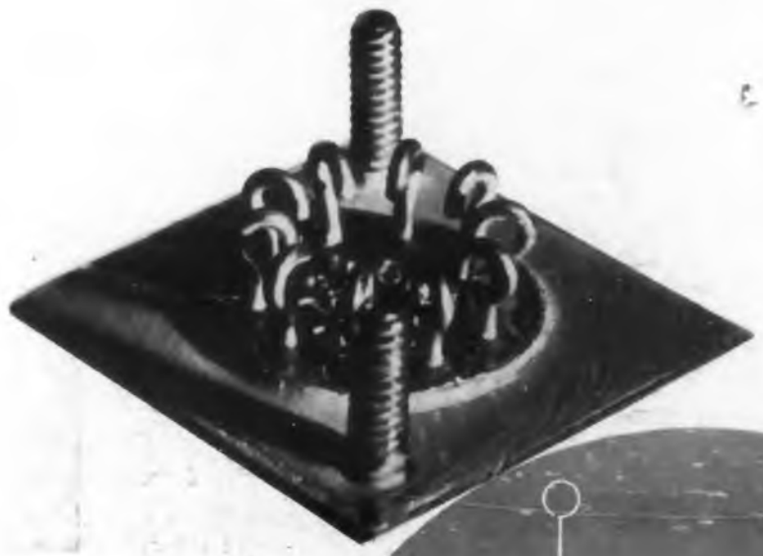
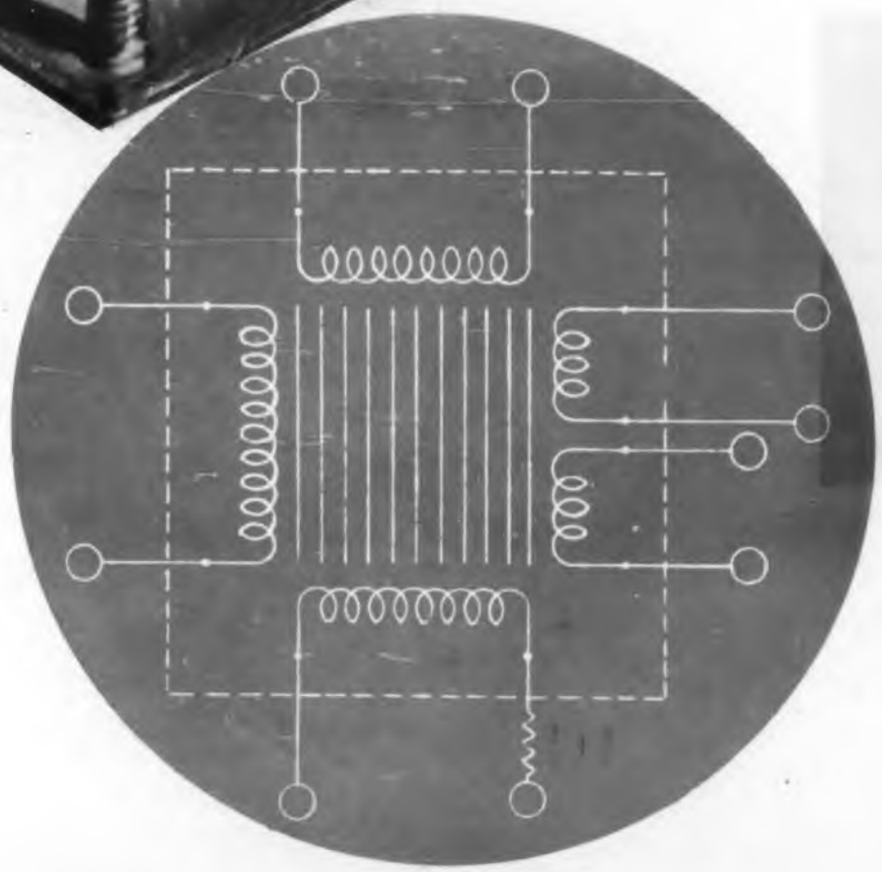
ELECTRONIC DESIGN

SEPTEMBER 1955





This magnetic modulator is stable, yet sensitive, and has unlimited life.

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

ELECTRONIC DESIGN is the fastest growing of all business publications.

Advertising increased 545 pages during first nine months of 1955 over the same period of 1954.

◀ CIRCLE 1 ON READER-SERVICE CARD

ELECTRONIC DESIGN

Vol. 3, No. 9
September 1955

Contents

BPA

ELECTRONIC DESIGN is published monthly by Hayden Publishing Company, Inc. at 19 E. 62nd Street, New York 21, N. Y., T. Richard Gascoigne, President; James S. Mulholland, Jr., Vice-President & Treasurer, and Ralph E. Marson, Secretary. Printed at Publishers Printing Company, New York, N. Y., ELECTRONIC DESIGN is circulated monthly without charge to men in the electronic industries who are responsible for the design and specification of manufactured devices, including development and design men of consulting laboratories and government agencies. Acceptance under section 34.64 P. L. & R. authorized. 24,000 copies this issue.

NBP

faster! more channels! more versatile!

THE NEW POTTER DIGITAL MAGNETIC-TAPE HANDLER

0 to 60 inches/sec. in 5 msec! 2, 6 or 8 channels

High-speed magnetic tape recorders with low start-stop times bring a new dimension to data handling by absorbing and dispensing digital information **when and where it's needed!** Any phenomenon can be recorded **as it occurs,** continuously or intermittently, fast or slow. It can later be fed into computers, punch cards, printers, etc.

Speeds of 60 inches per second with 5-millisecond start-stop times permit digital techniques with jobs previously requiring more expensive, less reliable methods. Typical applications include business problems, high-speed industrial control processes, missile study, and telemetering.

In addition, Potter Magnetic Tape Handlers offer wider tape widths for more channels with lower tape tension controlled by photoelectric servos. Yet, the price is a fraction of much less versatile recorders. Other data handling components and complete systems are available for special problems.

DETAILED SPECIFICATIONS

Model	902AJ	902BJ	902BK	902CJ	902CK
Number of Channels	2	6	6	8	8
Tape Width (inches)	¼	½	½	⅝	⅝
Tape Speed (in./sec.)	15/30	15/30	15/60	15/30	15/60
Reel Size (dia. in inches)	10½	10½	8	10½	8
Reel Capacity (feet)	2,400	2,400	1,200	2,400	1,200
Start Time	5 Milliseconds				
Stop Time	5 Milliseconds				

For complete information, write to Department 10-F.

Potter

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CIRCLE 2 ON READER-SERVICE CARD FOR MORE INFORMATION

Editorial

Designers and the Atom

Practically all scientific, industrial, and commercial activities make use of electronics in some form. The latest field to call upon the talents of electronic design engineers is atomic energy and its by-products.

It can truly be said that without electronic techniques, the advances made in both military and peaceful atomic energy development would have been impossible. The recent international conference on "Peaceful Uses of Atomic Energy" therefore has special significance for electronic design engineers. Each of the advances reported at this meeting, and many yet to be revealed, is tied to some advance in electronic techniques.

The importance of electronic technology to the atomic energy development program is indicated by the many electronic patents being released to industry by the Atomic Energy Commission on a royalty-free basis. The rapidly growing nuclear instrument industry also indicates the close tie between the two sciences.

This is a two-way relationship. The needs of the atomic scientist stimulate new and fresh design thinking among electronic design engineers to create new electronic devices. These in turn give the atomic scientist new tools with which to explore new frontiers which again create a need for more sensitive devices, and so on.

To stimulate this process, an exchange of information is needed. The electronic design engineer must know the needs of the atomic specialist. The government's plan to release more information on the atomic energy program is a great step in the right direction. It is however, only one step. What is really needed is a regular program of continually challenging the electronic industries to come up with needed devices. This challenge should be explicit, direct, and widely circulated among electronic engineers.

ELECTRONIC DESIGN will continue to do its part to stimulate electronic design engineers along these lines by bringing to their attention the needs of the growing atomic industry.

Engineering Review

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

Enormous Electronic Installation in New Mart . . . The world's largest building, the Palace of Progress, will incorporate revolutionary new electronic facilities costing millions of dollars. If present plans materialize, the huge merchandising mart will be constructed over Pennsylvania Station in New York City. Television programs, for both broadcasting and closed-circuit transmission to all parts of the nation, will originate in its extensive studios and by means of strategically placed cameras all over the building. In return, cameras in industrial plants all over the nation will feed images of heavy machinery to huge projection screens for the benefit of purchasing agents. Elaborate electronic computing facilities will control traffic, air conditioning, heating, and guard against fire.

To aid visitors, electronic travel directories will tell them how to reach a particular exhibit of goods and also inform the exhibitor that prospective customers are on their way. A bank of TV monitors in the entrance halls will give visitors a generous sampling of activities and exhibits in the building.

Long-Range TV Transmission

World-wide news will both originate from and be received in the building. Extensive press facilities are planned, while TV news programs originating live all over the World would be displayed in main rooms by projection. This latter feature is called "Teleprint" transmission. A cameraman will shoot an event by means of a portable TV camera. The image will be transmitted to a nearby central station. where the transmission would be recorded on magnetic tape. This tape is fed into a radio transmitter for long-range transmission to New York. At the Palace of Progress an identical magnetic tape is produced by a receiver. This tape is then placed in a kinescope for projection in main rooms. The projection could take place within minutes after the event occurs, depending on handling time and the bandwidth of the radio signal. The wider the bandwidth, the faster the tape can be fed into the transmitter.

The elaborate electronic building control facilities are necessary because large groups of people moving from one space to another require rapid adjustments in air conditioning, elevator operation, and policing. All of these electronic control facilities would be supervised by a master computer. At night when the building is empty, this computer could be used to solve business problems for the various tenants.

Twenty-four completely equipped TV studios are planned. The TV facilities call for the design and development of some unusual camera-mounting arrangements known as the "mobilescope" and the "remotemobile". The mobilescope is a remotely directed unit containing a camera and equipped with octopus-like arms supporting microphones and lights. A number of mobilescopes would run on monorails about the main exhibition halls. They would be directed by technicians in a large control booth suspended from the ceiling. A considerable number of servomechanisms are needed in the mobile scopes.

Remotemobile

The remotemoblie (illustrated on another page) is a self-contained vehicle with two mobilescopes attached to it. It would be manned by two technicians, who would drive it about the building providing spot news coverage and supporting the regular camera facilities. It will be quite a feat to design a small vehicle containing a power source, drive motor, TV monitors, and remote controls for the mobilescopes. In order to transmit the pictures photographed by the remotemobile, it will most likely have to be plugged into a nearby outlet by cable, thereby restricting its mobility. An enormous number of outlets and miles of co-ax cable would have to be built into the walls of the building.

The building would be constructed by Webb & Knapp, Inc., of New York City. The unusual TV facilities were conceived by Pereira & Luckman, 8 E. 54th St., New York 22, N. Y., in association with many leading electronic manufacturers.

All the features of this building are hardly likely to be duplicated anywhere else, but many of them may be applied in other ways to serve other purposes. A wider market for the electronic industry, new employment opportunities for engineers and technicians, and another chance for the electronic art to help raise our standard of living if this remarkable building is ever constructed as planned.

News events taking place thousands of miles away will be projected on huge screens in the main rooms of the Palace of Progress within minutes by means of the yet-to-be-developed "Teleprint" TV system.

Cooperative Reactor . . . Eight industrial organizations have joined together to provide funds to construct a cooperative nuclear facility for industrial and medical research. The reactor, to be located near New York City, will be operated by a leading university as the Industrial Research Laboratories.

The participating firms are AMF Atomics, Inc., which will also build the "swimming pool" reactor, American Tobacco Co., Continental Can Co., Corning Glass Works, International Nickel Co., Chas. Pfizer & Co., Inc., Socony Mobil Oil Co. Inc., and United States Rubber Co. Other companies are expected to join in the venture.

Part of the operating time of the reactor will be devoted to medical research. The reactor should be in operation in the fall of 1956.

In addition to its participation in the cooperative nuclear research facility, the Socony Mobil Oil Co., Inc., 26 Broadway, New York 4, N. Y., is establishing its own Nuclear Research Center. The center will operate a Van de Graff accelerator and various other radiation sources including secondary types utilizing antimony-124, cobalt-60, and iron-59.

Radio Show Back at Armory . . . Despite earlier assurances (*ED, June, 1955, p 6*) that the Coliseum in New York City would be completed in time for the next Radio-Engineering Show, it will not be ready before April, 1956. As a result the show will be held at the Kingsbridge Armory, the Bronx, for the third successive year, according to William C. Copp, exhibits manager. The show will run from March 19 to 22, 1956.

Over 750 exhibits are planned, compared to a record 705 last year. More than 250 concerns are on the waiting list for booths. According to Mr. Copp, there isn't a structure in the entire United States that could house all the exhibitors who want to participate in the 1956 Radio-Engineering Show.

Explosion Proofing . . . Design of electrical flight test instrumentation so that it cannot cause an explosion in flight is not too difficult, according to a paper read at the AIEE Pacific Meeting in August. B. F. Hager, Boeing Airplane Co., Seattle, Wash., pointed out that measuring and recording gear used in flight testing was designed primarily for non-hazardous locations such as laboratories. This equipment might ignite fuel vapors that are sometimes present in aircraft.

Hager suggested that certain design steps be taken to make this equipment explosion proof. These include hermetic sealing, proper venting, and holding heat-producing parts to a safe temperature—below 450°F. He stated that these design steps can best be taken by the original manufacturer.

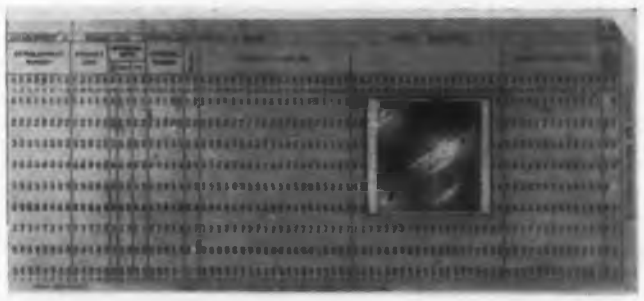
Tetrode Transistor Works at 1000Mc . . . An experimental tetrode junction transistor that oscillates at 1000Mc has been developed. The improved frequency characteristic results from the addition of the fourth electrode and greatly reducing the width of the central p-layer to less than 2/1000". The unit was produced at Bell Telephone Laboratories, Inc., 463 West St., New York 14, N. Y.

Blueprint Maintenance Mechanized . . . The finding, copying, and filing of engineering drawings, a very costly operation for most design laboratories and manufacturing plants, has been mechanized by new techniques. Prompted by exhaustive studies by various branches of the Government, a system involving the mounting of microfilm copies of the drawings in punched cards has been developed. One of the cards is illustrated below.

The punched cards are marked for identification and handled by conventional punched-card equipment. A special device known as the "Filmsort Surveyor" will project the drawing on a 24" x 36" screen from the mounted microfilm. The device is a product of Filmsort Div., Dexter Folder Co., Pearl River, N. Y. Microfilm now available is of a fine enough grain to permit projection of fine-line drawings on such a large screen.

The aperatures can be made in the card and the film mounted in the hole both manually or mechanically with various devices. Laboratories can set up their own mechanized blueprint department or hire various service organizations to perform the task.

A microfilm copy of an engineering drawing mounted in a punched card and equipment used to project the drawing on a large screen.



Transistors in Telephony . . . A telephone repeater utilizing transistors has been developed. The unit is used to raise transmission levels, thereby eliminating the need for expensive heavier cables.

The repeater was developed by Automatic Electric Co., 1033 West Van Buren St., Chicago 7, Ill. When located near the electrical midpoint of the line, it provides a gain of up to about 10db.

ASTM Committee on Electronic Materials . . . A new committee on electronic materials has been organized by the American Society for Testing Materials, 1916 Race St., Philadelphia, Pa., to cover the field of materials for electron tubes and semiconductor devices.

The committee, designated F-1 on Materials for Electron Tubes and Semiconductor Devices, will be concerned with materials for electron tubes such as grid wires, cathodes, mica stampings, glass-to-metal seals, and luminescent materials used in cathode-ray tubes and in fluorescent lighting.

TV Sets Kept Longer . . . People are holding on to their TV sets longer than heretofore, according to a report by the American Research Bureau, National Press Bldg., Washington 4, D. C. The average age of sets replaced has risen from 30 to 36 months. As a result sets should be designed to last for a longer period.

Production Speeded Electronically . . . By handling, inspecting, and testing speaker magnets by means of electronically controlled devices, production has been tripled at one plant. In addition, the new production line takes about 1/3 as much space as the old hand-labor line. Only two operators are required. The improvement was made at the Edmore, Mich., plant of the Carboloy Dept., General Electric Co.

◀ CIRCLE 6 ON READER-SERVICE CARD

American Color TV Shown Abroad . . . American color TV broadcasting and testing equipment was exhibited at the recent International Trade Fair in Hanover, Germany. The closed-circuit demonstration, stimulated by an invitation from the U. S. Dept. of Commerce, was put on by Telechrome Inc., 88 Merrick Rd., Amityville, N. Y. The exhibit attracted a great deal of attention from technical people and businessmen.

1000-Ampere Rectifier . . . A germanium rectifier with a capacity of 1000amp has been developed. Designed for plating operations, the rectifier is made by General Electric Co., Schenectady, N. Y. Down-draft air cooling is utilized to minimize the amount of dust and dirt taken into the unit.

Tuition Refunds . . . More than 1500 employees of the Radio Corp. of America are taking courses at colleges and universities outside working hours under the company's Tuition Loan and Refund Plan. During 1954, the corporation spent $141,000 to reimburse employees for the completion of their studies made possible by the plan.

In appreciation for the cooperation of over 60 colleges and universities where employees studied during the 1954-55 academic year, the corporation is making grants of up to $2500 to each institution.

Trans-Atlantic TV . . . At a recent press conference held in Paris, France, Henry Cassirer, head of the United Nations Education, Scientific, and Cultural Organization, predicted that television may span the Atlantic within the next five years, enabling an exchange of live shows originating in Europe and the United States. Submarine cables or relay links would be utilized in the predicted system. Present obstacles are high cost and the time differential, but the latter will always be present.

CIRCLE 7 ON READER-SERVICE CARD ➤

Printed Circuit Machinery . . . Another ingenious device has been added to the growing list of machinery for automatically assembling printed circuits. The machine will insert up to 40 self-retaining terminals in a printed circuit board in 3sec.

Known as the Automatic Pin and Contact Inserting Machine, it is made by Malco Tool and Manufacturing Co., Dept. EDN, 4025 West Lake St., Chicago 24, Ill. The device will insert the terminals in any symmetrical or non-symmetrical pattern. Components are then mounted in the terminals by some other means in the next production step.

TV Tube Sales Gain . . . Manufacturers' sales of receiving and cathode-ray tubes during the first six months of 1955 were considerably above the comparable period of 1954, the Radio-Electronics-Television Manufacturers Association, 777 14th St., Washington 5, D. C., reported. For the first half of this year RETMA reported sales of 4,914,024 picture tubes valued at $94,893,559 compared with 3,957,238 tubes worth $82,985,981 sold in the same 1954 period. From January through June manufacturers sold 226,502,544 receiving tubes with a value of $168,675,903 compared with 165,709,060 tubes worth $120,720,391 sold in the first half of 1954.

Forms Sorted Electonically . . . One of the most tiresome tasks in a business office—sorting forms of various types—has been placed on a mechanized basis. The operator glances at the form, depresses the proper key on a standard typewriter keyboard, and the form is placed in the proper bin automatically. The operation is about six times as fast as manual sorting.

The device, known as the "Rapid-Sort", was developed by Universal Business Machines, Inc., Columbia, S. C. It is being marketed by Underwood Corp., 1 Park Ave., New York 16, N. Y. It can handle various forms such as sales slips, bank checks and job tickets.

TV Sets in College Colors . . . Considering the sucess of the Bell Telephone System in installing phones done in college colors in dormitory rooms, TV manufacturers might develop a new market by offering portable receivers in college colors. According to the August 4 edition of *The Wall Street Journal* (*p 1*), the phones were very popular in a test installation at Georgia Tech.

APPLICATIONS !

Accurate Microwave Measurements . . . An apparatus that measure frequencies from 2400 to 40,000Mc to an accuracy of 0.001% has been placed on the market. This Microwave Frequency Standard consists of a temperature stabilized crystal oscillator followed by a multiplier-amplifier chain with outputs at 100, 500, and 1500Mc.

The instrument was developed by Narda Corp., Mineola, L. I., N. Y. It is supplied complete with sweep circuits for use with reflex klystron local oscillators to obtain beats with harmonics of the standard output.

Wireless F-M Microphone . . . An f-m wireless microphone for TV studio use has been developed. With its battery compartment, it can easily be concealed in the clothing of performers. It eliminates the need for booms and their cables.

The microphone and battery cases are each 4-1/2″ x 2-1/2″ x 1″ in dimension. Output is 75mw in the band from 26.110 to 26.470Mc. The unit was developed by Budelman Radio Corp., 375 Fairfield Ave., Stamford, Conn. A companion receiver is also available. An eight-transistor wireless microphone (ELECTRONIC DESIGN, *November, 1954, p 14*) has been available for some time, but it broadcasts a-m signals at 530kc.

Chemicals Examined Electronically . . . Carbide and Carbon Chemicals Co. has purchased an electron microscope to speed quality control tests of chemicals. The unit, with a magnification power of 30,000, will examine the particle size and structure of vinyl resins.

The microscope has been installed at the firm's S. Charleston, W. Va., plant where it will also be used in materials research. It was made by Radio Corp. of America, Camden, N. J. It would be interesting if the chemicals examined by the device were eventually used in electronic equipment or their manufacture.

Automation Equipment for TV . . . Automation of TV station film and slide programming equipment has been demonstrated by the General Electric Co. Once the system, now in the exprimental stage, is set into operation, supervision of the equipment is not necessary. All station breaks, commercials, and programs are handled automatically by the automation system. Key to this system are inaudibe tone signals recorded on magnetic tape.

The system is being used to demonstrate new color film and slide equipment for TV stations. It could be used to control a TV station's complete programming schedule.

Ultrasonic Pickling . . . Ultrasonic vibrations are being used in the pickling and descaling of metals in acids and caustics and in electroplating and electroless plating.

Developed by the General Ultrasonics Co., Hartford, Conn., the "Sonistrip" process accelerates the pickling and cleanup effects of acid or caustic solutions by radiating ultrasonic vibrations at 19,800cy. In the electroplating process, ultrasonic vibrations are introduced into the plating bath, increasing plating current density and throwing power, and eliminating anode polarization and edge build-up.

Computer Donated to Stevens . . . The Underwood Corp., Long Island City, N. Y., has donated one of its ELECOM 100 digital computers to Stevens Institute of Technology, Hoboken, N. J. The instrument will be employed in the graduate and research programs at the school.

TV Production Predictions . . . Radio and TV set manufacturers estimate that monochrome TV production be about 7 million sets in 1955 and somewhat less in 1956. According to the same unofficial poll conducted by the Radio-Electronics-Television Manufacturers Association, 777 14th St. N. W., Washington 5, D.C., radio set production should be about 13 million sets in 1955, including 4.5 to 5 million automobile radios.

Manufacturers were in less agreement about color TV set production but the average predictions were 35,000 receivers for 1955 and between 250,000 and 300,000 in 1956.

TV Sales Up . . . The number of TV receivers shipped to dealers during the first five months of this year was up nearly 13% above the same period in 1954. According to the Radio-Electronics-Television Manufacturers Association, 777 14th St., N. W., Washington 5, D.C., 2,677,630 sets were shipped during January to May, 1955, compared to 2,370,098 units shipped during the same months in 1954.

◀ CIRCLE 9 ON READER-SERVICE CARD

Home Computer . . . A simplified computer to perform household chores was mentioned as an electronic possibility in a recent speech. Dr. W. R. G. Baker, general manager, Electronics Div., General Electric Co., Syracuse, N. Y., discussed the computer in a speech on the effects of electronic research on American life. Among the duties of such a computer would be starting of the stove, turning on the radio or TV set, adjusting the thermostat, and closing the garage door.

Nuclear Energy Libraries . . . Technical libraries of non-classified data on nuclear energy and its applications have been shipped to 23 nations by the Atomic Energy Commission, Washington 25, D. C. Each library consists of approximately 6500 AEC research and development reports; 34 volumes of scientific and technical texts on nuclear theory; and 11 volumes of abstracts of some 50,000 reports and articles published in this country and abroad.

Engineers Largest Profession . . . There are some 700,000 persons in the United States who may be classified as engineers and physical scientists. The ministry, medicine, and law account for only 200,000 each, the engineers and scientists outnumbering the other three traditional professions combined, M. D. Hooven, AIEE president, said at a recent meeting. The demand for engineers is said to be 30,000 to 40,000 new graduates annually. This annual demand is three times the requirements of the other three professions put together.

Nuclear Society Officers . . . Dr. W. H. Zinn, director of the Atomic Energy Commission's Argonne National Laboratory, Lemont, Ill., has been elected the first president of the American Nuclear Society. Other officers are Philip Sporn, American Gas & Electric Co., vice-president; Dr. Karl Cohen, Walter Kidde Nuclear Laboratories, Inc., treasurer; and Dr. J. G. Beckerly, Schlumberger Well Surveying Corp., editor.

CIRCLE 10 ON READER-SERVICE CARD ➤

Electronics in Oil Industry . . . The oil industry is continuing to spend many dollars on electronic devices. An automatic control system for a pipe line, a two-ton electronic mass spectrometer, a tank-gaging system, and new microwave communication facilities are among the new installations.

The Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., is providing electronic flow controls for a key section of the Interprovincial Pipe Line. The line stretches from Alberta to Ontario, Canada. Built into the control system are a variety of protective devices that can instantaneously shut down the station when required, or can signal abnormalities in pressures or pumping engine operation.

