A, DC-1/8 types for additional sources of miniature 1/8 w resistors.

Equipment for Testing Transistors

Sol Prensky




TRANSISTOR TEST EQUIPMENT

Laboratory Instruments

Analyzers

Manufacturer	Model and Price	Description	Tests Performed	Auxiliary Equipment Required
Baird Associates, Inc. 33 University Road Cambridge 38, Mass.	GP $475	**Transistor Test Set.** Table model—22" x 10" x 13" high, 70 lbs., battery powered; also available for rack mounting.	Analyzes P.C., n-p-n and p-n-p types, GB and GE. Measures h_{11}, h_{12}, h_{21}, h_{22}, $f_{\alpha o}$, $f_{\beta o}$, V_{ch}, I_{co}, C_c, γ_e, γ_b, r_e, r_b, r_c, α and β over a freq. range from 100 cy. to 1 Mc.	Audio oscillator and VTVM.
	— —	**Transistor Beta Tester.** Portable—5" x 8" x 5". Battery powered.	Measures I_{co} and β. (Collector voltage variable in 1½ v. steps to 7½ v.; I_e continuously variable from 0.5 to 10 ma.).	External meter for measuring I_{co} below 1 μa. Oscilloscope for monitoring collector waveform.
CG Electronics Corp. 305 Dallas St. N. E. Albuquerque, N. M.	TR-2 —	**Transistor Tester.** Portable—4½" x 4" x 7½" high, 3 lbs., battery powered; a-c model also available.	Analyzes n-p-n and p-n-p types. Measures α, β and I_{co}.	None. Has built-in transistorized audio oscillator.
Electronic Research Associates, Inc. 67 East Centre St. Nutley 10, N. J.	AT-10 $325	**Transistor Alpha Tester.** Cabinet size 8" x 11" with sloping panel. For a-c operation.	Analyzes all types. Direct readings of α and β as function of emitter and collector bias, at frequency of 240 cy. With external oscillator, tests can be made to 5 Mc.	External oscillator not required but can be used to extend alpha frequency to max. of 5 Mc.
	TT11A $279	**Transistor Comparison Tester.** Cabinet size 8" x 11" with sloping panel. For a-c operation. Sweep voltage at 120 cy.	Compares r_e, r_b, r_c, gain and stability with standard transistor. "Go - no go" or quantitative measurements as selected.	None.
Owen Laboratories 412 Woodward Blvd. Pasadena 10, Calif.	210 $475	**Transistor Test Set.** Table model—15" x 13" x 4" high, 18 lbs.; for a-c operation.	Analyzes P.C., n-p-n and p-n-p types. Measures h_{11}, h_{12}, h_{22}, α, β, I_{co}, $f_{\alpha o}$, $f_{\beta o}$ and C_c; the last three parameters obtainable only by using an external oscillator and VTVM. Test frequency with built-in oscillator is 1.5 kc.	An audio oscillator and VTVM must be supplied to check $f_{\alpha o}$, $f_{\beta o}$ and C_c.
Quantum Electronics, Inc. 1921 Virginia St. Albuquerque, N. Mex.	JHI $245	**Transistor Analyzer.** Battery powered.	Analyzes n-p-n and p-n-p types. Measures α, β, and I_{co}; also $f_{\alpha o}$ using external audio generator. Internal test frequency is 2 kc.	Audio generator necessary for measurement of $f_{\alpha o}$.
Norden-Ketay Corp. 99 Park Ave. New York 16. N. Y.	BTS-400	**Transistor Test Set.** Table model—14" x 19" x 14", 40 lbs.; for a-c operation.	Analyzes all types GE and GB, in power ratings to 50w. Measures h_{11}, h_{12}, h_{21}, and h_{22}.	None.

Increased activity during the past year on transistor circuit design and application of transistors in electronic equipment has increased the need for test equipment to evaluate their characteristics. Also, the increasing number of transistor radios, hearing aids, etc. has brought about a need for test equipment to determine when transistors have deteriorated to a point where replacement is necessary. Some of this equipment is suitable for quick checking of transistors in the laboratory and is listed in the accompanying table along with laboratory-type analyzers.

It may appear that there are not as many new test instruments as might be expected considering the advance of the art during the last year; however, lack of transistor standards to date may be partly responsible for this. Most of the more complex equipment available is still relatively expensive. It is not designed for extremely rapid checking of characteristics, but supplies information on all basic characteristics with considerable accuracy for use in design evaluation.

To help the designer select test equipment suitable for his needs, we have grouped the equipment in the table under two categories: Laboratory Instruments, and Service Instruments. The Laboratory Instruments are further classified as: (1) transistor analyzers, (2) curve tracers, (3) noise testers, and (4) miscellaneous laboratory testers.

Principle of Transistor Testing

Most of the analyzers listed in the table can be represented in their test function by the block diagram as shown. The audio frequency signal oscillator and the a-c vacuum tube voltmeter are generally incorporated within the analyzer together with facilities for selecting the characteristic to be measured. The meter scale is usually calibrated to read directly α or β or both. Tolerances are generally ±5%. The audio-frequency signal oscillator supplies its signal to the transistor under test through a high series resistance to insure substantially constant current input.

In operation, the "calibration control" sets the

metering range of the internal a-c VTVM to indicate a full-scale reading corresponding to the desired full-scale β reading. The d-c operating voltages for the transistor under test are set by appropriate controls. Then the "functions" switch is placed in the test position. The collector a-c output current flows through a low value of load resistance, constituting a practical simulation of the short circuit output condition. The a-c voltage across this load is displayed in the indicating meter as a direct reading of α or β.

Transistor Power Supplies

Laboratory type power supplies for developing transistor circuits are necessarily somewhat different from those required for vacuum-tube circuit work. They must have multiple outputs, be closely regulated, continuously variable, and with almost micrometer-like voltage adjustment. Since supplies of this type are frequently made up on order, no listing is given here. However, there are some commercially available supplies on the market. Companies supplying such units are Dressen Barnes Corp., Pasadena, Calif., Electronic Measurements Co., Eatontown, N. J., Electronic Research Associates, Inc., Nutley, N. J., NJE Corp., Kenilworth, N. J., Baird Associates, Cambridge, Mass., Kepco Laboratories, Flushing, N. Y., Universal Electronics, Los Angeles, Calif., and Arnold Magnetics Company, Culver City, Calif.

Other Test Equipment

Transistor equipment development requires non-electronic test equipment, as well as circuit testers, to assure that such equipment meets military and commercial quality-control standards. An example of such equipment is a special component shock tester developed and manufactured by the JAN Hardware Manufacturing Company, Inc., of Brooklyn, N. Y. It is designed for ultra-short very high deceleration testing in the range from 250 to 2000 g's at 1.4 to 2.2msec.

Curve Tracers

Manufacturer	Model and Price	Description	Tests Performed
American Electronic Laboratories, Inc. 641 Arch St. Philadelphia, Pa.	**126H** ——	**Transistor Curve Tracer.** Comprises two relay-rack units mounted in table cabinet —21¾″ x 15¼″ x 22¾″ high; weighs 100 lb. approx.; for a-c operation.	Analyzes all types. Plots family of curves V_c—I_c for GB and GE; also, GE feedback characteristic superimposed on R_{22} curves, and GB feedback curves. Seven curves, corresponding to seven current steps, are shown, plus a zero-voltage axis, 7½ times per sec.
	126HS	**Oscilloscope unit also available.**	
Magnetic Amplifiers, Inc. 632 Tinton Ave. New York 55, N. Y.	**200A** $685	**Transistor Curve Tracer.** Table model, one unit; 16″ x 10″ x 8″ overall; 18 lbs.; for a-c operation.	Plots curves for all types of transistors, GB or GE; collector family or feedback curves. Entire family can be presented automatically or each curve can be plotted individually.
	300A $785	**Power Transistor Curve Tracer.** Similar to Model 200A; 16″ x 10″ x 13″; 28 lbs.; for a-c operation.	Will plot collector or feedback curves of n-p-n and p-n-p power transistors in GB or GE connection, automatically.
Norden-Ketay Corp. 99 Park Ave. New York 16, N. Y.	**BCT-300**	**Circuit Analyzer.** Table model—7″ x 19″ x 12″, 20 lbs.; for a-c operation.	Analyzes all types in forward or reverse direction, GB or GE. Calibrates both axes of oscilloscope for curve tracing.
Polyphase Instrument Co. Bryn Mawr, Pa.	**TA-1A** $1225	**Current Gain Meter and Curve Tracer.** Table model; one unit.	Plots α vs I_e and β vs I_b as an oscilloscope display. Measures current gain of all types on direct reading meter.
	TA-2A $745	**Negative Resistance and Characteristic Curve Tracer.** Table unit.	Traces negative resistance curves of P.C. type transistors. Traces collector and transfer characteristics of all types, GB and GE.
	TA-3A $645	**Family Curve Tracer.** Single unit in table cabinet.	Analyzes all types. Displays R_{12}, R_{22}, H_{12} curves in GB connection and R_{22} curves in GE connection. Has internally generated calibration signal.

Noise Testers

Manufacturer	Model and Price	Description	Tests Performed
Electronic Research Associates, Inc. 67 East Center St. Nutley 10, N. J.	**NFC-12** $275	**Noise Figure Calibrator.**	Supplies reference noise figure values for calibration and reference. Range: 5 - 60db in 5db steps.
	NFT $675	**Transistor Noise Figure Meter.** Table model unit; 8¾″ x 19″ panel x 14″ depth.	Automatically measures noise figure of all types of transistors and transistor amplifiers, directly on meter. Range: 5 - 65db at 1000 cy. center freq.
Radio Receptor Co., Inc. 240 Wythe Ave. Brooklyn, N. Y.	—— ——	**Transistor Noise Meter.** Table unit; 21½″ x 10⅞″ x 16¼″.	Shows noise figure directly on 5 - 25 or 25 - 45db range. A-g-c.

Aux. Equip. Req.
None with Model 126HS. Oscilloscope required with Model 126H.
Cathode-ray oscilloscope with d-c amplifiers.
D-C oscilloscope.
D-C oscilloscope for curve tracing. Oscillator for determining parameters to 1 Mc.
Oscilloscope.
Oscilloscope.
Oscilloscope.

Miscellaneous Test Instruments

Manufacturer	Model and Price	Description	Aux. Equip. Req.
American Radio Co., Subsidiary of CFS (Compagnie Generale de TSF, Paris, France) 445 Park Ave. New York 22, N. Y.	—— ——	**Minority Carrier Meter.** Four units mounted in a relay rack.	None specified.
Baird Associates, Inc. 33 University Road Cambridge 38, Mass.	—— ——	**Transistor Power Tester.** Two units vertically mounted in table cabinet; 21" x 21¾" x15¼". For a-c operation.	External meter for measuring only.
	JJ1 $2540	**Minority Carrier Lifetime Test Set.** Uses principle of conductivity modulation by pulsed infra-red radiation.	Preamplifier and oscilloscope.
	—— ——	**Semiconductor N-P Tester.** Portable bench unit. For a-c operation.	None specified.
	JN ——	**Semiconductor Resistivity Test Set.** Three units; designed for bench use.	None specified.
Electrical and Physical Instrument Corp. 25 W. 43rd St. New York 36, N. Y.	100 200 300 340	**Square Pulse Generator.** Single unit; for relay rack mounting. Difference in models is number of pulse outputs—1, 2, 3, and 4 respectively.	Oscilloscope with good transient response.
General Radio Co. 275 Massachusetts Ave. Cambridge 39, Mass.	561-D ——	**Vacuum-Tube Bridge.** Table unit; 18⅜" x 15¾" x 12" high; 60 lbs.	Audio generator; power source (preferably batteries).
Marconi Instruments 44 New Street New York 4, N. Y.	B601 and B801 ——	**Wayne-Kerr Admittance Bridge.** Table unit. Both models required to cover entire range.	Signal source and detector.

Aux. Equip. Req.
None.
None.
None.

Service Instruments

Manufacturer	Model and Price	Description	Aux. Equip. Req.
General Electric Co. Electronics Park Syracuse, N. Y.	—— $39.95	**Transistor Tester.** Portable; battery powered.	None.
Radio City Products Co., Inc. Easton, Pa.	325 $129.95	**Multi-Conductance Tube-Transistor Tester.** Portable; for a-c operation.	None.
Superior Instruments Co. 2435 White Plains Road New York 67, N. Y.	TV-12 ——	**Trans-Conductance Tube Checker.** Portable; for a-c operation.	None.

Tests Performed

Bulk lifetime value of semiconductor material can be read directly from meter in range from a few μ sec to 1 m sec. Measures phase difference between two semiconductor characteristics: photo-magneto-electric effect and photo- resistive effect.

Measures all h parameters. Has jack for external measurement of I_{co}.
Freq. range: 200 cy. to 200 kc.

For accurate investigation of semiconductor material. Accurately measures minority carrier life times from 1 μ sec to 5 m sec.

For sample testing. Sample contamination is minimized by using spectographically pure graphite electrodes. Electrode heating is controlled by front-panel switches.

Measures resistivity of semiconductor in range of 0.1 to 100 ohm-centimeters. Reproducibility better than $\pm 5\%$.

Determines characteristics of high-frequency transistors; $f_{\alpha o}$ can be calculated from rise-time; and gain measurements can be accurately made (input pulse can be varied in amplitude continuously from 6 to 100 mv).

Measures low-frequency forward and reverse parameters of all transistors.

Measures impedance parameters of transistors to 1% accuracy up to 5 Mc and 2% to 100 Mc.

Tests Performed

Measures types p-n-p and n-p-n. Checks for short circuits, opens, leakage, and current gain.

Measures current gain under full load for p-n-p and n-p-n types. Average current gain readings are shown for 12 transistor types.

Analyzes P.C., n-p-n and p-n-p types. Provides dynamic test of characteristics.

CIRCLE 309 ON READER-SERVICE CARD ➤

NEW from Transitron

2N200

military *type* transistors

Features

- DESIGNED TO MIL-T-25380/5
- RELIABLE OPERATION UP TO 75°C
- WELDED HERMETIC SEAL
- RIGID PRINTED BOARD MOUNTING
- UNIFORM CHARACTERISTICS
- SMALL SIZE

MAXIMUM RATINGS		
Collector Voltage, V_{ce} at 75°C	30	volts
Power Dissipation	100	mw
Collector Current	100	ma
TYPICAL CHARACTERISTICS		
Common Emitter Current Gain, B	45	
Common Emitter Power Gain	40	db
Input Resistance, h_i	32	ohms
Collector Cut-off Current, I_{co}	4	ua

Transitron's military type 2N200 germanium transistor is designed for use in electronic equipment where high ambient temperatures and severe environmental conditions require an extremely reliable transistor.

The 2N200 meets all of the requirements of MIL-T-25380/5, and due to its improved case design, is the preferred type for all transistor applications. It is the recommended replacement for the 2N43A.

Send for Bulletin TE-1320.

Transitron electronic corporation • melrose 76, massachusetts

Germanium Diodes Transistors Silicon Diodes Silicon Rectifiers

Silicone Rubber Compounds

Same Shrinkage As Organic Rubber

Designated SE-361, SE-371, and SE-381, these Class 300 compounds are making possible the molding of silicone rubber parts in the same molds used for organic rubber parts. They also permit specification of closer tolerances than before feasible with silicone rubber.

These compounds achieve their unusually low compression set without toxic additives, permitting use in equipment for food and drug industries. In addition to increasing the applications in which low compression set rubber can be used, the elimination of toxic additives simplifies the handling of Class 300 compounds.

Silicone Products Dept., General Electric Co., Dept. ED, Waterford, N.Y.

CIRCLE 53 ON READER-SERVICE CARD

Hexagonal Nut

Internally or Externally Wrenched

This is a lightweight full-strength hex nut that can be wrenched internally or externally. Designed with an elliptical self-licking shape, the new stamped hex nut is particularly adaptabe to the requirements of aircraft, guided missile, and electronic equipment designers.

The internal wrench adapter is intended for use where space is at a premium and there is insufficient clearance for wrenching in the conventional external manner by sockets or open end wrenches. Therefore, the nut may be nestled closer to adjoining structure and spotface diameters and flange widths may be substantially reduced.

These nuts are approved under applicable Air Force-Navy specifications and conform to Air Force-Navy Standard Drawings AN363, AN364, and AN365. They are made in a complete range of sizes from No. 4-40 through No. 5/16″-24.

The Kaynar Co., Dept. ED, Los Angeles, Cal.

CIRCLE 54 ON READER-SERVICE CARD

CIRCLE 55 ON READER-SERVICE CARD ➤

Portable Pyrometer

Accurately Measures Hot Glass

Applicable in a wide temperature range from 200°F to 1800°F, the new instrument, the Land glass pyrometer, will measure the temperature of plate glass before entering the lehr; bottles and other molded glass products coming from the molding machine, and such glass items as TV tubes in various stages of manufacture.

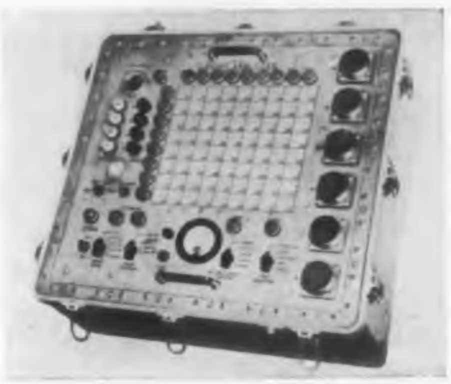
It consists of a measuring head mounted on an adjustable metal pole which can telescope to a length of 9 feet, and a small galvanometer temperature indicator. In accurately detecting the temperature of hot glass, the pyrometer utilizes long wave (over 5 microns) infra-red radiation, which responds to normally transparent or translucent glass as an opaque surface. The device is fully compensated for all temperature variations, such as ambient temperatures and heating of the instrument.

Fielden Instrument Div., Robertshaw-Fulton Controls Co., Dept. ED, 2909 N. Fourth St., Philadelphia 33, Pa.

CIRCLE 58 ON READER-SERVICE CARD FOR MORE INFORMATION

Electrical Circuit Analyzer

Tests 144 Circuits In Seconds



This new universal automatic electrical circuit analyzer is designed expressly for military use. The Model 144NX is completely waterproof, shockproof and vibration resistant. Its quality, flexibility and simplicity of operation in the field and on the flight line have been proved by extensive tests under every condition.

The instrument automatically tests up to 144 circuits in seconds. Electrically complex, interconnected, multiple circuits are tested for continuity or shorts with accuracy at extremely close predetermined values.

Faults are detected and identified immediately on the matrix chart. Tests may be made at both high and low voltages.

Electronics Div., DIT-MCO, Inc., Dept. ED, 911 Broadway, Kansas City, Mo.

CIRCLE 59 ON READER-SERVICE CARD FOR MORE INFORMATION

VTVM

Features Compact Size

The new Model 21-56 "Compact" VT-VM retains all the performance features of its prototype (Model 20-55), including fully automatic range-switching, automatic scale indicator lights, direct reading on an 8-1/2" meter (without zero multipliers) and complete burn-out protection up to 2000v.

In addition, Model 21-56 is notably compact in size (10" x 8-1/2" x 6"—weight: 11 lb) and convenient to service, with easy access (through a removable back plate) to batteries, fuses and controls.

The instrument measures a-c and d-c voltages from 0.1 to 1500v. It is particularly useful when dealing with unknown voltages. In measuring resistance, the instrument permits automatic reading from 0.5 to 1 billion ohms in 6 ranges.

Leitch Engineering Corp., Dept. ED, Manchester, N.H.

CIRCLE 63 ON READER-SERVICE CARD FOR MORE INFORMATION

Dual TR Shutter Tube

Has Integral Shutters For X-Band

The BL-317 is a new dual TR tube with integral shutters for X-band. It is designed to give complete crystal protection over a frequency range from 8500 to 9600Mc, when used between a balanced pair of shot-slot hybrid couplers.

