ELECTRONIC DESIGN

OCTOBER 15, 1956

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ELECTRONIC DESIGN

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CIRCLE 2 ON READER-SERVICE CARD FOR MORE INFORMATION

Editorial

Salaries up; but how about recruits?

Beginning engineering salaries are up about 10% over last year, according to an exhaustive survey by the staff of ELECTRONIC WEEK, reported in that publication Oct. 1. Yet, the survey also showed that there is little comfort to be gained from this fact by those who look for ways of increasing the enrollment of students in the engineering profession.

The survey also tends to point up an apparent danger in comparatively high engineering salaries. Less and less engineering graduates are staying on for graduate work in their profession. The high salary inducements seem to be the cause. Yet, graduates with master's degrees get on the average 20% more than those with bachelor's degrees. PhD graduates get 20% more. Perhaps the Soviet practice of a 10 or 15 fold increase for men with advanced study is a possibility. Dr. F. E. Terman of Stanford suggested that it might be important.

We might ask ourselves whether the salary matter is really the real crux of the problem. For the ELECTRONIC WEEK survey shows that graduates of engineering programs ranked type of work first in importance in taking their first job. Salary came third after such other inducements as company reputation, advancement possibilities and plant location.

In this column last issue we pointed up the low repute of the technical profession as seen by a large segment of our population.

It might be surmised that something is wrong with engineering jobs per se that make them generally unattractive —that something is lacking which makes engineering seem less professional. There is certainly still room for our profession to grow up. Improved professional working conditions, greater company status for engineers, a higher degree of delegated responsibility and authority to those in the profession, as well as top salaries, are all important—and they can't come too soon if we are to maintain our engineering leadership among the nations of the world.—E.T.E.

Engineering Review

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

Radical Ceramic Tubes Operate at 800 Degrees

Possibly destined to supersede transistors in many high-temperature applications, a radically new type of vacuum tube developed by General Electric has been publicly demonstrated. The intriguing new circuit element is essentially an ordinary vacuum tube dressed in a super rugged package. Continuous operation at ambient temperatures up to 800 degrees Centigrade has been exhaustively tested.

Unique properties of the revolutionary ceramic tube include increased efficiency as temperature increases, no need for filament power (full-dress transistor competition) and built-in grid bias.

Extremely simple circuits can be synthesized with the device, which has titanium grids and anode. Neither filament source nor grid bias source is required in a conventional amplifier. The normal ceramic tube has a positive contact potential of about 2 volts, corresponding to a circuit grid bias of minus 2 volts.

Another good feature of the high-temperature tube is its high transconductance per milliampere, higher than has been practicable heretofore in conventional vacuum tubes. Typical values lie around 6000 at one ma. Grid emission is negligible.

Development credit for the useful device goes to the staff of James E. Beggs, of the GE Electron Physics Research Department in Schenectady, N. Y.

Companion resistors, capacitors, and ceramic boards have been developed by GE, so that complete high temperature circuits are now possible.

After 800 C oven treatment ordinary electronic components melt. New ceramic devices are intact.

New resistors operate at heat level sufficient to light cigarette.

Shown here is a complete 3 stage circuit using all high-temperature components. The pancakes are tubes.

Shown above is a complete nuclear reactor installation. Extreme safety is built in.

Mass Produced Home-Style Nuclear Reactors

Quantity production of small, portable, self-contained nuclear reactors to sell for less than 100 thousand dollars has begun by Aerojet-General Nucleonics of San Ramon, California. By use of a unique method of core fabrication with radiation stabilized polyethylene moderator, the reactor resembles a liquid homogeneous reactor but actually has a solid homogeneous core.

The important feature, however is that the requirement for critical mass is approximately 600 grams of Uranium 235 of 20% enrichment, which is less than any other known reactor. Of further significance is the fact that the solid core locks in the fission products with four seals, eliminating the problem of waste disposal and preventing the escape of radioactive contaminants. Under normal operating conditions the core life will exceed 300 years.

Along with the normal reactor safety interlocks a thermal safety fuse built into the core enhances overall reactor safety. Reactor control rods are actuated from a control console which also provides continuous reactor monitoring. Every possible effort has been exerted to make the new midget the safest mass-produced reactor available. It is hoped by Aerojet that schools, small industries, and various other low-budget customers will develop for the device, designated Model AGN-201.

Hollywood Adopts Television Techniques

To make movies more like TV, Hollywood has accepted a standard television production technique, and Paramount will soon start shooting production movies with the new setup. The new DuMont system, called "Electronicam," unites a Mitchell 35 mm motion picture camera with a DuMont image-orthicon TV camera, using a common optical system so that parrallax is eliminated and an identical picture goes to each unit. A whole new power of vision is thus provided to the cameraman through his electronic viewfinder, and to the director and his entire production team through monitors. For the first time, they see instantaneously and exactly what is going to the camera without waiting for the following day's rushes.

Two functional trailers contain all the cameras and related equipment necessary to operate "Electronicam." One of the trailers normally remains outside the sound stage. This 32 foot vehicle contains the major part of the electronic gear for the cameras, monitors and control panels operated inside the stage, plus an audio recorder and kinescope recorder. The 18 foot smaller trailer functions as the control and communications center and gives a full range of vision through its glass side and top. It has five 17 inch monitors, including one on which the director can preview the results of special effects which are produced electronically.

World's Smallest 450 MC Transceiver

General Electric Company, Syracuse, N.Y., has announced that because of the widening use of Citizens Band Radio by commercial enterprises, it is introducing a new 450 mc, two-way radio unit which will be included as a standard item in the company's flexible and interchangeable Progress Line.

Industry's smallest 450 mc unit by cubic measurement, it will fit in a standard 14-inch Progress Line case, built for both trunk and front-mounting. The radio will be available with either automatic frequency control or temperature-controlled heated crystals.

Weather Radar Sees 50 Miles

Business aircraft owners and operators will welcome a new 50-pound weather radar developed by RCA. The lightweight airborne system can see up to 50 miles so that a business aircraft pilot may change his course in time to avoid a storm.

Heavier, long-range weather radar systems have been in operation for some time on larger aircraft. The new AVQ-50 has been designed specifically, however, for small business and private airplanes.

Added features include a range switching control to enable the pilot to view a portion of a storm closeup plus provisions for tilting the antenna so that terrain mapping operations can be carried out aloft.

TWA Gets Electronic Reservations

Trans World Airlines will install the first coast-to-coast electronic reservations network to be used by any airline next fall. According to E. O. Cooke, TWA Senior VP of Sales, and John H. Clemson, VP of Passenger Service, the new system will keep track of the availability of all seats on TWA domestic flights for 31 days and overseas flights for up to six months in advance. This information will be instantly and simultaneously accessible to TWA customers through several hundred agents in cities across the country.

Called Magnetronic Reservisor because of its unique combination of a magnetic drum for storing information and electronic means of transmitting it, the system was designed to TWA's specifications by the Teleregister Corporation, a subsidiary of Ogden Corporation. While other airlines have used electronic reservations systems in large metropolitan centers, this is the only interconnected, country-wide system yet announced.

Transistorized Image-Orthicon TV Camera

Specifically for the military, RCA has developed a portable, small-sized, light weight, fully transistorized image-orthicon TV camera for on-air or closed circuit telecasting. Especially suited for high sensitivity applications under conditions of low light levels, the completely self-contained camera requires only a 50 w dc source of power, normally available from standard military aircraft and vehicles.

With a weight of but 31 pounds, a case of 6 x 9 x 20 in. houses such normally external components as tube power supply, sync generator, and video amplifier. The unit can be supported on a lightweight photographic tripod, eliminating the gross pedestals usually required. The camera can be used as a direct replacement for conventional image-orthicon cameras now used in military applications. Built-in remote controls permit camera operation from up to 100 feet away.

Oil Industry Uses Electronic Computer

To solve complex oil and gas industry problems, an ALWAC computer, manufactured by Logistics Research Inc. Redondo Beach, California, was installed at the Southwestern Computing Center, Tulsa, Oklahoma.

Reported applications now include: oil explorations and other research calculations, simulating refining operations, oil production, blending, data reduction, evaluation of elaborate integrals, solution of differential equations, matrix calculations, tanker and pipeline scheduling, truck routing, market analysis, profit per product information, payroll and accounting.

Industrial Uses of Radioisotopes

According to a survey by the Atomic Industrial Forum, 260 Madison Ave., New York 16, New York, the number of industrial users of radioactive isotopes has increased more than 500 per cent during the past 5 years.

Radioactive materials supplied by the U. S. Atomic Energy Commission are being used for gaging and control operations in the manufacture of a wide variety of consumer products. Some firms are using nuclear by-products in radiation inspection of welds and castings and in other metal working operations. These and other radioisotope applications now mean an annual savings to industry of $200 million annually.

Shorter TV Picture Tubes Predicted

Dr. W. R. G. Baker, a GE V. P. and president of RETMA, indicated recently that a new picture tube with an opening angle of 110 deg, an increase of 20 deg over present models, will come into extensive use next year. At the same time, the picture tube will be made shorter, permitting a depth reduction in cabinet width of 4 to 5 in.

The industry produced 50,000 sets in the 15 in. size and smaller during the first 6 months of 1955. By comparison, Dr. Baker added, more than 326,000 were built in the first 6 months of this year.

He also predicted that the future, completely transistorized TV receiver will be powered by its own self-contained battery.

Australia Puts TV In Its Pouch

With its first TV station, Call Letters TCN, scheduled to start telecasting regular commercial programs from Sydney on Sept. 15th, Australia can anticipate a boom market for TV receivers. Two other TV stations in Sydney and three in Melbourne are in varying stages of construction.

Two of the Melbourne stations are expected to be operating in time to telecast the Olympic games to be held there in November.

Provision has been made for 96 vhf stations and 50 uhf outlets, although the uhf band may not be in use for some time. Eventually, every town with a population of over 5000 will have two TV stations.

Picture-Phone System Uses Telephone Wires

An experimental telephone system which transmits by wire pictures along with sound has operated between New York and Los Angeles, according to Bell Telephone Laboratories.

Experimental pictures vary in size from 1 x 1-1/2 in. to 2 x 3 in. and are viewed at about 2 ft away. Unlike TV, a new picture is displayed every 2 secs. The image, transmitted over standard low-frequency telephone channels and requiring only the natural daylight or moderate amounts of artificial light, has good black and white contrast. Head and shoulders can be seen and facial expressions are readily apparent.

UHF Scatter Transmission

Under contract to ARDC's Rome Air Development Center, the Westinghouse Electric Corporation's Electronics Division, Baltimore, Md., is operating an over-the-horizon UHF tropospheric scatter transmission system between locations at Verona, N.Y., and Baltimore, Md. The study is in the bands of 900 mc and 2000 mc.

The data resulting from this study will make it possible to determine scatter transmission system performance in terms of signal attenuations, fading limits, and bandwidth capability as well as practical antenna sizes for maximum gain and diversity considerations.

CIRCLE 7 ON READER-SERVICE CARD ➤

Water-Cooled Germanium Rectifier Unit Revealed

Development of a direct water-cooled germanium power rectifier was announced at the Fall General Meeting of the American Institute of Electrical Engineers in the Morrison Hotel in Chicago. "Major improvements in the design of this rectifier," R. E. Wahl, of the Lynn, Mass., branch of GE, told a symposium on metallic rectifiers, "are ease of cell replacements, reduction of cost per kilowatt output and inertness to chemical atmospheres."

Some of the transformerless units have almost 10 kw output per cubic foot of volume occupied and up to 60 kw per square foot of floor space required. The units incorporating transformers show smaller kilowatts per cubic foot and per square foot. Protection against chemical atmospheres is provided for the germanium rectifier cells by hermetic sealing which is part of the basic structure of the cell.

Mr. Wahl observed that development of water-cooled rectifiers followed development of hermetically sealed units.

Texas Instruments Will Pay Tuition

An educational assistance program has been announced by Texas Instruments Incorporated, electronics and geophysics firm. TI has over 4000 employees eligible for the plan.

Under the plan, the company will repay 90% of the cost of tuition, textbooks, and registration and laboratory fees upon successful completion of approved courses. The program will be administered by an Educational Assistance Committee within the TI company organization. Basic requirement in securing company financial aid is that the course have a general relationship to the employee's work with Texas Instruments.

Large Mill Combines Card Program With Transistorized Memory Unit

A new reversing roughing mill now being completed for Jones and Laughlin Steel Corporation's Aliquippa Works is expected to be the steel industry's first completely automatic card-programmed rolling mill. Its control system, developed by Westinghouse, will permit an operator to initiate a detailed rolling schedule by pressing a push button. By selecting the proper card from several prepunched for each schedule, it will be possible to attain a definite set of reductions while allowing for variations in temperature and composition among individual slabs.

In addition to the "Prodac" control system, as it is called, which stores program information in a transistorized memory storage unit, the mill contains magnetic power amplifiers to operate various actuators.

Full operation in late 1956 is anticipated.

Ceramic Magnet Retains Strength

Known as Ferroxdure, a new ceramic material that is non-metallic and electrically non-conductive can be permanently magnetized to hold its strength under adverse conditions. Patented by North American Phillips Company, Inc., 100 E. 42 St., New York, the new magnetic ceramic is produced without critical materials such as cobalt, nickel or other metals which are costly and, in times of emergency, are often unobtainable. Ferroxdure is unaffected by external fields and is difficult to demagnetize once it has been polarized. Since it can be molded into various shapes, the new material has many practical advantages. Compared with metal magnets, it is smaller in size, lighter in weight, has longer effective life, and provides improved performance.

The photo shows Dr. Frank G. Brockman of North American Phillips examining the repelling power of two Ferroxdure rings in a glass beaker.

Method Of Tallying Votes Wanted

Los Angeles County Board of Supervisors, 501 Hall of Records, Los Angeles 12, Calif., invites competent manufacturers to submit bids on the development of prototype vote tallying equipment. Proposals are to include a systems analysis, cost estimates covering developmental work as well as production expenses, FP or CPFF contract statement, history of company, and other pertinent data. Bids must be received at Los Angeles no later than Dec. 4, 1956.

Service Plan For Scientific Instruments

Regular preventive maintenance and emergency repairs of expensive scientific instruments has been undertaken on a subscription basis by the Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago 22, Ill. Heretofore such policies were restricted to office equipment or TV receivers. This is a continuation and enlargement endeavor to include scientific instruments.

NBS Will Move to Maryland

About 550 acres of land near Gaithersburg, Md., have been selected as the new home for the National Bureau of Standards. Hoping to get away from city noises and electrical interferences, the NBS laboratory staff plan to complete the move in about five years. The bureau has occupied its present Connecticut Ave. site in Washington for over 50 years.

Operations at the Boulder, Colorado, research center will not be affected by the Washington laboratory relocation.

Data Conversion Equipment

Conversion of bearing and range information into digital form suitable for transmission over a radio voice communication link is the mission of equipment delivered to the Navy Electronics Lab., San Diego, by the Electronic Engineering Co., Calif.

The unit has two channels, each of which represents the shaft positions of a two-speed synchro system. The rotational position is converted into a 12-digit number.

Portable Radio Transistors May Last Forever

Replacement of transistors in portable radios and other electronic equipment may never be necessary if they are used within the limits set by the manufacturer, a General Electric Engineer suggested recently in New York.

In addition he said transistors are rugged enough to withstand the 8000 G jolt of being fired from a mortar and still operate at full ratings.

Speaking to a transistor reliability symposium sponsored by a Department of Defense advisory group, C. H. Zierdt, Jr., engineering consultant in the Semiconductor Products Department of GE, reported results of various tests run by his company on transistors. He reported that life tests started in 1954 on transistors picked at random from regular manufacturing lots show no failures after 18,000 working hours at full power. This is equal to maximum load on the transistors eight hours a day for six years.

Results showed that only 1/4 of one per cent of the transistors could not be operated at peak ratings after 1000 hours at full power. The other 99-3/4 per cent showed no signs of wear whatever. All of the transistors were still usable in portable radios.

APPLICATIONS !

Newest Radar Hazard to Motorists

Officer John Sweeney of the Chicago Park District Police is shown operating a new radar speed meter that does virtually everything but chase violators and write tickets. The 26 pound unit produced by Admiral Corporation will register the speed of all cars or, if desired, only those exceeding the speed limit. It can be set to retain a reading up to two minutes. A description of the car, license number, date and time of violation can be recorded on an optional tape recorder. Also, an optional 16 mm camera will take a motion picture by the split image process of the car's license number and the speed reading on the meter.

Auto Industry Gets Transistorized Fuel Injection System

Yielding more power with less fuel, the Electrojector, a transistorized fuel injection system for automobile engines, promises to give automobile designers in Detroit new horizons in the fabrication of low-slung autos. First application of transistors to basic automobile design, the new Bendix design is said to result in better fuel economy, elimination of vapor locks, no cornering or hill-angle effects, and great reductions in smog generation.

Basically, the system is a fuel injector system utilizing a separate fuel flow valve on each cylinder. Each valve is electrically actuated by impulses from an electronic modulator unit. The time duration of each electrical impulse to its valve determines the amount of fuel injected. Impulses can be controlled to an accuracy of 1/2 millisecond with the completely transistorized modulator. The 4 x 5 inch modulator is a simple analog computer which combines transduced engine temperatures and spark distributor impulses to produce an output signal to the cylinder valves. Corrections for ambient temperature and altitude are built into the deluxe version.

Collins Air Collision System Wins

Development of an electronic device to prevent aircraft midair collisions has been given top priority by Collins Radio. The Air Transport Association announced that the Collins plan for such a device was the best submitted. ATA is a national organization of the major airlines.

Collins proposes development of interim equipment to warn the pilot of the presence of any aircraft dangerously close to his own. More comprehensive equipment to follow this initial development will automatically determine if a nearby aircraft is on a collision path by means of an electronic computer, and advise the pilot of the necessary evasive action to be taken.

"Proximity Warning Indicator" (PWI) equipment is expected to be available to the airlines in 1958, with the "Collision Detection and Avoidance" equipment ready the following year.

PWI maximum ranges of either 800 feet or two nautical miles can be selected. Information from each flight plane quadrant will be independently displayed with an included angle of 15 degrees. Four range lamps will be provided for the pilot in each quadrant.

Antennas for the PWI system will be four directional types for azimuth coverage and one for each of the upper and lower hemispheres. CW-FM radar will be utilized in the basic rf system and range detection will be by frequency change as the transmitter frequency is swept in a sawtooth manner.

Continuous Weather Data To Aircraft

Trans-Canada Airlines is conducting transatlantic flight test of an airborne radioteleprinter which automatically and continually receives the latest weather data from stations in Canada and Scotland. Developed jointly by Federal Telecommunications Labs, Nutley, N.J., and Creed and Co., Ltd., London, England, the equipment has functioned effectively for a distance of 1300 nautical miles.

Sending stations are at Chatham, New Brunswick, Canada and Galdenock, Scotland. The typewriter-size machine converts the signals into readable print at the rate of 100 wpm.

Human Engineering Face Lifting

Pacing the current swing to human engineering the Servo Corporation of America, New Hyde Park, N. Y., displayed a new Servoscope at the ISA Show in New York which was redesigned on the basis of a nationwide survey of engineers and technicians. Based on their survey findings, dials, switches, and information display were arranged to try to reduce fatigue and increase reading accuracy. The servo instrument is an old standby in the control field. No significant circuit changes were made—only a human engineering face-lifting.

CIRCLE 499 ON READER-SERVICE CARD ➤

and now a third MEDALIST model

Recently, Marion introduced a new concept in panel meter design, successfully combining for the first time greater readability with distinctive "color harmony" styling. These "MEDALIST" meters were made available in standard 2½ and 3½ inch sizes, interchangeable with ASA/MIL type mounting.

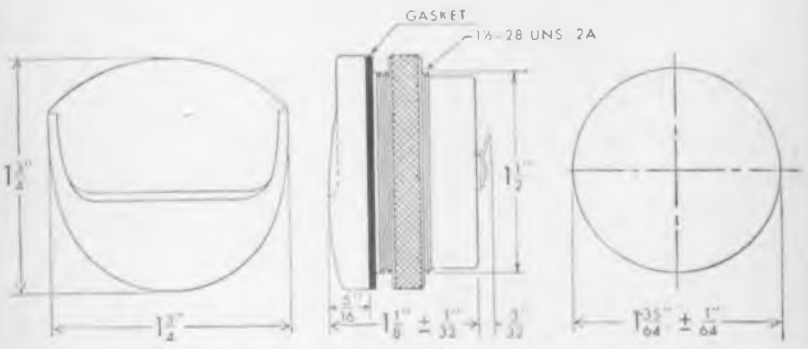
marion
MM1 1½" MEDALIST*

The MM1, shown actual size, provides scale length equal to or greater than most 2½" meters . . . and up to 50% more scale length than 1½" conventional meters. The new 1½" Medalist is available in all standard ranges including self-contained DC Ammeters and rectifier-type AC voltmeters. Basic mechanism of the MM1 is the Marion "Coaxial" MEP2-D, which assures performance and durability far surpassing conventional mechanisms. And like the MM2 and MM3, the MM1 is offered in a variety of standard and special case colors. Easy mounting is accomplished by a threaded ring.

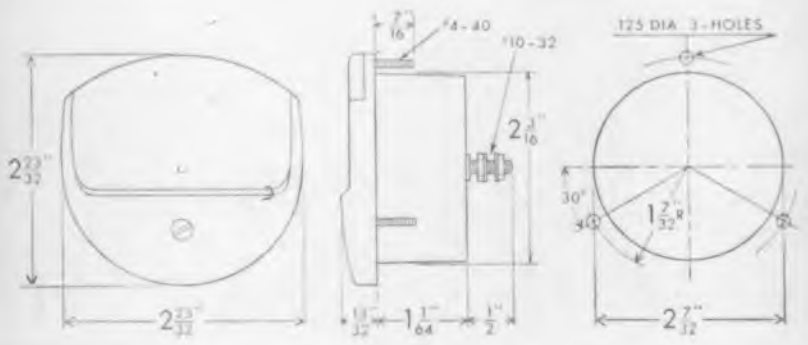
Medalists shown actual size

marion electrical instrument company
GRENIER FIELD, Manchester, New Hampshire

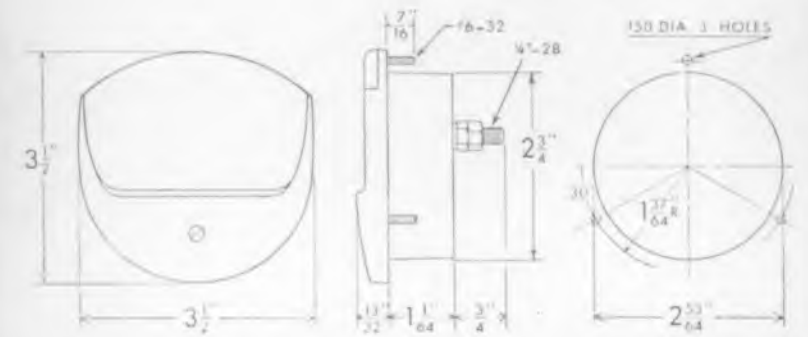
MM1 1½"



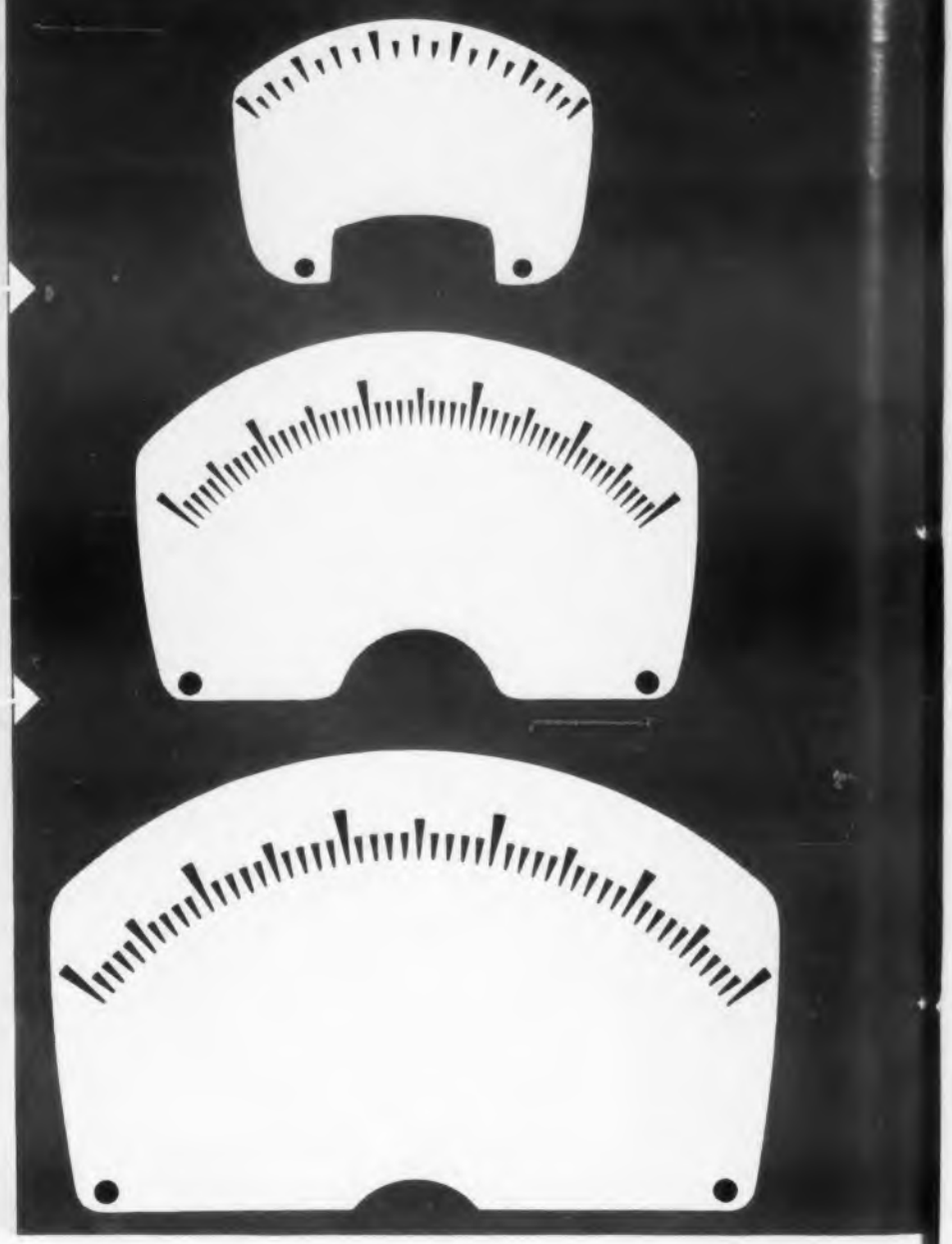
MM2 2½"



MM3 3½"



THESE ARE ACTUAL SIZE ILLUSTRATIONS OF THE MM1, MM2 AND MM3 DIALS. USE THEM WITH YOUR OWN TRADEMARK AND SCALE CONFIGURATION TO VISUALIZE A MEDALIST IN YOUR APPLICATION.



marion MEDALIST* **meters**...*"setting new standards"*

descriptive data

CONSTRUCTION

Undesirable shadows are eliminated and greater natural dial illumination is provided by the use of crystal clear, high temperature Plexiglas† fronts. Longer dial arc and distinctive markings provide greater readability in these space-saving meters.

COLORS

All "MEDALIST" meters are available in a wide choice of standard colors to harmonize with your equipment. Custom case and dial colors to match your individual requirements can also be supplied.

RANGES

"MEDALIST" meters are supplied in all standard DC ranges of microamperes, milliamperes, amperes, millivolts, volts, kilovolts, and AC rectifier types including VU and DB meters.

marion meters

marion electrical instrument company

GRENIER FIELD, Manchester, New Hampshire

Washington Report

Albert Warren

Washington Trends & Briefs

Top 100 defense contractors during 1955 included 29 heavily involved in electronics manufacture, according to list released by Defense Dept. The list, with each company's ranking and dollar volume (in millions) is as follows: (1) Boeing, $797.2; (2) North American Aviation, $790.9; (3) General Dynamics, $781.7; (4) United Aircraft, $587.4; (5) GE, $570.2; (6) AT&T, $505.3; (8) Lockheed Aircraft, $412.7; (10) Douglas Aircraft, $291.1; (11) Glenn L. Martin, $271.4; (12) Hughes Aircraft, $205.9; (13) Bendix Aviation, $194.1; (20) IBM, $128.4; (21) Sperry Rand, $127.7; (22) RCA, $125.7; (26) Philco, $97.6; (27) Avco, $84.5; (34) Raytheon, $59.7; (35) Collins, $57.8; (44) Hazeltine, $46.2; (48) Westinghouse Electric, $41.8; (57) Dynamics Corp., $34.2; (60) Gilfillan, $33.1; (62) Minneapolis-Honeywell, $32.6; (63) American Bosch Arma, $32.0; (68) ACF Industries, $31.3; (69) Motorola, $29.6; (71) Westinghouse Air Brake, $29.0; (75) American Machine & Foundry, $27.4; (80) IT&T, $18.9.

Institute for Defense Analyses has been formed, awarded $1.7 million contract, to assist Dept. of Defense's Weapons System Evaluation group. Headed by Maj. Gen. James McCormack Jr. (USAF, Ret.), trustees include top scientists of California Institute of Technology, Case Institute, MIT, Stanford U., Tulane U. Research director of IDA will be Dr. Albert G. Hill, former director of MIT's Lincoln Lab.

Circular polarization program of Civil Aeronautics Administration will convert airport surveillance radars at 47 airports at cost of $15,400 for each radar already in use, $5000 for those to be installed. CAA states that circular polarization produces superior results in picking up aircraft flying through snow & rain. One conversion, at LaGuardia, N.Y., has been completed.

New TV resolution chart offered by RETMA features, among numerous improvements, increase of resolution wedges from 600 to 800 lines, use of 100% rag stock of great brightness, very flat blacks & greys. Also, for greater performance, grey scales are supplied in photographic paste-on form.

Recent loans to electronics firms by Small Business Administration: $200,000 to Cleveland Electronics Inc., Cleveland, O.; $150,000 to Pioneer Engineering Corp., Los Angeles; Servonic Instruments Inc., Pasadena, Cal.

CIRCLE 499 ON READER-SERVICE CARD

Graphite Welded for First Time

Techniques in processing materials for the atomic age took a step forward when Union Carbide announced that pieces of graphite have been successfully welded together for the first time in history. Graphite is useful in nuclear reactors because of its neutron-slowing characteristics. In the past, sheets and panels for nuclear reactor moderators have been built up from graphite blocks. However, with the new process, forms can be prefabricated in various configurations directly by ordinary welding techniques.

In explaining the revolutionary process, Dr. Robert G. Breckenridge, director of the new Union Carbide Research Laboratories in Parma, Ohio, pointed out that the graphite welding process is essentially a melting process. Graphite electrodes are placed near each other in high-pressure argon and a carbon arc joins the two pieces as an electrical current flows between them.

Union Carbide also disclosed that the largest single crystals of cadmium sulfide ever reported have been "grown" in their new laboratories. A light-sensitive material, cadmium sulfide can be used in photo cells, solar batteries, and, when properly activated, as a light-producing phosphorescent material.

Glass Components Resist Moisture

Arising as an important material in electronics manufacturing today, glass is gaining momentum as a basic material for many new products. A new line of electronic components has recently been introduced to the market, including glass insulated capacitors, glass based resistors and metalized glass inductances. The capacitors are made with a thin glass ribbon as the dielectric material which, interleaved with metal foil such as aluminum or silver, heated and rolled together in the form of a multiple club sandwich, provides a monolithic structure which does not need to be buried in wax to make it moisture proof.

These glass insulated capacitors are competitive with the best mica types and have some advantages in electrical properties.

◀ CIRCLE 13 ON READER-SERVICE CARD

Hand-Held Underwater TV

A new development in underwater TV, announced by Pye Ltd., England, is a small hand-held underwater TV camera. It enables diving operations to be effectively supervised from above the water by observers grouped around a large screen.

Observers, then, can direct the diver by means of underwater loudspeaker equipment. Provision is made for the pictures reproduced on the screen to be photographed.

The small version of the camera, a 12 in. sphere weighing 38 pounds on land and buoyant in water, has been designed to withstand water pressure of 220 psi, corresponding to a depth of 500 ft.

All camera adjustments are carried out from the control unit above the water. The diver concerns himself only with the camera positioning.

A larger version, designed to operate at 3000 ft depths, is encased in a 19 in. aluminum sphere. This version can be propelled by an electrically operated cradle.

Camera Tracks Radar Target

Sighting through an aperture in the radar reflector, this new type 35 mm Boresight Camera, manufactured by Cameraflex Corp., 1947 Bway., New York 23, N. Y., photographs the target being tracked by radar. The radar secondary mount has azimuth, elevation and camera focusing adjustments which are independently operated. Lens, camera and focusing system are mounted on a plate which is removed and replaced easily, without disturbing adjustment positions.

World's Weather in a "Box"

To evaluate the effect of various weather conditions on airborne electronic systems, Westinghouse Electric Corp., Baltimore, Md., has installed an environmental testing chamber.

The chamber consists of two sections, each 10 x 18 x 16 ft deep. Rain, humidity and salt spray tests are conducted in one section, while altitude and temperature tests are performed in the other. In a matter of minutes, the temperature can be reduced to −100 F or raised to +500 F. Altitudes as high as 80,000 ft are simulated within 25 minutes.

CIRCLE 14 ON READER-SERVICE CARD ➤

Meetings

Oct. 16-18: Conference on Magnetism and Magnetic Materials.

Hotel Statler, Boston, Mass. Sponsored by the AIEE, IRE, American Physical Society, American Institute of Mining and Metallurgical Engineers. For further information, write to T. O. Paine, Measurements Laboratory, General Electric Co., W. Lynn, Mass.

Oct. 17: IRE Professional Group on Management.

Midston House, New York, N. Y., 8:00 p.m. Premeeting dinner, 6:00 p.m. Theme of the conference is "Investment in Research." Speaker of program, Harper Woodward. For further information contact the IRE, 1 East 79th St., New York 21, N. Y.

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. A session of invited papers on "Recent Developments in Electron Devices" will be a feature of the meeting. For information, contact Prall Culviner, Sylvania Electric Products, Inc., 1740 Broadway, New York, N. Y.

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.

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.

Oct. 31-Nov. 3: Gaseous Electronics Conference.
Westinghouse Research Laboratories, Pittsburgh, Pa. Co-sponsored by the Division of Electron Physics of the American Physical Society and the Westinghouse Research Laboratories. For more information, contact A. V. Phelps, Westinghouse Research Laboratories, Beulah Rd., Pittsburgh, Pa.

Nov. 7-9: Conference on Electronic Technology in Medicine and Biology.
McAlpine 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. 13-16: Fourth Annual Meeting of the Investment Casting Institute.
Sheraton Cadillac Hotel, Detroit, Mich. "Vacuum Metals Symposium" is the theme of the meetings. An extensive program of talks has been scheduled. Registration fee is $25.00. Details available from the Investment Casting Institute, 27 East Monroe, Chicago 3, Ill.

Nov. 14-16: Symposium on Optics and Microwaves.
George Washington University, Washington, D. C. Sponsored by the IRE Professional Group on Antennas and Propagation, the George Washington University and the Optical Society of America. For further information, contact the IRE, 1 E. 79th St., New York 21, N. Y.

Nov. 15-16: ORSA Tenth National Meeting.
Hotel Mark Hopkins, San Francisco, Calif. Operations Research is the theme of the meeting. Further information may be obtained from the Program Chairman at the U. S. Naval Postgraduate School, Monterey, Calif.

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. A two-day "Senior Officer Conference on Office Automation" directed by Gordon L. Mattson and sponsored by Fordham University School of Business will be held. For information, write to Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 22, Pa.

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

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

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

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

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

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

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

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

April 11-13, 1957: Southwestern IRE Conference and Electronics Show.
Houston, Texas. Sponsored by the Houston Section of the IRE. For information, write to Ninth Southwestern IRE Conference and Electronics Show, P. O. Box 1234, Houston 1, Texas.

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

Transistor Design

C. H. Zierdt

Consultant-Engineering
Semiconductor Products
General Electric Co.

MANY styles and shapes of transistors have evolved. Some have resulted from limited but special requirements; others apparently have been designed to further the publicity aims of companies caught in the throes of competition. The purpose of this article is to soberly examine transistor design from the standpoint of end-use requirements.

Design Requirements

A list of the design requirements would certainly include the following:

- Lowest overall cost consistent with other requirements;
- Smallest size consistent with other requirements;
- Applicability to printed wiring and automatic assembly techniques;
- Transistor reliability consistent with end product requirements;
- Interchangeability between similar products of various transistor manufacturers;
- Mechanical similarity between types (n-p-n, p-n-p, alloy, grown, etc.); and
- Electrical insulation of all transistor elements from the housing.

Cost

The necessity for lowest cost leads to a cylindrical form, which is least expensive to tool both in housing fabrication and in transistor assembly. This in turn makes a nearly circular lead pattern desirable for single-ended devices. Economical transistor manufacture at present requires that a transistor be mounted, cleaned, and tested before final sealing, and that the final seal be made under controlled atmosphere and without contamination from the sealing process. Single-ended design lends itself most readily to this procedure. A most important factor in cost is the size; units must not be so small that they cannot economically be machine-produced (although certain applications will probably continue to justify achievement of absolute minimum size by hand assembly at higher

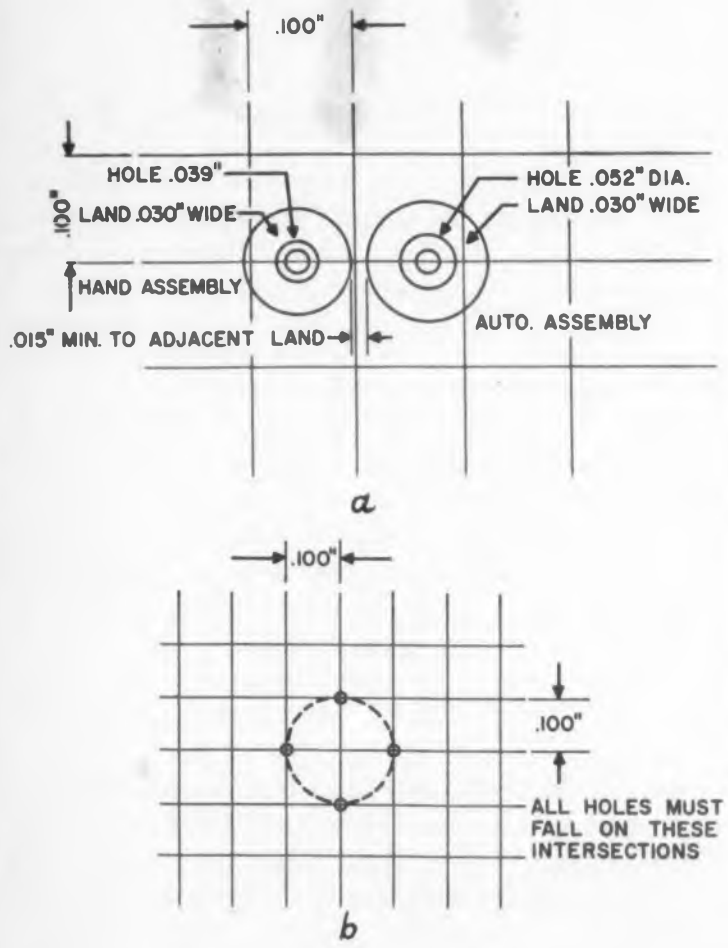


Fig. 1. Transistor lead specifications for use on printed wiring boards: (a) Hole spacings for hand and automatic assembly; (b) Preferred grid spacing for printed wiring boards (JTC-259).

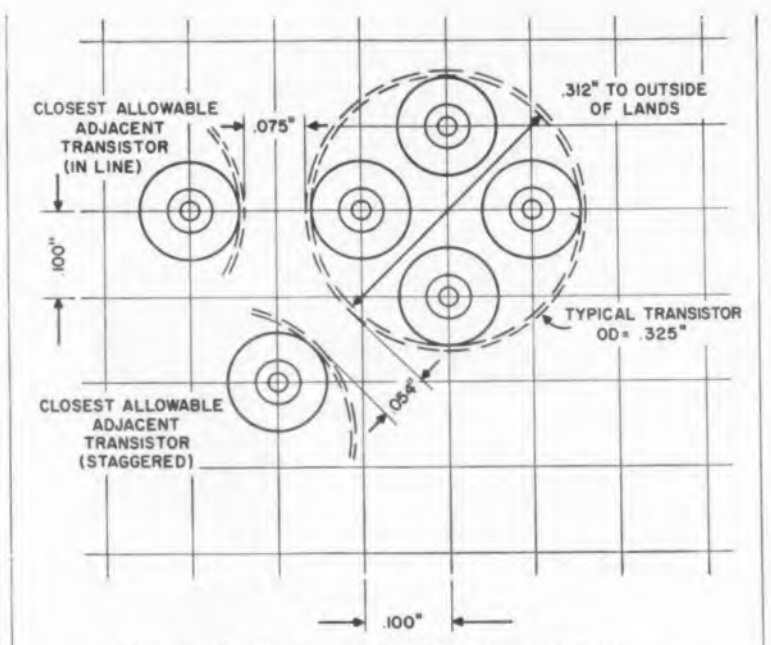


Fig. 2. Board layout for adjacent transistors.

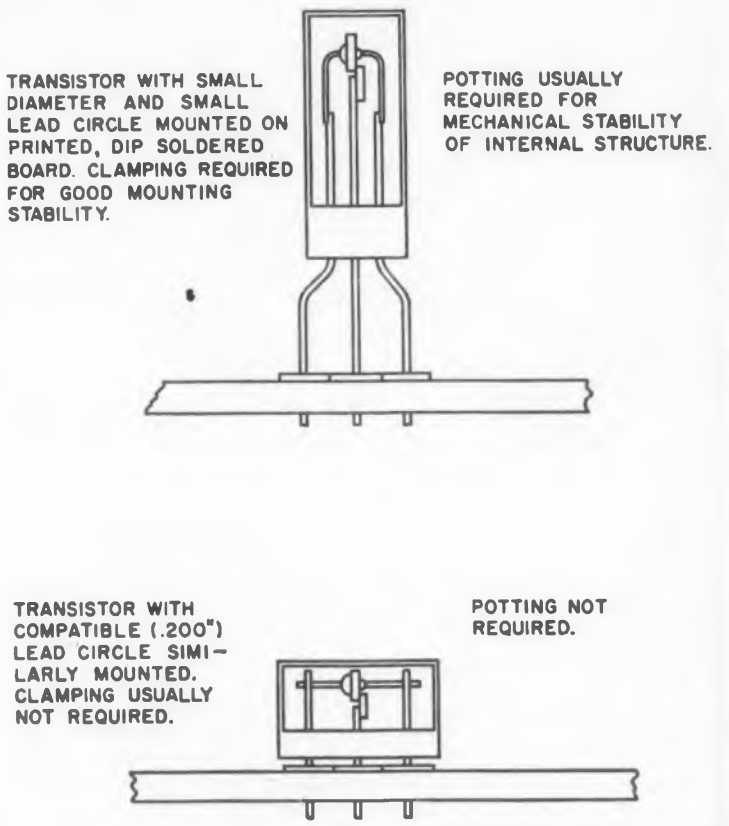


Fig. 3. Internal structure and board mounting of two transistor types.

cost). There is little cost difference at present between available housing materials and methods when considered as the overall cost of housing the transistor. Mechanical tolerances must, as usual, be as large as possible to keep price down. Lower cost will also result when the transistor manufacturer can use the same housing for many transistor types, with attendant purchasing and assembly tool economies.

Size

The question of smallest size resolves rapidly to one of form factor, as the cubage of machine-manufacturable transistors does not vary over any great range. For point-to-point wired assemblies, chassis space may be gained at the expense of transistor height by using a tall, thin housing. In printed wiring assembly, the board wiring usually puts a lower limit on the floor space required for any component, and allows a shorter, wider transistor design to be used with some fabrication and application advantages. For many applications, dissipation requirements also limit the **minimum usable size.**

Printed Wiring

Applicability to printed wiring requires primarily that the leads be spaced far enough between centers to allow the necessary land diameters of the printed board holes, without solder bridging between adjacent leads when dip soldered. The minimum center-to-center spacing usable with present board fabricating techniques is 0.100 in. for hand-inserted components and 0.125 in. for automatically machine-inserted components (Fig. 1a). An additional requirement of most board-drilling and/or automatic component placing machines is that the centers of all holes shall lie on intersections of a 0.100-in. square coordinate grid (Fig. 1b). The necessary transistor lead spacing may be obtained either by forming the leads from their positions at the transistor base to spacings in multiples of 0.100 in., or by so arranging the transistor base that the leads emerge from the transistor body at the proper spacings. The latter method is more economical, but generally requires a larger outside diameter of the transistor housing. This does not imply that more board space is required by such transistors, as the lands of the printed board generally approach very closely the transistor OD (Fig. 2). The wider lead spacings allow transistor elements to be mounted *between* rather than atop the *leads*, reducing the transistor's overall height appreciably. This reduced height is valuable in applications, such as computers, in which many boards are stacked together in a minimum space. A second requirement for transistors designed for assembly into equipment by automatic machinery is that an indexing point must be provided on the periphery, in a fixed angular relation to the transistor leads, so that the insertion machine may properly orient the transistor before placing it.

Reliability

Reliability has many aspects, of which the most general is the need for protection of the transistor from damage by environment during use. A look at today's transistor industry gives mute evidence that anything less than complete hermetic sealing has not provided reliability adequate for any application in which transistors have been used; this has been verified by hundreds of thousands of hours of testing and millions of hours of actual use in equipment.

Mechanical transistor internal ruggedness of the structure requires short, rigid sturcture if potting compounds are not used; their use renders most structures sufficiently strong mechanically, at some risk in electrical and high-temperature reliability because of the extreme sensitivity of transistor surfaces to foreign elements (Fig. 3).

In terms of mechanical ruggedness of a transistor when in place in a circuit, for any but "static use" applications such as radio or TV receivers, the transistor will probably require mechanical clamping to prevent vibration or shock damage to its leads if any appreciable lead length exists between the transistor base and a mechanical mount. This limitation does not apply to transistors whose leads are properly spaced for printed wiring; and which may therefore be mounted on the board with essentially no exposed lead length, as shown in Fig. 3.

Interchangeability

Mechanical interchangeability between transistors made by different manufacturers generally requires that the diameter be essentially the same for both, with somewhat less binding requirements on height and lead arrangement. This objective is best met by agreement between transistor manufacturers, which is now in process in several of the industry committees under Joint Electron Tube Engineering Council sponsorship.

Use of a common housing for a multiplicity of transistor types has a very real advantage to the user, in addition to its cost advantage to the transistor manufacturer. Both development and product improvement of transistor-using equipment are facilitated by ready interchangeability between nph and pnp transistors of grown or alloy junction types, for instance, without redesign of the equipment to accommodate different transistor sizes or shapes.

Circuit-wise, it is almost always advantageous that the transistor elements be electrically insulated from the housing and/or the mounting means. In an important exception, which requires maximum dissipation with minimum size, the required heat transfer may dictate connection of one element to the housing. A good design will therefore attempt to allow this option without introducing undesirable tool changes or alteration of the transistor form sufficiently to render it non-interchangeable with others in the same-size envelope.

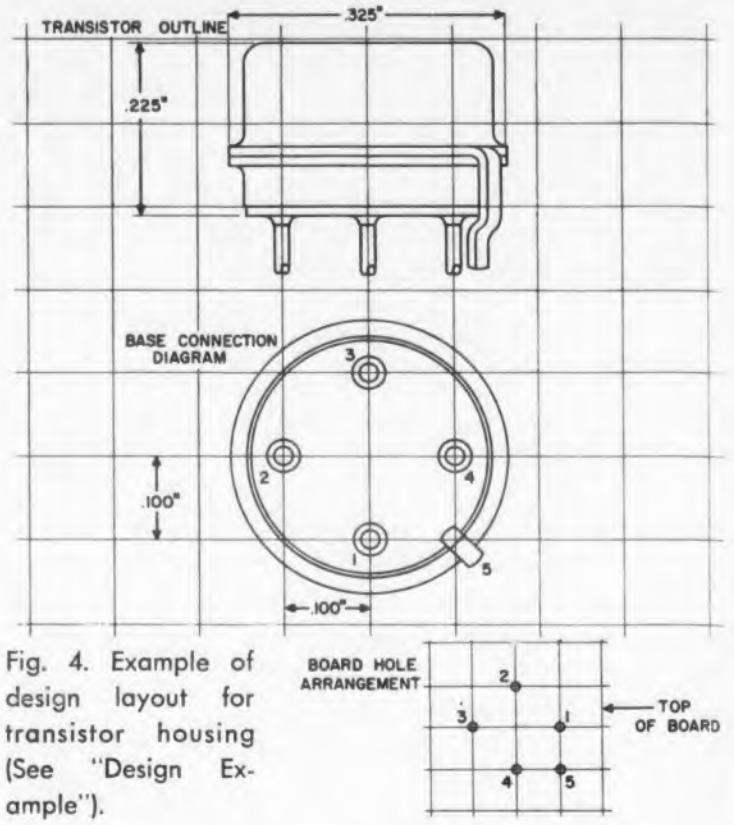


Fig. 4. Example of design layout for transistor housing (See "Design Example").

Design Example

To illustrate the application of these manifold considerations, consider the design of a housing, now used by General Electric Co., for signal and switching transistors rated to 150 mw dissipation (Fig. 4). The development specs for this housing were:

- It must be hermetically sealed (vacuum tight);
- It should be capable of automatic assembly into printed circuit boards;
- It should accommodate a maximum number of transistor types;
- It must be procurable at reasonable cost from several vendors, and must not be limited to one construction, which might preclude future cost reductions;
- It must be suited to mechanized transistor fabrication;
- It must be as small as possible, consistent with other requirements;
- It must introduce a minimum of interlead capacitance.