Consolidated Engineering Corp., Pasadena, Calif., has constructed a new mass spectrometer for the Houston, Texas, Refinery Research Laboratory of the Shell Oil Co. This instrument will identify two to three times as many chemical compounds in petroleum as the conventional mass spectrometer. The mass spectrometer breaks up, identifies, and counts the elements of complex gas and liquid mixtures by bombarding the substance with an intense electron beam. The unit weighs two tons.

Gilbert and Barker Mfg. Co., West Springfield, Mass., is supplying an electronic tank gage to the oil industry. The gage measures the depth of oil in large tanks to accuracy of $\pm 1/64''$. It also sounds an alarm when the level is too high.

Collins Radio Co., Cedar Rapids, Iowa, is going to build a large microwave communications facility for the Continental and Sinclair pipe line companies. To stretch from northern Oklahoma to Houston, Texas, near the Gulf of Mexico, the system is designed to carry 120 conversations simultaneously. There will be 25 relay stations between the terminals.

More Transistor Radios . . . Four more transistor radios have been placed on the market. Radio Corp. of America, New York, N. Y., has produced two types, a six-transistor type and a seven-transistor model. The former will fit in a case 5-1/2" x 3-1/4" x 1-1/2" in dimension. Both will sell for about $80.

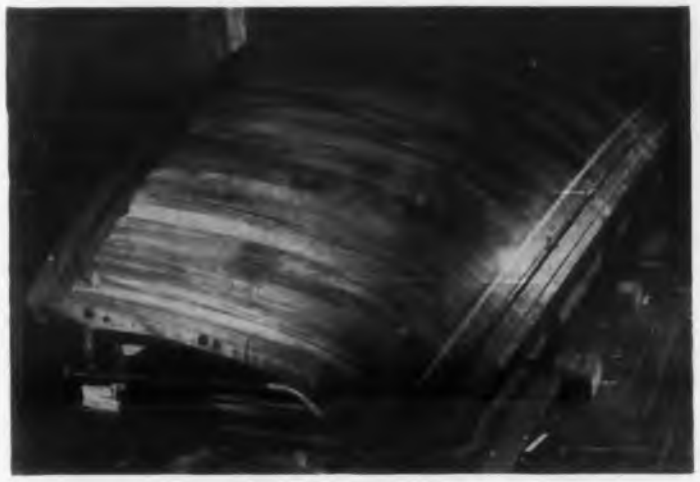
Crosley Div., Avco Manufacturing Corp., Cincinnati, Ohio, will market a hybrid portable. Like the previously announced Emerson portable (*ED, July, 1955, pp 48 and 49*), it will have two transistors and three subminiature tubes. It will be mounted in an enclosure 7" x 4-5/16" x 2" in dimension.

A four-transistor plus one diode portable has been developed by Mitchell Manufacturing Co., Chicago, Ill. It has the same semiconductor complement as the previously announced Regency portable and also costs about $50. It operates on a 22.5v battery. Several other manufacturers are expected to market all or part transistor radios in the near future. It will be of interest to see if the all-transistor or hybrid radio gains the greatest consumer acceptance.

Fiber Glass Antenna Reflectors . . . Fiber-glass reinforced plastics are being used to make large lightweight, inexpensive reflectors for radar antennas. The reflector is being employed in a K-band radar that observes aircraft taxiing about crowded airports.

This method of constructing plastic reflectors was developed by Emerson & Cuming, Inc., 869 Washington St., Canton, Mass. A wooden form, like the one illustrated below, is first assembled. Metal templates are set in the surface at 2" intervals. Then sheets of aluminum foil, which will form the reflecting surface, are stretched over the form. Fiber glass saturated with epoxide resin is then laid over the foil. A core material, either aluminum honeycomb, fiber glass honeycomb, or plastic foam, is applied on the cloth. A backing layer of fiber glass reinforced plastic is then placed over the honeycomb. Pads are embedded in this layer for attaching the supporting framework. The entire mass is cured to a rigid structure.

Instead of the aluminum foil, a metal could be sprayed on the laminate to form the reflecting surface. This reflector is used in a taxi radar developed by Airborne Instruments Laboratory, Inc., Mineola, N. Y. The antenna is made by ITE Circuit Breaker Co., Philadelphia, Pa.



The surface of this peruvian wood form for making antenna reflectors is accurate to ±0.007".

Aluminum reflecting surface of the fiber-glass reinforced antenna reflector for a taxi radar.

Mobile TV Studio

One of the electronic features of the "Palace of Progress" (see p 5) will be this self-propelled, self-contained "Remotemobile". The round objects contain TV cameras and servo equipment that controls the movements of the microphones and lights extending from the camera housing. The vehicle would move about providing spot news coverage.

Atomic Power Plant . . . An atomic-electric power plant of at least 150,000kw using the homogeneous-type reactor is planned for 1962. It is expected that such a plant will be commercially competitive with generating stations using conventional fuels. The reactor and plant will be developed by Westinghouse Electric Corp., and Pennsylvania Power and Light Co.

The fuel in a homogeneous reactor is in liquid form. This liquid, in addition to containing the radioactive fuel, also includes coolant and moderator to control the fission process. The liquid circulates freely throughout the nuclear power plant's system and carries heat to steam generators. The use of the liquid fuel system will permit the reactor to operate continuously as new liquid fuel can be added while the reactor is running.

Airlines Handle Reservations Electronically . . . Two airlines have joined the various transportation organizations that are now handling reservations by electronic data-processing equipment. United and National Airlines have purchased such electronic devices from Teleregister Corp., Stamford, Conn. This firm has recently sold similar equipment to the New York Central and New Haven Railroads.

The installations should result in considerable savings in handling reservations, quicker service, and fewer errors. The installation purchased by United Airlines, 5959 S. Cicero Ave., Chicago 38, Ill., is more extensive. It will be tied in with IBM automatic ticket printers. Eighty cities along United's routes will be

linked together. The equipment purchased by National Airlines, 80 E. 42nd St., New York, N. Y., will handle 3600 inquiries per hour.

The nation's large intercity bus systems are the only other possible means of transportation that have not as yet purchased automatic reservations devices. The ship lines are not likely to require such equipment.

40,000 Amperes . . . A capacitor recently developed for nuclear research purposes has an allowable peak r-f current of 40,000amp. The special capacitor is employed to provide a large amount of power in a very short time.

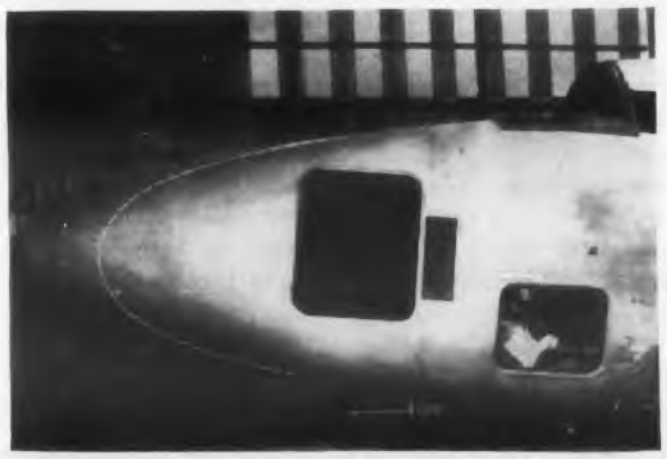
The unit was developed by Tobe Deutschmann Corp., Norwood, Mass. In order to accomplish the rapid discharge required, the internal inductance and resistance of the capacitor must be held to a minimum. This unit, encased in a cylinder 3′ diam x 2′ high, has an inductance of 0.08uh and an internal resistance corresponding to a Q in exces of 1000. The electrical rating is 0.12μfd at 50kv. Such capacitors are also used in high-power r-f generators.

Disappearing Antenna . . . The highest priced line of Crosley TV receivers for 1956 includes a disappearing indoor antenna. The directional antenna telescopes into a hole in the top of the cabinet.

Another line of receivers manufactured by the Cincinnati firm features an indoor antenna that plugs into the top of the cabinet. When not in use, this plug-in antenna can be stored in a rack on the back of the cabinet. All of this firm's receivers have their controls on the side of the cabinet.

Cyrano-Like Nose

The nose of this Learstar executive plane has been stretched to accommodate a Bendix X-band weather radar. The dotted line indicates the shape of the nose before the radome was installed. The speed of the craft, made by Lear Inc., Santa Monica, Calif., will actually be improved by the addition of the aerodynamically designed fiberglass radome to the aircraft.



Tube Simulates Typesetting . . . An electron-image tube translates coded signals from tape, keyboard, or radio into clearly defined letters and figures at speeds up to 100,000 words per minute for high-speed photographic recording. Further development is expected to fit the tube for wider application in general printing as an electronic means of typesetting.

In operation, the tube simulates typesetting in selecting letters and figures from a font and placing them in luminous form on the 5″ circular tube face either in lines or in any pattern desired. The source of the coded information can be perforated paper tape, magnetic tape, wire or radio signals, keyboard selection, or an electronic storage unit.

Since the image on the tube face is to be recorded on photographic film, the tube can produce letters with clear definition and high level of brightness. In laboratory tests 2,000 characters per second have been recorded from the tube face on standard 35mm film. The tube was developed at the David Sarnoff Research Center, Radio Corp. of America, Princeton, N. J.

Nuclear Waste for Atomic Batteries . . . At the recent international "Atoms - for - Peace" Conference in Geneva an American scientist suggested that radioactive waste from nuclear reactors could be used in making atomic batteries. Dr. E. G. Linder, Radio Corp. of America, New York, N. Y., made the suggestion in pointing out the large amounts of energy latent in the waste.

New AEC Division . . . A Division of Civilian Application has been established in the Atomic Energy Commission. The new Division takes the place and assumes the responsibilities of the Division of Licensing and carries out other civilian use activities.

The Division is responsible for developing AEC regulations and other instructions dealing with licenses and authorizations; authorizing the distribution of source, special nuclear, by-product, and other materials; administering the program of access to restricted data for civilian use; and

CIRCLE 15 ON READER-SERVICE CARD ➤

NEW HIGH STANDARDS O C
CAMERA-TUBE PRODUCTION B

Extreme delicacy in processing parts for G-E camera tubes is shown as this glass technician fabricates an image-orthicon target. The glass bubble she holds is only 1/10,000 inch thick. After cutting out a small section, she seals this carefully to a metal ring. Any slip or other false movement would completely ruin the fragile target.

Without aid from magnification, the human eye cannot see the openings (250,000 to a square inch) in this copper mesh for a G-E image orthicon—shown here being welded to its ring. Note the rubber finger cots used by the General Electric worker, to avoid contaminating the silk-fine mesh!

Target and mesh are assembled, then riveted together with a spacing of 1/500 inch, to form a link between optical image and electrical signal. A single dust particle could mar tube performance; so before work starts, these G-E specialists sit quietly for ten minutes, to permit any dust to settle that may remain in the air after filtering and conditioning.

18-inch offset screwdrivers are used to tighten the set-screws holding target and mesh assembly in place in the camera tube. Skill, care, and time are needed to complete the delicate operation. Again, dust and lint are barred. An important step toward cleanliness, is the lint-free Nylon garments worn by all persons in the G-E camera-tube area.

handling authorizations to export equipment and materials or to engage in atomic energy activities outside the United States.

More Homes With TV . . . More than six times as many households had TV sets in June 1955 than in April 1950, according to the results of a survey of the United States recently conducted by the Bureau of the Census. About 32 million, or 67% of the households enumerated in June had one or more TV sets, whereas in 1950, the first time that a question on TV was included in a census of housing, there were about 5 million households with TV sets or 12% of the total.

This finding agrees with a report made by RETMA that the number of TV sets shipped to dealers in the first half of 1955 was considerably above that of a comparable period last year. During the first six months of this year, 3,084,717 TV sets were shipped compared with 2,667,603 receivers shipped during the same 1954 period.

Accelerator to Middle East . . . A 3 million volt Van de Graaff positiveion accelerator has been sold to the Weizmann Institute of Science, Rehovoth, Israel. The machine, manufactured by High Voltage Engineering Corp., Cambridge, Mass., will be the first accelerator in the Middle East. It will be installed in the new nuclear physics department building.

The accelerator will be used in the study of nuclear reactions produced by bombardment of nuclei with high energy protons. It is expected that the machine will contribute substantially to Israel's atomic research program.

Electronic Firewatchers . . . TV cameras in forest lookout towers now are being used to relay TV pictures of surrounding areas back to forest headquarters, it was reported in the August issue of *Industrial Research Newsletter*, Armor Research Foundation, Chicago, Ill. The system of TV monitors and rotating, remote controlled cameras was demonstrated by Raytheon Manufacturing Co. to the Forestry Conservation Communications Association.

Underwater TV

An RCA closed-circuit TV camera is enclosed in this diving bell. The U. S. Fish and Wildlife Service is employing it to study experimental fishery methods at the ocean's bottom. Images obtained with natural light were clear enough for photography. The bell turns 360° and up and down.

New Computer Uses . . . Computers are now being used by various companies in solving machining problems, research for the utility gas industry, inventory control, aircraft manufacturing, refinery monitoring, and weather forecasting.

An electronic analog unit developed by the Carboloy Dept., General Electric Co., Detroit, Mich., will solve machining problems for tool engineers. The unit will determine whether the correct set of conditions for machining a job are being used; arrive at a proper set of conditions for setting up a new machining operation; or indicate the relative advantages of changing some of the present job conditions to obtain greater production.

Research in the utility gas industry will be facilitated by the use of a computer, ALWAC III. The computer will be used in computing composition of gas mixtures, pressure drops and flows, flame temperatures, thermodynamic properties of gases, and other research problems. The machine was built by Logisties Research Inc., Redondo Beach, Calif., and is installed at the Institute of Gas Technology, Illinois Institute of Technology, Chicago, Ill.

Nuclear Development Associates, Inc., White Plains, N. Y., is building a computer to watch over 35,000 different inventory items in the stock rooms of the Otis Elevator Co. The computing system will keep a continuous up-to-date record of quantity of each item on hand and on order; warn the company when and in what quantities to reorder items, provide

a daily report for expediters on all items that are going on shortage and all contracts affected by these shortages, and provide information for scheduling production to meet contract dates.

An analog computer that predicts the increasingly high temperatures that aircraft brakes must absorb without failure is at work in the B. F. Goodrich Co. airplane wheel and brake plant, Troy, Ohio. The machine supplies facts concerning heat flow characteristics of metals. Use of the computer makes it possible to discover immediately whether or not a new design or material has promise as an airplane brake part and if it warrants further research and engineering effort.

Three electronic data processing systems will be installed at the U. S. Air Force's Arnold Engineering Development Center, Tullahoma, Tenn. One will be for a fully automatic wind tunnel system that will measure pressures on jet engines and air-foil sections during wind tunnel tests. The second system will measure force and moments (lift, pitch, drag, yaw, side force, roll, etc.) on aerodynamic and propulsion models. Another data-processing system will speed up testing of turbojet, ramjet, and turboprop engines under simulated flight speeds, altitude, and flight conditions.

Decimal digital differential analyzers are used to solve differential equations employed in describing the dynamics of aircraft and missiles by Convair Div., General Dynamics Corp., San Diego, Calif.

An industrial data reduction system for the Canadi- and Petrofina Ltd. refinery, Montreal, Canada, is scheduled to go into operation in November. The "Automatic Logger" will automatically monitor, analyze, and record a total of 480 variables for the nine production units at the refinery.

The effects of violent surges of lightning on electrical apparatus can be studied in more detail through the use of an analog computer. One of the primary uses of the computer will be caculating voltages and stresses so that transformers can be designed and built to prevent damages inside transformers when lightning strikes the equipment. It has been installed at the Westinghouse Electric Corp., Transformer Div., Sharon, Pa.

Experimental weather forecasting has been carried on for some time using the International Business Machine's 701 digital computer. The computer is in use at the U. S. Weather Bureau, Suitland, Md.

Exporting Know-How . . . A private "Point Four" program has been set up by an American firm. The Minneapolis-Honeywell Regulator Co. has announced that it will establish a technical training school in England to train technical personnel in the use of American automatic control equipment. At first classes will comprise only members of the firm stationed in Europe, but later students from customer firms will be included in the instruction program.

Helmet Transceiver

The range of the hybrid f-m transceiver mounted on the soldier's helmet is a quarter-mile. Operating in the 45 to 50Mc range, unusually high for transistors, the experimental device weighs only 15 oz. The 10-transistor superhet receiver can be detached for separate use. The transmitter uses two transistors and one tube. Developed by RCA, the unit is now being evaluated by the Signal Corps.

Pleasing the Public . . . RETMA has taken two steps to insure better understanding between the public and the television manufacturing and servicing industry. An "accreditation" program for television servicemen has been proposed, and another edition of a booklet telling how to buy a TV receiver has been published.

If the accreditation plan goes into effect, local committees would sponsor servicing courses for servicing personnel. All men passing the course would receive a certificate from RETMA suitable for hanging in their shops. The public would benefit from their improved proficiency.

The booklet is entitled "Things You Should Know About the Purchase and Servicing of Television Sets". Better Business Bureaus and local TV dealers will distribute the booklet.

Engineers Following Plants Inland? . . . The Air Force's emphasis on dispersal of aircraft manufacturing plants inland may force many electronic engineers to move. The major aircraft companies are building new factories in the Southwest, Middle West, and South rather than on the coasts. At present only a very small percentage of the nation's electronic engineers are employed in the Southwest and South.

TV in Trailers . . . The growing number of trailers purchased in the United States represents a potentially valuable market for TV receivers. Although some trailers among the close to 100,000 being sold each year are equipped with TV, no manufacturer has brought out a set specifically designed for this market.

A small screen (14 or 17″) set with some shock-mounting and ruggedization is required. It must be able to operate in fringe areas. Some means of securing it to the wall of the trailer or to a shelf should be incorporated. For high sales, the set would have to be sold as original equipment, just as most auto radios are sold today.

Literature Searches Simplified . . . The National Bureau of Standards has devised a punched-card system for speeding searches by Government researchers into previously published literature on instrumentation. Searches in this field are particularly time-consuming because the material is not as well organized and because the same information may be required by researchers in widely divergent fields.

Referred to as the "multidimensional approach", the system was designed and constructed by Joshua Stern of the Bureau's Office of Basic Instrumentation. Only inexpensive hand-operated indexing equipment is required for use with the system.

Rear Warning Radar . . . Among the electronic devices demonstrated at the recent air show at Le Bourget airport, Paris, France, was a rear warning radar. According to the August, 1955, issue of *Wireless World* (*p 375*), the device was installed on a French "Ouragan" jet fighter. It would be especially valuable in warning of approaching interceptors.

A radio compass in which the indicator is a small cathode-ray tube was also demonstrated. A product of the French firm S.I.N.T.R.A., it avoids the use of moving parts. It also has the advantage of indicating immediately if the equipment stops working.

High Research Total in '65 . . . National research and development expenditures will be at the annual rate of between six and seven billion dollars by 1965. This prediction was recently made by Dr. W. R. G. Baker, general manager, Electronics Div., General Electric Co., Syracuse, N. Y.

In order to spend such a huge amount on research, the number of students studying the sciences and technologies will have to be increased. At the present time the number of students entering scientific training institutions is dropping alarmingly.

If you need to locate a special component, send a brief statement of your specifications addressed to Bulletin Board, Electronic Design, 19 E. 62nd St., New York 21, N. Y. Include your complete address.

Conductance Curve Design of Relaxation Circuits

Keats A. Pullen, Jr., Ballistic Research Labs
Aberdeen Proving Ground, Maryland

Small signal amplification and distortion as well as preferred component sizes can be determined directly from conductance type data sheets. Conductance curves are contours of given constant values of transconductance, g_m, and plate conductance, g_p, plotted on I_p vs E_p graphs.

Values of g_m and g_p are read at the bias contour-load line intersections of interest. The pairs of values are then inserted in the amplification and distortion equations.

$$VA = -g_m R_L/(1 + g_p R_L)$$

The approximate second harmonic distortion is found by substituting VA for the limit values of grid bias in the distortion equation

$$\% \text{ Distortion} = 25(VA_1 - VA_2) / (VA_1 + VA_2)$$

For a more complete discussion of electron tube circuit design using conductance curves, see reference at the end of this article.

PLATE conductance data for dynamic conditions as determined from conductance curves can aid in the analysis and design of relaxation circuits. General equations which can be used in conjunction with conductance curve data are presented to help determine exact initiation time.

Analysis and design of relaxation circuits may be divided into two phases. The first phase might be called the passive phase. The second phase is the active phase. The techniques for calculating passive circuit performance are well understood. However, the correction for plate conductance on the decay characteristic in multivibrators has been handicapped by the lack of adequate plate conductance data. Lack of adequate data on dynamic parameters of the active elements has hampered the determination of the initiation point and active transition characteristics.

The problem of presentation of dynamic data for aiding the design of comparatively linear tube circuits has been described (see references). However, where a wide degree of variation for the range of the tube parameters is required, previously described forms of curves may not prove adequate.

The use of a logarithmic plate current scale on the standard plate or screen conductance type characteristics curves provides the required range of data on at least the static parameters. Choice of suitably scaled contour values for the conductance contours could then provide the dynamic data.

A set of logarithmic curves on the *6SN7* (*6J5*) triode tube has been prepared on one triode section. Fig. 1. As can be noted, the plate current range is from 1μamp to 10ma. The grid bias range is from 0 to —26v. The transconductance and plate conductance contours plotted are those having 1, 2, 5, 10, 20, 50, etc. μmhos up to the maximum value provided

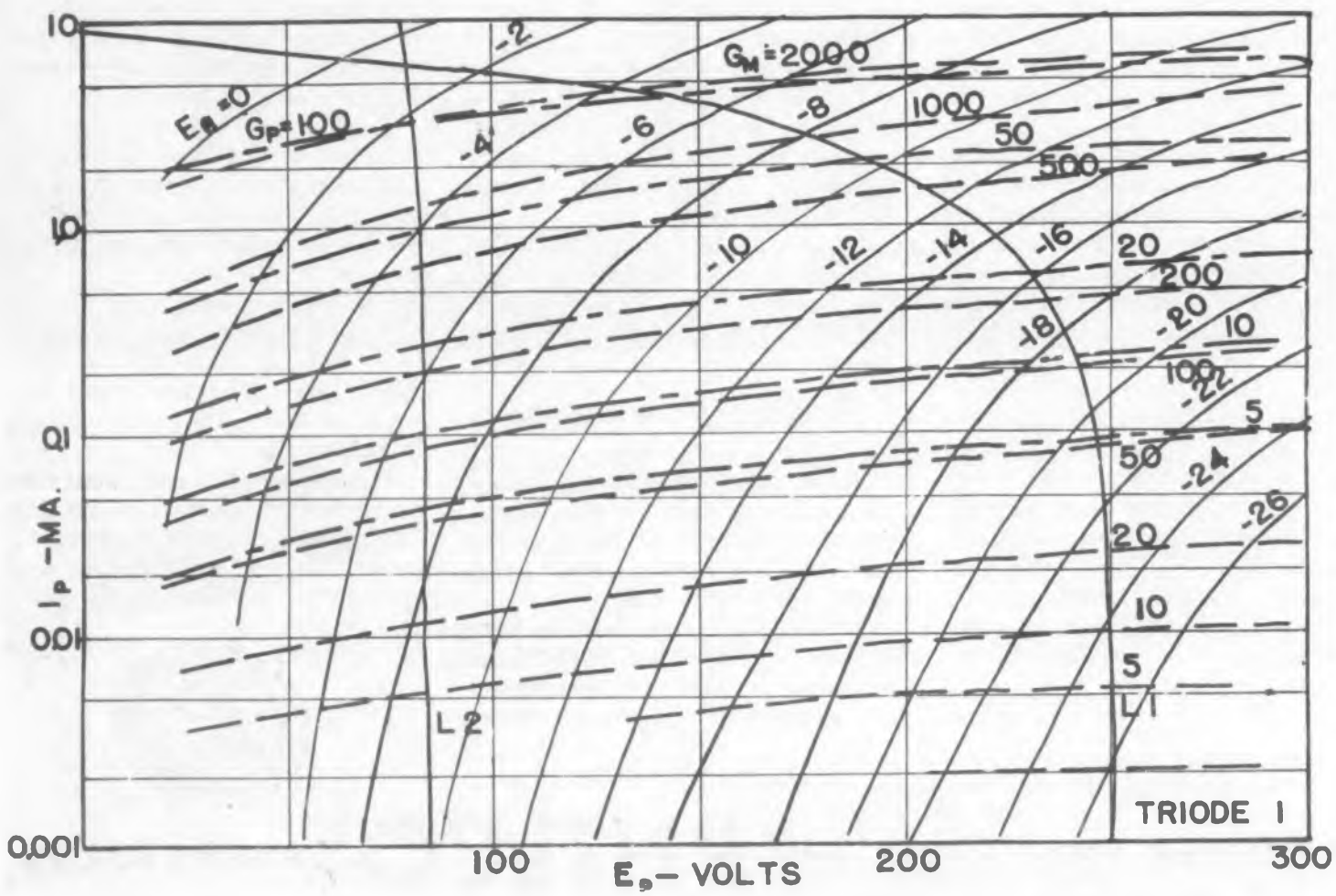


Fig. 1. Logarithmic plate current scale for plate conductance characteristic curve of *6SN7* tube.

in the tube at zero bias. The comparison with conventional curves is indicated by Fig. 2.

Although the requirement of a curved load line would initially appear to lower the usefulness of the semi-logarithmic plot of Fig. 1, as compared to Fig. 2, the operation of plotting the curved load line is not difficult. Whenever a wide range of data must be provided, the usefulness of the spreading of the data in the low transconductance area more than offsets the inconvenience.

During the initation of transition in the multivibrator, dynamic characteristics on both active elements must be known. Transition initiation in a free-running multivibrator occurs as a result of the slow drift of the bias of the tube which has been switched off back toward the conducting condition. Transition may be expected to start immediately upon establishment of an open circuit loop amplification of approximately unity. The drift of bias, neglecting the effect of loop amplification, would be comparatively uniform. The effect of the rise of loop amplification is to speed up the transition by introduction of a voltage in series with the discharging capacitor which acts in such a direction as to change the bias more rapidly. If, for example, the amplification of triode *1* is minus A_1 and triode *2* is minus A_2, the voltage change in triode *2* from a change in voltage E_0 in the grid of triode *1* is $E_0A_1A_2$. Consequently, the apparent voltage applied at the grid of tube *1* now becomes $E_0(1 + A_1A_2)$. Expanding this equation with successive cycles of feedback, gives a product series.