The shutters operate on 28v d-c with a maximum current requirement of 320ma. The ignitor dropping resistors of 5.2 megohms are included and attached to the ignitors with leads brought to solder terminals on the terminal board. The ignitor voltage required on these terminals is —1000v d-c minimum.

The maximum cubic volume required for the BL-317 is only 10.2 cu in. The total weight increase resulting from the shutter mechanism is approx 4 oz.

Bomac Laboratories, Inc., Dept. ED, Salem Rd., Beverly, Mass.

CIRCLE 64 ON READER-SERVICE CARD FOR MORE INFORMATION

but only when components are reliable

Modern fire control and gun direction equipment must depend completely on the reliability of hundreds of components. The products of G-V Controls Inc. have been adopted by the major manufacturers of this vital equipment and have proven themselves by a long record of dependable performance.

G-V Hot Wire Time Delay Relays
1/10 to 5 seconds with fast recovery

G-V Thermal Time Delay Relays
Adjustable delays of 2 to 300 seconds

G-V Voltage & Current Sensing Relays
For circuit protection

G-V Electrical Thermostats
Hermetically sealed, still adjustable

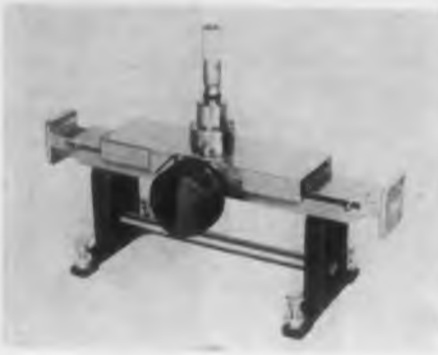
A well-qualified G-V Representative is ready to serve you. Write for data.

G-V CONTROLS INC.
18 Hollywood Plaza, East Orange, N. J.

CIRCLE 65 ON READER-SERVICE CARD FOR MORE INFORMATION

Variable Reactance

Rated at 300kw Peak Power



Model 910 is a new versatile high power variable reactance for the 8.20-12.4 kMc frequency range. This instrument is used to introduce a standing wave of desired magnitude and phase in a waveguide transmission line.

Rated at 300kw peak power in matched line, it operates directly at any power level up to the breakdown power level of the waveguide. The magnitude of the standing wave ratio in the line can be varied from 1.02 to 2.0 by means of a micrometer adjustment on the top carriage. The residual VSWR is less than 1.02 and the phase of the standing wave is separately variable by the movement of the carriage. Phase adjustment is greater than one-half wavelength at the lowest frequency. The phase scale offers direct reading to 0.5mm with vernier reading to 0.05mm.

Applications of the Model 910 are: high power breakdown studies, plotting Rieke diagrams, determining characteristics of high power magnetrons and klystrons, and determining breakdown power of system components.

Narda Corp., Dept. ED, Mineola, N.Y.

CIRCLE 69 ON READER-SERVICE CARD FOR MORE INFORMATION

Threaded Studs

For Potting Compounds

Threaded studs for molding in plastics, rubber, die castings, or potting compounds have been added to this threaded insert line. They are designed to be molded into the product at time of fabrication; no secondary operations for inserting or locking are required.

The studs are made with a knurled head to prevent rotation in use, and are provided with two circular relief bands as added protection against pullout.

They are made in all regular thread sizes from #2 to 3/8" for both NC and NF threads. Standard material is brass, but studs may be made to order from steel, aluminum or stainless.

Standard Insert Co., Dept. ED., 12270 Montague St., Pacoima, Calif.

CIRCLE 70 ON READER-SERVICE CARD FOR MORE INFORMATION

Electronic Frequency Counter

Measures Periodic or Random Frequencies

A commercial version of the military type AN / USM - 26, this frequency meter is a precision direct reading type, which displays the measured frequency automatically in digital form. Frequencies measured may be periodic or random; 10cy to 220Mc. In addition, the counter may be used to measure time intervals, pulse lengths, repetition rates, frequency drift, total events, etc.

The basic feature of the unit is a precision time base generator, operating from a crystal-controlled 100kc precision oscillator, which opens and closes a gating circuit. This allows the signal under measurement to actuate a counting circuit for a known time interval, thus giving a direct reading of cycles per unit time or frequency. The counting circuit reads directly in kilocycles.

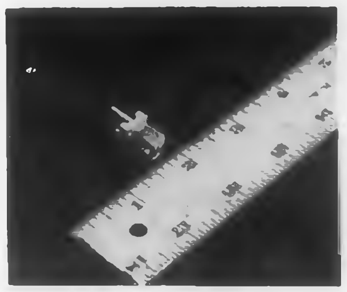
Period or time intervals are measured by reversing the roles of the time base generator and the signal under measurement. One cycle of the signal opens, the succeeding cycles closes the gating circuit, thus allowing the known frequency of the time base generator to be displayed.

Northeastern Engineering, Inc., Dept. ED, Manchester, N. H.

CIRCLE 74 ON READER-SERVICE CARD FOR MORE INFORMATION

Subminiature Trimmer Capacitors

Have Air Dielectric



Designated subminiature trimmer series 75, the new units are designed for tab mounting on dip-soldered printed wiring boards or screw-mounting on conventional chassis. The capacitors measure just 25/64" x 7/16" x 17/32" behind mounting surface.

They have a minimum effective capacity range of 5, 10, and 15μμf. The nominal minimum capacity of the units is 1.2, 1.2, and 1.5μμf.

The brass stator and rotor assemblies and rotor contact spring are silver plated. The units are easily adjusted by means of a screwdriver slot provided in the rotor shaft.

Radio Condenser Co., Dept. ED, Davis & Copewood Sts., Camden, N. J.

CIRCLE 75 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 76 ON READER-SERVICE CARD FOR MORE INFORMATION

Acceleration-Sensitive Switch

Operates at Pre-Set "G" Level

Suitable for use where instruments, controls, or safety devices are required to operate at a pre-determined acceleration level, the acceleration-sensitive switch has a snap-action switch element capable of being set precisely to open or close when the desired "g" level is reached.

Two basic styles are available: a momentary-contact unit that operates at the rated "g" level and snaps back to its initial position when the acceleration falls below this level, and a manually reset unit that latches on its operated position until the reset button is pushed. Both styles are available in explosion-proof case, or in hermetically sealed housing.

These switches are rated at 30v, 1 amp inductive or 2amp resistive load. They can be furnished to operate at any level from 2.5 to 15g absolute with precision of ± 0.2g; higher "g" ratings are available on special order. Frequency range is 0 to 10cy; shock resistance is 25g for 11 millisec, on all three axes. These switches are designed to function through a temperature range of -60 to $+180$°F and to withstand 100% humidity at 160°F.

Maxson Instruments, Div. of the W. L. Maxson Corp. Dept. ED, 47-37 Austell Pl., Long Island City 1, N. Y.

CIRCLE 79 ON READER-SERVICE CARD FOR MORE INFORMATION

Dual Servo Balancer

Provides Transducer Excitation

This new device provides transducer excitation and can handle multi-channel inputs in either a-c or d-c form. The outputs of the unit consist of the sum of the integral of the input plus a signal proportional to the amplitude of the input. The outputs have a 0 and 180° phase relationship to the input.

The proportional channel has an adjustable scale factor and the integral channel has an adjustable time constant. The phase relationship of the proportional channel to the integral channel can be either in phase or 180° out of phase.

Transval Engineering Corp., Dept. ED, 10401 Jefferson Blvd., Culver City, Calif.

CIRCLE 80 ON READER-SERVICE CARD FOR MORE INFORMATION

Digital Ohmmeter

5-Digit Display

This is a new digital ohmmeter that automatically measures and digitally displays resistance measurements to 5 digits. Called the Model DO50, it has a range of 0.1 ohm to 10 megohms, and is accurate up to 0.01% ±1 digit, depending upon the range.

Electro Instruments, Inc., Dept. ED, 3794 Rosecrans St., San Diego 10, Calif.

CIRCLE 153 ON READER-SERVICE CARD FOR MORE INFORMATION

D-C to D-C Power Supplies

Have Switching Transistor Circuit

Small size, light weight and elimination of moving parts are featured in this line of switching transistor d-c to d-c power supplies. These compact units invert low-voltage d-c to higher voltage d-c. Standard models operate from an input of 28v d-c. Outputs are available in 100, 250, 300, 400 and 600v, with power up to 60w max.

Arnold Magnetics Co., Dept. ED, 5962 Smiley Dr., Culver City, Calif.

CIRCLE 154 ON READER-SERVICE CARD FOR MORE INFORMATION

Fast Pulse Transmission Equipment

From D-C To 1 Millusec Pulses

This line offers most equipment needed for wide band pulse transmission problems from d-c to 1 millimicrosecond rise time pulses (0 to 350Mc). Standard co-axial cables are prefabricated to any desired length with any desired standard connectors.

Coaxial line terminations from any impedance from 50 to 200 ohms, impedance matching boxes for joining different impedance lines, pulse splitting-mixers, pulse attenuators, and variable pulse delay boxes are included.

Electrical and Physical Instrument Corp., Dept. ED, 42-19 27th St., Long Island City 1, N. Y.

CIRCLE 155 ON READER-SERVICE CARD FOR MORE INFORMATION

means
more value in
every

HI-Q† Plate Assembly

Something has been added — a brand new protective coating — **AEROROCK.** Which means that **HI-Q** Plate Assemblies now offer: still greater mechanical strength in withstanding rugged handling and assembling operations; some flexing; higher insulation resistance; greater immunity to moisture and other climatic conditions; still higher stability.

These handy **unitized** components are more popular than ever. The radio-electronic designer can start with entire block-diagram sub-assemblies instead of individual components, thereby saving untold time, labor, space, and even on overall cost. Wide choice of pre-wired capacitor-resistor combinations. With wire leads or with lug terminals for printed-wiring assemblies.

GET THE FACTS . . .

Write on business stationery for engineering data. Let our specialists collaborate with you on *unitized* or *modulized* assemblies.

*Trademark †Reg. Trademark

HI-Q® DIVISION

AEROVOX CORPORATION
OLEAN, N. Y.

In Canada: AEROVOX CANADA LTD., Hamilton, Ont.
Export: Ad Auriema, 89 Broad St., New York, N. Y., Cable: Auriema, N. Y.

CIRCLE 86 ON READER-SERVICE CARD FOR MORE INFORMATION

Microwave Signal Generator

Covers Frequencies of 4,200 to 11,000Mc

This is a new ultra broadband microwave signal generator covering a frequency range equal to two or more present day units. The MSG-34 covers S, C, and X Band frequencies—4200 to 11,000Mc—with a power output of 1mw. It is equipped with uni-dial construction which provides complete integration and simple operation. Large, direct-reading dials indicate frequency and attenuation.

Other features of the signal generator are: provision for external modulation by multiple pulses; automatically tracked power monitor; and non-contacting oscillator choke.

The modulator, utilizing printed circuit techniques, permits internal pulse and square wave modulation from 10 to 10,000pps at pulse widths of from 0.2 to 10μsec.

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

CIRCLE 87 ON READER-SERVICE CARD FOR MORE INFORMATION

Pulse Transformers

Have Fast Rise Times

This is a complete line of miniature and subminiature pulse transformers offering very fast rise times and high duty cycles. These components will greatly extend the use of pulse transformers in blocking oscillator and coupling circuitry for high-speed digital computers—especially airborne types. Some of these transformers have been operated at repetition rates of 5 to 6Mc and it is possible to obtain up to 40% duty cycle without backswing.

The transformers are either molded in epoxy resin, wound in a ferrite potcore, or encased in an aluminum can. They are constructed either as encapsulated or plug-in types. The latter type has a 7-pin molded glass base to fit a miniature 7-pin socket. The variety of core materials and winding methods makes possible a wide range of electrical characteristics.

Allen B. DuMont Labs., Inc., Dept. ED, 750 Bloomfield Ave., Clifton, N.J.

CIRCLE 88 ON READER-SERVICE CARD FOR MORE INFORMATION

Digital Timer

Has High Accuracy

Model 210 digital timer is a compact, 4-decade, electronic counting instrument. Glow-tube decades and simplified circuitry are employed to achieve high accuracy and extreme reliability in a volume less than 1/5 cu ft.

The 210 may be used as an electronic counter at rates as high as 60,000cy. Time is indicated in units of 100 or 1000usec. Maximum indicated time using one-millisecond unit is 10 sec.

Time is registered by counting pulses generated by an internal 100kc crystal-controlled oscillator, for an interval determined by externally applied Start and Stop impulses. Each timing cycle is initiated by momentarily pressing an internal or external reset button.

Hupp Instru/Mation, Dept. ED, 2119 Sepulveda Blvd., Los Angeles, Calif.

CIRCLE 92 ON READER-SERVICE CARD FOR MORE INFORMATION

Charge Storage Tube

For Use With Computers

This charge storage tube, called the "Radechon," is intended for use with computers and a variety of other type of information - processing systems. Design of the tube (RCA-*6499*) permits information in digital or analogue form to be introduced to the active elements, stored for a period of time controllable from microseconds to minutes, and then extracted at a rate the same as or different from the writing rate.

Features of the *6499* include an electron gun capable of providing an electron beam having high current density and relatively small cross-sectional area at the focus plane, and a storage surface having uniform secondary emission to provide a uniform output signal. Electrostatic deflection of the beam is utilized to permit the design of deflection circuitry having relatively low power consumption and providing high speed of response.

The Radechon is 12-7/32" long and 3.35" diam.

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

CIRCLE 93 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 96 ON READER-SERVICE CARD FOR MORE INFORMATION

Electronic Load

Has Mechanical Keying Device

Model 102 electronic load is a precision device which combines in a single, compact unit all of the conventional instrumentation required for the complete testing of regulated and unregulated power supplies.

The unit comprises a group of parelleled power tubes, a wide band modulation amplifier, a variable bias supply, a mechanical keying device, and an a-c vacuum tube voltmeter.

Built in controls provide for simulation of a wide range of static loads and measurements of dynamic characteristics under any conditions within the instrument's range. Physical size, compactness, ease of operation and reliability in continuous use make the unit suitable for field production testing as well as for laboratory use.

Electronics Div., Bristol Engineering Corp., Dept. ED, Bristol, Pa.

CIRCLE 97 ON READER-SERVICE CARD FOR MORE INFORMATION

Bonding Process

For Printed Circuit Laminates

This new bonding process results in faster production, fewer rejects and better printed circuits. The process is being adopted to form a new line of copper clads designated as the HP series.

The new copper clads possess double bond strength (12 to 15 lb) and a much higher dip solder temperature resistance (30 sec at 500°F). Production-wise, the HP series speeds up the operation, provides cleaner soldered joints, and minimizes bridging in the printed circuit. The materials also exhibit high retention of bond strength after repeated heating and cooling.

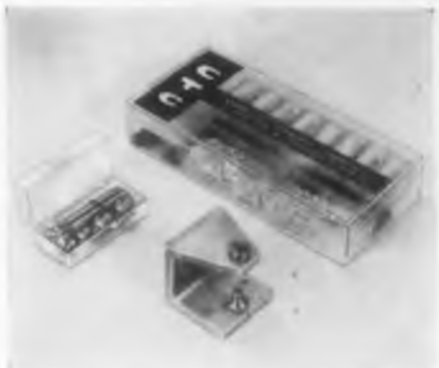
The process includes a method for uniformly conditioning the bonding surface of either electrolytic or rolled copper foil. Combined with this is the use of a stronger adhesive for bonding the treated copper surface to the laminate. The process applied to the HP series forms a thin, pure cupric oxide layer which acts as a primer coat for the subsequent adhesive coating.

National Vulcanized Fibre Co., Dept. ED, 1055 Beech St., Wilmington 99, Del.

CIRCLE 98 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 99 ON READER-SERVICE CARD FOR MORE INFORMATION

New Solder Terminal Kit Complete with Tools



A new solder terminal board kit containing all needed tools has just been announced by Cambridge Thermionic Corporation.

This "package" unit contains 100 each of the popular types of the CTC solder terminals, together with anvils and punches for making assemblies. All terminals are supplied for 1/16" thick boards and are standard CTC grade with silver plating and water dip lacquer.

The kits are suitable for prototypes and sample terminal boards for laboratory work. Terminals supplied are designated X1558, X2027, X1785, X2040, X2041, X2042, X2043, X2044, X1548 and 1724.

Manufactured to CTC's rigid quality standards. For specifications and prices write direct. Cambridge Thermionic Corporation, 457 Concord Ave., Cambridge 38, Massachusetts.

CIRCLE 100 ON READER-SERVICE CARD FOR MORE INFORMATION

Germanium or Silicon Diodes

For Transistor Bias Stabilization

These new circuit elements are germanium or silicon diodes produced to close tolerance limits in the forward direction. They exhibit relatively high resistance in the pre-threshold region, then break sharply with the dynamic resistance dropping to the region of 10 ohms or less.

The stabistors are particularly useful for transistor bias stabilization, and significantly reduce bias power requirements. Their predictable temperature coefficient allows compensation for the effects of temperature on transistor circuits.

Transitron Electronic Corp., Dept. ED, Melrose 76, Mass.

CIRCLE 102 ON READER-SERVICE CARD FOR MORE INFORMATION

Wire-Wound Controls

For Printed Wiring

For fast, efficient insertion in printed-wiring assemblies, this redesigned version of the space-saving Series 39 "Humdinger" control has been developed. Mounting is by two tabs for positive locking to printed-wiring board.

The control is rated at 2w. Resistance range is from 4 ohms to 5000 ohms. It measures 3/4" diam by 3/8" deep. Adjustment is by screwdriver slot.

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

CIRCLE 103 ON READER-SERVICE CARD FOR MORE INFORMATION

Electric Oven

Operating Range 100 To 850° F

This is a new line of electric ovens capable of operating in the range of 100-850°F. The unit is particularly adaptable for aircraft component laboratories and test facilities or as a small production unit for silicone, teflon and other high temperature curing productions. Four standard sizes are available. Special instrumentation may be provided as an extra.

Steiner-Ives Co., Dept. ED, Springfield Rd., Union, N. J.

CIRCLE 104 ON READER-SERVICE CARD FOR MORE INFORMATION

2N156
CBS
2N158

KA-Band Barreter

Interchangeable Coaxial Cartridge

This coaxial type barreter (bolometer) has been developed for r-f attenuation and power measurements in the 26.5-40kMc region.

Designated as the MA-571, the unit is housed in a coaxial cartridge which is physically interchangeable with the 1N53 mixer diode. This feature allows its use in any tunable 1N53 crystal holder. For optimum performance, the d-c bias is adjusted to approximately 6ma, which allows operation of the barreter at 200 ohms resistance.

Microwave Associates, Inc., Dept. ED, 22 Cummington St., Boston, Mass.

CIRCLE 107 ON READER-SERVICE CARD FOR MORE INFORMATION

Hysteresis Clutch

140 Oz In Torque

This hysteresis clutch has been designed for use in applications requiring proportional torque control.

Torque generated in the clutch is 140 oz in with input power of 65ma at 78v d-c. The coil resistance at 25° is 1200 ohms. Overall dimensions are approx 3-5/8″ OD and 4-1/2″ length.

American Electric Motors, Div. of American Electronics, Inc., Dept. ED, 655 West Washington Blvd., Los Angeles 15, Calif.