The requirement for automatic assembly in printed boards establishes a minimum center-to-center lead spacing of 0.125 in. which is incompatible with a 0.100 in. coordinate grid. The closest compatible spacing is 0.141 in. (diagonal of a 0.100 in. square); therefore the arrangement of Fig. 1b is the smallest compatible with the 0.100 in. grid. Leads are 90 deg apart on a 0.200 in. diam circle, centered. It is noted that this allows four leads without size penalty; it will therefore accommodate many types of devices in addition to the triodes now commonly manufactured. A lead dia of 0.017 in. was chosen as a reasonable compromise between desired lead stiffness and the OD of the transistor (which should be increased if larger leads are used).

From the lead circle diameter, using 0.017 in. leads, good glass-to-metal seal practice requires at least 0.125 in. of added diameter for insulation, fabrication, and final sealing purposes. The minimum OD is therefore 0.325 in., which was the value chosen. Of this, 0.030 in. is devoted to the resistance welded final seal. The required height is determined by the internal transistor elements; a value of 0.025 in. overall was chosen as suitable for all presently foreseen devices adaptable to this housing.

These dimensions permit stable mounting of the transistor by soldering the leads directly into a printed board, without clamping the device body. They also allow a very low overall height for stacked-board applications, and an extremely rugged internal transistor structure without resort to potting or other potentially costly reinforcements.

Several types of seals, and various seal materials, may be used for this housing, allowing a wide latitude of future manufacturing economies, special design for thermal dissipation, etc. It will dissipate 150 mw at 100 C junction temperature and 25 C ambient; it is thus equal to many much (3-4 times) larger housings in this respect, primarily because of the short heat conduction path inside the unit.

A case orienting index is provided by a peripheral "bump" which is so located that, if made in the form of a lead, it may be used to ground a metal transistor shell for shielding. This feature has proven most valuable in 30-100 mc applications. It is noted that a lead so placed is compatible with the 0.100 in. grid system.

This housing (Fig. 4) is currently being used by General Electric Company for several developmental triode, tetrode, and other transistor types. It was developed under USAF contract AF33(600)17793 for these uses, and has demonstrated its ability to withstand all military environment and mechanical tests. Its outline is also under consideration by JETEC as a proposed mechanical standard for general industry use.

The equipment designer's vision of transistors having neither size nor weight nor losses, with infinite gain and life in millennia, is not likely to be achieved during the present rapid growth of the semiconductor industry. Transistor and other component design people must continue to push the frontiers of size reduction, reliability improvement, and decrease of characteristic spreads as fast as technological advances permit. In the meantime, it should be remembered that compromise among many conflicting factors is the essence of good product design, whether of components, equipment, or consumer items. Insistence of users upon infinitesimal size and single purpose forms of transistors will produce an inevitable delay of the more important achievements in uniformity, low cost, and reliability.

A definite move toward logical transistor housing standards now will contribute a great deal to earlier fruition of the better, lower-cost products which better transistors make possible.

Circuit Design For Transistor Interchangeability

William J. Maloney

General Electric Company, Syracuse, N. Y.

TRANSISTOR replacement in circuits often necessitates changing circuit parameters to restore the original operating conditions. It is desirable to avoid this necessity. The work done at GE, disclosed here, offers practical suggestions to designers for developing circuits that allow germanium triode interchangeability in if power amplifier circuits. This method of approach may be applied to similar problems encountered in other transistor circuit design.

Interchangeability of components is a very necessary criterion in the design of intermediate frequency amplifiers. Transistors have not, in the past, adequately fulfilled this requirement. Consequently, designs must include compensating factors, such as neutralization, which add materially to the cost. An investigation of factors affecting amplifiers without neutralization revealed practical limits of certain parameters which can be valuable to both the designer and the manufacturer. Since only a single stage was considered, additional problems of cascading are not covered.

The common-emitter configuration was investigated since it is most widely used in industry. This configuration is more practical from an impedance matching standpoint, and at 455 kc it gives higher power gain than the common-base circuits. From this point the designer needs to know the optimum impedance for the collector, the input impedance at the base, and the best operating point on the characteristic curves. The operating point will be determined as a compromise between dc power drain and signal power gain. However, it will be shown that the dc components do affect the signal-handling parameters of the device and thereby further complicate the design problem.

A conjugate impedance match at the input and output of the germanium triode common-emitter configuration will approach an unstable condition where oscillation may occur. To avoid this, a resistive input match is used as in Fig. 1. A pi-matching network is used at the collector output. This provides a good means of varying the load at the collector terminal as well as keeping the output tuned. The constants for the pi-network were calculated according to general network theory.

In this case, a 200 μh coil is used with a high Q (325 at 455 kc). The input capacitance, C_1, is variable from 200 to 700 μμf; C_2 at the output is variable from 4500 to 14,500 μμf in steps of 1500 μμf. When the output circuit is tuned, the load is a pure resistance (R_o). In this condition, the input impedance (Z_i) is not resistive, but the resistive component (R_i) is measurable. This makes it possible to compute power into the base. Since it is necessary to know the exact impedance into which the collector is working at any one setting of C_2, it can be measured according to the method presented in Fig. 2. Note that it is necessary to keep C_1 tuned. When taking these measurements, a slight trimming will be necessary when the transistor is removed from

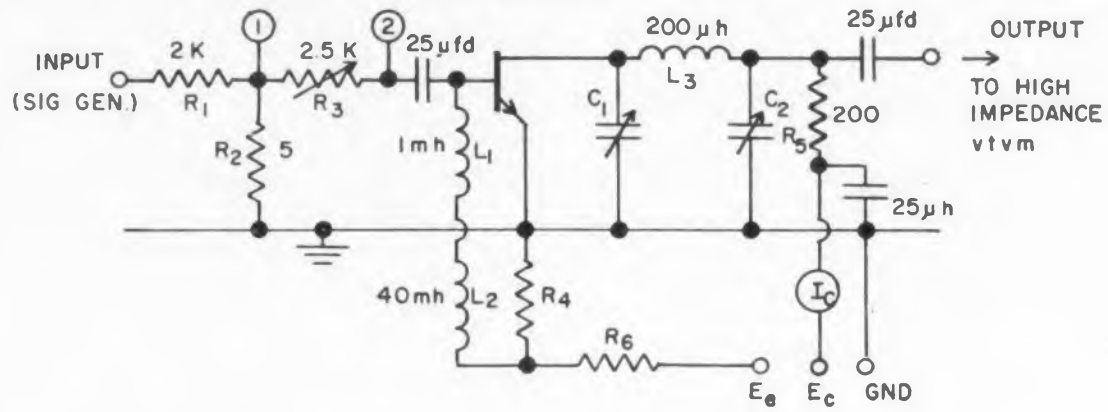


Fig. 1—Circuit employed for measurement of power gain.

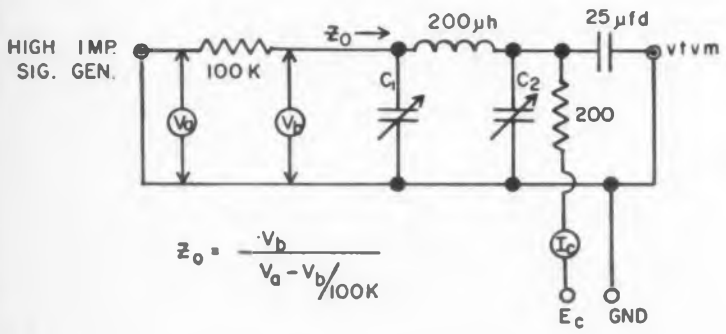


Fig. 2—Collector Load Impedance measurement circuit (tuned).

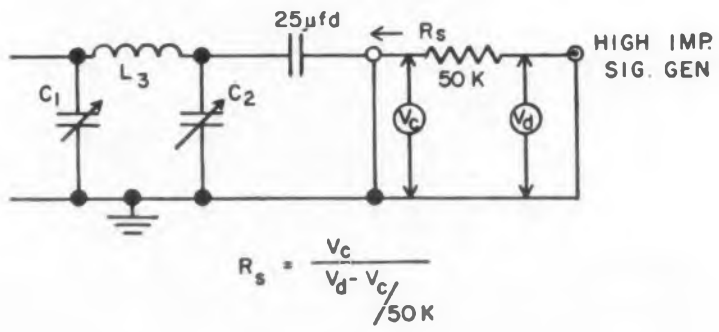


Fig. 3—Circuit used for measurement of shunting resistance of matching network (tuned).

Design Calculations

$$Q_L = 3\sqrt{\frac{R_o}{R_L}} = 26\,; \qquad (1)$$

where: Q_L = loaded Q
R_o = collector load (15,000 ohms)
R_L = terminating resistor (200 ohms)

$$\text{Bandwidth (B.W.)} = \frac{455}{26} = 17.5 \text{ kc} \qquad (2)$$

(If $Q_L > 26$, B.W. will be less. In the laboratory, the model was measured to have a B.W. of 12 kc.)

$$Q_L = \frac{R_o}{X_{C_1}} \cdot X_{C_1} = \frac{R_o}{Q_L} = \frac{15{,}000}{26} = 577 \text{ ohms}$$

$$C_1 = 600\ \mu\mu\text{f} \qquad (3)$$

$$Z_a = \frac{X_{C_1}^2}{R_C} = 22.2 \text{ ohms}; \qquad (4)$$

where Z_a = characteristic impedance of pi-network.

$$Z_{C_2}^2 = Z_o R_L = 4440$$

$$Z_{C_2} = \sqrt{4440} = 66.7 \text{ ohms}$$

$$C_2 = 5000\ \mu\mu\text{f} \qquad (5)$$

$$X_L = X_{C_1} + X_{C_2} = 644$$

$$L = 200\ \mu\text{h} \qquad (6)$$

the circuit and the signal inserted. The voltmeter at the output can be used to monitor the tuning. The collector impedance is controlled by C_s when the circuit is tuned. A tap switch is used to vary the size of C_s, and it can be calibrated directly in impedance.

With the proper value for R_1 and R_s, point 1 in Fig. 1 is a constant voltage point. Furthermore, R_s is effectively the internal impedance of the generator. Therefore, if the voltage at point 2 is one-half the voltage at point 1, R_s will be equal to R_1. The power into the transistor (P_i) will closely approximate E_s^2/R_s provided C_1 is tuned to the point where E_2, the voltage at the base, is minimum. Since h_{rb} has not been neutralized, this is not at the resonant point for the collector circuit. If the collector circuit is then tuned to exact resonance, as indicated by the output meter, the voltage across R_s can be read. This will give the useful power output of (P_o) as E_o^2/R_s.

As a matter of basic philosophy, there is an amount of power lost (P_L) in the matching network which must be taken into account. Although this is not useful power, in that it is not available at the output, it is supplied by the transistor. Obviously, not all transfer networks, such as if transformers, have the same efficiency. It is possible to design a highly efficient network which in actual tests would indicate high power gain but would not be optimized for practical use. The only equitable method is to add this power lost to the useful power output, thereby crediting the transistor with it and allowing the circuit designer to choose the most practical matching network.

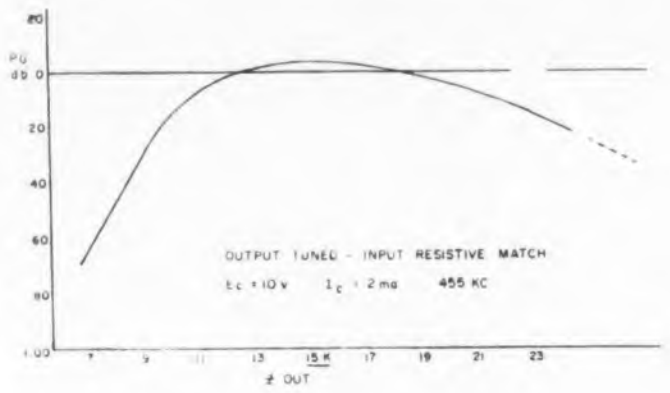


Fig. 4—Variation in power gain with output loading.

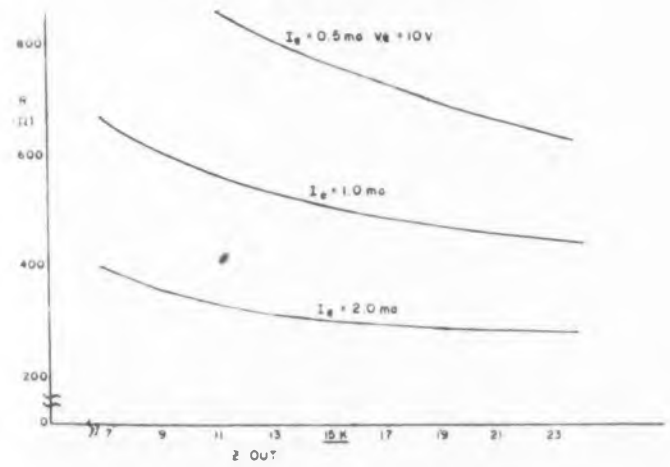


Fig. 5—Variation in input resistance with output loading. Output tuned to 455 kc.

A suitable method is presented, Fig. 3, for measuring the power lost. This is a function of the value of C_s and, as before, C_s can be calibrated in R_s (a shunting resistance across R_L). Obviously, R_s is removed for this measurement. From R_s and E_o the power lost is computed: ($P_L = E_o^2/R_s$). The total power out of the transistor (P_{ci}) is the sum of P_o and P_L. From this power gain can be obtained: (P.G. = 10 log P_{ot}/P_i).

Test Results

Data was taken on forty transistors of the GE 2N78 npn type. The output impedance was varied to determine the optimum load for the transistor. In the range of C_2, it was possible to vary the load from 7000 ohms to 23,000 ohms. The results are plotted in Fig. 4. The load can be varied from 8000 to 26,000 ohms with only 0.5 db loss in gain. At all times, the input was resistively matched in order to keep the power-in at the proper level. In doing so, it became apparent that the input resistance was affected by the output load. This is to be expected from a theoretical analysis. In general, the input resistance goes up as the output load is decreased (Fig. 5). The emitter bias is presented as an independent parameter. As was expected, the input resistance is higher for lower values of emitter bias.

Although the input resistance decreases with an increase in output impedance, some units showed a lower input resistance than others. It was noted that these units gave a higher power gain. A plot of input resistance against emitter bias current showed a sharp increase in R_{in} with lower values of I_c. Changing the collector voltage did not affect these results, showing that R_{in} does not vary appreciably with V_c (Fig. 6).

Dc bias levels have an effect on the power gain also. Data shows that gain increases with V_c, rather rapidly at the lower levels and tapers off at values above 6 v (Fig. 7). With I_c there is a definite peak on the gain characteristic. This peak occurs between 1 and 5 ma, depending upon collector voltage.

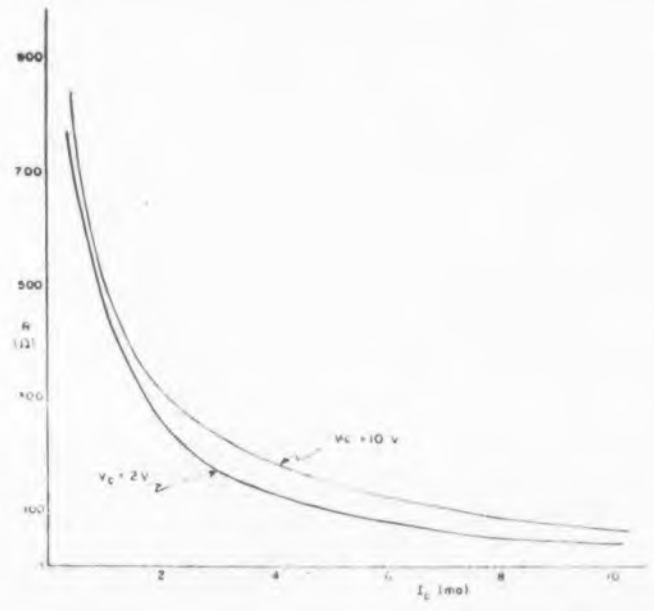


Fig. 6—Variation of input resistance with I_e. Output 455 kc, load 15,00 ohms.

In all considerations of power gain, alpha cutoff frequency must be taken into account. In this investigation the alpha cutoff varies between 4 and 12 mc. From the experimental results, it did not seem to affect the power gain since units with the same power gain showed different alpha cutoff frequencies. Several checks revealed that beta cutoff gave a better correlation. Before pursuing this further, it became evident that R_{in} is more significant. It is apparent from Fig. 8 that the gain of a matched stage is nearly constant. The difficulty arises from the wide variations in R_{in} which varies with h_{rb}. If an amplifier is designed with certain input matching characteristics, excessive variations in the input resistance of the unit leads to loss of power gain, instability of operation, or in the case of converters, no operation. Therefore, a narrower spread on R_{in} would alleviate the interchangeability problem.

Power gain in intermediate amplifiers is a close function of the input resistance. The input resistance varies with h_{rb} and alpha cutoff. Further variations in input resistance are experienced as a result of operating bias, output impedance and individual transistor characteristics. Realizing this, interchangeability can be done with transistors by proper circuit design.

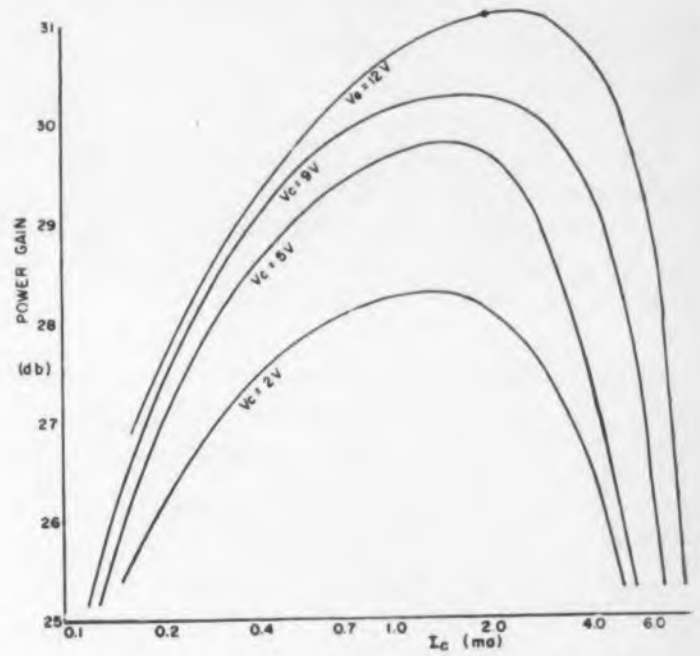


Fig. 7—Power gain vs emitter current. Resistive input match.

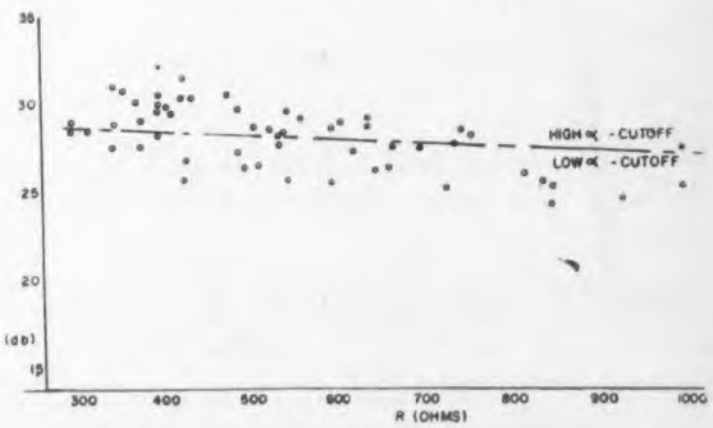


Fig. 8—Power gains for a number of 2N78 transistors; gain is relatively constant.

How To Evaluate Screen Phosphors

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FACED with the problem of selecting the proper screen phosphors, the engineer picking a display tube might ask himself the questions itemized below. Results of various screens are discussed in the answers to these questions, to enable an equipment designer to arrive at the best compromise.

Phosphors discussed here are classified as: *P4*—short, i.e. for all practical purposes there is no image clearly visible to the eye once the electron beam is cut off; *P1*—medium; *P2*—medium long; *P7, P12, P14,* and *P17*—long, i.e. an image that is fairly bright during luminescence remains clearly visible to the eye for a few seconds after beam cutoff (*P17* has in addition a component of μsec duration); *P19* and *P25* are classified as very long.

Questions Regarding Displays

1. Brightest Phosphor—If operation is restricted to low voltage and if very long persistence is not desired, what phosphor will give the brightest image for a given beam current, and how far can the beam current be increased without burning a particular screen?

2. Anode Voltage Effect on Brightness—How much brightness is gained for various phosphors by increasing the anode voltage?

3. Aluminizing and Brightness—How much brightness is gained at higher anode voltages by aluminizing the screen, a process which is detrimental in that it restricts tube operation to voltages above 5 kv?

4. P19 vs P25—How do the very long persistent phosphors *P19* and *P25* compare?

5. Contrast—How many distinct brightness steps can be perceived on a given screen type, i.e. how good is contrast?

6. Gray Envelopes—Is there any advantage to using gray glass envelopes?

7. Glare Coatings—Is there any advantage to using a reflection reducing coating on the outside of the face plate?

Answers to Questions

1. Brightest Phosphor—Fig. 1 gives the light output *L* (in foot-lamberts) of a 1/2" x 1/2" raster for various screens at 5 kv anode voltage, which is a standard operating voltage for the tubes used. *L* is plotted as a function of the beam current *I*, starting with $I = 1\mu A$. In view of the raster size, *I* represents 1/4 the beam current density per square inch. The measurements were made with an eye-corrected Weston illumination meter, so that the relative brightness of the various screens is recorded as it appears to the eye. The data on *P19* could not be included since these screens burn at very low beam currents. *P12* and a carefully processed *P25* screen can sustain beam currents of 1 and 2 μA, but the light output is too low to be plotted on this diagram. The light output measurements were carried out up to as high a value of the beam current as possible without causing a burn at the bright edge of the raster. This determination of the burning point of the screen is only approximate. Particularly worth noting is that the short persistent phosphor *P4* used for TV screens is the most efficient while *P17* is the least efficient. The closeness of the other curves shows that at 5 kv the variation in efficiency from screen to screen is not too pronounced.

2. Anode Voltage Effect on Brightness—In order to evaluate correctly the effect of increasing the anode voltage, the following considerations must be taken into account: It is possible to use screen thickness and processing, which will give optimum light output in a given range of anode voltage. The data on light output at 12 kv shown in Fig. 2 were obtained with the same size tubes used to get the data at 5 kv, i.e. tubes designed primarily for the 4-7 kv range; 12 kv is the maximum allowable voltage for these tubes.

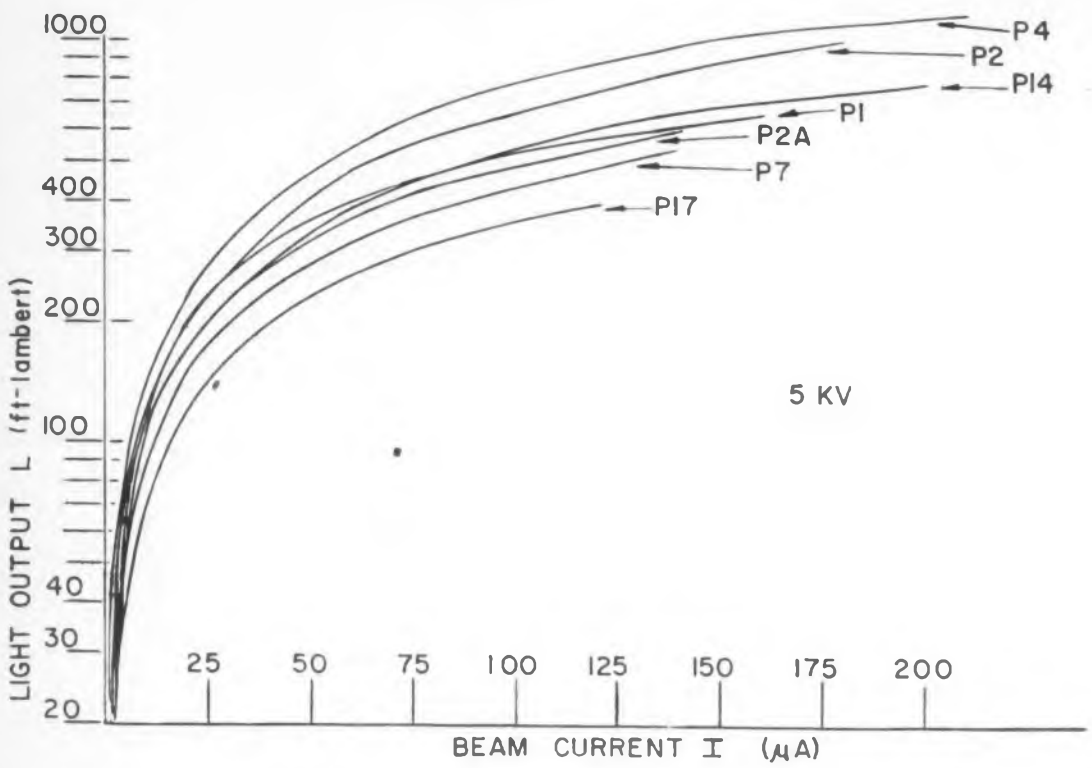

Fig. 1. Light output of various phosphors at 5 kv anode voltage in tubes with screens made for optimum operation in the 4-7 kv anode voltage range.

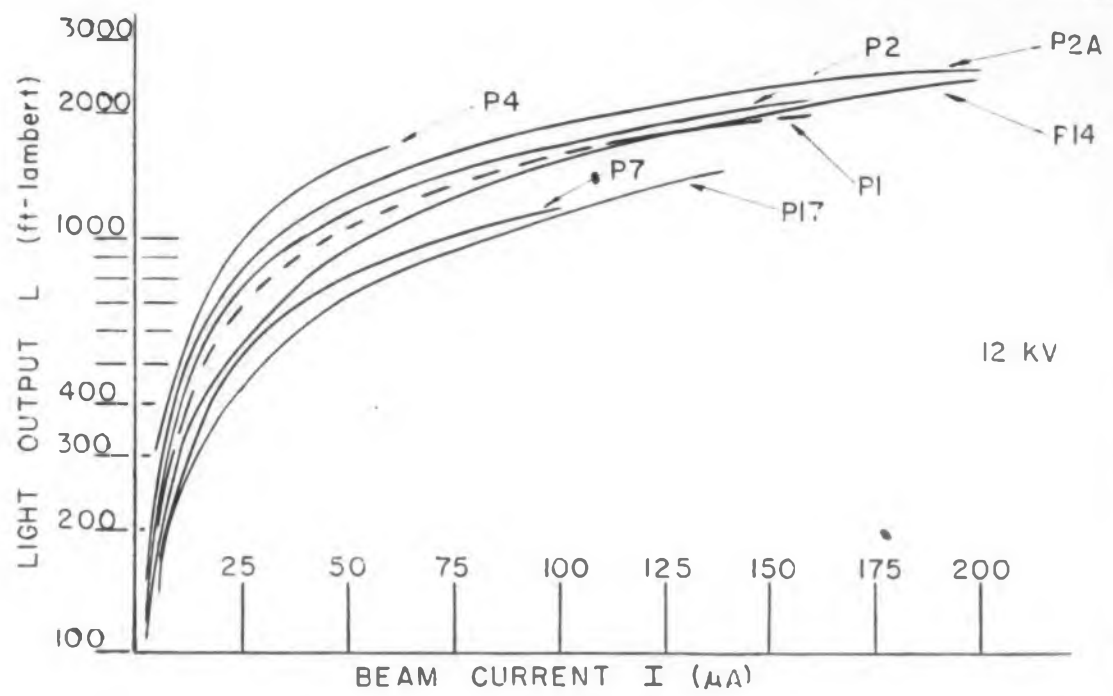

Fig. 2. Ratio of light output at 12 kv to that at 5 kv for screens optimized for the 4-7 kv anode voltage range at various beam currents.

Fig. 3. Light output at 12 kv anode voltage of various screens optimized for the 4-7 kv anode voltage range.

Thus at least some improvement in light output at 12 kv is to be expected from tubes designed specifically for that voltage range. Fig. 2 shows the ratio of the light output at 12 kv to that at 5 kv for different phosphors at beam currents of 5, 30, and 60 μA. For *P2* and, to a lesser extent, *P4* screens this ratio is considerably higher at the low beam current than at the high beam current, showing that, for these phosphors, screen saturation sets in more readily at the higher anode voltage. *P2A* is a form of the *P2* phosphor. In view of the very marked increase in light output of *P2A* with anode voltage, its use for high voltage tubes is particularly recommended.

Fig. 3 shows a plot of light output of a 1/2" x 1/2" raster versus beam current at 12 kv anode voltage for the tubes just mentioned. *P1* is shown dotted since measurements on it were carried out at 11 kv. Except for the short persistent *P4*, *P2A* and *P14* are the most efficient and the most resistant to burn. Since the decay characteristics of *P7* and *P14* are fairly similar, it may prove advantageous in a number of applications to replace *P7* by the more efficient *P14*. Tube users may also want to consider possible alternatives for the low efficient *P17*.

3. *Aluminizing and Brightness*—What is the gain to be achieved by aluminizing? Fig. 4 shows that the *P1* screen benefits markedly from aluminizing, its light output at 12 kv being increased by a factor of nearly 3. The type of aluminizing that is discussed here is standard for the tubes manufactured at our plant. The crossover voltage is around 3 kv. A question mark placed at the point representing the *P12* data indicates that the exact value is uncertain, but in any case aluminizing is highly effective for this phosphor as well. *P17* remains consistently in the cellar being the only screen whose light output at 12 kv is affected adversely by aluminizing.

4. *P19 vs P25*—To compare the efficiency of *P19* and *P25* phosphor, measurements were made on a

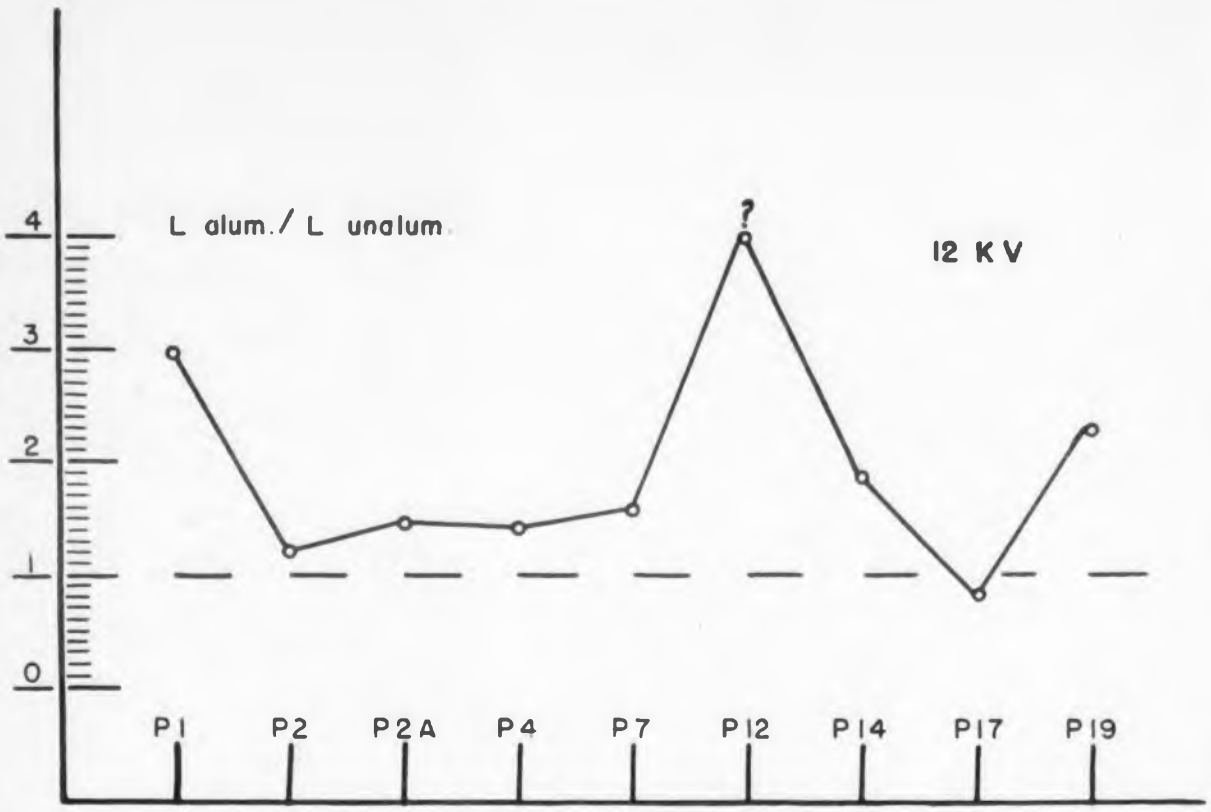

Fig. 4. Ratio of light output from aluminized tubes to that of unaluminized ones at 12 kv anode voltage.

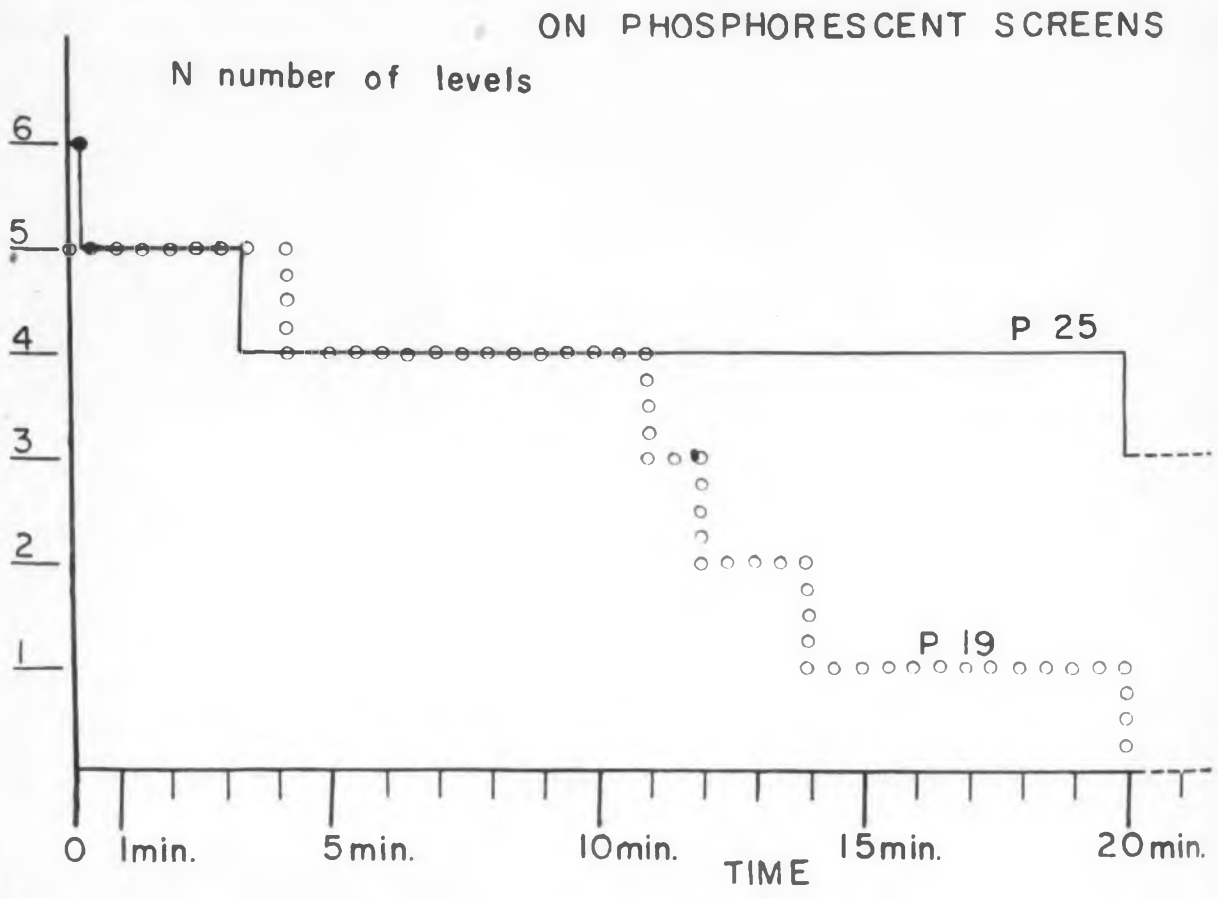

Fig. 5. Number of distinct bright steps observable during the decay of *P19* and *P25* screens as a function of the time after beam cutoff.

4″ x 4″ raster in order to work with beam currents that could be readily measured while using only a low beam current density. Findings are that for a given value of the beam current, *P19* is nearly 40% more efficient, but this higher efficiency is more than counterbalanced by its lower resistance to burning. Carefully processed *P25* screens will withstand a current more than 30 times as high as a *P19* screen.

5. *Contrast*—When the image of a slide with a number of distinct brightness gradations is formed on the tube screen, the number of brightness levels that can be distinguished visually on a given screen depends primarily on *a.* whether there is any background illumination produced by the bright steps or *b.* whether the background is black. As shown in Table I, the maximum number of distinct brightness steps that can be viewed on any screen is 7 under optimum condition *a* and only 5 for condition *b.*

Table I

Number of Distinct Brightness Levels Discernible During Fluorescence

Condition (see text)	P1, P2, P4 P7, P14	P12, P17 P25	P19
a	7	4	5
b	5	6	4

This number is smaller for *P12*, *P17*, and *P25* and still smaller for *P19*.

The point of interest with regard to the long persistene phosphors *P19* and *P25* is not the degree of contrast during fluorescence (i.e. while screen citation is maintained) but the degree of contrast during phosphorescence (i.e. after beam cutoff). Fig. 5 shows the number of distinct brightness levels that can be observed on these two screens as a function of time after beam cutoff.

6. *Gray Envelopes*—The use of gray glass envelopes has been advocated for cathode-ray tubes as a means of improving contrast. Measurements studied by the author indicate that the number of distinct brightness steps on any given screen is not increased by the use of gray glass envelopes. Since gray glass absorbs anywhere from 15% of the radiation for yellow and green light to 22% for red, there seem to be no advantages that can be derived from its use.

7. *Glare Coatings*—In contrast to gray envelopes, the reflection reducing coating applied to the outside of the face plate appears to be quite effective. It reduces the halo around an extremely bright luminous area and thus permits observing a dimly luminous area adjacent to it. It results in reduced background illumination while the image brightness is maintained at a high level. For example, it increases from 5 to 6 the number of contrast steps that can be distinguished on a *P14* screen when the background is black.

If extreme persistence is desired from a cathode-ray tube, the standard phosphor screen has to be replaced by a storage target.

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Tolerance Compensation of Thermistors

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Morris Plains, N.J.

NONLINEAR circuit elements such as thermistors or varistors may be compensated for tolerance variations of their parameters. With proper compensation, these elements may be used in precision instruments or other circuitry where accuracy and uniformity are of prime importance.

This article outlines a method using zero-temperature-coefficient resistors for compensation, one resistor in series with the nonlinear element and one shunting it. Cost of such compensation is less than the cost of having the nonlinear components held close to the desired tolerances.

By making the resistance of all thermistors equal at two points on their resistance-vs-temperature characteristic, all variations are limited to a narrower temperature range. Effectively, a closer tolerance is obtained, Fig. 1.

Tolerances may be held to one per cent over a temperature range of 100 C. Varistors can also be held to comparable close tolerances. Although this method of compensation applies to varistors as well as thermistors, its application to thermistors only will be discussed in this article.

Resistance temperature characteristics of thermistors is given by:

$$R_T = R_o \, \epsilon^{\beta (1/T - 1/T_o)} \qquad (1)$$

Differentiating Eq. 1 with respect to temperature,

$$\alpha = 1/R \; dR/dT$$

$$= -\frac{\beta}{T^2} \qquad (2)$$

Addition of a zero-temperature-coefficient resistor, either in series or in shunt with a thermistor, will result in a lower α for the combination than that of the original thermistor. Obviously, a series resistor will raise the resistance, while a shunt resistor will lower the resistance.

It is important to note that variations in α are usually represented by manufacturers' tolerances on β (Eq. 2).

The correction of two independently variable tolerances such as R_0 and α, Fig. 2a and 2b, by means of one corrective device is impossible. Therefore, compensating these two variables involves the use of both a shunt and series resistor.

Effect of a shunt resistor on a thermistor possessing the lowest α and the highest resistance acceptable, and one having the lowest α and the lowest resistance acceptable are shown on Fig. 2c.

Temperature coefficient α, of either combination was lower than that of the basic thermistor. Also, the resultant resistance of the network was brought further inside the acceptable R_0 limits.

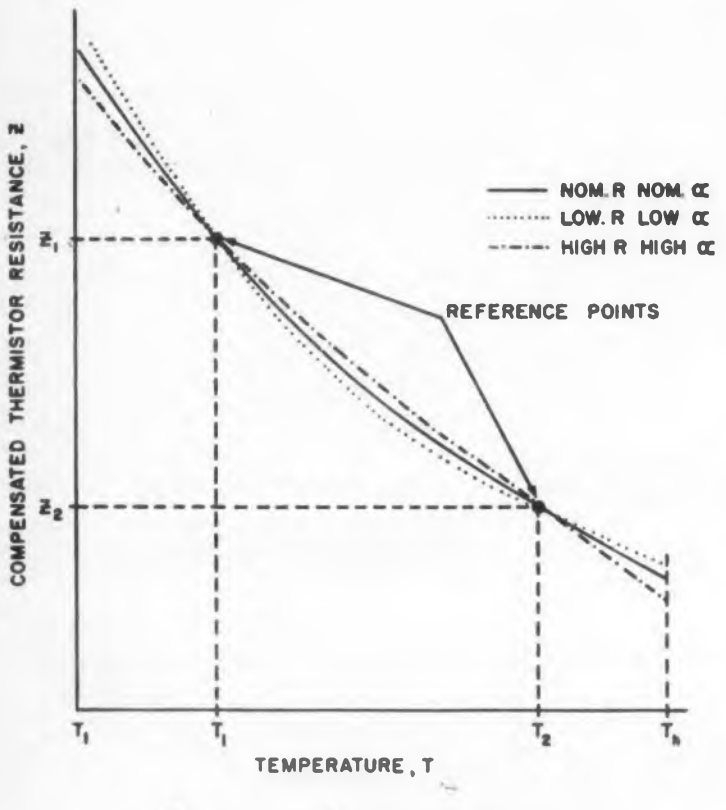


Fig. 1. Resistance—temperature curve for compensated thermistors.

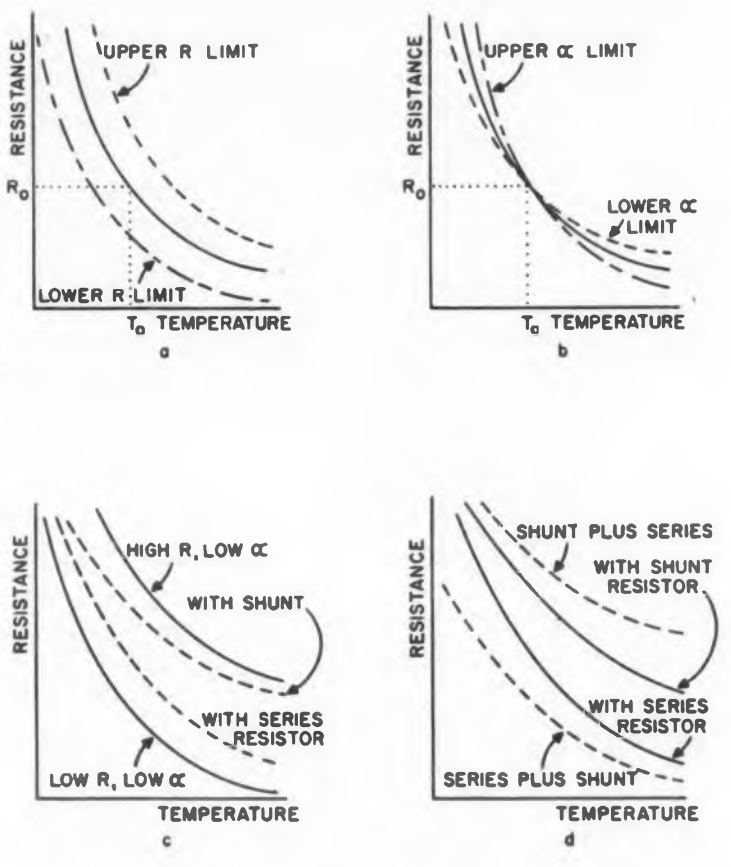


Fig. 2. (a) Effect of R_0 tolerance on thermistor resistance at any temperature. (b) Effect of B tolerance on thermistor resistance at any temperature. (c) Effect of both shunt and series resistors on specific thermistors. (d) Effect of adding a second resistor to the combination of (c).

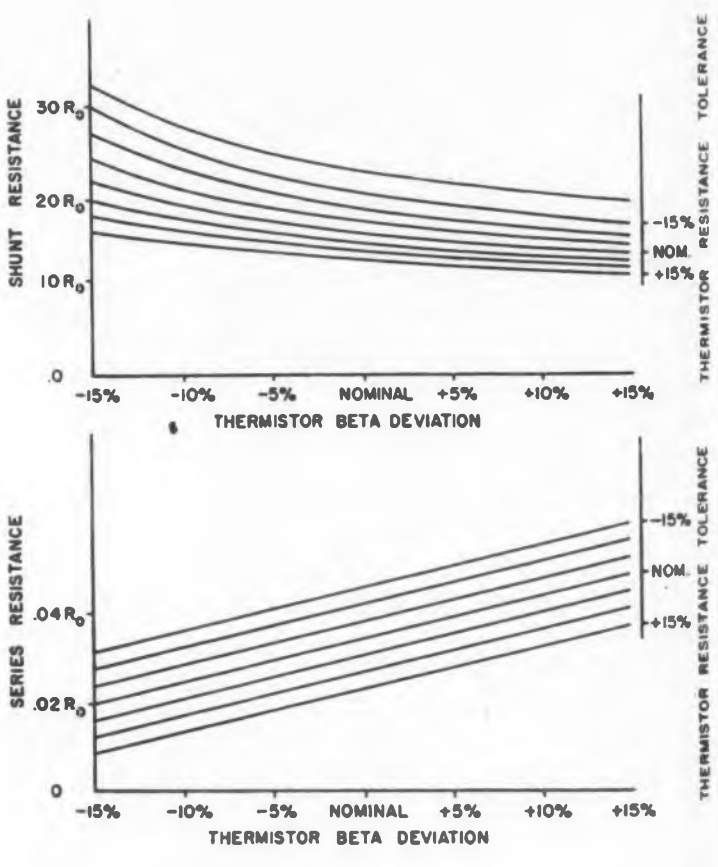


Fig. 3. Values of S vs tolerance and Y vs tolerance.

Adding a series resistor to the shunted thermistors, curve (a) in Fig. 2c and a shunt resistor to the series combination curve (b) of Fig. 2c, results in the curve of Fig. 2d. Both cases result in further lowered network α as indicated by the lower slope of the curves. However, the network resistance in (a) approaches the upper acceptable resistance limit; the network resistance in (b) approaches the lower acceptable limit. Network resistance is:

$$Z = Y + \frac{R_T S}{R_T + S} \qquad (3)$$

Then a shunt resistor will lower Z and lower α.

When Z increases, T decreases, Fig. 1. Hence, a shunt resistor will most effectively compensate the lower temperature. Similarly, the series resistor is used for compensation at the higher temperature.

At Z_1, Fig. 1, use as a limit the lowest R_0 and lowest α thermistor tolerance desired; at Z_2, the highest R_0 and the lowest α thermistor tolerance. Choosing these tolerances as reference points, assures that compensation will be possible over the tolerance range desired. At the same time, these points represent the minimum effect on the thermistor α and R_0, i.e., a thermistor having low R_0 and low α would need no shunt resistor, whereas one having high R_0 and low α would need no series resistor. Therefore, choose Z_1 to equal resistance of thermistor with lowest R_0 and lowest α desired, and choose Z_2 to equal resistance of the thermistor with highest R_0 and lowest α desired.

Temperature references are determined by first assuming that compensation is desired over a temperature range T_{low} to T_{high}. Then T_1, the lower reference temperature should be chosen at about 1/4 of the desired range, and T_2 about 3/4 of the range. This gives about ±1/4 of the entire range at each reference temperature. Hence:

$$T_1 = T_\epsilon + \tfrac{1}{4}(T_h - T_\epsilon) \qquad (4)$$

$$T_2 = T_\epsilon + \tfrac{3}{4}(T_h - T_\epsilon) \qquad (5)$$

Choosing the Value of Shunt and Series Compensators from equation (3),

$$Z_1' = Y + \frac{R_{T_1} S}{R_{T_1} + S} \qquad (6)$$

$$Z_2' = Y + \frac{R_{T_2} S}{R_{T_2} + S} \qquad (7)$$

Note that R_{T1} and R_{T2} are known for each thermistor to be compensated. Their value depends on the R_0 and the α tolerance of the particular thermistor.

To solve for the value of shunt compensating resistance, S, let $Z_1 = AR_0$, $Z_2 = BR_0$, $R_{T1} = CR_0$ and $R_{T2} = DR_0$. Constants A, B, C, and D serve merely to present S in terms of R_0. R_0 is usually chosen at some mid-range temperature, but any tempera-

ture may be used in its determination. The equation for S in terms of R_o is:

$$S = -\frac{(A - B)(C + D)R_o}{2(A - B + D - C)} \pm \sqrt{\left[\frac{(A - B)(C + D)R_o}{2(A - B + D - C)}\right]^2 - \frac{(A - B)CDR_o^2}{A - B + D - C}} \quad (8)$$

After finding S for each desired tolerance combination, Y can be found by substituting in Equations (6) and (7). Actually, the same value of Y should result from substitution in either (6) or (7). This is a convenient way of checking for errors.

Varistors follow the law $I = E^N/R$ where I=instantaneous current, R=resistance of material, E=instantaneous voltage and N=material constant. Since there is a tolerance on both R and N, an analagous situation exists. The method described in this article then, can be applied equally well to varistors.

Sample Calculations

Given: $R_o = 2000$ ohms
$T_1 = 40\ F\ (277.44A)$
$T_o = 70\ F\ (294.10A)$
$T_2 = 80\ F\ (299.66A)$

Step 1. Calculate β. Assume R at 32 F = $2.9R_o$ = 5800 ohms.