The voltage rise due to amplification, of course, does not occur instantaneously. The rate of rise depends on the stray circuit capacitances as well as the amplifications of the two amplifier tubes. Strictly, at least two build up functions will interract to control the time delay around the loop. The amplification then may be written as

$$VA = \prod_{j=1}^{\pi} [1 + A_{1j}A_{2j}\sigma_{1j}\sigma_{2j}\Delta b_j^2] \qquad (1)$$

The function σ is related to G's and C's, which are variable, and must be calculated from the circuit parameters by the use of equations 2 and 3.

$$\begin{aligned} G_{1j} &= 1/R_{l1} + G_{p1} + 1/R_{c2} \\ G_{2j} &= 1/R_{l2} + G_{p2} + 1/R_{c1} \\ C_{1j} &= C_{pk} + C_{pc1} + C_{ck2} + (1 + A_{2j})\,C_{cp2} + C_d \\ C_{2j} &= C_{pk2} + C_{pc1} + C_{ck1} + (1 + A_{1j})\,C_{cp1} + C_d \end{aligned} \qquad (2)$$

$$\sigma_{1j} = G_{1j}/C_{1j};\quad \sigma_{2j} = G_{2j}/C_{2j} \qquad (3)$$

The physical significance of equation 1 is rather interesting. The effect of amplification in the multivibrator is to cause a multiplication of voltage change on successive loops around the feedback circuit. Consequently, relatively small rates of change of bias can be converted into extremely high rates of change at the steepest point in the transition. This steepness may be great enough to render the steepest part of the transition difficult to observe on even the highest speed oscilloscopes.

Practical use of equation 1 does not require its reduction to an integral equation. Choosing a value of Δt_j to satisfy the relation $A_{1j}A_{2j}\delta_{1j}\delta_{2j}\Delta t_j^2 = c \leq 0.1$ on an iterative basis enables one to determine the time required per incremental ratio of amplification change. This relation does not indicate the rate of change of bias with time. Conversion of the rate of change of amplification to rate of change of voltage requires division of Δt_j *by* $(1 + c)^j$, since the initiating voltage for each pass around the loop should be reduced by $1/(1 + c)$ of the final output voltage of the previous passage around the loop.

A table giving on a point by point basis the values of A_{1j}, A_{2j}, δ_{1j}, δ_{2j}, Δt_j, and $1/(1 + c)^j$ may be formulated for a given multivibrator. The values of C_{1j}, C_{2j}, G_{1j}, and G_{2j} must be determined in order that the deltas, equation 3, may be used in the determination of both the amplification values and the net bias values. The correct value of j must be determined on the basis of the chosen value of c, and the amount of the total bias change. If the basic increment ΔE_0 is taken as 10^{-3}v, for example, $E_{cj} - E_{co} = (1 + c)^j \Delta E_0$ volts or $(1 + c)^j\ 10^{-3}$v.

Completing the solution in the indicated manner, produces several interesting results. The first is that the rate of transition in a multivibrator may reach 1000v per μsec. Secondly, the second tube apparently is cut off before the first tube reaches zero bias.

Examination, however, of the plate voltage change in the second tube required to carry the first tube to grid conduction shows that a nominal bias change on the second tube of the order of between one and five volts is sufficient to provide full transition. Integration of $A_{1j}A_{2j}$ as a function of input bias shows the bias change at tube *1* required for the active portion of the transition. When the integral of $A_{1j}A_{2j}$ with respect to the bias on the first tube numerically equals the initial negative bias on tube *1*, transition should be nominally completed.

The input capacitance of the second tube prevents the nominal voltage changes read from the tube characteristics contours from being realized. The input capacitance of the first tube has a similar effect. If $\delta_{1j} = \delta_{2j}$, the loss of voltage change due to time constant would be the same, percentagewise, on each tube. Where δ_{1j} and δ_{2j} are not equal, however, the time delays must distributed between both tubes.

Effect of Plate Conductance

The decay circuit which controls triggering in the conventional multivibrator is a resistance-capacitance combination which holds a decaying negative potential on a tube grid. Three resistors are included in the decay path for the capacitance. The first of these is the conducting-tube load resistance, the second the conducting-tube plate conductance, and the

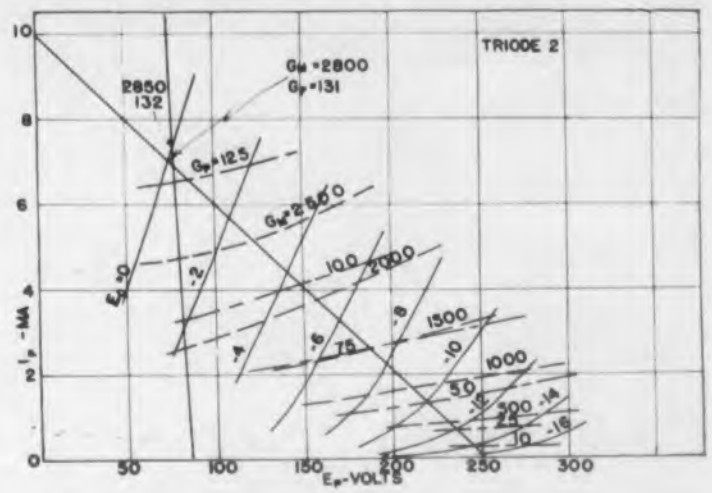


Fig. 2. Conventional plate conductance curves for 6SN7.

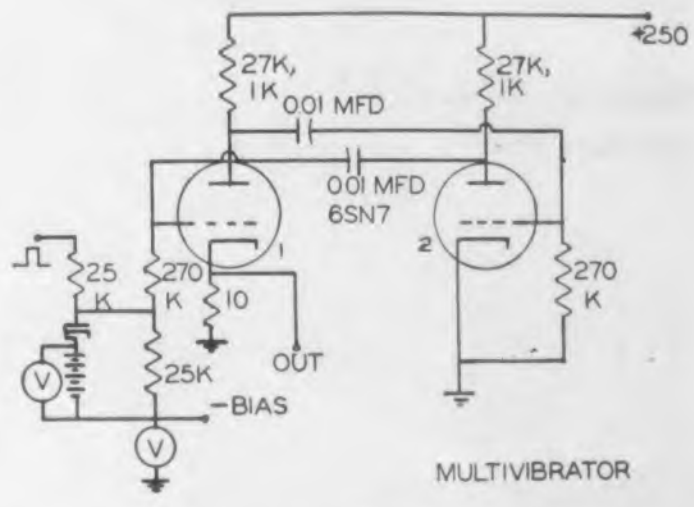


Fig. 3. Circuit to test the triggering of multivibrators.

	$E_b = 250$v	$E_b = 85$v
Load Impedance	27000 ohms	1000 ohms
Initiation Bias	—25.5 volts	—5.4 volts
Uncorrected Initiation Gain	1.21	1.26
Corrected Gain*	0.88	1.003

* Taking time constant into account.

Initiation conditions for different plate loads and voltages.

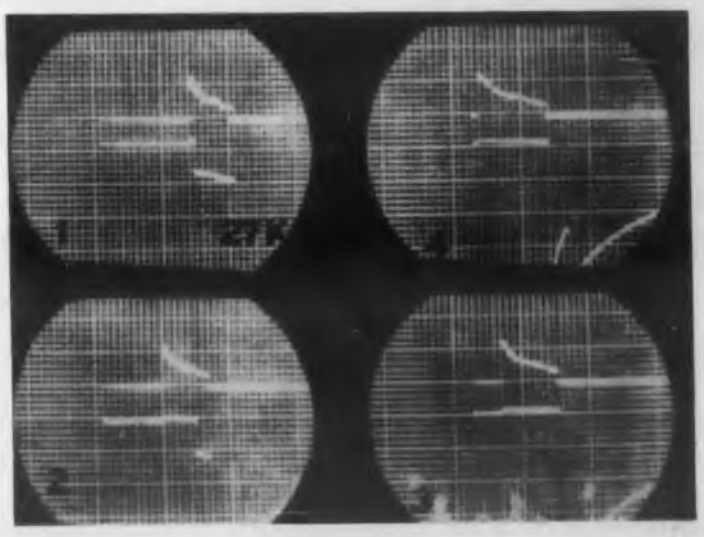


Fig. 4. Smooth output change for different bias values.

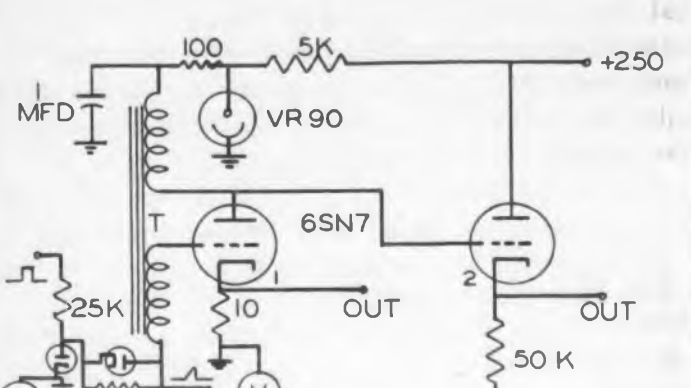


Fig. 5. Circuit for testing initiation of blocking oscillator.

third the grid resistance in the grid of the non-conducting tube. If the coupling circuit is reduced to its simplest form, the plate load resistor and the plate conductance in parallel are effectively connected in series with the grid resistor. The rate of decay is determined by this combination. The plate conductance may be read from the plate characteristics curve as in Fig. 1 or Fig. 2. The decay action may be assumed to continue until the unity loop amplification is reached.

Experimental tests on the multivibrator were made first, to examine the predictability of the initiation point and secondly, to attempt to learn something about the triggering of multivibrators. The tests were made with the circuit shown in Fig. 3. One set of tests was performed with 27,000-ohm tube load resistors and a 250v supply, the second with 1000-ohm load resistors and an 85v supply. The former required a bias near cut-off at the initiation point, and the latter design required very small bias at the initiation point. Initiation conditions for the four tests made are given in the table on the preceding page. In the initial tests giving loop amplifications of 1.21 and 1.26, the initiation point could be moved back and forth smoothly across the initiating pulse by shifting the applied bias. Fig. 4 shows a series of oscillograms of this test with different values of bias. The smoothness of the change indicated that a time constant effect was being observed. The time constant involved proved to be that of the 0.01μf capacitor and the 270,000-ohm resistor connected to the grid of tube *1* in Fig. 3. The circuit behaved as if the capacitor were returned to ground potential instead of appearing to have zero signal potential across the capacitor which would be expected statically at unity loop again. (Reduction of the coupling capacitor size to 0.001μf proved the correctness of the analysis.)

The requirement of slightly less than unity amplification for initiation with the 27,000-ohm load resistors at first appears curious. The possibility of existance of this condition with a large-gain margin had been postulated on the basis that with loop amplifications very close to unity, the system might not

reach stability before the unity amplification point had been reached. This condition apparently can occur. The initiation points, corrected for time constant, were calculated from the time constant of the pulse buildup and were also checked by experiment. Over-all results are believed to be within about 5%.

The Blocking Oscillator

The blocking oscillator uses a tube and a transformer to initiate and form a pulse through uncontrolled regeneration, Fig. 5. Initiation, as in the multivibrator, results from slow decay of the charge stored in the capacitor. The capacitor in this case is in the grid return lead.

The presence of the transformer provides several interesting characteristics to the blocking oscillator. For very slow rates of change of bias, the transformer will behave as if it were without appreciable resistance, reactance, or magnetic coupling. When the grid voltage leaks off to a point that the effect of the grid voltage change on the transconductance produces sufficient change of plate current, the transformer behaves as a unity coupled transformer-phase inverter. Its load is then the grid leak resistor until zero bias is reached, then the grid conductance and grid leak resistor is in parallel. After cycle reversals the loading exists in reverse order.

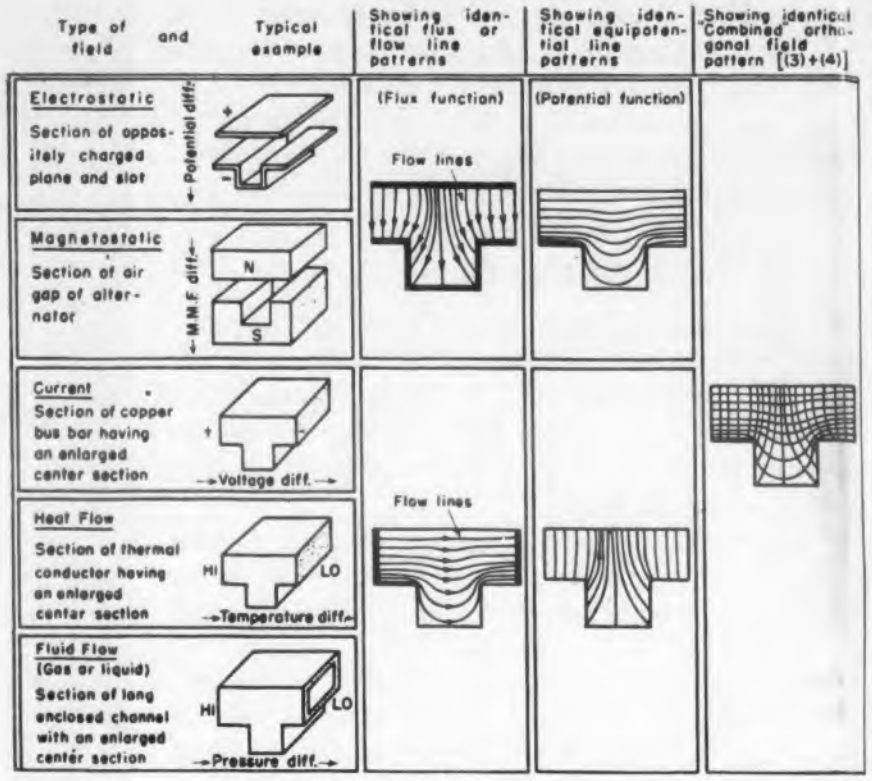
Answers to two questions were desired in the tests performed on the blocking oscillator. The first of these was: Does the blocking oscillator initiation point vary with the slope of the applied triggering pulse? A corollary question was: If so, does it vary in such a way that L g_m (dE_c/dt) is approximately constant? The second question was: What is the appearance of the blocking oscillator load line?

The significance of the first question is that $L\ g_m$ (dE_c/dt) will be constant if a loop gain, with the transformer behaving purely as an inductance, of a fixed value is required for initiation of the blocking oscillator. The measurements made indicate that the triggering of the blocking oscillator tested does appear to depend on the slope of the triggering pulse. In fact, to at least a rough approximation, the function $L\ g_m$ (dE_c/dt) does appear to be a constant at the initiation point.

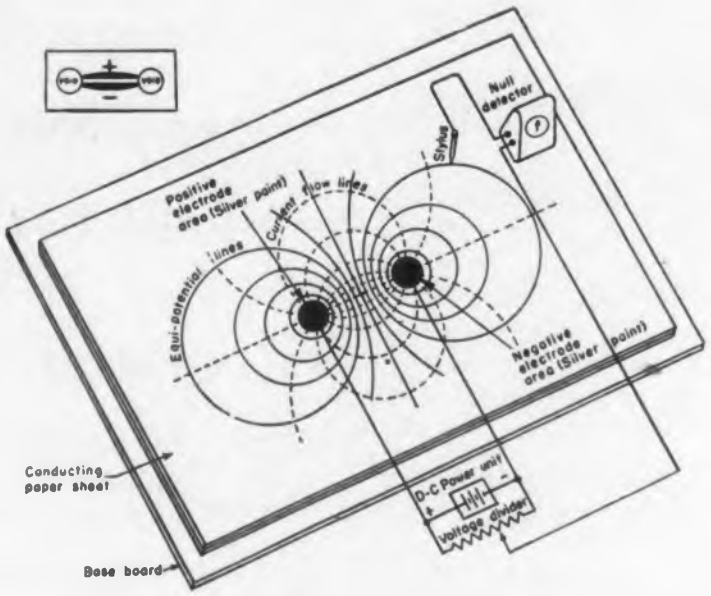
The circuit of Fig. 5 was designed to provide access to both the cathode current and the plate voltage to permit oscillograph recordings to be made of the load line. Two typical load lines obtained: the first of these was made without the two clamper diodes (high vacuum) across the sawtooth generator circuit. The load line rises as expected but then drops vertically and follows the zero current axis. This condition apparently is a result of the load line shift with accumulation of rectification bias. With clamping diodes to discharge this bias, the load line takes a more conventional appearance.

See K. A. Pullen, "Conductance Curves Speed Triode Amplifier Design", *Tele-Tech*, May 1953 for further references.

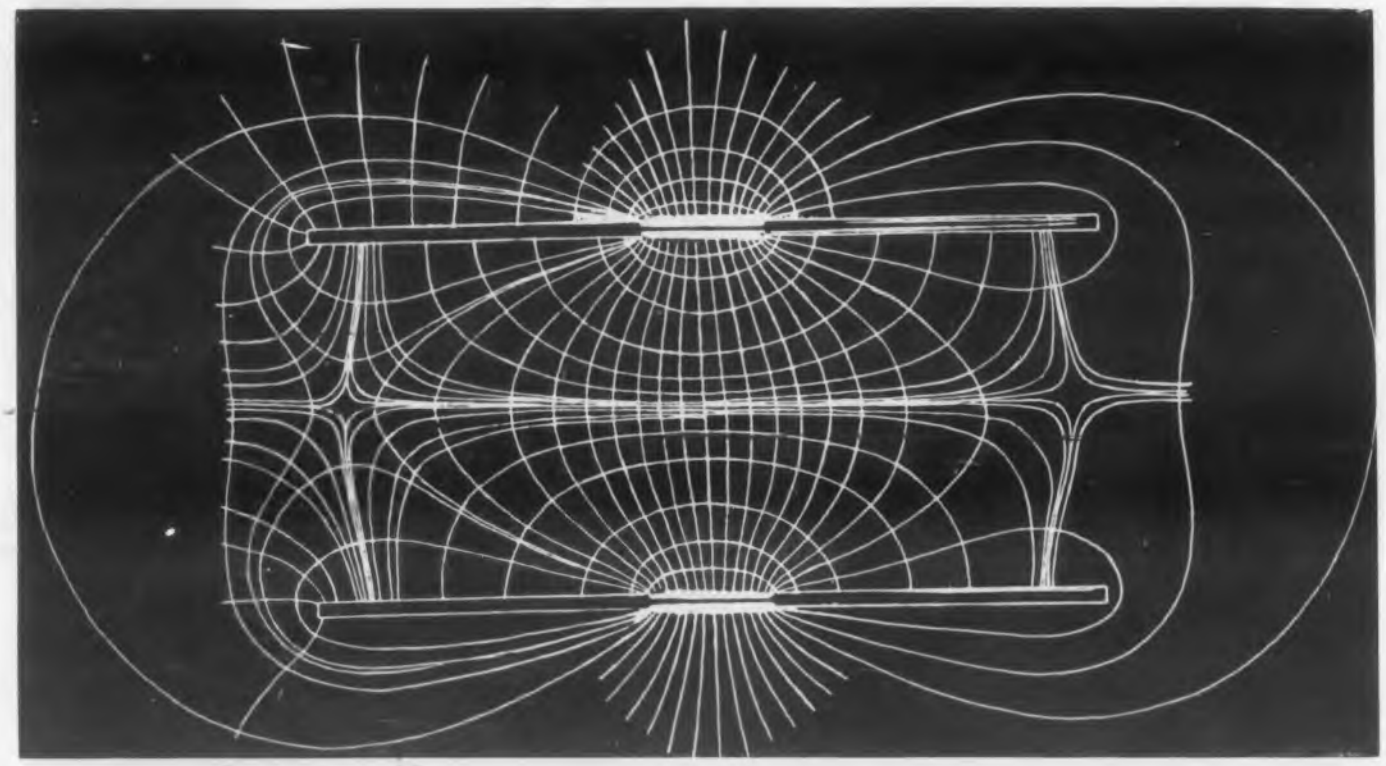
Analog Field Plotter



Examples of analogies between problems in five different types of fields.



Method for getting equipotential lines. Current flow lines can be plotted by cutting out initial electrodes and painting new lines as electrodes as shown in boxed sketch at top of illustration.

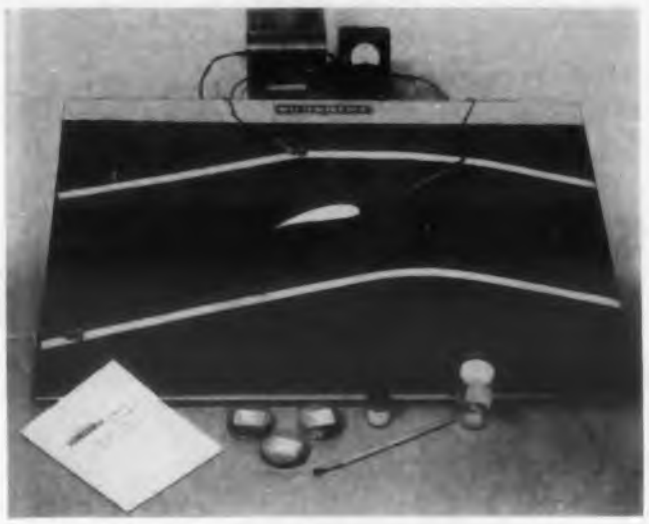


Field plot of experimental electron lens system showing 2-stage combined plot of dielectric flus and equipotential lines.

ELECTRIC current flowing in a sheet of thin conducting paper set up on this device creates a potential pattern which is analogous to electrostatic and electromagnetic fields, and current-, thermal-, fluid-, or air-flow. By probing and detecting the potential drop between appropriately shaped electrodes, a visual permanent record is plotted. The plotter is a valuable tool in studies of electrostatic patterns around wires, insulators, and shields; magnetic flux distribution and intensity in magnetic circuits and pole-piece arrangements; current flow and temperature distribution in conductors; electrode shapes; and field patterns in waveguides and electron lenses. It is also useful for studies of air flow in wing and propellor design, fluid flow patterns and velocity gradients in steam and gas-turbine blade design, and, orfice and piping design.

The analog field plotter, manufactured by Sunshine Scientific Instrument, 1810 Grant Ave., Philadelphia 15, Pa., consists of a plotting board, graphite impregnated paper, a 6v d-c power supply and high-accuracy voltage divider (potentiometer), a sensitive microammeter null detector, and exploratory stylus. Silver paint, and rolls of bare copper and nickel wire are also furnished for construction of electrodes. A comprehensive instruction manual is included showing the basic approach to a variety of technical problems.

The conducting paper, which is 0.004″ facsimile paper, can be cut with a scissors in the desired pattern. The opposing plates, or electrodes, can be made of silver conducting paint or copper bars or wire tacked to the paper. In operation, equipoten-



Analog Field Plotter set up to study flow around turbine blade.

tial lines are located with the exploring stylus. If it is desired to plot, for example, the 10% equipotential line, the potentiometer is set to 10%. The exploring stylus is moved in contact over the conducting paper until the null detector indicates zero. The point of the stylus is pressed to indent the paper. The stylus is moved in this manner until enough points are selected to form the desired 10% equipotential line. The potentiometer is changed to another reading and the procedure is repeated. In the illustrations showing two oppositely charged parallel conductors, plots of both dielectric equipotential lines and dielectric flux lines can be made in two stages. Equipotential lines, resulting from current flow lines, can be probed directly after painting on the electrode area. Since the flux lines are the reverse, the second stage requires that the original electrode be physically cut out and two new electrode strips painted on as shown in the sketch with "void" circles. The direct interchangeability of various "flux" and "potential" components of different types of field systems is shown graphically in the accompanying table.

The experimental determination of a field pattern is accomplished very simply with this current-sheet type of field plotter, and the considerable effort that might be required to build scale models is saved. The process for determining the electron lens pattern is far simpler with the plotter than it would be to actually construct the lens elements and then take and record hundreds of potential values. For more information on this field plotter, turn to the Reader's Service Card and circle **22.**

Two views (top and right) of the first step in making these inductors—cutting the helix groove in the tube.

The groove has been covered with resin.

All the excess metal has been cut out of the interior to form the coil. The excess resin has also been removed.

The tuning slug shorts out turns of the inductor.

Epoxy Resins in H-F Inductor Design

David Lichtman
Airborne Instruments Laboratory, Mineola, N. Y.

VARIOUS properties of epoxy resins were essential to the making of the high-power, high-frequency variable inductor whose design is discussed here. The plastic's exceptional adherence to metal, excellent machineability, and very low shrinkage were necessary to the mechanical design of the inductor, while the case with which it is formulated and cast and its resistance to plating solutions simplified the manufacture of the unit. These inductors can be employed to 400Mc and dissipating 40w and more.

Starting with a thick-walled brass tube, the desired helical shape of the inductor is machined on the outside. The part is then cleaned and silver plated. The inductor is then placed in a simple aluminum mold, which has been well greased with No. 7 Mold Release, made by Dow Corning Corp., Midland, Mich. In some cases, a Teflon mold was used. The resin used in this application was Araldite 502, manufactured by Plastics Div., Ciba Co., New York, N. Y. The proper amount of hardener is added to the base resin and stirred carefully to keep the mixture bubble-free. It is then poured into the mold by tilting the mold and pouring down the side (as is done with beer to prevent foaming). It was found that pouring in this manner prevented the inclusion of any air bubbles in the helical turns. The mold was then placed in an upright position in a drying oven and baked for several hours at 40 to 50°C. By increasing the temperature slightly, the viscosity of the resin is reduced appreciably, thereby enabling air bubbles to rise to the surface. This low-temperature bake-out was usually sufficient to remove any small air bubbles that may have remained in the resin mixture.