CIRCLE 108 ON READER-SERVICE CARD FOR MORE INFORMATION

Storage Oscilloscope

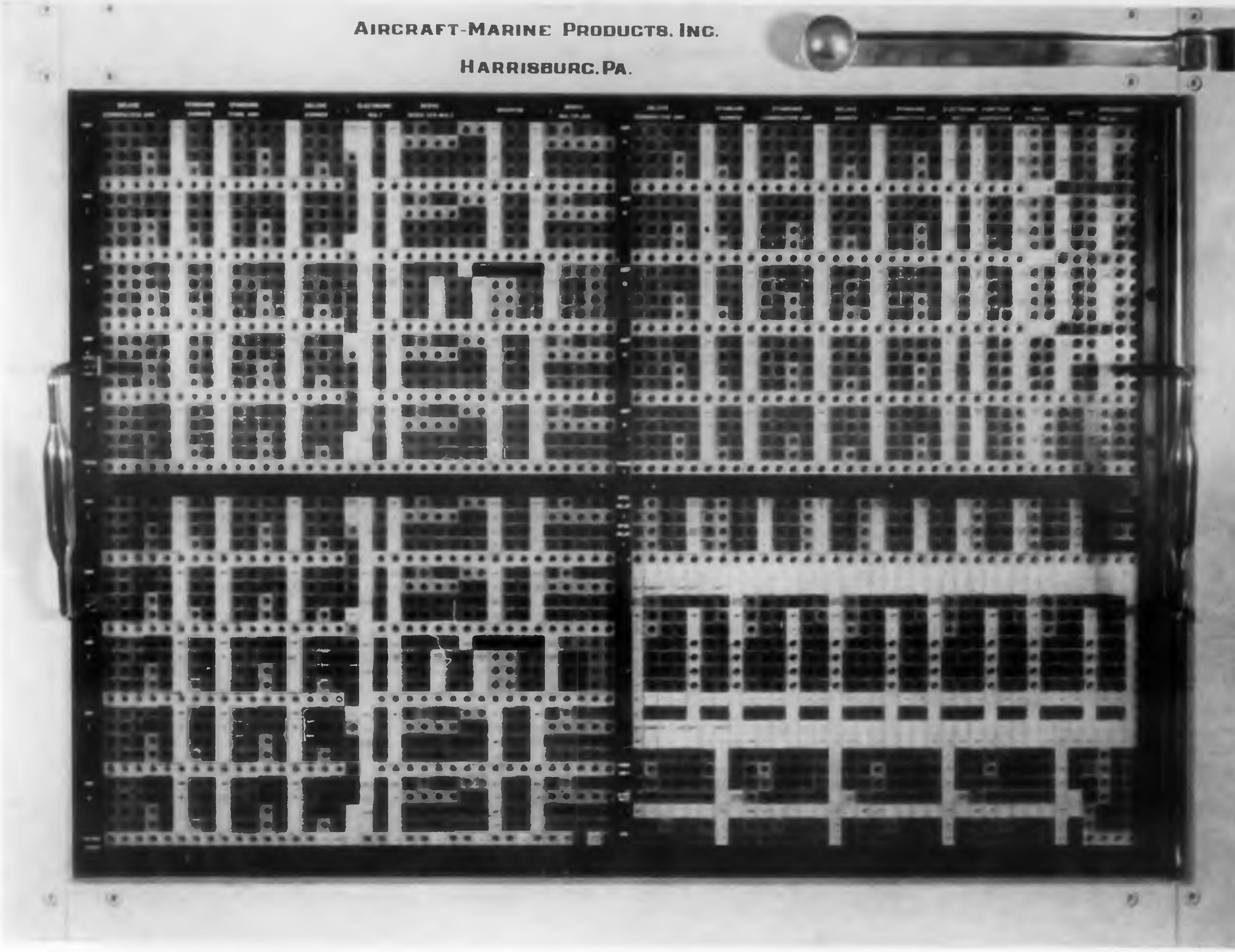
Retains Traces Indefinitely

Basically, the Memo-Scope 103 is a storage oscilloscope. It forms and retains traces at a constant intensity until they are deliberately erased by the operator. This feature permits the study of transient electrical phenomena as short as 10μsec in duration, presentation of tube and transistor characteristics without the necessity of repetition, display of frequency response curves without the need of a sweep generator, spectrum analyses, etc.

Advanced Electronics Mfg. Corp., Dept. ED, 2025 Pontius Ave., Los Angeles 25, Calif.

CIRCLE 109 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 497 ON READER-SERVICE CARD ➤



THE NEW A-MP CELLULAR, SHIELDED PATCHCORD PROGRAMMING SYSTEM

Carbon Microphone

Moisture-Proof

This new carbon microphone, built for extreme ruggedness in mobile communications use, can be shielded with a special rubber boot making it completely moisture proof.

Known as the C504C, the microphone has a Bakelite case, is 2-1/8" by 1-5/16" in size, and weighs but 9 oz. With a 40 ohms impedance and a frequency response in the 200 to 5000cy range, the microphone is suitable for use as a close talking unit.

Elgin National Watch Co., Dept. ED, Elgin, Ill.

CIRCLE 112 ON READER-SERVICE CARD FOR MORE INFORMATION

Gram Gage

From 0.5 To 5 Grams

This is a gram gage for measuring minute pressures having a range of 0.5 to 5 grams. Illustrated in use for checking brush tension on a synchro, this tool will be the answer to problems concerning measuring of extremely low pressure. The line now covers a total range from 0.5 grams to 1000 grams or its equivalent in ounces, using only 9 gages. The first 6 gages have a dial diameter of 1-1/2" and the 3 larger ones 2-1/2" diameter.

George Scherr Co., Dept. ED, 200 Lafayette St., New York 12, N. Y.

CIRCLE 113 ON READER-SERVICE CARD FOR MORE INFORMATION

Radiant Heating Units

Wide Range of Applications

A much wider range of application is the principal advantage offered by two new types of radiant heating equipment. The new style radiant heating components include: (1) quartz lamp oven sections, and (2) radiant rod oven sections, both designed for easy assembly into complete infrared ovens.

The Fostoria Pressed Steel Corp., Dept. ED, Fostoria, Ohio.

CIRCLE 114 ON READER-SERVICE CARD FOR MORE INFORMATION

RADAR TRANSFORMERS AND INDUCTORS

ONE OF MANY TESTS made on G-E oil-filled components is this six-hour vibration check.

PRETESTED G-E RADAR TRANSFORMERS HELP YOU

Speed Up Production of Your Radar System

Have you ever had to stop production to replace a faulty component—or to retest all units of one kind? Headaches like these make production engineers turn gray. Install pretested G-E oil-filled radar transformers and inductors for more dependability.

Thermal cycling, vibration, moisture resistance, and special ultraviolet leak detection tests are made in addition to routine electrical tests to provide more reliable units and cut time losses.

Progress Is Our Most Important Product

GENERAL ELECTRIC

SEND ME YOUR NEW RADAR COMPONENT BULLETIN

General Electric Co., Section D 434-3
Schenectady 5, New York

Name ....

Address ....

City ....

State ....

CIRCLE 115 ON READER-SERVICE CARD FOR MORE INFORMATION

Twin Power Triode

Higher Amplification Factor

Designated Type 5998, this tube is recommended for use when circuit conditions demand a tube with higher amplification factor than provided by Chatham type *6AS7G* or the *6080*. Features of the *5998* twin power triode include very low microphonics, improved triode balance, reduction of plate current drift and absence of grid current.

Electrical data include: a mu of 5.5; transconductance of 14,000μmhos; and a plate dissipation of 13w/plate.

Chatham Electronics, Div. of Gera Corp., Dept. ED, Livingston, N.J.

CIRCLE 116 ON READER-SERVICE CARD

Layout Grid Paper

For Designing Printed Circuitry

This is a new layout paper with reproducible grid, designed especially for the easier drafting of printed circuitry drawings. Although the grid pattern is drawn to 1/10" segments, drawings made on it may be two, three or four times actual size for clearer and cleaner reproduction after reduction to actual size.

This new reproducible-grid paper is of 12" x 24" sheet size, and is available in lots of 100, 200, and 500 sheets at cost comparable to regular drafting paper stock.

Photocircuits Corp., Dept. ED, Glen Cove, N.Y.

CIRCLE 117 ON READER-SERVICE CARD

Dowel Pins

#303 Stainless Steel

Type #D2 precision ground dowel pins are available in the following basic diameters 1/32, 1/16, 3/32, and 1/8", the most common used in the instrument field. They are available in lengths from 3/32" to 7/8" long and are held to precision tolerance within ± 0.0001 on the diam.

Material is #303 stainless steel and finished to a fine ground surface. It is clear passivated to remove any foreign substances.

PIC Design Corp., Dept. ED, 160 Atlantic Ave., Lynbrook, L.I., N.Y.

CIRCLE 118 ON READER-SERVICE CARD

◄ CIRCLE 119 ON READER-SERVICE CARD

Rate-Of-Turn Table

For Testing Rate Gyros

This rate-of-turn table, for use in calibrating and evaluating rate gyros has an accuracy of setting and repeatability of within 1%. Angular velocity is constant within approximately 0.25%, including cumulative drift, wow and flutter errors. Vibration accelerations do not exceed $\pm$ 0.015g at frequencies up to 500cy.

Genisco, Inc., Dept. ED, 2233 Federal Ave., Los Angeles 64, Calif.

CIRCLE 121 ON READER-SERVICE CARD FOR MORE INFORMATION

Rotary Multipole Switch

Has 16 Contact Positions Section

The new Type HT rotary multipole switch has twice as many contact positions per pole as previous switches of the enclosed type. It is designed for tap, transfer and selector service requiring interrupting rating up to 5 amp, 125v a-c. The make and break of the switching action is fully enclosed within the molded phenolic structure of each section. The switch will carry 10amp at 125v a-c. All-silver contacts provide low contact resistance, 0.001 to 0.005 ohm.

Electro Switch Corp., Dept. ED, Weymouth 88, Mass.

CIRCLE 122 ON READER-SERVICE CARD FOR MORE INFORMATION

Silicon Diodes

Have High Conductance

High voltage and current ratings, combined with operation up to 200°C, make this rugged silicon diode suitable for printed-board rectifier service in transistor or other power supplies.

Combined with forward current ratings up to 200ma, these units have inverse currents or less than 0.25μamp at voltages up to 225v. Two type IN486. A diodes can deliver up to 400ma at 65v d-c in a full-wave center tapped single-phase circuit.

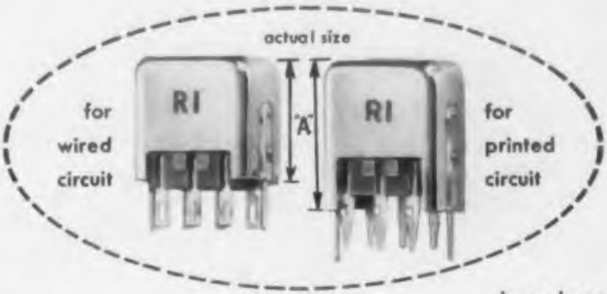
Transitron Electronic Corp., Dept. ED, Melrose 76, Mass.

CIRCLE 123 ON READER-SERVICE CARD FOR MORE INFORMATION

used by LEADING MANUFACTURERS! of transistorized radios

1/2" TRANSISTOR I. F. RI·trans

designed to meet any transistor impedance



top and bottom tuned • higher efficiency • low loss dielectric base material

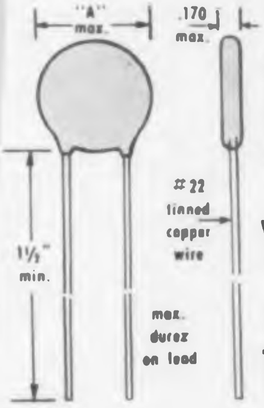
available in wired or printed circuit types

	type I		type II		type III	
	W.C.	P.C.	W.C.	P.C.	W.C.	P.C.
capacity in mfd.	65-450	65-450	125-450	125-450	140-450	140-450
"Q"	200 max.	200 max.	200 max.	200 max.	110 max.	110 max.
dim. "A"	45/64	27/32	37/64	23/32	37/64	23/32

low voltage class 2

DISC CAPACITORS

RI·CAP K-500 series



cap. in mfd.* +100% −20%	.001	.005	.01	.02	.03	.05	.10	.20
"A" dim.	.285	.285	.340	.400	.575	.595	.720	.720

**Above values also available in ± 20% tolerance*

W.V.—30 VDC **P.F.**—3% max. at 1 KC

I.R.—2500 megohms min. **T.V.**—2 X rating

T.C.—from 25°C to 10°C not greater than 20%, and 25°C to 65°C not over 60%

built by RI economical quantity production process

RADIO INDUSTRIES, INC.
5225 no. ravenswood ave. • chicago 40, ill.

write for details and prices

CIRCLE 124 ON READER-SERVICE CARD FOR MORE INFORMATION

99.07* ENGINEERS and DESIGNERS Stay with AC

THE ELECTRONICS DIVISION OF GENERAL MOTORS

PIONEERING OPPORTUNITIES in the following fields!

- MISSILE GUIDANCE SYSTEMS
- JET and TURBO PROP ENGINE CONTROLS
- BOMBING NAVIGATIONAL COMPUTER SYSTEMS
- AIRBORNE FIRE CONTROL
- U.H.F. COMMUNICATIONS
- MICRO-WAVE EQUIPMENT

* Our current monthly turnover figures are phenomenally good. Have been, we are proud to say, for years. It speaks well for the job opportunities, working conditions and the wages we pay our Engineers and Designers. Investigate for your future. Write us today.

Write today for Employment Application:
Mr. John F. Heffinger, Supervisor of Salaried Personnel

AC SPARK PLUG • THE ELECTRONICS DIVISION
GENERAL MOTORS CORPORATION
Milwaukee 2, Wis. Flint 2, Mich.

CIRCLE 125 ON READER-SERVICE CARD FOR MORE INFORMATION

Miniature Trimming Potentiometer

From 25 to 100k Ohms

Miniature trimming potentiometer, Model 303-00, offers a broad range of resistance values from 25k to 100k, with wide applications in electronic, electric or electro-mechanical systems. The unit measures only 0.750″ sq by 0.280″ thick with a 6.5 gram max weight.

Daystrom Potentiometer Div., Daystrom Pacific Corp., Dept. ED, 3030 Nebraska Ave., Santa Monica, Calif.

CIRCLE 126 ON READER-SERVICE CARD FOR MORE INFORMATION

Free Gyro

Compact and Versatile

Compact versatility is the primary characteristic of Model F10A-1 free gyro. Compactness centers around its dimensions—length 6.250″, diam 3.297″ and weight, 4.5 lb. An unusual feature is the a-c pickoff adjustment which can be made on the exterior of the gyro case, leaving the hermetic seal unbroken. D-c pickoffs are furnished in resistance ranges from 100k to 500k. A-c pickoffs can be either synchro or two-phase resolver.

American Gyro Corp., Div. of Daystrom Pacific, Dept. ED, 3030 Nebraska Ave., Santa Monica, Calif.

CIRCLE 127 ON READER-SERVICE CARD FOR MORE INFORMATION

Digital Magnetic Tape Handler

Start-Stop Time Less Than 5millisec

Increased reliability for digital computing and data processing systems is provided by new Model 101 digital magnetic tape handler. Magnetic amplifier reel servos provide improved dependability, greater output, and smaller size than the vacuum tube amplifiers they replace.

Key Electric Corp., Dept. ED, 287 Post Ave., Westbury, L.I., N.Y.

CIRCLE 128 ON READER-SERVICE CARD FOR MORE INFORMATION

Precision Stampings

For Aircraft and Electronic Equipment

Precision stampings of 1075 or 1095 carbon spring steels, are available annealed or tempered (clock spring steel), spring brass, phosphorous, bronze, aluminum, beryllium copper, or stainless steel. Applications include use in aircraft, guided missiles, and electronic equipment. Available in short, experimental, or pilot runs, these stampings are formed to close precision tolerances.

California Spring Co., Dept. ED, 8401 E. Slauson Ave., Los Angeles 22, Calif.

CIRCLE 131 ON READER-SERVICE CARD FOR MORE INFORMATION

Miniature Choppers

Rigidly Mounted

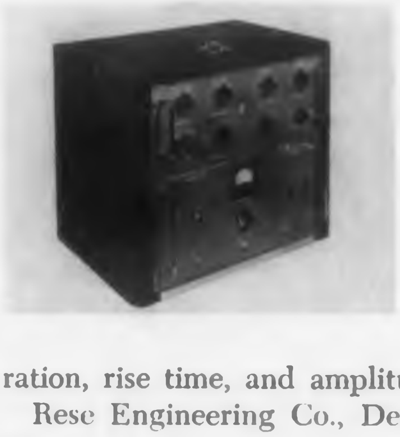
Types 175 and 300 miniature choppers are available with several mounting adapters. The illustration shows two of the more popular adapters: one for horizontal mounting, the other for vertical mounting.

Airpax Products Co., Dept. ED, Middle River, Baltimore 20, Md.

CIRCLE 132 ON READER-SERVICE CARD FOR MORE INFORMATION

Pulse Generator

Metered Current Output

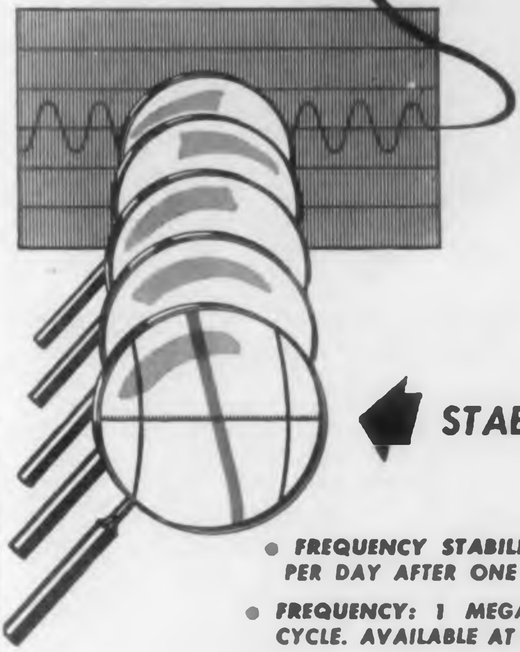


Model 1050 pulse generator is a new laboratory or production line pulse equipment for the generation of high current pulses at high frequencies, with full control over frequency, duration, rise time, and amplitude.

Rese Engineering Co., Dept. ED, Philadelphia, Pa.

CIRCLE 133 ON READER-SERVICE CARD FOR MORE INFORMATION

Precision Frequency Source...



Hycon Eastern's new Ultra Stable Oscillator is a one megacycle signal source of exceptional stability. It is useful wherever precise time measurements or frequency control are required, as in reinsertion of carrier in suppressed carrier systems, telemetry, astronomical measurements, navigation systems, geophysics or other critical applications.

STABILITY: 1 PART IN 10^9

- **FREQUENCY STABILITY: DRIFT RATE LESS THAN 1 PART IN 10^9 PER DAY AFTER ONE MONTH'S OPERATION.**
- **FREQUENCY: 1 MEGACYCLE, VARIABLE OVER A RANGE OF 1 CYCLE. AVAILABLE AT OTHER FREQUENCIES ON SPECIAL ORDER.**
- **CRYSTAL OVEN: STABILIZED TO BETTER THAN 0.01°C BY TEMPERATURE-SENSITIVE RESISTANCE BRIDGE. OVEN CONTAINS NO MOVING PARTS.**
- **DISSIPATION IN OSCILLATOR CRYSTAL: STABILIZED AT A POWER LEVEL LESS THAN ONE MICROWATT.**
- **2 OUTPUTS: SINE WAVE—4 VOLTS RMS; PULSE—1 VOLT.**
- **OUTPUT IMPEDANCE: APPROXIMATELY 250 OHMS.**

Write for Ultra Stable Oscillator Bulletin

HYCON EASTERN, INC.

75 Cambridge Parkway   Dept. F-7   Cambridge 42, Mass.
Affiliated with HYCON MFG. COMPANY, Pasadena, California

CIRCLE 134 ON READER-SERVICE CARD FOR MORE INFORMATION

Aircraft Compass System

High Accuracy Directional Gyro

Designated the Type MA-1, the compass is a highly accurate, all-purpose, gyro-slaved directional system designed for use under all operating conditions including high altitudes. Engineering features of the MA-1 include: high accuracy directional gyro with a random drift rate of less than 4°/hour; tubeless amplifier using silicon transistors and magnetic amplifiers, total weight only 16.7 lb., compact packaging of gyro and amplifier; printed circuits; and multiple indicators.