Assume R at 122 F = $0.4\ R_o$ = 800 ohms.

$$R_{32F} = R_{122F}\, E^{\beta\left(\frac{1}{T32} - \frac{1}{T_{122}}\right)}$$

Then:

$$5800 = 8000^{\beta\left(\frac{1}{273} - \frac{1}{323}\right)}$$

$$\beta = \ln \frac{5800}{800} \bullet \frac{273(323)}{323 - 273}$$

$$= \frac{1.981 \times 273 \times 323}{50} = 3500$$

Step 2. Calculate R_{40F}

$$R_{40F} = R_o\, E^{\beta\left(\frac{1}{T_{40}} - \frac{1}{T_o}\right)}$$

$$= 2000\, E^{3500\left(\frac{1}{277.44} - \frac{1}{294.1}\right)}$$
$$= 2000\, E^{0.72}$$
$$= 4120$$
$$= 2.06\ R_o$$

Step 3. Calculate R_{80F}

$$R_{80F} = 2000\, E^{3500\left(\frac{1}{299.66} - \frac{1}{294.1}\right)}$$
$$= 2000\, E^{-1.221}$$
$$= 1604$$
$$= 0.802\ R_o$$

Step 4. Calculate R_{40F} and R_{80F} for -5% tolerance on β.

$$-0.05\ \beta = (0.95)(3500)$$
$$= 3325$$

Then:

R_{40F} = 3810
= $1.9\ R_o$

R_{80F} = 1620
= $0.811\ R_o$

Step 5. Calculate R_{40F} and R_{80F} for $+5\%$ tolerance on β.

$0.05\ \beta = (1.05)\ (3500)$
$= 3675$

Then:
$R_{40F} = 4250$
$= 2.13\ R_o$
$R_{80F} = 1580$
$= 0.792\ R_o$

Step 6. Set up a table of tolerance extremes.

				Tolerance (Per Amt.)	
R_{40F}	C	R_{80F}	D	R_o	β
$2.06\ R_o$	2.06	$0.802\ R_o$	0.802	Nominal	Nominal
$1.81\ R_o$	1.81	$0.770\ R_o$	0.770	-5	-5
$2.00\ R_o$	2.00	$0.850\ R_o$	0.850	$+5$	-5
$2.03\ R_o$	2.03	$0.753\ R_o$	0.753	-5	$+5$
$2.24\ R_o$	2.24	$0.831\ R_o$	0.831	$+5$	$+5$

For the conditions used to specify Z1 and Z2 (Fig. 1), $C = A$ and $D = B$.

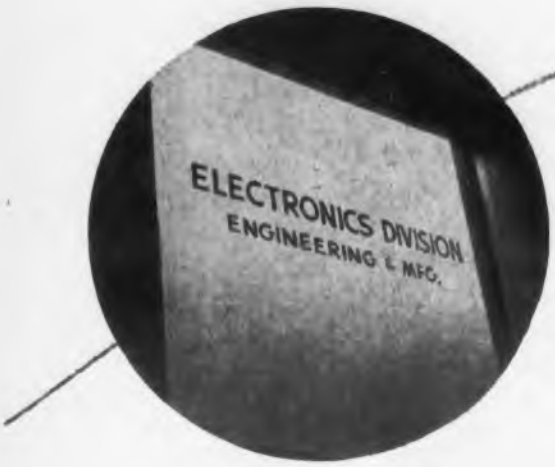
Step 7. Calculate S using Equation 8. Then calculate Y using Equations 6 and 7. After calculating enough values of S and Y, plot S vs. tolerance and Y vs. tolerance, Fig. 3.

Step 8. For various tolerance combinations, find values of S and Y from Fig. 3. Calculate Z for several values of temperature using Equation 3.

Step 9. Plot Z vs. temperature as in Fig. 1. Best values of S and Y can be chosen for proper compensation by evaluating the plotted curves.

Definitions.

A = Constant used to present Z_1 in terms of R_o.
B = Constant used to present Z_2 in terms of R_o.
C = Constant used to present R_{T_1} in terms of R_o.
D = Constant used to present R_{T_2} in terms of R_o.
R_T = Thermistor resistance at any absolute temperature, ohms.
R = Thermistor resistance at a chosen absolute reference temperature, ohms.
S = Value of shunt resistance necessary for compensation, ohms.
T = Temperature, absolute.
T_o = Chosen reference temperature, absolute.
T_1 = Lower absolute temperature at which all compensated thermistor resistances will be equal to Z_1, absolute.
T_2 = Higher absolute temperature at which all compensated thermistor resistances will be equal to Z_2, absolute.
T_{low} = Lowest absolute temperature to which it is desired to compensate, absolute.
T_{high} = Highest absolute temperature to which it is desired to compensate, absolute.
Y = Value of series resistance necessary for compensation, ohms.
Z = Resistance of compensated thermistor of any tolerance at any temperature, ohms.
Z_1 = Resistance of thermistor having lowest R_o and α tolerance at temperature T_1, ohms.
Z_2 = Resistance of thermistor having highest R_o and α tolerance at temperature T_2, ohms.
α = Temperature coefficient of resistance of thermistor.
β = Material constant, usually specified by manufacturer.



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The formula for success in the field of electronics might be resolved to the equation, "Scientific ability plus engineering skill plus modern plant facilities equals achievement." You will find all three behind these doors of Marvelco Electronics. Scientific ability represented by some of the finest electronic scientists in the nation . . . dedicated scientists whose research not only has produced such achievements as the Tandem Transistor, but practical scientists who have the ability to apply the fruits of their research to industry. They are backed up by skilled engineering technicians working with modern production facilities to make their formulas a finished product. If you have an electronics problem or a research and development project why not query Marvelco today?

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Design
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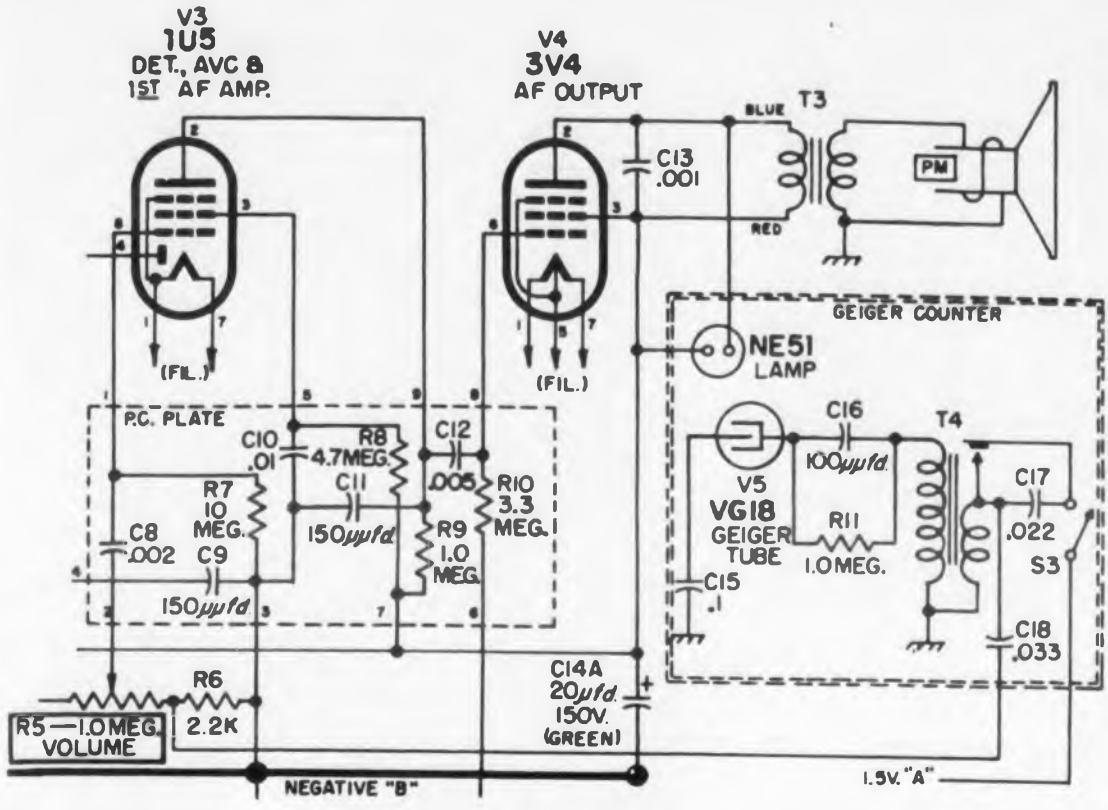
Two-In-One Designs

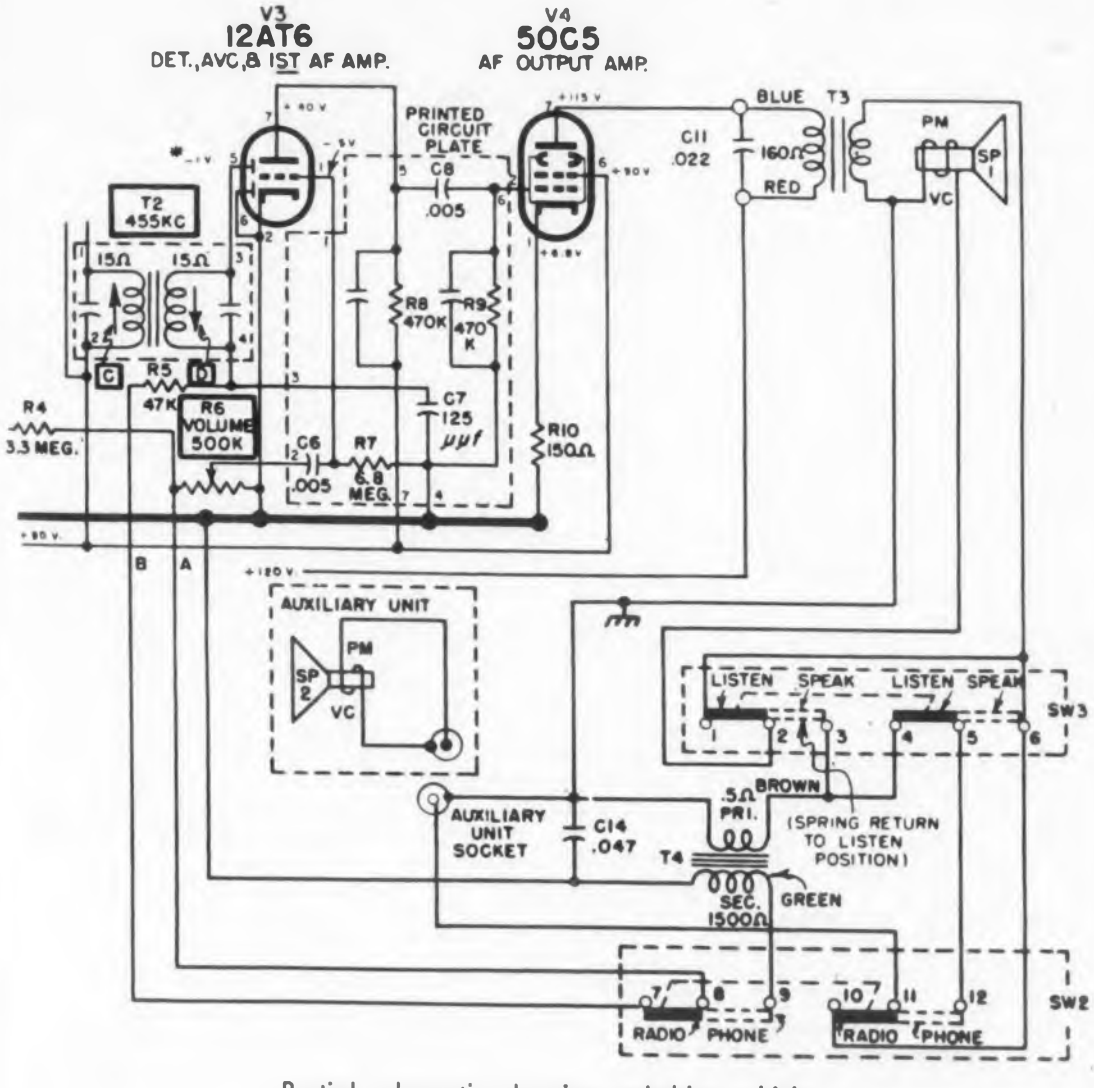
SEVERAL years ago we were particularly impressed with the extensive training value that the Navy had just gotten out of a conventional radio receiver kit by slight modifications that made it also: an audio amplifier, a signal tracer, a 400-cps oscillator, a rf signal generator (with modulation) and a power supply. Early this year we noted with interest a commercial example of making a simple radio convertable into another piece of equipment—in one instance an intercom system, and in another a Geiger counter. Two for almost-the-price-of-one looks like a good sales feature, especially in a market with extremely heavy competition.

Since the intercom model, especially, received considerable consumer approval, we thought the idea worthy of mention. Other designers may want to take the lead and modify some of their own products to take advantage of this "multiplexing" principle.

The partial schematics on this page show how simply Sylvania Electric Products Inc. incorporated the additional functions into conventional radio circuits. In the intercom model, the speaker of the master unit serves as both microphone and speaker. The system is one way, the remote end being a listening post only. High voltage for the Geiger tube is obtained from a vibrator-transformer. A neon lamp flashes the count which is also heard over the speaker.



Geiger counter section is incorporated into standard portable radio.



Partial schematic showing switching which makes an intercom out of a table-top radio.

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

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

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

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

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

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

OTHER G-E RELAYS TO MEET YOUR NEEDS

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

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

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

MAIL TODAY FOR SEALED-RELAY DATA

General Electric Co., Sect. E 792-5, Schenectady 5, N. Y.

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

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GENERAL ELECTRIC

An Open Interview with an Engineer

at Westinghouse Electronic Tube Division, Elmira, N.Y.

Today's engineering applicants are interested not only in their opportunities for growth and advancement in their chosen fields, but they also carefully consider the community and its facilities for pleasant living.

Most young engineers today are married . . . many with small families already established. They usually ask about housing, schools, churches, community organizations and outdoor activities. Almost always they want to look the town over to make sure it's an attractive healthful place to raise a family.

Here is part of a typical interview as we see it at the Westinghouse Electronic Tube Division, Elmira, N.Y.

(Interviewer) "We're glad you could arrange to come to Elmira to talk over our professional openings."

(Applicant) "I've enjoyed it so far."

(I.) "Good! Looking over your resume, I see that you've been primarily concerned with circuit design problems since you got your degree in '52."

(A.) "That's right. While the work has been quite interesting, I feel that I'd like to get into something a little different—something that will make use of my circuit experience and also broaden my background."

(I.) "Do you want to stay in the equipment design field?"

(A.) "Well, no, not necessarily. I'd like to explore some aspects of tube design if you think I might fit in."

(I.) "I think so. It's been our experience that anyone with an E.E. degree has the background for learning design rapidly. This is even more true of those engineers who have taken our fundamentals of vacuum tubes course, here in Elmira. This, along with your experience, should make you highly competent rather quickly."

(A.) "Where would I fit into the Tube Division, then?"

(I.) "There's a possibility in each of several sections—Camera Tube Design, Application Engineering, Receiving Tube Design, and Equipment Development where our own manufacturing and test equipment is designed, to mention only a few. We will arrange interviews with heads of those sections so you can go into detail of our work in each. Is that okay?"

(A.) "Sounds good."

(I.) "Do you have any other questions that can be answered while the interviews are being arranged?"

(A.) "Is there a Pension and Insurance plan?"

(I.) "You bet! Two of the best plans I've seen. Here are short, quickly read booklets describing them. You will find that they cover most every contingency. Incidentally, the life insurance and pension plan goes into effect the day you start to work."

(A.) "What about housing?"

(I.) "It's pretty good. We've been able to find suitable quarters fairly quickly in the past year or so. To help you get located, we'll run an ad in the local papers for you—Elmirans have found that Westinghouse engineers make desirable tenants. There are some good real estate buys available too. Do you go in for outdoor activities?"

(A.) "Whenever possible. Fishing and golf are my favorites. Haven't had much time for either since living in the big city."

(I.) "There's good trout and bass fishing here—both in the streams and the lakes. And $30. pays your annual greens fees at the 18 hole course about a mile from the plant. There are lots of other activities that might be of interest—chess, little theatre, hiking, bridge, soft ball teams, management club, bowling, bird watching, sailing, community concerts, and others—lot of choice."

(A.) "How about Churches?"

(I.) "I don't know your choice, but I'll bet you'll find it! We have more than 50 churches within a radius of 5 miles. There are excellent Sunday Schools, too."

(A.) "How about the schools here?"

(I.) "Several beautiful schools have been completed recently to take care of the increasing school population. Your youngsters would get the benefit of fine modern schools—and both the public and parochial schools maintain high scholastic standards."

(A.) "Sounds good so far—now about pay."

(I.) "A very important item! After you have had your interviews, I'll get together with those men you talked with and the Wage and Salary Administrator. The contributions we can expect from you, your estimated potential and your relative spot in the organization will be translated into a monthly salary. That will be included in our offer-letter which you will receive soon after your visit. You will find our salaries are very competitive."

(A.) "Any reasonable chance of getting more?"

(I.) "Naturally. There'll be at least a 3% general increase each Fall for the next three years, quarterly cost of living adjustments and periodic performance reviews to determine merit increases. There is nothing 'hit or miss' about our salary program. Promotions are very possible too, in a growing, dynamic organization like Westinghouse."

(A.) "Well—that sounds encouraging—and quite challenging too. It seems to me you've covered all my questions very well."

(I.) "Here, let me pin this identification badge on your lapel—and we'll go through the plant and offices on the way to your talks with each of the men with whom appointments have been made. I'll take you to the first one, and he'll 'pass you along' the chain. After the last interview, you will come back to my office for any further questions. We're aware of your travel arrangements—so we shall see that you make your plane home. Let's go meet the Engineering Manager."

If you are interested in advancing your career in the electronics field, we invite you to submit information which may lead to an interview with us at our Tube Division. Our rapidly expanding plants in both Elmira and Bath, N.Y., will give you an opportunity to find satisfaction and challenge in important branches of engineering.

The Elmira-Bath area is a beauty-spot in upstate New York, located at the gateway to the Finger Lakes . . . just the kind of a community you and your family will enjoy.

At present we have opportunities for engineers in Tube Design and Development for Microwave Tubes, Receiving Tubes, Pickup Devices, Power Tubes, Cathode Ray Tubes; Application Engineering, Electrical Equipment Design, Manufacturing Engineering, and in Glass Engineering.

In submitting information concerning your background, phone collect to Westinghouse Electronic Tube Division, Elmira 9-3611 and ask for Robert M. Jarrett in Department T21. (After 5 p.m. or weekends phone collect Elmira 9-2360). If you prefer, write a letter attention above person and Dept., giving basic information, and ask any questions you wish.

MODEL CR-10 Signa-Glow is intended for use where measurement of capacitance and resistance must be made rapidly with moderate accuracy. The bridge, based on the Wheatstone Bridge principle, covers the ranges of 10 μμf to 200 μf, and 5 ohms to 50 megohms.

The null point direct reading is determined visually by observing the two glow tubes, as the pointer knob is turned manually. When the balance position is reached, both lamps extinguish, or occasionally both lamps glow with the same intensity. As the knob is turned past the balance position, the glow shifts from one lamp to the other. The transfer of the glow from one lamp to the other is sharp, which permits precise determination of the null point of balance.

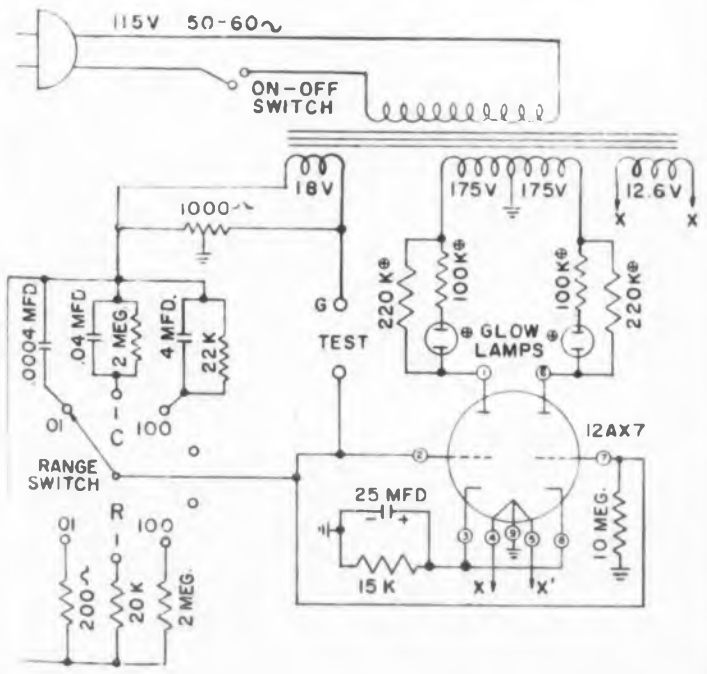
Manufactured by Industrial Development Laboratories, Inc., 17 Pollock Ave., Jersey City, N.J., the instrument is housed in a phenolic case 3-3/4 x 6 x 2 in., and weighs less than 2 pounds.

Basic wheatstone bridge type circuit incorporating dual-null glow tubes

C-R Dual-Null Glow Bridge

Supplied with each instrument are a 5 ft line cord for power input of 60 cps, 115 v, as well as test leads, pin prods, test clips and clip adapters.

For more information, turn to Readers' Service Card and circle **No. 500.**



Human Engineered Instrument

This Type, 401 "human-engineered" oscillograph features ruggedness and reliability together with operating ease.

DESIGNED for reliability, visual and mechanical efficiency, and virtual elimination of deterents to human accuracy, the Types 401 Oscillograph and 404 Pulse Generator shown are manufactured by Allen B. Du Mont Labs., Inc., 750 Bloomfield Ave., Clifton, N. J.

Additional features of interest to designers include revised cabinet shapes, new lettering styles, new control knobs logically grouped, and the extensive use of push-push switches, all in sharp contrasting colors. The color and lay-out scheme accentuates the main controls on the front panel while subsidiary controls are subjugated. Certain knob or control lettering has been eliminated by locating controls at their obvious functional positions on the front panel.

Among a number of new construction techniques is the complete encirclement of units with sturdy castings which provide excellent mechanical protection. Careful circuit design, conservatively rated components, and an exacting quality control program improve instrument reliability under continuous operation and adverse field conditions. A particularly significant feature of the 400 Series instruments is the use of fall-away side panels, to minimize down times or adjustments for parts replacements.

A functional front panel color scheme, a unique tuning dial, and push-button attenuation, are some of the outstanding features of 404 Pulse Generator.

Designs

Emphasizing reliability and dependability, Du Mont warranty covers printed wiring and power transformers for five years.

The Type 401 cathode-ray oscillograph is a general purpose instrument having calibrated sweeps, both driven and recurrent, and of high stability.

Technical features of the Type 404 pulse generator are excellent pulse rise time and low over-shoot, a high precision output attenuator, a 100 kc pulse repetition rate, and an automatic overload protection.

Pulse output from the Type 404 more nearly approaches the step function which is ideal for use in depicting and testing system response. Rise-time is 0.018 μsec and the range of the variable pulse width is from 0.05 to 100 μsec. The exceedingly high repetition rate—20 times higher than any comparable instrument on the market—is limited only by a 10 per cent duty cycle. The higher repetition rate produces better light output on the cathode-ray oscillograph. It also simplifies camera, film, and oscillograph requirements if photo-recordings are to be made.

A push-button attenuation switch conveniently allows attenuation in 1/2 db steps up to 60 db total, instead of the usual somewhat confusing gain control-stepped attenuator combination control. The push-button attenuator in the Type 404 is completely compensated and does not degrade the pulse shape regardless of the db setting. An advantage of this attenuator is that it allows exact repeatability of impli-tude setting, which is impossible with the step-and-gain control system.

The instrument is protected by an automatic overload relay against a combination of pulse width and repetition rate which exceeds the allowable 10 per cent duty cycle. A warning light flashes on the front panel and a clicking sound is produced to indicate that pulse width and/or repetition rate should be decreased.

For more data about these products, fill out the Reader's Service Card and circle 34.

Polar to Rectangular

H. E. Schrank

Bendix Radio Div., Bendix Aviation Corp.
Towson, Md.

DESIGNED to aid in calculations which involve converting complex numbers from rectangular to polar form, this chart is particularly suited for circuit and transmission line problems involving impedances or admittances.

The chart consists of a simple combination of the Smith impedance chart and its alternate "Z-θ" form, known as the Carter chart. Both charts are normalized to unity impedance at the center, and the halves corresponding to positive reactance components were chosen in making this conversion chart. Negative reactances can, of course, be handled simply by reading θ as a negative angle.

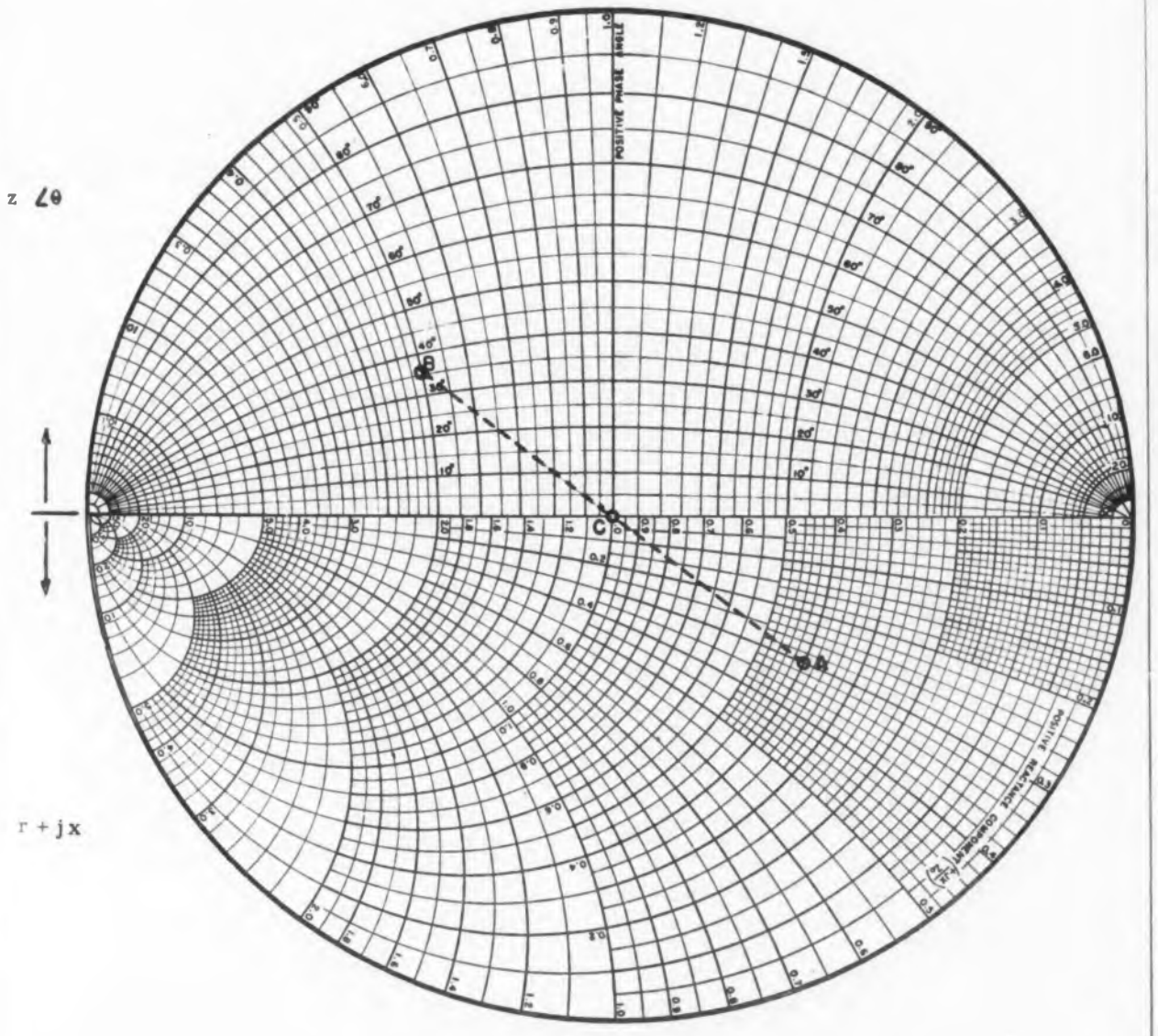
Using the chart is simply a matter of locating the rectangular components of an impedance $(r + jx)$ in the lower half of the chart, and then reading its polar components $(z/\theta$ in the upper half of the diagram.

Although the accuracy of this chart is not as good as slide-rule computations, it is a useful time-saver for rough estimating and checking. Its best accuracy is obtained by scaling the r, x, and z components to avoid the regions of the chart where the respective contours are crowded. For example in converting $z = 10\ /53$ to rectangular form, it is advisable to use a scaling factor of say 10, in order to work near the middle of the chart; thus, the chart is entered with $z' = z/10 = 1.0\ /53$, and the rectangular components $r' = 0.6$, $x' = 0.8$ are found as indicated in the example. The angle θ is, of course, not scaled. The final results are $r = 10\,r' = 6.0$, $x = 10\,x' = 8.0$, i.e., $z = 6.0 + j\,8.0$.

Example: To convert $z = 0.4 + j\,0.3$ (rectangular form) to the polar form $|z|\ /\theta$:

(1) Locate intersection A of the $r = 0.4$ and $x = 0.3$ contours on the lower half of the chart.
(2) Draw a straight line from point A through the center of the chart C, and extend it into the upper half of the chart to point B, such that distance $\overline{BC}$ equals distance $\overline{AC}$.
(3) At point B, read $z = 0.5\ \theta \cong 37$ deg.

Conversion Chart



Modern Synthesis Network Design From Tables—III

Louis Weinberg
Senior Staff Engineer
Hughes Research Laboratories
Culver City, Calif.

TABLES presented in this series of articles make the design of three classes of practical networks simple. The tables give the element values for the normalized low-pass network with a Butterworth, Tschebyscheff, or Bessel-polynomial characteristic. To convert the normalized element values to practical design values requires only simple multiplications. The low-pass networks that are realized can also be transformed in a straightforward manner to serve high-pass, band-pass, or band-elimination functions. In Part I, Butterwork Characteristics were covered (*ED Sept. 15, 1956, p 22*). In Part II, several Tschebyscheff characteristics were covered. *(ED Oct. 1, 1956, p. 22.)* In this part, Bessel functions for constant time delays are given. Part IV will cover conversion and transformation data and additional Tschebyscheff characteristics.

Bessel Polynomials

The preceding two sets of Butterworth and Tschebyscheff polynomials were used in the approximation of a desired *magnitude* characteristic. However, the nonlinear phase characteristic of both approximations and the resulting variation of the time delay preclude their use where a constant time delay is a paramount requirement. For such time-delay filters an excellent approximation is given by the use of Bessel polynomials.[5,6,7] This approximation yields a maximally-flat time delay along with a low-pass magnitude characteristic.

The Bessel polynomials in the variable $1/s$ are defined by

$$y_n(1/s) = \sum_{k=0}^{n} = \frac{(n+k)\,!}{(n-k)\,!\,k\,!\,(2s)^k} \qquad (7)$$

The polynomials of interest are derived from the above as

$$h_n(s) = s^n y_n(1/s)$$

$$= \sum_{k=0}^{n} a_k s^k \qquad (8)$$

The coefficients of h_n for n running from 1 through 11 are given in Table III-4, the zeros are listed in Table III-5.

The transfer function is given by

$$Z_{21}(s) = \frac{H}{h_n(s)} \qquad (9)$$

The constant H is equal to a_0 for a ladder terminated in a 1-ohm resistance, that is, for this configuration at $s = 0$, $Z_{21}(0)$ is unity. This transfer function has a maximally-flat time delay. By this is meant that the time delay t_d is given by a function of the form

$$t_d = \frac{d\theta}{d\omega} = \frac{t_0\,(b_0+b_1\omega^2+b_2\omega^4+\ldots+b_{n-1}\omega^{2n-2})}{b_0+b_1\omega^2+b_2\omega^4+\ldots+b_{n-1}\omega^{2n-2}+b_n\omega^{2n}} \qquad (10)$$

where 0 is the phase of $Z_{21}(j\omega)$, and t_0 is the zero-frequency time delay. It is noted that the first $(n-1)$ coefficients of the denominator are equal to the corresponding coefficients of the numerator. Therefore the Maclaurin series for t_d obtained by dividing the numerator by the denominator, namely,

$$\frac{d\theta}{d\omega} = t_0\left(1 - \frac{b_n}{b_0}\,\omega^{2n} + \frac{b_1 b_n}{b_0^2}\,\omega^{2n+2} - \ldots\right) \qquad (11)$$

will have the first $(n-1)$ derivatives of t_d (considered as a function of ω^2) at $\omega = 0$ equal to zero. Thus the time delay is as flat as possible in the vicinity of $\omega = 0$; hence the term maximally-flat time delay. The delay is very closely equal to t_0, the zero-frequency value, up to a certain frequency (which is an increasing function of n), and then declines smoothly for values greater than this frequency.

To determine the value of n to use for satisfying a specific requirement, it is necessary to have expressions for the magnitude and time delay. We give here the exact expressions in terms of Bessel functions of half an odd integer*; but most often the values of the magnitude and time delay for varying n given in Table III-1 suffice so that the need for using the exact analytical form is eliminated. The time delay is given by

$$t_d = t_0\left[1 - \frac{1}{u^2\left(\frac{\pi}{2u}\left\{J^2_{-n-\frac{1}{2}}(u) + J^2_{n+\frac{1}{2}}(u)\right\}\right)}\right] \qquad (12)$$

and the magnitude is

$$\left|Z_{21}(ju)\right| = \frac{H}{u^{n+1}\left\{\frac{\pi}{2u}\left[J^2_{-n-\frac{1}{2}}(u) + J^2_{n+\frac{1}{2}}(u)\right]\right\}^{\frac{1}{2}}} \qquad (13)$$

Table III-1 Significant Values of u for Time Delay and Loss Characteristic of a Maximally-Flat Time-Delay Network

a) Time-Delay Table: Giving Frequencies(u) at which Time Delay Deviates a Specified Value from its Zero-Frequency Value

n	u for 1% deviation	u for 50% deviation
1	0.10	1.00
2	0.56	2.20
3	1.21	3.40
4	1.93	4.60
5	2.71	5.78
6	3.52	6.97
7	4.36	8.15
8	5.22	9.33
9	6.08	10.50
10	6.96	11.67
11	7.85	12.84

b) Loss ($L = -20 \log |Z_{21}(ju)|$, in db) Table: Giving Frequencies (u) at which Loss is a Specified Number of db Down from its Zero-Frequency Value

n	u for $\frac{1}{2}$ db	u for 1 db	u for 3 db
1	0.35	0.51	1.00
2	0.57	0.80	1.36
3	0.75	1.05	1.75
4	0.89	1.25	2.13
5	1.01	1.43	2.42
6	1.12	1.58	2.70
7	1.22	1.72	2.95
8	1.31	1.85	3.17
9	1.40	1.97	3.39
10	1.48	2.08	3.58
11	1.55	2.19	3.77

The loss in db, $L = -20 \log |Z_{21}(ju)|$, tends to the Gaussian form with increasing n,

$$L = \frac{10\, u^2}{(2n-1)\, 1n\, 10} \qquad (14)$$

In the above formulas u is the normalized frequency variable ω/ω_0 and J is a Bessel function.
Use of Eq. 14 gives the 3 db bandwidth as

$$u_{3\,db} \cong \sqrt{(2n-1)\, 1n\, 2}\,, \qquad (15)$$

which approximation is good for $n \geqq 3$.

In Table III-1 are given values of u for two significant points on the time-delay curves and three significant points on the loss curves. The element values corresponding to the values of n of 1 through 11 are given in Table III-2 for a network terminated in a resistance at the output end. The impedance level is normalized with respect to the output resistance so that $R_1 = 1$.

Example

Design a ladder network with a delay of 0.1 μsec and a constant loss (not greater than 1 db) up to 3 mc/s. The network is to be terminated in a load resistance of 2000 ohms and is to be driven by a current source.

Since $t_0 = 1/\omega_0 = 0.1$ μsec, then $\omega_0 = 10^7$. For $f = 3$mc/s, $\omega = 6\pi \times 10^6$, and $\omega/\omega_0 = 0.6\pi$, which is approximately 1.9.

Using Table III-1 for $u = 1.9$, we see that for $n = 7$ the loss is less than 1 db. Now by using Table III-1a, it is seen that the time delay for $n = 7$ is constant at this frequency.

Consulting Table III-2, we find the element values for $n = 7$; the unprimed values are used since n is odd and the input is a current source. We remove the normalization by multiplying C's by $1/R\omega_0 = 0.5 \times 10^{-10}$, and L's by $R/\omega_0 = 2 \times 10^{-4}$, and thus obtain the final network given in Fig. III-1.

Acknowledgement: The author expresses his thanks to the members of the Mathematics Section, Systems Analysis Department, Hughes Aircraft Company, who carried through the calculations for almost all of the tables in this paper.

References

5. Delay Networks Having Maximally-Flat Frequency Characteristics, W. E. Thomson, *Proc. I. E. E.*, Part 3; Nov. 1949.

6. Networks with Maximally-Flat Delay, W. E. Thomson, *Wireless Engineer;* Oct. 1952.

7. Synthesis of Constant-Time-Delay Ladder Networks Using Bessel Polynomials, L. Storch, *Proc. I.R.E.*, Nov. 1954.

° Tables for these functions are given in Tables of Spherical Bessel Functions, 2 vols., NBS, Math. Tables Project, Columbia University Press, N. Y., 1947. The particular combination of the spherical Bessel functions that occurs in the magnitude and phase functions is tabulated in Table 13 of Scattering and Radiation from Circular Cylinders and Spheres, Tables of Amplitude and Phase Angles, Office of Research and Inventions, U. S. Navy Department; July 1946.

Table III - 2
Element Values (in ohms, henrys, farads) of a Maximally-Flat Time-Delay Network with Resistance Termination at Load End ($R_1 = 1$ for all values of n). (For this case unprimed values correspond to a current-source input for n odd and to a voltage-source input for n even.)

Value of n	C_1 or L_1'	L_2 or C_2'	C_3 or L_3'	L_4 or C_4'	C_5 or L_5'	L_6 or C_6'	C_7 or L_7'	L_8 or C_8'	C_9 or L_9'	L_{10} or C_{10}	C_{11} or L_{11}'
1	1.0000										
2	0.3333	1.0000									
3	0.1667	0.4800	0.8333								
4	0.1000	0.2899	0.4627	0.7101							
5	0.0667	0.1948	0.3103	0.4215	0.6231						
6	0.0476	0.1400	0.2246	0.3005	0.3821	0.5595					
7	0.0357	0.1055	0.1704	0.2288	0.2827	0.3487	0.5111				
8	0.0278	0.0823	0.1338	0.1806	0.2227	0.2639	0.3212	0.4732			
9	0.0222	0.0660	0.1077	0.1463	0.1811	0.2129	0.2465	0.2986	0.4424		
10	0.0182	0.0541	0.0886	0.1209	0.1549	0.1880	0.2057	0.2209	0.2712	0.4161	
11	0.0152	0.0451	0.0741	0.1016	0.1269	0.1499	0.1708	0.1916	0.2175	0.2639	0.3955

Table III-3
Exact Coefficients of the Polynomials $h_n(s) = s^n + a_{n-1}s^{n-1} + a_{n-2}s^{n-2} + \cdots + a_1 s + a_0$ Used for Maximally-Flat Time-Delay Networks

n	a_0	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	a_9	a_{10}
1	1										
2	3	3									
3	15	15	6								
4	105	105	45	10							
5	945	945	420	105	15						
6	10,395	10,395	4,725	1,260	210	21					
7	135,135	135,135	62,370	17,325	3,150	378	28				
8	2,027,025	2,027,025	945,945	270,270	51,975	6,930	630	36			
9	34,459,425	34,459,425	16,216,200	4,729,725	945,945	135,135	13,860	990	45		
10	654,729,075	654,729,075	310,134,825	91,891,800	18,918,900	2,837,835	315,315	25,750	1,485	55	
11	13,749,310,575	13,749,310,575	6,547,290,750	1,964,187,225	413,513,100	64,324,260	7,567,560	675,675	45,045	2,145	66

Table III-4 Zeros of Polynomials $h_n(s) = s^n y_n(1/s)$ Derived from the Bessel Polynomials for Values of n from 1 through 11

n	Zeros
1	-1.0000000
2	-1.5000000 ±j0.8660254
3	-2.3221854; -1.8389073 ±j1.7543810
4	-2.8962106 ±j0.8672341; -2.1037894 ±j2.6574180
5	-3.6467386; -3.3519564 ±j1.7426614; -2.3246743 ±j3.5710229
6	-4.2483594 ±j0.8675097; -3.7357084 ±j2.6262723; -2.5159322 ±j4.4926730
7	-4.9717869; -4.7582905 ±j1.7392861; -4.0701392 ±j3.5171740; -2.6856769 ±j5.4206941
8	-5.5878860 ±j0.8676144; -2.8389840 ±j6.3539113; -4.3682892 ±j4.4144425; -5.2048408 ±j2.6161751
9	-6.2970193; -6.1293679 ±j1.7378484; -5.6044218 ±j3.4981573; -4.6384399 ±j5.3172717; -2.9792608 ±j7.2914637
10	-6.9220449 ±j0.8676651; -3.1089162 ±j8.2326995; -6.6152916 ±j2.6115683; -5.9675282 ±j4.3849471; -4.8862195 ±j6.2249855
11	-7.6223398; -6.3013375 ±j5.2761917; -5.1156483 ±j7.1370208; -7.4842299 ±j1.737028; -7.0578924 ±j3.4890145; -3.2297221 ±j9.1771116

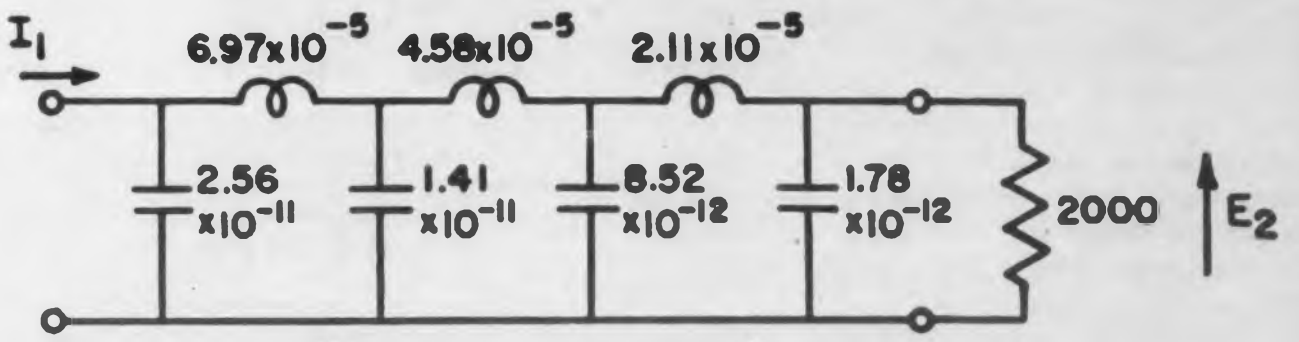


Fig. III-1 Time-delay ladder obtained in example at right.

Reluctance Amplifier

Power in a Small Package

THIS patented amplifier, developed several years ago, was intended primarily for driving servo motors. Its features have gone somewhat unnoticed; because we think it might answer the need of designers of mobile or aircraft we are calling it to your attention. The unit has the desirable characteristics of a class B vacuum tube amplifier, yet is smaller in size and weight. It has no time delays which are usually associated with "magnetic" amplifiers.

The "Reluctance Amplifier" is named from the fact that its output is controlled by the electrical insertion of reluctance into one or another leg of a three-legged transformer, As shown in Fig. 1, a winding on the center leg of the transformer is excited from the ac line. This creates a flux which divides equally between the two possible return paths. If two coils *B* and *C* are connected in series opposing, a total voltage of zero is delivered to the load. If, however, one were to short circuit coil *B*, the voltage produced by that coil would become zero, while the current induced in that coil would create a high reluctance in the left hand leg of the transformer, substantially reducing the flux in this path. As a consequence, the flux in the right hand path is almost doubled, inducing a large voltage in coil *C*, and causing a current to flow through the load. Similarly, had the coil *C* been shorted instead, coil *B* would have created a current in the opposite polarity through the load.

It is possible to employ vacuum tubes shunted across coils *B* and *C* respectively to produce the various degrees of short circuit which would be required to produce a smooth and proportional control of the power into the load. However, because the range of im-

Comparison of Reluctance Amplifier with Conventional Types

A comparison of three reluctance amplifiers with amplifiers of other types in the adjacent table serves to show the achievement of the desirable objectives of low size and weight per watt output, together with absence of undesirable feature (time constant, drift, etc.). All figures given are obtained from the advertised characteristics of typical reputable amplifiers of other types. Note when comparing these figures that *a.* all examples contain built-in preamplifier except example "B"; *b.* all operate directly from 115 v 400 cps power except that example *A* includes external power supply (see footnote ‡); and *c.* types 1123 and 1124 are of accessible chassis type construction for easy servicing while examples *A*, *B*, and *C* are sealed or potted units.

From the last two columns of the table, it is seen that the reluctance amplifier achieves a saving of weight and size of 40 to 70% over a conventional vacum tube amplifier. Further, it equals or betters the weight and size of the magnetic and transistor-magnetic amplifiers in most applications, and has no drift or time lag.

Class of Amplifier (all 400 cps)	Symbol	Rated Power Output, Watts	Power Gain at Rated Power Output	MIL Type Construction	Weight, Lbs.	Volume, Cu. In.	Bandwidth or Response Time	Max. Zero Drift (% of Max. Output Voltage)	Critical to Line Freq. Variations (from published ratings)	Pounds per Watt Output	Cubic Inches per Watt Output
Reluctance Amplifier	1121	10*	1×10^8	No	3.5	66	**	None	No	0.35*	6.6*
	1123	8	1.6×10^6	Yes	2.95	106	**	None	No	0.37	13.3
	1124	8	8×10^9	Yes	3.25	106	**	None	No	0.41	13.3
Vacuum Tube Amplifier	A	10	6.4×10^7	Yes	6.3‡	151‡	**	None	No	0.63	15.1
Magnetic Amplifier	B†	15	1.3×10^4	Yes	3.8	70	0.1 sec.	14%	±10%	0.25	4.7
Transistor-Magnetic Amplifier	C	7	2×10^7	Yes	2.25	40	70 cps	9%	±5%	0.32	5.7

Footnotes

* Rated at 18 watts output when in reversing or intermittent service. At 18w, lb/w output is 0.20 and cu. in./w is 3.7.

** Information bandwidth limited only by use of 400 cps carrier.

† When using 3000 ohm forcing resistor to shorten time constant to .1 second.

‡ Figures include prorata portion of plate and heater power supply furnished specifically for multiple installations of this type amplifier.

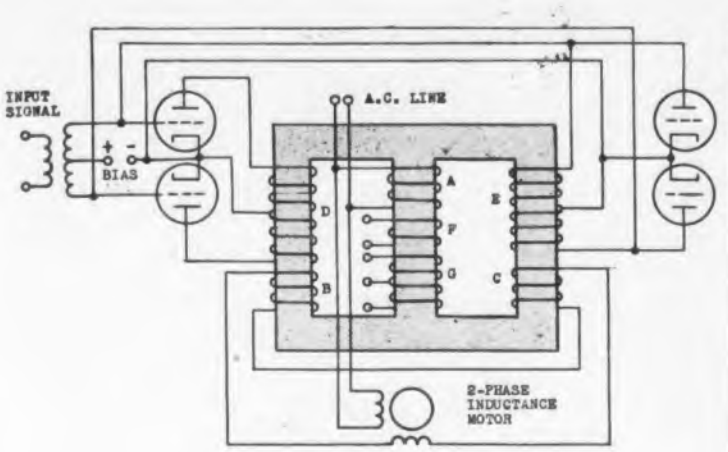


Fig. 2. Simplified circuit of reluctance amplifier.

pedances of vacuum tubes is ordinarily higher than that of common servo motors, it is preferable to utilize the circuit of Fig. 2. The control coils, *D* and *E*, may have a different number of turns than the load coils *B* and *C*, thus achieving the required effect together with an impedance transformation. If the load is a phase sensitive device, such as a two-phase induction motor, a reversible proportional control is achieved.

The amplifier's power supply is self-contained. The center leg of the transformer is utilized to produce conventional filament and "B" supply voltages, since the total flux carried by the center leg is related to the primary winding in the same manner as in an ordinary power transformer. Windings *F* and *G* are provided to supply respectively "B" supply voltage for a preamplifier and heater voltage for all tubes.

With the circuit shown in Fig. 3, the power tubes are normally biased near cut off so that the efficiency and low no-load losses of a class B amplifier are achieved. AC input signals are applied to two of the

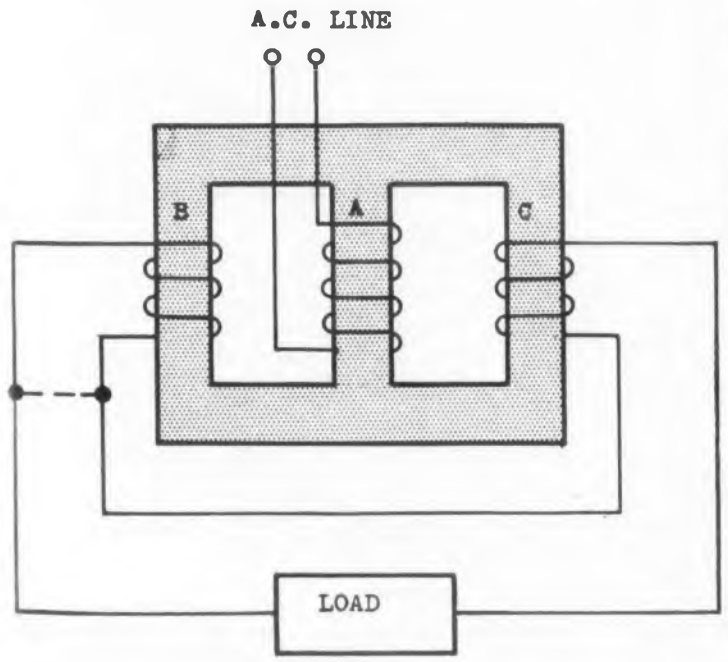


Fig. 1. Principle of "Reluctance Amplifier"

Fig. 4. Eighteen-watt reluctance amplifier.

preamplifier input terminals, the three terminals (*1*, *2* and *3*, Fig. 3) being provided to match the source impedance. The terminals *4*, *5* and *6*, shown shorted in Fig. 3, may be used to insert a dc input voltage, such as is obtained from a dc feedback tachometer.