After the resin has cured completely, the inductor is removed from the mold. The unit is then placed in a lathe, and the inside metal is machined away until the inner metallic wall is just removed, leaving the plastic-supported helix. The inductor can then be silver-plated and a rhodium flash put on the inside exposed surfaces. The epoxy resin has the additional advantage of not being attacked by any of the plating solutions. We now have the desired inductor held in a precise shape, mechanically supported and electrically insulated. In actual use, the inductor is mounted by the base plate. The tuning slug rides inside the inductor. This tuning slug has spring fingers that make contact with the exposed surfaces, and its forward motion is calibrated to provide the desired tuning operation.

Design Procedure

In designing an inductor of this type, one can determine an approximate set of parameters using the standard inductance formula for a single-layer solenoid. From the circuit involved, one can calculate the maximum inductance required. We must then make several assumptions based on the necessary mechanical configuration. In order to facilitate the designing of the tuning slug assembly, a reasonable coil inner diameter must be selected. Let us choose one inch. This diameter should allow ample space for the tuning slug and should result in an inductor

The spring fingers of the tuning slug contact the helix.

that is capable of handling the specified power

To make the helix easy to cast and bore out, the length should not be too long. Let us choose 1-1/2".

The formula for the approximate inductance of a single-layer solenoid is:

$$L = F N^2 D$$

where L is the inductance in microhenries, F is the form factor, N is the number of turns, and D is the diameter of the coil in inches. From the values of the diameter of the coil and its length, one can find the form factor F*. In this case, the ratio of diameter to length is 0.67, which yields a form factor of .013.

Putting these values into the formula, the turns are found to be approximately 9 for the application discussed on these pages. One can then make a coil with these parameters and test it in the equipment. These tests should indicate if any small changes have to be made in the design.

Using the above procedure, inductors up to 6" long x 3" in diameter have been constructed. For large inductors of this type, it may be necessary to add a powdered quartz filler to the epoxy resin to bring its temperature coefficient of expansion closer to that of brass. If necessary, polyamide can be added to the epoxy to give greater resiliency.

* From the form factor table on p. 75, *Reference Data for Radio Engineers Handbook*, New Third Edition, Federal Telephone and Radio Corp., 67 Broad St., New York, N. Y., 1955.

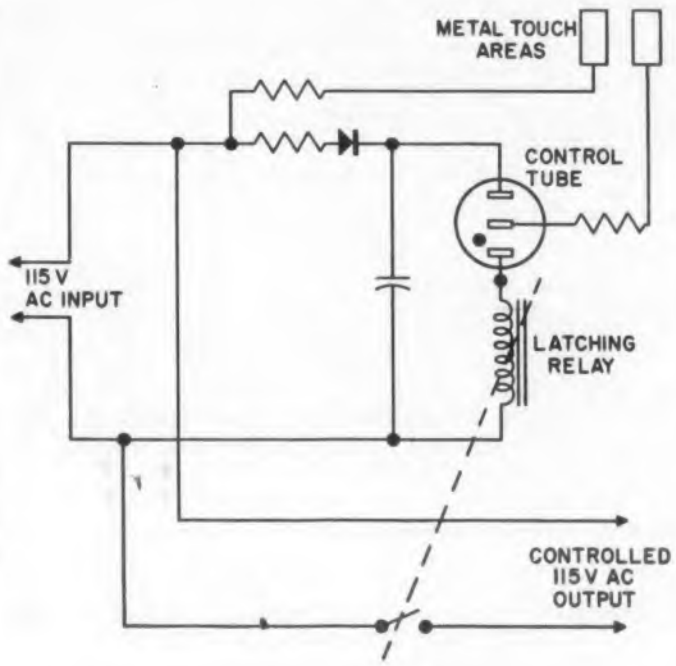
Touch-Control Switch

TOUCHING two metal areas simultaneously with the hand is all that is required to operate the illustrated switch. This "Touchtron" switch could be utilized in many electronic devices for the consumer market such as TV receivers, radios, and sound-reproduction equipment. It could also be used in various automatic controls for machinery as a safety device. The switch is particularly useful for paralyzed or similarly handicapped people.

The initial form in which the switch is made is the illustrated disc, which is about 4-3/4" diam x 1-1/8" thick. This form is used in lamp bases. However, the components can be rearranged to fit any suitable shape having a minimum volume of about nine cubic inches. Capable of controlling a-c loads of up to 5amp or more, depending on the type of load, the circuit has been designed for complete stability throughout the voltage range of 100 to 125v a-c. It is not dependent on the polarity of the a-c power plug, nor are any ground planes required. The switch is normally activated continuously, but only negligible standby power is consumed. The unit is manufactured by Accessory Equipment Dept., General Electric Co., Bridgeport, Conn.

As shown in the circuit diagram, the incoming a-c power is rectified for circuit control by a half-wave rectifier. The rectified d-c voltage, while dependent on the magnitude of the a-c input, never reaches the voltage required to break down the control tube. The latching relay operates whenever the control tube fires, discharging the electrolytic capacitor. The control tube fires whenever a hand is placed across the two metal areas, thus connecting the firing electrode of the tube to the anode side of the a-c line. For more information, turn to the Reader's Service Card and circle **26**.

The initial form of the switch. It can be packaged in a variety of shapes.



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(actual size)

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Class H insulation.
Plunger opening sealed to withstand 200 P.S.I.
3 lbs. pull @ 1/16" stroke.
Continuous duty.

2 new miniatures

MODEL A-205 *Shown*
PARTIAL SPECIFICATIONS

PUSH OR PULL
9 oz. @ 1/16" stroke
7½ oz. @ 1/8" stroke
6 oz. @ 3/10" stroke
5 oz. @ 1/4" stroke

MODEL A-1 *Shown*
PARTIAL SPECIFICATIONS

PUSH OR PULL
5 lbs. @ 1/4" stroke
3½ lbs. @ 1/16" stroke
2½ lbs. @ 3/32" stroke
1½ lbs. @ 1/8" stroke

Many other solenoid models available. Mounting furnished to meet your requirements.

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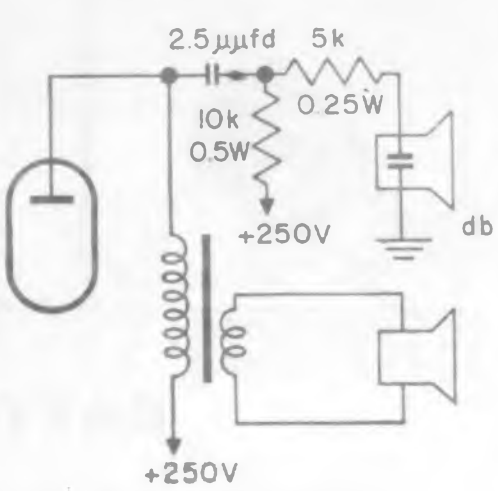
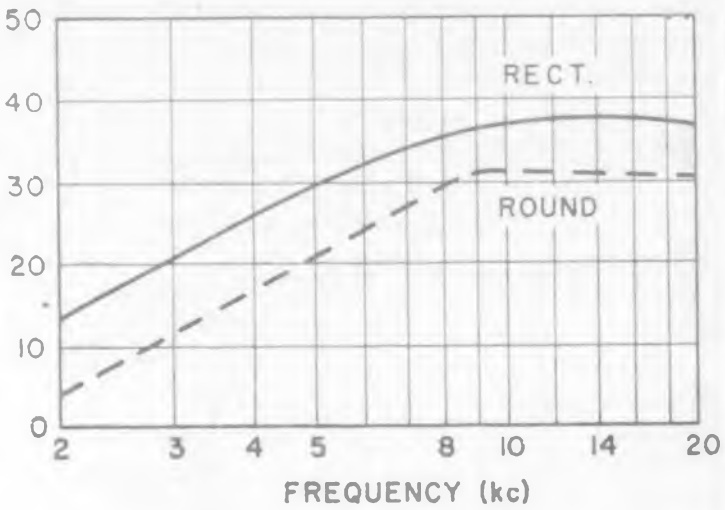
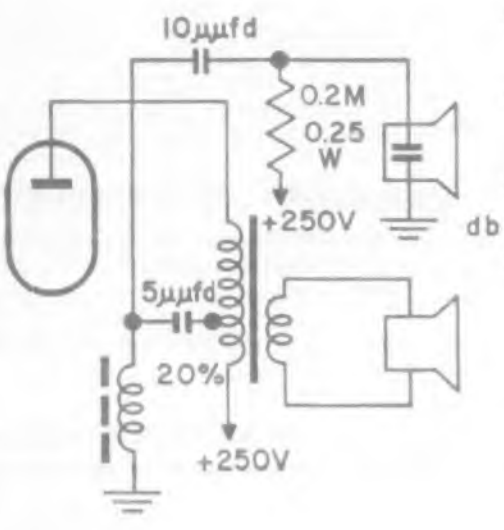
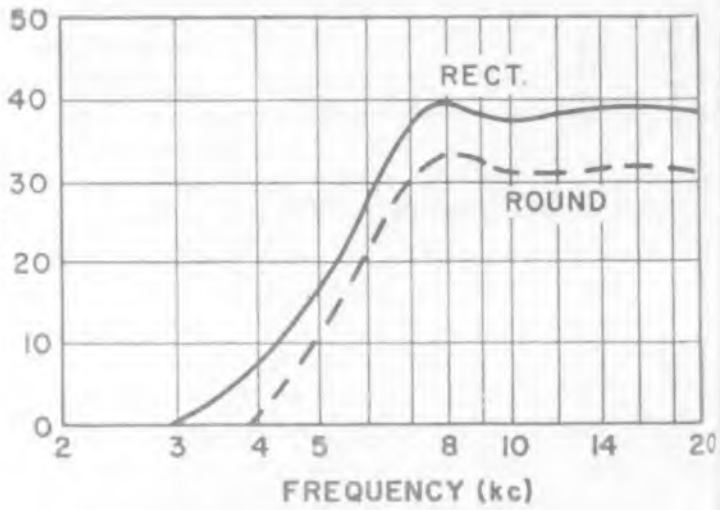
Electrostatic Speakers



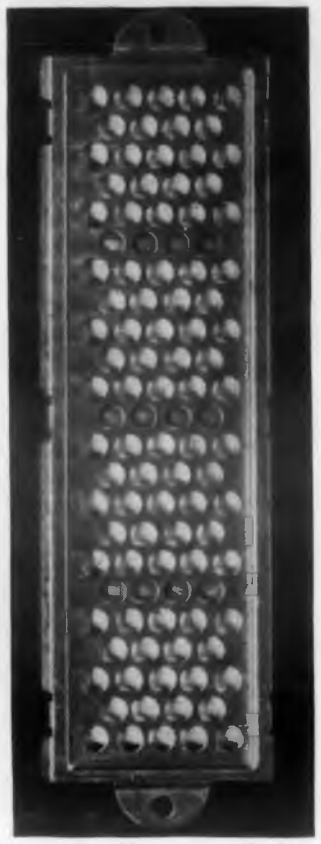


An r-c coupled circuit utilizing an electrostatic speaker and the frequency response of both the round and rectangular types in this circuit.





The frequency response of the rectangular speaker is better in this I-c coupled circuit.

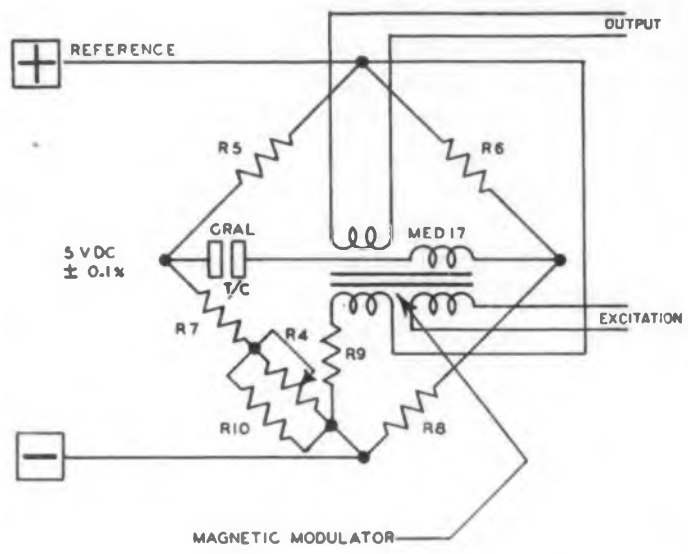


The round speaker is shown actual size. The rectangular speaker is actually 7" long.

HIGH-FREQUENCY response of phonographs, TV receivers, and radios can be greatly improved at low cost by utilizing these electrostatic speakers. Since the units are very compact, they can be easily added to a line of equipment already in prototype form or even in production.

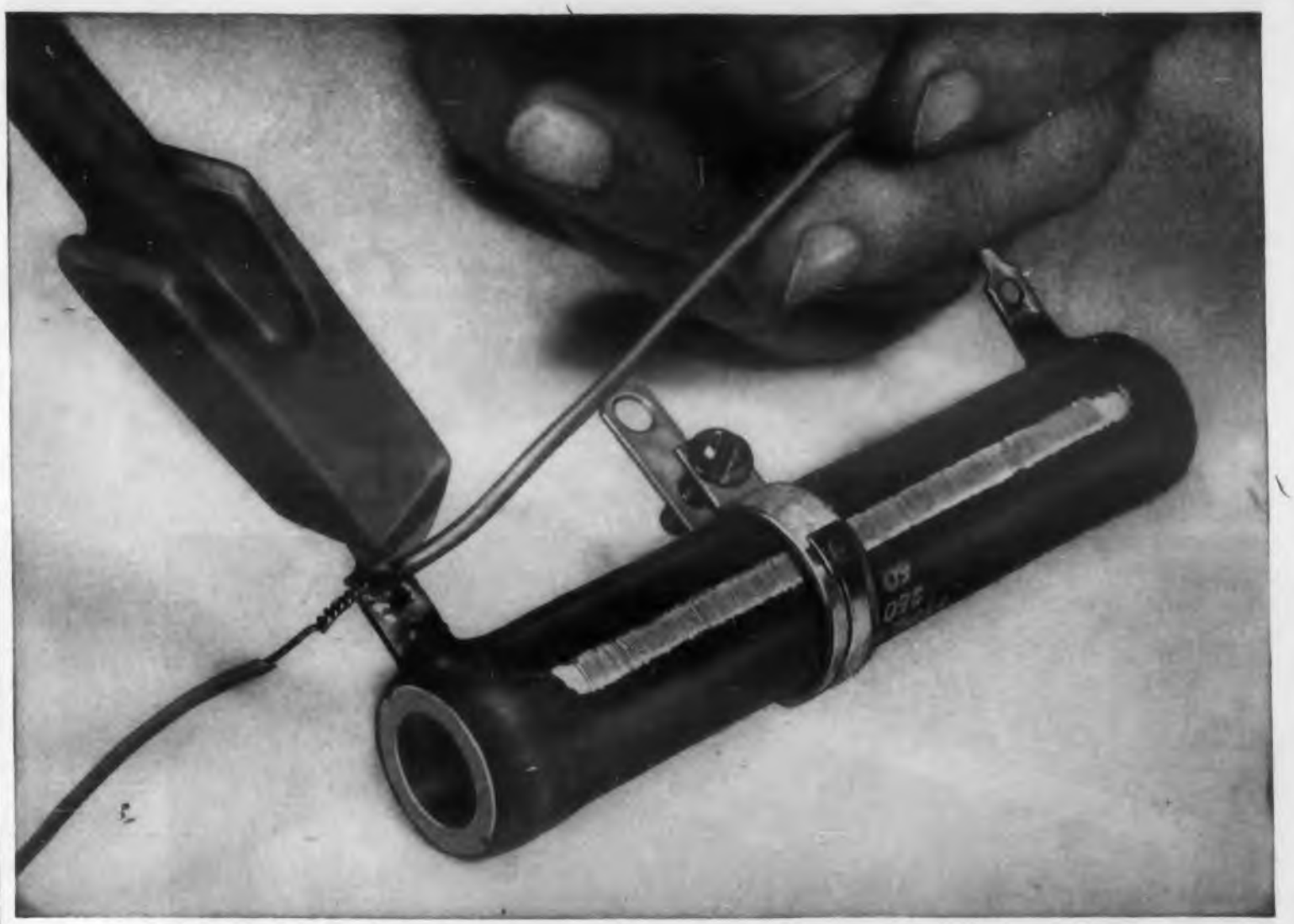
These "Isophon" speakers are made in two models: round (Type StIIB7) and rectangular (Type StH5/16). The moving element is a gold-metallized synthetic plastic foil. Two circuits in which the speakers are used in conjunction with conventional dynamic speakers with low-frequency response are illustrated. In the l-c coupled circuit, the by-pass inductance has values of 72mh and 180 ohm, and 42mh and 180 ohm for the round and rectangular types, respectively. These speakers are made by E. Fritz & Co., Berlin, Germany. They are available here from Arnhold Ceramics, Inc., 1 E. 57th St., New York 22, N. Y.

Although these speakers can carry an a-c potential of 180v, the recommended maximum is 60v. The d-c voltage must be at least 50% greater than the a-c signal, but should not exceed 350v. The membrane of the larger rectangular type, because of its large size, acts like a number of small single speakers. The round speaker has baffles across its face which diffuse the sound. Both types should be mounted in the vertical position. The long side of the rectangular type should be perpendicular to the floor. The units are mounted in bakelite cases. For more information, turn to the Reader's Service Card and circle **29.**



This temperature control circuit, used by Manning, Maxwell & Moore, Inc., is a typical application for the magnetic modulator. A reference voltage is compared with the error signal originating in the thermocouple and the d-c result is converted to a-c.

Magnetic Modulator

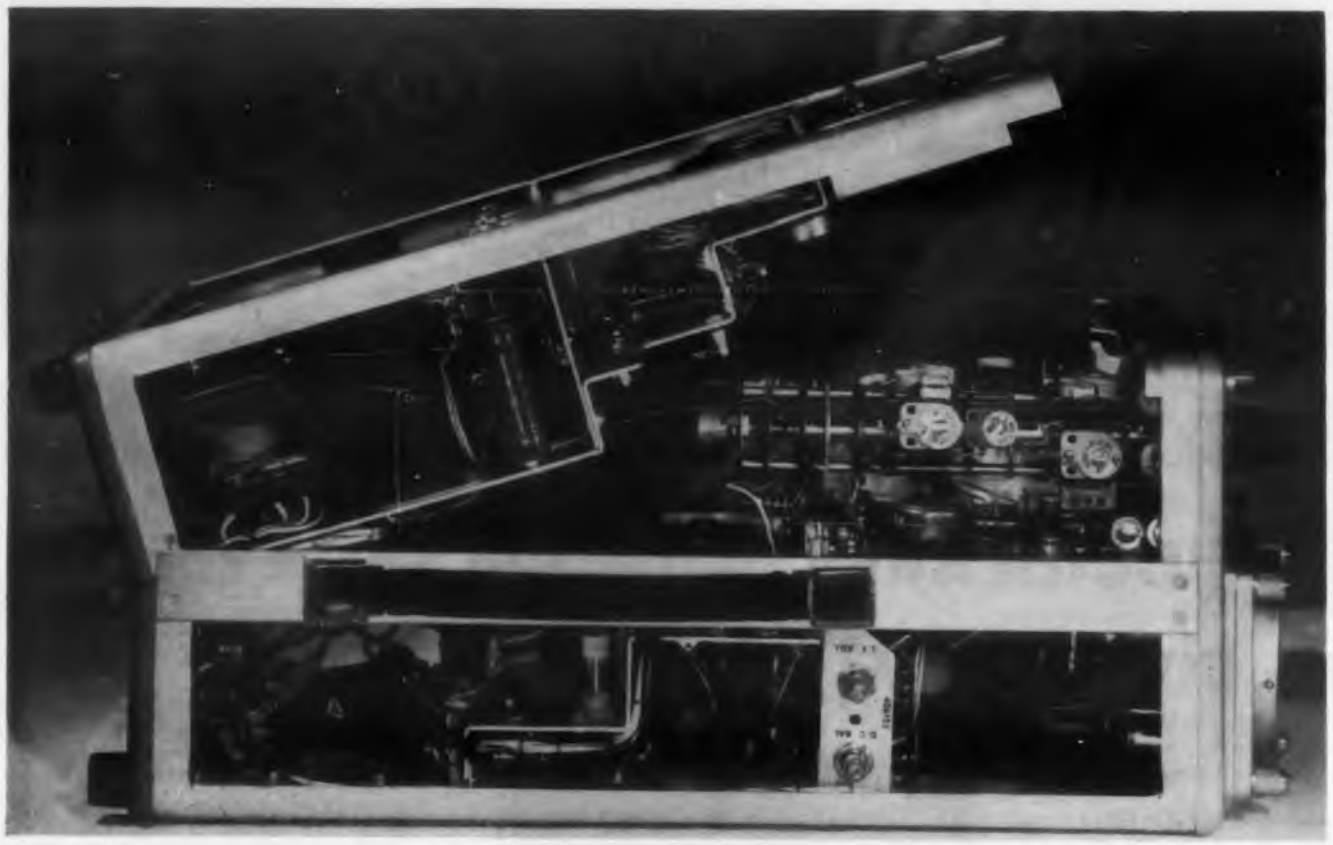


UNLIMITED life and good stability coupled with high sensitivity are features of this magnetic converter which answers the demand for modulators with no moving parts. Weak bipolar d-c can be converted to 400cy sinusoidal a-c voltages of corresponding amplitude and phase sense for control of servomotors or other automatic regulating devices. The complete schematic diagram of the unit is illustrated on the front cover.

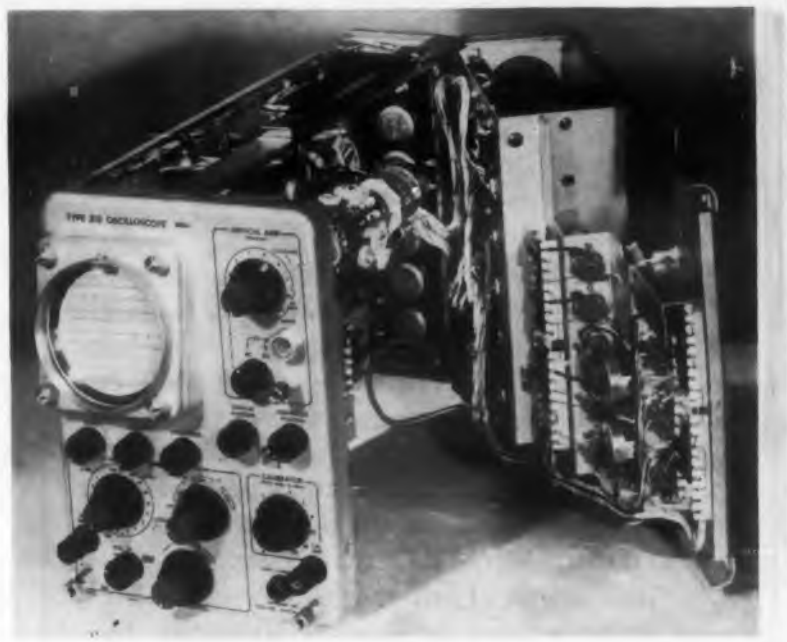
The null amplitude of the "1000" model illustrated, manufactured by General Magnetics, Inc., 135 Bloomfield Ave., Bloomfield, N. J., can be established for 20-30mv rms or lower. Average units may have a null or noise level rating of 10mv (which can be made as low as 1mv). The amplitude response curve for the "1000" units shows an output of 5.5v rms for 100μa d-c control current (the signal range is 0 to 200μa). The input impedance is 1000ohms. Null stability under adverse environmental conditions is good; 10^{-9}w is average. Excitation for the unit pictured is 5v rms, 300-500cy. Magnetic modulators can be designed for excitation frequencies ranging from 10cy to 10kc and up. A d-c bias signal is necessary, 1.7ma is typical. A separate bias winding is used.

The speed of response is about 1/100sec—or within a half cycle. Hysteresis is extremely low. The output phase is 0 or 180° ±10%. Operating range extends from −70° to +200°C. The size is 1" by 11/16" by 1-3/4" high. It weighs but 3 oz. The unit has high shock and vibration resistance; it meets all requirements of MIL-T-27. For more information about this unit's specs and other models, turn to the Reader's Service Card and circle **32.**

Compact Oscilloscope



The two hinged and stepped chassis parts are not equal in size.



The 310 oscilloscope can be operated when hinged apart.

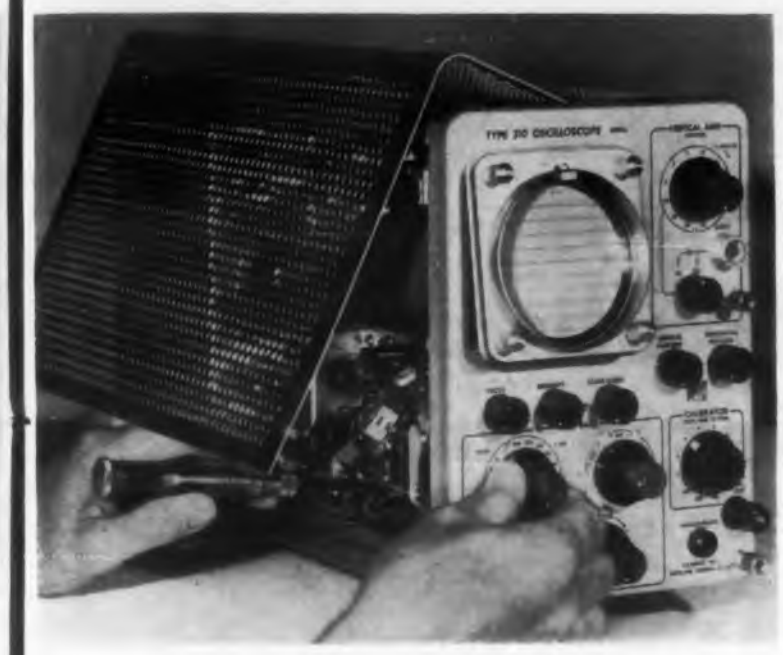
SPECIFICATIONS for the oscilloscope shown on these pages called for an instrument weighing about 20 lb and occupying about 3/4 cubic foot. Planned for field use, it must have performance comparable to that of laboratory oscilloscopes. By first constructing a dummy to determine heat rise and then utilizing an unusual hinged and stepped chassis, the designers of this instrument have produced a rugged equipment that can be used in crowded planes where the temperature inside the unit nears 80°C.