Lear, Inc., Dept. ED, Grand Rapids, Mich.

CIRCLE 136 ON READER-SERVICE CARD FOR MORE INFORMATION

Vaneaxial Fan

Miniaturized for Missile Use

Known as the AXIMAX II, the vaneaxial design of this fan is novel in that the motor is of the inside-out construction, whereby the electrical rotor and the air moving impeller are integrally cast in one piece.

Only 2" diam and 1-1/2" long, this fan moves 58cfm at free delivery and 35cfm at 2" static pressure. The entire unit weighs only 4 oz.

Rotron Mfg. Co., Dept. ED, Schoonmaker Lane, Woodstock, N. Y.

CIRCLE 137 ON READER-SERVICE CARD FOR MORE INFORMATION

High Voltage Connectors

In Two and Three Contacts

This is a new group of precision high voltage pressurized connectors in two and three contacts designed for an AN24 shell. These connectors were developed for altitude applications where leads are required for pressure-tight instrumentation.

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

CIRCLE 138 ON READER-SERVICE CARD FOR MORE INFORMATION

Momentary Contact Switch

Features A Normally "On" Position

This is a single-circuit momentary-contact switch featuring a normally "On" position. It is especially recommended for automatic control of lights, as in door openings.

Switch No. 29 is rated for 0.75 amp at 125v in a-c circuits. It has a molded-phenolic case and nickel-finished metal parts. Wiring into circuits is simplified by use of 6″ wire leads permanently attached to the switch.

Dimensions are: 1/2″ wide, 1/2″ thick, and 1″ long. The stem has a 15/32″ diameter and 9/32″ length.

McGill Mfg. Co., Dept. ED, Valparaiso, Ind.

CIRCLE 141 ON READER-SERVICE CARD FOR MORE INFORMATION

Sweep Circuit Analyzer

Leakage Tests Up To 50 Megohms

This is a new TV test instrument for dynamic trouble shooting of horizontal and vertical deflection and sync circuits. The Model 820 supplies 60cy sawtooth, 15kc horizontal sawtooth and horizontal output transformer drive for rapid trouble shooting of both sync and sweep circuits by signal substitution. Accessory probes produce the synchronization pulses.

In addition, the instrument provides a positive test of flyback transformers and yokes, using an oscillating neon indicator. The continuity test function of the analyzer checks insulation leakage up to 500 Megohms and provides a fast condenser test for open or leaky capacitors.

Winston Electronics, Inc., Dept. ED, 4312 Main St., Philadelphia 27, Pa.

CIRCLE 142 ON READER-SERVICE CARD FOR MORE INFORMATION

Particle Accelerator

Vertical or Horizontal Mounting

This new 3-million-volt Van de Graaff particle accelerator is designed to produce nearly all the fundamental radiations — electrons, x-rays, positive ions or neutrons. The accelerator can be shifted from electron processing to x-ray production by replacing the beam scanner of the machine with a special heavy metal target 1″ diam and 1/8″ thick.

High Voltage Engineering Corp., Dept. ED, 7 University Rd., Cambridge 38, Mass.

CIRCLE 143 ON READER-SERVICE CARD FOR MORE INFORMATION

Transformer

Reduced Size and Weight

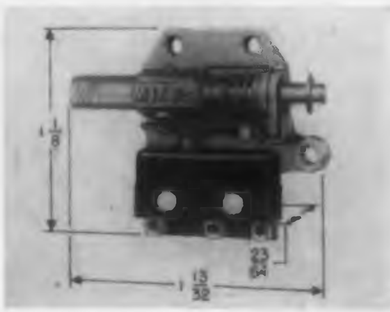
A new transformer manufacturing technique has been developed that results in size and weight reduction. The design is applicable to all types of units and finds particular advantage in heavy current windings. At present, facilities are limited to sizes up to 2kva.

Signal Transformer Co., Dept. ED, 2518 Coney Island Ave., Brooklyn 23, N. Y.

CIRCLE 146 ON READER-SERVICE CARD FOR MORE INFORMATION

Subminiature Interlock Switch

For Radio, Radar Cabinets



This is a new subminiature door interlock switch for use on radio, radar, x-ray, and other hazardous high frequency equipment cabinets.

This tiny switch, type 7AC1-T, is used to automatically cut off power when the service door is opened. By pulling a rod actuator to the maintained contact position, it is possible to check circuits with the power on. The rod automatically returns to normal position when the door is closed.

The total travel in either direction of the actuator plunger is 5/32″ approx. The overall size of the assembly is 1-13/32″ x 23/64″ x 1-1/8″.

Micro Switch, Dept. ED, Freeport, Ill.

CIRCLE 147 ON READER-SERVICE CARD FOR MORE INFORMATION

Semi-Rigid Epoxy

High Electrical Resistance

EPOCAST 15 is a new modified epoxy resin system developed and designed especially for electronic insulation applications requiring a semi-rigid, low modulus material that will still offer high electrical resistance throughout the temperature range of −65°F to at least +300°F. It combines good flexibility with outstanding properties as a dielectric material.

Furane Plastics, Inc., Dept. ED, 4516 Brazil St., Los Angeles, Calif.

CIRCLE 148 ON READER-SERVICE CARD FOR MORE INFORMATION

Classified Security Log

208 Pages, Registers Secret Information

The Defense Department requires that all prime and sub-contractors maintain a register of all classified information received, reproduced, originated, dispatched and destroyed. A separate log must be used for secret and confidential classifications. Each department operated by the contractor must keep its own registers.

The first page of Classified Security Log outlines with examples how entries are to be made covering all movements of classified material within and outside the plant. 206 pages form the log with an eleven column ruled form and appropriate headings.

The log page size is 8-1/2" x 14". Each page is numbered. The book is sewed, case (hard) bound and covered with buckram for long life. The price is $25.00 per copy for 12 or under.

Riverbank Laboratories, Dept. ED, 3630 Eastham Dr. Culver City, Calif.

CIRCLE 82 ON READER-SERVICE CARD

Encapsulating Material

For Electrical Circuits

Lockfoam is a gas-expanded, foamed-in-place, cellular plastic developed for use in the electrical and electronic industries as a potting and encapsulating material.

By its nature, this organic material makes an ideal potting medium for delicate electronic instruments, and an excellent barrier against deterioration of electrical wire connections, resistors, capacitors, electron tubes, etc.

Lockfoam's light weight and strength, resulting from its closed cell structure, assures a tamper-proof assembly that protects sensitive instruments against shock and vibration, corrosion, dampness, and fungi growth. Its high heat resistance and ability to withstand thermal distortion make it a suitable material for heating systems.

Nopco Chemical Co., Dept. ED, Harrison, N.J.

CIRCLE 83 ON READER-SERVICE CARD

CIRCLE 84 ON READER-SERVICE CARD ➤

ACTUAL SIZE

Photocells

In 11 Sensitivity Categories

Power sufficient to operate a relay at normal daylight levels is featured by this new line of cadmium sulphide photocells. The highly miniaturized unit will control a commercial sensitive relay without amplifications.

Called "Powermaster Photocells," these elements are light sensitive over the entire visible spectrum, with a peak sensitivity to a blue-green color. They have a low noise level and high dark resistance.

The photocells are divided into 11 sensitivity categories. Low impedance cells are intended primarily for direct relay operation, while high impedance cells are intended for use with an amplifier. The sensitivities range between 20 and 1500μamp (5megohms down to 67,000 ohms) at the very low illumination of 1 foot candle. With proper amplification, these photocells will detect 0.001foot candle.

Hupp Electronics Co., Div., of Hupp Corp., Dept. ED, 743 Circle Ave., Forest Park, Ill.

CIRCLE 157 READER-SERVICE CARD

Standard-Circuit Modules

Speeds Up Prototype Assemblies

These standard-circuit modules and handy breadboard are designed for simplifying and speeding up experimental and prototype assemblies. Engineers, technicians, experimenters, and special equipment builders can work up breakboard layouts by simply plugging in complete basic-circuit modules in the breadboard sockets, and completing the necessary connections with banana plug jumpers plus the basic bus-bar wiring of the breadboard.

They are now available in seven popular and basic circuits or block diagrams. Each module includes all necessary components on the stacked wafers wired together by the riser conductors and provided with base prongs for plugging into a socket.

Aerovox Corp., Dept. ED, New Bedford, Mass.

CIRCLE 158 ON READER-SERVICE CARD

◄ CIRCLE 159 ON READER-SERVICE CARD

Delay Lines

Pushbutton Decade Units

These 8 new pushbutton decade delay lines are ideally suited for laboratory applications to facilitate the development of advanced computer and radar systems. Designated as Series #200 and Series #200-R, the units can be terminated in their characteristic impedance at the selected tap.

ESC Corp., Dept. ED, 534 Bergen Blvd., Palisades Park, N. J.

CIRCLE 162 ON READER-SERVICE CARD FOR MORE INFORMATION

Revolution Counter

For Use On Tape Recorders

Model KU 142 revolution counter is designed for use on tape recorders on dictating machines to indicate position on the tape. The unit is essentially a mnemonic device whereby the location of the message or any portion of the message is indicated by clock position rather than direct numerical values.

This unit can be furnished with or without an illuminated dial, and for different types of mounting and different types of drives out of the back. Overall size is 1-13/32" x 1-13/16" x 1-29/64". The diameter of the clock face itself is 1-13/64".

Presin Co., Dept. ED, 12128 W. Pico Blvd., Los Angeles 64, Calif.

CIRCLE 163 ON READER-SERVICE CARD FOR MORE INFORMATION

Tachometer Servo Motor

Has Low Null Voltage

This is a size 15 tachometer servo motor combination featuring an accurate and stable tachometer section. The unit passes all military qualification tests without deviations.

The drag cup type tachometer has an extremely low null voltage. Null voltage is a maximum of 0.008v a-c fundamental and 0.013v a-c rpm. Output voltage is 3.2v a-c/1000rpm.

Input is 115v a-c 400cy on single-phase and 115 or 230v a-c on the control phase. Torque is 1.5oz in at stall. No load speed is 4500rpm.

Basler Electronics, Inc., Dept. ED, Highland, Ill.

CIRCLE 164 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW! BENDIX-FRIEZ DESIGNER'S THERMISTOR KIT

12 Individually Packaged Rod-Type Elements, 25 to 1,000,000 ohms range

Here's a real time-saver for the busy designer from Bendix-Friez.* This new Rod-Type Thermistor Kit contains twelve standard elements for applications in sensing, controlling and indicating devices. Handy compartment case keeps thermistors separate and ready for quick use. Indexed boxes save time, assist in specifying and ordering.

These twelve thermistor elements range in resistance from 25 ohms to 1,000,000 ohms. Kit comes complete with specifications, covering dimensions, voltage-current characteristics and temperature resistance relationships. An up-to-date list of references are cataloged for your convenience according to thermistor applications. Mass quantities available for any or all of these 12 different thermistors.

*Reg. U. S. Pat. Off.

Order your kit now. Or write for complete information.

Bendix-Friez

FRIEZ INSTRUMENT DIVISION
BENDIX AVIATION CORPORATION
BALTIMORE 4, MD.

Export Sales and Service:
Bendix International Division
205 E. 42nd St., N. Y. 17, N. Y., U. S. A.

Bendix-Friez
1406 Taylor Avenue
Baltimore 4, Maryland

Gentlemen:

Enclosed is my check for $..................(add .50 per kit for packing and shipping charges). Please send.......... No. 100 Designer's Thermistor Kits. C.O.D.'s accepted.

Name..............................

Street..............................

City.................... State..........

CIRCLE 165 ON READER-SERVICE CARD FOR MORE INFORMATION

Thermostats
High Capacity Ratings

This is a new series of thermostats with exceptionally high capacity ranges in ratio to thermostat size. The resistive load is 6000w at 240v a-c, 3000w at 120y a-c.

The Type E series thermostats are preset, snap action, non-adjustable and are designed to be used for operating temperatures up to 350°F. E series thermostats are for s-p-s-t operation and can be supplied with normally open or closed contacts; are available with inclined blade, horizontal blade or screw terminals; surface or air stream mountings—enclosed or exposed bimetal discs.

Thermo-O-Disc, Inc., Dept. ED, Mansfield, Ohio.

CIRCLE 167 ON READER-SERVICE CARD FOR MORE INFORMATION

Switching-Type Transistor
For D-C Converter Applications

Designated as type OC76, the new transistor was developed particularly for d-c converter applications. Some of its important uses as a d-c converter will be in the high voltage supplies of portable and mobile radio sets, in transistorized photo-flash units and in Geiger counters.

Amperex Electronic Corp., Dept. ED, 230 Duffy Ave., Hicksville, L. I., N. Y.

CIRCLE 168 ON READER-SERVICE CARD FOR MORE INFORMATION

Sealed Potentiometers
Wire-Wound and Composition-Element Types

These "Potpot" units are available in both wire-wound and composition-element types, including the series 48 and 49 miniature controls, the 43, 37 and 51 medium-sized controls, and the larger 58 and 10 wire-wounds.

The molded, smooth, green-colored encapsulating material means water- and vapor-tight molded enclosures, imbedding the entire unit with the exception of the external shaft assembly and terminals. A special water-tight assembly for the shaft bushing completes the sealing.

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

CIRCLE 169 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 173 ON READER-SERVICE CARD FOR MORE INFORMATION

Mercury Switch Pulser

Up To 10Ma Delivered Output

Model N-101 mercury switch pulser is ideally suited for calibration and stability measurements involving scintillation spectrometry circuits. The instrument features: continuously adjustable rise time (0.03-0.5sec); output up to 10ma (max 22v) either polarity and continuously variable with better than 0.1% linearity; battery pulse source; stability better than 0.1% per day after initial warm up.

Hamner Electronics Co., Inc., Dept. ED, P. O. Box 531, Princeton, N. J.

CIRCLE 174 ON READER-SERVICE CARD FOR MORE INFORMATION

Traveling Wave Tubes

For S-Band and X-Band

These two traveling wave tubes feature broadband operation over their respective bands. Their greatest use is utilization of their pulsed power characteristics in microwave measurement applications and in medium power driver applications. Positive grid control is provided for amplitude modulation and automatic gain control.

The tubes are designated the HA-12 in S-Band and the HA-13 in X-Band.

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

CIRCLE 175 ON READER-SERVICE CARD FOR MORE INFORMATION

Germanium Diodes

Have High Conductance

These new germanium diodes have typical forward voltage drops of 1v at currents up to 200ma. Used in transistor circuits, they offer improved switching performance and greater efficiency as a result of the low forward impedance afforded by the gold bonded construction.

Transitron Electronic Corp., Dept. ED, Melrose 76, Mass.

CIRCLE 176 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 177 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Rectifier Guide — 181

A 12-page guide has been published describing different sizes and styles of rectifiers for every d-c power need, annotated with detailed information to aid in the selection of rectification equipment for specific applications. The pamphlet also illustrates a self-contained selenium unit which is typical of the recently introduced Sel-Rex "economy line" of quality rectifiers. Bart-Messing Corp., 125 Manchester Pl., Newark, N.J.

Wire Material — 182

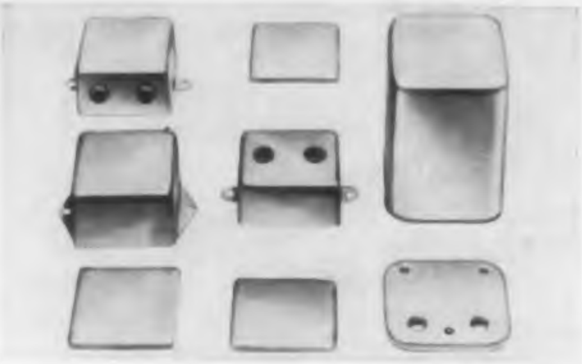
A booklet has been issued describing techniques for installing connectors, lead wires and T/C junctions upon their swaged MgO wire. The catalog illustrates various accessories which aid in designing and fabricating components of swaged MgO. Applications are also included. Aero Research Instrument Co., 315 No. Aberdeen St., Chicago 7, Ill.

Facilities Report — 183

An 8-page catalog has been released giving a new facilities report entitled "Electronic Advancement," describing available engineering and production facilities. Also, a 12-page insert has been included giving detailed characteristics of coaxial, waveguide and airborne lobing switches. Thompson Products Inc., Electronics Div., 2196 Clarkwood Rd., Cleveland 3, Ohio.

Shielding For Tape Recordings — 184

A data sheet has been offered describing how to protect tape recordings from various low and high intensity magnetic fields by storing or carrying in Fernetic and Co-Netic protective cans. In addition, the release includes dimensions, prices and terminology. Perfection Mica Co., Magnetic Shield Div., 20 No. Wacker Dr., Chicago 6, Ill.



"Bathtub" Condenser Cans and Covers

A new catalogue illustrating a complete line of "bathtub" condenser cans for the capacitor industry is available from the manufacturer, Northern Metal Products Company of Franklin Park, Ill.

Northern features a line of triangular ear and regular bathtub type cans, available in lake copper or steel, and with hot solder coating and extruded holes, as desired.

A complete line of transformer housings and lids is also available.

The company's modern facilities are available for producing chassis and other large and small electronic parts to specifications in production quantities or in small run lots. Write for catalog material or quotations to Northern Metal Products Company, 9595 West Grand Avenue, Franklin Park, Illinois.

CIRCLE 188 ON READER-SERVICE CARD FOR MORE INFORMATION

Computing and Simulation Service 190

A 7-page brochure has been offered describing simulation, computing, data reduction and data processing. Included in this booklet are written explanations and descriptive diagrams showing the flow of data. From the problem analysis and preparation service, the data is routed to the desired facility—analog simulation—digital computing and record reading—analog-to-digital conversion—digital-to-analog conversion.
J. B. Rea Co., Inc., 1723 Cloverfield Blvd., Santa Monica, Calif.

Rack and Panel Connectors 191

Catalog R2 has been issued giving a complete listing of the rack and panel connectors manufactured by this company. Blue ribbon connectors, in standard, miniature and circular types, pin and socket connectors, and printed circuit connectors are included. Dimensions, current ratings and availability are given for each type. American Phenolic Corp., 1030 S. 54th St., Chicago 50, Ill.

Molded Fiber Glass 192

A 16-page catalog has been issued describing custom molding services. This illustrated booklet includes processes and lists mechanical, electrical and chemical properties of this product. Also included are fabricating operations which are performed on this material.
Molded Fiber Glass Co., 4403 Benefit Av., Ashtabula, Ohio.

Magnetic Tapes 193

A 12-page booklet has been issued describing the physical and magnetic properties of magnetic tapes and films, their physical properties as backing thickness, ultimate tensile strength, yield strength, elongation at break, residual elongation, tear and impact strength and coefficient of expansion. Minnesota Mining & Mfg. Co., 900 Fauquier St., St. Paul 6, Minn.

Plastics 194

A 100-page catalog has been made available giving definitions and detailed information on working with and buying plastics. The brochure includes hundreds of different items, their uses, applications, techniques and prices, and is a handy working guide for design and electronic engineers. Fry Plastics Co., 7826 S. Vermont Ave., Los Angeles 44, Calif.