The power output of the amplifier is limited primarily by the allowable plate dissipation of the control tubes. The plate dissipation is a minimum when the tube approximates either a short circuit or an open circuit (full power output or zero power output) and is a maximum at that intermediate value (as transformed by the turns ration between coils *E* and *C*) when the static plate resistance is equal to the load impedance. The maximum instantaneous plate dissipation is therefore determined by the load impedance. When used in reversing service, a load power twice as large may be delivered, because the plate dissipation is then divided between four tube sections, as compared with two when operated in one direction continuously.

A commercially available version of the Reluctance Amplifier is shown in Fig. 4. It is 3-1/2 in. deep by 5-3/4 in. wide by 3-1/4 in. high, weighs only 3 lb, 8 oz and delivers an output of 18 w reversing or 10 w one direction to a 115 v, 400 cps servo motor. Self contained with preamplifier and power supply, it has a voltage gain of 1000 and is powered from 115 v, 400 cps line.

Other versions of this amplifier, originally developed to meet military requirements of the airborne automatic Dead Reckoning Tracer computer employed on the WV-2 radar early warning planes, are shown in Figs. 5 and 6. The Model 1124 also provides a chopper input, whereby dc signals of 10 millivolts will produce full amplifier output.

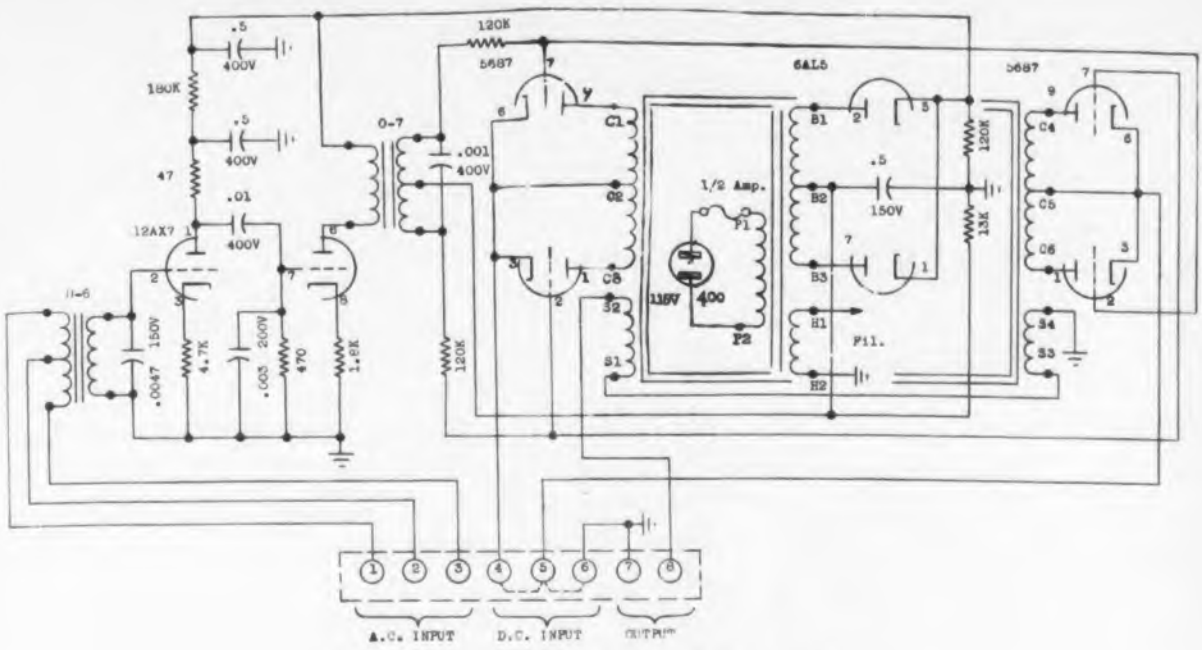


Fig. 3. Circuit diagram of a-c model

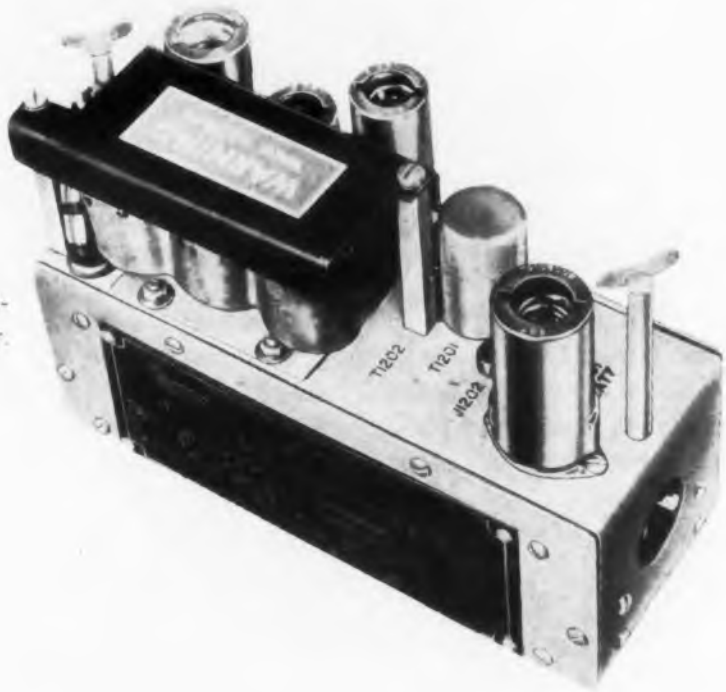


Fig. 5. Eight-watt ac input reluctance amplifier.

Fig. 6. Eight-watt dc input reluctance amplifier, Model 1124.

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Designing Deflection Systems Around Available Tubes

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Application Engineer
Electronic Tube Div.
Westinghouse Electric Corp.
Elmira, N.Y.

THE design of magnetic deflection systems for television receivers depends to a large extent on the tubes used, their uniformity, variation of characteristics in use, etc. It is the purpose here to consider the various factors that tubes impose on design and to give some suggestions for satisfactory circuit development.

Linear deflection of the electron beam in a cathode-ray tube, using a magnetic deflection system, requires that the current through the deflection coils approach a sawtooth waveform as in Fig. 1. The required peak-to-peak amplitude of this sawtooth is determined by the deflection yoke, the type of cathode-ray tube, and the accelerating voltage used. The deflection coils will produce a magnetic field whose strength is proportional to the applied current. Therefore, to produce a linear deflection of the electron beam, the current passing through the coils must increase linearly. The retrace must occur within approximately five percent of the total sweep time; therefore, the coil current must drop sharply to its starting value. These requirements define a sawtooth current waveshape. A typical value for a *27ALP4* 90° cathode-ray tube, with 16.5 kv accelerating voltage, is 460 ma peak-to-peak.

In order to supply this large change in current, a power output stage must be used. Its design is very similar to an audio ouput power amplifier where the primary consideration is a linear change in plate current. Either triodes or triode-connected beam-power tubes are used. A pentode can and has been used, but its application is more critical since the non-linearities in the plate characteristics must be avoided. The typical pentode plate characteristics exhibit a sharp decrease in the plate current at the lower plate voltages. This sharp change from almost constant plate current is often referred to as the knee of the E_p-I_p curve. To maintain a linear variation in plate current, the operating load line must be kept above the knee region. Since the slope of the load line is determined by the load impedance, this restricts the impedance to a certain maximum value.

The driving circuit for the output stage is a 60 cy, self-oscillating sawtooth generator. The two most popular types of circuits used for this stage are the multivibrator and the blocking oscillator. Neither of these circuits has any significant advantage over the other. The multivibrator requires two triodes and the blocking oscillator one. This apparent advantage of the blocking oscillator is equalized by designing the multivibrator to operate with the output amplifier as the second triode.

The frequency of the oscillator is determined by the RC time constant in its grid circuit. The oscillator tube is held at cut-off until the grid condenser discharging through the grid resistor reaches cut-off. To allow for synchronizing the sawtooth generator to the incoming signal, it is commonly designed to operate at slightly under 60 cy. A positive sync signal having an amplitude of 3 or 4 v is usually applied to the cut-off grid of the oscillator just before it would normally go into conduction. This drives the tube into conduction and locks the oscillator to the incoming sync signal frequency. Because of this requirement, the cut-off point of the oscillator tube must be sharp and must be held within fairly narrow limits.

The waveshape of a typical exponential condenser discharge with superimposed sync pulses, which might appear on the grid of the oscillator, is shown in Fig. 2. In either type of oscillator circuit, the sync

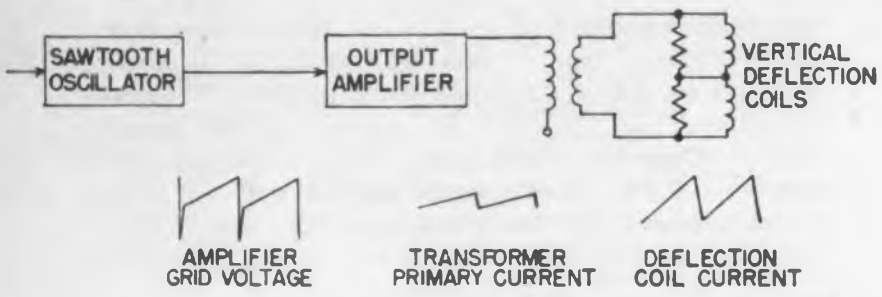

Fig. 1. Block diagram showing the required circuitry and desired wave forms for the vertical deflection system.

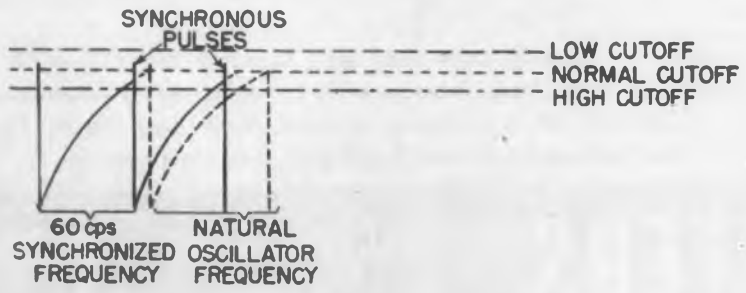

Fig. 2. The wave shape of a typical exponential condenser discharged with superimposed sync pulses that might appear on the grid of the oscillator.

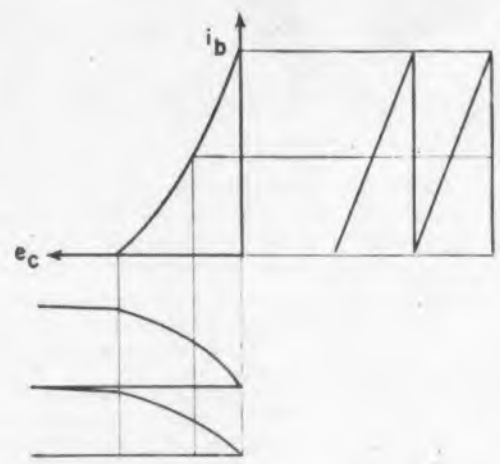

Fig. 3. Compensation of nonlinearity in the transfer characteristics by making grid voltage wave form slightly convex.

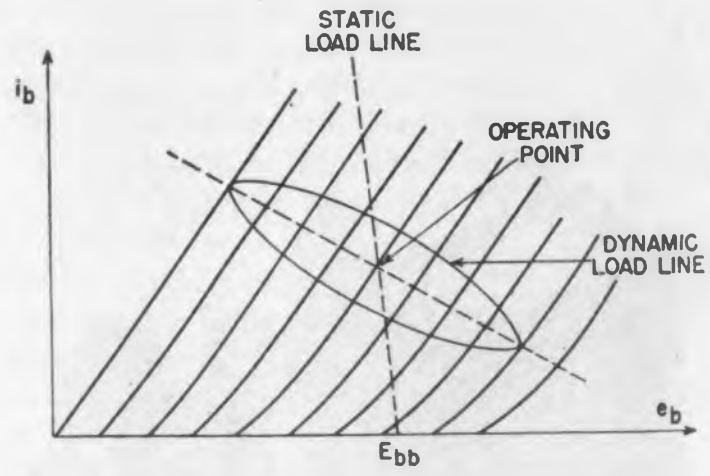

Fig. 4. Design of output amplifier made by using plate characteristic curves.

Note: The elliptical dynamic load line is exaggerated to emphasize the complex plate load impedance.

pulse must be of sufficient amplitude and occur at such a time as to initiate conduction. Once enough plate current is flowing, positive feedback will force it into full conduction. If the tube has a remote cut-off characteristic, then the point of conduction will vary, thereby varying the oscillator frequency. A remote cut-off tube will also require a larger sync pulse to initiate feedback. A sharp point of intersection between the cut-off voltage and the grid voltage waveform will insure a more stable oscillator frequency. If the cut-off voltage is not held within narrow limits from tube to tube, then the time of cut-off intersection with the discharge waveform will vary, thereby varying the oscillator frequency.

Although tube manufacturers conduct the necessary tests to hold their production within reasonable limits, the set designers must still provide a vertical hold control to adjust for the natural variance in tube and component characteristics or changes with life. The hold control can be used in either of two ways. The bias on the tube may be changed or the RC time constant may be changed. Either of these will control the time of intersection or frequency.

The exact voltage waveform presented to the grid of the output amplifier is dependent upon the values of resistance and inductive reactance in the amplifier plate circuit. To obtain a sawtooth of current in a pure inductive circuit would require a squarewave voltage on the grid. To obtain a sawtooth of current in a pure resistive circuit would require a sawtooth voltage on the grid. Since the plate circuit impedance contains both, the grid voltage must be a combination of the two waveforms which is a trapezoidal waveforms, However, at 60 cy the plate impedance is predominantly resistive so that it requires only a small step portion in the waveform. This step portion of the trapezoid is obtained by putting a resistor in series with the charging condenser to ground.

The transfer characteristic of the amplifier tube will also affect the exact voltage waveform desired at its grid. All tubes show some degree of non-linearity in the transfer characteristic as can be seen by the concave nature of the typical curve in Fig. 3. To a certain degree, this can be compensated for by making the grid voltage waveform slightly convex as shown. Since the sawtooth portion of the waveform is derived from the exponential charge of a condenser, this is easily accomplished.

Any vertical non-linearities appearing in the raster, excluding those caused by defective circuit components, can usually be attributed to variations of the output amplifier's transfer characteristic. Compression at the top of the raster is caused by an irregularity of the transfer characteristics in the region of the cut-off. It is due to a remote cut-off effect where the plate current levels off at some finite value, usually due to a wide spacing in the grid laterals. Compression can also occur at the bottom of the raster which is also due to leveling off the plate current. In this case, the leveling off is in the higher plate current region. This can be carried a step further, to where the plate cur-

rent drops off in the zero bias region and causes fold over.

Stretching of certain portions of the raster can also occur. As would be expected, this is caused by a too high transconductance in some parts of the transfer characteristic curve. It is commonly found in the top raster where the concave portion of the curve may be unusually linear. As has been mentioned above, the concave nature of the transfer characteristic is necessary due to the nature of the applied waveshape. The vertical linearity control allows for adjusting the operating point of the tube for optimum linearity.

Knowing the peak-to-peak amplitude of the sawtooth current required by a particular cathode-ray tube and deflection yoke, the proper design of the output amplifier is best illustrated by using the plate characteristic curves of the tube directly as shown in Fig. 4. The static load line is determined by the dc resistance of the output transformer primary. Since this is small (a few hundred ohms), the static load line will extend almost vertically from the E_{bb} point. The quiescent operating point and dynamic load line should be chosen such as to obtain the maximum linear variation in plate current with the minimum grid voltage variation. The required bias is obtained by a by-passed cathode resistor. Part of this resistor is usually made variable to provide for a vertical linearity control.

The output transformer has a step-down ratio to provide for impedance matching between the low impedance deflection coils and the relatively high plate impedance of the tube. The load impedance presented to the tube is equal to $Z_{pri} + N^2 Z_{sec}$; where Z_{pri} is the total primary impedance, n is the turns ration and Z_{sec} is the total secondary impedance including the deflection coils. A turns ratio should be chosen so that the load impedance to the tube will yield the desired dynamic load line. The leakage impedance of the output transformer is so small that it may be neglected. The transformer itself may be either an auto transformer or an isolated-winding transformer.

The type of tube chosen in combination with its output transformer must be capable of delivering the required yoke current variation. Since the transformer steps up the current by a factor equal to its turns ratio, the tube must be able to supply a linear current change of $\frac{I_{sec.}}{n}$. In the new low B+ sets, this requirement is difficult to obtain with the presently available tube types. Some manufacturers are using the boost voltage to supply B+- to the vertical output. This puts an added burden on the horizontal output section in that it must be capable of supplying the added power. The solution to the problem, and one which all the tube companies are working toward, is a new double triode tube which will combine the vertical oscillator and output tubes in one envelope. One half of the tube must be a low voltage, high-current triode for the output circuit. Ideally, this would

e high current at zero or very low plate voltage. The ther half need only be a medium-mu low-power tube with sharp cut-off for the oscillator circuit. The miniature *12BH7* double triode working off the boost voltage is a good example of what is currently being used to satisfy the dual circuit requirement. Under these conditions, however, there are the problems of total heat dissipation and cut-off. With the tube operating at or near its maximum ratings, its life may be greatly reduced and any slight variation in its characteristics are more apt to cause a visible effect on the raster. In the *12BH7*, the concave portion in the cut-off region of the transfer characteristic curve is critical because the complete curve is being used to obtain the needed plate current change.

Now that the critical design parameters of the tubes in the vertical deflection circuit have been pointed out, it would be worthwhile mentioning some of the less critical parameters that can cause troubles.

In selecting a tube to be used for a vertical deflection application, the designer should take into consideration the peak positive pulse voltage rating of the tube. During the vertical retrace time the plate of the output tube must be capable of withstanding up to a 1500 v positive pulse without arcing. The pulse is developed across ethe plate load inductance when the output tube is driven sharply to cut-off at the end of the trace time.

As has been pointed out above, a large linear change in plate current is the main consideration of the output stage. Loss of vertical raster height is a common trouble that can often be attributed to a defective output tube. It can be caused by a slump in emission, gas, or grid current. Any of these tend to decrease the plate current, thereby reducing the output. The vertical height control provides for some compensation. The height control is usually a variable resistor in the RC time constant circuit which provides the sawtooth portion of the trapezoidal grid voltage waveform. Varying this control varies the amplitude of the driving waveform by changing the RC time constant.

Two other common troubles worthy of note are heater-cathode leakage and microphonic noise in either the sawtooth generator or output amplifier tubes. Heater-cathode leakage will cause more or less stationary non-linearities of the vertical sweep because it will modulate the sweep waveform at 60 or 120 cy. Microphonic noise in either of these tubes will cause horizontal bars to appear on the picture which will drift either up or down, depending upon the frequency of the noise.

The variations in tube characteristics have long been recognized. This is evidenced by the existence of vertical height, hold, and linearity controls. Most of the trouble mentioned can often be overcome or minimized by these controls; but frequently, as in the case of the *12BH7*, the tube is being used too close to its limits with very little safety factor. This is particularly true in the new low B+ sets.

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CIRCUIT	Three Phase Bridge Rectifier, Resistive Load.
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RECTIFIER LOSSES	Less than one percent (½ KW).
COOLING REQUIRED	One 6½ inch square ⅛" thick copper fin for each of six rectifying units when used with 2000 fpm 30°C forced air. Free convection cooling may be utilized by increasing the fin area.
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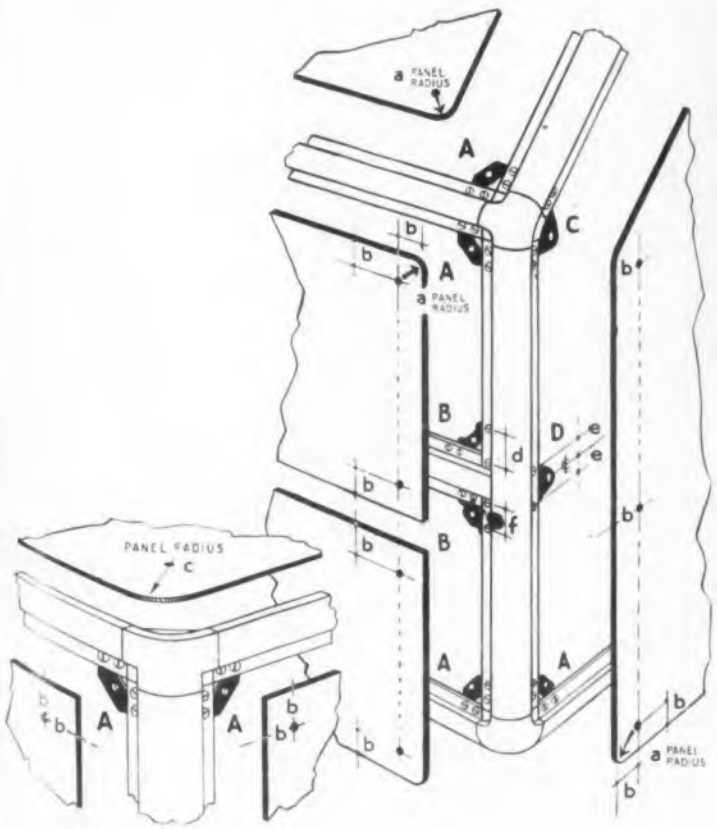
Pre-fab Cabinets

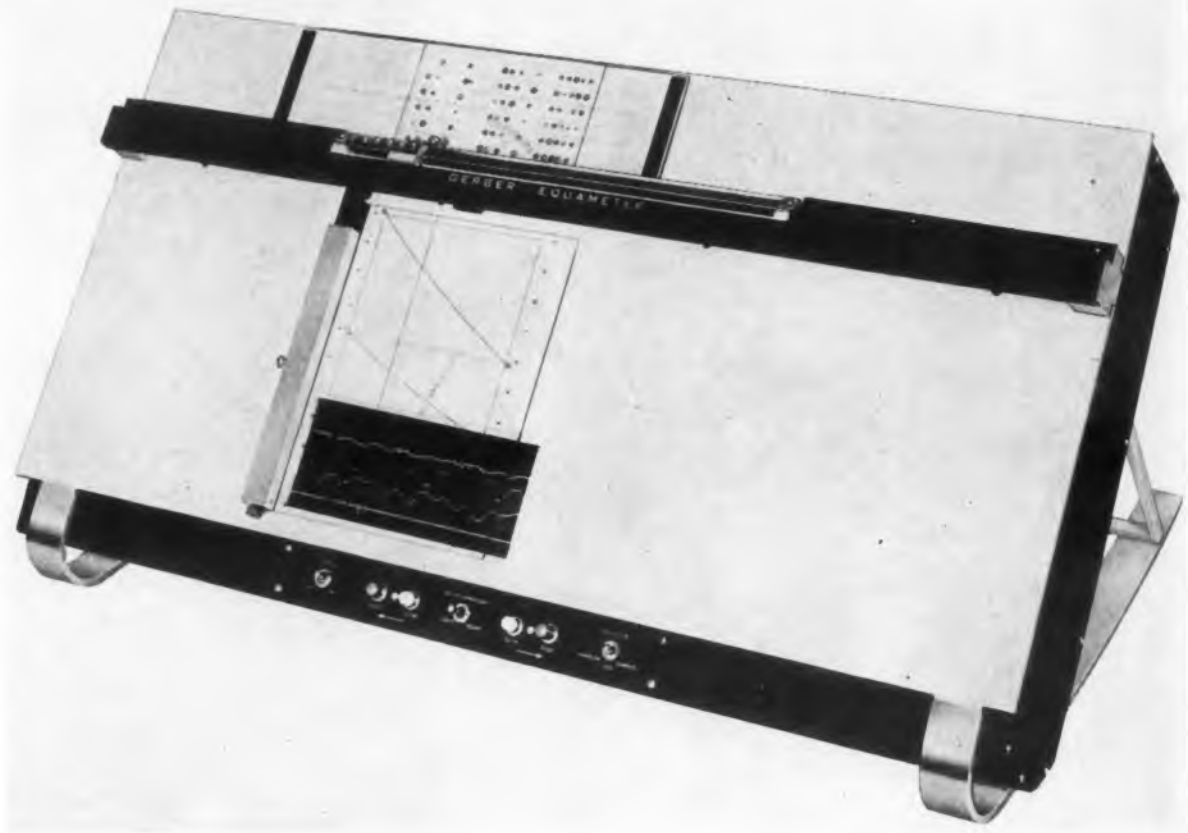
cabinets, intermediate crossbars provide added strength and enable multiple units to be held neatly. Sloping 45 degree fronts as well as sliding drawer sections can also be erected as shown in the accompanying illustrations.

Framework components are available in different radii, 1-3/16, 13/16 and 7/16 in. By varying the several combinations of components, any desired size or shape of cabinet may be assembled. For more data on these pre-fab cabinets, turn to the Readers Service Card and circle No. 45.



Mechanical Equation Finder

Coefficients Directly From Curve



Program sheet, superimposed on recorded curve, is linked to variable scale. As variable is moved to position variable hairline over curve, sub-coefficients are indicated at top of panel. Separate program sheets are used for Fourier and power series equations.

HARMONIC analysis and curve fitting from plotted or recorded curves is possible with the Equameter Model GEQ-400, an electrically-driven analog computer. This table top device permits equations to be obtained directly from the machine readings recorded after "tracking" or "tracing" the original given curve. It is necessary only to record the readings taken from the Equameter on the program and add these. A simple arithmetic multiplication produces the equation, thereafter. The work is easily performed by relatively inexperienced operators without extensive mathematical background.

A 12-term Fourier analysis can be completed in less than 10 minutes. The rapidity and flexibility of operation of this instrument, manufactured by Gerber Scientific Instrument Co., 162 State St., Hartford, Conn., suggests many applications. For example, the Equameter finds frequency components of complex harmonic wave forms, aids distortion analysis in amplifiers, prepares raw data for further processing in digital computers, finds best curve fit for scattered test points, develops empirical equations for complex dynamic and electronic situations, and transforms equations to best fit power series functions.

Fourier coefficients can be determined for 48 constants, and power series coefficients up to the eighth power. Least square equations for curves fitting arbitrary test points can be obtained up to the fifth power and up to 50 equally spaced points. The device can accommodate a maximum vertical amplitude up to 10 in. and a horizontal span (period) of 15 in. with a 1 in. variable reference line. Longer periods may be subdivided for analysis.

It is simple to operate the device. The recorded curve is fastened to the machine. The number of terms to be included in the analysis is decided and the corresponding program is selected from the program sheet. The curve cycle is automatically divided with the built-in variable scale, as specified on the program sheet. Either manually or electrically, the curves and hairline are moved to intersect the recorded trace at the programmed intervals. As directed on the program sheet for each ordinate required, the sub-coefficients from "Equameter Scales" are read and entered as data on the program sheet. Finally, the sub-coefficients are added in each column to obtain the coefficients for the equation being sought. For more data on this device, turn to Reader's Service card and circle No. 48.

Telefunken

Leslie M. Balter

Consulting Engineer

UNQUESTIONABLY the design engineer today who is working in any phase of audio must be high fidelity conscious. One of the methods in popular use of achieving better fidelity, and the same time a type of binaural effect is the use of multiple speakers. The manner in which the Telefunken, an imported German made receiver, matches 6 speakers to a push-pull audio output stage is deserving of your interest.

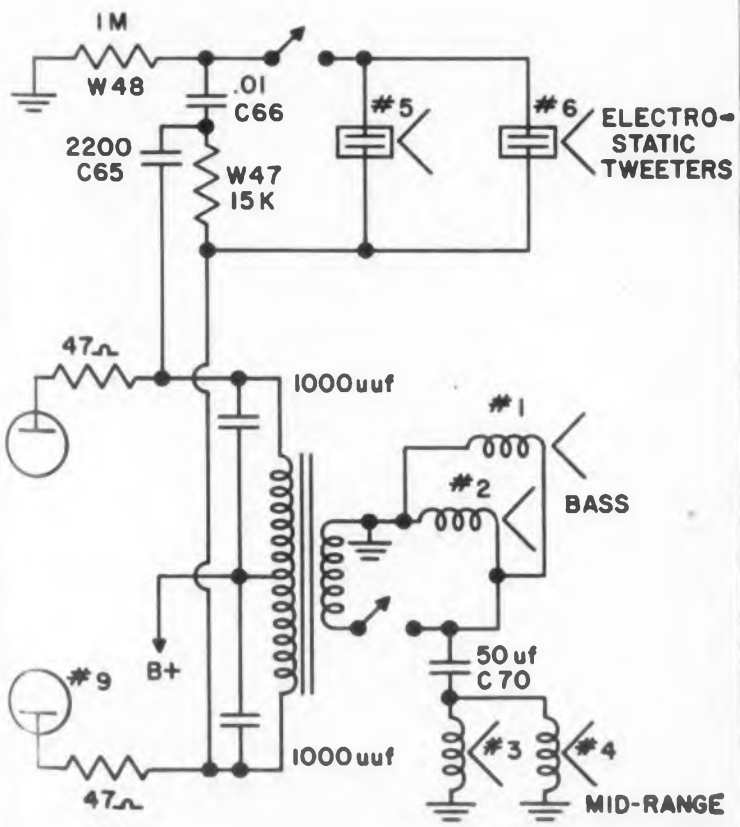
The audio section of the Telefunken Opus 6 high fidelity receiver consists of a voltage amplifier feeding a pair of push-pull pentode output tubes. The push-pull tubes are fed, one from the plate side and the other from the cathode side to accomplish the necessary phase inversion. The push-pull output stage is then coupled to two electrostatic 2-3/4 in. high frequency speakers, two low frequency 8-1/4 in. PM speakers and two midrange 4 in. PM speakers. The output coupling system figure shows the two electrostatic high frequency speakers coupled to the primary side of the output transformer. The push-pull plates have 47 ohm parastic elimination resistors in the leads to the output transformer. Both ends of the output transformer have a 1000 mmf capacitor to B plus, which is signal ground, also to reduce the tendency to oscillate parasitically.

The electrostatic speakers are connected through a high pass filter network, inasmuch as these speakers should become effective at approximately 6-7000 cps, dependent somewhat on the load the air presents to them. A switch is in the circuit to cut these speakers in or out as desired. The speakers are parallel connected. One end of the electrostatic speaker feed is taken from the plate of tube 9 at which both B plus and audio are present. The other end is fed to ground through a 1-M resistor W48 which completes the electrostatic voltage circuit for the speakers. The audio is coupled through a high pass filter, a 2200 mmf capacitor C65 which controls the cut-in point of the speakers. The 0.01 mfd-capacitor C66 has a low reactance to these frenquencies, and in conjunction with W48 and W47, acts as a low frequency de-coupling network.

Opus 6

The mid-range speakers #3 and #4 are in 4 in. PM speakers connected through high pass filter consisting of a 50 mfd capacitor. Their construction with a small hard cone is such that they become effective at about 3 or 4000 cps. The bass speakers *1* and *2* are directly connected across the secondary of the output transformer. The design is such that they have a natural resonance at about 70 cps and roll off in the vicinity of 4 to 5000 cps with the impedance rising sharply with increasing frequency.

Through the use of the above circuitry, constructed of components which are matched to work well together, Telefunken has been able to produce an excellent sound reproduction system.



Output Coupling System

Nomogram For Some Transistor Parameters

MOST transistor test equipment is designed for determining the short-circuit current amplification factor, alpha (α), by measuring either the quantity ($1-\alpha$), or the current amplification factor in the common emitter configuration, beta (β). Measurements of either of these parameters enable α to be determined to three place accuracy. However, in order to achieve this accuracy, when determining α from a measurement of β, the calculation must usually be made using long division. The nomagram permits alpha to be determined directly.

The relationship for making this calculation, with the assumptions required for its use, is as follows:

$$a = \frac{r_m}{r_c} \qquad \alpha = \frac{r_m + r_b}{r_c + r_b}$$

Therefore if

$$r_m >> r_b \quad \text{and} \quad r_c >> r_b$$
$$\alpha \cong a$$

Beta is defined as

$$\beta = \frac{a}{1 - a}$$

Therefore

$$\beta \cong \frac{\alpha}{1 - \alpha} \quad \text{or} \quad \alpha \cong \frac{\beta}{1 + \beta}$$

Where a = Current amplification factor
r_c = equivalent collector resistance
r_m = equivalent emitter-collector transresistance
r_b = equivalent base resistance
α = short-circuit current amplification factor in the common base configuration
β = current amplification factor in the common emitter configuration

An important parameter in transistor-circuit design is the alpha cutoff frequency, $f_{\alpha o}$. This is defined as

Howard Lefkowitz
Naval Ordnance Laboratory
White Oak, Silver Spring, Maryland

the frequency at which /α/ is 3 db below its low frequency value. Since in present commercially available transistors this parameter may range as high as 30 mc, its measurement presents many problems. A method of doing this indirectly, used by several commercially available test sets, is to measure the beta cutoff frequency or the frequency at which the /β/ is 3 db below its low frequency value. Since this parameter is on the order of 100 kc, the measurement problems are greatly reduced. Knowing the low frequency value of alpha, α_o, and the beta cutoff frequency, the following relationship may be used for determining $f_{\alpha o}$:

$$f_{\alpha o} \cong \frac{f_{\beta o}}{1 - \alpha_o}$$

The accompanying nomogram allows the direct determination of alpha, knowing either 1–α or β, to three place accuracy. The parameter $f_{\alpha o}$ may then be directly determined knowing 1–α and $f_{\beta o}$.

Example

An example of the use of this nomogram is as follows:

Measurement of $\beta = 49$

Reading directly off the α/β scale

$$\alpha = 0.98$$

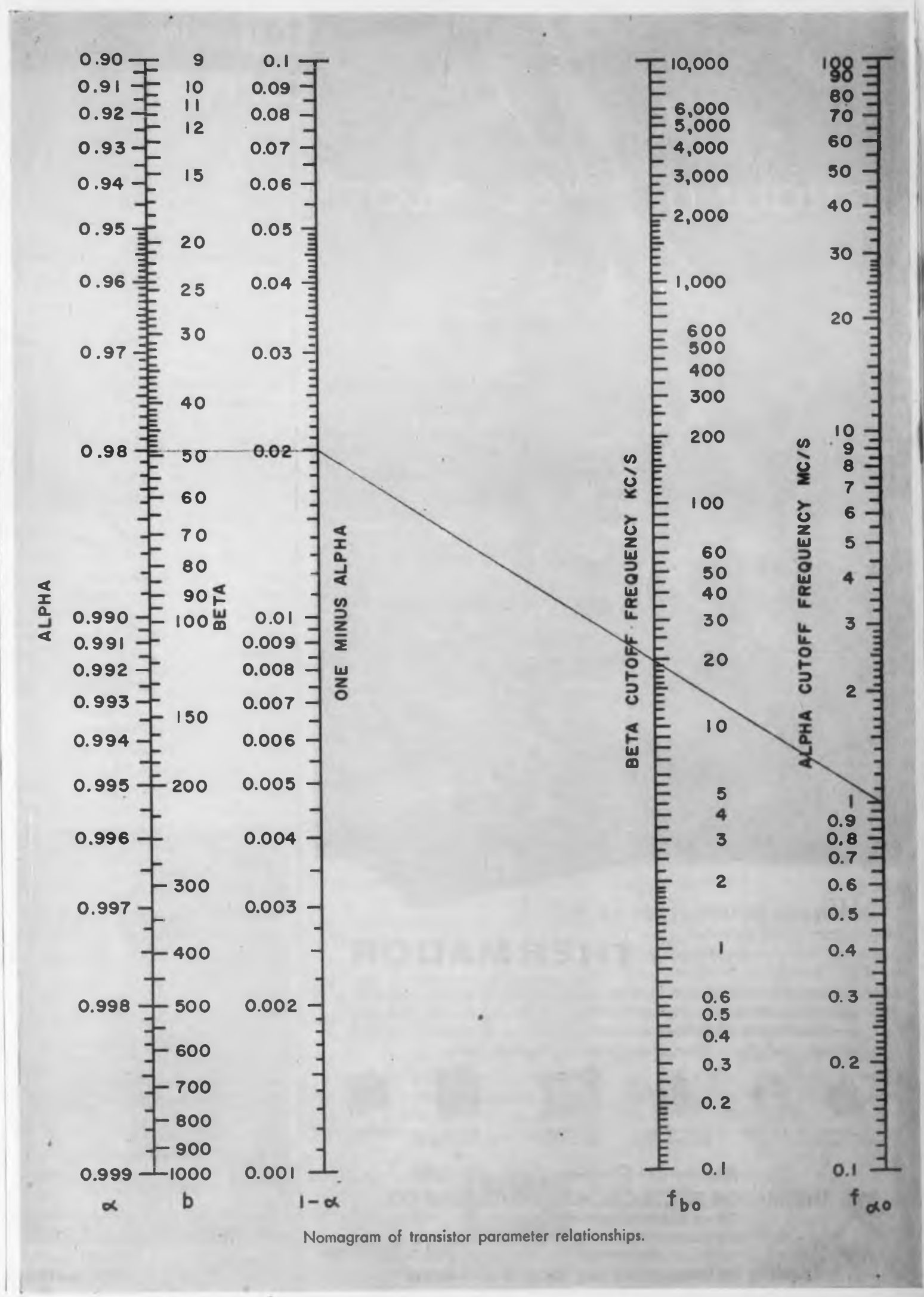
Laying a straight edge from the β line to the 1–α line

$$1-\alpha = 0.02$$

Measurement of $f_{\beta o} = 20$ kc

Laying a straight edge intersecting the value determined for 1–α and the measured value for $f_{\beta o}$ results in a value for $f_{\alpha o}$ of

$$f_{\alpha o} = 1.0 \text{ mc}$$

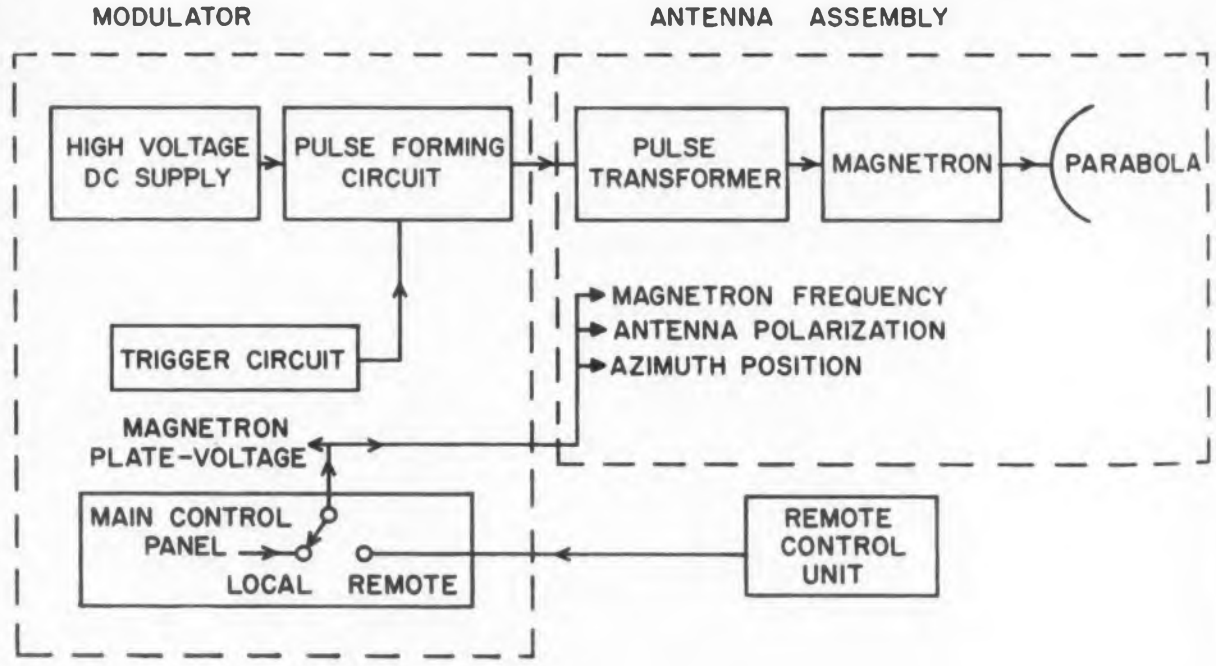


Nomagram of transistor parameter relationships.

References

1. Principles of Transistor Circuits, R. F. Shea, John Wiley and Sons, Inc., 1953.

X-Band Antenna-Pattern Transmitter Model 119 has its own self-contained power supply and modulator, and is tunable from 8500 to 9600 mc.



BLOCK DIAGRAM
CTI ANTENNA — PATTERN TRANSMITTER

X-Band Antenna-Pattern Transmitter

DELAY, expense, and the nuisance of building your own transmitter for testing microwave antennas can be obviated by purchasing this complete, compact X-band antenna-pattern transmitter. High power output results in an excellent signal-to-noise ratio, which permits measurements to be made far down on the secondary antenna lobes.

Normally operated in the 8500 to 9600 mc with a 2J51 tunable X-band magnetron, other magnetrons may be substituted with slight modification of the transmitter. Two antenna ranges can be illuminated from one location. A hydrometer is employed to prevent waveguide moisture condensation, permitting the unit to be used outdoors with minimum open shed protection. The transmitter is manufactured by Color Television Inc., Belmont 9, Calif.

The modulator trigger circuit, of the conventional line-discharge type, produces a 1-μsec high-voltage pulse. The magnetron is modulated by 1-μsec pulses at a repetition rate of 1000 pps. Maximum peak power is 20 kw. Input ower is 60 cps, 115 v, 10 amp.

The parabolic reflector is 24 in; gain is 33 db; beam width is 3.5 degrees; motor controlled polarization through 360 degrees is possible with stops located at 0, 45, 90, and 135 degrees.

Testing is facilitated by the provision of two azimuth positions so that measurement can be made on one antenna while the other is being readied. For additional information on this product, turn to Readers Service Card and circle 53.

New Products

Meters

Electro-dynamometer Units

A new line of "Astatic" Wattmeters, Voltmeters, and Milliammeters has been announced. The instruments should be of particular interest to engineers in aircraft electronics and servomechanisms, where power supplies operate at 400 cps to 1000 cps. They are electro-dynamometer type instruments with an entirely new coil system which results in an outstanding high frequency response. A typical voltmeter has a practically flat response to at least 1000 cps. The wattmeters feature very low internal losses, making them useful at extremely low power factors and at low wattage readings; a typical wattmeter is shown.

Rawson Electrical Instrument Co., Dept. ED, 110 Potter St., Cambridge 42, Mass.

CIRCLE 55 ON READER-SERVICE CARD FOR MORE INFORMATION

Potentiometer

Has Linear Motion

The 86125A "Pancake Rectipot," a miniature spring-loaded linear motion precision potentiometer, is for applications requiring measurement of a short stroke in limited space. It has less than 1 in. of body length for a full 1/2 in. stroke of the stainless steel shaft. Standard stroke ranges, from 0.1 to 0.5 in., are offered in resistance ranges of 1000 and 2000 ohms with linearity of $\pm 1\%$ and resolution of 0.0012 in.

Capable of long life under adverse conditions of vibration, acceleration, and temperature, the 86125A is designed for use in laboratory equipment, and control systems.

G. M. Giannini & Co., Inc., Dept. ED, 918 Green St., Pasadena 1, Calif.

CIRCLE 57 ON READER-SERVICE CARD FOR MORE INFORMATION

Micro-microammeter

Measures, Records, Controls

The Model 410 is a moderately priced micro-microammeter well-suited to measure, record, or control low currents. Uses include measuring low currents in photocells, vacuum tube grids, semiconductors, and ion chambers.

The 410 measures currents over 10 decades on 20 ranges, from 1×10^{-3} to 3×10^{-13} amp full scale. Accuracy is within ± 3 per cent or better. Zero drift is less than 2 per cent of full scale after a 5 minute warmup, with less than 2 per cent in any subsequent 24 hr period.

Other features include the ability to drive 1 ma or 5 ma recorders as well as the 50 mv rebalancing types; a regulated tap of about 250 v for polarizing ion chambers; and input noise below 1 per cent full scale on all ranges.

Keithley Instruments, Inc., Dept. ED, 12415 Euclid Ave., Cleveland 6, Ohio.

CIRCLE 59 ON READER-SERVICE CARD FOR MORE INFORMATION

Transistor Curve Tracer

Has Many Laboratory Uses

The Model BCT 300 Transistor Curve Tracer is for designing transistor circuits; comparing, matching, selecting transistors; detecting anomalies; studying effects of temperature, age, normal usage, and over-loading; and for detecting failures and cause. The unit is flexible and permits testing on all types in forward or reverse direction; it plots the entire family of curves on a standard laboratory dc oscilloscope.

Norden-Ketay Corp., Dept. ED, 99 Park Ave., New York, N.Y.

CIRCLE 56 ON READER-SERVICE CARD FOR MORE INFORMATION

Digital Ohmmeter

Accurate to $\pm 0.01\%$

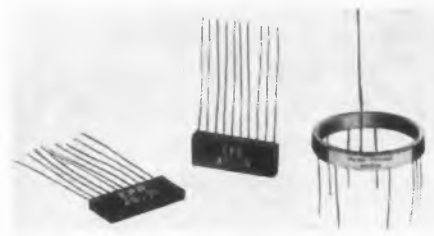
This completely automatic digital ohmmeter is a high sensitivity unit. It displays five digits, presenting quick, accurate measurements which are visually indicated on a true, digital, in-line readout. Accuracy is within 0.01 percent ± 1 digit, from 0.01 ohm to 100 K, with ranges to 10 megohms at reduced accuracy. Range is indicated by a lighted, automatically-positioned decimal point and by the symbol Ω or a $K\Omega$ in the extreme right window.

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

CIRCLE 58 ON READER-SERVICE CARD FOR MORE INFORMATION

Precision Resistors

In Multiple Encapsulation



This firm can encapsulate a series of subminiature precision resistors in a single housing of almost any configuration. The use of heat sinks and glass fiber insulation allows for wattage dissipation up to 4 w on a ring of tapped resistors measuring approximately 1 in. diam x 1/4 in. high. The thickness of the ring is approximately 1/8 in. Designed principally to meet the high reliability called for by the Government's ARC-34 program, this same type of construction can be applied to any number of shapes and sizes.

Eastern Precision Resistor Corp., Dept. ED, 675 Barbey St., Brooklyn 7, N.Y.

CIRCLE 60 ON READER-SERVICE CARD FOR MORE INFORMATION

Epoxy Laminate

Has 1,000,000 Megohms Resistance

Grade G-10-865 is a glass-base sheet laminate bonded with an epoxy resin. Similar to the company's Grade G-10-860, it is superior in its lower water absorption, lower dissipation factor, and higher bond strength and meets MIL-P-18177.

The material is intended primarily for electrical and electronic uses. Particularly notable are its high insulation resistance (1,000,000 megohms) and dimensional stability, due to low water absorption. It is available in sheet size of 39 x 47 in. with thicknesses from 1/32 to 1/2 in. Standard finish is a semigloss, and standard color is natural (light brown). It is supplied as either a standard laminate or with copper foil on one or both sides for printed circuits, where its high bond strength and excellent dip solder resistance are particularly valuable.

National Vulcanized Fibre Co., Dept. ED, 1056 Beech St., Wilmington 99, Del.

CIRCLE 61 ON READER-SERVICE CARD

Power Supply

Is Short Circuit Proof

This maintenance free, dual magnetically regulated power supply features outstanding line transient regulation and is short circuit proof. Designated the Stablvolt MR 28-5 Type A, it is tubeless and has a continuously variable output of 24-32 dc, 0-7.5 amp. Dynamic regulation is held to within 3% for 10% line voltage and load current step changes at rated load. Static regulation is within 0.2% for 10% line voltage change at full load, and 0.2% for load current variations from 10% to full load. Ripple is within 0.25% at rated load.

The design of this unit's flux oscillator provides extreme short circuit protection. When short circuited, line current is automatically limited, guarding the unit from internal damage; normal operation is resumed automatically, without fusing or resetting of switches.