Known as the Type 310 oscilloscope, it is made by Tektronix, Inc., Portland, Ore. A preliminary survey of the requirements (For technical specifications and characteristics of this unit, see p. 74, July, 1955, issue of ELECTRONIC DESIGN, or turn to the Reader's Service Card and circle **59.**) showed that it would be necessary to have at least 30 to 35 tubes, 5 or 6 selenium rectifier assemblies, a bulky power transformer, and several filter capacitors in addition to numerous other components. In order to meet the sweep speed and bandwidth requirements, power requirements were 200w. Since a cooling fan was not practical because it would have to operate on 60 to 800cy supplies, a study was made of a proposed instrument with dimensions of 6-1/2" x 9-1/4" x 14" to see if it could dissipate 200w. (The final dimensions are 6-3/4" x 10" x 17").

In order not to exceed the ratings on the capacitors and other components, a dummy instrument was constructed of the proposed size. Resistors were placed throughout the dummy to simulate the tubes and the dummy was operated with 200w dissipated in the resistors. Thermocouples placed throughout the dummy checked on the temperature rise. By using a packaging material made of perforated metal with at least 40% opening and placing the heat producing elements near the outside of the case, the dummy instrument dissipated 200w safely. The heat-producing elements were arranged in natural chimneys.

To place all the heat-producing elements as arranged in the dummy, the stepped and hinged chassis shown in the photographs was developed for the completed oscilloscope. The "fold-apart" line was to some extent dictated by some of the major parts such as the power transformer and the cathode-ray tube.

In the initial case design, the front and back panels were in single sections, and the instrument was split diagonally down the center. In the final design,



The perforated sides raise for quick servicing.

the back panel is split down the center and the unit is divided into two unequal parts. The final case is composed of three pieces: a bottom section that snaps on and two identical side panels which fold up and are removable for ease of servicing. All three pieces are made of perforated aluminum. The side pieces are attached with coin-operated fasteners.

As planes fly faster and higher, it is becoming more and more difficult to simulate test conditions on the ground that can equal the actual environment to which electronic and other equipment will be subjected. Test instruments must be taken aloft. The designers of this oscilloscope are to be congratulated for developing a fine instrument that can be used in the air and under demanding field conditions as well as in the design and development laboratory.

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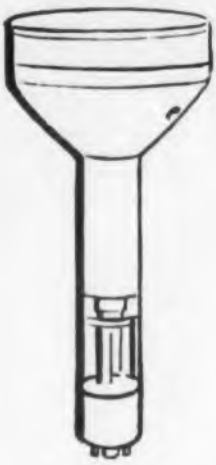

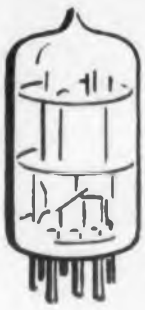

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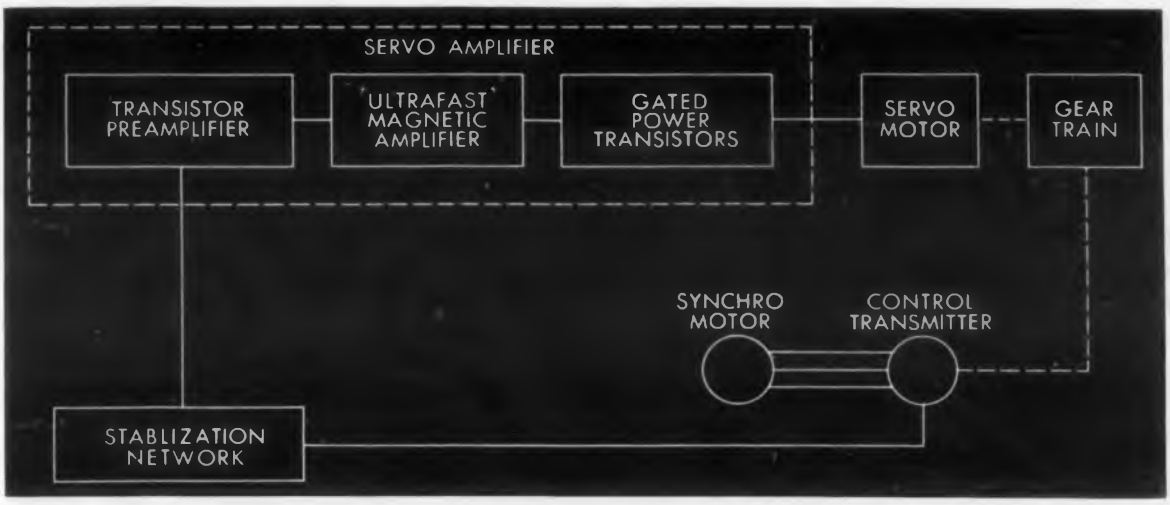
Transistor Servo Amplifiers



Block diagram of unique combination mag-amp and transistor servo amplifier which converts amplitude modulated signals to pulse time modulated voltages.

Demonstration model, left, of this new servo amplifier is shown almost full size.

COMBINING the advantages of magnetic amplifiers and transistors, these highly-efficient servo amplifiers are housed in small, plug-in type containers. Two types are available: a standard 60cy unit and a magnetically-gated converter unit. The 60cy version is capable of delivering 10w to a servo motor, such as Kearfott Type *R160*, modified slightly for transistor operation.

The "Ultra-Fast" type magnetic amplifier, manufactured by Librascope Inc., 808 Western Ave., Glendale 1, Calif., is used as a converter to change amplitude modulated signals into pulse time modulation. The signal sent to the power transistors occurs before a half cycle of line frequency power feeding the magnetic amplifier elapses. Because of the high speed of response of the magnetic amplifier, the time lag of the complete amlpifier is less than one-half cycle of line frequency. The frequency response is flat within ±3db to 30cy either side of 400cy. It then drops off 12db per octave. In the standard 60cy, 10w servo amplifier, a single stage of transistor preamplification is used. The overall power gain is 100,000 with an input impedance of 5000 ohms. Full output power can be delivered over an ambient temperature range of —55 to +55°C. The temperature range can be extended to +85°C by substituting silicon diodes for germanium.

The amplifier package is cylindrical, with a diameter of 1-1/2" and an overall length of 5-3/4". It weighs less than 20 oz. For more information on these radically new transistor servo amplifiers, turn to the Reader's Service Card and circle **36.**

Design Procedures for Power Transistors — II

Howard T. Mooers, Transistor Engineering
Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

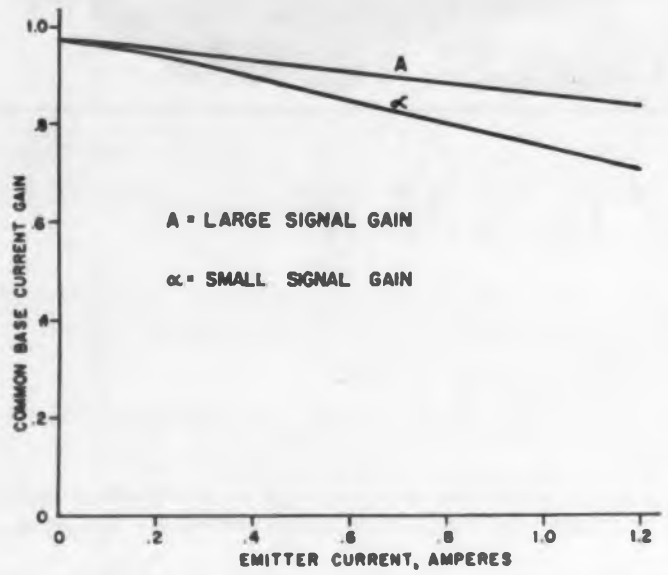


Fig. 1. Variation of common base current gain with emitter current with base at 70°F and $V_c = 2v$.

PARAMETERS of power transistors are not constant and may vary depending on values of bias current, temperature, voltage, etc. This Part II discusses external behavior of the transistor as it affects circuit design and indicates what may be expected in parameter variation. Previously in Part I (*ED, July 1955, p. 58*), it was illustrated that neither voltage, current, or power limits of transistors can be exceeded even momentarily without danger of immediate failure. Maximum power output is the designer's goal; but this criteria is not the same as maximum power gain as will be pointed out.

Alpha is not constant. It drops with increasing current at extreme current densities. In the region near current cutoff, the value of α may decrease with decreasing currents. It does not change greatly with changes in collector voltage. The change of α with emitter current is shown in Fig. 1. The curve is essentially a linear function of the emitter current except for the region near zero emitter current where its value falls off.

The value and variation of α are certainly useful quantities, but since α is not constant, its value does not indicate the collector current to expect for an emitter current of say 600ma. The first 100ma will increase the collector current more than the last 100ma. Consequently, the change in collector current due to 600ma emitter current is equal to the integral of α times the emitter current. The total collector current will include a small value of leakage current which is dependent principally on the collector junction quality, voltage, and temperature. By including the collector junction leakage current, I_{co}, the total collector current can be specified as

$$I_c = \int_o^{I_e} \alpha \, dI_e + I_{co} \qquad (1)$$

or, to have a parameter which expresses the d-c collector current in terms of the d-c emitter current, the symbol A has been selected to represent this large signal or d-c value of α and $I_c = AI_e + I_{co}$.

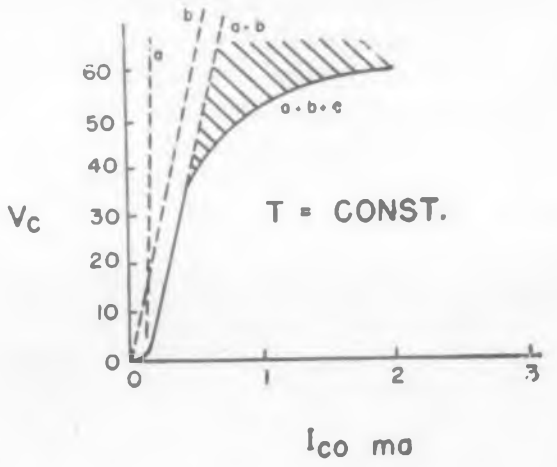
The values of A are plotted on Fig. 1, also. It can be seen that for any emitter current, the value of A is the average value of α from zero to the value of emitter current in question.

The value A can also be defined as $A = I_c - I_{co}/I_e$. The leakage current of the collector junction, I_{co}, is given for one or more collector voltages with the emitter open. The variation of the leakage current with voltage is shown for a typical unit in Fig. 2.

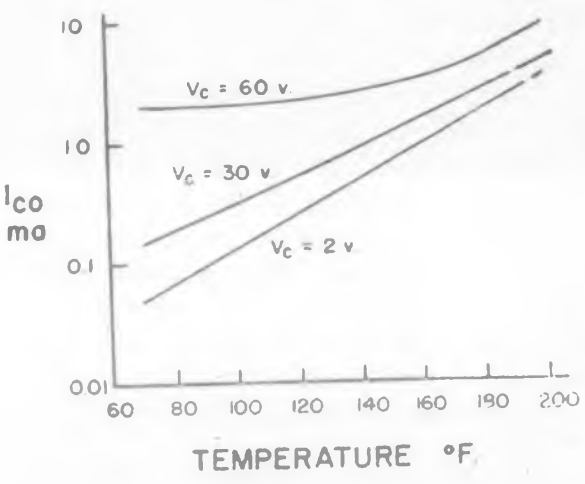
The curve for the total leakage current seems to be composed of three parts. The first component is the theoretical leakage current which is labeled *a*. In a theoretical junction, this would be the only leakage current. With power transistors, it accounts for almost all the leakage current up to about 2v. The second component of this leakage current is shown as the curve *b*. It is ohmic in character, and is assumed to be various high-resistance leakage paths around the junction. The sum of *a* and *b* account for almost all of the leakage current up to about 40v. Here the actual curve again departs from the predicted values. For lack of a name, this is called "excess leakage current." This excess leakage current increases very fast with the voltage beyond a certain point.

The total leakage current is very temperature sensitive. It increases rapidly with increases of temperature. The theoretical leakage current is predicted to increase exponentially with temperature. The variation of leakage current at a collector voltage of two volts is shown in Fig. 3. It can be seen that the increase is exponential at the rate of about 4½% per degree Fahrenheit.

The ohmic component and the excess leakage current also increase with temperature, but not nearly so fast. Consequently the leakage current at a higher voltage



Figs. 2&3. Variation of I_{co} with V_c and temp.



will increase at a rate dependent on the proportions of the various components.

The values of B and β are also functions of the operating point and, if plotted against the base current, the same type relationship can be established between B and β as exists between A and α. Since power output stages are usually designed from output to input it is convenient to plot B and β against collector current as shown in Fig. 4; $B = I_c - I_{co}'/I_b$ where I_{co}' is the common emitter leakage current with the base circuit open. The value of B at any base current is seen to be the average value of β up to that point.

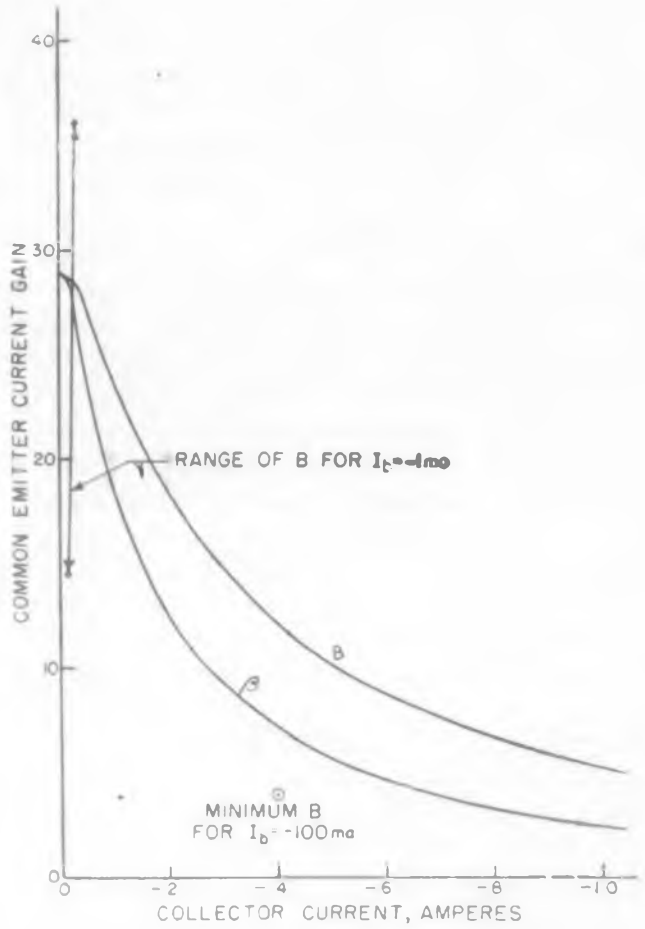


Fig. 4. Variation of common emitter current gain vs collector current at 70°F and V_c of −2v.

The common emitter leakage current with open circuit base has been specified many times as a parameter for the transistor. However, it is not an independent parameter. Solving I_e for the condition of zero base current gives $I_e = (1/1-A)I_{co}$. Since now $I_e = I_c$ because $I_b = 0$, $I_c = (1/1-A)I_{co}$.

Thus, the common emitter leakage is a parameter derived from the current gain of the unit and its basic collector junction leakage. Higher gain units will consequently have greater common emitter leakages than lower gain units for equal collector junction leakages.

Examination of the latter equations in the extreme right-hand column shows that with zero base current, the collector current is identical to that shown above. There is a belief that this leakage current represents the limit to which this device can be cut off in the common emitter configuration. This is not true. Suppose that the base current were reversed and made equal to $-I_{co}$. The next to the last equation in the extreme right-hand column would then be

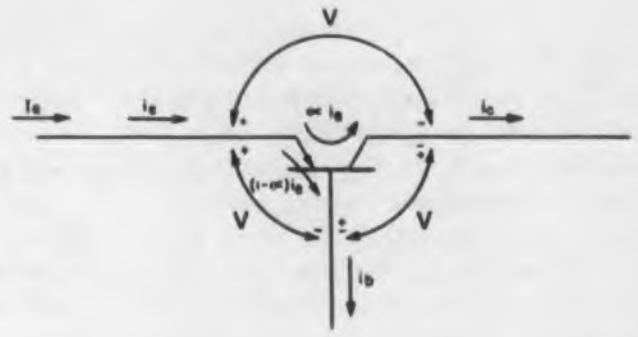
$$I_c = (A/1-A)\,(-I_{co}) + (1/1-A)\,I_{co} = (1-A/1-A)\,I_{co} = I_{co} \qquad (2)$$

Thus, if the collector junction leakage current can be supplied by the base lead, the leakage current in the collector circuit can be reduced to the fundamental collector junction leakage current.

Thermal Instability

The basic voltage limit for all junction transistors is set by the thermal runaway characteristic arising from the increased power dissipation caused by the normal increase of leakage current with junction temperature. The resulting increase in dissipation leads to still higher junction temperatures, and so on.* The condition for thermal stability for junction transistors (namely, that the increase in dissipation due to temperature increase

* John S. Saby, "Transistors for High Power Application," Convention Record of the I. R. E., 1954 National Convention, Part 3, pp 80-83.



In normal transistor operation, current flows into the emitter junction at a low impedance level, and most of this current flows out the collector junction at a high impedance level. The difference of these currents flows out the base of the transistor. This is true both for d-c current signals (*I*) and for a-c current signals (*i*) which are superimposed upon a suitable d-c quiescent bias. If the collector circuit must drive a relatively high impedance, the a-c collector current will be reduced somewhat and the a-c base current will increase by this amount. The ratio (α) between the a-c collector current and the a-c emitter current is usually specified for an a-c short circuit termination of the collector.

$$i_c \cong \alpha\, i_e$$
$$i_b \cong (1-\alpha) i_e$$

Describing the d-c operation of transistors, emitter current flows into the transistor and most of it comes out through the collector junction. The remainder flows out the base. The d-c value of α is A. Superimposed upon this is the leakage current of the collector junction which flows into the base and out the collector circuit.

$$I_c = AI_e + I_{co}$$
$$I_b = (1-A)I_e - I_{co}$$

Here, the input current is given for the common base configuration, and these parameters are mostly used with the common base circuit. Solving for i_e and i_c in terms of i_b,

If $\beta = \alpha/(1-\alpha)$

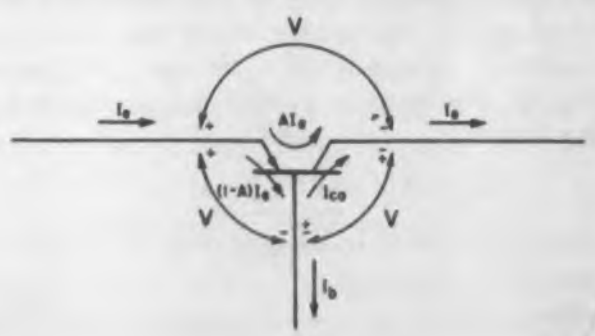
$$i_c = \beta i_b$$
$$i_e = (\beta+1) i_b$$

Likewise,

If $B = A/1-A$

$$I_c = BI_b + (B+1)\,I_{co}$$
$$I_e = (B+1)\,I_b + (B+1)\,I_{co}$$

The above equations are useful in the common emitter and common collector circuits since i_b is the input current.



must be less than the corresponding increase in heat flow from the junction) can be written $dP_d/dT_j < 1/\theta$ where P_d is the total power dissipation of the transistor, T_j is the junction temperature, and θ is the total thermal resistance, i.e., the rise per watt dissipation of the junction temperature above ambient.

For a thorough evaluation of all of the operating points, an analysis of the input bias dissipation must be included to arrive at the total power dissipation as a function of temperature. In most cases the greatest share of the power dissipation is at the collector junction. An exception to this occurs when the transistor is driven into saturation, as in switching service.

The thermal stability of the leakage current is easier to evaluate because there is no input power dissipation. If the collector voltage is constant the circuit stability equation can be written $V_c\,(dI_c/dT_j) < 1/\theta$ where V_c is the collector voltage, and I_c is the collector leakage current (I_c being used in the general case).

If the rate of increase of junction leakage current with temperature is assumed to be approximately 4½% per degree Fahrenheit (8% per degree Centigrade), as actually occurs at low collector voltages, the stability condition for cut-off conditions with a low impedance collector circuit can be derived.

In the common base circuit when the emitter current is zero the collector current is composed only of the leakage current which varies with temperature and voltage.

Assuming

$$I_c = I_{co}\,(1.045)^{\triangle Tj} \tag{3}$$

where T_j is measured in degrees F,

$$P_d = V_cI_c = V_cI_{co}\,(1.045)^{\triangle Tj} \tag{4}$$

$$dP_d/dT_j = V_cI_{co}ln\,(1.045)\,(1.045)^{\triangle Tj}$$

$$= V_cI_{co}\,(0.044)\,(1.045)^{\triangle Tj} \tag{5}$$

Evaluated at $\triangle T = 0$

$$dP_d/dT_j = V_cI_{co}\,(0.044) < 1/\ \theta \tag{6}$$

or $$V_c < 23I_{co}\theta \tag{7}$$

or $$I_{co} < 23/V_c\theta \tag{8}$$

This means that with variations in collector voltage, total thermal resistance, and junction temperature, the common base circuit will have a theoretical limit of stability at the point where its common base leakage current I_{co} approaches the limit value given by equation 8 above.

For the most ideal condition where a *2N57* transistor is attached to an infinite heat dissipator the total thermal resistance will be 7½°F, per watt (6½°/watt internal, 1°/watt interface resistance with the best contact from mounting base to heat dissipator using silicone oil, and 0°/watt for the infinite heat dissipator). At a collector voltage of 60v, the unit will become unstable as the leakage current I_{co} approaches its stability limit.

$$I_{co} < 23/\ 60 \times 7.5 = 51\ \text{ma} \tag{9}$$

Assuming the total leakage current I_{co} varies exponentially with temperature

$$I_{co}\,(\text{at } T_1) = I_{co}\,(\text{at } T_o)\,[1.045^{\,T_1 - T_o}] \tag{10}$$

The leakage currents can be measured at 60v and 70° F to predict stable operation at various elevated junction temperatures with a low impedance collector supply sources.

Highest Junction Temperature Expected	Predicted Safe Value of Maximum Junction Leakage Current 70° F and 60v.
200° F.	.17 ma
150° F.	1.51 ma
100° F.	13.6 ma

The table shows leakage limits extrapolated back to 70° F for a *2N57* transistor to predict the high temperature thermal stability. The above values are conservative because the total leakage current at 60v does *not* increase exponentially as was assumed in the derivation. The theoretical junction leakage current is the only component that increases at the above exponential rate. The other components also increase with a temperature increase, but not as fast. Thus, since the bulk of the leakage current is something other than the theoretical leakage current at 60v, the leakage current at this voltage will not increase as fast as predicted for changes in temperature. Consequently stability can be achieved with units which have 60v leakages somewhat higher than shown.

As the temperature increases, more and more of the total leakage current is due to the theoretical leakage and consequently the temperature coefficient will approach the theoretical increase at higher temperatures. The leakage current as calculated from equation (8) should be regarded as the leakage current limit for stable operation at any temperature.

This same limit of 51ma can be applied equally well to the common-emitter leakage current at 60v. The temperature coefficient of this leakage will be the same if the current gain at these low levels is constant with respect to the changes in leakage current and temperature. Since the gain falls off with both increased current and elevated temperatures, the above determined limit is somewhat more conservative for the common emitter configuration.

Current Stability

The common base circuit is relatively stable with respect to changes in temperature. The common emitter circuit, on the other hand, amplifies the leakage current when the base lead is open. This often causes high enough values of temperature sensitive collector current to make runaway possible.

The total common emitter leakage current can be reduced considerably by allowing or even encouraging the leakage current to flow through the base lead to the collector.

The various leakage current characteristics are shown in Fig. 5. Curve *1* shows the leakage current for the common base configuration when the emitter is open. If a resistor were connected between the emitter and base leads, the leakage current would increase. The smaller the value of the resistor, the higher will be the leakage until the resistance is zero and the leakage is given by Curve *2*. When the emitter and base are shorted, the common base and common emitter circuits are indistinguishable. In the common emitter circuit, the leakage is highest when the base is open. As the resistance between the base and emitter is decreased, the leakage current decreases, until with a short circuit base to emitter, the leakage will again be given by Curve *2* of Fig. 5.

Fig. 6a shows the circuit used to measure the common emitter leakage current. In actual use, this circuit is generally impractical. There will usually be a d-c resistance path from base to emitter which reduces the zero signal leakage of this circuit. A circuit using a capacitor input with no bleed resistor will duplicate this circuit and have the highest leakage current. Any appreciable drive will cause blocking due to the capacitor charging during the conducting cycle. Thus Curve *3* on Fig. 5 represents the high limit for leakage current.

Fig. 6b shows the circuit used to measure Curve *2* of Fig. 5. This leakage can be approximated in an actual circuit by resistors in the emitter and base leads so that the voltage from the emitter to the base is zero.

Fig. 6c provides a circuit which is basically a common emitter circuit, but the leakage characteristic is that of the common base circuit as shown in Curve *1* of Fig. 5. In this case, the leakage current is supplied by the base biasing configuration, and the emitter current becomes zero.

The curves for $I_b = -I_{co}$ and $I_b = 0$ are related to one another by the gain of the transistor. Specifically, the open base current is $B + 1$ times the collector junction leakage current. The curve for $V_b = 0$ is similar to the I_{co} curve, but at a somewhat higher current. The manner in which these two curves are related is dependent upon the internal resistance of base and emitter sections of the transistor. If the emitter junction is biased in the reverse direction, the leakage current will be below the normal I_{co} curve until some elevated voltage, at which time the curve will cross the I_{co} curve and the leakage will start to increase rapidly.