A-C Transistor Voltmeter

Has 2uv Sensitivity

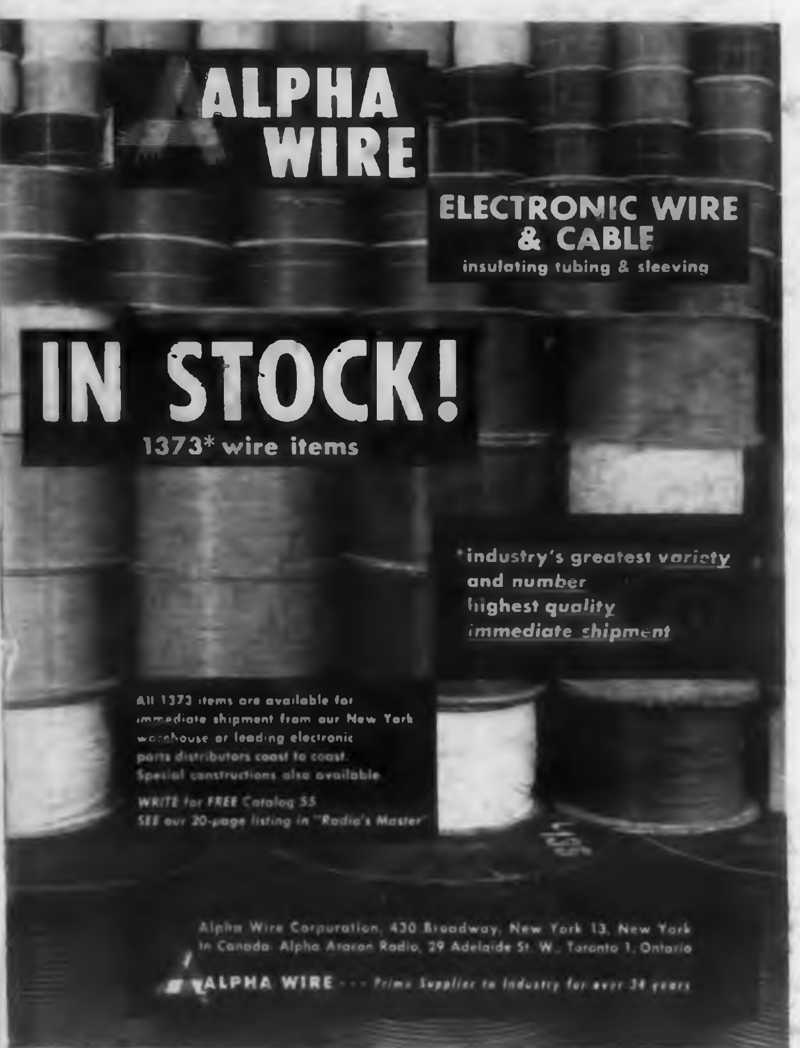
Unusual sensitivity of 2uv and battery operation make the Model MV-45A a-c voltmeter a new tool for laboratory use. Minimum battery life is 200 hours, made possible by 9 transistors incorporated in the unit.

Full scale ranges run from 10uv to 1kv in 10db steps, making a total of 17 ranges. Frequency range is 10cy to 150kc. Accuracy is 2% of full scale on all except the lowest range. Noise level in the MV-45A is well below 500 milli-microvolts over a 100kc pass band. All ranges from 3mv to 1kv have individual calibration controls.

MILLIVAC INSTRUMENT CORP.
444 SECOND STREET
SCHENECTADY 6, N. Y.

CIRCLE 196 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 198 ON READER-SERVICE CARD FOR MORE INFORMATION



CIRCLE 199 ON READER-SERVICE CARD FOR MORE INFORMATION

Welding Steel Castings 200

A 40-page manual has been published entitled, "Recommended Practice for the Welding of Steel Castings." The preface states: "the recommended practices outlined in the report are as adaptable to the fabricator as they are to the steel foundryman," and "the report should be assigned to the individual in the plant who is responsible for welding quality." Tempil Corp., 132 W. 22nd St., New York 11, N.Y.

Teflon Tape 201

A data sheet has been offered describing the availability of cementable Teflon tape in thicknesses as low as 0.005″. Included in the pamphlet are characteristics defining the dielectric properties of Teflon and broad service temperature range. The new cementable Teflon is available in continuous rolls in thicknesses from 0.005″ to 0.060″—in width from 1/2″ to 12″. Garlock Packing Co., Plastics Div., Box 93, Camden 1, N.J.

Plastic Laminates 202

An 8-page brochure has been published giving a complete range of industrial and decorative plastic laminates. The illustrated catalog contains descriptions of base materials, binders, sizes, tolerances and fabricating qualities, being marketed under the name Farlite. Farley & Loetscher Mfg. Co., Plastics Div., Dubuque, Iowa.

Microwave Components 203

An illustrated technical catalog has been made available describing a wide range of standard and custom-engineered microwave components and complex mechanical assemblies. These and similar components are available either as standard, built to blue print specifications or designed for and integrated into a particular application. J-V-M Engineering Co., 8846 W. 47th St., Brookfield, Ill.

Gram Gages 204

An illustrated brochure has been offered on a line of precision dynamometers, also known as gram gages or spring tension gages. Included in the brochure are numerous applications for these measuring instruments, some of which are: measuring contact pressures; checking predetermined measuring pressures; and as a spring tension indicator for the automotive field. George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.

Ribbon and Wire **208**

A new catalog has been issued describing ribbon and wire made of precious metals. The 24-page booklet includes specifications and illustrations of the various products.

Sigmund Cohn Corp., 121 S. Columbus Ave., Mt. Vernon, N. Y.

Survey Meter **209**

A bulletin has been released describing the "Cutie Pie" survey Meter Model CS-40. The pamphlet includes specifications, features and applications. A schematic diagram is also included showing the circuit arrangement.

NRD Instrument Co., 6425 Etzel Ave., St. Louis 14, Mo.

Circuit Selectors **210**

A data booklet has been published offering circuit selectors and stepping relays. The illustrated catalog includes applications, general features, and dimensional drawings of this product.

G. H. Leland, Inc., 123 Webster St., Dayton 2, Ohio

Transistors **211**

A new 32-page transistor brochure has been released featuring a complete line of miniaturized parts available and listing practically every transistor on the market. Whole pages are devoted to transistor specifications. Request brochure No. T4-56.

Lafayette Radio, 100 Sixth Ave., New York 13, N. Y.

Die Filer **212**

A new bulletin, No. 256, has been released illustrating and describing the Keller die filer, available in three models. This unit is extremely desirable for filing, sawing and lapping operations.

Sales Service Machine Tool Co., St. Paul, Minn.

Leak Detector **213**

Type H-1 leak detector is described in an 8-page bulletin, GEC-233F. Described are features, applications, specifications, and operation of this portable instrument for locating leaks in closed systems.

General Electric Co., Schenectady, N. Y.

Molybdenum Borides 219

A 6-page catalog has been released describing molybdenum borides. The booklet includes applications, and physical and mechanical properties of the product. The properties of these materials are high melting points, high hardness, excellent resistance to corrosion, and high electrical conductivity.
Climax Molybdenum Co., 500 Fifth Ave., New York 36, N.Y.

Terminals 220

A brochure has been issued describing the company's Wade-Weld terminals. Manufactured in continuous strips wound in coils, these terminals can be designed to crimp onto the wire or crimp on both the wire and insulation. The brochure also describes the company's Weld, Stake and Cut Off machine which automatically feeds coiled continuous strip terminals through a special mechanism to deliver a finished terminal connection on each stroke of the machine.
Wade Electric Products Co., Sturgis, Mich.

Instruments 221

A new quick reference catalog has been published describing various instruments in the company's line. Included are low and high frequency instruments, accessory instruments, recording equipment, cathode ray oscilographs, and accessory equipment. Included are illustrations, features, applications, specifications, and prices.
Allen B. Du Mont Laboratories, Inc., Clifton, N. J.

Aluminizer 222

A new 4-page, 2-color bulletin, No. 405, has been made available describing the Model CRS-48 aluminizer. The bulletin describes the construction of the unit, which is totally enclosed in a console-type cabinet of steel fitted with convenient, drawer-type control panel. The text discusses the method of operation and includes complete specifications and diagrams. Photographs illustrate the arrangement of components from the front and both sides.
Kinney Mfg. Div., The New York Air Brake Co., 3529 Washington St., Boston, Mass.

Testing Instruments 228

Eighty different devices are described in a 0-page "testing instruments reference ok" recently published. The publication, talog GEC-1016, contains complete prod- information including applications, rces of additional information and pic- s. There are instruments for research, duction, laboratories, and educational

G neral Electric Co., Schenectady 5, N.Y.

S miconductor Crystals 229

Technical data bulletin SMEL #1, "Con- Systems For Semiconductor Crystal Pr duction" has been offered to assist those connected in any way with the develop- ment or production of germanium silicon crystals. The first part of the bulletin out- lines the crystal growing process and the function performed by the element of con- trol systems. The second part describes the specific components of the control systems, and the final part combines the components into control systems.

Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia, Pa.

Solenoids 230

Bulletin No. 200 has been offered describing various type solenoids, continuous and intermittent duty, in the company's line. Featured are solid frame solenoids a-c and d-c and laminated a-c solenoids. Included are graphs showing performance and dimensional drawings giving size and mounting data.

Comar Electric Co., 3349 W. Addison St. Chicago, Ill.

Amplifiers 231

Two data sheets have been made available; one on a Type 34 recording amplifier, described in bulletin 4110, the other on the Type 82 playback amplifiers, described in bulletin 5102. The type 34 amplifier is one of a series designed for those systems utilizing direct recording techniques with a high frequency bias. Type 82 amplifiers are designed for the same systems and, in addition, for digital pulse reproduction.

The Davies Laboratories, Inc., 4705 Queensbury Rd., Riverdale, Md.

Patents

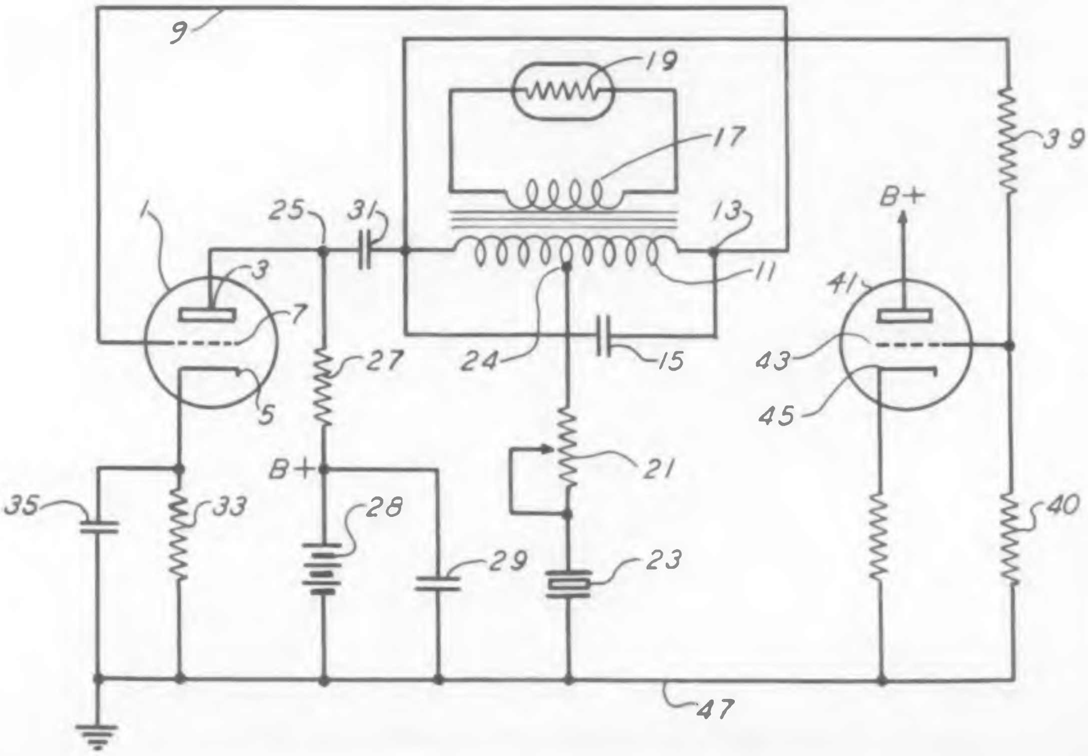
John Montstream

Stabilized Oscillator . . . *Patent No. 2,727,-993. N. N. Epstein. (Assigned to Lenkurt Electric Co., Inc.)*

In order to obtain an oscillator having a fixed frequency and with an output which remains at a substantial fixed amplitude, it has been necessary to rely upon various expedients which are more or less complicated. A stabilized oscillator which maintains a fixed oscillating frequency and a fixed amplitude of output without complex circuitry is described in this patent.

The basic oscillator circuit includes tube *1* with resonant circuit *11, 13* in series between the plate and the control grid. The circuit uses a T network with the resonant circuit in the series connection and peizo-electric crystal 23 in shunt between the electrical midpoint of inductor *11* and the cathode. The crystal is the primary frequency determining element rather than the series resonant circuit as in a Hartley oscillator.

When the oscillator is in operation at the fixed frequency, the resonant circuit and the shunt arm of the T network are both resistive, so that the oscillations on the control grid and cathode of the oscillator tube are in phase. If, however, the frequency should change even slightly, the impedance of the crystal and the shunt arm changes greatly because of its high Q. This results in the potentials applied to the grid becoming degenerative. The circuit will oscillate at the resonant frequency of the crystal even if the series arm of the T network is not accurately tuned to the resonant frequency.



In order to secure high amplitude stability, the circuit must be such that any changes in the amplitude results in a change which substantially increases any circuit losses. This result is secured by making inductor *11* the primary winding of a transformer and connecting resistance *19*, having a negative resistance characteristic, in series with secondary winding *17*. A thermistor 19 or thyrite material is a suitable element to supply resistor *19*. With the amplitude correcting circuit, any changes in the anode voltage which normally would change the amplitude of the oscillations is corrected by element *19*.

The circuit described secures frequency and amplitude stability in the oscillator with a very simple circuit. The output is derived from voltage divider *39* and *40* connected with the plate of the oscillator. The most suitable driving potential for tube *41* may be selected by adjustment of the grid connection with the voltage divider.

Cathode Ray Apparatus . . . *Patent No. 2,735,956. Joseph T. McNaney. (Assigned to General Dynamics Corp.)*

Cathode ray tube display means for visually presenting characters in response to an applied signal. The applied signal causes the electron beam to be deflected so as to pass through an appropriate mask which forms the beam in the shape of a predetermined character. Further deflection means are available so that the resulting character may be displayed anywhere on the fluorescent screen.

Two Speed Control Circuit . . . *Patent No. 2,735,971. Robert S. Raven and Harry C. Moses. (Assigned to the United States of America as represented by the Secretary of the Navy.)*

A servo system utilizing two synchros to produce both fine and coarse control. The fine control synchro is connected to the input by a high gear ratio while the coarse synchro utilizes a low gear ratio. If the error signal is small, the coarse control is disconnected by a diode circuit, and the fine control is operative. If, however, the error signal becomes larger, the diodes close and the coarse control becomes operative. It is thus possible to eliminate any ambiguity that might exist if the fine synchro were in error by a complete revolution.

Sound Recording Apparatus . . . *Patent No. 2,738,385. William Stephen Bachman. (Assigned to Columbia Broadcasting System, Inc., New York, N. Y.)*

Apparatus for the variable pitch recording of sound. This patent describes a system containing a rectifier circuit which develops a voltage proportional to the sound signal amplitude. This voltage controls a variable frequency oscillator which in turn drives a synchronous motor. The motor is used to control the position of the recording head; by changing the motor speed it is possible to vary the pitch of the recording. It is then possible to space the record grooves according to the amplitude of the signal and thereby conserve recording space.

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

An oscillator circuit consisting of a chain of cathode coupled monostable multivibrators connected plate to plate in a ring. The termination of the pulse from one multivibrator triggers the succeeding multivibrator and so forth around the ring with the result that sustained oscillations occur. By controlling the voltage on the grid of the normally off tube in each multivibrator, it is possible to independently control the duration of each pulse. The period of the complete cycle is the sum of the durations of the pulses produced by each multivibrator and thus can be controlled by a number of separate inputs.

Pulse Echo Altimeter With Sensitivity Time Control . . . *Patent No. 2,738,503. Horace C. Allen. (Assigned to Radio Corp. of America.)*

A pulse echo altimeter comprising a means for transmitting a pulse of radio energy to a reflecting object, a means for receiving and amplifying the reflected pulse, and an automatic gain control circuit for controlling the receiver gain. The automatic gain control is actuated by a voltage proportional to the distance of the reflecting object. The receiver thus always has sufficient sensitivity to detect the reflected pulse but is able to discriminate against undesirable reflections and noise.

Electron Discharge Device of the Traveling Wave Type . . . *Patent No. 2,735,958. William C. Brown. (Assigned to Raytheon Manufacturing Co., Newton, Mass.)*

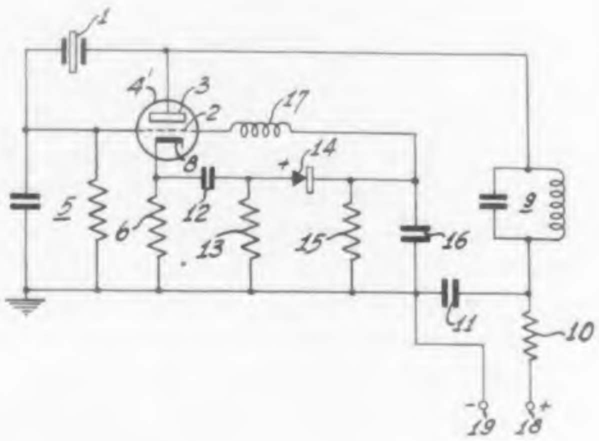
A high frequency electronic amplifier of the traveling wave type. A series of baffle plates serve to slow the signal wave such that it travels at approximately the same velocity as an adjacent electron beam. The interaction of the signal wave and the electron beam produces amplification.

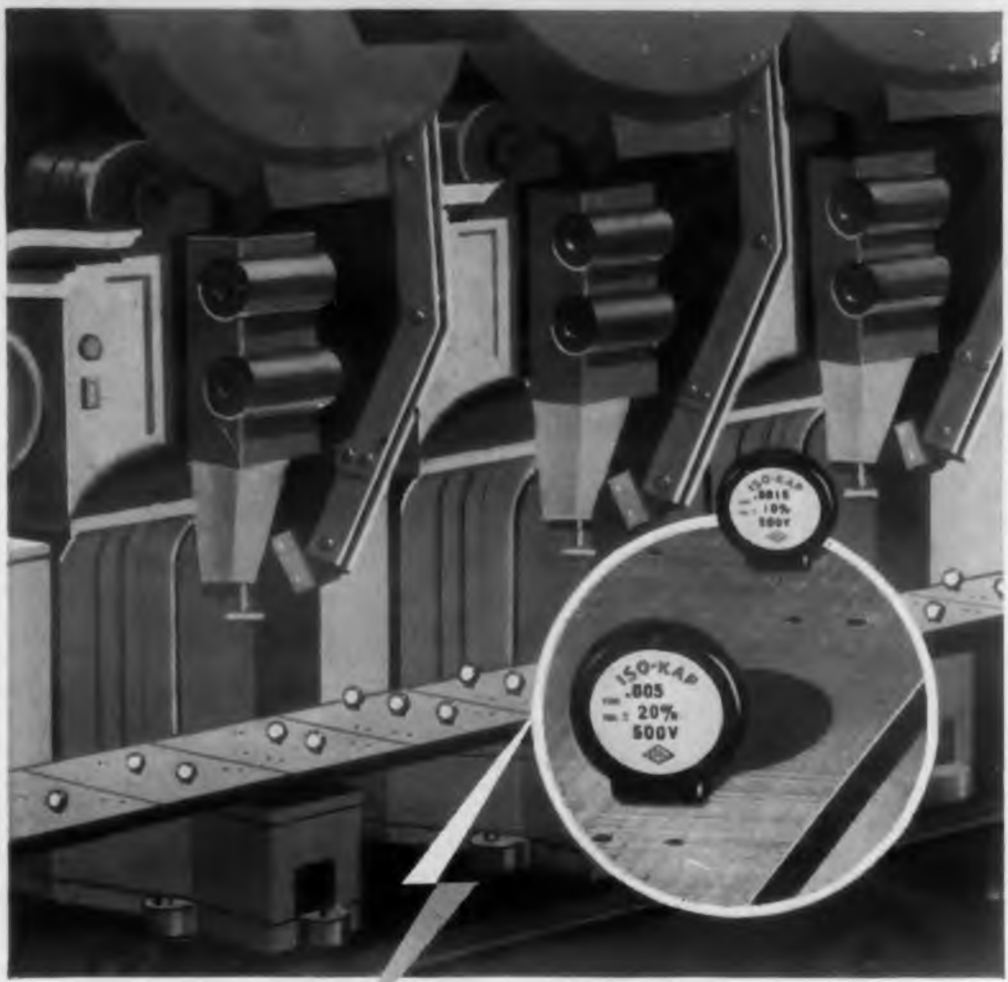
Amplitude-Stabilized Crystal Oscillator . . . *Patent No. 2,724,777. F. M. Brock. (Assigned to Radio Corp. of America)*

A Pierce type oscillator using a crystal coupling between the plate and grid tends to have a substantial harmonic content in the output and some amplitude instability. The circuit shown reduces the harmonic content and improves the stability of the oscillator.