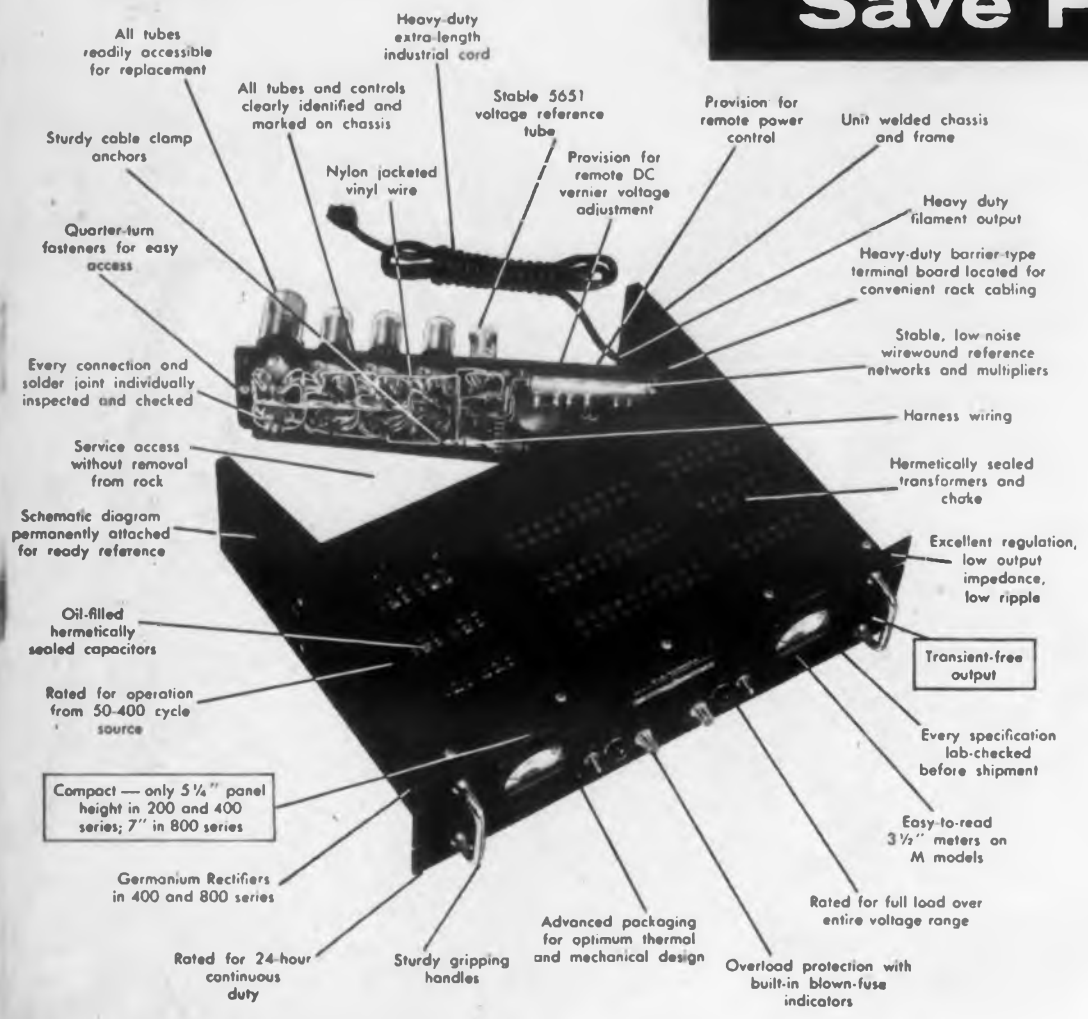
Magnetic Research Corp., Dept. ED, 200 Center St., El Segundo, Calif.

CIRCLE 62 ON READER-SERVICE CARD

CIRCLE 63 ON READER-SERVICE CARD ➤

LAMBDA 200, 400, 800 MA SERIES

New Power Supplies Save Panel Space!



***New!* HERMETICALLY-SEALED TRANSFORMERS**

***New!* TRANSIENT-FREE**

***New!* FUSE FAILURE INDICATORS**

***New!* GERMANIUM RECTIFIERS IN 400 AND 800 MA SERIES**

These new, compact, regulated Lambda D.C. power supplies are precision engineered, designed to displace minimum panel space. Wiring and tubes are easily accessible for maintenance and replacement. Hermetically-sealed transformers and chokes, protected from moisture, assure long trouble-free service. Meters optional.

Germanium rectifiers in 400 and 800 MA series for higher efficiency, compact design, longer life.

200 AND 400 SERIES ONLY 5¼" HIGH

800 MA SERIES			400 MA SERIES			200 MA SERIES		
MODEL 881	125-325 VDC	$315.00*	MODEL 481	125-325 VDC	$244.50*	MODEL 281	125-325 VDC	$149.50*
MODEL 882	325-525 VDC	$360.00*	MODEL 482	325-525 VDC	$259.50*	MODEL 282	325-525 VDC	$159.50*
INTERNAL IMPEDANCE	less than 1.5 ohms		less than 3 ohms			less than 6 ohms		
AC OUTPUT 6.5 VAC (unregulated)	20 amp.		15 amp.			10 amp.		
SIZE	7"Hx19"Wx14⅜"D		5¼"Hx19"Wx14⅜"D			5¼"Hx19"Wx14⅜"D		
WEIGHT (net)	75 lbs.		53 lbs.			53 lbs.		

REGULATION:

(line) . . . Better than 0.15% or 0.3 Volt (whichever is greater). For 105-125 VAC.

(load) . . . Better than 0.25% or 0.5 Volt (whichever is greater). For 0 to full load.

TRANSIENT RESPONSE:

(line) . . . Output voltage is constant within regulation specifications for step-function line voltage change of plus (+) 10 volts or minus (−) 10 volts rms within the limits of 105-125 VAC.

(load) . . . Output voltage is constant within regulation specifications for step-function load change between 0 to full load or full load to 0 MA.

OVERLOAD PROTECTION:

External . . . AC and DC fuses, front panel, with built-in fuse-blown indicator.

Internal . . . Fuse, rear of chassis.

*Metered models identified by letter "M", add $30 to base price.

LAMBDA Electronics Corp.

THE FIRST NAME IN POWER SUPPLIES

11-11 131 STREET, COLLEGE POINT 56, NEW YORK

Small Drive Units

In Up to 3 Reversible Speeds

The DSU-100 Series of "Dual-Speed" Units consists of two standard Bristol "Circle B" motors combined with a differential unit. The motors are connected so that the speed of the output shaft will be the sum of the two motor speeds. This gives a choice of three output shaft speeds by electrical switching, using two motors of different speeds. These units are also available with the Bristol reversible motor, in which case three speeds in each direction are available.

Available output speeds in this type of unit range from 180 rpm down to as low as 1 revolution per month. Uses include: chart drives in which the output speed of the chart can be electrically switched by energizing one or the other motor; control devices in which a fast or a slow speed drive would be available; and timers, particularly in cases where a finite reset time is desired.

Bristol Motor Div., Vocaline Co. of America, Inc., Dept. ED, Old Saybrook, Conn.

CIRCLE 65 ON READER-SERVICE CARD

Nickel-Base Alloy

Withstands 1240 F Under Load

M-252 vacuum-melted nickel-base alloy, is suitable for extended operation under load at temperatures of 1240 F. Already being used in the form of forged buckets in the first stage of heavy-duty land gas turbines, the alloy is reported to exhibit high rupture strength, good fatigue strength, and high resistance to thermal shock.

The material is valuable for such applications as turbines, where speed and operating temperature are definite factors. In a turbine, where the centrifugal force of buckets rotating at high speeds produces very high stresses, M-252 is strong enough to resist these stresses, maintaining strength at the high temperatures produced by the gases from the combustion chambers. It is being used as buckets in four 7600 hp gas turbines which operate at 1240 F at 6900 rpm.

Metallurgical Products, Dept. ED, General Electric Co., Detroit 32, Mich.

CIRCLE 66 ON READER-SERVICE CARD

◀ CIRCLE 67 ON READER-SERVICE CARD

New Line of Adhesives

Many Industrial Applications

Adaptable to many assembly operations, a new line of industrial adhesives, protective coatings and sealers, are capable of bonding a large variety of materials. Resistant to very low (—80 F) and very high temperatures (700 F), and applied by virtually any commonly used industrial method, the new line is to be marketed under the trade name, Ray-BOND.

Techniques for Ray-BOND adhesives include use spray, pressure flow systems, brush, roller coat and manual application.

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

CIRCLE 69 ON READER-SERVICE CARD

Epoxy Adhesive Kit

Field Use

This Epoxy Adhesive Kit is designed for use in the field and contains the required proportion of resin and hardener in two flexible tubes. Complete instructions are inside the kit.

Resin and hardener are pre-weighed and pre-proportioned. One tube contains the resin and when a bead of any length is squeezed on the mixing surface, the user then needs only to match that bead length with the hardener bead. After thorough mixing, the adhesive is ready to use.

Houghton Laboratories, Inc., Dept. ED, Adhesives and Coatings Division, Olean, N. Y.

CIRCLE 70 ON READER-SERVICE CARD

Sealed Miniature Relay

Wide Range DC Operation

Developed for the reliable switching of a large variety of circuits, Class 11-6PDT Relay is available with various contact arrangements, and contact ratings up to 5 amp.

It is furnished with a 20-pin octal plug or 20-pin solder terminal header, and choice of open or with dust tight enclosure.

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

CIRCLE 71 ON READER-SERVICE CARD

CIRCLE 72 ON READER-SERVICE CARD ➤

Silicon Diode

Rated at 1000 V

One of a series of high voltage silicon diodes available in production qualities, this diode is especially designed for power applications where high ambient temperature, reliability, high efficiency, and miniaturization are prime factors.

These diodes are available in peak inverse voltage classifications of 600 v, 800 v, and 1000 v, with half wave dc output currents of 125 ma at 75 C ambient. The operating temperature range is from —55 to 150 C ambient. The diodes occupy a volume of only 1/16 cu in. (3/8 in. diam x 9/16 in. long) and are provided with pigtail leads to facilitate easy wiring into crowded chasses. They are hermetically sealed.

International Rectifier Corp., Dept. ED, El Segundo, Calif.

CIRCLE 74 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Oscillator

Covers 200 to 2500 Mc

Substantial rf power output throughout a broad band of high frequencies characterizes the Model 1141 Power Oscillator. Output exceeds 40 w from 200-400 mc, 25 w from 400-1000 mc, and 10 w from 1000-2500 mc. The frequency range of instrument is covered in two, overlapping bands: 200-1050 mc and 950-2500 mc, Calibration accuracy is ±1 per cent or ±5 mc, whichever is greater; resettability is better than 0.1 per cent.

The oscillator is equipped for square-wave or sine-wave modulation from built-in 400 cps and 1000 cps sources. Provision is also made to allow modulation at other frequencies from a suitable external source. Modulation level and rf output level are adjustable over wide ranges.

The instrument comprises an oscillator unit and a power-supply modulator unit, each contained in a well ventilated 11-1/2 x 9-1/2 x 20-1/2 in. metal case.

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

CIRCLE 75 ON READER-SERVICE CARD FOR MORE INFORMATION

Ferristors

Offered as Standard Units

Ferristors, developed to replace vacuum tubes in electronic equipment are now available as independent standard products. They are reliable, lightweight, low power components, unaffected in humidity and temperature. These 9/16 in. cubes (shown compared with a vacuum tube) perform virtually all vacuum tube functions; input amplifier, gate, time base, decimal counting unit, coincidence amplifier, and control circuitry. They are immune to damage from shock, vibration, and accidental overload.

Essentially, the Ferristor is a miniature saturable reactor consisting of simple wirewound coils on a magnetic core, encased in epoxy resin with four pigtail leads. Two classes are available, one for high speed magnetic amplifier applications and a second type for counting circuits. Some feature adjustable magnets to supply fixed magnetic bias. Others, minus magnets, are tailored for use with dc fixed current bias. Windings of 1000, 2000, and 4000 turns provide a choice of sensitivities and gain factors for different aplications. Designed to work with carriers in the 1-10 mc frequency range, magnetic amplifier type Ferristors can generate a wide variety of circuits.

Berkeley Div., Beckman Instruments, Dept. 1352, 2200 Wright Ave., Richmond, Calif.

CIRCLE 77 ON READER-SERVICE CARD FOR MORE INFORMATION

Cooling Fan Blades

Standard Diameters

The fan blade illustrated is available in eight standard diameters; 4, 3-1/2, 3-5/16, 3, 2-3/4, 2-1/2, 2-1/4, and 2 in. Intermediate sizes also can be furnished. All blades can be supplied to fit shaft diameter requirements.

Low hp consumption, high air delivery, and quiet operation are provided. The units can be furnished with a hubu, or punched center hole only, for friction type mounting. Blades can be supplied for cw or ccw rotation and may be fabricated from either steel or aluminum.

PM Motor Co., Dept. ED, 5051 W. Waveland Ave., Chicago 41, Ill.

CIRCLE 78 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnetic Tape Handler

Designed for Airborne Use

For aircraft and missile applications, the Model 3186 airborne magnetic tape handler is available for operation on either 60 cps or 400 cps Standard 1 in. wide magnetic tape is used with an interlaced head stack arrangement that provides 25 data channels. Tape speed is 54 ips on standard models, but other tape speeds can be accommodated. Fast starts and stops (0.6 sec) to add from full speed permit maximum utilization of recording medium. Standard 2400 ft NARTB reels are used, and adapters are available for other reel types.

Tape travel may be controlled by front panel switch or remote contact closure. Tape drive is automatically halted in the event of tape or power failure. Although the handler is intended primarily for digital recording, wow and flutter are held to less than 3 per cent peak-to-peak when a signal is recorded and reproduced on the same machine, thus satisfying requirements of many analog recording applications. Reliable operation may be obtained from —4 to 113 F and under acceleration, shock, and vibration conditions normally experienced by airborne equipment. Miniaturized versions are also available.

Potter Instrument Co., Inc., Dept. ED, 115 Cutter Mill Rd., Great Neck, N.Y.

CIRCLE 81 ON READER-SERVICE CARD FOR MORE INFORMATION

New Marking Method

1/10th the Cost

A brand new marking method to meet the needs for more permanent markings on nameplates, dials, panels, etc. at lower costs, passes government specifications and a 300 cycle abrasion test. Called photo-Wrinlay, it looks and feels like an expensive engraving.

The process eliminates the problem of dirt or dust setting in the markings, and gives a subdued effect with its recessed markings. Photo-Wrinley can also be ordered in any color combination, offering the chance to add color to their units.

This high quality, photo marking method is applicable for every type finish, including hammertone, and can utilize all types of baking enamel including epon, melamine, phenolic, urea and alkyd.

Photo Chemical Products, Dept. ED, 479 Walton St., New York, N.Y.

CIRCLE 82 ON READER-SERVICE CARD FOR MORE INFORMATION

Transistor Analyzer

An Alpha Display Unit

The "Transalyzer" measures alpha and alpha cutoff characteristics of point contact, junction, and tetrode transistors. Provided are a sweep generator, attenuators, dc biasing and metering circuits for the transistor, and an rf amplifier and detector. A 50 kc to 50 mc sweeping oscillator may be used independently of transistor test circuitry. All transistor biases are electronically regulated. An oscilloscope is the only auxiliary equipment necessary for measurement.

Kay Electric Co., Dept. ED, 14 Maple Ave., Pine Brook, N.J.

CIRCLE 84 ON READER-SERVICE CARD FOR MORE INFORMATION

Oscilloscope

For Non-Repetitive Events

Model 2100-A-1 is a dual channel oscilloscope, 100 mc nominal, for the study of non-repetitive phenomena having rapid rise time. It has amplitude with better than 70 db gain. Attenuation is 40 db in 20 db steps, 20 db vernier control. Input impedance is 200 ohms nominal, and amplitude axis positioning is individual for each channel.

Sweep is variable in steps from 500 milliμsec/in. to 100 μsec/in. Time axis positioning is common for both channels; sweep gain expansion as required. Automatic lock-out is provided. Maximum repitition rate is 25/minute (approx). Calibration marks are provided at 1 μsec and 0.2 μsec intervals, controlled from a 1000 kc crystal. The unit has comb-type presentation, with amplitude variable.

The instrument is provided with a control desk which handles time axis position and gain, synchronization selection, calibration gain, amplitude axis position, sweep duration, and polarity of synchronization. Intensity and focus controls are located adjacent to the desk. Overall dimensions are 44 x 65 x 60 in. high. The control desk projects an additional 18-1/2 in.

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

CIRCLE 85 ON READER-SERVICE CARD FOR MORE INFORMATION

10-In Picture Tube

Designed for Portables

The rectangular glass tubes are the st specialized line for portable tele- sion receivers.

Two new 10-in. television picture bes, designated as experimental pes ST-1925 and ST-1926, feature ecreased weight, larger screen area id better contrast.

Both tubes have standard neck ameter, 90 deg. deflection, and elec- ostatic focus. Anode voltage is 13.2 , absolute maximum, and nominal verall length is 11-7/16 in.

The new tubes weigh 3 lb 10 oz id have an approximate screen area 56-1/2 sq in. Better contrast is pro- ided by gray filter glass which sub- antially increases picture contrast. he tubes have spherical faceplates. he ST-1926 is aluminized, while the T-1925 is not. Both Types are avail- ble for engineering evaluation.

Sylvania Electric Products Co., ept. ED, 1740 Broadway, N. Y. 19, . Y.

CIRCLE 88 ON READER-SERVICE CARD

Non-Corrosive Solder Fluxes

In Gallon and Pint Containers

Non-corrosive, quick wetting solder uxes, designed primarily for use on opper and copper base alloys, utilize afe-to-handle derivatives of the war- orn chemical, hydrazine.

The H-series Fluxes, for soft solder- ng, have the properties: 1) small mounts of flux residues are non-cor- sive; 2) excellent solder spread haracteristics; 3) almost no residue roduced; 4) washing or cleaning can e eliminated; 5) prefluxing for pro- uction economies.

The H-series Fluxes can be used ith all soldering techniques. In addi- ion, other metals, like steel, alumi- um, zinc and stainless steel can be oldered with these fluxes, if they are rst coated or plated with copper, tin, older, or silver.

Federated Metals Div., American melting & Refining Co., Dept. ED, 20 Broadway, N. Y. 5, N. Y.

CIRCLE 89 ON READER-SERVICE CARD

P6M

Regulated Power Supplies

No Under Chassis Components

Power supplies series Z-95000 w plug-in circuit design simplifies ma tenance. Output voltage varial from 175 to 250 v dc at 200 r (Either plus or minus may grounded.) Regulation is better th 1 per cent from 0 to 130 per cent rated load. Total ripple and noise less than 7.2 mv rms.

Filament voltage available is 6.3 unregulated at 8 amp. A 0 to 150 bias supply is available.

All output voltages are available front or rear panels. Input is 105 135 v ac 60 cps. Both bench and ra mounted models are available.

EECO Production Co., Dept. E 506 E. First St., Santa Ana, Calif.

CIRCLE 92 ON READER-SERVICE CARD

Microwave Resistance Cards

Of Metal Film on Fibre Glass

The Filmohm metal film fibre gla plastic resistance card is a high stable microwave attenuator materi The base is a fine weave glass clo impregnated with high temperatu thermosetting resin. The resistan material is a thin film of pure metal approximately 50 millionths of an inc thick, uniformly deposited on one both surfaces of the plastic. A prote tive coating is provided over the met film.

Metal film resistance cards can b punched, drilled, sheared, machine and sanded, with normal care to avoi scratching the film surface. Resistanc range is 25 to 750 ohms per squar Standard tolerance is +10% (this a plies to end-to-end resistance and t all areas throughout the card). Th standard card is 5 x 12 in. exclusiv of colloidal silver terminals. Maximu size which can be accommodated i 8 x 22 in. Thickness is 0.025 ±0.003 i or 0.032 ±0.003 in. Maximum surfac temperature should be limited to 13 C.

Filmohm Corp., Dept. ED, 48 W 25th St., New York 10, N.Y.

CIRCLE 93 ON READER-SERVICE CARD

TWT Amplifier

For 2-4 Mc Region

Providing high, broadband amplification in the shf region between 2 and 4 mc, the Model 510 A Amplifier offers a power output of 10 mw with a small signal gain of 25-35 db, a noise figure of 20 db, and vswr (input and output) less than 2:1. Complete with traveling-wave tube, the 510 A is available in a bench model (illustrated) 21 x 12 x 5-1/2 in. high, approximately 45 lb; or, for rack mounting in a model 5-1/4 x 19 x 9 in. deep behind panel, weighing 35 lb.

Panel equipment includes trim controls for the grid, anode, and helix, plus a meter and selector switch for monitoring cathode, anode, helix, and collector currents. Necessary line potentials are regulated; the tube cathode is protected by a time delay; and automatic tube protection is provided against helix-current overload.

Amplitude-modulated by the traveling-wave-tube grid, the amplifier has these characteristics: bandwidth is dc to (approx) 100 mc; pulse rise-time is (approx) 5 milliusec at max power output; pulse delay is (approx) 15 milliusec.

Phase-modulated by the traveling-wave-tube helix, the amplifier has a bandwidth 10 cps to 10 mc and requires approximately 30 v input for ± 180 deg phase shift.

Wave/Particle Corp., Dept. ED, 858 Kaynyne St., Redwood City, Calif.

CIRCLE 97 ON READER-SERVICE CARD FOR MORE INFORMATION

120 Diametral Pitch Gears

For Instrument Uses

To aid in instrumentation miniaturization, this firm offers 120 diametral pitch gears in 14-1/2 and 20 deg pressure angles. Hub type gears are available, offering 20 through 120 teeth in 303 stainless steel, and 61 through 120 teeth in 24 S.T. aluminum, with bores ranging from 0.1200 to 0.1875 in. These gears are stocked in both Precision Class I and Class II. 121 through 300 teeth are available as 1/8 in. face aluminum hubless gears, or assembled with either clamp or solid type hubs in Precision Class I. Stainless steel is passivated, and aluminum is chromic acid anodized.

Dynamic Gear Co., Inc., Dept. ED, Amityville, N.Y.

CIRCLE 98 ON READER-SERVICE CARD FOR MORE INFORMATION

DC Tach-Generators

Temperature Compensated

A line of temperature compensated dc tachometer generators is available in two basic model series, depending on the degree of compensation required. Units can be furnished with outputs held to less than 0.1 per cent, or to less than 0.25 per cent voltage variation due to temperature changes over a range of —40 to 100 C. This accuracy eliminates the necessity for costly or complicated external compensating networks.

The generators are available in six basic frame sizes and mounting types. Available outputs are from 1 v to 175 v per 1000 rpm, with operating speeds up to 10,000 rpm or higher as required.

Electric Indicator Co., Dept. ED, 100 Camp Ave., Springdale, Conn.

CIRCLE 104 ON READER-SERVICE CARD FOR MORE INFORMATION

Headset

Provides "3-D" Hearing

"Tele-Fi," a lightweight headset, is designed to produce realistic hearing with 30 per cent better understanding by inducing a 1 millisec time lag between ears, creating greater depth of sound and better first-time understanding.

Made for personnel who must wear headsets for sustained periods of time and in applications where initial understanding is vital, "Tele-Fi" weighs only 1/2 oz and features foam rubber eartips. It gives the wearer practically no sensation of weight. Frequency response is 60-6000 cps. Comfortable listening is achieved at 1 mw input. The unit is available in two impedances: 128 ohms and 1000 ohms.

The continuous single tone arm of durable Tenite plastic is constructed to achieve 1 millisec time delay in reception of sound by the ear opposite the receiver. It has replaceable foam rubber eartips. The receiver snaps on the headset, or slips in a slot on a plastic earset. A lightweight single cord with polarized plug permits freedom of movement.

Telex, Inc., Electro-Acoustic Div., Dept. ED, 1633 Eustis, St. Paul, Minn.

CIRCLE 105 ON READER-SERVICE CARD FOR MORE INFORMATION

Military Type Potentiometer

Low Weight

The DP-12 Potentiometer is designed to withstand environmental vibration, shock, and ultra-high altitude. It surpasses JAN-R-19 specifications calling out Type RA-30 potentiometer requirements. It is completely hermetically sealed. Difficulty in dissipating heat from a totally enclosed resistance is overcome by close fitting of the resistance element with the die cast aluminum case. Heat is rapidly transferred to the outside of the case, providing rapid heat radiation.

Rated power is 4 w. The unit is built to provide a resistance range of 100 ohms to 40 k. Standard models have ±5 per cent tolerance, but other tolerances are available. Effective rotation of the shaft is 275 ± 2 deg. Shaft torque is 6 in.-oz max. Linearity is ± 3 per cent max. Resolution is 0.5 per cent max.

Shafts are available in round, flat, or screwdriver slotted styles 1/2, 7/8, 1, 1-1/4, and 2-1/2 in. long. Weighing only 1.2 oz, the potentiometer operates over an ambient range of —55 to 125 C. It operates at 100 per cent power to 40 C, derating to 0 to 125 C.

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

CIRCLE 110 ON READER-SERVICE CARD FOR MORE INFORMATION

Torque Watch

Furnished in Two Ranges

Model B, an improved Torque Watch, has an increased outer shell length of 1-3/6 in., affording a firmer grip by the operator and making the gage easier to use as its upper limit of measurement is approached. The chuck has been redesigned for greater versatility and now allows torque measurement on devices with 1/4 in. diam shafts as short as 1/16 in. For safety, the crystal is now recessed and is made flat, allowing the instrument to be set on end.

The Torque Watch is furnished in two ranges: 0.01-1.2 oz-in. and 1-20 oz-in. Each range is available in choice of clockwise or counter-clockwise rotation.

Waters Manufacturing, Inc., Dept. ED, P.O. Box 368, So. Sudbury, Mass.

CIRCLE 111 ON READER-SERVICE CARD FOR MORE INFORMATION

Pulse Modulator

Provides up to 50 Kv Pulses

The Model PC 40 Pulse Modulator, when used with an appropriate high-voltage dc supply, provides up to 50 kv positive output pulses. Pulse width is continuously variable from 5-200 μsec at repetition rates up to 1 kc. Both pulse width and repetition rate are controlled continuously by knobs located at ground level. Pulse rise and pulse fall times are both 1 μsec independent of pulse length. Sag on the flat top of the pulse is determined primarily by the size of the output filter-capacitor used in the high-voltage power supply.

This pulse modulator was designed primarily to operate into a high-impedance load such as that represented by the modulating anode utilized in many high-power klystrons. Nominal load impedance is 1 megohm shunted by 25 mmfd. The equipment includes a floating deck which is tied to the modulating anode and switched to ground by an appropriate 50 kv tetrode. Also included is an internal trigger generator for determining pulse length and repetition rate. Total power requirements are 2 kw from a 120 v 50/60 cps source.

Levinthal Electronic Products, Inc., Dept. ED, 2758 Fair Oaks Ave., Redwood City, Calif.

CIRCLE 115 ON READER-SERVICE CARD FOR MORE INFORMATION

K & E Template

For New Electrical Symbols

Electrical Symbol Template, for Leroy lettering and symbol-drawing equipment, that conforms to the new and revised Graphical Symbols prepared by the American Standards Association, meets military specifications. The new templates are expected to replace the earlier version in general use.

The Leroy Electrical symbols are available in three sizes: One as shown in the American Standards Association Bulletin; another one half again as large; and a third that is twice as large.

Keuffel & Esser, Dept. ED, Hoboken, N. J.

CIRCLE 116 ON READER-SERVICE CARD FOR MORE INFORMATION

Volt-Ohmmeter

An Accurate Digital Unit

The Model 352 Digital Volt-Ohmeter is a three-digit instrument available in both portable and rack mount models. The in-line luminous numerical readout can be read from 30 ft or more, from straight-on or at angles. Accuracies are: dc volts, ±0.1 per cent; ac volts, ±2 per cent of full scale from 30 cps to 3 mc for voltages greater than 1 v; ohms, ±(0.1 per cent of value read + 1 digit).

This instrument has manually-selected ranges of: ac, 0.01-999 v; dc, 0.001-999 v; and ohms, 1 ohm to 9.99 megohms. A high input impedance (dc volts, 11 megohms; ac volts, 1.5 megohms) presents a very small load to the circuit under measurement. A short balance time of 1 sec (average) permits high readout and printing rates.

Printer connection and automatic printer controls are available for use with parallel entry data printers. A scanner for use with serial entry data printers and complete printing systems also are available. The portable instrument is 11 x 8-1/4 x 15-1/8 in. deep. Rack mount: 5-1/4 x 19 x 15-1/8 in. deep.

Non-Linear Systems Inc., Dept. ED, Del Mar Airport, Del Mar, Calif.

CIRCLE 120 ON READER-SERVICE CARD FOR MORE INFORMATION

16 KV Power Supply

Fits in The Hand

This compact, completely electronic transistorized dc to dc power supply produces 16,000 l from as little as 3 v input. It weighs only 1-1/2 lb and is only 1-1/2" x 3" x 6". Units are also available that deliver 16 kv at as much as 200 μa from 12 v input, where more current is desired.

Standard ambient temperature range is —25 C to 75 C; the range can be extended to —55 C to 100 C or more on special models. The units are available in rectangular shape and can be custom-made to fit any specifications.

Universal Atomics Corp., Dept. ED, 19 East 48th St., New York 17, N. Y.

CIRCLE 121 ON READER-SERVICE CARD FOR MORE INFORMATION

Phototube

Peak Sensitivity in Blue Light

This photo cell, Number XR-673A, features a 7-1/2-in. cathode that opens up a multitude of applications in that the long cathode eliminates the use of a bank of smaller photo tubes, cuts down on circuitry, and assumes stability of output over its entire length. Its peak sensitivity is in the blue and is particularly useful with light sources rich in blue and green light, such as mercury vapor lamps.

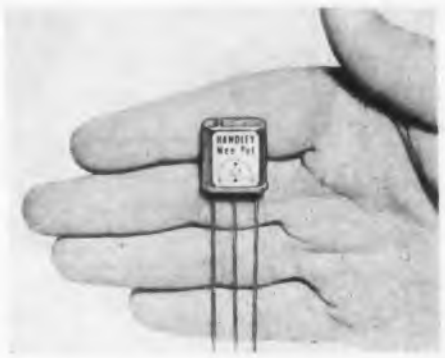
Minimum, nominal, and maximum sensitivities are 75, 120, and 200 μamp/lumen (read at 0.1 lumen on a spot 1/2 in. diam with a tungsten filament lamp operated at 2870 K, at an anode voltage of 90 v dc, 1.0 megohm load resistor). Maximum operating temperature is 75 C. Projected cathode area is 4.68 sq in. Spectral response is S4. Maximum anode voltage is 90 v dc. Maximum dark current at 90 v dc, 25, is 0.05 μamp. The shadowless anode is 7-1/2 x 5/8 in.

Continental Electric Co., Dept. ED, Geneva, Ill.

CIRCLE 125 ON READER-SERVICE CARD FOR MORE INFORMATION

Trimmer Potentiometer

For Printed Circuit Use



Designed especially for printed circuit use, this miniature wirewound trimmer potentiometer features resistances from 100 to 40,000 ohms, resolutions ranging from 0.3 per cent to better than 0.1 per cent, power rating of 1 w at 40 C, and a metal case which can be potted or hermetically sealed. The wiper position is varied over the full resistance by a self-locking 40-turn screw adjustment. This unit is 3/4 x 3/4 x 5/16 in., weighs only 5 gr, and requires no mounting brackets.

Standard units have a resistance tolerance of 5 per cent and a temperature coefficient of 0.002 per cent per degree C. Maximum operating temperature is 120 C. Movable contact surfaces are of precious metal, and internal connections are welded to the terminal leads. The adjustment remains firmly held under conditions of severe vibration, shock, humidity, and temperature change. Special designs such as pin terminals or extended adjustment screw can be supplied.

Handley Electronics Inc., Sept. ED, 14758 Keswick St., Van Nuys, Calif.

CIRCLE 126 ON READER-SERVICE CARD FOR MORE INFORMATION

Universal Joints

Have Many Applications

These precision universal joints are available in three basic shaft sizes: 1/8, 3/16, and 1/4 in. They are made of stainless steel throughout and passivated to meet Military requirements.

The joints are valuable for a wide variety of coupling applications and operate at angles up to 30 deg, for most efficient operation they should operate at a maximum angle of 10 deg.

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

CIRCLE 130 ON READER-SERVICE CARD FOR MORE INFORMATION

Connectors

For Printed Circuits

Printed circuit connectors for 50, 70, and 93 ohm miniature coax assemblies are offered by this firm. The receptacles are available for circuit boards 1/16 to 3/16 in. thick. Receptacles are designed for regular Microdot mating plugs and provide efficient coaxial or shielded cable connections.

Microdot, Inc., Dept. ED, 1826 Fremont Ave., South Pasadena, Calif.

CIRCLE 131 ON READER-SERVICE CARD FOR MORE INFORMATION

Single-Channel Analyzer

Has Fast Window Amplifier

The N-601 Precision Single-Channel Analyzer is the latest P.R. Bell design, employing a fast window amplifier with 404-A tubes. For scintillation counter spectrometry, it has a base line range of 100 v with the window continuously adjustable 0-5 per cent in width. Linearity is better than 0.1 per cent. Window width constancy is 1 per cent of width for pulse amplitudes less than 80 v and pulse rise times greater than 0.1 sec. Window width stability is better than 0.2 per cent per day.

The N-601 is constructed for relay rack mounting or table top use.

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

CIRCLE 132 ON READER-SERVICE CARD FOR MORE INFORMATION

Teflon Contact Sockets

Press-Fit Units

These color-coded "Press-Fit" miniature contact sockets to take the popular 0.050 in. test probes have been added to this firm's line, making sockets available for three different probe sizes: 0.040, 0.050, and 0.080 in. The Teflon bushing or insulator body measures only 0.185 in. diam with 0.218 in. diam front face, permitting spacing as close as 1/4 in. between centers.

The contact receptacles are rugged and positive, and have beryllium-copper silver-plated-with-gold-flash contact members. Units are simply pressed into a chassis hole for a rigid, secure, permanent installation.

Sealectro Corp., Dept. ED, 186 Union Ave., New Rochelle, N.Y.

CIRCLE 135 ON READER-SERVICE CARD FOR MORE INFORMATION

Speed Determining System

For Genisco Accelerators

An accessory is available for accurately determining boom rotation speed of Genisco G-Accelerators, Models B78, C159, and D184. The G-Accelerators are used to subject electrical and mechanical components and assemblies to simulated acceleration forces, such as required by MIL-E5272, Procedure II.

The new rate-determining system consists of a toothed wheel and a magnetic pickoff which can be directly connected to any standard electronic counter with a set time base. Accuracy is dependent upon speed, the length of the measuring time interval, and upon the accuracy of the counter used. In general, the accuracy is ±1 least count. At 60 rpm, average speed over a 1 sec interval will be indicated to an accuracy of 1 part in 600, and over a 10 sec interval to 1 part in 6000, neglecting other errors in the counter.

The new system can be installed at time of purchase of the basic machine, or on machines now in the field.

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

CIRCLE 136 ON READER-SERVICE CARD FOR MORE INFORMATION

Data Logger
Electronic Design

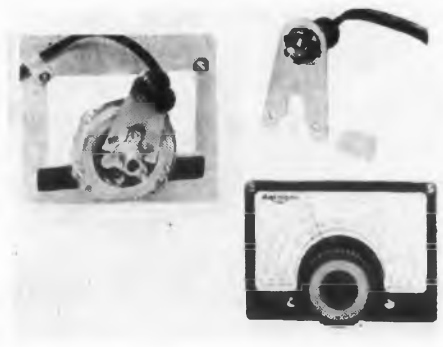
The Kybernetes Logger eliminates servos, mechanical digitalizers, binary conversion components and stepping switches. The design simplifies the overall system and enhances accuracy and reliability. Accuracy is guaranteed at 0.2 per cent for all inputs, including non-linear types, over extended periods of operation. Reliability is claimed because of the complete absence of mechanical operations except for the normal complement of high quality sealed relays which have an extreme life expectancy.

Hermetic sealing is incorporated throughout, providing Class I, Division 2 classification for operation in semi-hazardous areas. Analog-to-digital conversion is effected by sweep comparison circuits operating an electronic gate which passes discrete crystal oscillator counts to magnetic storage in decimal form.

The Kybernetes Corp., Dept. ED, 9 E. 40th St., New York 16, N.Y.

CIRCLE 140 ON READER-SERVICE CARD FOR MORE INFORMATION

Calibrating Dial
With Illuminator



The MCN dial, smallest of this firm's dials for individual calibration, now includes a dial illuminator kit as optional equipment. The illuminator is bracket-mounted to the output coupling so that the 6.3 v No. 51 panel light rotates behind the scale with the pointer over the dial face. Thus the pointer is constantly illuminated for easy, accurate reading. The illuminator unit mounts on the same pair of screws that hold the coupling to the dial.

The MCN dial features three blank calibrating scales and a 0.100 logging scale. Overall measurements of the dial with illuminator are 3-7/8 x 2-3/4 x 1-1/4 in. behind panel.

National Co., Dept. ED, 61 Sherman St., Malden 48, Mass.

CIRCLE 141 ON READER-SERVICE CARD FOR MORE INFORMATION

Converter

Operates X-Y Plotters

For operating X-Y plotters from digital inputs, this converter operates from a punched tape reader. It is designed to accept data from the output punched paper tape of the Electrodata Datatron Computer; however, it can be modified to operate with any other digital computer, or from a tape-actuated typewriter, such as a Flexowriter.

With this converter, programming need not be specified on the tape. A number of switches on the converter determine the words and digits to be plotted. This means that a particular tape can be run through the converter several times and a different plot obtained each time.

While the converter was designed for operation with the Librascope X-Y Plotter, it can be readily modified for use with similar plotters such as the Electronic Associates Variplotter. Normally, a seven column paper tape is provided for the converter; however, only four of these are actually used. The tape reader normally operates at 20 characters/sec. Maximum plotting speed approaches 40 points/minute. Accuracy is ±0.1 per cent.

Librascope, Inc., Dept. ED, Glendale 1, Calif.

CIRCLE 145 ON READER-SERVICE CARD FOR MORE INFORMATION

DC Motor

Weighs Only 12 oz

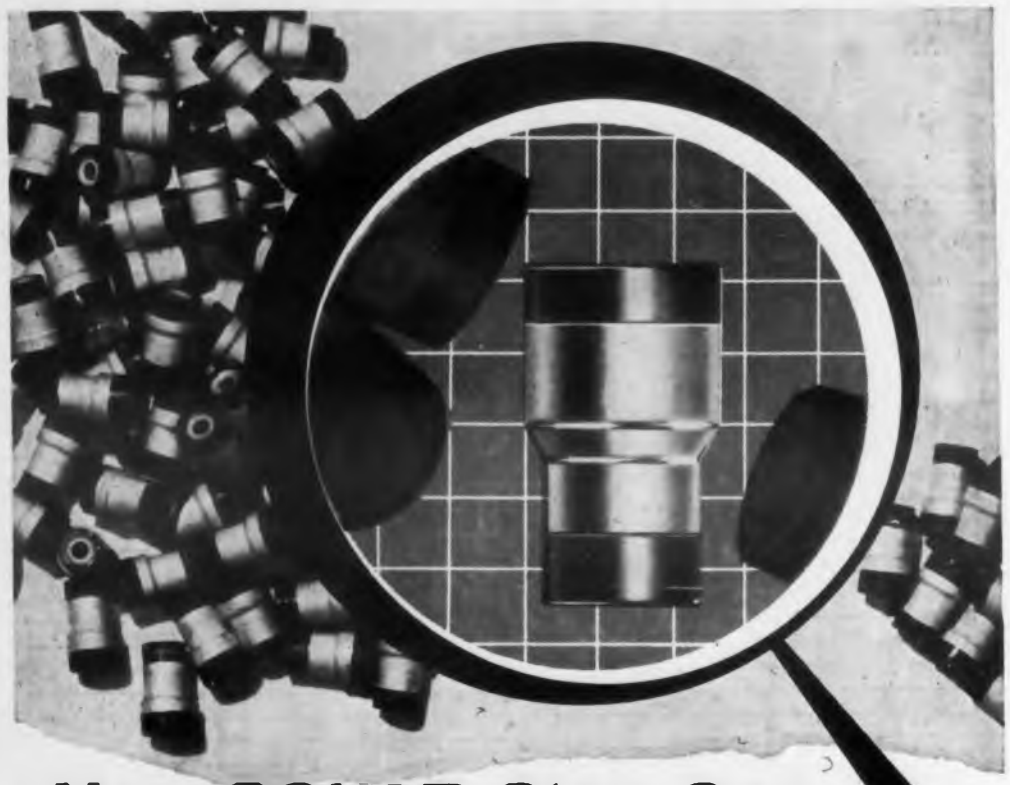
The Model 1700-3 is a dc fractional - hp planetary geared motor with clutch. Highly adaptable, the unit's lead configurations, shaft lengths, and shaft diameters are furnished to meet customer specifications. The motor is designed to meet or exceed all government environmental specifications.

Supply is 28 v dc, 1-3 amp (full load). Output is 150 oz-in. at 60 rpm, with clutch setting for slippage at 160 oz-in. Size is 4.025 in. long x 1.125 in. diam. Weight is 12 oz. Output speeds and clutch settings are adaptable to customer specifications.

The motor has an all-anodized aluminum case and all ball bearings which are permanently lubricated.

El Ray Motor Co., Inc., Dept. ED, 11747 Vose St., N. Hollywood, Calif.

CIRCLE 146 ON READER-SERVICE CARD FOR MORE INFORMATION



New SOLAR Step-Cap lead-thru capacitors speed assembly and cut costs

Cupped ends are silvered, for direct soldering.

Part numbers and/or coding furnished on request.

These units are the low-priced answer to lead-thru wiring. Soldering is direct to silver in each end. The ends are cupped, and serve as solder retainers, keeping solder from bridging the insulating gaps. Since center terminals are eliminated, the price is reduced.

Fast handling and mounting. The simple contour of Step-Caps permits their use in automatic parts feeders. Units won't tilt when mounted because each is self-centering. A "step-type" shoulder holds each unit at the proper distance above ground, and makes jigging unnecessary. Silver is bonded homogeneously to the ceramic body to permit quick soldering to chassis in multiple units.

Less space needed. The shoulder construction eliminates the need for eyelets. Hence these units can be mounted much closer together, leaving more room available on the chassis.

Immediate deliveries in unlimited quantities. SOLAR lead-thru Step-Caps are furnished in capacity ranges from 3 to 275 mmf @ ±10% and ±20% tolerances; from 276 to 1000 mmf @ GMV. Units are rated at 600 VDCW. Mounting hole: .193". Can be supplied with center lead as a feed-thru type. Write for samples and details, or send us your requirements.

"QUALITY ALWAYS"

SOLAR MANUFACTURING CORP.
New York, N. Y.

SALES OFFICES: 46th & Seville, Los Angeles 58, Calif.
4000 W. North Ave., Chicago 39, Ill.

SOLAR

CERAMIC CAPACITORS • PRINTED NETWORKS • PIEZO CERAMICS

CIRCLE 149 ON READER-SERVICE CARD FOR MORE INFORMATION

Flexible Coupling

For Minaturized Equipment

This miniature flexible coupling was developed especially for sub-fractional horsepower motors and other small units, such as used in coding devices, radar equipment, film and tape recorders, actuators, laboratory test equipment, aircraft components, etc. Rated at 1/20 hp at 1750 rpm, the full range is from 0.003 hp at 100 rpm to 0.103 hp at 3600 rpm. Dimensions are 5/8 in. OD x 3/4 in. overall length. Bore sizes are 1/8, 3/16, 1/4, and 5/8 in.

Bodies are standard in die cast aluminum, but can also be furnished in brass. Spiders are one piece and are made from a resilient Buna-N compound. The coupling never requires lubrication and is otherwise maintenance-free for the normal life of the equipment. There is no wear on the metal jaws, since the load is transmitted by cushion compression.

Lovejoy Flexible Coupling Co., Dept. EDN, 4801 W. Lake St., Chicago 44, Ill.

CIRCLE 150 ON READER-SERVICE CARD FOR MORE INFORMATION

Sweeping Oscillator

for VHF and Video

The "Ligna-Sweep" Model C is a laboratory quality, low-cost, all-electronic sweeping oscillator. It features variable center frequency and sweep with high output automatically held constant over frequency sweep and frequency band. Ranges are covered by six switched bands with a direct reading frequency dial.

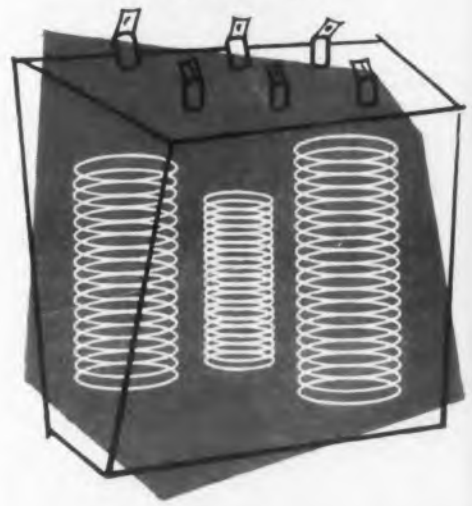
Specifications for vhf include: range 30-220 mc continuous, with fundamental frequency output of 1.0 v rms into 75 ohms. Sweep width is variable to at least 15 mc; 20 mc over vhf TV bands. There is a separate low if band.

For video, specifications include: range 100 kc to 12 mc with beat frequency output of 0.25 v rms into 75 ohms; sweep width is variable over the full range.

Kay Electric Co., Dept. ED, 14 Maple Ave., Pine Brook, N. J.

CIRCLE 151 ON READER-SERVICE CARD FOR MORE INFORMATION

WE KNOW SATURABLE REACTORS INSIDE OUT



Chicago Electronic engineers have led in research and development work on saturable reactors for eighteen years, resulting in the production of the most consistently accurate and closely controlled components available today.

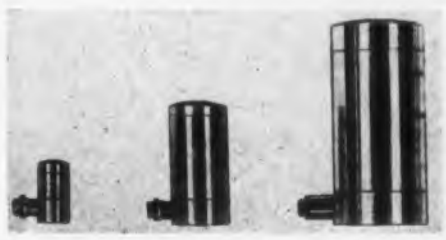
Chicago Electronic
ENGINEERING CO., INC.
3223 WEST ARMITAGE AVENUE
CHICAGO 47, ILLINOIS

INDUSTRIAL TRANSFORMERS • SATURABLE REACTORS • SELF-SATURATING TRANSFORMERS

CIRCLE 152 ON READER-SERVICE CARD

Accelerometers

For Vibration Measurement



Three accelerometers offered by this firm are stiffness controlled vibrating systems suited for making transient vibration measurements over a wide frequency range of operation. High order harmonic components of vibration are revealed with this equipment. Another important use is in making vibration measurements for noise reduction.

There is no phase shift between the applied vibration and the generated output voltage. These units are sensitive only to the vector component of the vibration lying along the axis of the unit. The sensitivity is independent of frequency over the entire frequency range of operation. For constant velocity of vibration the accelerometer output is directly proportional to frequency, and for constant displacement the accelerometer output is proportional to the square of the frequency.

Dynamic range of the three units is 0.001-2000 G, 0.001-1000 G, and 0.001-500 G, respectively; frequency range is 10-80,000 cps, 10-30,000 cps, and 10-15,000 cps; and weight is 1/6 oz, 1 oz, and 4 oz, respectively.

Massa Laboratories, Inc., Dept. ED, Hingham, Mass.

CIRCLE 155 ON READER-SERVICE CARD FOR MORE INFORMATION

Noise Sources

For Airborne Microwave Use

Already finding wide use for the calibration and test of radar, microwave equipment, and communications systems, these gas tube noise sources feature extreme compactness, the unit for the "S" Band being only 3-1/8 in. long, and units for higher frequencies correspondingly smaller. They pass all environmental mil specs for shock, humidity, vibration, and temperature cycling.

The units will provide an excess noise ratio of 18 ±0.5 db. They will fire and operate at conventional airborne power supply voltages. Operating effectively from 2.6-26 kMc, they require no warm-up time, and correction for ambient temperatures is unnecessary.

Roger White Electron Devices, Inc., Dept. ED, 96 4th Ave., Haskell, N.J.

CIRCLE 156 ON READER-SERVICE CARD FOR MORE INFORMATION

Computing Indicator

Permits Direct Readings

With the DY-2500, precise measurements of speed, rpm, pressure, thickness, and numerous other quantities can be read directly in desired units without time-consuming conversion calculations. The unit is an electronic counter with a variable gate time that functions as a multiplier of the transducer input to provide direct readings.

Features include a front panel plug-in board that automatically sets any predetermined conversion multiplier. Gate time may also be selected manually and is adjustable from 0.0001 to 0.9999 sec in 0.0001 sec increments. There is also provision for a second input to permit measuring ratios of two independent variables and direct readings of such quantities as engine revolutions per gallon.

A pushbutton on the front panel permits a quick check of proper operation. The DY-2500 is available in cabinet or standard rack mounting.

Dynac, Inc., (a subsidiary of Hewlett-Packard Co.) Dept. ED, 395 Page Mill Rd., Palo Alto, Calif.

CIRCLE 160 ON READER-SERVICE CARD FOR MORE INFORMATION

Vibration Shaker

For High Frequency Operation

The Model 177 Shaker is one of a new series of "wide-band" shakers specifically designed for higher frequency operation and lower input requirements. The vibrating armature behaves as a simple rigid body over an extended frequency range. The first resonance is at approximately 3000 cps (bare table).

Other features include: a force rating of 5000 lb vector, sine input, and 3450 lb rms, collinear table motion; table size of 12 in. square; 412 lb load for 10 g vector and 162 lb load for 20 g vector. The shaker has a maximum stroke of ± 0.5 in. with a recommended stroke of ± 0.25 in. for continuous duty. It weighs approximately 9500 lb. Field supply requirements are 715 kw at 250 v dc. When used with electronic amplifiers, a separate rotary MG set is supplied.

Calidyne Co., Dept. ED, Winchester, Mass.

CIRCLE 161 ON READER-SERVICE CARD FOR MORE INFORMATION

Generator

Of Pulse, Sweep, Time Delay

The Type 1391-A Pulse, Sweep, and Time-Delay Generator is a pulse source and measuring device designed to meet the diverse requirements of laboratories engaged in time-domain measurements. It produces pulses of medium power and good rise time over a wide range of durations and repetition rates, and it generates time delays and saw-tooth sweeps over comparably wide time intervals. Accuracy, reliability, and convenience are design features.

The time-delay generator has a calibrated range from 1 μsec to 1.1 sec, and the linear sweep generator produces saw-tooth waveforms ranging in duration from 3.0 μsec to 0.12 sec. The start and stop times of pulses, which are continuously adjustable in duration from 0.05 μsec to 0.1 sec, can be precisely set at any point along this sweep by amplitude comparators. The pulse repetition rate is set by an external generator, which may have almost any waveform.

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

CIRCLE 165 ON READER-SERVICE CARD FOR MORE INFORMATION

Relay

Has 5 Mw Sensitivity

Incorporating a complete wiping action with sensitivity as low as 5 mw per contact, the Type 100-D Relay has an operating life rated well into the millions. It is designed for dc applications. The wiping action also has the advantage of eliminating bounce and chatter at normal operating voltage.