Within the boundaries shown in Fig. 5, we can establish whatever leakage current we desire by means of circuitry. Fig. 6d represents a general case of a source

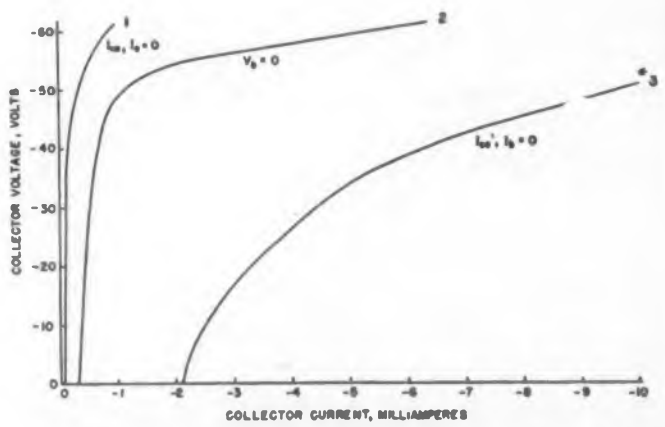


Fig. 5. Leakage current characteristics for emitter open *1*, short circuit *2*, and with test circuit *3*.

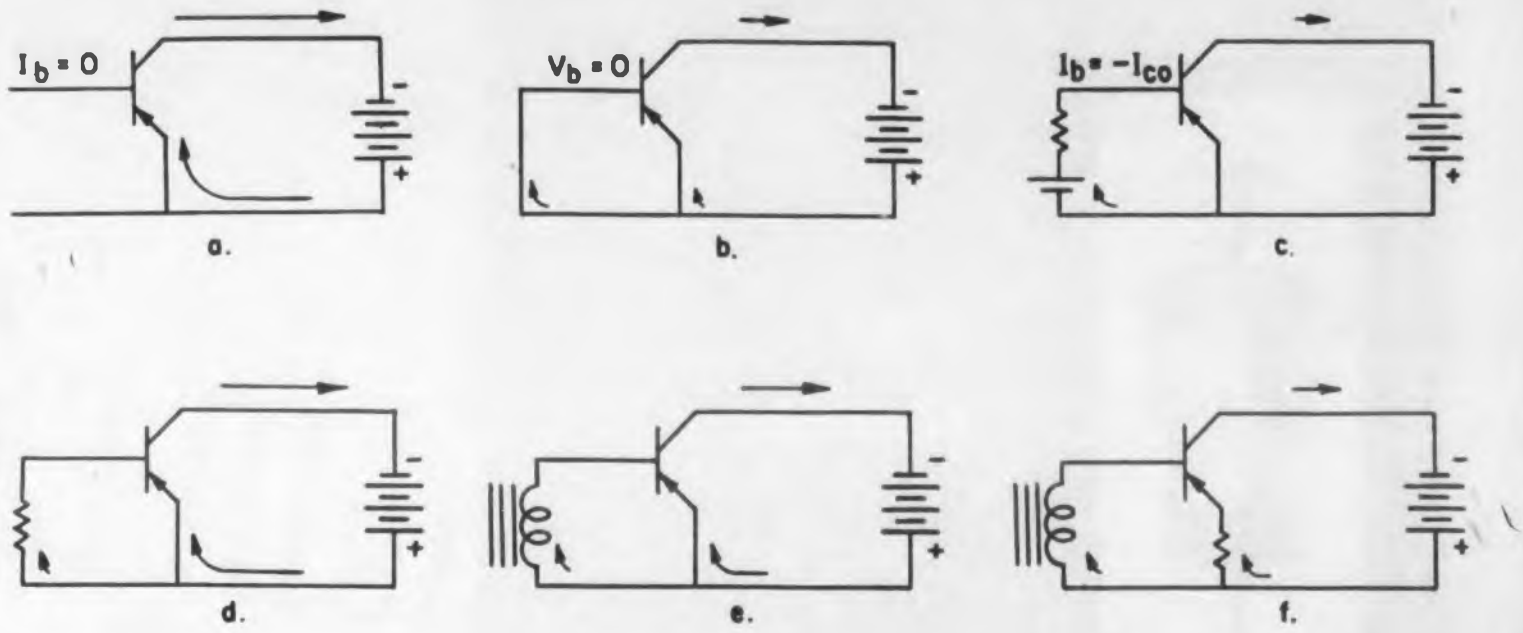


Fig. 6. Circuit to measure common emitter leakage *a*; with emitter shorted *b*; leakage supplied by base biasing *c*; resistance for leakage control *d*; scheme for eliminating signal shunting *e*; and most effective method of leakage control *f*.

resistance in the base lead without an external resistance in the emitter lead. If this resistance is terminated on the emitter circuit, the leakage will be reduced. A high resistance will yield only a small reduction in leakage current from the $I_b = 0$ curve. Lower and lower resistances reduce the leakage further, until the leakage characteristic $V_b = 0$ is approached. Low resistance in this part of the circuit causes difficulty in driving the transistor due to signal shunting.

One solution is shown in Fig. 6e. A transformer has low d-c resistance and can do an excellent job of driving a transistor because of its impedance matching ability. The d-c resistance of the secondary winding will determine its excellence in reducing the leakage current.

Fig. 6f shows one of the most effective ways of controlling the leakage current. The portion of the leakage current not supplied by the base of the transistor is amplified and flows through the emitter resistor, causing a voltage drop that helps the base provide more of the leakage current. This is a self-bias device, and its operation depends upon some amplified leakage flowing through the emitter resistor. Consequently, it is impossible for this circuit to reduce the leakage current to the value of I_{co}. The amount of reduction will often be determined by the degree of degeneration or negative feedback that can be tolerated in the amplifier stage. The resistor will also reduce the available power output by about the value of the ratio of the emitter resistance to the load resistance.

The stabilizing effect can be retained, and the a-c degeneration eliminated, by bypassing the resistor with a suitable capacitor. This capacitor, however, may have to be inconveniently large for many applications.

For example, suppose that the temperature requirements were such that Class B push-pull operation must be limited to an output of 7½w. Using a 28v supply, the load line would be about 50 ohms. If the stabilizing emitter resistor should be 5 ohms, this would reduce the output power by about 10%, and approximately double the required power input. To bypass this resistor for a 60cy signal and keep the phase shift under 6°, the reactance of the capacitor should be less than ½ ohm. This would require at least 5000mfd.

The required value of the emitter resistor will be dependent upon the resistance in the base circuit. If the d-c resistance of the transformer in Fig. 6f is high, a higher value of emitter resistance is necessary. If the d-c voltage drop across the emitter resistor equals the d-c voltage drop across the base resistance, the emitter to base potential will be zero and the leakage will be equal to the characteristic for $V_b = 0$. If the base is positive with respect to the emitter, the leakage will be lower than for $V_b = 0$; and, if the base is negative with respect to the emitter, the leakage current will be greater than for $V_b = 0$.

A configuration such as Fig. 6c is often useful to reduce the leakage current to a minimum. In this case the value of the voltage and series resistance must be such that it will supply the total leakage current to the base at the highest junction temperature expected. When the junction temperature is decreased, a restraining potential will be applied to the base because of the smaller leakage current. This has two undesirable effects. First, it increases the collector junction voltage, and second, it causes an input voltage threshold. Low level signals will not be amplified until their magnitude is high enough to overcome this threshold.

Both of the above effects can be reduced and still provide the base with the total leakage current by using a smaller voltage and smaller resistor. This procedure is limited by the signal losses when the resistor becomes too low. For switching circuits, the input threshold is usually unimportant, because the switching signal will have little trouble in overcoming the threshold.

Power Gain vs. Power Output

The maximum power gain from a transistor is attained by matching the load resistance to the output impedance of the transistor. Very high power gains can be achieved this way, but the power output will usually be very small. If the output impedance of a power transistor were 8000 ohms, then the maximum power gain can be achieved with a load of 8000 ohms. Operating the transistor from zero to 60v, the rms voltage will be about 20v. Thus, the power output will be 50 mw. With this power output, it is debatable if a high performance power transistor is economically desirable. The same job could possibly be done at a lower cost by using a lower power device. To attain a higher power output the transistor must be *mismatched considerably*, and, as a result, the power gain goes down as the power output is increased.

For most applications the load resistance is such a mismatch to the transistor that it makes no significant difference whether the output impedance is infinite, 50,000 ohms, or 1000 ohms. In addition, the collector resistance (which is the principal part of the output resistance) changes with collector voltage, collector current, and temperature. Consequently, no value can be stated without specifying the conditions, and, even if stated, has no use in most design problems.

The choice of a load line has other aspects. Suppose that a 28v supply is available, and it is desired to have a 2.5w Class A output from a *2N57* transistor. The load resistor could be 35 ohms and would pass a peak current of 0.800 amp. The power output would be 2.5w with a 15db gain.

If an output transformer were used, the same power output could be derived from a 140 ohm load. The quiescent bias point would be at 28v and 0.200 amp with a peak current of 0.400 amp. With this circuit the power output would also be 2.5w, but the gain would be 23db.

Even though power transistors are capable of high currents, it is often desirable to use them at a high voltage and low current, rather than at low voltage and high current. [Next month, specific problems.]

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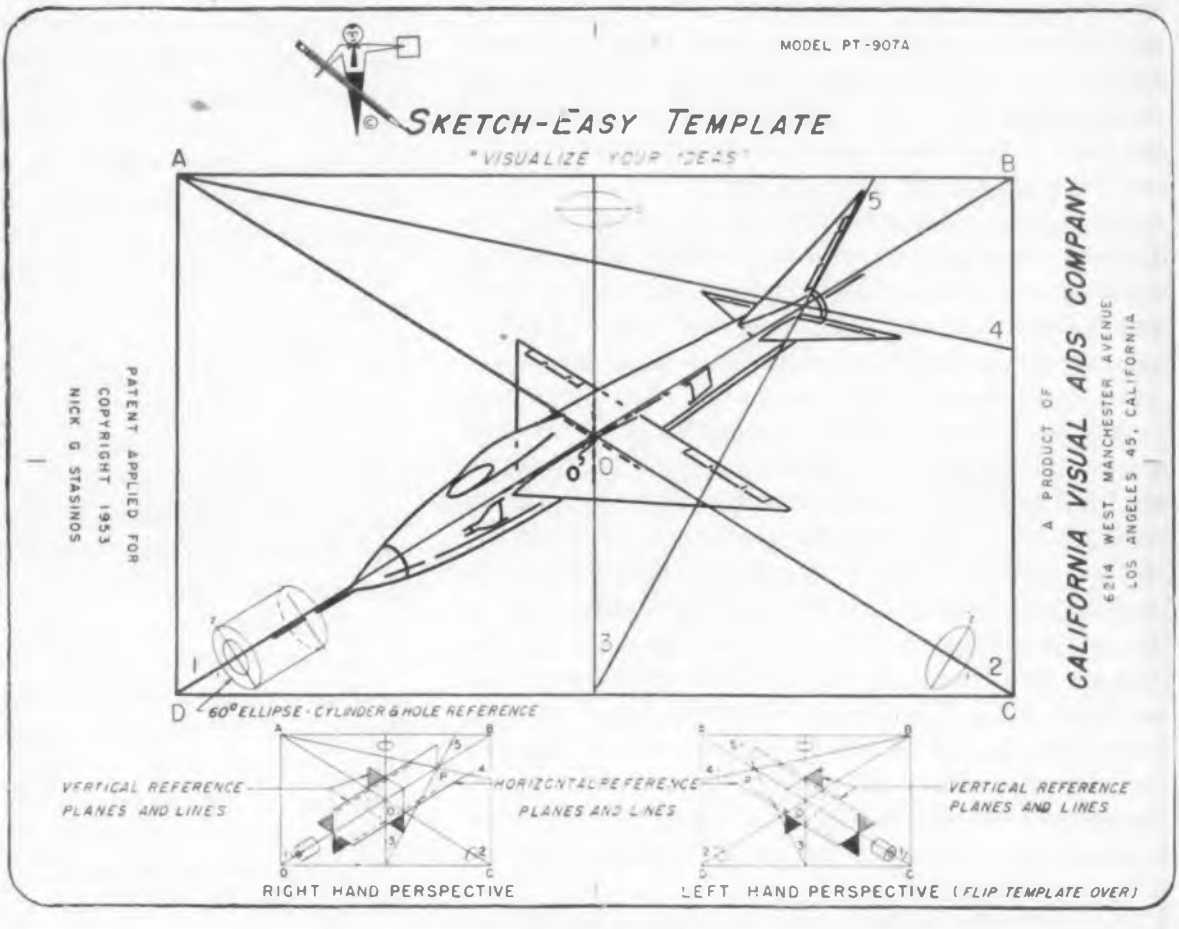

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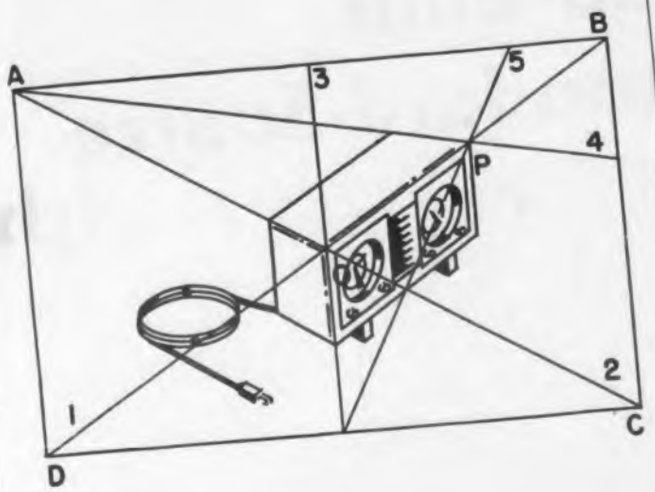

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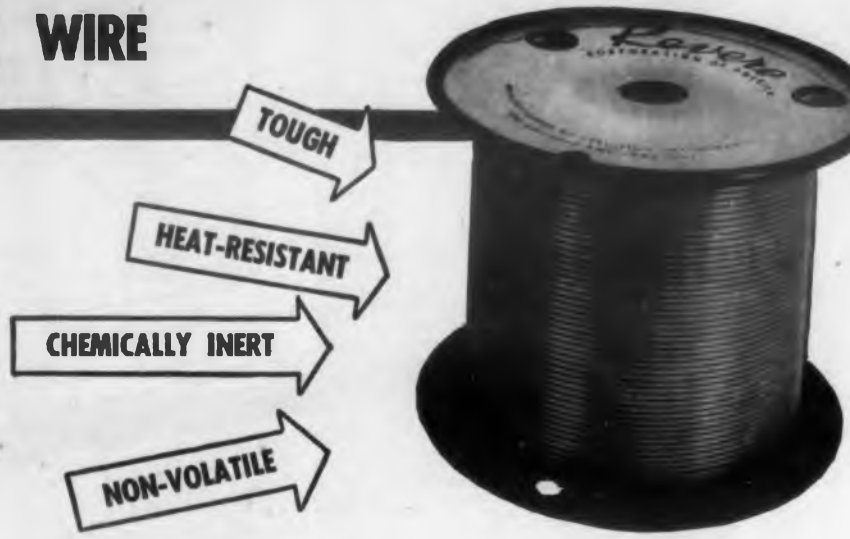

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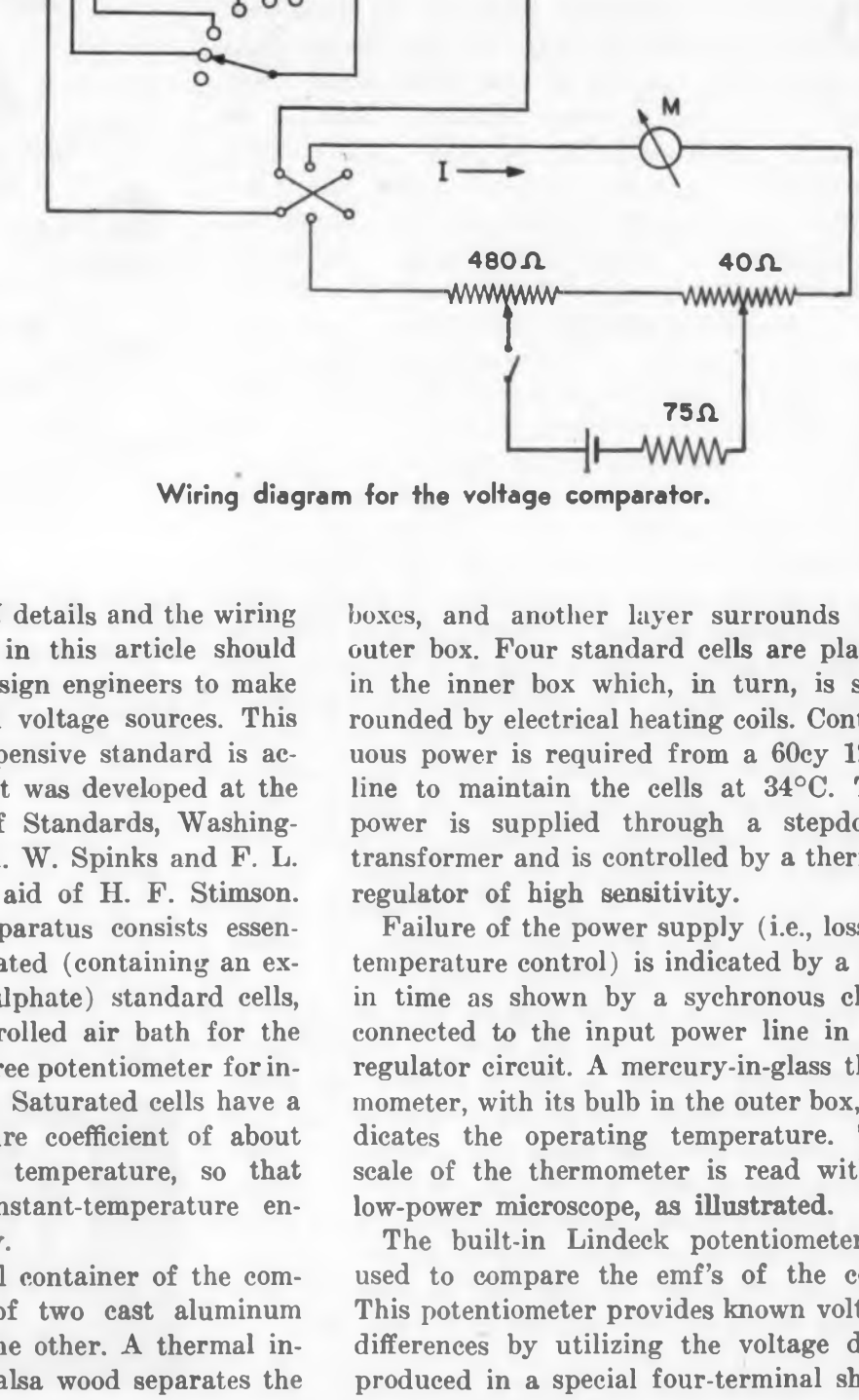

Wiring diagram for the voltage comparator.

CONSTRUCTION details and the wiring diagram given in this article should enable electronic design engineers to make their own standard voltage sources. This comparatively inexpensive standard is accurate to 0.002%. It was developed at the National Bureau of Standards, Washington 25, D. C., by A. W. Spinks and F. L. Hermach with the aid of H. F. Stimson.

The portable apparatus consists essentially of four saturated (containing an excess of cadmium sulphate) standard cells, a temperature-controlled air bath for the cells, and a thermofree potentiometer for intercomparing them. Saturated cells have a negative temperature coefficient of about 50μv/°C at room temperature, so that some form of constant-temperature enclosure is necessary.

The standard cell container of the comparator is made of two cast aluminum boxes, one inside the other. A thermal insulating layer of balsa wood separates the boxes, and another layer surrounds the outer box. Four standard cells are placed in the inner box which, in turn, is surrounded by electrical heating coils. Continuous power is required from a 60cy 120v line to maintain the cells at 34°C. The power is supplied through a stepdown transformer and is controlled by a thermoregulator of high sensitivity.

Failure of the power supply (i.e., loss of temperature control) is indicated by a loss in time as shown by a sychronous clock connected to the input power line in the regulator circuit. A mercury-in-glass thermometer, with its bulb in the outer box, indicates the operating temperature. The scale of the thermometer is read with a low-power microscope, as illustrated.

The built-in Lindeck potentiometer is used to compare the emf's of the cells. This potentiometer provides known voltage differences by utilizing the voltage drop produced in a special four-terminal shunt

One form in which the standard source was constructed.

by a measured current. This adjustable current is measured with a 2ma milliammeter shown as M. This meter has a 100-division face and an accuracy of $\pm 0.5\%$.

The special four-terminal multiple-range shunt consists of an annealed manganin strip to which are silver-soldered long copper leads to provide appropriate potential taps. The resistor is thermally shielded by a copper box which surrounds it. Each resistor section is adjusted to the desired value to better than 0.1%. The five taps on the shunt, R_1, are at 0.05, 0.1, 0.25, 0.5 and 1.0 ohm, respectively.

To perform an intercomparison, the standard cell of known voltage and the cell of unknown voltage are connected in series, emf's opposing, and the small difference in their potentials is measured with the potentiometer. The negative terminals of the two cells are connected to each other, and the positive terminal of the unknown cell is connected to one post of the potentiometer. The positive terminal of the known cell is connected through a galvanometer and a switch to a second post of the potentiometer. When the voltages are balanced, the difference in the emf's of the two cells is equal to the product of the milliammeter reading and the resistance value of the shunt for the taps used. A reversing switch indicates by its position which cell has the higher emf. By applying this difference to the value for the known cell, the emf of the unknown is found.

In order to insure the most reliable accuracy, it is essential that the standard cell comparator be maintained continuously at a constant temperature. The thermoregulator used in the illustrated comparator has an inherent sensitivity of $\pm 0.02°C$. Tests have shown that the temperature of the cells does not vary by more than 0.01°C. Thus changes in emf arising from temperature variations of the cells in the comparator should be less than $0.5\mu v$.

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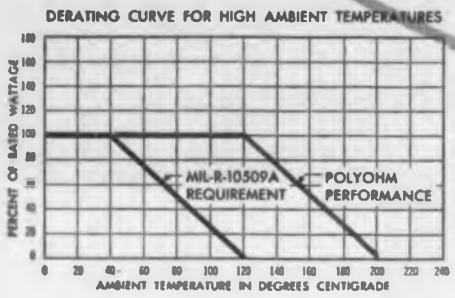

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TABLE OF TEST RESULTS

TEST	MIL-R-10509A Allowable change	POLYOHM Test Results (Median Value)
Temperature cycling	1%	.03%
Low temperature exposure	3%	.08%
Short time overload	.5%	.03%
Load life @ 40°C — 1000 hrs. @120°C — 1000 hrs.	1% —	.2% .5%
Temp. coeff. ppm/°C (char. X) (char. R)	±500 ±300	—150 —150
Moisture resistance test	5%	.3%

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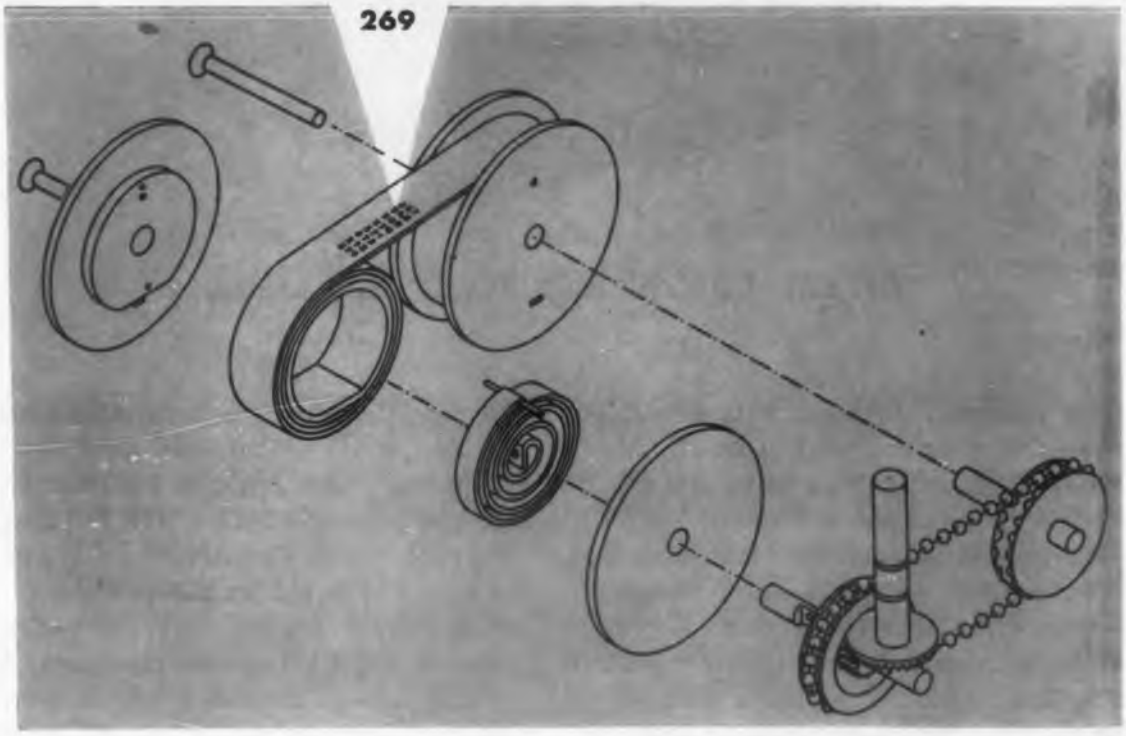
CIRCLE 43 ON READER-SERVICE CARD FOR MORE INFORMATION

Tape Potentiometer



Exploded view shows constructional design of tape potentiometer. Spring keeps tape taut. Resistance-wire element is bonded to edge of the fibre tape. Embossed numerals on tape indicate resistance.