These improved results are secured by providing rectifier *14* and resistor *15*, coupled to the cathode of oscillator tube *41*, through capacitor *12* and resistor *13*. Cathode resistor *6* is not bypassed by a capacitor as in the usual practice. Filter capacitor *15* is connected across resistor *15*. Rectifier *14* is connected in the circuit with its polarity such that the d-c voltage across resistor *15* is in opposition to the negative grid bias on the tube. The d-c voltage developed across resistor *15* is coupled to the control grid of the tube through choke *17*, which presents high impedance to the a-c voltage on the grid.

The a-c voltage on the grid does not then leak through the d-c portion of the circuit. The circuit substantially reduces the harmonic content of the oscillator output, and the amplitude of the output of the oscillator is made more stable as well.





Fast, positive insertions

in automatic assembly

Centralab Molded Disc Ceramic Capacitors

The only completely insulated ceramic disc capacitor. Breakdown to ground in excess of 3000 V. D. C.

Unaffected by extremes of vibration; by ozone, salt water, or any known acid or solvent at room temperature.

Leads dimensioned to meet automation standards.

- Thickness, diameter, and lead spacing always exact—for trouble-free feeding.
- Leads always on perfect center line — never offset.
- Lead strength greater than the tensile strength of No. 20 wire — leads can't pull out.
- Clearly labeled to avoid confusion and mistakes, in either machine- or hand-insertion. Stamped with capacity, voltage, rating and tolerance.

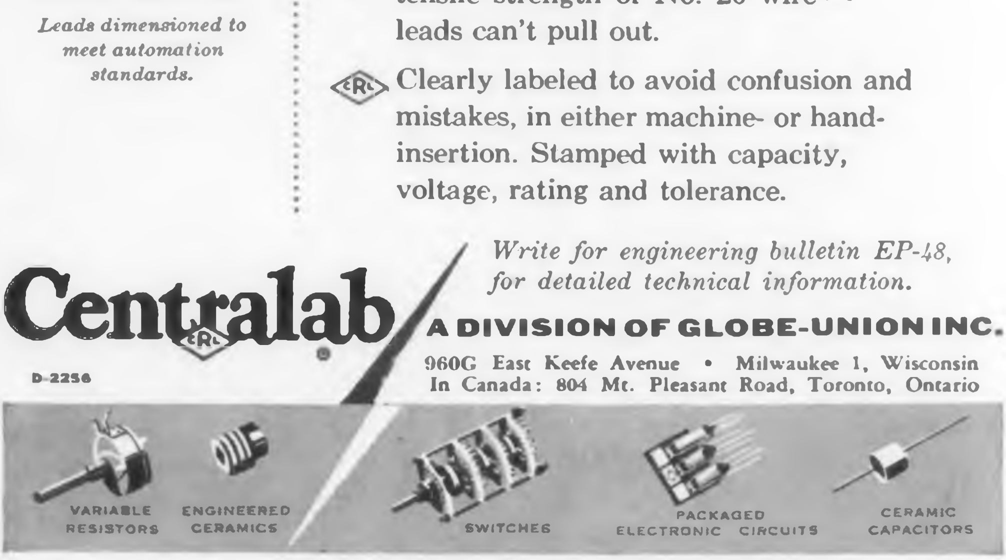
Write for engineering bulletin EP-48, for detailed technical information.

Centralab

D-2256

A DIVISION OF GLOBE-UNION INC.

960G East Keefe Avenue • Milwaukee 1, Wisconsin
In Canada: 804 Mt. Pleasant Road, Toronto, Ontario



CIRCLE 245 ON READER-SERVICE CARD FOR MORE INFORMATION

Books

Analysis of Electric Circuits . . . *William H. Middendorf. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. 306 pages, price $6.00.*

The author presents in this book a fundamental treatment of a-c and d-c circuit analysis, excluding all nonessential material. He first sets forth six basic physical laws and definitions established by the early experimenters. The reader needs only to learn the full meaning of these six laws and how to apply them with complex algebra to advance to our present store of knowledge.

The book's emphasis is on developing the reader's ability to think for himself. Proofs, rather than mere presentation, are accented. The book is conveniently arranged into three sections: the first section provides all that is necessary to meet the problems encountered in the usual undergraduate courses; the latter two sections extend the scope of the work for electrical engineers.

An unusual feature of this book is a valuable chapter on communications circuits. Some other special features included are: the development of the instantaneous power equations; the analysis of low Q resonant circuits; the use of the exponential form of Fourier's series; the analysis of star networks based on the node method; and the proof that the transfer and mutual impedances are linear and bilateral.

Industrial Research Laboratories of the U.S. Compiled by James F. Mauk . . . *National Academy of Sciences-National Research Council, 2101 Constitution Ave., Washington 25, D.C. 560 pages, price $10.00.*

This tenth edition for 1956 includes information on 4,834 laboratories of 4,060 companies gathered during the first half of 1955. The entry for each organization reported shows the names and locations of its laboratories, its principal research executives, the number of professional, technical, and administrative employees in each laboratory, as well as the kinds of research in which they are engaged. In addition, as an aid in finding individual laboratories or subsidiaries of large companies, an effort has been made to report the entire structure of an organization under its parent company's name with extensive cross-reference to component units, subsidiaries, and laboratories.

A simple alphabetical code indicates the types of research services performed by each laboratory, showing whether it undertakes research for only its parent company or sponsor or whether it also does fee or contract research for others, whether it offers consultation or advice, and whether it does testing and analysis.

An index of research activities includes well over 1,000 major subject headings. A 10-page index of the geographical location of the laboratories is also included. The usefulness of the directory for reference purposes is increased by the addition of an edge index to the alphabetical listing of the laboratories.

Color Television—Simplified Theory and Service Techniques . . . *Donald G. Fink. Philco Corp., Electronic Education Unit, Philadelphia, Pa. 288 illustrations, 100 in color, 50,000 words of text.*

The preparation of this book has taken two years of intensive study and research. The subject, usually considered very complex, has been skillfully and completely described in easy-to-understand terms, with many illustrations for further simplification. The book is technically accurate in every detail—theory, design, transmission, reception, installation, and service.

This book presents the subject in such a manner that the text and the illustrations will not be rendered obsolete by future changes in manufacturing and receiver design. A complete index is provided for rapid reference for any term or subject covered.

Industrial Automatic Controls . . . *Millard H. LaJoy. Prentice-Hall, Inc., 70 Fifth Ave., New York, N.Y. 278 pages, price $7.00.*

This book brings together new practical concepts of automatic controls of all types and the method of using each type in such a way as to achieve maximum performance.

The four basic modes of automatic control—2-position, proportional, floating (integral), and rate (derivative)—are treated separately in Chapters 2, 3, 4, and 5. Each control effect is given a thorough analysis. The controller output characteristic, when subjected to various input disturbances, is graphically shown. Many of the industrial automatic controllers which contain more than one control effect, such as proportional plus reset, proportional plus rate, or proportional plus reset plus rate, are discussed in Chapter 6. Chapters 7, 8, and 9 cover the internal circuitry of pneumatic, hydraulic and electronic controls. Each circuit is built up from the most simple elements required for 2-position control to the more complex arrangement of elements required for the proportional-reset-rate controller combination.

A representative group of applications described in Chapter 10 have been selected to show the diversity of industries utilizing automatic controls. Also included in this chapter are the Instrument Society of America's standard practice of identification, and symbols to be used in making instrumentation drawings.

Soviet Professional Manpower, Its Education, Training, and Supply . . . *Nicholas DeWitt. U.S. Govt. Printing Office, Washington 25, D.C. 400 pages, price $1.25.*

A knowledge of the capabilities of other nations in science and technology is an indispensable part of the background of our own national policies and programs in science. The last few years has brought increasing speculation as to the rate at which the Soviet Union is producing scientists and engineers and the quality of their specialized manpower. Data on the number of scientists and engineers coming up through the Soviet educational system have been fragmentary and incomplete, however.

The aim of this study was to investigate the availability and growth of the specialized manpower resources of the U.S.S.R. insofar as they might be judged from the Soviet educational effort during the past 25 years. Work on this study, in its present form, began in the summer of 1954 under the auspices of the National Academy of Sciences-National Research Council, with encouragement and financial support from the National Science Foundation.

Most of the research, the reconciliation of material, and the preparation of the manuscript were done at the Russian Research Center, Harvard Univ.

Radio Electronics . . . *Samuel Seeley. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y. 487 pages, price $7.00.*

More than just an analysis of the elements of radio systems is undertaken in this book. For this reason, general system block diagrams are discussed before any analysis is begun. Many of the important aspects of communication-systems engineering are also discussed, in order to bring into focus some of the major factors that must be considered in system synthesis. This accounts for the inclusion of such topics as noise, signal/noise ratios, gain-bandwidth products, and an introduction to information theory.

Wherever possible, the analysis proceeds in two stages. An effort is made first to present an explanation of the operation of the circuits from a physical point of view. This is followed by mathematical analyses, which have three objectives: (1) to illustrate the technique of analysis; (2) to deduce a solution which yields a description of the operation of the circuit; and (3) to examine the effects of the various parameters on the operation of the circuits.

In all analyses, considerable care has been taken to include the requisite reference conditions for potential polarities, current directions, and transformer-winding sense.

Proceedings of the Second Annual Computer Applications Symposium . . . *Armour Research Foundation of Illinois Institute of Technology, Chicago 16, Ill. Price $3.00.*

The Proceedings were prepared from a stenographic transcript of the Symposium and include the discussion following each paper. The Symposium, held in Oct. 1955, covered applications of computers and data processing machines to business and management problems, as well as to engineering and research problems. A principal objective of the sessions was to develop expressions of diversity and likeness both in application and in opinion.

MEAT & POTATO RELAYS

If you don't really need super-this, high-that or ultra-something else in a relay you are to be envied, not scorned. Then you should be assured that Sigma makes just plain relays too. They're not really "plain", but well-designed for certain jobs that they perform commendably. They don't have wrap-around windshields and back-up lights, but they get you there and they bring you back.

There was a time when four just such relays (Types 4, 5, 6 and 41) were *the* basic Sigma lines. Now, of course, there are sixteen of these basics and some of them are super-sensitive, high speed or ultra ultratissimo. It is perhaps significant that the old stand-bys are still best sellers.

Here they are, and they're for sale:

Sigma Series 4
GENERAL PURPOSE
MEDIUM SENSITIVITY
Balanced armature design. SPDT. High reliability. Medium priced. 20-50 mw sensitivity. Switches up to 2 amps. resistive (28 VDC, 115 VAC) for 100,000 operations.

Sigma Series 5
VERY SENSITIVE
HIGH STABILITY
Withstands aircraft vibration on inputs as low as 5 mw; undamaged by 500 g shocks. Sensitivity range 1-40 mw, 35 basic standard adjustments.

Sigma Series 6
POLARIZED
NULL SEEKING,
BIASED or LATCHING
Contacts up to 4PDT, 5 amps. nominal rating. Sensitivity 8-44 mw (Latching: 22-450 mw).

Sigma Series 41
SENSITIVE
LOW COST AC
SPDT shaded pole construction. Unusually quiet. Sensitivity 0.2-1.0 v-a. Contact ratings up to 5 amps. Voltage operated, current operated; 16-400 cycle versions; also DC and high speed keying types.

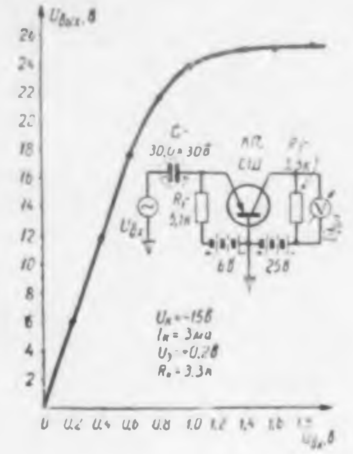
All four relays are available in a wide variety of mounting enclosures. Catalog on request.

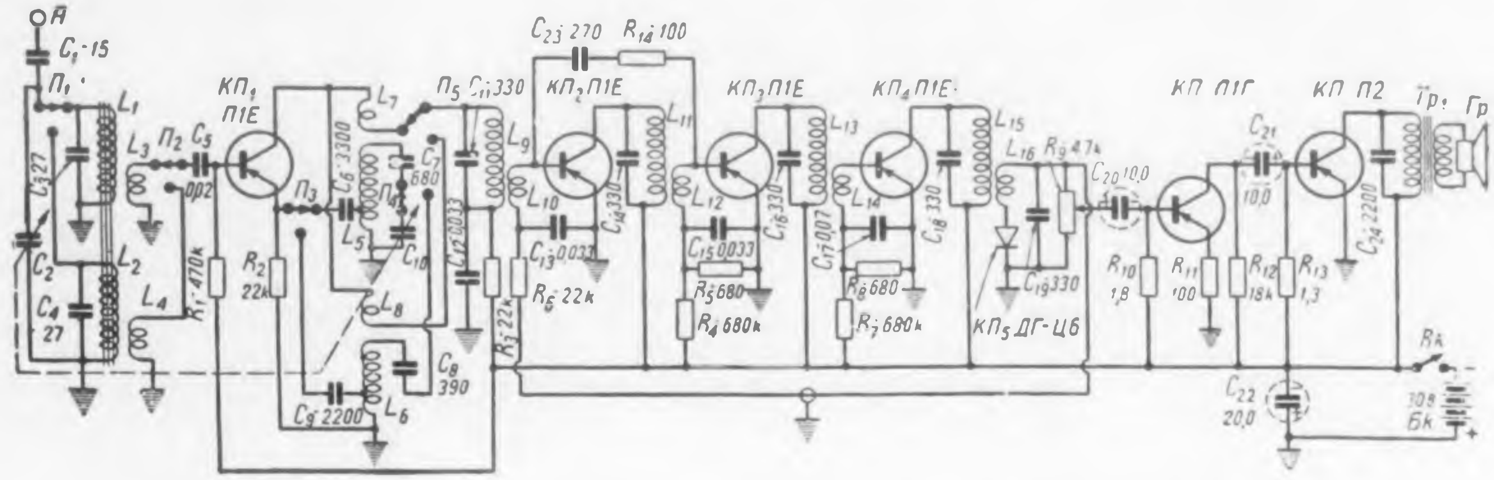
SIGMA

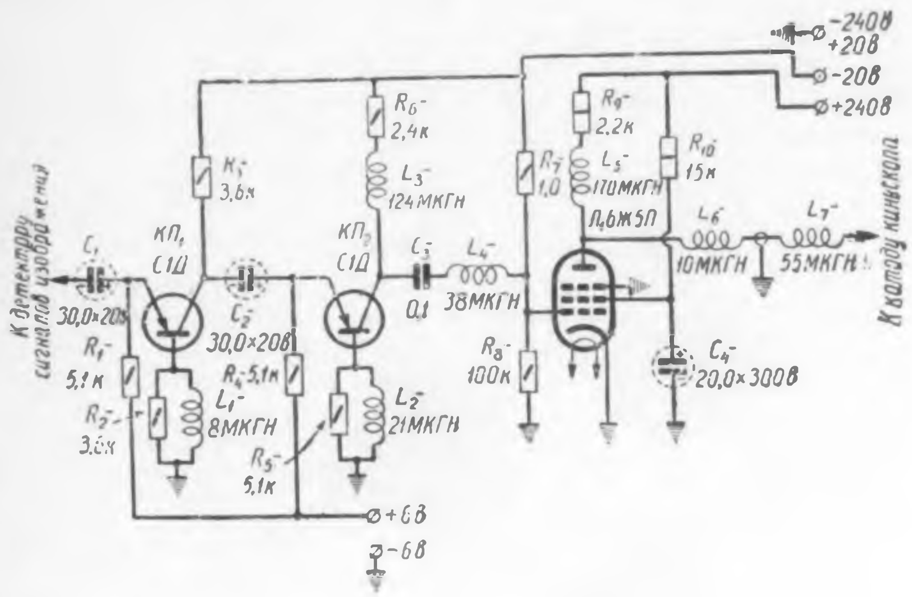
SIGMA INSTRUMENTS, INC.,
9½ Pearl Street, So. Braintree, Boston 85, Massachusetts
CIRCLE 252 ON READER-SERVICE CARD FOR MORE INFORMATION

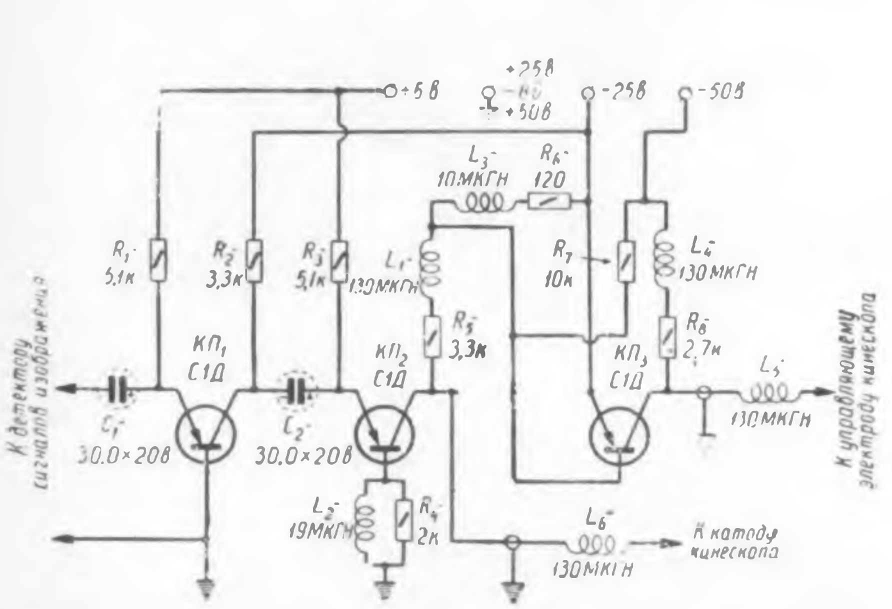
Some Russian Transistor

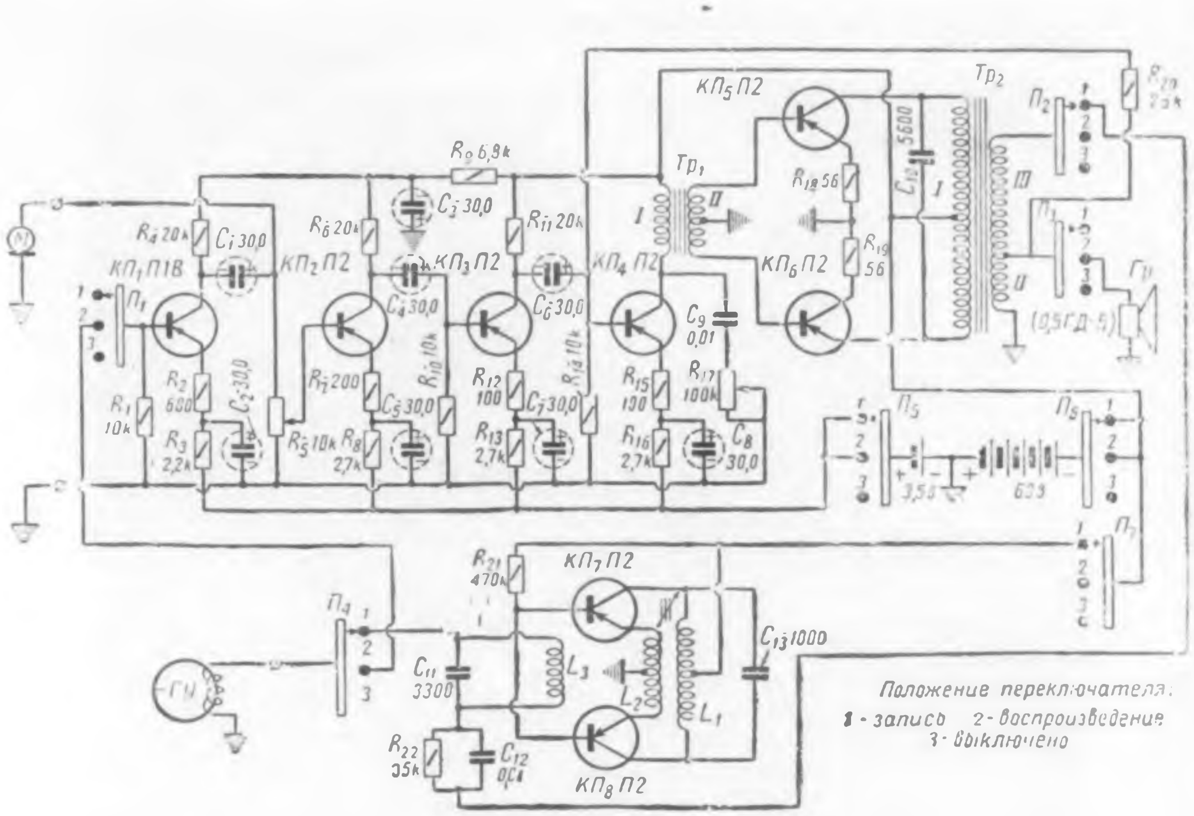
FROM all indications, the Russians are transistorizing extensively. The two circuits shown are video amplifiers using type "S1D" transistors, the characteristics of which are also shown. Illustrated also, is a superheterodyne receiver for medium and long-wave reception. The three circuits are described in the December 1955 issue of *Radio*.