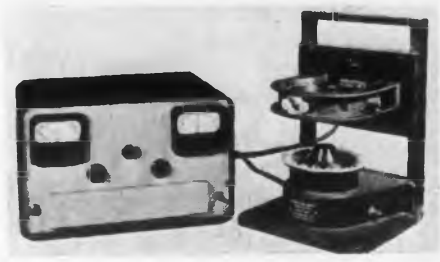
Capacity on the contacts is 1 amp inductive or 5 amp resistive. Available coil resistance is up to 30,000 ohms. Contact capacity is from spst to dpdt. Contacts are available in silver, palladium, gold alloy, or alloy variations of these. The relay comes either hermetically sealed, dust cover, or open. Headers are either plug-in, solder lug, fixed mounting, or variations according to customer's specifications. The unit has a diameter of 1-1/4 in. by approximately 3-1/4 in. above the mounting line.

Hedin Tele-Technical Corp., Dept. ED, 87 Dorsa Ave., Livingston, N.J.

CIRCLE 166 ON READER-SERVICE CARD FOR MORE INFORMATION

Rotor Balancer

Takes Speeds to 200,000 rpm



The Rotor Balancer is capable of rapidly balancing all types of rotors, including those of gyroscopes, motors, and turbines. It is equally suitable for laboratory and production line balancing; and it can also be used for the identification and measurement of vibration frequencies other than those arising from unbalance.

Rotors or rotor assemblies are mounted in fixtures which are in turn clamped in a split mounting ring. They can be driven by either internal or external means. Rotor vibrations arising from unbalance are picked up by two mechano-electronic transducers. An electronic computer unit computes the magnitude of the corrections required in any two correction planes selected.

Approximate maximum rotor dimensions are 5 in. diam x 8 in., with a weight of 20 lb. A continuous indication of speed is provided in two ranges, 0 to 20,000 rpm or 0 to 200,000 rpm. Sensitivity is 0.3 μin. full scale. Unbalance sensitivity varies with the total mass of the assembly being balanced.

M. Ten Bosch, Inc., Dept. ED, Pleasantville, N.Y.

CIRCLE 170 ON READER-SERVICE CARD FOR MORE INFORMATION

A-D Converters

Offered in Counter to 543,288

A series of three analog-to-digital converters is offered by this firm in a complete range of counts up to 543,298. These units are conservatively estimated to operate for 4 million revolutions, or better than 500 million counts at 200 rpm before cleaning is required. Featured on all converters are: number and complement available simultaneously, rapid readout, increasing count available in either direction, low torque and inertia, easy reading while shaft is in motion, dc or pulse input, unambiguous natural binary ouput, parallel readout, and high accuracy.

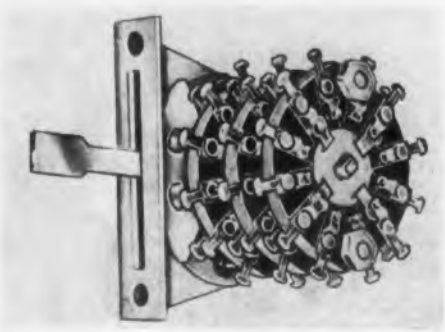
Sizes range from 1.750 in. diam x 2-19/32 in. long to 1.750 in. diam x 5-1/4 in. long, with weights from 3.7 oz to 10.2 oz.

Norden-Ketay Corp., Dept. ED, 99 Park Ave., New York, N.Y.

CIRCLE 171 ON READER-SERVICE CARD FOR MORE INFORMATION

Lever Switches

Available with Spring Return



These subminiature lever switches are available with and without a spring return that provides return to center from two positions. Designated Series L-7000 (without spring return) and SRL-7000 (with spring return), the switches are designed for use in miniaturized or transistorized test equipment, speech input systems, intercoms, remote control panels, and other electronic installations. Switches with 1, 2, or 3 decks and up to 4 poles per deck can be supplied.

Contact resistance is 0.006 ohms max. Dielectric strength is 1000 v rms. Insulation resistance is 100 megohms minimum. Current carrying capacity is 1 amp in a 120 v dc circuit, and 800 ma in a 115 v ac circuit, non-inductive. Current breaking capacity is 400 ma in a 50 v dc, 300 ma in an 80 v dc, and 250 ma in a 120 v dc circuit; and 200 ma in a 115 v ac circuit, non-inductive.

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

CIRCLE 175 ON READER-SERVICE CARD FOR MORE INFORMATION

Thermal Conductivity Cell

Makes Stable Measurements

This thermal conductivity cell, used for determining the thermal conductivity of gases, is based on a patented compensated thermopile principle. It is designed to permit highly accurate measurements without the instability and temperature effects of older resistance type instruments.

The cell incorporates six noble metal thermocouples, arranged in such a manner as to compensate not only for temperature changes in the gas, but also for rate of change of temperature effects. These elements are directly heated with ac and have an electrical output directly in terms of mv. The instrument is ideal for use in chemical analysis of gases and in detection of explosive gases and vapors. When used with gases of high thermal conductivity, such as helium, it can be used as a tracer.

Hastings-Raydist, Inc., Dept. ED, Hampton, Va.

CIRCLE 176 ON READER-SERVICE CARD FOR MORE INFORMATION

Signal Generator

For Audio Measurements

This signal generator and control system, made by Bruel & Kjaer, meets the varied requirements of a signal source for electrical, electro-acoustical, and acoustical measurements. It is a beat frequency oscillator designed for a wide range of audio frequency measurements with particular emphasis on facilities for automatic frequency scanning and chart recording of data.

Typical applications include all af response curve measurements; high frequency vibration testing; calibration measurements; automatic sound insulation testing; acoustical measurements; and automatic distortion measurements. The completely logarithmic frequency range from 20-20,000 cps can be swept continuously either manually or by means of an external drive. Other features include remote control facilities, an output control system to permit external signal feedback, and automatic frequency markers.

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

CIRCLE 181 ON READER-SERVICE CARD FOR MORE INFORMATION

Resistance Bridge

5 Ohms to 100 Megohms

The Model 605 Resistance Bridge provides a means for rapidly and easily checking resistances to an accuracy of ±0.15% + 0.05% full scale. Seven ranges from 100 ohms to 100 megohms full scale are selectable by front panel pushbutton switches. The lowest measurable resistance is 5 ohms.

For operation, the unknown resistance is connected to the appropriate terminals, the range switch set, a key depressed, and a Helipot precision potentiometer turned to obtain a null indication on the large 4 in. zero center galvanometer. The value of the unknown is then read directly from the Helipot dial setting and multiplied by the appropriate factor of 10.

Shasta Div., Beckman Instruments, Inc., Dept. ED, P. O. Box 296, Station A, Richmond, Calif.

CIRCLE 182 ON READER-SERVICE CARD FOR MORE INFORMATION

Colorimeter

Provides Close Color Control

To provide for color difference determination in temperature-sensitive materials and to make accurate color measurement possible in dusty atmospheres, a new cooling system and air filter have been added to the Model C "Color-Eye." The Model C is a colorimeter designed for control of industrial colors in raw materials and in finished products. It performs the dual functions of an abridged spectrophotometer and a tri-stimulus colorphotometer in analyzing color formulations, determining metameric conditions, and quickly measuring color differences in hue, value, and chroma.

The new cooling system reduces the temperature rise at sample ports and maintains it at a point where rapid analysis of colors on temperature-sensitive materials is possible. The replacement-type filter removes dust from the incoming air to prevent dirt deposition from decreasing the sensitivity of the optics.

Instrument Development Laboratories, Inc., Dept. ED, 67 Mechanic St., Attleboro, Mass.

CIRCLE 188 ON READER-SERVICE CARD FOR MORE INFORMATION

Portable Calibrator

DC Voltage Current Source

Designed for full protection on all meter ranges, the Model 151 Calibrator has better than 1% accuracy. All voltages and current ranges are balanced to allow a smooth adjustment on each range without danger of excessive overshoot. No warm-up period is required. The unit is especially valuable in ensuring that equipment meets such specs as MIL-Q-5923B.

The calibrator has seven voltage ranges from 50 mv to 500 v dc. There are eight current ranges from 100 μamp to 1 amp. The two highest current ranges (500 ma and 1 amp) are the only ones not available over all voltage ranges, but are available up to 1 v levels.

Thomas L. Stevens Co., Dept. ED, 5333 S. Sepulveda Blvd., Culver City, Calif.

CIRCLE 189 ON READER-SERVICE CARD FOR MORE INFORMATION

Chassis Slide

Simplifies Mounting Problems

This "Easy-Mount" chassis slide assembly (Model CTEM) simplifies mounting of electronic equipment in cabinets or racks. Bolting of the slide to the rear of the cabinet has been eliminated in this construction. The unit has a built-in crossbar which provides the necessary rear chassis support and also serves to prealign the slides without adjustments. Installation requires only a screwdriver. The chassis is simply set into the cradle after the slide assembly has been attached to the front rails of the cabinet. The complete installation job takes about five minutes.

Chasses slide in and out freely and tilt back to provide full access to wiring sections. The slide supports up to 125 lb while fully extended. It fits any standard 19 in. cabinet or rack. Cradle bars across the front and rear permit mounting of any size chassis up to 17 in. wide.

Chassis-Trak Corp., Dept. ED, 525 S. Webster St., Indianapolis, Ind.

CIRCLE 194 ON READER-SERVICE CARD FOR MORE INFORMATION

Adiabatic Temperature Probe

For Airstream Measurements

An extremely accurate adiabatic temperature probe measures airstream stagnation temperatures in aircraft and missile applications. Designated Model 49127, either of two fast response temperature elements provide a voltage or resistance output proportional to airstream stagnation temperature.

These instruments offer a recovery factor of 0.985 with a response time of 0.25 sec or less, and repeatability within 0.5 per cent. Instrument housings are constructed of stainless steel with all exposed surfaces highly polished to minimize emissivity and reduce aerodynamic friction. Excellent aerodynamic configuration helps to provide superior performance over the wide velocity range of Mach 0.3 through 2.0, at altitudes as high as 60,000 ft.

G. M. Giannini & Co., Dept. ED, 918 E. Green St., Pasadena 1, Calif.

CIRCLE 195 ON READER-SERVICE CARD FOR MORE INFORMATION

thinking of resistors? think of SPEER

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It will give you helpful information about the complete line of Speer Resistor Products–specifications, characteristics and applications:

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CIRCLE 198 ON READER-SERVICE CARD

Single Sideband Converter

Self-Contained

The Model 67A Single Sideband Converter may be used for any of the normal receptions of a communications receiver. It offers single sideband reception by the use of a mechanical filter and product detector with front panel switch selection of upper and lower sideband reception without retuning.

The filter has sharp cut-off characteristics and provides excellent sideband rejection and channel selectivity. The product detector is valuable for exalted-carrier, single-sideband, double-sideband, phase-modulation, or CW reception.

Self-contained with power supply for rack mounting, the converter may be connected to any receiver with an if frequency between 440 and 510 kc.

Crosby Laboratories, Inc., Dept. ED, P.O. Box 233, Robbins Ln., Hicksville, N.Y.

CIRCLE 199 ON READER-SERVICE CARD FOR MORE INFORMATION

Pulse Packages

Radar Systems

These packages are pre-engineered and pre-assembled radar transmitter components, which, when installed in their systems, furnish outputs guaranteed to meet reasonable performance requirements of any specific radar system employing a hydrogen thyratron tube. They are the main determinants of the transmitted-pulse parameters of a radar system. Two types of packages are available.

The "High Power Pulse Package" is built around the charging choke, pulse-forming network, and pulse transformer of the line-type modulator. Designed to individual pulse requirements, it is possible to obtain the optimum required pulse shape with a minimum of development work.

The "Trigger-Pulse Package" contains components schematically similar to those above, but is designed specifically to generate pulses of the required power and impedance to trigger any high-power hydrogen thyratron tube.

Filtron Co., Inc., Dept. ED, Flushing, L.I., N.Y.

CIRCLE 200 ON READER-SERVICE CARD FOR MORE INFORMATION

Kearfott FERRITE MICROWAVE COMPONENTS

KEARFOTT FERRITE DUPLEXERS

Improvements in recovery time, reduction in insertion loss and excellent magnetron isolation are performance benefits offered by Kearfott Ferrite Duplexers – designed to meet specific radar space requirements.

A Faraday rotation type unit is illustrated. A type and configuration is available for your requirements.

KEARFOTT FERRITE ISOLATORS

For superior performance KEARFOTT ISOLATORS *custom* designed to fit the exact combination of characteristics, available space and configuration for *your* radar system. For high or low power – for broad or narrow band use and with db ratios of isolation to insertion up to 150 to 1.

FARADAY ROTATION ISOLATOR

DIFFERENTIAL ABSORBER ISOLATOR

DIFFERENTIAL PHASE SHIFT ISOLATOR

Kearfott offers 3 types of Ferrite Isolators to assure the optimum performance of all microwave applications.

KEARFOTT FERRITE ATTENUATORS AND SWITCHES

Ferrites offer new circuit possibilities and product improvement for AGC and electronic switching of R.F. energy. Kearfott designs, precisely tailored to your most exacting requirements, assure maximum performance and reliability with minimum weight.

The 30 db variable attenuator illustrated, requires less than 3 watts control power.

Write for information on multi-purpose R.F. Test Sets. Available from stock — for X-Band, Ku Band and C Band

Kearfott's complete Microwave engineering and fabrication facilities are at your command. Inquiries on your Microwave problems will be treated in confidence.

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CIRCLE 201 ON READER-SERVICE CARD FOR MORE INFORMATION

New Miniature Tubes

For B & W, Color TV

Four new 9-pin miniature tubes, for use in both black and white, and color television receivers, have been announced. The 5CL8 and 5CM8 are 600 ma series-string types and the 6CL8 and 6CM8 are their 450 ma counterparts.

The 5CL8 and 6CL8 are 9-pin miniature triode-tetrodes, intended for service as oscillator mixers in VHF tuners. Each tube's section has its own cathode, provided for increased circuit design flexibility.

5CM8 and 6CM8 are high mu triodes, sharp-cutoff pentodes, featuring high transconductance, sharp-cutoff and low number one grid to plate capacity, and they may be used for service as if, video or age amplifiers, as well as reactance tubes. With the comparatively low grid to plate capacity, 5CM8 and 6CM8 pentode sections are desirable for narrow band, high gain amplification into a relatively high impedance load.

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

CIRCLE 203 ON READER-SERVICE CARD

Coaxial Transmission Line

For High Power Applications

This is a new 9" rigid coaxial transmission line for very high power application at frequencies up to 550 mc. The line is capable of handling average powers of 300 kw at 150 mc, and peak power of 3 mw. It has a 50 ohm characteristic impedance, and attenuation of 0.042 dm/100 feet at 150 mc.

This line comes in 20 ft sections and features a new quick-assembly flange using only one bolt, instead of the many bolts required by conventional flanges. A complete complement of elbows, gas barriers, adaptors, power dividers, tuners, slotted lines, hangers, and other associated equipment have been designed and are available for prompt delivery.

Andrew Corp., Dept. ED, 363 E. 75th St., Chicago, Ill.

CIRCLE 204 ON READER-SERVICE CARD

CIRCLE 205 ON READER-SERVICE CARD

Socket and Tube Holder

Of One-Piece Construction

The one-piece Socket and Tube Holder, an adaptation of this firm's standard subminiature tube holder, has an extra support for holding the socket in the same firm grip as the tube itself. The holder combines mounting ease with ability to withstand severe shock and vibration conditions while still affording adequate heat dissipation.

It will grip the standard Eby and Cinch button or press type subminiature tube sockets and the T-3 or T 2x3 subminiature tubes. It is made of SAE 1065 carbon steel formed in the annealed state, cadmium plated, per QQ-P-416 Class B Type II iridite No. 8, to withstand 50 hr salt spray tests. The construction greatly reduces the possibility of vibration and shock differentiations between tube and socket.

Atlas E-E Corp., Dept. ED, Bedford Airport, Bedford, Mass.

CIRCLE 207 ON READER-SERVICE CARD

TV Transformers

Potted in Heat Conductor

A heat conducting compound, developed by this company, has improved and reduced the cost of their transformers. The losses, involved in converting electrical energy in a transformer, appear as heat; the temperature rise of the transformer windings, caused by this heat, is a limiting factor in transformer design and application. A typical TV power transformer of conventional construction may have a difference in temperature from the inner windings to the outer surface of 20 to 25 C when measured according to standards of the RETMA. When the transformer is potted with the new Foster compound, this difference is reduced to about 10 to 15 C. Thus, the heat is moved from the inner windings to the outer surface, where it can be dissipated by air circulation.

A variety of sizes of transformers using the potting compound is available.

Foster Transformer Co., Dept. ED, Cincinnati, Ohio.

CIRCLE 208 ON READER-SERVICE CARD

CIRCLE 209 ON READER-SERVICE CARD ➤

Temperature Indicator

0.8 Sec Full-Scale Response

Already used in aircraft from jet fighters to transports, this rugged null-balance temperature indication system features 1/3 per cent accuracy and 0.8 sec full-scale response. The 2-1/4 in. diam indicator houses a 13 in. moving vertical scale readable to one degree and excellent for photo-panel work. Standard scale ranges are —100 to 600 F for iron-constantan and 300 to 900 C for chromel-alumel thermocouples. Input power is 45 va at 115 v 400 cps.

Thermocouples can be grounded and long extension leads used. The high-gain amplifier provides threshold sensitivity of 15 μv, with zero, span, and damping adjustments. Internal reference voltage is supplied by a long-life mercury cell. The indicator is thermetically sealed, and the system operates in ambient temperatures from —65 to 160 F and altitudes to 60,000 ft. Indicator size is 2-1/4 in. diam x 9 in. long; the control unit, 3-1/4 x 3-1/2 x 7 in. Other scale ranges can be supplied.

Handley Electronics, Inc., Dept. ED, 14758 Keswick St., Van Nuys, Calif.

CIRCLE 212 ON READER-SERVICE CARD FOR MORE INFORMATION

Speed Changer

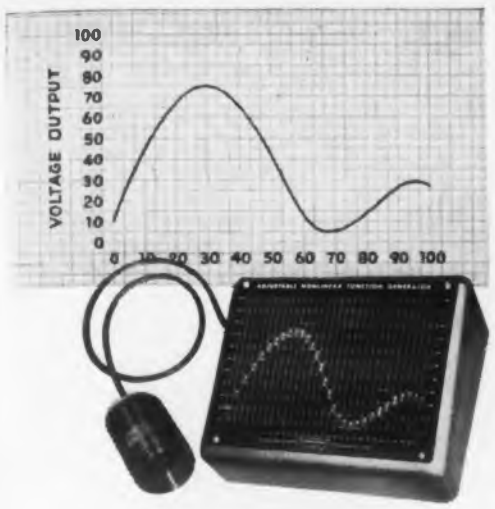
Lightweight Unit

This adjustable ratio speed changer has anodized aluminum end bells with two pressed-fit ball bearings for each shaft, resulting in high concentricity and extremely smooth operation. Metal construction gives high resistance to impact and vibration. Increased stability over a wide temperature range is obtained because of close correspondence of coefficients.

This small 6 oz unit delivers 0.025 hp and 5-40 oz-in. of torque, depending upon the ratio setting. Speeds up to 10,000 rpm on either shaft are permissible. The ratio of input to output speed is infinitely adjustable between 1:5 up and 5:1 down, a total range of 25 to 1. A dial pointer indicates the ratio. Six different speed controls are available: thumb screw (shown), push rod, lever arm, spur gear, miter gear, or worm gear.

Metron Instrument Co., Dept. ED, 432 Lincoln St., Denver 3, Colo.

CIRCLE 213 ON READER-SERVICE CARD FOR MORE INFORMATION



Now from **VERNISTAT** Adjustable Non-Linear Function Generator

Introduces any non-linear function related to shaft rotation into a system — quickly and easily.

Here's a new variation of the famous P-E VERNISTAT* precision potentiometer. The new idea is that the curve of output voltage versus shaft rotation is immediately adjustable by a printed circuit switch to help you introduce non-linear functions into systems. Any mathematical or empirical function including those with multiple slope reversals can be generated.

The switch is arranged in the form of a graphic panel to give a visual presentation of the output. Shaft rotation is represented by the x-axis, voltage output by the y-axis. **Trademark*

PHYSICAL CHARACTERISTICS:

- 100-transformer taps connected to 31-pole, 100-position printed circuit switch.
- any pole can be switched to any tap.
- size: 6¼" x 7⅞" x 2⅞".

ELECTRICAL CHARACTERISTICS:

- potential at each pole adjustable to ± 0.5% of applied voltage.
- minimum slope of voltage output curve: zero.
- maximum voltage between adjacent poles: 12 volts.
- frequency rating: 400 or 60 cps @ 130 volts depending on model. (frequencies below 60 cps, input voltage reduced).
- with variations can be operated to 10,000 cps.
- output impedance: 130 ohms maximum.

For more information on this adjustable non-linear function generator, write to:

vernistat®
division
PERKIN-ELMER CORPORATION
Norwalk, Connecticut

CIRCLE 216 ON READER-SERVICE CARD

Count Rate Meter

Line-Operated

Model A-116 "Monitor" Count Rate Meter is a line-operated unit designed for quantitative radioactivity measurements. An integrating rate meter, it provides instantaneous audible and visual indications of the counting rate of radioactivity detected by the probe-type detector heads. Its stabilized high voltage supply permits use with Geiger counters, as well as with scintillation and proportional counters having built-in cathode follower or preamplifier circuits.

Five different counting ranges, up to 50,000 cpm full scale, are readily available, with a choice of time constants to give a 2, 5, or 15 per cent statistical accuracy on each range. Provision is made for attaching a 1 ma strip chart recorder, or radiation level alarm. For most applications either a beta-gamma Geiger counter, or end-window alpha-beta-gamma Geiger counter is used.

Atomlab, Inc., Dept. ED, 489 Fifth Ave., New York 17, N.Y.

CIRCLE 217 ON READER-SERVICE CARD FOR MORE INFORMATION

Vacuum Gage

Offers Extended Range

The PHG-27 is a single-station, discharge - type vacuum gage which gives continuous pressure readings over an extended range from 25 microns to 1 x 10^{-7} mm Hg. It measures the total pressure of condensable vapors and permanent gases on three scales: 25 microns to 1 x 10^{-4} mm Hg; 1 x 10^{-4} to 1 x 10^{-5} mm Hg; and 1 x 10^{-5} to 1 x 10^{-7} mm Hg. Automatic voltage regulation is incorporated for more accurate pressure indication and easier operation. Terminals are provided to permit driving a potentiometer-type recorder.

The PHG-27 is 6-1/2 x 11 x 6 in. deep and weighs 12 lb. Operable on 115 v power, it is readily adaptable to 230 v.

Consolidated Electrodynamics Corp., Rochester Div., Dept. ED, 1775 Mount Read Blvd., Rochester 3, N.Y.

CIRCLE 218 ON READER-SERVICE CARD FOR MORE INFORMATION

WE PHONE . . . . . WRITE . . . . . OR VISIT

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.

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

Safeway HEAT ELEMENTS INC.

680 NEWFIELD STREET • MIDDLETOWN, CONNECTICUT

CIRCLE 219 ON READER-SERVICE CARD FOR MORE INFORMATION

Use 'dag' Colloidal Graphite in CRT manufacture because . . .

1. A uniform, conductive film produced by a dispersion of colloidal graphite in de-ionized water on inside walls functions as a ray-focusing anode, retards secondary emission, absorbs gases.

2. A special **'dag'** dispersion in lacquer used on outside walls dries in 2-3 minutes, forms an electrically-conductive graphite film which is opaque and tenacious.

3. **'dag'** Colloidal Graphite produces films which adhere equally well to all types of glass.

Other ways in which **'dag'** dispersions are used in electrical and electronic applications are described in a free bulletin. Ask for Bulletin 433-K-10.

dag DISPERSIONS

'dag' is a registered trademark of Acheson Industries, Inc.

ACHESON COLLOIDS COMPANY

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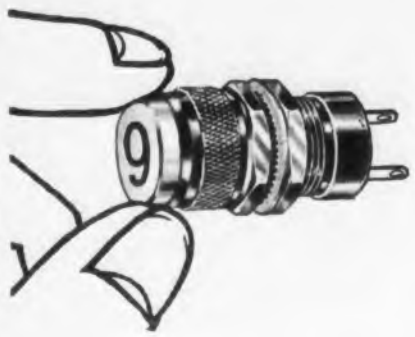
CIRCLE 221 ON READER-SERVICE CARD FOR MORE INFORMATION

Miniature Lights

Rotatable Lens



These compact indicator lights (approx. 1-1/4 x 9/16 in. overall) are ideally suited where lighted "messages" are required.

In this series of Dialco lights (No. 134-3830-375), a figure, letter, or word is hot-stamped into the flat face of the translucent plastic lens. Since the light bulb is just below the surface of the lens, a bright and even distribution of the light is the result. The debossed legends are filled in for sharp contrast.

The newly designed spring-mounted lens assembly is made to rotate smoothly so as to enable positioning *after* the entire pilot light is screwed into place. In this way the hot-stamped legend is brought into perfect alignment with a minimum of effort.

The lens assembly unscrews from the front of panel for easy replacement of the lamp.

Dialight Corp., Dept. ED, 60 Stewart Ave., Brooklyn 37, N. Y.

CIRCLE 222 ON READER-SERVICE CARD FOR MORE INFORMATION

Laboratory Standard

Highly Shielded

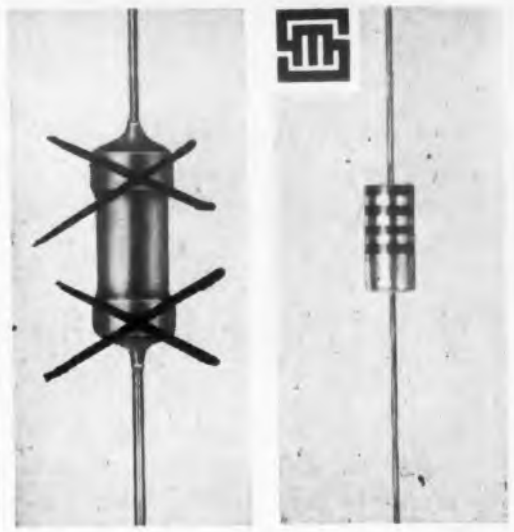
The Model 235 DC Laboratory Standard (0.1 per cent) replaces the previous Model 5. It incorporates the "Cormag" self-shielded mechanism. In addition, a far greater degree of shielding than that inherent in the basic core magnet design is provided by including a special shield around the entire mechanism.

Tests show that there is no measurable error in a 5 oersted field, thus making it unnecessary to position or mount the instrument with relation to the earth's magnetic field, or to take special precautions in the presence of current carrying conductors. In addition, the Model 325 is effectively compensated for normal room temperatures, and it has a vernier type corrector for rapid and precise zero adjustment.

Weston Electrical Instrument Corp., Dept. ED, Newark 5, N.J.

CIRCLE 223 ON READER-SERVICE CARD FOR MORE INFORMATION

STEMAG PRESENTS THE FIRST CAPLESS* FILM RESISTOR



1 w Regular Carbon Film Resistor with end caps.

1 w patented STEMAG Film Resistor without end caps.

Now you can obtain *long life stability* of carbon film resistors with *small size* and *low price* of carbon composition types. Available in the same wattage ratings, dimensions, tolerances and color code as carbon composition type resistors.

NOTE THESE FEATURES:

- **Derating:** 75° C. (½ w type)
- **Load-Life Test:** MIL-R-11A max. change 1.3%
- **TC:** 200 to 400 PPM per °C
- **Lead Connection:** Direct *capless* contact inside resistor body
- **Noise Level:** Extremely low. No noise generating end caps
- **Tolerances:** ± 5 % and ±10%
- **Sizes:** ½, 1, 2 watt

*U. S. Pat. 2658980

For complete specifications and test data write to:

Arnhold **ARNHOLD CERAMICS, INC.**

1 East 57th St., New York 22, N. Y.

CIRCLE 224 ON READER-SERVICE CARD

Degaussers

For Telemetering and Recording

Two lightweight degaussers, the "5000" and the "2400", are offered for telemetering and sound recording. The standard-sized "5000" Eraser (illustrated) handles reels up to 16 in. diam and erases recorded data or sound from 1/4 in. tape, or 35 mm, 17-1/2 mm, or 16 mm magnetic film recording media. It weighs only 33 lb and measures 3-3/4 x 6 x 15 in. It requires 2000 w of 115 v, either 50 or 60 cps, and can also be supplied for 220 v operation.

The other degausser is a miniature erasing unit. The "2400" is for use with reels of film or tape up to a maximum of 9 in. diam. It weighs only 16 lb and measures 3-3/4 x 6 x 9-1/2 in. One of the smallest bulk sound-erasing units marketed, it has a 1000 w power consumption and accomplishes complete erasure within a few seconds.

Kinevox Div., Electromation Co., Dept. ED, 116 S. Hollywood Way, Burbank, Calif.

CIRCLE 227 ON READER-SERVICE CARD FOR MORE INFORMATION

Screw Products

Offered in Micro Sizes

Micro sizes, from No. 0 through No. 3, have been added to this firm's heat-treated alloy steel line of socket cap and set screws, completing a standard range of socket cap sizes up to 3-1/2 in. diam and of socket sets up to 1-1/4 in. In addition to cup points, cone, oval, half-dog, and flat points are now available.

The firm is also marketing a line of socket head shoulder screws of heat-treated alloy steel in standard diameter sizes from 1/4 to 3/4 in., and tight-seal pressure plugs in standard pipe sizes from 1/16 to 1-1/4 in. Another product is precision-ground dowel pins in standard and oversize diameters from 1/8 through 1 in.

A line of 18-8 stainless-steel non-heat-treated non-magnetic socket cap screws and socket set screws has also been put on the market.

Cleveland Cap Screw Co., Dept. ED, Cleveland, Ohio.

CIRCLE 228 ON READER-SERVICE CARD FOR MORE INFORMATION

DC Power Supplies

7 in. High Panel Units

Rack model regulated dc power supplies offered by this firm feature germanium rectifiers and a panel height of only 7 in. Models rated at 800 ma are available for the ranges of 125-325 v and 325-525 v dc.

The supplies have fuse failure indicators and oil-filled hermetically-sealed transformers and chokes. Internal impedance is less than 1.5 ohms. Ac output, 6.5 v (unregulated) is 20 amp. Rated for 24-hour continuous duty, the models feature transient-free operation, a stable 5651 voltage reference tube, and harness wiring. Line regulation is better than 0.15 per cent or 0.3 v (whichever is greater) for 105-125 v ac. Load regulation is better than 0.25 per cent v for 0 to full load. Size is 7 x 19 x 14-3/8 in. deep. Weight is 75 lb.

Lambda Electronics Corp., Dept. ED, 11-11 131st St., College Point 56, N.Y.

CIRCLE 232 ON READER-SERVICE CARD FOR MORE INFORMATION

DC Microvolt-Ammeter

Also Used as Amplifier

The Model 203R is a rack-mountable unit. It permits accurate current measurements from 10 μμamp to 100 ma and voltage measurements from 10 μv to 1000 v, with an input impedance of 100 megohms and an output impedance of 2 ohms. The impedance accuracy is ± 1.5 per cent. The unit may also be used as a low drift dc amplifier with 80 db gain.

High input impedance and stability are assured by a feedback arrangement which provides up to 84 db of overall feedback. A zero-center meter indicate polarity on two mirrored scales which cover all of the 10 current and 15 voltage ranges.

The 203R is useful as a recorder driver where the recorder does not have the required high input impedance or sensitivity. The wide range also makes it valuable as a general purpose laboratory dc microvolt-ammeter.

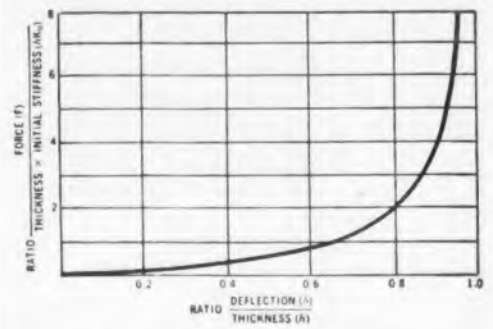
Kay Lab, 5725 Kearney Villa Rd., San Diego 11, Calif.

CIRCLE 233 ON READER-SERVICE CARD FOR MORE INFORMATION

How to Design for Isolation during Sustained Acceleration

It is becoming increasingly important that vibration isolators continue to provide isolation during sustained acceleration. This is a requirement in some classes of guided missiles. If the force-deflection characteristic of the isolator is linear, it is easy to calculate the required deflection by multiplying the static deflection of the isolator under the deadweight load by the sustained acceleration expressed as a dimensionless multiple of the gravitational acceleration.

Unless it has clearances at least equal to this calculated deflection, the isolator bottoms during the sustained acceleration, and provides no vibration isolation. One way to alleviate this effect is to use an isolator having non-linear force deflection characteristics, as shown by this dimensionless curve and defined by the equation



$$\frac{\delta}{h} = \frac{2}{\pi}\tan^{-1}\left[15.37\left(\frac{\ddot{x}_s}{f_0^2 h}\right)\right]$$

where δ is the deflection of the isolator under the sustained acceleration $\ddot{x}_s$, is the natural frequency under normal deadweight load, and h is the "effective thickness" of the load-carrying spring.

When sustained acceleration increases the static force on the isolator, deflection increases, but less than if the stiffness of the isolator were linear. This increase in deflection is accompanied by an increase in stiffness; i.e., by an increase in the slope of the force-deflection curve. The effective natural frequency is thus increased because there is no increase in mass, and the transmissibility increases.

To simplify the evaluation of changes in transmissibility, we have prepared a nomograph and set of curves for graphic solution of this problem. Write for your free copy of these useful design data — Bulletin #THO-5.

From "Natural Frequency of a Nonlinear System Subjected to a Nonmassive Load", Transactions ASME, January, 1954.

Proximity Systems

Detect Metal Objects

The 4950 Series of high-frequency carrier - operated proximity transducer systems is capable of detecting the presence of metal objects at twice the maximum range of this firm's 4900 system.

Metal objects can be sensed up to 3/4 in. away through such non-metallic substances as plastic, paper, pasteboard, or wood, at rates up to 1000 units/sec. Two systems, 4950-B and 4950-RB, are available. Both operate on 115 v ac input and feature a sensitivity control which adjusts to desired operating ranges and compensates for surrounding temperature changes. The "B" system is used primarily with electronic equipment; the "RB" contains a spdt mercury relay for controlling various kinds of electrical machinery.

Electro Products Laboratories, Dept. ED, 4500 N. Ravenswood Ave., Chicago 40, Ill.

CIRCLE 237 ON READER-SERVICE CARD FOR MORE INFORMATION

Tube Shield

Cuts Power Tube Temperatures

This heat-dissipating tube shield is designed for 826, 829B, 3E29, or other tubes of the same outline dimensions. Thorough testing to date indicates bulb temperature reduction of tubes operating at high plate dissipations to be as much as 100 to 150 C. Extensively improved mechanical support and retention of tubes against shock and vibration conditions, plus excellent electrostatic shielding, are provided. The shield is the largest in a series of over 200 different types of heat-dissipating tube shields for power, octal, miniature, and subminiature tubes.

International Electronic Research Corp., Dept. ED, 145 W. Magnolia Blvd., Burbank, Calif.

CIRCLE 238 ON READER-SERVICE CARD FOR MORE INFORMATION

Ferrite Isolator

For Airborne Microwave Use

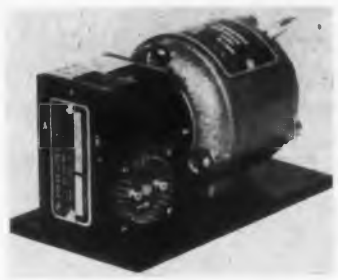
A Faraday rotation type ferrite isolator for airborne microwave applications, the Model W 152-2A weighs only 6 oz. It will handle 100 kw of peak power and give 25 db of isolation with an insertion loss of less than 0.25 over a 200-300 Mc bandwidth in the 8-12 kmc band. This new unit is one of a family of isolators available for the microwave, radar, and communication fields.

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

CIRCLE 242 ON READER-SERVICE CARD FOR MORE INFORMATION

Sampling Switch

For Many Applications



For telemetering, display systems, and programming, the Type AA Switch features two poles with 24, 30, or 32 contacts per pole and sampling rates up to 6 rps. Special construction allows manual phasing of both poles through 360 deg. Both poles may be manually phased during operation.

The switch will operate efficiently up to 175 F and under a wide range of shock and vibration conditions. It weighs only 26 oz, including the 115 v 60 cps motor.

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

CIRCLE 243 ON READER-SERVICE CARD FOR MORE INFORMATION

Transistor Tester

Available Wired or as Kit

Designated the TT-2, this precision tester is available as a kit or in wired and tested form. It features a 4-5/8 in., 2 per cent meter, and 1 per cent components. Ranges include current gain beta 0-100 and 0-300, and expanded alpha scale 0.50-0.99, and leak I_{bo}.

The unit measures pnp and npn transistors and crystal diodes. It is self-contained, self-calibrating, and operates on flashlight batteries. The panel is punched, lettered, and finished.

Kit-Tronics, Dept. ED, 2315 Hendola Dr., N. E. Albuquerque, N.M.

CIRCLE 244 ON READER-SERVICE CARD FOR MORE INFORMATION

Ceramic Terminal

Strong Metal Bond

A new metal-bonded alumina terminal for soft-soldered assemblies provides a bond-strength stronger than the materials involved, with excellent high-temperature ceramic-to-metal adherence.

The metal-bonded technique used is an ordinary intimate bonding of ceramic and metal. The bond remains hermetically tight well beyond the temperature limits of soft solder, keeping assembly processes simple and dependable.

Carborundum Co., Stupakoff Div., Dept. ED, Latrobe, Pa.

CIRCLE 247 ON READER-SERVICE CARD FOR MORE INFORMATION

High Q Coils

For Low Frequency Application

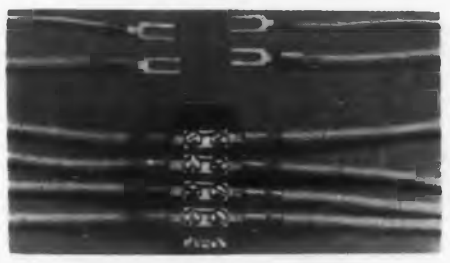
These coils employ special laminated Hipermalloy structures to provide extremely high Q and stability for low frequency (10-400 cps) applications. Laboratory adjusted to 2% accuracy at 1 v 60 cps, stability is such that inductance change is less than 1% for a 10 times voltage change. Total inductance change is less than 3.5% from the extremes of −55 to +85 C.

United Transformer Co., Dept. ED, 150 Varick St., New York 13, N.Y.

CIRCLE 248 ON READER-SERVICE CARD FOR MORE INFORMATION

Connectors

For Terminal Blocks



This line of fork-tongued terminal connectors, with vibration-resistant multi-fingered insulation grips, is designed specifically for terminal blocks. For No. 22 through No. 8 cable, the connectors are crimped to the conductor with standard Burndy handtools, and attached to the terminal block with a screwdriver.

Omaton Div., Burndy Engineering Co., Dept. ED, Norwalk, Conn.

CIRCLE 249 ON READER-SERVICE CARD FOR MORE INFORMATION

Transistor Checker

Check PNP and NPN Types

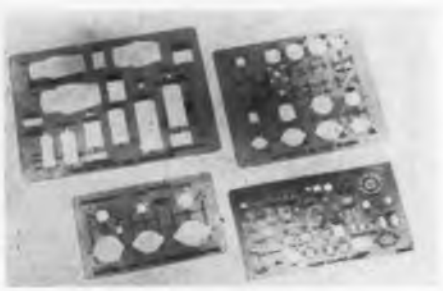
This transistor checker, Model 210, is available for both civilian and military electronics. Housed in a rugged, molded bakelite case, this economical unit checks all pnp and npn transistors, measures gain in three ranges, and measures leakage on a two-color "Poor-Good" scale. It also checks crystal diodes. It is supplied complete with batteries. It is available wired and tested or in kit form.

Electronic Measurements Corp., Dept. ED, 280 Lafayette St., N.Y.

CIRCLE 253 ON READER-SERVICE CARD FOR MORE INFORMATION

Templet Kit

For Tubes, Bases, Switches



This matched set of dimensionally stable Vinylite templets can help make accurate full size drawings of tube envelope outlines, twist-lock capacitator bases, rotary switches, and tube sockets. In addition, all industry approved dimensions and specifications are printed clearly on the templets.

A. Lawrence Karp, Dept. ED, 16 Putnam Park, Greenwich, Conn.

CIRCLE 254 ON READER-SERVICE CARD FOR MORE INFORMATION

DC Power Supply

Has Less Than 3/4% Ripple

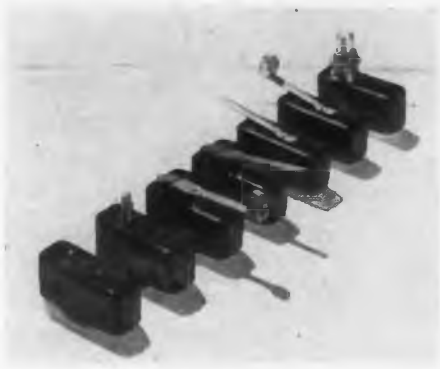
Model NFA is a specially filtered dc power supply featuring less than 3/4% ripple at top load. It provides filtered dc with a continuously variable source for voltages from 0 to 32 v for all current loads from 1 to 15 amp. It operates on 115 v 50/60 cps.

Electro Products Laboratories, Dept. ED, 4500 N. Ravenswood Ave., Chicago 40, Ill.

CIRCLE 255 ON READER-SERVICE CARD FOR MORE INFORMATION

Sensitive Limit Switches

Long Life



Licon (R) Type-10 series of limit switches offer movement differentials less than 0.0005 in., for use in operations requiring extreme sensitivity, and the exclusive "serpantine" snap action of the switches consistently gives more than 10,000,000 actuations in tests. The low stress design eliminates drift at the trip points.

Licon (R) Switch Control Div., Illinois Tool Works, Dept. ED, 2501 N. Keeler Ave, Chicago 39, Ill.

CIRCLE 258 ON READER-SERVICE CARD FOR MORE INFORMATION

Frequency Meter and Counter

Uses Glow Transfer Decade Tubes

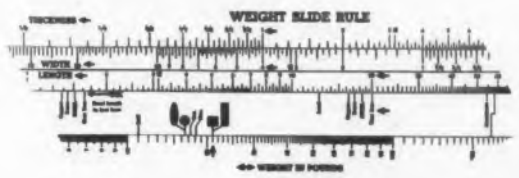
WE-130 is an all electronic frequency meter and counter using glow transfer decade tubes. The all-electronic feature permits the start of the counting interval to be determined by an external signal, also giving the added convenience of a continuously variable display time (0.5-5.0 sec and manual).

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

CIRCLE 259 ON READER-SERVICE CARD FOR MORE INFORMATION

Weight Slide Rule

Covers Many Materials and Shapes



This slide rule is designed to instantly figure the weight of any shaped object from known dimensions. Calculations cover most materials, including aluminum, cast iron, steel, brass, copper, and lead. Almost any shape can be figured: rounds, squares, hexagons, fillets, prisms, balls, hollow cylinders, wedges, cubes, cones, and irregular objects.

American Pattern, Dept. ED, 772 Bryant St., San Francisco 7, Calif.

CIRCLE 260 ON READER-SERVICE CARD FOR MORE INFORMATION

Miniaturized Control

Meets Rugged Mil Specs

Model 3 "Radiohm" is a versatile miniaturized control designed to meet rugged military specifica tions. These units have a wide range of applications, in addition to the military, including miniature amplifier, telephone, and carrier systems, and test and geophysical equipment, and many other types of equipment.

Centralab, Div. of Globe-Union, Inc., Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.

CIRCLE 265 ON READER-SERVICE CARD FOR MORE INFORMATION

Transistor Test Set

Covers Wide Hybrid Range

The Model KP1 Power Transistor Test Set is designed to measure all the hybrid parameters including $1+h_{21}$ and I_{co} in either grounded base or grounded emitter configurations over a frequency range from 100 cps to 200 kc. I_{co} is indicated on the front panel meter in the range spread of 1 μa to 5 ma. An external jack is provided for measurements of I_{co} below 1 μamp.

Baird Associates—Atomic Instrument Co., Dept. ED, 33 University Rd., Cambridge 38, Mass.

CIRCLE 266 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Relay

25 Amp Unit

In addition to switching heavy current or high voltage loads, the new 25 amp power relay incorporates the patented "interchangeable coil" feature. By removing two easily accessible screws, the complete coil assembly can be removed and replaced in a few minutes by a coil of the same or different value ranging from 6 to 230 v ac.

Guardian Electric Mfg. Co. Dept ED, 1621 W. Walnut St., Chicago 12, Ill.

CIRCLE 267 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Supply

For DC Oscillographs

Type 3-131 Power Supply is designed for oscillograph operation, but is usable in many other applications. It provides 23.5 to 28.5 v dc at 16 amp max for operation of dc oscillographs or other equipment from an ac line. Input requirements are 115 v ±10 v, at 50, 60, or 400 cps, and 4.2 amp at full load.

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

CIRCLE 270 ON READER-SERVICE CARD FOR MORE INFORMATION

Ribbon Cable Assemblies

With Woven Metal Harness

"Metalbraid" offers a line of flat cable assemblies featuring a woven harness of tin/lead or silver plated copper. One of the outstanding features of "Metalbraid" is its ability to be soldered in place thus eliminating binding posts, cable clamps and lacing cord. "Metalbraid" ribbon-type assemblies give conductor footage savings up to 6%, over conventional twisted types.

Hitemp Wires Inc., Dept. ED, Mineola, N. Y.

CIRCLE 271 ON READER-SERVICE CARD FOR MORE INFORMATION

FM-AM Receiver

Low Noise

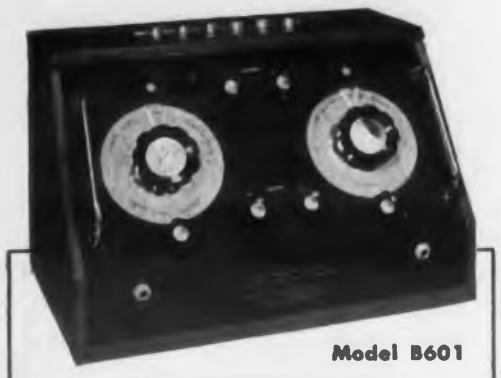
Operating in the frequency range of 55-260 mc, the Type 1502 is designed for both fm and am reception. The use of a type 416-B planar triode in the first rf stage assures that the noise figure does not exceed 6 db at any frequency. Features include a five position variable bandwidth control, squelch, and if gain control.

The receiver is useful in telemetering, guided missile, and radiosonde reception, and as a high quality general purpose laboratory receiver where high sensitivity and low noise are desired.

Nems-Clarke, Inc., Dept. ED, 919 Jesup-Blair Drive, Silver Spring, Md.

CIRCLE 272 ON READER-SERVICE CARD FOR MORE INFORMATION

Balanced R. F. Admittance Bridge by Wayne Kerr



Model B601

BRIEF SPECIFICATION:

B601	
Frequency Range:	15Kc—5Mc
Resistance:	10Ω — 10MΩ (in 6 ranges)
Capacitance:	.01μμF—.02μF (in 5 ranges)
Inductance:	0.5μH — .05H
Accuracy:	±1%

PRICE $640.00

Measurement of balanced impedances such as antennas, cables and feeders can now be made without calculation with WAYNE KERR R. F. bridges. Transistor transfer impedances may also be measured using the three-terminal facility of these hand calibrated instruments.

SPECIAL FEATURES:

- Balanced, unbalanced or three terminal measurements made *without calculation.*
- Makes transistor admittance measurements.
- Tapped transformer ratio arms give wide range and high accuracy.
- Low impedance at balance provides a high order of stability.

Model B801 (not illustrated) covers the frequency range 1 to 100 MC.

Watch for further announcements by — Wayne Kerr — *Specialists in RF Measurement*

Exclusive Sales & Service in U.S.A.

MARCONI instruments • 44 NEW STREET • NEW YORK 4, N. Y.

CIRCLE 275 ON READER-SERVICE CARD FOR MORE INFORMATION

JK PRODUCTS

For Control of Transmitted Intelligence

Frequency range: Band pass filters 1 mc to 17.5 mc. Available for special filtering purposes to 150 mc.

Bandwidth at 6 db: 0.01% to 4% of nominal on all frequencies and up to 12% for certain frequencies

Precise transmission characteristics. Compact, rugged, hermetically sealed, stable

JK CRYSTAL FILTERS

THE JAMES KNIGHTS COMPANY—Sandwich, Illinois

CIRCLE 276 ON READER-SERVICE CARD FOR MORE INFORMATION

Transistor Circuits
Available as Plug-In's

Transistorized plug-in pulse circuits are available from this firm in a variety of types. Multivibrators, binary counters, one-shot multi-vibrators, triggers, gated integrators, buffers, pulse-inverters, blocking oscillators, crystal oscillators, and relay drivers, with compatible circuitry, are offered in units mounted with standard Noval plugs.

Tripl-T Co., Dept. ED, Box 352E, Pasadena, Calif.

CIRCLE 277 ON READER-SERVICE CARD FOR MORE INFORMATION

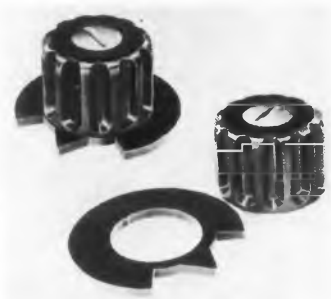
Pulse Forming Networks
Offered in Many Ranges

A complete line of capacitor pulse forming networks is offered by this firm for industrial and military applications. All networks have an "E" circuit configuration, with equal, self-contained, capacitor and coil sections. They are filled with highly purified, low-loss dielectric, insuring against voids and consequent corona deterioration.

Axel Electronic Div., Axel Bros., Inc., Dept. ED, 134-20 Jamaica Ave., Jamaica 18, N.Y.