RESISTANCE wire bonded to the edge of numeral-embossed tape makes this clever potentiometer unique: one compact package features direct-reading calibration and laboratory slide-wire advantages. A straight slide wire, 144" long, can be directly calibrated in either linear or non-linear functions. Direct-reading of numerical digits minimizes the possibility of human error in interpreting scale readings.

Low-resistance straight wire elements up to 300 ohms for infinite resolution, or high-resistance spiral-wound elements up to 30,000 ohms can be bonded to the white vulcanized fibre tape. Up to 1200 calibration-number points can be added by the manufacturer, Howell Instrument Co., 1106 Norwood, Fort Worth 7, Tex., to a 144" roll. The units are calibrated after assembly, linearly or non-linearly, on a resistance increment basis accurate to ±0.1%. The potentiometer can be calibrated in conjunction with the circuit with which it will be used. With this method, accuracy as high as 0.05% is obtainable. Temperature curves corresponding to different type themocouples, strain-gage calibrations, resistance-bulb calibrations, or direct readings in resistance values are examples.

Power dissipation is 2w at 40°C. Wire temperature coefficient is ±0.00002. Approximately 12 turns of shaft rotation are necessary to cover 144". Case size is approximately 1-1/4" wide x 4-7/8" long x 2-1/2" high. Clearance dimensions are somewhat greater. For more information on this tape pot, turn to the Reader's Service Card and circle **44.**

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CIRCLE 46 ON READER-SERVICE CARD FOR MORE INFORMATION

Digital Meter with Recorder

The readings on this meter are recorded at the rate of one per second on the recorder at the right.

ANOTHER device—a VTVM with a recording attachment—to aid design and development engineers in these times of scarce technical assistance is illustrated on these pages. The Model 503 Multitester also features a digital display, which means that parallax errors are avoided. Designers testing some circuit parameter with this instrument can tend to other problems while voltage or resistance values are recorded continuously on standard adding-machine paper tape.

The meter and the Model 504 Digital Recorder are available separately. The VTVM measures positive and negative d-c voltages to 1000v, a-c voltage to 1000v rms from 50cy to 100kc, and resistance to 10megohm. Accuracy on d-c, a-c, and resistance reading is ±0.15%, ±1%, and ±0.2%, respectively, of full scale. Over-all linearity is 1%, ex-

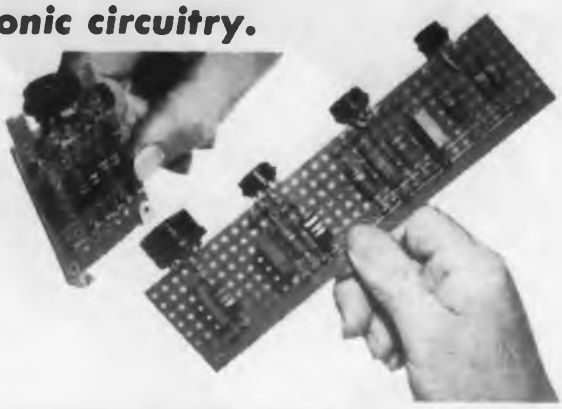
A typical parameter recording on paper tape.

cept for a-c measurements. The meter has a readout of 20 times a second. The recorder can print once a second. A single probe is used for all measurements. The meter is not damaged by the application of excessive voltage when the selector switch is turned to resistance reading. Both of these devices are manufactured by Laboratory for Electronics, Inc., 75 Pitts St., Boston 14, Mass.

The recorder can be attached to other instruments made by this firm. The meter and recorder can also be used in production-line testing as well as in the laboratory. The meter weighs 35 lb and is 14-3/4" high x 9-1/4" wide and 12" deep. The recorder is 12-1/2" wide x 13" high x 15-1/2" deep and weighs 45 lb. For more information on the use of these two unusual laboratory instruments, turn to the Reader's Service Card and circle **47.**

Ideas, Techniques, Designs

from the Alden Handbook of mechanical components to mount, house, fasten, connect and monitor electronic circuitry.

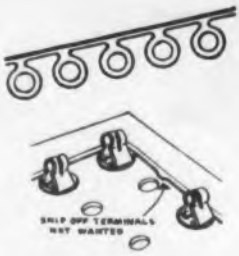


Now for the first time, using standard Alden Terminal Mounting Card components, you can mount all circuitry elements including vacuum tubes and other plug-in sockets directly on terminal cards with all their associated components . . . to have a construction that for all intents and purposes makes your terminal card the complete electronic chassis by itself.

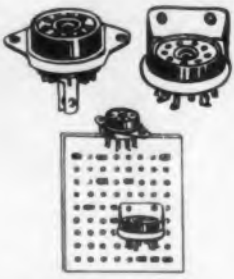
It's as simple as this — you start with these standard Alden Terminal Mounting Card Components in your lab:

1 You take the Alden Prepunched Terminal Mounting Cards and plan your component locations on planning sheets.

2 Choose the Alden Miniature Ratchet Terminals that fit your components, and stake them per pattern using lab staking tool.



3 Use Jumper Strip staked under terminals to eliminate wiring to common circuit.



4 Bracket and turret mounting Tube Sockets eyelet directly to the card.

Simply and easily you end up with beautiful sub-assemblies of completed circuitry. If you wish, Alden will handle the volume staking production, delivering to you the cards with all terminals staked in position.

Once organized in single planes for volume requirements, it's a simple step to go to printed circuitry as the next step. Even in printed circuitry, Alden Ratchet Terminals are desirable where components are heat sensitive, or where you might want to remove certain components without disturbing the solder of printed circuitry.

By making the Terminal Card your chassis, you —

1) Eliminate point-to-point chassis wiring.

2) Make your circuitry simple unit sub-assemblies . . .

3) . . . that mount compactly in chassis as accessible rows of wiring.

By organizing all circuitry in single planes, packaging problems are tremendously simplified by permitting their mounting in close spaced rows in metal chassis. The metal chassis now returns to its proper function of being a protective housing, like a watch case — and your circuitry, though taking little space, is accessible for easy checking, removal or replacement — with spare circuit functions being small enough to airmail.

For those who would like to house their circuitry in plug-in units, the Alden Basic Chasses are available into which the circuitry planes snap mount, organizing all in-out circuitry leads as accessible "point of check" connections, and providing the quick-acting locking and ejecting mechanisms to make each metal chassis a plug-in unit replaceable in 30 seconds.

Send for samples and the latest Alden Handbook specification sheets on the Alden Terminal Card Mounting System.

ALDEN PRODUCTS CO.

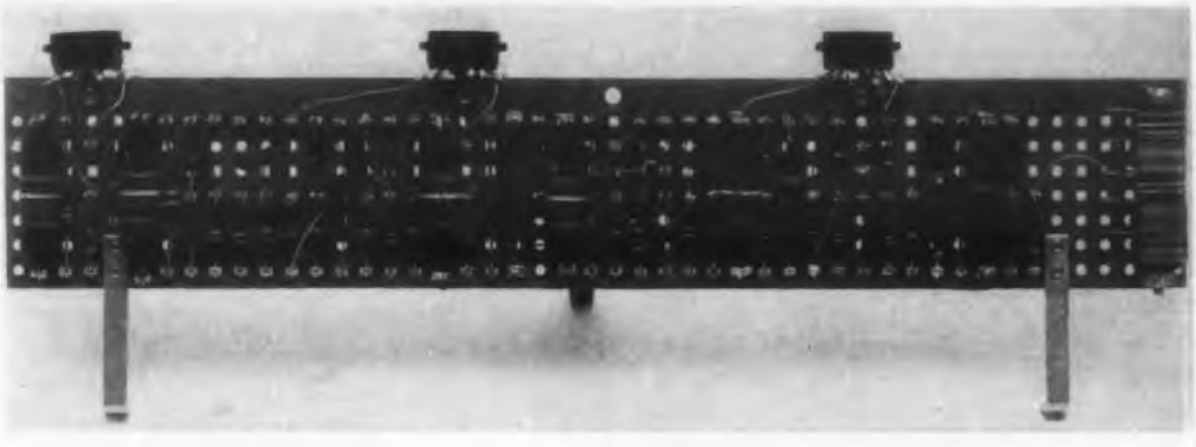
139 N. MAIN ST., BROCKTON 64, MASS.

CIRCLE 49 ON READER-SERVICE CARD FOR MORE INFORMATION

Easily Operated Preamplifier

The entire outer cabinet of this preamplifier is perforated for improved cooling.

The red ball below the bar tonal control is a listening level control.



Circuit design and production were speeded by use of this terminal-board chassis.

Design Forum

SIMPLIFIED controls are one of the outstanding features of this attractive high-performance home preamplifier. It also utilizes an unusual chassis construction technique of interest to electronic designers. The Model 240 is a product of Fairchild Recording Equipment Co., 154th St. and Seventh Ave., Whitestone 57, N. Y.

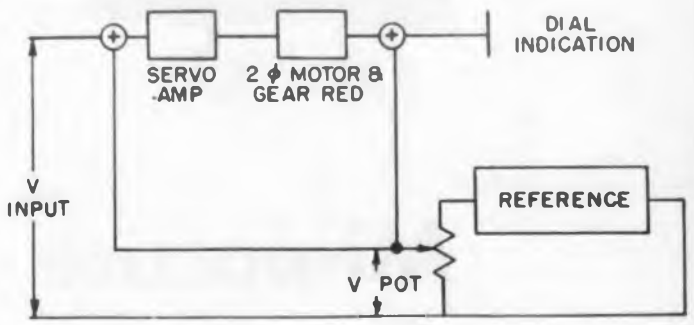
A control called the "Balanced-Bar" handles bass and treble response, as illustrated. The bars on either side of the main bar swing up and down. Each preamplifier is adjusted in the factory for electrically uniform response with the bars in the horizontal position. The setting can be adjusted for conditions in a particular room for "straight line" operation. In addition to this bar control, a listening level control just below it makes changing of response at different volumes very simple. When the red ball is thrown to the left for low level, bass response is increased. When the listener wants high volume, a more satisfying treble response change is introduced by throwing the ball to the right. Both of these controls can be read at a distance.

The chassis utilizes a construction technique developed by Alden Products Co., Brockton, Mass. The components are mounted in terminals that have been inserted in the illustrated strip of phenolic plastic. Since this board is mounted horizontally in the cabinet, the tubes are horizontal. They are removed through holes in the inner cabinet.

The terminals have a gripping action that holds the components in place until they are soldered. (All the solder points can be soldered in rapid succession at the same time for a considerable saving in labor costs.) This type of chassis can be used during the breadboard stage of circuit development, thereby eliminating design steps between the breadboard and the production model. Once the circuit is in production, design changes can easily be made. This last feature is particularly important these days when new, saleable improvements must be offered to the public every year.

Thumb Size Servo

The stator of the tiny servo is shown beside it.



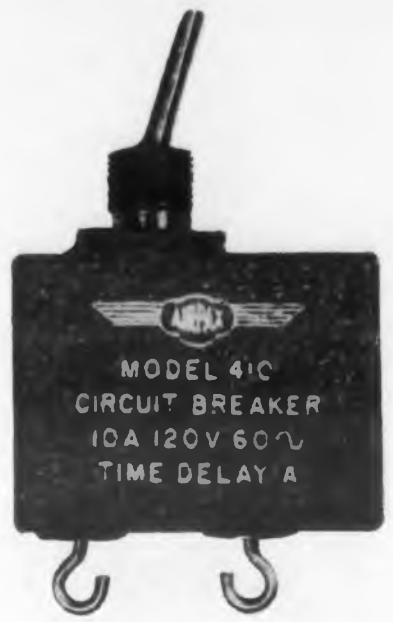
A dial-indication application of the 1.2 oz motor.

ONLY 5/8" in diameter and 1.2" long, this tiny two-phase servo motor can be utilized in many aircraft applications. It performs at altitudes up to 60,000'. Among its applications are null-method measurements and multiplication of two quantities.

The induction motor operates at a rated voltage of 26v, 400cy. It has a no-load speed of 21,000rpm and a stall torque of 0.11 in-oz. The moment of inertia is 0.0009 oz-in^2/min. The motor was developed by the Instrument Div., General Electric Co., Lynn, Mass., for use with a gyro-compass.

In one application in which the 1.2-oz motor is used to initiate control, one phase is continuously excited from the 400cy line, while another is fed from the output of the servo amplifier. The necessary 90° phase shift between the input to the fixed phase and the variable phase may be introduced in the error signal circuit, in the amplifier, or in the fixed-phase circuit. In this way, the error signal from a synchro-control transformer may be amplified and used to initiate control through the servo motor.

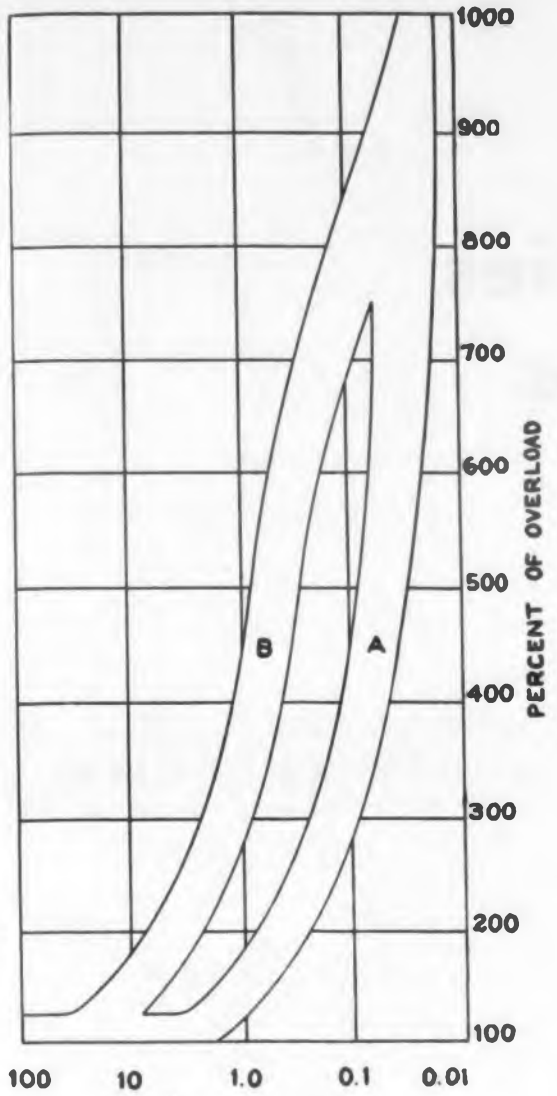
If single-phase, 400cy power is supplied to the fixed phase of this servo, the output of the other phase will then be a single-phase voltage proportional to the velocity of the rotor. Such an arrangement permits the multiplication of two quantities, one of which is in the form of an a-c voltage, and the other in the form of a velocity. The motor may be used at ambient temperatures ranging from −55° to +90°C. For more data on these servos, turn to the Reader's Service Card and circle **52.**



Miniature Circuit Breaker

POWER on-off control as well as circuit protection is provided with this miniature circuit breaker. Its operation is fully magnetic giving time-delay trip-free action. Its small size and light weight (less than 2oz) enables it to be used in any electronic equipment that normally contains an on-off switch. The bat handle has two positions: *on* and *off*. It moves to the *off* position when the breaker trips, yet the breaker cannot be prevented from tripping by holding the handle in its *on* position. Service is restored after a fault has been remedied by resetting the handle to *on*. A breaker having the maximum time delay of 30sec recovers its delay in about 20sec.

Being hermetically sealed, the breaker, manufactured by Airpax Products Co., Middle River, Baltimore, Md., is free from erratic effects of altitude. It operates reliably in any atmosphere withstanding 50g of shock and vibration of 0.03" amplitude at 10 to 55cy. The magnetic circuit can be made to have various time-overload responses. Two standard responses that meet most equipment needs for protection are illustrated. The trip coil can be wound to operate at any specified current from 50ma to 10a. The minimum trip level (lowest



value of overload at which tripping is guaranteed) is 125% of continuous current rating; the unit can be produced with higher minimum trip points for special needs. In characteristic *A*, the 125% delay is centered about 3sec; in characteristic *B*, it is centered about 20sec. The instantaneous trip point is approximately 10 times the continuous current rating. The interrupting capacity is 500a at 30v d-c rating.

Typical electronic equipment utilizing inverse time delay circuit breaker protection includes blower motors and motor-operated auxiliary devices. Starting inrushes of about 800% of rated current can be handled for a fraction of a second. Response characteristic *B* is intended for this general circuit protection. Response *A* is suited to electronic equipment where extremely sensitive overload protection is desired.

The actual size is 5/8 by 1-1/2 by 1-1/2". Seven d-c ratings of 0.05a through 10a at 50v, and five a-c ratings of 1.0a through 10.0a at 120v, 60cy are available. Life is specified at 10,000 operations; tests have been run to 20,000. Temperature range is from −40 to +100°C. For more information, turn to the Reader's Service Card and circle **55.**

Dielectric Breakdown Properties of Thermosetting Laminates

Norman A. Skow
Director of Research
Synthane Corporation, Oaks, Pa.

PERPENDICULAR TO LAMINATIONS

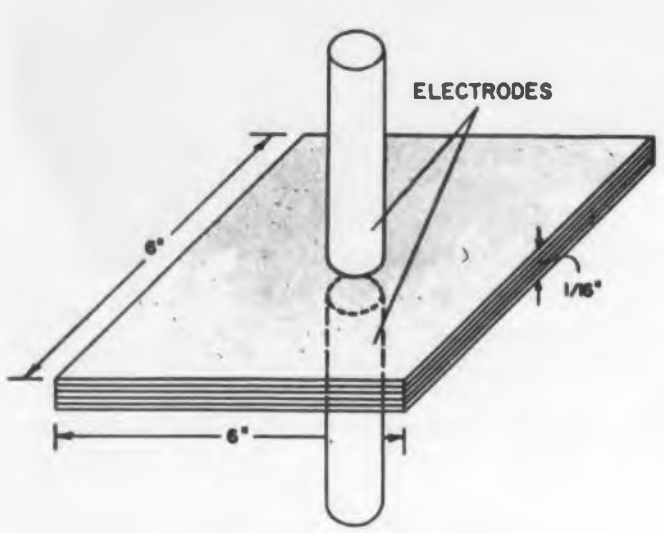
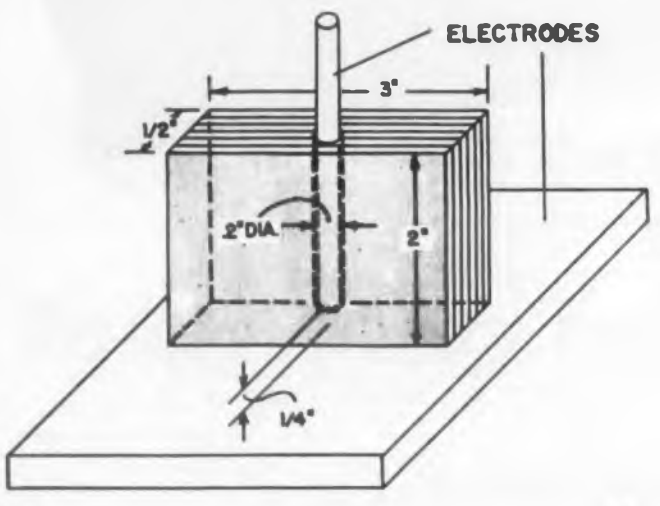


Fig. 1. Sample sizes and test arrangements for dielectric breakdown. For parallel tests, lower, thickness of laminates is 1/4". Thickness for perpendicular test, upper, is 1/16".

PARALLEL TO LAMINATIONS



WHEN selecting a laminate, aside from physical properties, the designer of electronic equipment is primarily concerned with insulation resistance, dielectric loss, and dielectric breakdown. The relative importance of these various properties depends on the application involved, but dielectric breakdown is almost always a major consideration.

Dielectric strength is the maximum potential gradient that a material can withstand without rupture. It is difficult to evaluate quantitatively because its magnitude varies with temperature, thickness of material, moisture content, and time exposed to stress.

Since long service without breakdown is a primary requirement of electrical insulating materials, determination of the endurance limit is most essential. This can be measured by stressing the laminate with voltages less than the short-time test value and recording the results at each voltage. The maximum voltage that can be applied for an indefinite time without breakdown establishes the endurance limit.

Differences between the dielectric breakdown properties of thermosetting laminates stressed *parallel* to laminations and those stressed *perpendicular* to laminations are sufficient to warrant investigation of behavior for each direction.

Seven typical NEMA grades of laminated thermosetting plastics were tested: Grades X, XX, XXP, LE, A, G-5, and N-1. Tests were made only upon laminates in sheet form, but the dielectric properties of tubes, rods and molded parts are quite similar.

Grades X, XX, and XXXP are paper-base laminates bonded with phenolic resin. Grade X is intended primarily for mechanical applications and is to be used with discretion under high-humidity conditions. Grade XX is made with a more absorbent paper and has a higher resin content. Grade XX is better electrically, although slightly weaker mechanically, than Grade X. Grade XXXP, which has a still higher resin content, is one of the best electrical laminates produced. Grade LE has a cotton-fabric

Table 1. Effect of sample thickness on short time dielectric strength of laminates at temperature rating of 73° F.

THICKNESS Inches	DIELECTRIC STRENGTH (SHORT TIME) Volts per Mil		
	PERPENDICULAR TO LAMINATIONS[1]	PARALLEL TO LAMINATIONS[2]	
	Grade XX paper-base	Grade X paper-base	Grade XX paper-base
1/32	940	—	—
1/16	695	360	530
1/8	515	270	275
1/4	—	160	190
3/8	—	120	130
1/2	—	110	120

[1]Average for five specimens, conditioned for 1 hr. at 220 F.
[2]Average for five specimens, conditioned for 8 hrs. at 220 F.

Background for Designers

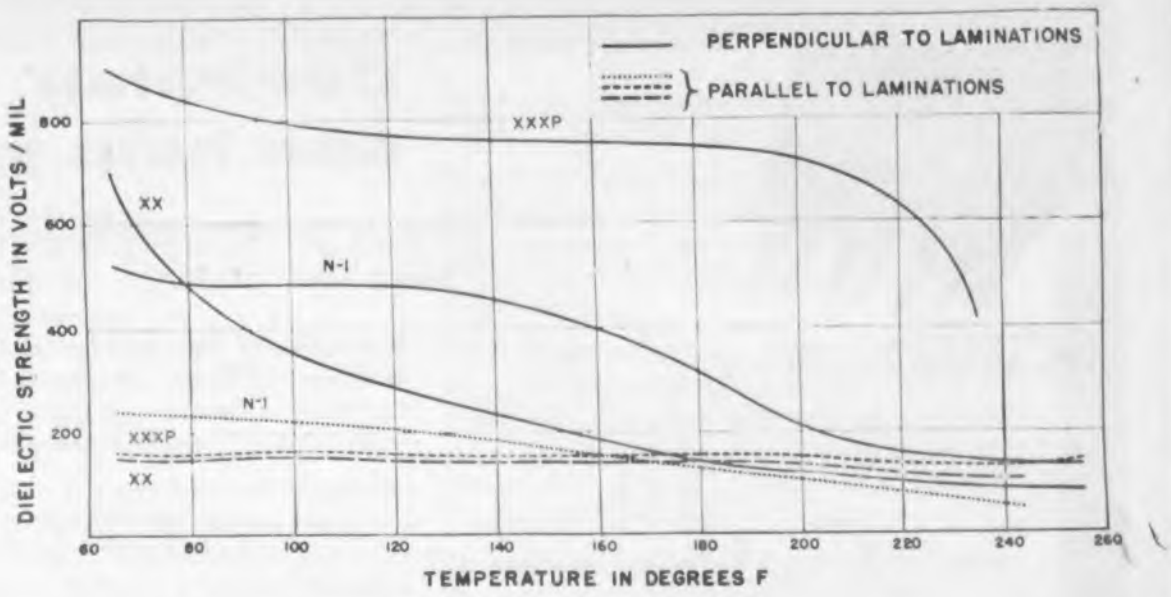


Fig. 2. Effect of temperature on short time dielectric strength of laminates.

base and is bonded with phenolic resin. This grade is used on electrical applications requiring greater toughness than is provided by Grade XX.

Grade A is an asbestos paper-base laminate bonded with phenolic resin. It is more flame- and heat-resistant than the cellulosic grades. Bonded with melamine resin, Grade G-5 is a glass-base laminate with very high mechanical strength, excellent electrical properties under dry conditions and good heat, flame and arc resistance. Grade N-1, is a nylon-fabric-base laminate bonded with phenolic resin. It has excellent electrical and mechanical properties even under high humidity conditions.

The drawings in Fig. 1 indicate the sample size and test arrangements used. For testing perpendicular to laminations, samples were selected at random from standard production sheet 1/16″ in thickness. For tests parallel to laminations, specimens were cut from standard sheets 1/2″ thick. A small hole was drilled leaving a 1/4″ thickness of laminate between the bottom of the hole and the edge of the sample.

Short-time dielectric strength measurements perpendicular to laminations were made with the specimens in oil. Samples were first dried in an oven at 220°F for 1 hour and then cooled in a dessicator for 16 hours at 73°F. Tests were made using five specimens for each grade. Measurements parallel to laminations were made in oil with a metal pin and plate as electrodes, Fig. 1. Because of the 1/4″ thickness of the electrode gap, a longer conditioning period was necessary to insure uniform dryness.

Results of tests in both directions are plotted in Fig. 2 for Grades XX, XXXP, and N-1 at temperatures from 65 to 256°F. The breakdown strength for electrodes parallel to laminations is considerably less than that for the perpendicular arrangement.