Somewhat less usual is the all-transistor tape recorder shown here. The amplifier output is on the order of 0.25 watts, the non-linear distortion coefficient does not exceed 12%, the range is 200-2500cy, and the capacity is 100 meters of tape (35 minutes at 95.25mm per second). The motor is spring wound. *Radio*, February, 1956.

Applications

Quartz Clock

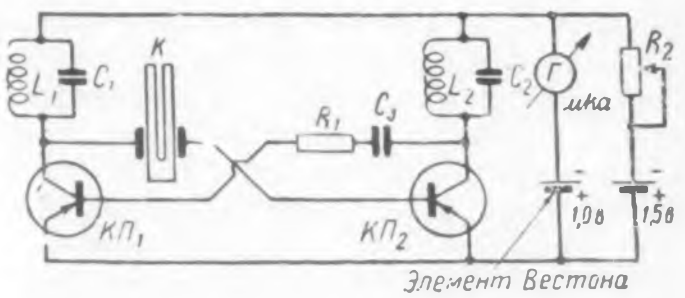
THE resonant frequency of the crystals used in quartz-controlled clocks is usually on the order of 100kc, while the frequency of the synchronous motor used to drive the hands seldom exceeds 1000cy. This calls for multiple frequency division.

The transistorized clock control shown in the figure was developed at the Khar'kov Institute for Measures and Measuring Instruments, and employs a quartz tuning fork operating directly at 1000cy. The current drain is 15uamp at 1v, furnished by a dry cell (a Weston Standard cell is used as a buffer for voltage regulation).

The control is kept at a constant temperature simply by burying it 25 meters into the ground. The temperature fluctuations do not exceed 0.0001°C and the absence of vacuum tubes keeps the heat dissipation at 15 microwatts, not enough to raise the ambient temperature significantly.

The average frequency deviation is less than 7×10^{-10}, corresponding to less than 0.0001 seconds daily. Immediately after the oscillator was put into operation, the frequency rose continuously at a rate of 3×10^{-9} daily, but this rate has stabilized at 5×10^{-10} after 5 months' operation.

Although the article does not mention it, we assume that the quartz tuning fork controls a vacuum-tube generator for the synchronous motor. The author does suggest, however, that one-watt transistors be used to supply low-power synchronous motors for this application, thereby dispensing with vacuum tubes completely.—*from article by L. Bryzhev in* Radio, *December, 1955.*



What the Russians Are Writing

J. George Adashko

Radiotekhnika, Vol. II, No. 1, January 1956.

Non-Linear Distortion and Stability of Reflexed Circuits; Iu. A. Chernov; (15pp; 5 figs.). Reflex circuits, (in which one tube is used to amplify two frequencies) in spite of their economy, have not been treated to any length in the literature, probably because of their high inherent distortion and low stability. The article analyses mathematically several reflex circuits from this point of view. The non-linear distortion coefficients (K_f) are computed for several reflex circuits (Fig. 1, 2, 3, and 4) and are plotted against the relative change (δA) in the tube transconductance produced at the h-f operating point by the applied low-frequency voltage (Fig. 5). It is shown that by minimizing the effect of the anode detection in the circuit (Fig. 4) the distortion can be reduced considerably. The article gives also the stability criterial for the reflexed circuit.

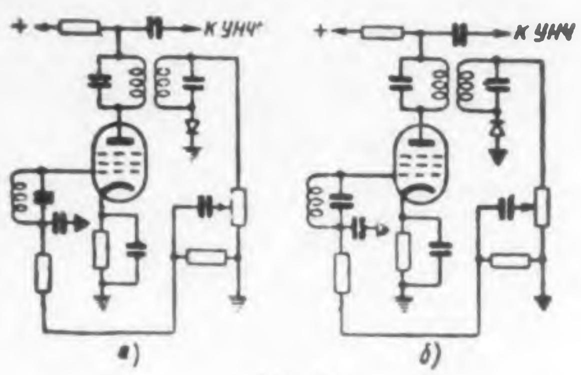


Fig. 1

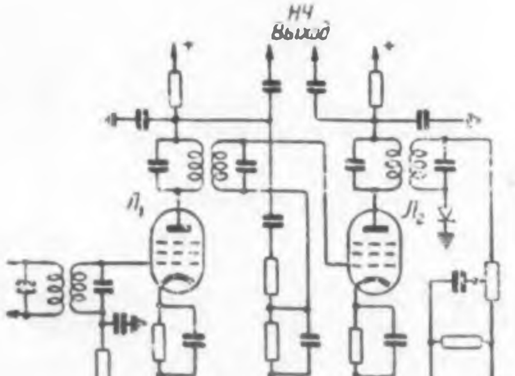


Fig. 2

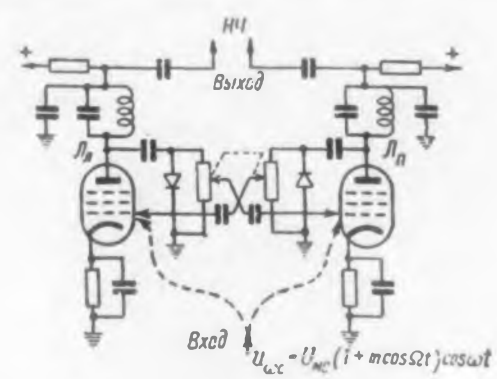


Fig. 3

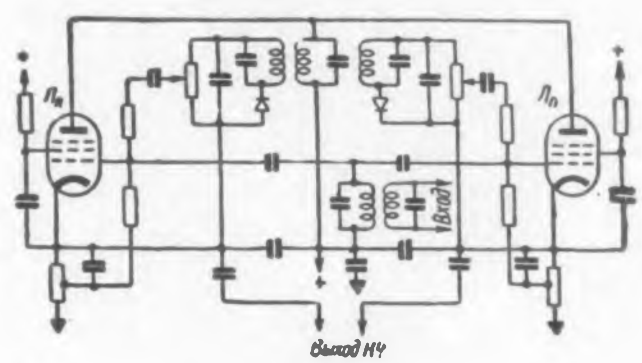


Fig. 4

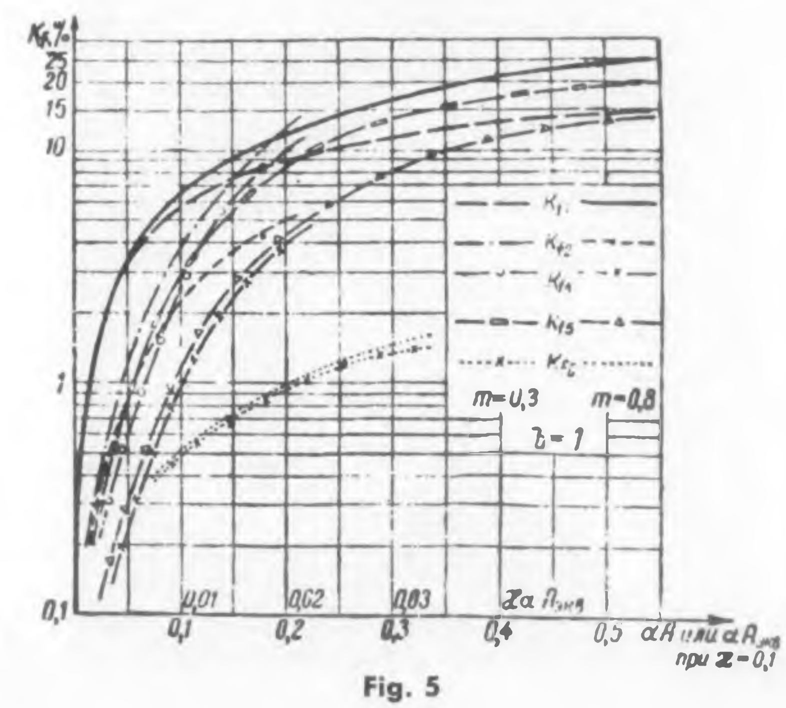


Fig. 5

Response of Linear Systems to a Voltage of Linearly-Varying Frequency; S. M. Khlytchiev; (12pp; 13 figs). A method is given for investigating the transients produced in a linear system by a voltage having a linearly varying frequency. The derived general solution is used to evaluate the dynamic frequency characteristics of an n-stage resonant amplifier with identical tuned stages. A solution is also derived for a system having a "maximum" transfer coefficient. Graphs showing the variation of the distortion of the form of the frequency characteristics of the systems analyzed with the rate of change of the applied-voltage frequency. Refers to article by G. Hok, "Response of Linear Resonant Systems to Excitation of a Frequency Varying Linearly with Time." *Jl of Applied Physics*, v. 19, No. 3, 1948.

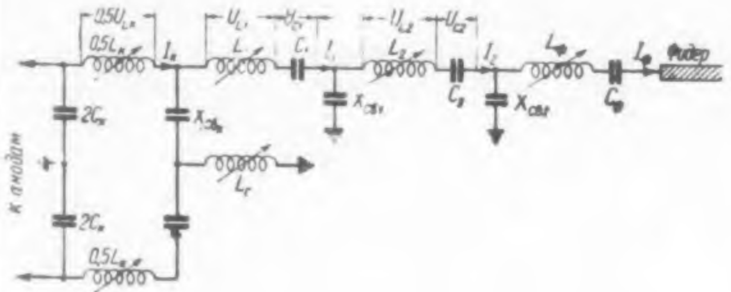
On the Design of Frequency Detectors; E. S. Antselovich; (8pp; 10 figs). Design of frequency detectors with tuned and untuned circuits. It is shown that the optimum values of Q (product of coupling coefficient between the tuned circuits and the Q factor) and f/f_0 (relative frequency deviation) are the same whether maximum transmission or minimum distortion is desired. The article is primarily devoted to a design procedure in which Q and the maximum relative frequency deviation are chosen so as to produce a maximum signal at minimum distortion at the output of the detector.

Movement of Electrons in the Space Charge Region of a Diode with Rapidly Varying Anode Voltage; N. I. Ivanov; (7pp; 1 fig; 1 table). Differential equations for the motion of electrons in the space charge region of a diode have been known for a long time. These equations can be solved only by approximate numerical methods. This article proposes a numerical-integration method which is much less labor consuming, and which furthermore can be used for all electron velocities. This permits investigations of conditions in which electrons emitted in one cycle continue their movement in the next cycle.

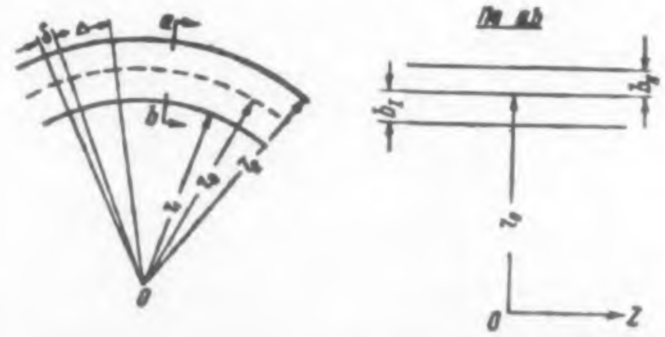
Reflection of Ultra-short Waves from Layer-Like Inhomogeneities in the Troposphere; V. N. Troitskii; (10pp; 4 figs.). The dielectric "constant" ϵ of air in the troposphere varies with temperature and humidity, and contains many regions of inhomogeneities. Gravity and the earth's topography shape these inhomogeneities into layers causing considerable reflection of radio and radar signals, and contributing to the forward scattering of u-h-f waves. The article explains the nature of the atmospheric phenomena causing these inhomogeneities, indicates the approximate variation of the dielectric constant within the layers, and derives expressions for the reflection coefficient under various simplifying assumptions.

Meterological Foundations for a Method of Measuring Non-Linearities with Rectangular Pulse; V. M. Vol'f; (10 pp; 2 figs.). This is a sequel to a theoretical discussion on the measurement of non-linearities by means of signals of complex waveform (see ELECTRONIC DESIGN): April 15, p 128) in which it was shown that a periodic sequence of rectangular pulses is the most suitable for the purposes. This article continues with a discussion of a proposed design of an instrument based on this method.

Principles of Construction of Output-Circuit Systems for Medium-Wave Transmitters; E. P. Khmel'nitskii; (4pp; 1 fig; 1 table). In most modern transmitters the antenna is fed over a feeder, and a system of tuned circuits is inserted between the power-stage tubes and the feeder. This system passes the required sideband frequencies and filters out the harmonics. This article proposes a tuned system in which the entire transmitter frequency range can be covered by varying only the inductances of the tuned circuits, without disturbing the operating conditions of the oscillator power stage. Such a circuit is shown in Fig. 1. The load seen by the anodes of the (push-pull) output tubes (connected at the left) can be kept constant over the entire frequency range of the transmitter.



Propagation of Electromagnetic Waves Between Two Circular Cylindrical Surfaces in the Presence of Longitudinal Periodically-Distributed Diaphragms; E. G. Solov'ev; (4pp; 1 fig). The circular cylindrical surfaces are in the r, φ plane and the periodicity of the diaphragms is in with respect to φ (Fig. 1). This is straightforward analysis, using the Hertz potential, and the Floquet theorem, matching the field values on both sides of the diaphragms.



Interconnecting Electronic Computers

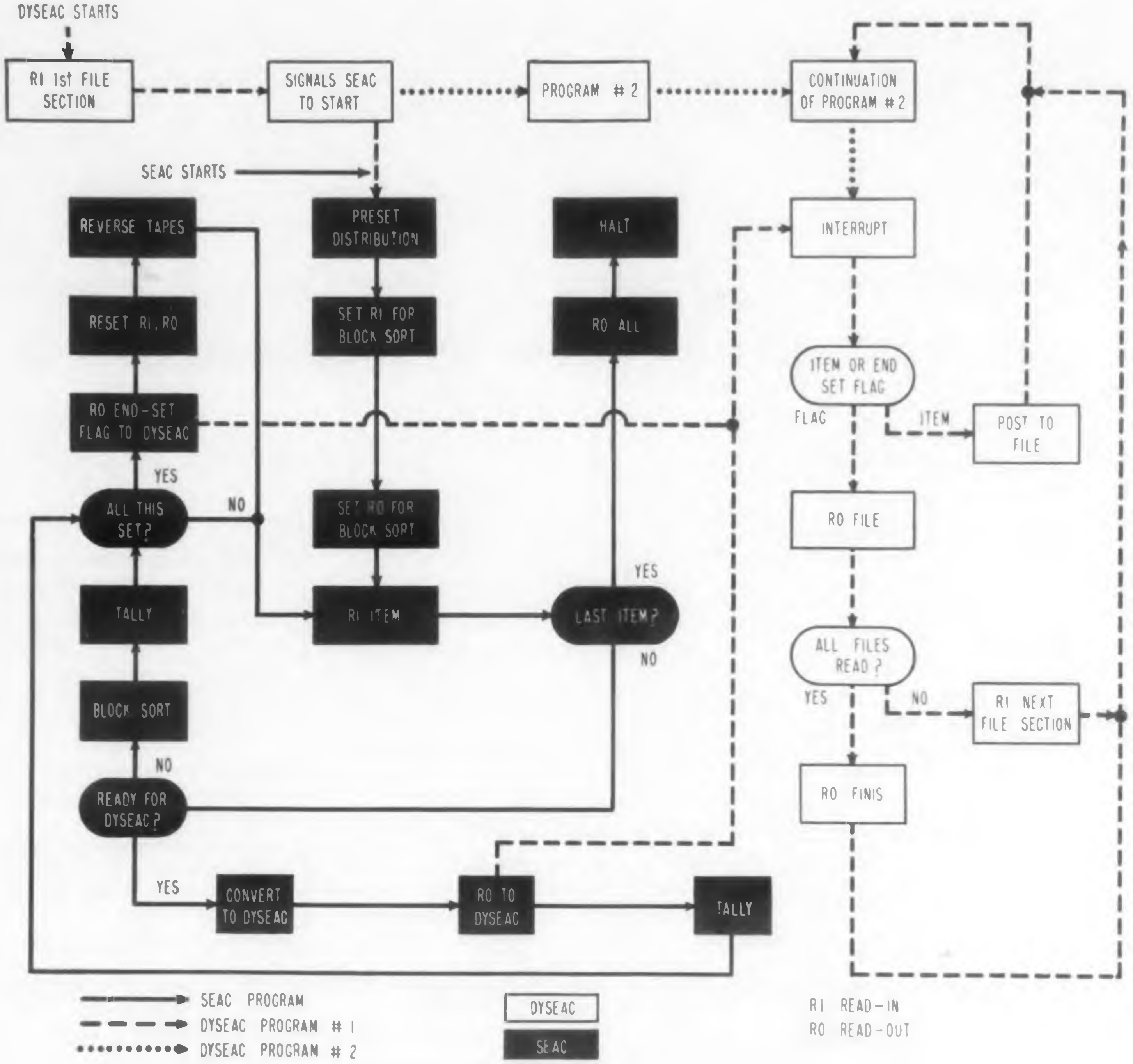


Fig. A. Flow diagram of a typical problem shared by the interconnected computers.