CIRCLE 278 ON READER-SERVICE CARD FOR MORE INFORMATION

Collet Fitting Knob
For Flatted Shafts



This military style knob, the type MK-2, is for 1/4 in. flatted shafts. It incorporates a positive locking collet which eliminates all possibility of inoperativeness due to loosening on the shaft. The collet snugly grips the shaft, evenly distributing locking pressure on all outside surfaces. It will not scratch or gouge the shaft surface. The collet is actuated by a slotted cap screw, made to fit screwdrivers.

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

CIRCLE 279 ON READER-SERVICE CARD FOR MORE INFORMATION

electrical laminations

Thomas & Skinner's OrthoSil laminations prove ideal for applications requiring good directional electrical characteristics with extremely high permeability and low core loss. For high frequency inductors where an unusually high Br/Bm ratio is desirable, 4 mil OrthoSil laminations are recommended. The exceptionally high permeability from low to very high induction provides correspondingly low core loss for frequencies of 400 to 2000 cycles.

Also, T&S's widely used EI 3-phase laminations are designed especially for OrthoSil and are available in 4 mil and 14 mil thicknesses. The smaller thickness makes excellent core material for high frequency, 3-phase transformers. The 14 mil thickness is particularly adaptable to 60-cycle applications.

If you have application problems involving laminations, you can depend on Thomas & Skinner. Thomas & Skinner has been providing reliable solutions to magnetic material problems for more than 50 years.

Write today for Bulletin L-355 on laminations.

Specialists in magnetic materials

THOMAS & SKINNER, INC.

INDIANAPOLIS, INDIANA
1157 East 23rd St.

CIRCLE 280 ON READER-SERVICE CARD

50 W Power Supplies

Transistorized

Completely electronic, these dc to dc transistorized power supplies deliver 50 w from 24 v input and weigh only 2 lb. Light weight and compact size make the units especially suitable for guided missiles, rockets, aircraft, marine, and police mobile communications and emergency power systems.

Universal Atomics Corp., Dept. ED, 19 E. 48th St., New York 17, N.Y.

CIRCLE 282 ON READER-SERVICE CARD FOR MORE INFORMATION

Subminiature Relays

—65 to 125 C Ambient

"CPL" Relays are for application where low and high temperatures are a major factor. Hermetically sealed or open, they are available in spdt or dpdt, in contact ratings to 5 amp resistive at 28 v dc, 115 v ac, or 3 amp inductive. Qualification test is to MIL 6106 A.

Ambient range is —65 to 125 C. Minimum operating life expectancy is 50,000 cycles. The relays withstand 10 G's at 10 to 500 cps. Rated for continuous duty, they have a fused tin finish and Mylar insulation.

Pacific Relays, Inc., Dept. ED, 12027 Vose St., North Hollywood, Calif.

CIRCLE 283 ON READER-SERVICE CARD FOR MORE INFORMATION

Epoxy Resin Adhesives

Cure at Room Temperatures

Three epoxy resin adhesives that cure at room temperature, under contact pressure, to a strong solid state without forming volatile by-products are now available from this firm. Designated as EC-1294, EC-1474, and EC-1472, all three of these high strength adhesives can be used for bonding aluminum, brass, copper, steel, and other metals to each other, to glass, and to many plastics. They are each cured with different activators to form epoxy resin adhesives that have 100 per cent solids content.

Adhesives and Coatings Div., Minnesota Mining and Manufacturing Co., Dept. ED, 411 Piquette Ave., Detroit 2, Mich.

CIRCLE 284 ON READER-SERVICE CARD FOR MORE INFORMATION

Miniature Control

For Transistorized Equipment

The Series 44 Miniaturized Control has many applications in transistorized assemblies such as hearing aids, pocket radios, portable radios, TV sets, portable test equipment, and printed circuits. It measures only 21/32 in. diam x 5/16 in. deep. It is rated at 0.2 w at 40 C.

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

CIRCLE 289 ON READER-SERVICE CARD FOR MORE INFORMATION

Induction Potentiometer

Size 11 Unit of ±0.1% Linearity

This size 11 induction potentiometer has a linearity of ±0.1% over a range from 0 to 75 deg. Input windings are on the stator, relieving the brushes and collector rings from the necessity of carrying current. In addition, the unit is completely machine wound. It operates at 70,000 ft without pressurization.

Input impedances are up to 750 ohms. Phase shift is ±5 min with rotor position. Maximum null voltage is 1 mv per volt of input. Weight is 4.7 oz.

Diehl Manufacturing Co., Finderne Plant, Dept. ED, Somerville, N.J.

CIRCLE 290 ON READER-SERVICE CARD FOR MORE INFORMATION

Potentiometer

For Military Electronics

The Model LAO9 10-turn potentiometer is especially designed to meet the critical demand for reliability in military electronics equipment. A 7/8 in. diam unit, it is built with a rugged all-metal external construction, metal-to-metal stops, precision stainless steel ball bearings, and glass-sealed terminals positively seated to the metal housing. Terminals are gold-plated for excellent solderability.

Litton Industries, Components Div., Dept. ED, 5873 Rodeo Rd., Los Angeles 16, Calif.

CIRCLE 291 ON READER-SERVICE CARD FOR MORE INFORMATION

Drum Dial and Vernier Sets

6 Minute Accuracy

These precision engraved Drum Dial and Vernier sets are available in diameters of 1-1/2, 2, 2-1/2, and 3 in. A complete set consists of a drum dial and a vernier which allow readings within 6 minutes of accuracy. These sets are made of 24ST aluminum and are finished black anodized to MIL specs.

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

CIRCLE 294 ON READER-SERVICE CARD FOR MORE INFORMATION

Sampling Switch

For Plug-In Connection

A precision unit designed for commercial applications, this high speed sampling switch features economy, plug-in connections, and high performance. Up to 40 shorting channels or 20 non-shorting channels are available.

Approximate dimensions are 1-5/16 in. square x 1-1/8 in. long plus shaft. The shaft is 1/4 or 1/8 in. diam x 1/2 in. long.

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

CIRCLE 295 ON READER-SERVICE CARD FOR MORE INFORMATION

Thyratron Control

Uses Inert Circuit Elements

This thyratron control is a simplified, fast response, grid control circuit. It produces a steep wave front grid firing potential which can be varied in phase from 0 to 180 deg. It is available for such applications as high power, fast response servos, regulated power supplies with variable frequency inputs, motor controls, etc. Units are supplied in matched sets for full wave or three phase applications. Where extremely small levels of control power are available, the unit can be driven by a transistor.

Ortho Filter Corp., Dept. ED, 196 Albion Ave., Paterson 2, N.J.

CIRCLE 296 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Generators and Oscillators 300

A 2-page bulletin has been released on delay generators and pulse oscillators featuring variable with μsec range pulses with or without calibrated delay to 10 sec. Included in this bulletin are response time studies, synchroscope sweep delay, sonar and many others.
Electro-Pulse Inc., 11861 Teale St., Culver City, Calif.

Synchro Chart 301

A chart of synchro null connections has been offered to engineers based upon new industry standards. At a glance, the chart provides the proper synchro lead combinations which produce nulls at the various rotor angles.
Theta Instrument Corp., 204 Market St., East Paterson, N. Y.

Multiplier Phototubes 302

A 64-page catalog has been published discussing operational theory, applications and specifications for standard and special multiplier phototubes. Illustrations, graphs, and circuit diagrams are included in the three-sectioned catalog.
Allen B. Du Mont Labs., 750 Bloomfield Ave., Clifton, N. J.

Fractional HP Motors 303

A 16-page catalog has been released giving new developments in fractional hp motors and gear reduction units. The motors are for use in a wide variety of applications including electronic devices, vending machines, therapeutic equipment, music machines, fans, dental plates and many others.
Rae Motor Corp., 2009 Kewaunee St., Racine, Wisc.

Test Systems 311

A booklet has been published examining testing as a production tool, where it can help the output of satisfactory parts and increase profits. It presents some of the philosophy behind the use of test systems in manufacturing. Several actual case histories are used to illustrate the ideas in concrete form. Magnaflux Corp., 7300 W. Lawrence Ave., Chicago 31, Ill.

Diodes 312

An 8-page brochure has been published describing recent advances in the changing field of microwave silicon diodes. Catalog No. 56s is intended to bridge the gap between the specification and application of microwave diodes. It is directed to the designer of microwave receivers and test equipment as well as production, maintenance, and purchasing personnel. Subjects discussed in the illustrated catalog include: factors in silicon selection, silicon versus germanium, diodes as video detectors, mixer diode considerations, broad band widths, pricing, selection and inspection, and recent developments in low noise diode performance.
Microwave Associates, 22 Cummington St., Boston, Mass.

Temperature Probe 313

A brochure has been released describing Model 101U, giving its essential performance data and important considerations basic to the choice of total temperature probes, which meet accuracy requirements of outside air measurement in supersonic aircraft applications up to Mach 3 and beyond. The brochure includes other information on temperature probe in flight test and laboratory research.
Rosemont Engineering Co., Rosemont, Minn.

Plating Process 314

A 10-page pamphlet has been released describing the company's Lectro-Nic compressively stressed nickel plating process. Developed specifically as an undercoating to counteract rhodium electro-plate's inherent high stress characteristics. The process which is described utilizes only one addition agent with all other operating conditions being identical to conventional nickel plating. The pamphlet explains such important subjects as: plating solution composition and operating conditions; make-up and control of Lectro-Nic solutions; analysis and properties; and how to gage the rate of consumption of the Lectro-Nic addition agent.
Sel-Rex Precious Metals, Inc., 229 Main St., Belleville, N. J.

Thermostats 320

A 4-page, 2-color catalog listing physical, electrical and performance specifications for many types of snap-action, locally-adjustable thermostats has been offered. It describes in convenient pictorial and tabular form the assortment of head styles, snap switches, electrical ratings, temperature ranges, and modifications for the Series 20,000 thermoswitch by which the user can specify a thermostat exactly suited to his requirements.

Catalog MC-120B also presents general information about snap-action thermostats, and discusses installation and service factors which affect temperature control.

Fenwal Inc., Ashland, Mass.

Membership Listing 321

A 63-page booklet entitled "Directory of the Members of the American Standards Association" includes a listing of 115 national technical societies, trade associations and public interest groups, and the 2300 companies which are affiliated with ASA. It also includes the officers and members and the Board of Directors of the association. Gives state and city governments, colleges, and universities and various individuals affiliated with the association.

American Standards Assn., Dept. ED, 70 E. 45th St., N. Y. 17, N. Y.

Test Instruments 322

A catalog has been published describing the easy and quick reference to a complete line of test instruments. The listing featuring "Complete Coverage" includes over 250 instruments. More complete data and specifications are available on any of these instruments.

Hewlett-Packard Co., 257A Page Mill Rd., Palo Alto, Calif.

Switch Relay 323

A data sheet has been offered describing an electronic relay designed to be safe for water bath operation. One example would be an immersion heater in a water bath to be controlled by a mercury-column thermoregulator. This four-way function switch enables the relay to attain a high flexibility of application. Fail-safe operation is afforded by the reliability and flexibility of the function switching, so that every application can be set up for safe failure of the system. The function switch can be turned to one or four modes of operation.

Arthur S. LaPine Co., 6001 S. Knox Ave., Chicago 29, Ill.

Components 331

Catalog C-703 has been issued describing newly developed systems for data handling and a new series of analog computers. Engineered systems included in the booklet are those for data reduction, data logging, data handling, industrial measuring and recording, and industrial process control. Three new analog computers plus four components for control systems are outlined. Components include amplifiers, electronic multipliers, and function generators. Also described are newly developed frequency meters, decimal counting units, events-per-unit-time meters and others of interest to the electronic field.

Beckman Instruments, Inc., Berkeley Div., 2200 Wright Ave., Richmond 3, Calif.

Balancing 332

Bulletin No. 53 has been published describing a new concept for efficient, in-place analysis and correction of unbalance with the virbrodyne balancer. The illustrated brochure shows how you can pinpoint and remove vibration caused by unbalance at normal operating speeds from 225 to 3600 rpm.

Tinius Olsen Testing Machine Co., Easton Rd., Willow Grove, Pa.

Sensing System 333

An 8-page booklet, AD-404, has been made available describing the liquid level sensing system recently developed. The system is capable of operating a lamp to indicate that gasoline, oil or other liquid is above or below a certain level. It can also be used to control to start and stop pumps or operate valves to transfer liquid from one tank to another. The system is adaptable to a great variety of liquids and liquefied gases either relatively inert or chemically active and over a wide range of temperatures and pressures.

Simmonds Aerocessories, Inc., Dept. ED, 105 White Plains Rd., Tarrytown, N. Y.

Fasteners 334

A 12-page, 2-color catalog has been released describing a number of fasteners. The illustrated catalog describes in detail the three main types of quarter-turn fasteners—No. 5, No. 2, and type H—and their applications for general, light, or heavy duty, including their use in aircraft. Included also is information on specifications, head styles, installation procedures, strength characteristics, and other data of general interest to the user.

South Chester Corp., Southco Div., 200 Industrial H'way, Lester, Pa.

Cables 340

A 4-page bulletin has recently been released for engineers, designers and manufacturers of flexible, multi-conductor electronic cable. Bulletin 656 explains in detail how cable is designed, fabricated, installed and tested to exactly meet system requirements. Feature of this bulletin is the reproduction of a form for ordering electronic cable.

Pacific Automation Products, Inc., 1000 Air Way, Glendale 1, Calif.

Electronic Instruments 341

A 256-page Catalog O has been issued describing the complete line of electronic instruments and parts. Included are: amplifiers, bridges, coaxial elements, detectors, frequency and time measurement, generators, meters, monitors, power supplies, capacitors, inductors, resistors, sound and vibration equipment, stroboscopes, sweep drives, unit instruments, Variacs, waveform-measuring equipment, parts and accessories, charts, tables and indexes.

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

Transistor Design Data 342

A package of transistor design brochures, publication no. GD-71, have been made available for the designer of transistorized radios, phonographs and other audio amplifiers. The brochure package contains complete specifications information on the company's 17 standard, entertainment transistors and applications notes on transistor audio amplifiers.

General Electric Co., Semiconductor Products, Electronics Park, Syracuse, N. Y.

Components 343

A 2-color, 16 page catalog has been issued for manufacturers who have problems in joining small metal parts. The catalog features the company's line of welding heads, power supplies, all-electronic control units, and welding accessories. Included is information on the proper selection of ac or dc (stored energy) welding systems, uses of resistance welding equipment, welding hints, and applications. Raytheon Mfg. Co., Commercial Equipment Div., 100 River St., Waltham 54, Mass.

Precision Potentiometer 344

Data Sheet 54-66 is illustrated and lists specifications, construction, coil characteristics and available modifications on the 3" diam series 5700 precision potentiometer.

Helipot Technical Information Service, Newport Beach, Calif.

Panel Instruments 351

Bulletin A-7-F, covering styles and ranges of panel instruments in sizes from 2-1/2 to 4-3/8 in., contains complete specifications on all ac and dc instruments. Included are the rectifier type ac and thermo instruments, power level meters, VU and DB meters, frequency meters, wattmeters, and high frequency measuring instruments.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

Transistor Equipment 352

An 8-page two-color catalog has been published describing the company's line of transistorized and tubeless equipment. The catalog includes descriptions of test equipment, power supplies, packaged circuits, miniaturized components, constant current generators, and others items. These units are intended to replace vacuum and magnetic amplifier equivalents whenever used.
Electronic Research Associates, Inc., 67 E. Centre St., Nutley, N. J.

Wire Stripper 353

Bulletin No. 23 has been offered describing the development of a non-corrosive, highly efficient chemical wire stripper that will completely remove most synthetic enamel tube insulation from magnet wire in less than 15 seconds. It will maintain its effectiveness over a long period of time, thereby resulting in lower stripper usage and reduced maintenance.
Hi-Grade Alloy Corp., 1236 S. Talman, Chicago 8, Ill.

Power Presses 354

A 3-color catalog has been published describing the company's line of standard, high production and patented power percussion presses. Many models for various industrial requirements are clearly illustrated with photographs. Detailed specifications, capabilities and capacities have been included in tabular form for easy reference.
Zeh & Hahnemann Co., 184-6 Vanderpool St., Newark 5, N. J.

Ruggedized TV Camera 355

A specification sheet for the Model PD-152 TV Camera describes the operation, design details and features which make this unit suitable for automotive testing, rocket and jet test stand, flight testing, wind tunnel and other applications.
General Precision Laboratory Inc., 63 Bedford Road, Pleasantville, N. Y.

Magnetic Storage Systems 359

A brochure has been released stating the availability of ultra-reliable magnetic drum systems and components. The illustrated booklet describes magnetic drums, read-record heads and magnetic selection circuits which have proven reliable in computers and in competitive systems. Highlights are a 2 million bit drum and stacked wafer thin read-record heads providing 16 tracks per in. with interlacing of only two stacks.
Monroe Calculating Machine Co., Electronics Div., Morris Plains, N. J.

Electronic Components 360

A 20-page catalog (C56-B) lists a variety of components, which includes miniature toggle and rotary switches, capacitors, transformers, motors, dynamotors, selsyns, connectors and insulators.
Wells Sales, Inc., 833 W. Chicago Ave., Chicago 22, Ill.

Socket Screws 361

A 6-page bulletin, 723, has been published explaining the use of the multiple-spline method of power transmission in the socket screw. The illustrated, 2-color booklet describes their advantages and applications. These screws are available in both set and cap screw types, in sizes down to #0 wire size.
The Bristol Co., Socket Screw Div., Waterbury 20, Conn.

Beryllium Copper Alloy 362

A new 4-page bulletin has been offered, entitled "Berylco 10 Strip—A High Conductivity Beryllium Copper Alloy." The bulletin describes the physical properties which make this alloy particularly suited for applications in the electrical and electronic fields, including these design factors: high electrical conductivity; service temperatures of 400 F and above; excellent spring characteristics; and corrosion resistance.
The Beryllium Corp., Reading, Pa.

Guide To Flexible Mountings 363

A 4-page booklet, containing a vibration isolation efficiency curve in three colors, is a guide to the selection of flexible mounting systems for equipment where noise and vibration control is desirable. Vibration and noise magnification, which occurs when the characteristics of the system approach resonance, is also discussed.
Lord Manufacturing Co., 1635 W. 12 St., Erie, Pa.

NEW COMPUTING INDICATOR

Normalizing; eliminates conversion calculations; reads ratios directly in digital form.

The new DY-2500 Computing Indicator is a variable time-base counter providing direct, normalized ratio readings of unlike parameters in simple digital form. New dual input permits ratios between (for example) RPM and gallons-per-minute be read directly. Speed, pressure, thickness, weight, etc., may also be measured or compared with suitable transducers. In single input operation, DY-2500 may be easily switched from one transducer to another and results read directly in different kinds of units without calculation. A self-check assures correct operation; DY-2500 is portable, rugged, easily used by non-technical personnel. Frequency range 1 cps to 100 KC, variable sensitivity to 0.2 v minimum. Display variable 1 to 10 sec. $1,350.00 f. o. b. factory (single input). Product of Hewlett-Packard affiliate, Dynac, Inc., 391K Page Mill Rd., Palo Alto, Calif. Write Dynac for details.

CIRCLE 369 ON READER-SERVICE CARD FOR MORE INFORMATION

Coupling Selection Chart 371

A coupling Selection Chart has recently been developed for selecting a coupling which determines the smallest size that will be large enough to accommodate the shafts to be connected. Specifications of their three distinct types of couplings—"Roller Chain, Morflex and Silent Chain." The horizontal headings of the chart are the three coupling types and sizes with the bore diameter range of all coupling halves. Under each separate coupling heading the bore diam range is indicated by means of a color code as a cross reference with the appropriate shaft size.
Morse Chain Co., Ithaca, New York.

Shock and Vibration Mounts 372

Bulletin No. 56-02 has been published giving a complete procedure for application of shock and vibration mounts to protect shipboard and vehicular equipment. Static and dynamic characteristic curves are given for all 16 load ratings from 20 to 1800 lbs per isolator. Design, construction and specification data include complete dimensions of the unit isolators, hardware specifications, material specifications and environmental characteristics.
Barry Controls Inc., 700 Pleasant St., Watertown, Mass.

Insulating Tapes 373

Brochure, CCD-1, has been issued describing the use of irradiated polyethylene tape as an insulation by motor repair shops. In addition the brochure cites the compatability with other insulating materials and describes uses of the tape in a complete insulation system. It gives the special properties of the insulating tape and its ability to encapsulate when heat provides a lasting seal against water, chemical and dust.
General Electric Co., Chemical Development Dept., 1 Plastics Ave., Pittsfield, Mass.

Reservation System 374

A 4-page brochure describing and diagramming the functions of the new Airlines Reservation System has recently been issued. Using a question-and-answer format to cover those questions most frequently asked by airlines personnel, the literature shows the relation between the system, the centrally-located file computer and other reservation offices. Final section of the brochure deals with additional uses of the system and the adaptability to meet varying requirements.
Remington Rand Univac, 1902 W. Minnehaha Ave., St. Paul, Minn.

Rate Gyros 381

Three technical bulletins containing photos, descriptions and general specifications of rate gyros, accelerometers, and potentiometers are available in bulletin R-100. Information is offered on four basic series of rate gyros, ranging from a miniature gyro to one developed specifically for systems in which position information is obtained by integrating the rate gyro output. Bulletin A-100 describes three basic series of accelerometers, the smallest and lightest being used in production instrumentation and control systems. Bulletin P-100 covers a variety of types and models of potentiometers.
Humphrey Inc., 2805 Canon St., San Diego 6, Calif.

Variable Speed Pulleys 382

This catalog, V-563, emphasizes the use of pulley parts and outlines design features for increased rigidity, ruggedness and improved disc lubrication. For low cost variable speed applications, the use of diagrams, charts and rating tables makes the selection of the proper size of pulley unit and type of motor base extremely simple. Also, these selection aids apply to other components, motor, V-belt and sheave, required for the complete variable speed drive.
Reeves Pulley Co., Div. of Reliance Electric and Engineering Co., 1225 7th St., Columbus, Ind.

Large Waveguide 383

Bulletin EPW-656 provides mechanical and electrical characteristics and standard shape data for latest type waveguide for multi-megawatt radar and communications systems. Sizes described are from WR770 and larger with maximum VSWR limited to 1.05 for bends and 1.03 for straight sections over entire operating band.
I-T-E Circuit Breaker Co., Engineering Prods. Sec., 601 E. Erie Ave., Philadelphia 30, Penn.

Wire Products 384

A catalog has been published which gives a complete listing of wire, ribbon, weld and carbostrip products including alloy, clad and plated types.
Sylvania Electric Products Inc., 12 Second Ave., Warren, Penn.

Microwave Antennas 385

A 14-page handbook containing a selected group of curves of antenna characteristics has been announced as an aid for engineers working with microwave antennas or systems involving such antennas.
I-T-E Circuit Breaker Co., Engineering Prods. Sec., 601 E. Erie Ave., Philadelphia 34, Penn.

CIRCLE 498 ON READER-SERVICE CARD

Silver-cadmium Contacts 391

Two issues of a bulletin dealing with silver-cadmium oxide electrical contacts, including the results of recent development work, are available. They provide a complete description of the uses and properties of this new contact material. Contents include case studies of specific applications, a hypothesis explaining silver-cadmium oxide's high resistance to sticking and welding, and a list of the compositions commonly available. Included is a graph contrasting the conductivity of various compositions of the new material with that of conventional silver-cadmium alloys, and a comparison of silver-cadmium oxide's physical properties with those of fine silver, silver alloys, and silver-tungsten.
H. A. Wilson Co., 2655 U. S. Route 22, Union, N.J.

Mycalex Engineering Data File 392

A revised Engineering Data File is now available containing technical information, design considerations on ceramoplastic and glass-bonded mica products. Information is given on glass-bonded mica formulations for capacitor dielectrics, and machining and fabricating procedures. Charts of electrical and thermal characteristics and tubular data on the physical properties of the materials are also included. Ceramoplastics, made from high quality electrical glass, and synthetic mica, are suitable for use at temperatures as high as 1000 F.
Mycalex Corp. of America, 125 Clifton Blvd., Clifton, N.J.

Bondable Teflon, Rulon 393

Three pieces of literature pertinent to bondability of Teflon and Rulon is now available. Using a recently developed method Rulon and Teflon surfaces are treated so that careful process control and use of suitable adhesives permits firm bonding to metals, wood, other plastics, and cloth. Bondability has been imparted to tape or film, rods, sheets, and extruded or molded shapes. The printed reports describe in detail the nature of the bondability treatment, fluorocarbon products which can be treated to render them bondable, nature of the treated areas, and suitable adhesives.
Dixon Corp., Bristol, R.I.

Plastic Rods and Tubes 394

A 24-page catalog on plastic rod and tube stock covers the available sizes and prices of rod and tube stock made of crystal clear methyl methacrylate, Teflon, cast acrylic, vinyl, polyethylene, cellulose acetate and polystyrene. Complete ordering data are supplied and specifications added where necessary.
Friedrich & Dimmock, Inc., Lincoln Ave., Millville, N.J.

Patents

Magnetic Amplifier

Patent No. 2,730,574. F. H. Belsey. (Assigned to General Electric Co.)

Magnetic amplifiers use saturable core reactance means, the saturation of which are controlled by a direct current and in this manner control the output current of an alternating current. These amplifiers usually are of the two stage push-pull type as shown in the illustration. The circuit shown secures stability of the output current irrespective of changes in the ac voltage supply.

The alternating voltage is applied to terminals *2a*, *2b*, *2c* and *2d*. Since each stage and each push-pull circuit is essentially similar, the description will be confined to one stage and one push-pull circuit. The current passes through opposed windings *1A1* and *1B1* and rectifiers *1R1* and *2R1*. Rectifier *1R1* controls the second stage and rectifier *2R1* provides positive feedback to coil *7*. A control potential is applied to terminals *4* to control the saturation in cores *A1* and *B1* through winding *3*. A constant biasing current component is supplied at terminals *11* at a fixed potential and a second feedback current component is supplied from resistor *17* connected in the common output circuit of the second stage.

This feedback current will be in opposition to the constant current supplied from terminals *11* and is proportional to the sum of the output currents. With this circuit the output is stabilized irrespective of any potential variations applied to input terminal *2a*.

Pulse Separating Circuit

Patent No. 2,732,427. R. C. Palmer. (Assigned to Allen B. Du Mont Laboratories, Inc.)

A multiplex system of signals is commonly used to control a television camera, in order that a two wire cable may be used. With such a system it is necessary to separate the horizontal and vertical blanking signals.

The circuit of the patent accomplishes this separation of signals with a new form of circuit which is also a stabilized circuit.

The signal source *10* provides a series of pulses 25 of short duration for horizontal sweep blanking or synchronization and a relatively long duration pulse *26* for vertical blanking or synchronization. This signal is transmitted to the horizontal sweep circuit 23 which utilizes all of the pulses of short duration. In order to separate the vertical signal an amplifier tube *12* is connected to the signal source. Anode potential for the amplifier is supplied from a potential source *14* through a load resistor *13*. The output signal appearing at the anode is a series of positive pulses 25 of short duration which is the horizontal signal and a vertical blanking signal *26* or pulse of substantial duration.

The anode of the amplifier tube *12* is also connected with a differentiating circuit including a condenser *15* and resistor *16* with a bias source *21*. This integrating circuit controls the control grid of a clamping tube *19*. In parallel with the differentiating circuit is an integrating circuit including a condenser *18* and a series connected resistor *17*. The anode of the clamping tube is connected between the resistor *17* and condenser *18* and with a vertical sweep circuit *20*.

The positive pulses of short duration are integrated and produce a sharply peaked wave at the control grid of tube *19*. The bias *21* clips the positive peaks of the integrated signal and renders the clamping tube *19* conductive. The pulses of short duration also charge the condenser *18* of the differentiating circuit at a low level 29. However, the charge leaks off in a sawtooth form until the next integrated signal at the grid renders the clamping tube *19* conductive whereupon the condenser *18* discharges through this tube. The charging of the condenser *18* by the pulses of short duration are insufficient to trigger the vertical sweep circuit. For a vertical blanking pulse *26* of long duration, however, the condenser *18* is charged substantially as shown by curve 28 to a potential above the triggering potential *34* for the vertical sweep circuit.

Upon the termination of a pulse of relatively long duration the potential on the condenser *18* leaks off as shown by curve *46* until a peaked pulse appears in the integrating circuit and is applied to the control grid of the clamping tube *19*. The condenser discharges immediately through the tube *19* to its former level below the trigger level *34*. The patent shows the wave forms for the interlace scan but these are essentially the same as that described but with the various wave forms displaced a half cycle in known manner. By discharging the condenser *18* completely at each pulse, the condenser begins charging at a zero potential for both the first signal and interlace signal and thereby assures exact synchronization for the vertical sweep circuits.

Books

Basic Electricity
Paul B. Zbar and Sid Schildkraut; McGraw-Hill Book Co., 330 W. 42nd St., N. Y. 36, N. Y., 84 pages. Price: $1.75.

This is one of a series of basic laboratory manuals. It has been developed primarily for the training of radio and television technicians. The manual provides a laboratory program closely correlated with recommended instruction. By using up-to-date equipment and by following a logical sequence of jobs in which he learns basic technical skills, the individual is taught electrical, electronic, and radio principles which are integrated with work on commercial products of the industry. Basic principles, techniques in the use of specific instruments, and circuit parameters are discussed; and the effect of variation of these parameters on circuit operation and performance are emphasized.

Mathematics for Electronics with Applications
Henry M. Nodelman and Frederick W. Smith; McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y. 391 pages. Price: $7.00.

A book especially designed for the practicing engineer to correlate engineering practice and mathematical topics which are of interest to the electronics and communications fields. Mathematical topics presented in this text are thoroughly integrated with electronic engineering problems taken directly from the technical literature. Extensive correlation is achieved between the mathematical theory and the practical electronic application.

The text offers a most complete set of up-to-date exercise problems based on actual current industrial engineering practice.

Cams
Harold A. Rothbart; John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 350 pages. Price: $9.50.

This book offers a thoroughly up-to-date treatment of dynamics and machine design, using cams as a basis. It represents a significant extension of the usual kinematic approach to cam action.

It also provides coverage of both the theoretical and practical side, and makes concrete recommendations concerning such topics as mass, acceleration, materials, and the type of cam and follower to be used. A discussion of profile accuracy and error is also included, and mathematics are at a minimum.

Vacuum-Tube Circuits & Transistors
L. B. Agiumbau and R. B. Adler; John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 646 pages. Price: $10.25.

This book includes up-to-date material on such topics as transistors, frequency modulation, inverse feedback, and noise. Fundamental principles are emphasized throughout the book. The approach avoids complicated answers in the early portions of the discussions. Formalized mathematics is also eliminated wherever possible. Coverage of transistors is carefully integrated with the body of the work. Stressed in this treatment is the physical meaning of transistor parameters.

Communication Engineering
W. L. Everett & G. E. Anner; McGraw-Hill Book Co., 330 W. 42nd St., N. Y. 36, N. Y. 644 pages. Price: $9.00.

This book is a clear step-by-step analysis of major problems confronting the communications engineer. Emphasis is placed on the area which precedes the study of all other divisions of communications, namely, the fundamentals of linear-network analyses and synthesis, including the use of unilateral elements. In order to demonstrate the design requirements which are imposed on the linear portions of communications systems networks, the book develops both an analysis of various types of modulation and the transformation of transients from the time to the frequency domain.

Linear Transient Analysis—Volume II
Ernest Weber, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. 452 pages. Price: $10.50.

This book begins with a brief review of the Fourier and Laplace transforms. It includes a treatment of the two-terminal-pair network. Simple matrix algebra systematizes this presentation and permits considerable generalization of solutions to fourpole problems. Material which has previously been given only sketchy presentation in English is introduced in discussions of active fourpoles, idealized network characteristics, and transmission lines.

Practical Solution of Torsional Vibration, Volume I
W. Ker Wilson; John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 704 pages. Price: $16.00.

This book is an attempt to set down the principles and computation details of the subject in a manner suitable for everyday reference. Frequency calculations and analyses of the characteristics of different types of oscillating systems are included, which now contains considerable additions, particularly in the sections dealing with geared systems and systems containing distributed masses.

The effective inertia method for determining natural frequencies is discussed in greater detail and there is more comprehensive treatment of the application of this method in cases of coupled vibration.

Russian Germanium Diodes

J. George Mashko

Table 1

Characteristics of Various Point Contact Germanium Diodes

Diode type		Min. dc in ma at +1 v	Maximum inverse current in ma at following working voltage:							Nominal rectified current, ma	Max. rectified current, ma	Max. inverse working voltage	Min. Inverse Breakdown volt
Ceramic case	Glass case		-10	-30	-50	-75	-100	-150	-200				
ДГЦ-9	Д2А	10	0.1							16	50	30	45
ДГЦ-10	Д2Б	5	0.06							16	50	30	45
ДГЦ-8	Д2В	10		0.5						25	75	30	50
ДГЦ-1	Д2Г	2			1					16	60	50	60
ДГЦ-2	Д2Д	5			0.5					16	50	50	75
ДГЦ-4	Д2Е	5				0.8				16	50	75	100
ДГЦ-	Д2Ж	2				0.25				16	50	75	100
ДГЦ-6	Д2К	5					0.8			16	50	100	125
ДГЦ-7	Д2М	2					0.25			16	50	100	125
ДГЦ-15	Д2Н	1.5						0.8		16	50	150	170
ДГЦ-16	Д2П	1.5						0.25		16	50	150	180
ДГЦ-17	Д2Р	1.5							0.0	16	50	200	220

Table 2

Characteristics of Junction Germanium Diodes

Serial No	Definition	Type DGTs						
		21	22	23	24	25	26	27
1	Maximum inverse voltage	50	100	150	200	300	350	400
2	Applied ac voltage (effective)	35	70	105	140	210	245	280
3	Rectified current, ma	300	300	300	300	100	100	100
4	Direct voltage drop at nominal rectified current (average)	0.5	0.5	0.5	0.5	0.3	0.3	0.3
5	Inverse current at nominal applied voltage (average microamps)	0.5	0.5	0.5	0.5	0.3	0.3	0.3
6	Operating frequency	To 50 kc						

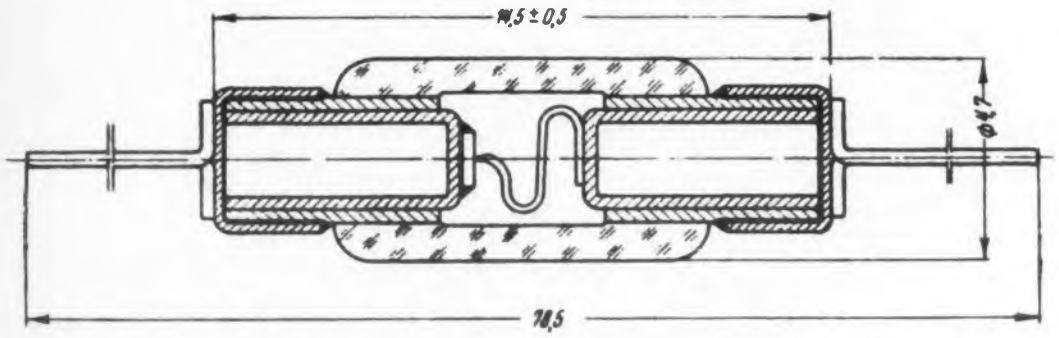
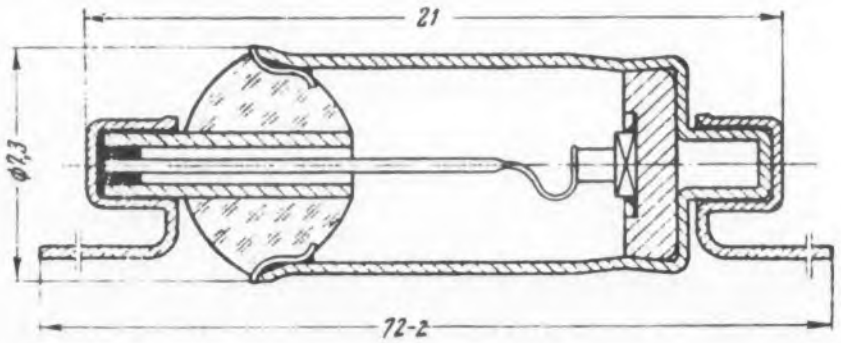


Fig. 1. Experimental germanium diode in glass case.

Fig. 2. Junction type germanium diode for voltages up to 400 v.



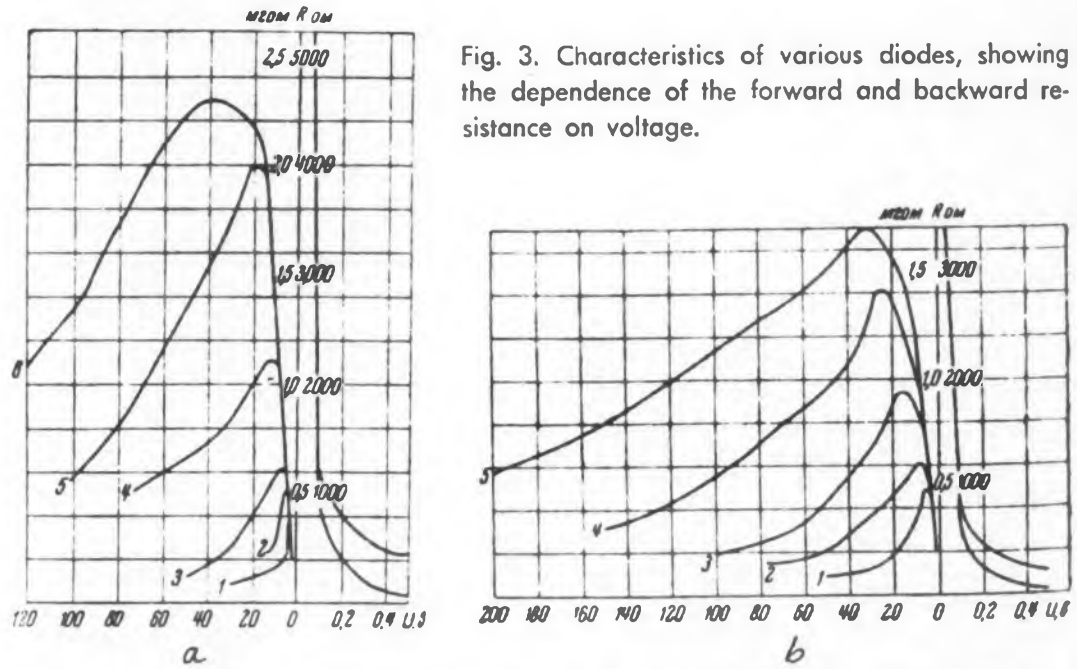


Fig. 3. Characteristics of various diodes, showing the dependence of the forward and backward resistance on voltage.

a 1—(Д2В)ДГЦ-8, 2—(Д2А) ДГЦ-9, 3—(Д2Д) ДГЦ-2, 4—(Д2Н) ДГЦ-5, 5—(Д2М) ДГЦ-7, 6—(Д2П) ДГЦ-16

b 1—(Д2Г) ДГЦ-1, 2—(Д2Е) ДГЦ-4, 3—(Д2К) ДГЦ-6, 4—(Д2Н) ДГЦ-15, 5—(Д2Р) ДГЦ-17

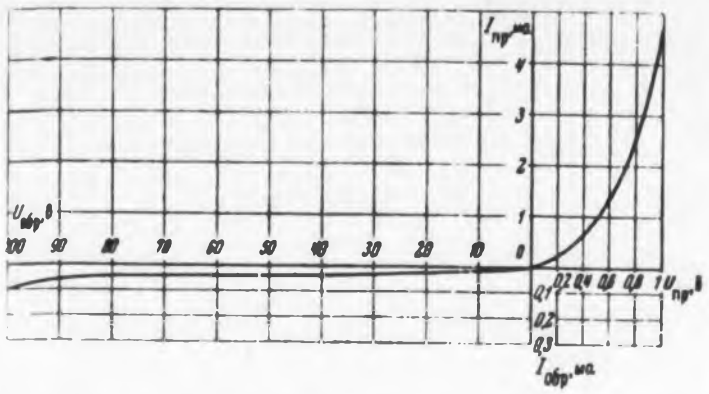


Fig. 4. Typical current-voltage characteristic of a germanium diode.

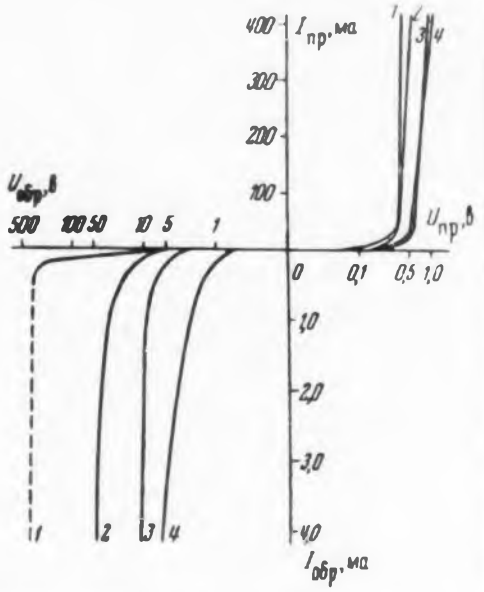


Fig. 5. Typical current - voltage characteristic of junction diode (curve 1) as compared with selenium (curves 2 & 3) and cuprox (curve 4) disk-type rectifiers.

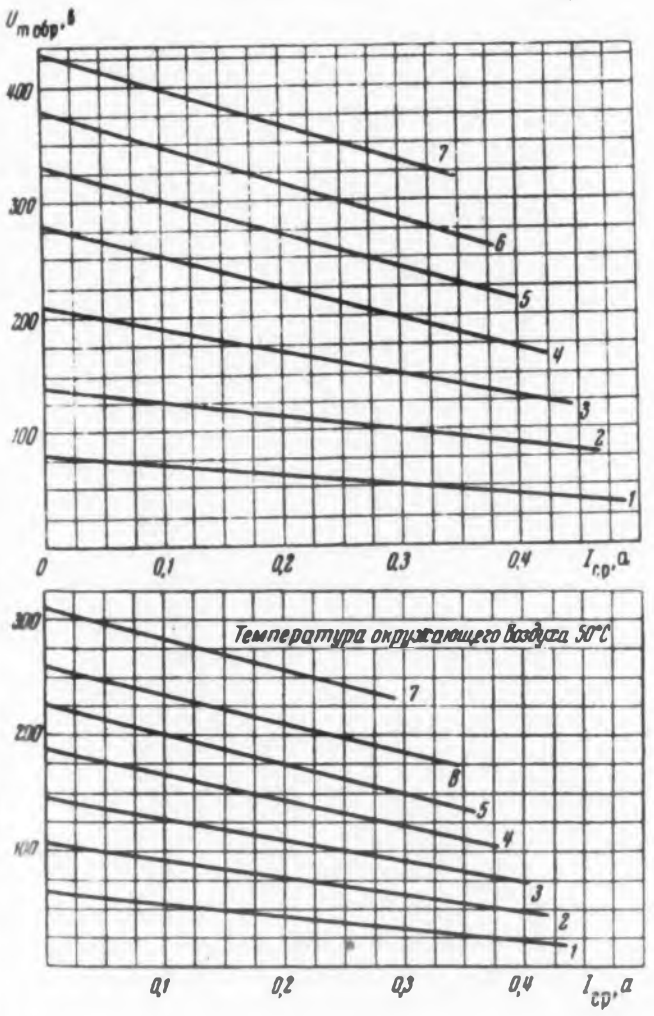


Fig. 6. Variation of the working voltage with the value of the rectified current and with the ambient temperature.

Russian Translations

What the Russians Are Writing

J. George Adashko

Elektrosviaz', No. 3, 1956

Design of Sound-Amplification System for Closed Rooms, I. G. Dreizen (8 pp).

Brief discussion of the qualitative indices and design coefficients involved in the design of a sound-amplification system for large halls and auditoriums.

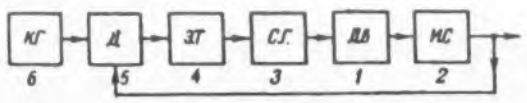
A procedure is given for engineering design of a sound system to meet a prescribed loudness level, and means are indicated for minimizing acoustic feedback.

Trends in the Development of Automatic Telephone, A. D. Kharkevich (7 pp, 3 figs, 1 table).

Survey article, referring to American, Swedish, and British developments.

Analysis of Synchronization of Electronically-Braked Facsimile Apparatus, S. M. Neiman (8 pp, 7 figs.)

Servo-loop analysis of the dynamic system shown in Fig. 1 and used to synchronize the rotating drum of a facsimile system. Blocks in the diagram represent the following: *1*—series motor, driving the entire system; *2,3*—synchronous generator; *4,5*—"electronic brake" consisting of discriminator, which compares the phase of the voltage produced by the synchronous generator with that produced by tuning fork oscillator *6*, and a variable load). Refers to article by Brown and Hall in *Trans. ASME*, vol 68, No 5, 1946.



Measuring the Asymmetry of Communication Apparatus, I. A. Leshchuk & B. F. Kondrat'ev (4 pp, 6 figs).

Discusses the use of an ac Wheatstone bridge to measure the "asymmetry" (unbalance of the impedance of communication equipment relative to ground, and discuss the optimum values of required bridge parameters.

Design of Coupling between Antenna and a Short-Wave Communication Receiver. V. S. Mel'nikov, (8 pp, 1 Fig. 1 Table).

Discusion of problems involved in matching the antenna and feeder of a short-wave receiver used in a main-line communication system.

Analysis of Noise in Radio-Relay Channels of Lines employing Frequency Sharing and Frequency Modulation. S. V. Borodich (8 pp, 1 Fig.).

The March 15 and Aug. 1 issues of ELECTRONIC DESIGN contain brief abstracts of articles by the same author, both on the analysis of transient noise occuring in multichannel radio-relay FM systems. In this article the discussion is extended to thermal noise and also to the combined effect of all types of noise. Correlation analysis is employed, as in the other articles.

Distortion produced by Harmonic and Random Noise in Telegraph Pulses in Tonal-Telegraphy AM and FM Channels. V. N. Amarantov (10 pp, 4 figs, 2 tables).

Survey Article: Foreign Facsimile Techniques.

Analysis of Regenerative Frequency Divider with Ring-Type Converter. I. A. Abolits, (11 pp, 8 Figs).

A regenerative frequency divider differs from a conventional vacuum-tube oscillator. The analysis of the regenerative frequency divider (Fig. 1 & 2) is very similar to the non-linear oscillation theory used for vacuum-tube oscillators. Nevertheless, the analysis must be quite different, primarily because of the following major differences between the two circuits:

1. In an ordinary oscillator the frequency depends primarily on the parameters of the tuned circuit; in a regenerative frequency divider it depends on the input voltage and on the properties of the frequency converter;

2. Excitation of an oscillator is due to the non-linearity of the tube; in the frequency divider it is caused by non-linearities in the multiplier and frequency-converter circuits.

3. Oscillations can be excited in a vacuum-tube generator without an externally applied voltage; this does not hold for the regenerative frequency divider, which must be considered as a non-autonomous oscillating system.

The article derives equations for the amplitude and phase relationships in the circuit, employing the quasi-linear method (method of linearized characteristics) used for vacuum-tube oscillators, and plots several families of operating characteristics.

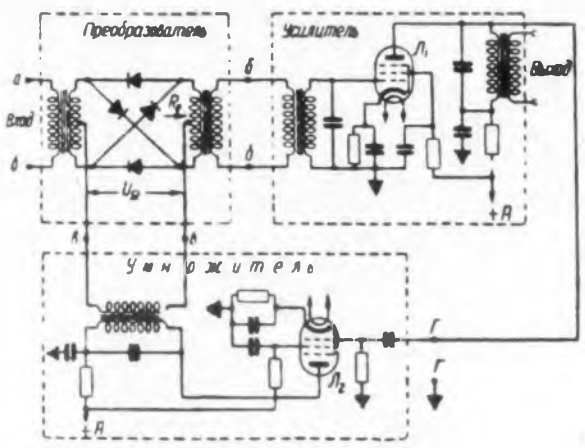


Fig. 1

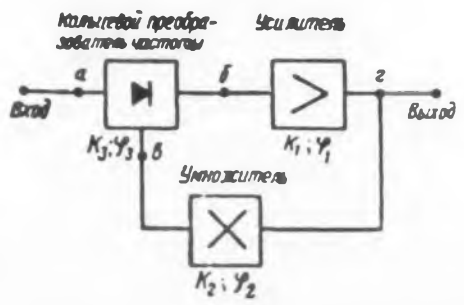
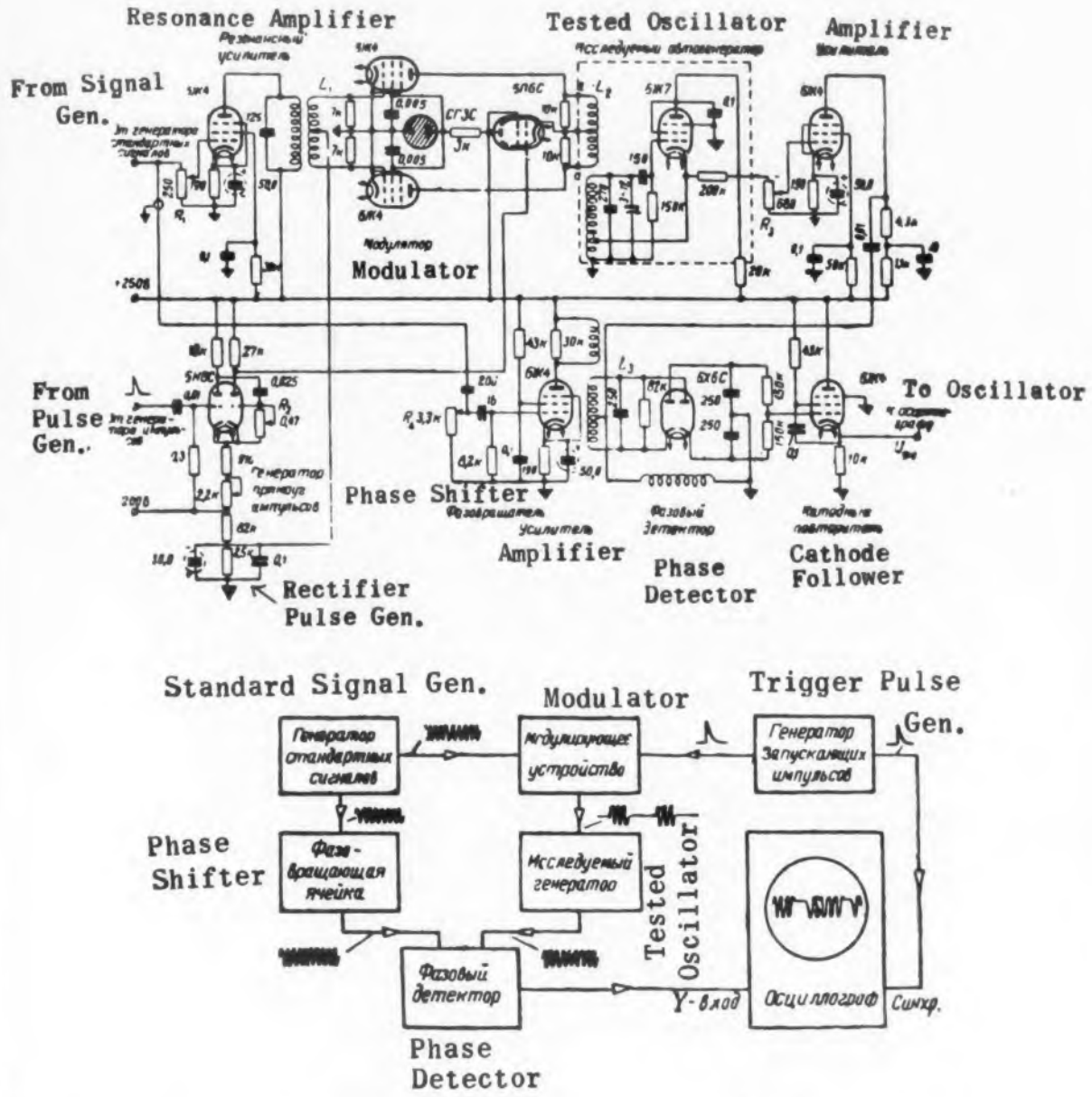


Fig. 2

Russian Translations

Radiotekhnika, No 3, 1956



Synchronization of Self-Excited Oscillators by means of Radio Pulses, E. S. Voronin & G. N. Berestovskii (7 pp, 12 figs).

The synchronization of oscillators by means of continuous oscillations has received wide coverage in the literature. This article is devoted to a discussion of synchronization by means of pulses at a frequency p that is nearly equal to the oscillator frequency ω_0. Figs. 1 and 2 show the circuitry employed in the experiments. The modulator is of the balanced type to eliminate the dc component of the pulses and to produce rectangular pulses at the load L_2 (point *aa*). The synchronizing pulses were variable in amplitude (0-0.75 v), duration (0.2 to 6 milliseconds) and repetition rate (50 to 1000 cy). The tested-oscillator frequency was 1 mc with an approximate amplitude of 100 v. Both analytical and experimental data show that the synchronization time depends greatly on the initial phase difference between the oscillator and synchronizing voltages.

Trailing Edge of Pulse in Cathode Follower with Capacitive Load, M. L. Volin (7 pp, 9 figs).

If a rectangular pulse is applied to the input of a cathode-follower stage (Fig. 1 shows the actual circuit, Fig. 2 the equivalent one), the leading edge of the ouput pulse is quite similar to that of the input pulse, but the trailing edge is not. This is due to the relatively long time constant of the cathode circuit (Fig. 4 shows reading down, the input, output, and charging voltages in the circuit). The article presents an experimentally based procedure for computing the time delay of the trailing edge and discusses method for increasing its steepness.

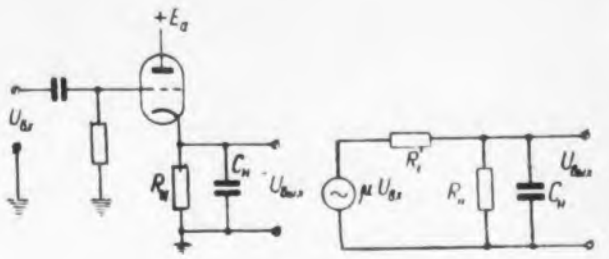


Рис. 1

Рис. 2

Essentially the scheme is to apply at the time t_2 (see Fig. 7) another charging pulse that compensates for the "stretching" of the trailing edge. Fig. 8 shows a circuit of this type, and Fig. 9 illustrates the possible improvement in waveform.

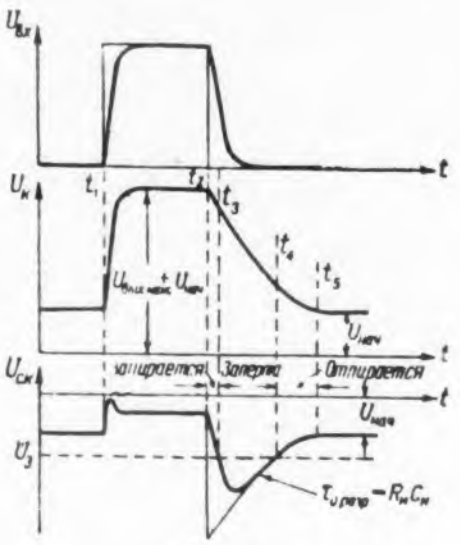
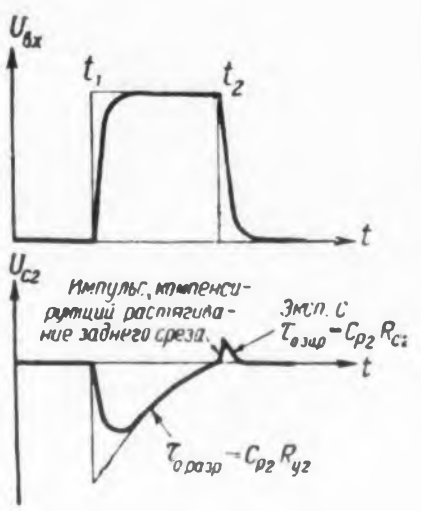


Рис. 4



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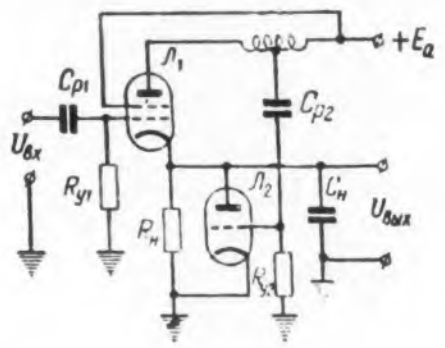


Рис. 8

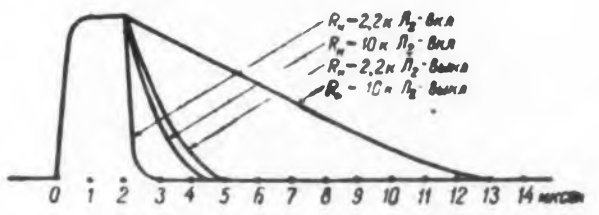


Рис. 9

Antenna System with Reflector, V. D. Kuznetsov (12 pp. 9 figs.).

Analytical discussion of the behavior of an antenna system for centimeter and decimeter waves, where the antenna itself is located on the ground, and the reflector (mirror) is placed on a tower. The author discusses the advantages and disadvantages of such a system, the optimum shape of the reflector, the efficiency, the directivity pattern, and the shielding produced by the reflector. Equations for the design of such a system are derived.

Stabilization of the Amplitude of Self-Excited Oscillations by means of a Non-Linear Element having Inertia, E. O. Saakov (11 pp, 5 figs. 2 tables).

Discussion of the operation of simple stabilizer circuits containing non-linear resistances having thermal inertia. The equations of the steady-stade oscillator amplitudes are derived.

Methods for Analysis of Complicated Transistor Circuits, Ia. K. Trokhimenko (7 pp, 4 figs).

Employs matrix analysis.

Design Ideas from Germany

A. Jorysz

Absorbing Centimeter Waves

Absorption materials for short electromagnetic waves are needed to produce reflection-free test spaces, to eliminate reflections from disturbing objects by covering them or to hide targets from radar detection.

Application of the techniques of sound field absorption yields new solutions to similar electromagnetic problems. This is based on the fact that the coefficient of reflection r in both fields is defined by two impedances, the input impedance of the absorber Z_i and the characteristic impedance of the surrounding medium Z: $r = Z_i - Z/Z_i + Z$.

In order to produce perfect absorption, (r equals zero), Z_i must be real and equal to Z in the desired frequency range. The three methods available to obtain this result are discussed below.

Homogeneous absorption media—By selecting a flat sheet of homogeneous material with high internal attenuation it is possible to reduce the penetrating wave very quickly and make reflections from the back side of the material negligible. The complex dielectric constant and the complex permeability of the absorbing medium have to be equal in magnitude and angle to insure perfect impedance match to the characteristic impedance of space, which is 377 ohms. As yet it has not been possible to develop a material meeting all these requirements, primarily because high values of permeability are not obtainable at centimeter waves. Wide variation of dielectric constant and losses can be accomplished by imbedding small conducting particles, such as graphite powder, in a dielectric base material, such as paraffin. The use of ferromagnetic particles instead of graphite results in higher permeability and increased magnetic losses, but the dielectric quantities are not of the correct magnitude.

Principle of gradual transition: *Wedge absorbers*—Wedge absorbers produce gradual geometric transition from space to the absorber and therefore produce better impedance match. The dimensions of the wedge, when referred to the wavelength, are now important. The orientation of the electric field vector is critical when wedges are used which are less then half a wavelength apart. Absorption is much lower if the electric vector is parallel to the tapered edge of the wedge rather than at right

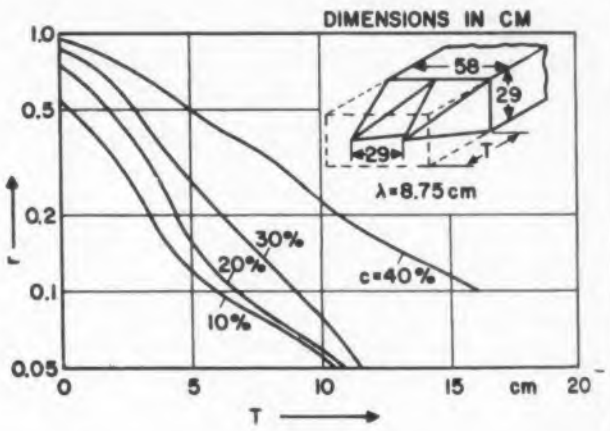


Fig. 1. Coefficient of reflection of paraffin-graphite pyramid absorbers as a function of pyramid length for various concentrations.

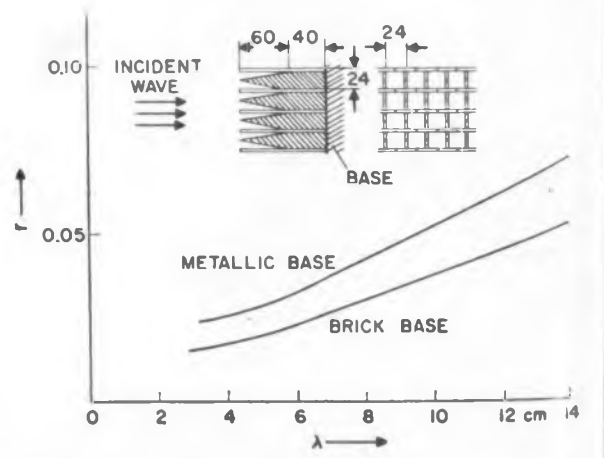


Fig. 3. Coefficient of reflection vs. wavelength for parallel plate medium with pyramid transition—plate impedance 200 ohms.

angle. Pyramidal shaped absorbers made of paraffin-graphite mixtures do not show any variation in absorption with polarization. Variation of the graphite concentration from five to forty volume per cent increases the wave attenuation from 0.5 db/cm to 18 db/cm. See Fig. 1 for the dependence of r on the pyramid height. By varying the base length of the pyramid bottom extension control of the magnitude of the coefficient of reflection is possible. A metallic plate forms the common base for the graphite elements.

In analogy to similar sound absorbers, a parallel-plate medium of graphite foils was also investigated, Fig. 2. The plate impedance and the distance between plates determine the attenuation of the incident wave. Spacings of less than half a wave length are not usable. In order to eliminate polarization effects it is advisable to use two stacks of foils at right angles to each other. Impedance matching is achieved by using a transition element such as a pyramid, Fig. 3.

Resonance absorbers—If the required band width of the absorption spectrum is small, it is possible to use tuned absorption elements. The simplest case consists of a metal foil of 377 ohms plate impedance at a quarter wavelength in front of a conducting wall. For a certain frequency the imput impedance of this arrangement equals the characteristic impedance of the medium. Absorption occurs due to cancellation of the wave reflected from the front of the foil by the one reflected from the conducting rear wall, Fig. 4.

In another form of absorber the resonance elements are a number of small loop antennae which are evenly distributed at right angles to the metallic wall. The loops are interconnected capacitively behind the wall, Fig. 5. Impedance matching is accomplished by varying the number of loops per area and proper choice of the individual circuit losses.

Multi-circuit absorbers, their construction and characteristics are discussed in the rest of the article. *(E. Meyer and H. Severin, "Absorption devices for electromagnetic cm waves and their acoustical analogs"; Zeitschr. f. angew. Physik, vol. 8, pp. 105-114; March 1956)*

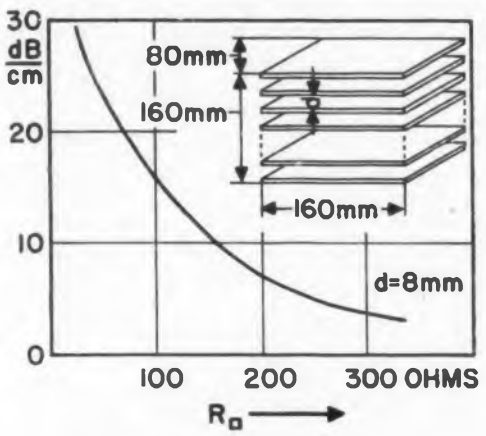


Fig. 2. Attenuation of electric wave of 3.2 cm in a medium of parallel conducting plates as a function of plate impedance and plate distance —electric vector of incident wave parallel to plates.

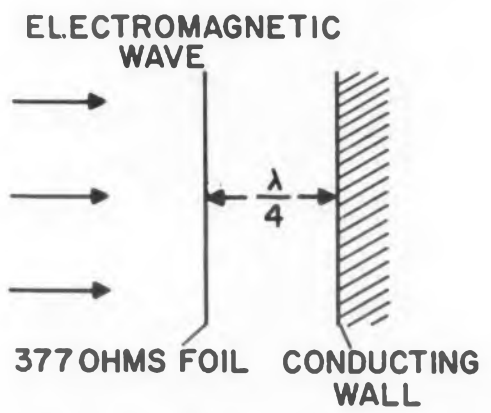


Fig. 4. Single circuit absorber—foil within quarter wavelength distance from wall.

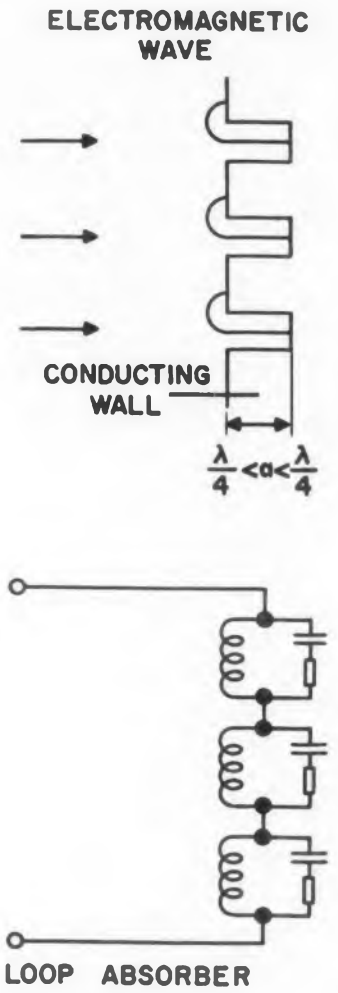
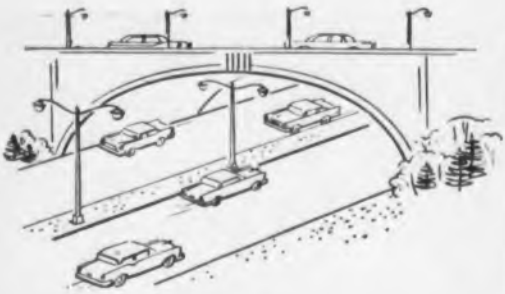


Fig. 5. Single circuit absorber—loop elements in front and behind wall.



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Abstract—German

Measuring G's Electrically

Starting accelerations of several g's may occur in the motion of high voltage switch contacts. Described here is a simple electrical measurement for the determination of mechanical motion. Until now, in order to observe such a motion, a moving contact had to produce either a resistance or a capacity change which was recorded with a string oscillograph. The resultant distance vs time curve was frequently inaccurate because of sliding contact problems and the limited writing speed of the oscillograph.

Replacement of the latter by a cathode-ray oscilloscope permitted direct observation of the voltage change across the plates of a charged variable capacitor, Fig. 1. For a fixed charge, the increase in spacing between plates produces an easily measured voltage rise. The wiring capacity has to be kept small compared to the variable capacity, which must also be well insulated, so that the charge will not be lost during the test. The movable capacitor plate must not vibrate during the measurement and its mass must be small enough not to influence the motion.

Calibration only involves plotting the change in voltage across the variable capacitor vs the distance between plates for a fixed charge on them. A typical voltage vs time oscillogram is shown in Fig. 2. A time marker has been recorded on top. By using

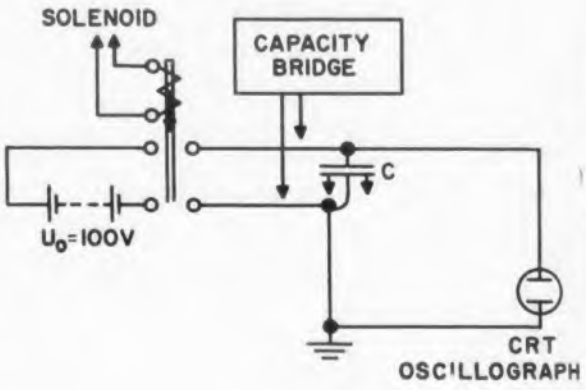

Fig. 1. Circuit for distance vs. time measurement.

the oscillogram and the calibration curve, a distance vs time curve can be computed and graphical differentiation of the latter yields the velocity vs time characteristic. Its initial slope is then the required starting acceleration of the observed motion, Fig. 3. Values as high as 1000 g have been measured with this method without difficulty. *F. Melchert, "The electrical measurement of high initial accelerations,"* Archiv f. techn. Messen, *No. 241, pp. 25-26; February 1956.*

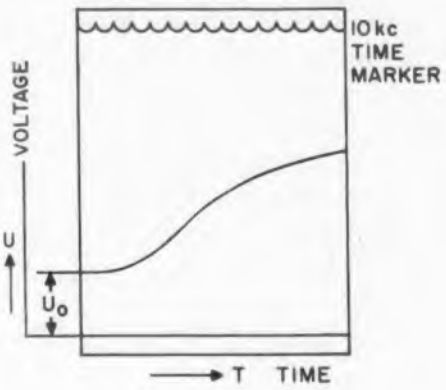

Fig. 2. Oscillogram of voltage vs. time.

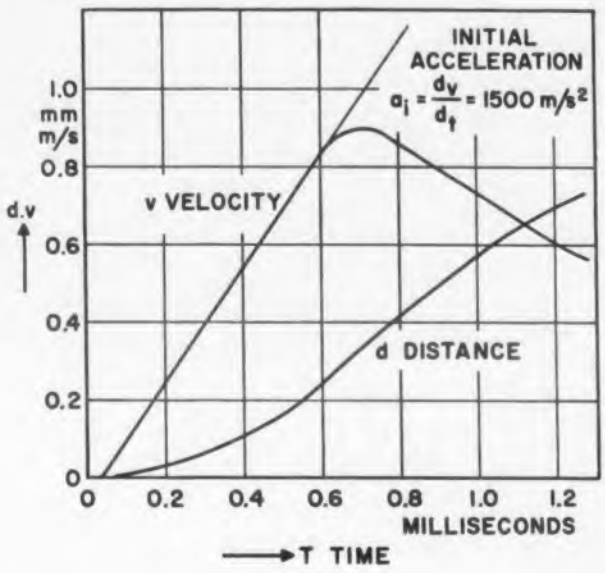

Fig. 3. Derived distance and velocity curves.

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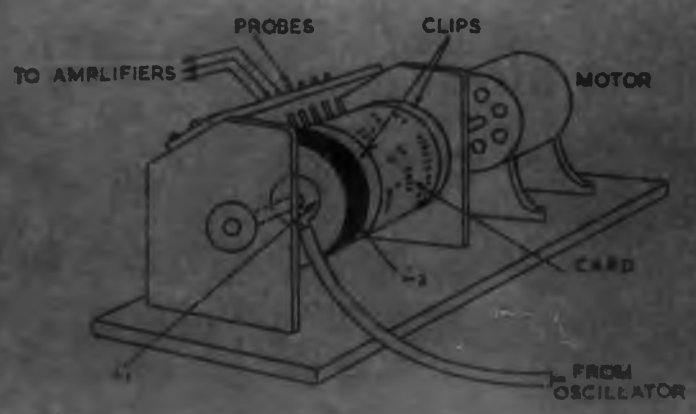
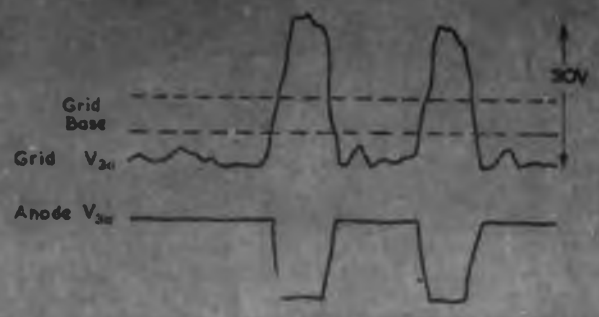
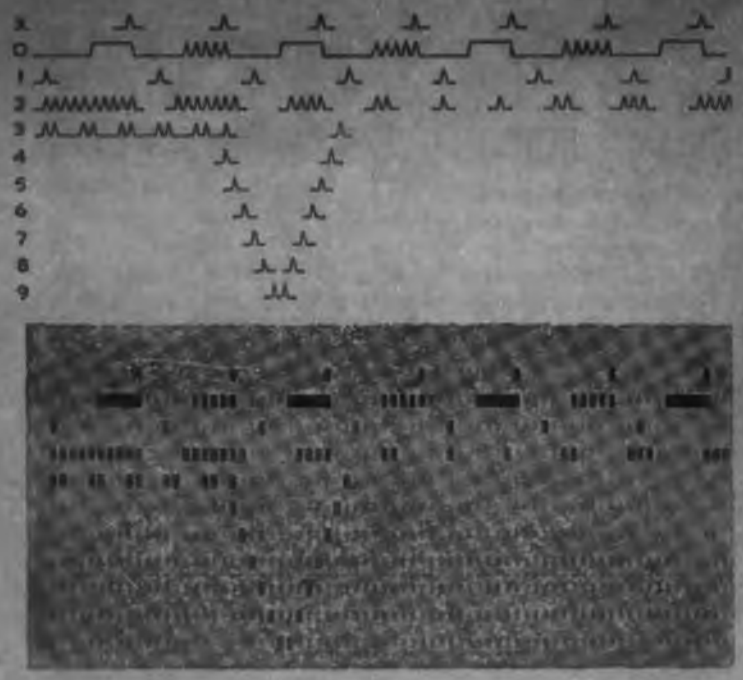


Motor-driven drum mechanism.



Waveforms produced at grid and anode of V_{2a}.



Output pattern given by punched card (below).

Abstract—British

Simple Computer Tester

DURING the development of circuits intended for use in electronic computers there is a need for checking, with minimum of apparatus, the logic of circuits which require numerous pulse streams for their operation. This article describes such an apparatus using an electrostatic pick-up.

Because the requirements of yet undesigned equipment are virtually unpredictable, the pulse patterns obtained must be completely flexible within the capability limits of the apparatus and, of course, quickly alterable from one pattern to another.

Description

As shown diagrammatically in Fig. 1, the apparatus consists of a motor driven drum revolving at high speed, to the surface of which are approached 11 metal probes. The drum is provided with two clips capable of holding in place a card wrapped around the periphery. This card is coated on one side with thin metal foil which makes electrical contact with the holding clips. The card is punched with holes at positions representative of the desired pulse stream coding.

The metal backing to the card is connected, via the clips, to a radio frequency coil L_2 wound around one end, and rotating with the drum. This coil is supplied with radio frequency by means of a low impedance coupling loop L_1, concentric with, but not attached to, the driving shaft on the same end of the drum as the coil is wound.

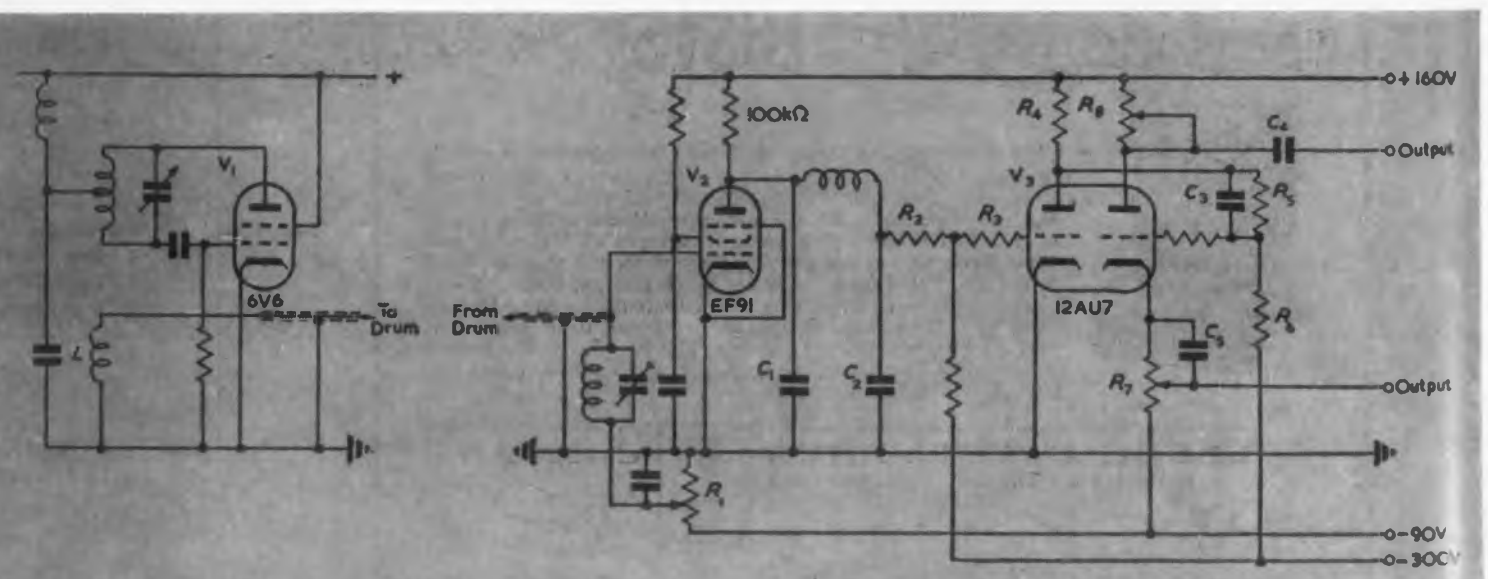
This coupling induces a high rf voltage in the coil L_2 which is resonated by the capacitance of the metal backed card and a swamping capacitor. This rf raises the potential of the card to 200 v on peaks. The probes P_1 to P_{11} are approached close to, but not in contact with the card and as they are electrically screened along their whole length, can only pick-up rf from their tips held close to the card surface.

When a punched hole passes immediately under the tip of any probe the amount of rf picked up by that probe drops sharply.

This reduction in energy reaching the probe is interpreted at the output of the amplifiers and rectifiers attached to the probe, as a positive pulse. This pulse is clipped and shaped by the following circuits, and delivered at low impedance to the output lines.

Circuits

The Hartley oscillator supplying the card with radio frequency is shown at left in Fig. 2. It is coupled by a three turn loop L to an 80-ohm coaxial cable which feeds the drum tuned circuit via the fixed loop previously mentioned.



Oscillator, probe amplifier, pulse clipping and shaping stages.

Probe amplifier V_2 couples the drum output to the clipping stage. Briefly V_2 combines the functions of rectifier and amplifier. R_1, the negative bias control to the grid of V_2, is adjusted so that the radio frequency peaks picked up when a hole is stationary under the probe just does not cause any anode current flow. Rotating the drum until the metallizing is under the probe raises the amplitude of the rf peaks reaching the grid of V_2 so that it now conducts on positive half-cycles. The rf component is filtered out into the anode circuit and the resultant waveform is applied via R_2 to the grid of V_3, the clipper stage.

The positive waveform reaching the grid of the clipper each time a hole is sensed has an amplitude of approximately +30 v. As the grid is maintained at −20 v and a *12AU7* has a grid cutoff of −10 v under these conditions, the first part of the positive pulse is lost together with any noise picked up. The peak of the wave on the other hand is truncated as soon as the grid is driven positive to ground potential because of the grid leak R_3. In this way anode current can only change in V_{3a} during the center swing of the positive pulse.

As shown (Fig. 3), a somewhat irregular shaped pulse has become a clear square wave in the anode of the V_{3a}, with a peak-to-peak amplitude of approximately 130 v.

The second half of V_3 is working as a cathode-follower and has the waveform from the anode of V_{3a} applied, via C_3 and R_5, to its grid.

The voltage dividing network $R_4R_5R_6$ reduces the voltage swing available at the anode of V_{3a} to 70 v at the grid of the cathode-follower (V_{3b}) and hence approximately 70 v is available across the cathode load R_7, at low impedance.

What percentage of this waveform is required can be adjusted by R_7. Capacitor C_5 is included to compensate for any high frequency loss due to the series component of R_7 when the slider approaches the center and lower settings.

An optional output has been provided to give the opposite phase and takes the form of R_8 in the anode of V_{3b}. It should be noted that the circuits of Fig. 2 are dc connected so that the drum can be slowed down to zero speed with no great change in pulse amplitude available at the output of each channel. This does not apply to the inverted phase available from the anode because a capacitor C_4 has to be included to block the high voltage.

Fig. 4 shows a card punched with holes which will give an output in accordance with the pattern specified.

Notice how by breaking through one hole to another where required, pulses of long duration can be provided. This should not be carried to an extreme however, because the strength of the card may be overweakened if too many bridges are removed.

Abstracted from an article "A Variable Multiple Pulse-Stream Generator" *by W. Woods-Hill, British Tabulating Machine Co., Ltd., published in Electronic Engineering, July 1956.*

Abstract

FM Mixer Design for Selectivity and Low Radiation

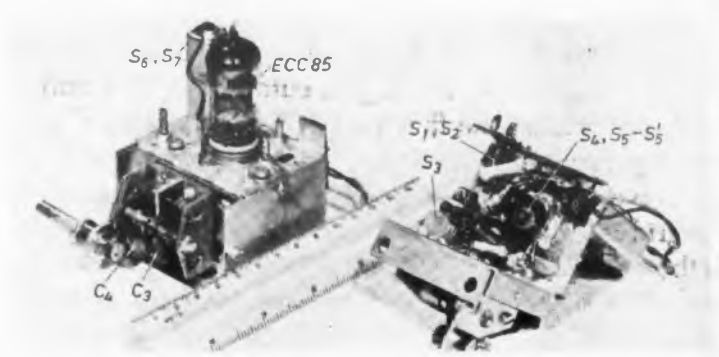


Fig. 1. One form of the circuit of Fig. 2a, seen from above and below. The letters refer to the corresponding components in Fig. 2.

IN Europe, good FM selectivity and low local-oscillator radiation are particularly important. The carrier frequencies of European FM transmitters are generally 300 kc apart. Local oscillator radiation must be suppressed both at the fundamental and second harmonic frequencies. Outlined here are how these requirements are attacked in mixer design of the Philips fm receivers. Consideration must also be given, of course, to the rf (hf) Amplifier and if amplifier designs.

The Mixer Stage

The rf (hf) amplification stage is followed by the frequency-changer stage consisting of oscillator and mixer. 10.7 mc/s is chosen as the intermediate fre-

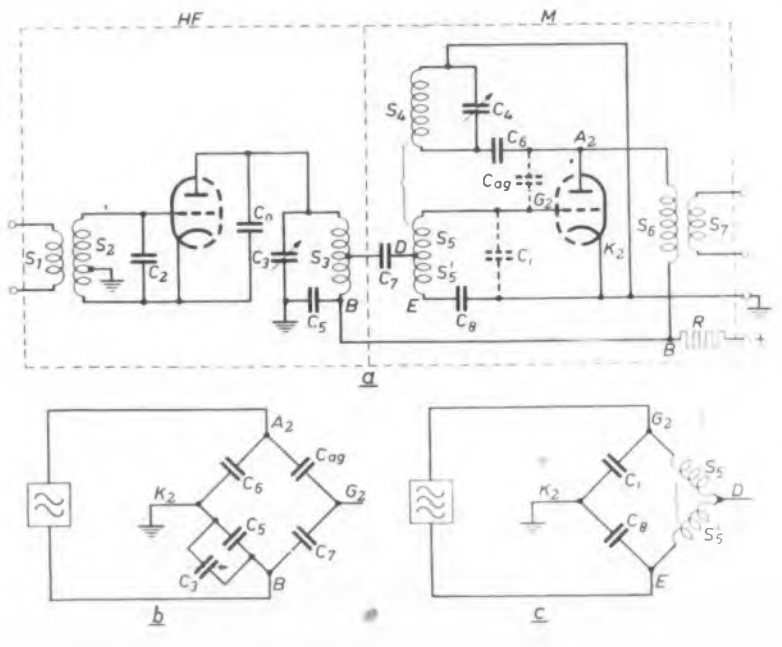


Fig. 2. a) Simplified diagram of high frequency amplifier (HF) and mixing stage (M).
b) Bridge circuit in circuit (a) which, at the correct value of C_5, causes a reduction in the damping of the band-pass filter.
c) Second bridge circuit, incorporated in (a) which, at the correct value of C_8, ensures that no voltage at the oscillator frequency appears at point D, so that there is no radiation.

uency. As regards the mixer tube the most important roperties are minimum noise and large conversion onductance. The triode is the best tube to meet these equirements; thus the ECC85 is often used. Owing to the large hf amplification of the previous stage the amount of noise from the mixer tube is negligible. Since a triode has only one grid, a so-called additive mixing circuit has to be used, i.e. a circuit in which the two signals to be mixed are applied to the same grid.

Fig. 2 shows the circuits of the hf stage and the mixer stage. Two features of the circuit are: the dampings of the first if band pass filter and the stray radiation.

The plate resistance of the mixer tube measured on dc amounts only to about 20,000 ohms, which implies a fairly strong damping in the band-pass filter and, as a result, low amplification. In addition, an if voltage passes to the grid via the grid-anode capacitance, causing the effective plate resistance to become even lower—about 5000 ohms. However, the bridge circuit shown in Fig. 2b causes another if voltage to appear at the grid such that the effective plate resistance is increased to a value at which the damping is small enough. The bridge circuit comprises four capacitances (regarding coils S_3, S_4, and S_5 as short-circuits for if currents). Of these four capacitances C_{ag} is given by the tube and C_6 and C_7 are for other reasons also fixed within certain limits. Typical values in practice are: $C_{ag} = 2$ μμf, $C_6 = 20$ μμf and $C_7 = 200$ μμf. With these values the bridge would be balanced if $C_5 + C_3 = 2000$ μμf. By choosing another value for $(C_5 + C_3)$, the if voltage appearing across the diagonal K_2-G_2 can be varied; with $C_5 \approx 900$ μμf. this voltage has the correct magnitude and sign. The capacitance C_3 of the tuning capacitor is adjustable from 2.5 to 12.5 μμf, and this range is so small compared to C_5 that the required condition is maintained over the entire tuning range.

A second bridge circuit is incorporated in the circuit of Fig. 2a, to counteract radiation. This is shown in Fig. 2c and is formed by the two sections of the reactance coil $S_5 + S_5'$, the input capacitance of C_1 of the oscillator tube and the capacitor C_8. The bridge is balanced with C_8 so that the diagonal K_2-D remains free of oscillator voltage and this voltage can therefore not reach the antenna via D and the hf amplifier. The self-inductances, mutual inductances and capacitances in the bridge circuit are such that the balance of the bridge is theoretically independent of the frequency in practice, but in the range within which the oscillator frequency varies the balance holds satisfactorily.

In this way and with very short wiring, the circuit in Fig. 2a can produce a total amplification of 200X (ratio of if voltage on control grid of first if tube to antenna emf). Fig. 1 shows two views of such a hf section.

Abstracted from "The FM Section of Modern Broadcast Receivers" by H. de Quant and P. Zijp, Philips Technical Review, Vol. 17, No. 12, June 1956.

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.

Airborne Sonar

MIL-E-19400 (AER), Electronic Equipment, Airborne Sonar; General Specification For, 1 February 1956 . . . The philosophy of design and manufacture of airborne sonar and related equipments are established by this spec. The detail requirements for the particular equipment are specified in the specs for the particular equipment. This spec is intended to cover all classes of airborne sonar and related equipment and all applicable phases of design, including research, service test, preproduction, and production.

Electron Tubes

56IRE7.S3, Electron Tubes: TR And ATR Definitions, 1956 . . . Forty-five definitions of various terms commonly used in the design and construction of Transmit receive and Anti-Transmit Receive tubes are covered in this newly issued standard. A transmit receive tube is defined as a gas-filled radio-frequency switching tube used to protect the receiver in pulsed rf systems. An anti-transmit receive tube is a gas-filled rf switching tube used to isolate the transmitter during the interval for pulse reception. Copies of this standard may be obtained from the Institute of Radio Engineers, 1 E. 79th St., New York 21, N.Y. for $0.50 per copy.

Interference From TV Receivers

56 IRE, 27 S1, Methods Of Measurement Of The Conducted Output Of Broadcast And Television Receivers In The Range Of 300 kc To 25 mc, 1956 . . . This standard is a supplement to 54 IRE 17.S1, entitled Standards on Receivers: Methods of Measurement of Interference Output of Television Receivers in the Range of 300 to 1000 kc, 1954. The newly issued standard permits the extension of conducted interference measurements, as previously defined in 54 IRE 17.S1, from a range of 300 to 1000 kc to a range of 300 kc to 25 mc. It also replaces sections 3.22 and 3.2.5 of the earlier standard. The extension in frequency coverage involves a revision of the characteristics of the line impedance network. Copies of this standard are available from the Institute of Radio Engineers, 1 E. 79th St., New York 21, N.Y. for 50 cents per copy.

ASTM Proceedings

A 1264-page volume, recording the technical accomplishments of the American Society for Testing Materials for the year 1955, has recently been published. Reports of the technical committees, of which there are 70, and their appendices provide a wealth of useful information. Also included are 34 technical papers and discussions, dealing with a wide variety of subjects pertaining to research and testing of materials. Copies of the ASTM Proceedings may be purchased from American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa. for $12.00 per copy.

Relays

MIL-R-6106B (ASG), General Specification for Aircraft Electric Relays, Amendment 2, 27 June 1956

The scope of the spec has been changed to cover relays for use in ac and dc electrical systems instead of for use in 115/220 v ac and 28 v dc electrical systems. The grounding requirement has been changed to state that finish around the mounting holes shall provide positive electrical contact to ground when the relay is mounted in the airplane. This requirement does not apply to relays which are mounted on insulated bases. The requirements for preservation and packing have been modified.

Signals

MIL-A-15303D (Ships), Audible Signals: Alarms, Bells, Buzzers, Horns and Sirens—Naval Shipboard, 6 April 1956

Various types of audible signals for alarm and signaling purposes on Naval ships are covered in this spec. A typical classification for an audible signal under this spec is 1C/B1D1.

RETMA Standards Proposals—Requests for Comment

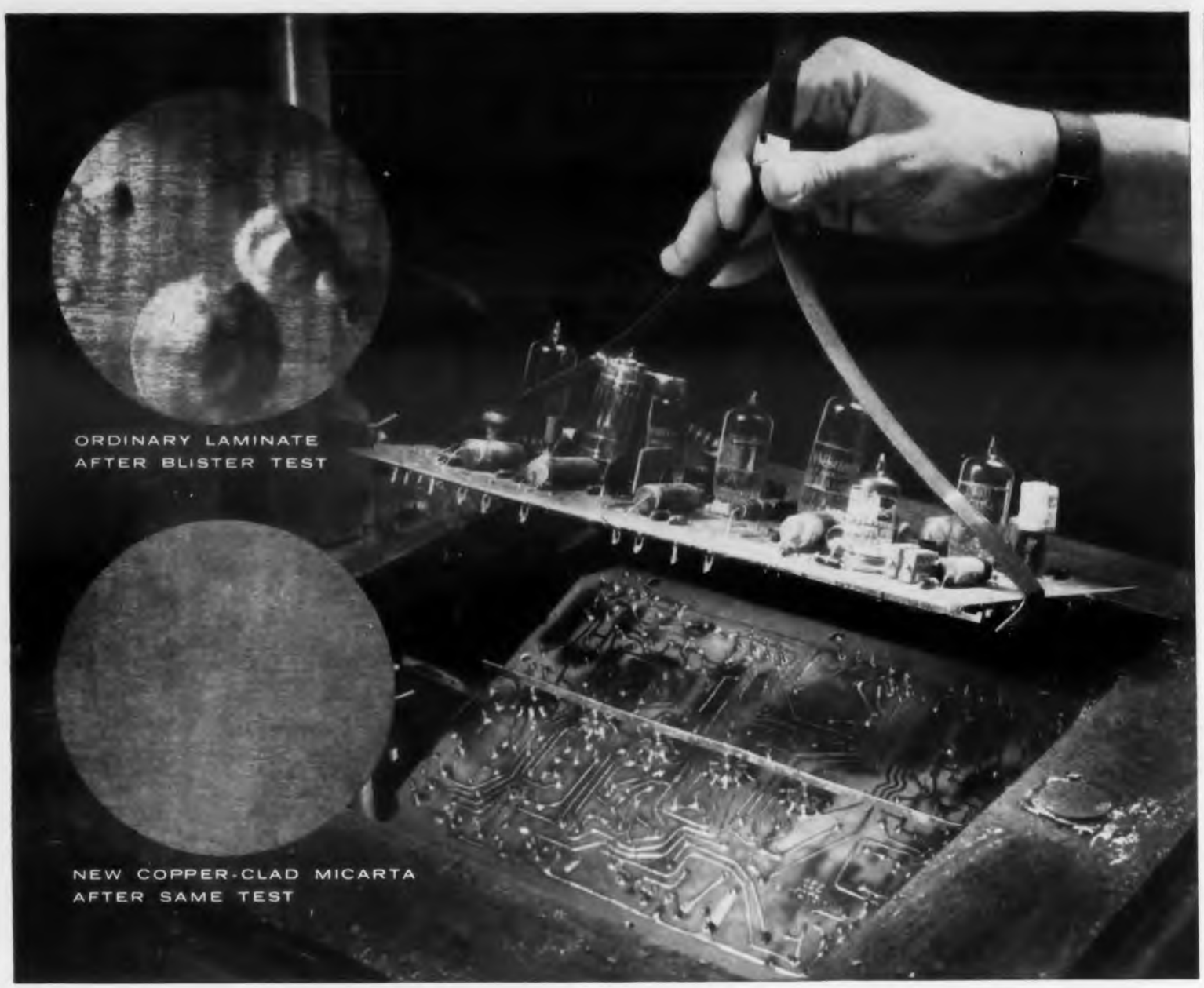
The RETMA Engineering Office, 11 W. 42nd St., New York 36, N.Y., requests industry comments on the following proposed standards. (Although the official comment period may have expired, you are encouraged to send for a copy of the proposal and comment if you are vitally interested.)

SP-507, Precision Film Resistors

Requirements for a film-type resistor distinguished, in general, by its accuracy of initial tolerance and stability under standard tests are established by this proposed standard. The type of resistor covered differs from the general purpose fixed composition and fixed precision wirewound resistors.

SP-508, Printed Wiring Definition and Register

Definition and register of all forms of printed wiring are included in this proposal. Definition is defined as the degree of faithfulness of reproduction of the conductor referred to the original master drawing. Register is the degree of alignment of conductor with intended position on the printed wiring board.



Indicators

MIL-L-7806, LIGHT, PANEL, PLASTIC PLATE LIGHTING AMENDMENT 1, 10 APRIL 1956

The requirement for the design of the holder assembly have been tightened by specifying that parts that deform under the environmental conditions specified are not acceptable. In addition the cap may be either opaque or transparent as specified, and the light omitted by the transparent cap shall be identification red.

Dollar Savings Through Standards

Seventy-nine cases of savings resulting from standardization are covered in a newly-published survey by ASA entitled, "Dollar Savings Through Standards." The studies were prepared for ASA by 70 American companies and 6 associations. They cover about 27 industrial fields. Copies of the survey will be furnished by ASA free on request. Also recently published by ASA is a four-page booklet entitled "What Is an American Standard?". Copies of this booklet may also be obtained without charge from ASA.

Application Design Notes

ASESA 51-4, APPLICATION DESIGN NOTES (ELECTRONIC COMPONENTS,

The following new ADN's have been added to this publication:

Part Name	ADN No.	Date
Rectifiers, Metallic, Selenium	11050	10 June 1956
Type Designations and Color Coding of Capacitors	CAP-1	31 July 1956

BuShips QPL Additions

BuShips intends to establish qualified products lists for the following procurable items:

- Metallic Rectifiers (MIL-P-15736)
- Plastic Rods, Polytetrafluoroethylene, Molded and Extruded (MIL-P-19468 (Ships))
- Insulation Sheets, Electrical, Pasted Mica, Silicone Bonded (MIL-I-19526 (Ships))
- Molding Plastic and Molded Plastic Parts
- Glass-Fiber Filled Phenolic Resin (MIL-M-19536 (Ships))
- Capacitors, Fixed, Ceramic Dielectric, Standoff, Style CK 80 and CK 81 and Feed Thrus Style CK 70 (MIL-C-19321 (Ships))

Companies having a product which meets the requirements of these Specifications are urged to contact the Chief, Bureau of Ships, T10 Room 3403 Main Navy, Washington 25, D.C.

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.

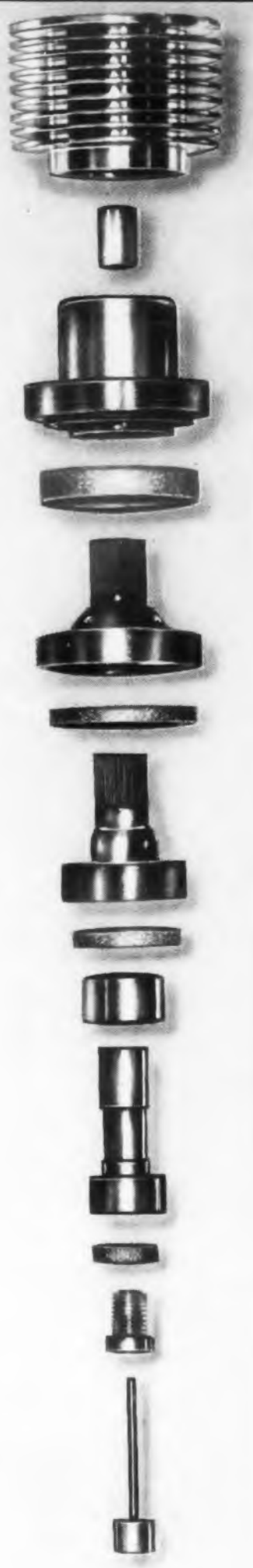
ADVERTISING INDEX

October 15, 1956

Ceramic bushings—important design feature of

NEW UHF BEAM POWER TUBES

RCA-6816 and RCA-6884



Actual size exploded view of these new UHF Beam Power Tubes. Seen are the coaxial structure, the one-piece construction of elements and the unique control and screen grids.

lightweight...small size...high efficiency

80 watts cw output at 400 Mc! • 40 watts cw output at 1200 Mc!

Only 1⅛" high, 1¼" diameter, and 2-ounces in weight, RCA-6816 and RCA-6884 are exceptionally well suited for oscillator, multiplier, and amplifier applications in communications equipment where *light weight, physical compactness, and rugged construction* are important design considerations.

These versatile RCA-designed tubes are the result of unusual precision-production techniques and processes. For example, simultaneous cutting of both control grid and screen grid is effected by an electrical-discharge method which assures exceptionally uniform and accurate alignment of these structures. All welding of tube elements to their individual supports and internal leads is eliminated through use of one-piece construction which combines each electrode, its support, and its external contact surface. This feature provides low-inductance paths, high electrical and thermal conductivity, and rugged construction. Coaxial electrode structure, and low-inductance large-area rf electrode terminals *insulated from each other by low-loss ceramic bushings* facilitate the use of these tubes in circuits of the coaxial-cylinder cavity type. Both types have integral radiator and gold-plated contact surfaces.

Because of their high power sensitivity and high efficiency, these new RCA tubes can be operated with relatively low plate voltage to give large power output with small driving power. RCA-6816 has 6.3-volt, 2.1-ampere heater and RCA-6884 has 26.5-volt, 0.52-ampere heater.

Typical CCS Values for RCA-6816 and RCA-6884 in CW Service

	400 Mc	1200 Mc
DC Plate Volts	900	900
DC Plate Amperes	0.170	0.170
Useful Power Output (watts)	80	40
Power Gain	28	9

Investigate these two new types for your uhf equipment designs. For sales information, contact the RCA District Office nearest you:

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MIDWEST: WHitehall 4-2900
Suite 1181,
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For technical bulletin now in production, write RCA, Commercial Engineering, Section J18-R2, Harrison, N.J.

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