DATA-PROCESSING shared by two interconnected electronic digital computers has been successfully performed at the National Bureau of Standards. SEAC and DYSEAC, two high-speed computers designed and built at the Bureau, worked cooperatively at a common task to demonstrate program-controlled machine intercommunication in which coordinated programs were read into both machines. The experiments showed that two digital computers need not have identical operating characteristics to work together, provided that one of them has the necessary control flexibility.

Most general-purpose electronic computers employ a generally compatible digital language. They can receive and transmit data in the form of electrical signals via standard communication channels over any desired distance and can alter the course of processing programs in accordance with new or revised information. It should therefore be possible to interconnect two or more general purpose machines so that they can cooperate on a common task.

DYSEAC, a computer designed by the National Bureau of Standards for the Department of Defense, incorporates a number of operating features enabling it to respond automatically to information from remote external devices. These operating features include manual-monitor facilities, program control flexibility, and special input-output controls. Together they provide DYSEAC with unusual properties of concurrent operation, self-regulation, and interruptability which enable it to interact effectively with another computer.

During a period of three weeks the two machines, the SEAC, a permanent installation at NBS, and DYSEAC, were available for experiments in interconnection. The program chosen was a new method of sorting, merging and posting of records. Stock transaction reports were tabulated and summarized by SEAC, then forwarded to DYSEAC for posting. As detail items were identified as belonging to each file section in a scheduled order, they were transferred to DYSEAC for posting. In addition, after each complete set of detail items for a particular file section had been processed, SEAC transmitted a special end-of-set flag to DYSEAC.

Information transfers were initiated and terminated by transmission of control signals between the two machines. Whenever a SEAC output instruction called for selection of the particular output used for transmission to DYSEAC, a preparatory signal was sent from the SEAC external selector unit to DYSEAC. This signal activated appropriate monitor operations in DYSEAC. As soon as DYSEAC was ready to accept this data, it transmitted a signal to SEAC. Only upon receipt of this signal was SEAC able to proceed with its next instruction. In effect, SEAC continued trying to complete this output instruction until DYSEAC signalled readiness to accept the transfer.

For the DYSEAC-SEAC interconnection, monitor switch settings were arranged so that upon receipt of the preparatory signal from SEAC, DYSEAC at its next breakpoint read in one information word to a predetermined memory address and took its next instruction from the location indicated in the address storage register. This next instruction was a "file" order which recorded both counter settings, reset the proper counter to the initiation of the routine for the processing of the data from SEAC, and transferred control to that counter. Upon completion of the processing of any one set of data from SEAC, DYSEAC would return to the sequence of operations it had been performing immediately prior to each interruption.

Several runs of the shared program were successfully made, and the "posted" file sections were printed out on a DYSEAC magnetic wire cartridge. These results clearly demonstrated the ability of DYSEAC to respond to the monitor signals originating in SEAC and to interrupt its program in order to receive and process the detail data from SEAC. The two machines were thus made to work cooperatively in the common task that involved preliminary processing of data by SEAC, transmission of these data and program information from SEAC to DYSEAC, and further processing by DYSEAC.

Abstracted from Interconnection Electronic Computers, National Bureau of Standards Technical News Bulletin, *March 1956, P. 33.*

Standards and Specs

Sherman H. Hubelbank

This department surveys new issues, revisions, and amendments, covering military and industry standards and specifications. Our sources of information include the Armed Services Electro-Standards Agency (ASESA), the cumulative indexes to Military Specifications, Vols, II, IV, American Standards Association (ASA) and other standards societies.

Shunts

MIL-S-61A, Shunts, Instruments, External, 50 Millivolt (Lightweight Type), Amendment 1, 4 April 1956 . . . "MS" part numbers have been added to the requirements for marking and for ordering data.

Cable

MIL-C-3432A, Cable, Flexible and Extra Flexible, 300 and 600 Volts, 30 April 1956 . . . Intermediate duty cable for the same use as light duty cable which may have more severe usage has been added. A heavy duty, multi-conductor, unshielded cable containing ground wires has been added. Low temperature cable operating at —55°C has also been added by this revision. The type designation examples have been clarified. Conductors are now to be in accord with MIL-W-3861, and insulating and jacketing compounds are now to be in accord with MIL-I-3930. Cotton textiles for fillers, separators, and binders are now permitted, while jute is also permitted for fillers.

MIL-C-3885, Cable Assemblies and Cord Assemblies, Electrical (for Use in Electronic, Communication, and Associated Electrical Equipment), Amendment 2, 16 April 1956 . . . The scope of the spec has been changed to include power and audio-frequency cable and cord assemblies for voltages up to and including 600 volts a-c or corresponding d-c. Spec MIL-I-3930 is now called out as the basic material spec for insulating or jacketing compounds. Cables or cord assemblies 50 feet long are now considered to be standard.

Couplers

MIL-C-15370A, Couplers, Directional (Coaxial and Waveguide), 16 April 1956 . . . Directional couplers for unidirectional or bidirectional use with coaxial lines or waveguides are covered in this spec. These couplers are used in the transmission lines of radar and radio equipment to inject or sample, at attenuated levels, the r-f energy being transmitted. These couplers may also be used to transmit a r-f wave into a transmission line so that the wave flows only in one direction. They may also be used to sample a r-f wave flowing in a particular direction in a transmission line while accepting relatively insignificant portions of a r-f wave flowing in the opposite direction. Preproduction testing is required.

Dynamotors

MIL-D-24A, Dynamotors . . . The status of this spec seems to be confused. The Army Index of Specs dated 1 February 1956 lists this spec as being cancelled as of January 27, 1956. ASESA, on the other hand, states that this spec was amended as of April 16, 1956. This amendment corrected the note for dynamotor type BD-77 to indicate that this type is not for airborne use "over 10,000 feet." The heading in Figure 24 was corrected to read DY-97/GRC-9.

Temperature Controls

NEMA DC 1-1956, Automatic Temperature Controls . . . Room thermostats, solenoid gas valves and diaphragm gas valves, refrigeration controls, voltage rating and load characteristics for primary control equipment of 30 volts or less, wiring symbols, and surface-type electric heater controls are covered in the spec. Copies of this standard may be obtained from the National Electrical Manufacturers Association, 155 E. 44th St. New York 17, N. Y. for $1.50 per copy.

Recently Cancelled MIL Specs

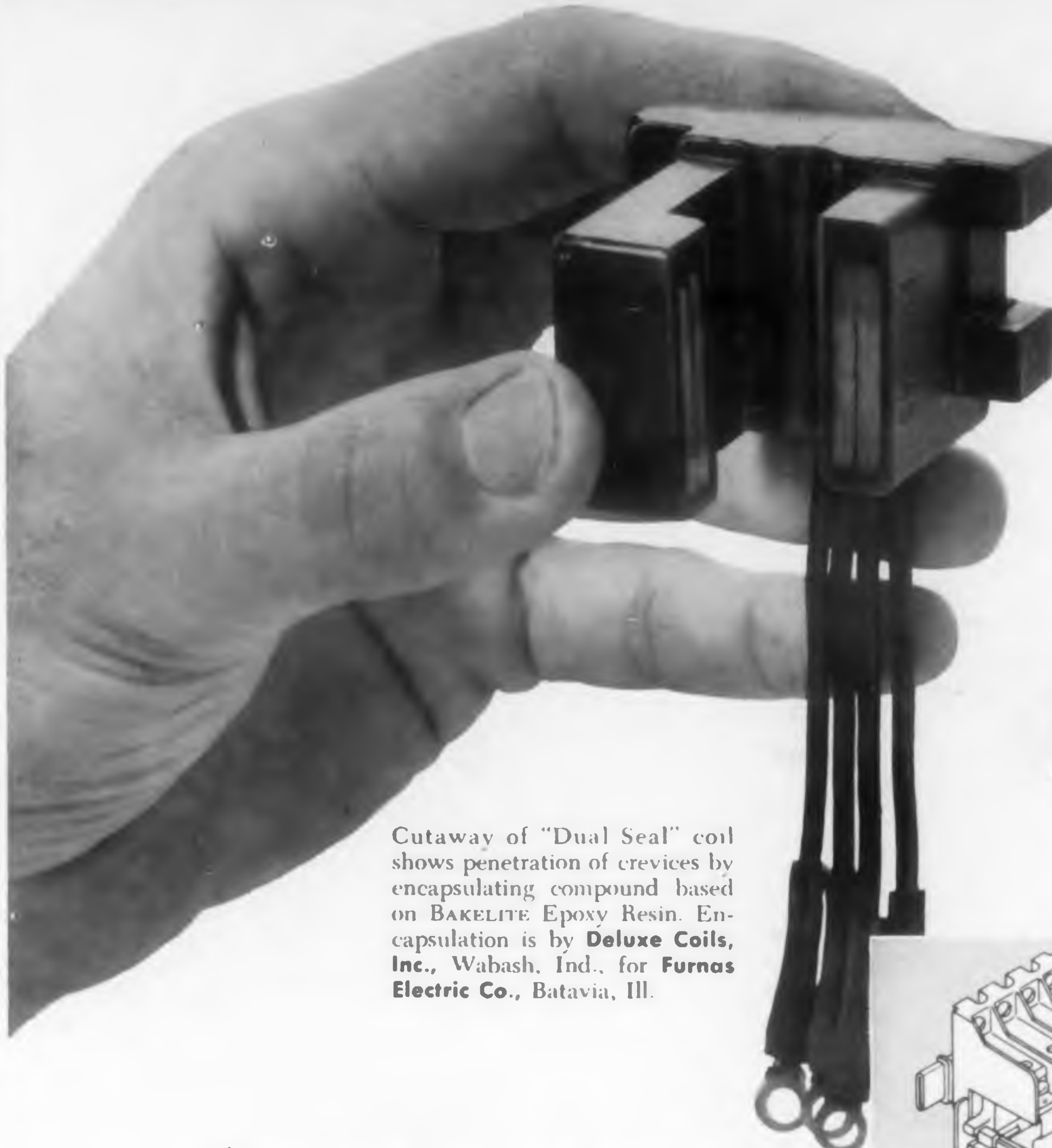
The following specs have recently been cancelled by the military:

Spec	Date Cancelled
MIL-H-3679, Headset, Electrical	10 Feb 56
MIL-R-4277 (USAF), Resistors, Fixed Film, High Stability (Replaced by MIL-R-10509)	13 Sep 56
MIL-E-8287 (USAF), Electron Tube, Type USAF HT-415 (Replaced by MIL-E-1/115B)	2 Dec 56
MIL-T-8280A (USAF), Tube, Eelectron, Type 5FP14A (Rplaced by MIL-E-1/948)	19 Jan 56
MIL-T-25096 (USAF), Transistor, Type USAF 2N43A (Replaced by MIL-T-25380)	7 Oct 56
MIL-E-1/760A (NAVY), Electron Tube, Type QK-386	16 Jan 56
MIL-R-15401A, Resistors, Fixed, Composition, Uninsulated	3 Oct 55
MIL-E-1004A (SIG C) Electronic Standard and Nonstandard Parts, Materials and Processes in Signal Corps Equipment	23 Dec 55

Specifications listed on these pages are for information only and government contractors should be guided by their contracts. Copies of military specs should be obtained from sources recommended by procuring officers. ASESA bulletins may be obtained from Fort Monmouth, N. J. ASA standards may be obtained from American Standards Agency, 70 E. 45th St., New York 17, N. Y., unless otherwise noted.

Advertising Index

July 1st, 1956



Cutaway of "Dual Seal" coil shows penetration of crevices by encapsulating compound based on BAKELITE Epoxy Resin. Encapsulation is by **Deluxe Coils, Inc.**, Wabash, Ind., for **Furnas Electric Co.**, Batavia, Ill.

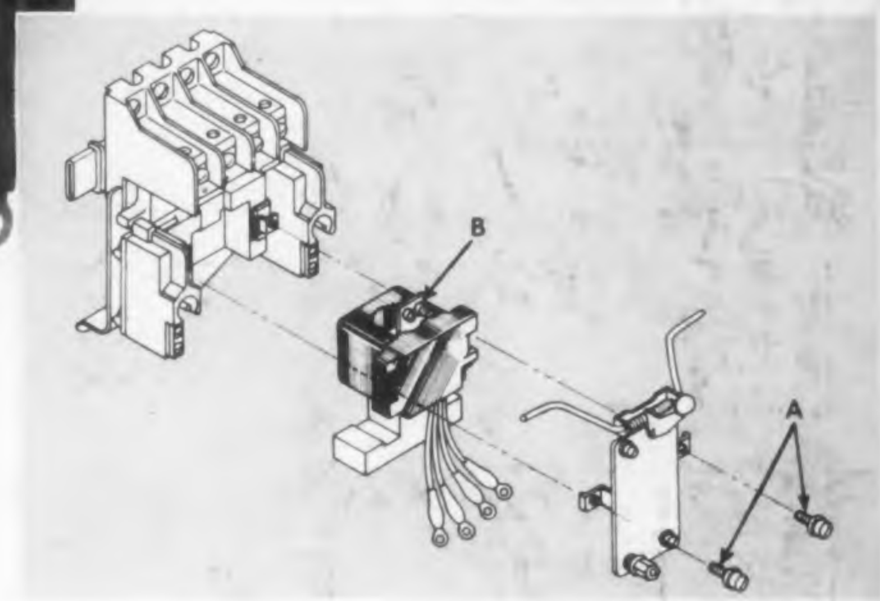
Encapsulated in epoxy resin

One coil replaces six!

A single 220-440 volt dual voltage coil encapsulated in BAKELITE Brand Epoxy Resin takes the place of six coils usually needed in 3, 7½, and 10 hp. starters. It virtually eliminates coil changing, reduces stocking of coils and starters.

The BAKELITE Epoxy Resin encapsulation is extremely tough. It resists moisture, fungus, and aging; cuts moisture-caused burnout almost to zero. The tough resin prevents damage by vibration or impact. It withstands temperatures from −90 to +250 deg. F, and results in a motor that runs eight per cent cooler. Dielectric strength of the resin is high.

Encapsulation with BAKELITE Epoxy Resin is effected by mixing the liquid resin with its liquid hardener and pouring the mixture into place. It penetrates every crevice, then hardens into a tough, dimensionally stable mass that holds each element of the assembly firmly in position.



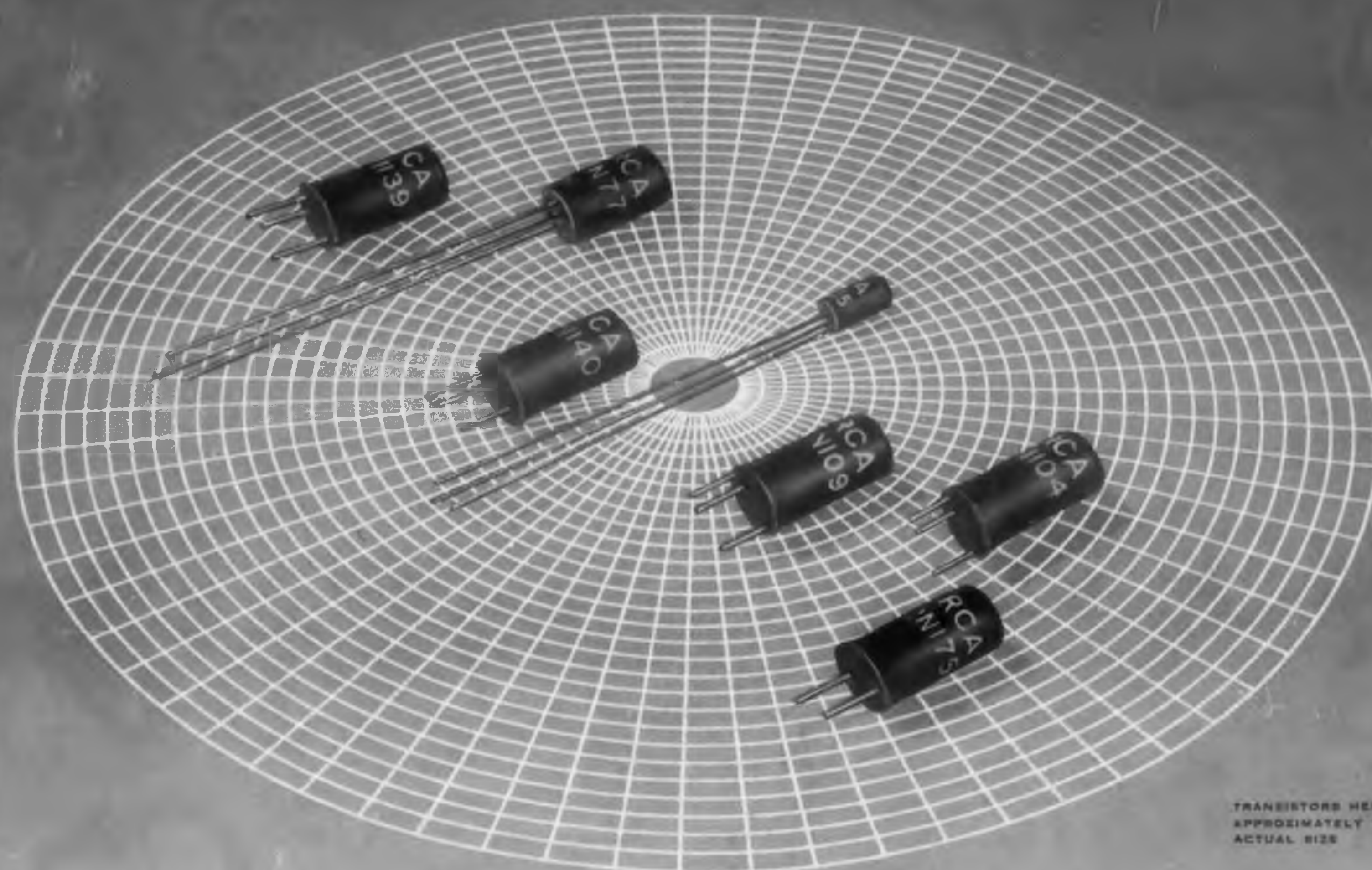
New coil design has stretched mechanical life of starter more than 50%. Extracting two bracket screws "A" and loosening of cross arm screws "B", as shown in exploded drawing, make coil removal easy.

BAKELITE BRAND EPOXY RESINS

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

CIRCLE 260 ON READER-SERVICE CARD FOR MORE INFORMATION

RCA TRANSISTORS



TRANSISTORS HERE SHOWN APPROXIMATELY 1-1/2 TIMES ACTUAL SIZE

Quality Performance

. . . NEXT TO PERFECTION!

Circle 261 on Reader Service Card

With field returns reported by equipment manufacturers now running well under *one-tenth of one per cent*, RCA transistors are the No. 1 choice among circuit designers who are looking for the highest in quality. Savings in transistor testing, replacing, and handling are substantial. And the exceptional uniformity and extreme stability of RCA transistors—*stay that way throughout life!*

Manufactured under advanced production techniques—and held to tolerances among the strictest in the industry (through RCA's unique "in-process" quality control system)—all RCA commercial-type transistors meet rigid environmental requirements.

RCA TRANSISTORS—A STANDARD OF COMPARISON

For sales information, call the RCA office nearest you. For technical data, write RCA, Commercial Engineering, Section G-18 Q1, Harrison, N. J.

EAST: HUmboldt 5-3900
744 Broad Street
Newark 2, N. J

MIDWEST: WHitehall 4-2900
Suite 1181
Merchandise Mart Plaza
Chicago 54, Ill.

WEST: RAymond 3-8361
6355 East Washington Blvd
Los Angeles 22, Calif.

RADIO CORPORATION of AMERICA
SEMICONDUCTOR DIVISION SOMERVILLE, N. J.

ELECTRONIC DESIGN
HAYDEN PUBLISHING COMPANY, INC.
19 East 62nd Street, New York 21, N. Y.