Data from Fig. 2 indicates that for the parallel to laminations test, Grade N-1 (nylon-base laminate) has the most rapid decrease in dielectric strength (short-time) with temperature, while the breakdown

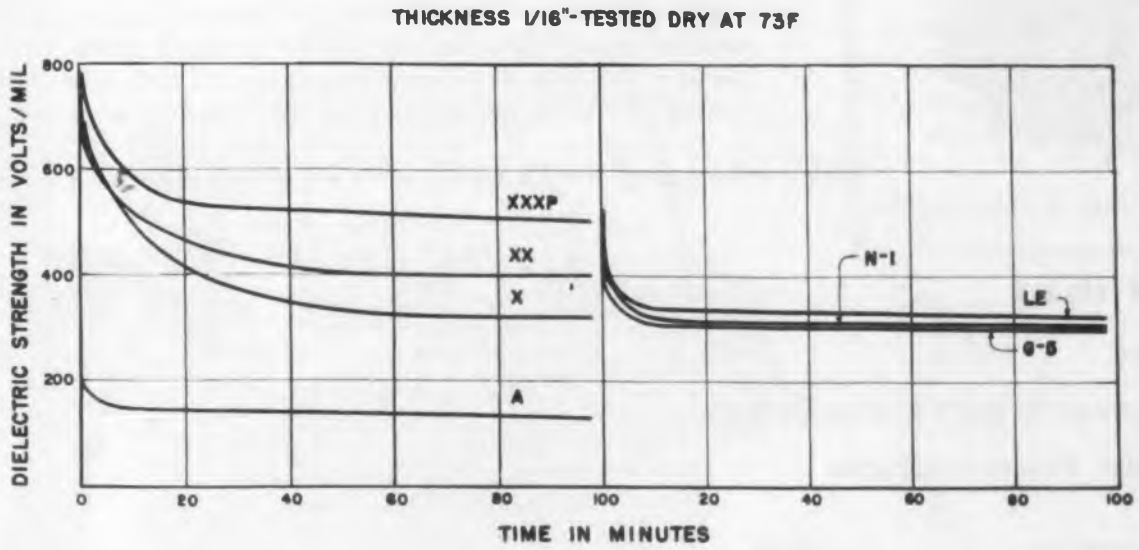


Fig. 3. Endurance limits of dielectric strength perpendicular to the laminations.

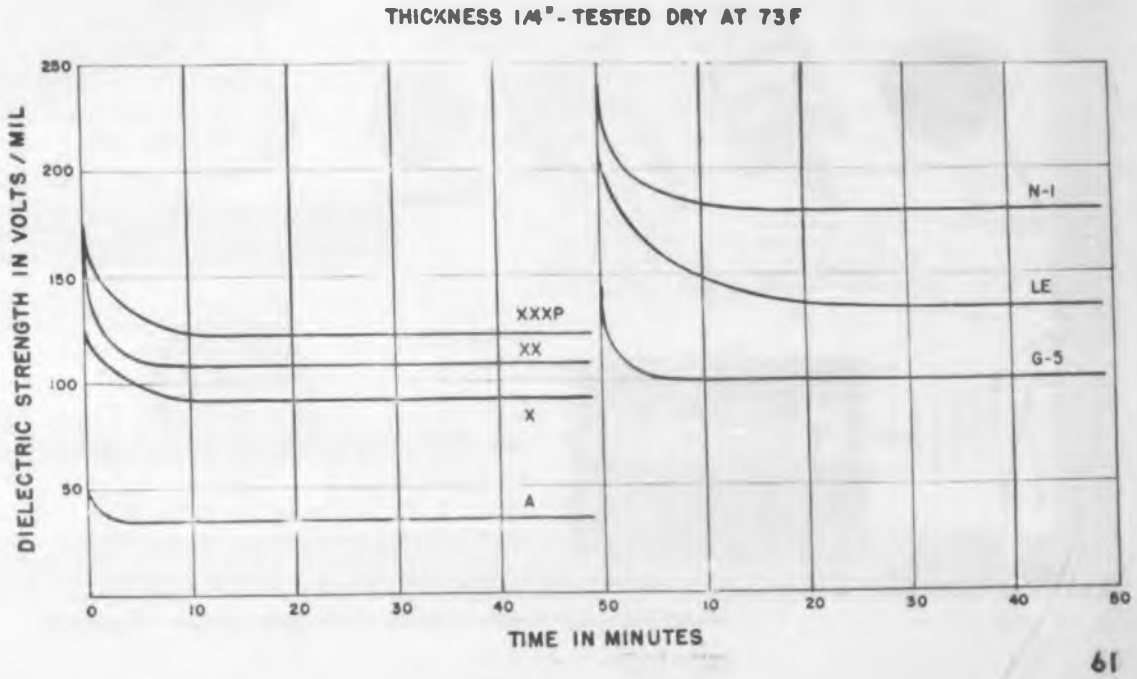


Fig. 4. Endurance limits of dielectric strength parallel to laminations.

GRADE THICKNESS CONDITIONING		PERPENDICULAR TO LAMINATIONS: Short Time Diel. Str. Volts/Mil	Endurance Limits Volts/Mil	Endurance Limits Short Time Diel. Str. %
1/16" Thick Dry a	X	649	320	49.3
	XX	695	390	56.1
	XXXP	780	500	64.2
	LE	434	320	73.8
	A	155	130	83.8
	G-5	450	310	68.9
	N-1	394	305	77.4
XX b	1/16", 96 hrs. at 90% RH 95F.	240	150	62.5
	1/16", 48 hrs. in H_2O at 122F	112	55	49.5
XXXP c	1/16", 96 hrs. at 90% RH 95F.	700	400	64.2
	1/16", 48 hrs. in H_2O at 122F	680	375	57.2

voltages of Grade XXXP, although it has a lower dielectric strength at lower temperatures, drop slightly between 65 and 256°F. The breakdown voltages of Grade XX appear between these two extremes throughout the temperature range.

Data in Table 1 indicates the effect of sample thickness on short-time dielectric strength measured in both directions. Here the decrease in dielectric strength may be compared to the law of diminishing returns in that each additional thickness of laminate provides a smaller increase in the total dielectric breakdown voltage of the sample.

The endurance limit of dielectric strength in both directions was determined by applying voltages at the rate of 10kv/sec until 85, 70, 60, 55, 50, and 45 per cent of the short-time breakdown value was reached. After rupture occurred, the voltage and time for failure were recorded. For all tests, the samples and testing procedure were made as uniform as possible to assure reliable results.

The endurance limits, perpendicular and parallel to laminations, for the seven grades of laminates tested are given in Figs. 3 and 4. The curves show that the breakdown voltage gradually approaches a magnitude that is independent of time. The endurance limit of the material is considered approximately equal to the maximum dielectric strength which will not rupture after a 100-minute exposure to stress. This assumption is based on tests on five samples which, after resisting breakdown for 100min, continued to withstand the applied stresses for 18 hrs.

Short-time dielectric strengths and endurance limit values are compared in tables above. In part *a*, where the seven grades of laminates are tested dry at 73°F, the ratios (per cent) of endurance limits to short-time dielectric strength are tabulated (data from curves in Figs. 3 and 4) to indicate the relative characteristics of the seven grades. Grade A (asbestos-base) plastic laminate has the lowest dielectric strength and endurance limit in either direction but is recommended in high-temperature applications be-

GRADE THICKNESS CONDITIONING		PARALLEL TO LAMINATIONS Short Time Diel. Str. Volts/Mil	Endurance Limits Volts/Mil	Endurance Limits Short Time Diel. Str. %
¼" Thick Dry a	X	124	92	74.2
	XX	176	108	61.3
	XXXP	172	124	72.0
	LE	206	134	65.0
	A	48	36	75.0
	G-5	144	100	69.4
	N-1	240	180	75.0
XX b	¼", 21 days at 90% RH, 50C.	100	80	80.0
	¼", 21 days in water at 50C	38	18	47.4
XXXP c	¼", 21 days at 90% RH, 50C.	112	96	85.7
	¼", 21 days in water at 50C	56	28	50.0

cause of its superior heat resistance. The six remaining grades tested are suitable for high-voltage applications, Grade XXXP having the highest breakdown voltages perpendicular to laminations and Grade N-1 the highest parallel to laminations.

For dry specimens, the endurance limits (in either direction) of the seven standard grades of laminates tested vary from 49 per cent to 84 per cent of the corresponding short-time dielectric strength. Therefore the designer can consider a safety factor of three, based on the short-time test, to be sufficient. For Grades XX and XXXP exposed to high humidity and elevated temperatures (parts *b* and *c* of tables above), the percentage ratio of endurance limit to short-time dielectric strength ranges from 47 per cent to 86 per cent (including both directions). Again, a safety factor of three should be satisfactory. In actual practice, a designer may expect to use equipment under highly humid conditions, yet available data on the laminates may be limited to short-time dielectric strength under dry conditions. In these cases, the NEMA-recommended safety factor of six may be necessary.

Conclusions drawn from these tests would indicate that for selecting thermosetting plastic laminates to be used as a dielectric medium, it is important to know the temperature at which the equipment is to be operated, the atmospheric conditions to be encountered, the mechanical strain and the dielectric stress to be applied. If the equipment is used under dry conditions and the mechanical strength requirements are not severe, paper-base laminates are very satisfactory. If humid conditions are a factor it would be advisable to use the more water-resistant paper base grades such as Grade XXXP. Under dry conditions requiring high mechanical strength it may be necessary to use a fabric grade such as LE and under continuous humid conditions requiring high mechanical strength it may be necessary to use Grade N-1. If arc-resistance is an important requirement. Grade G-5 is indicated.

Background for Designers

The Effect of Heater Coating Thickness on Warm-Up Time

R. L. Pear and A. Szilasi
Westinghouse Electric Corp., Electronic Tube Div., Bath, N. Y.

SERIES-STRING tubes for radio and television receivers must have the same heater warm-up times. In the course of developing a group of 600ma series-string tubes, the following information and the illustrated graphs on the influence of heater coating thickness on heater warm-up time were compiled. An approximately linear function was established between heater warm-up time and coating volume.

The filaments to be compared were taken from the same spool of tungsten wire. This coating was applied by the drag coating process. After each section of coated wire, a piece of bare wire was cut out and the coating thickness was increased for the next section. Each section was held to as short a length as possible. The variations in wire size indicated by the pieces of bare wire were negligible. Consequently, the filaments had practically all the same tungsten core with different thicknesses of coating.

Each filament was cut to the same length and welded straight between two electrodes into the largest available bulb. The tube was evacuated, the filament degassed, and the getter flashed to guarantee a good vacuum in the enclosure.

Referring to Fig. 1, the filament voltage versus the filament current curves show that, for constant voltage, the current increases with coating thickness, that is, the hot resistance decreases. It is known that for tungsten wire the hot to cold resistance ratio determines the hot temperature. Assuming the same cold resistance for all experimental filaments (the variations were only slight due to inaccuracy of the welding process) it is evident that the applied coating decreases the average temperature of the core wire, apparently due to the bigger radiating surface.

The Emerson method, for determining warm-up time, uses a series resistor equal to three times the heater's hot resistance and a supply voltage equal to four times the heater voltage. The heat-up time end point is the 80% point of the final heater voltage.

To compare different heaters with only one common property, the cold resistance, another common characteristic had to be chosen. The following possibilities could have been used:

1. same heater current.
2. same heater voltage.
3. same heater power.
4. same temperature or hot resistance.

Due to the fact that the heaters in receiving tubes are designed for a normal operating temperature of 1500°K, which corresponds to a ratio of hot-to-cold resistance of about seven, the comparisons of the different filaments were based on equal temperature, that is on equal hot resistance.

The necessary data for setting up the conditions of the warm-up time were furnished from Fig. 2. The ratio of hot-to-cold resistance of 6 and 7 times the cold resistance was selected. The average cold resistance was taken for all the filaments in order to simplify the test conditions.

The warm-up time measurements on filaments ranging from bare wire to about 11 mils coated diameter, based on a test point corresponding to a hot resistance of six and of seven times the cold resistance are shown in Fig. 3. A more linear function was achieved by plotting Fig. 4, the volume of coating versus warm-up time. It can be concluded that the warm-up time is better related to the volume of the body to be heated than to the diameter. Diameter readings were taken as an average of three readings because of the non-uniformity of the coating.

The warm-up time curves, for the ratios of six and seven times the cold resistance, show very little difference, the curve for six times the cold resistance requiring slightly longer warm-up times than for seven. This difference of fractions of a second can be attributed to the greater influence of the end losses, when the filament is colder.

Comparison proves that the Emerson test method is fairly independent of the operating temperature of the heater to be tested, as long as conditions are adapted to varying hot resistance and heater voltage.

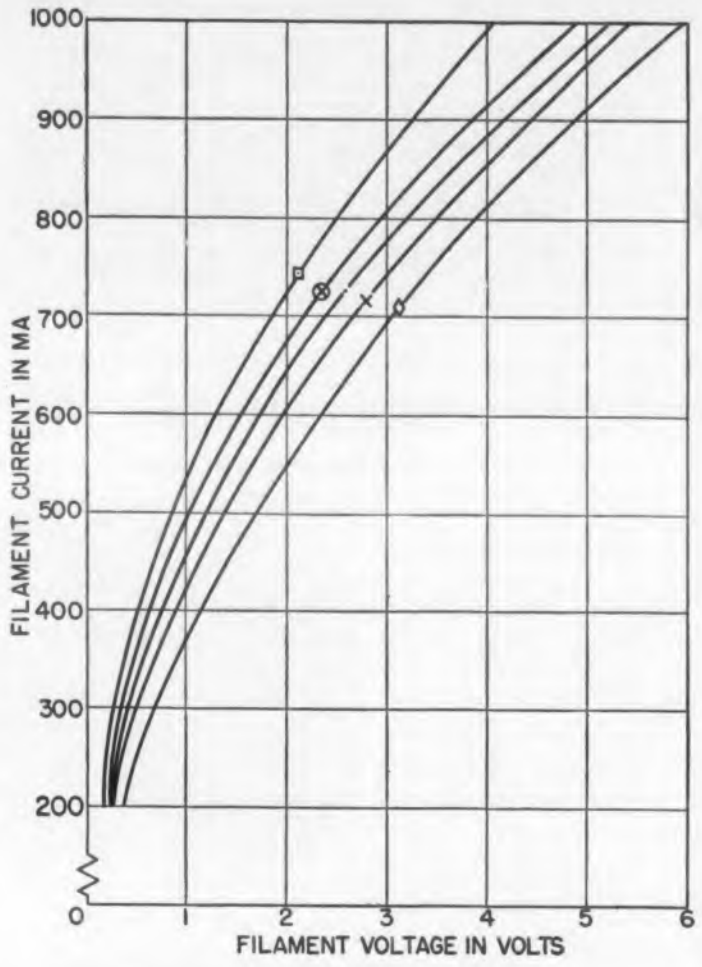
A third warm-up time curve versus coating thickness was based on a setting of constant power. The voltage-current characteristics of the different filaments served for the calculation of heater power versus heater voltage. A constant power of 4w was selected and the hot resistance and filament voltages read from Fig. 2 are shown in the table below.

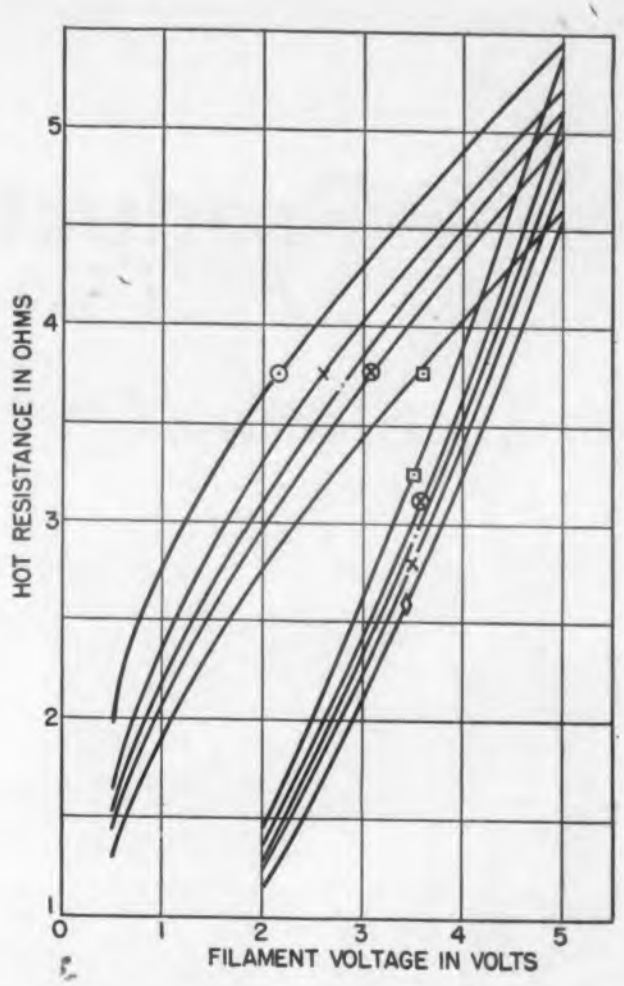
	Filament OD (mils)	Filament Voltage	Hot Resistance (ohms)
Bare Wire	3.58	4.58	5.22
Coated	5	4.42	4.9
Coated	7	4.35	4.72
Coated	9	4.25	4.52
Coated	11	4.05	4.08

The above values were used in the warm-up test.

Fig. 4 shows less linearity than the curves for equal hot resistance, that is temperature. As the power settings correspond to different temperatures for the individual filaments, the curve for constant power crosses from the line of highest temperature over to lower temperatures.

The tests show a good linear relationship between coating volume and warm-up time. The values of warm-up time are in all cases smaller than those in regular tubes, although the filament used was very similar. Undoubtedly the addition of the cathode increases the mass to be heated. Calculations show that the presence of the cathode could easily double the warm-up time of the heater.





◇ Bare wire 3.58mil OD

× Coated wire 5mil OD

• Coated wire 7mil OD

⊗ Coated wire 9mil OD

⊡ Coated wire 11mil OD

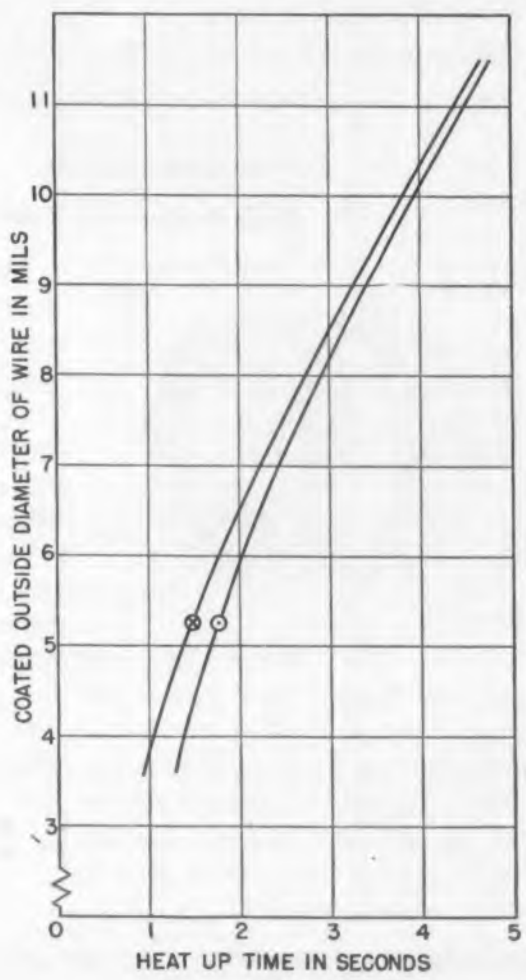
The above key applies to Fig. 1 (left) and Fig. 2 (right).

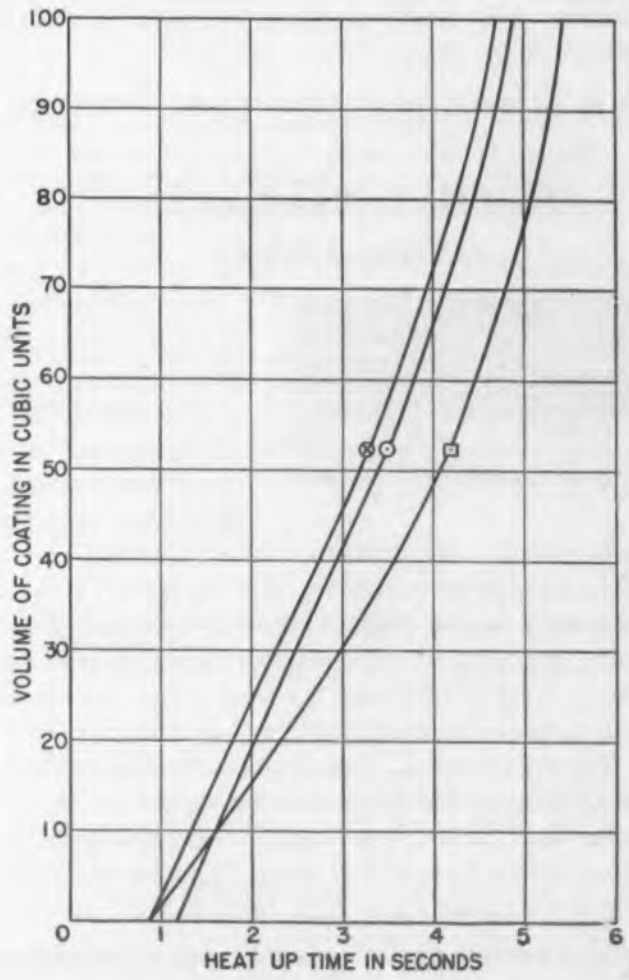
⊙ Hot resistance 6 times cold resistance

⊗ Hot resistance 7 times cold resistance

⊡ Constant power on filament—four watts

The above key applies to the heating time characteristics shown in Fig. 3 (left) and Fig. 4 (right).





New Products

Microwave Oscillators

Backward-wave Type

Known as backward-wave oscillators, these tubes sustain oscillation by energy interchange between an electron beam and a guided electromagnetic wave. Conventional applications include local oscillators, sweep-frequency signal generators, high-speed AFC circuits, and laboratory microwave signal sources. With wide-range electronic tubing (a single type covers a 2000Mc range), they also have low pulling figure, freedom from hysteresis and long-line effects, and freedom from spurious modulation when modulated at high frequencies.

Tubes covering L-band through X-band are currently available. X-band through K-band types will be available soon. Raytheon Manufacturing Co., Dept. ED, Waltham 54, Mass.

CIRCLE 60 ON READER-SERVICE CARD FOR MORE INFORMATION

Multiple Carbon Controls

For Printed Circuits

Strip-type carbon controls, with the resistance wafers mounted directly on a phenolic panel, are available from this firm for printed circuit applications. The controls have straight, tinned terminals which project through punched slots in the printed sheet for dip soldering. They are mounted at right angles to the chassis by means of shouldered tabs. To save space, multiple sections can be mounted about 1/2" behind each other. The shafts of the rear section extend through holes factory-punched in the front strip.

Single, dual and triple sections are available, in resistance values from 250 ohms to 10 megohms. P. R. Mallory & Co., Inc., Dept. ED, Indianapolis, Ind.

CIRCLE 61 ON READER-SERVICE CARD FOR MORE INFORMATION

Feed-Thru Capacitor

Mounted by Shoulder

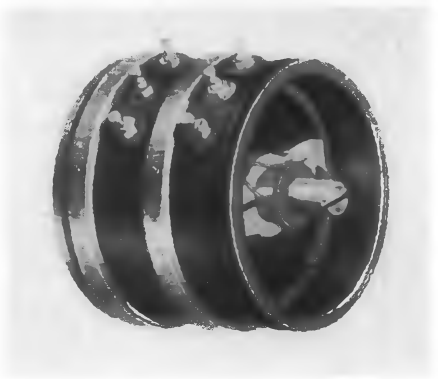
"Step-Cap" ceramic feed-thru capacitors have a shoulder in the body for mounting, instead of an eyelet. By eliminating the eyelet, it is possible to mount the units in smaller areas, or mount them much closer together on the chassis. They will not tilt when mounted, because they are self centering. The only assembly operations needed are dropping the unit into place, and soldering. Silver is bonded homogeneously to the ceramic to facilitate soldering.

The units are supplied in capacity ranges from 3mmfd to 275-mmfd at ±10% and ±20% tolerances; from 276mmfd to 1000-mmfd at GMV. Units are rated at 1000v d-c (w). The mounting hole is 0.192". Solar Mfg. Corp., Dept. ED, 46th and Seville, Los Angeles 58, Calif.

CIRCLE 62 ON READER-SERVICE CARD FOR MORE INFORMATION

Potentiometers

2" High-Resolution Units

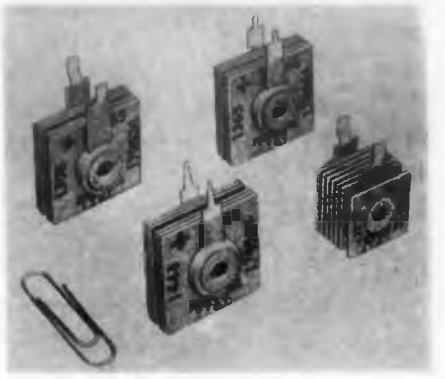


The Series K-200 High-Resolution Kohlrausch-wound Potentiometers are especially designed for low-torque, high-function-angle applications. These 2", ball-bearing potentiometers are completely enclosed and can be used as single or multiple ganged units. Any practical number of sections can be ganged on a single shaft by one-piece stainless steel clamp rings. This arrangement permits precise independent phasing of each unit without disassembly of other units. DeJur-Amsco Corp., Dept. ED, 45-01 Northern Blvd., Long Island City 1, N. Y.

CIRCLE 63 ON READER-SERVICE CARD FOR MORE INFORMATION

Selenium Rectifiers

For Printed Circuits



A line of selenium rectifiers for use with printed circuits has been announced by this firm. Employing three different types of terminals, they are designed for insertion into the printed circuit automatically or manually.

The three types of terminals available are: a square-tipped type for insertion into printed circuit boards up to 1/16" thick; a tapered type designed for maximum ease of insertion by automatic equipment in printed circuit boards up to 1/8" thick; and a snap-in type which holds the rectifier firmly in place even when the circuit board is subjected to vibration or inverted prior to soldering. Components Div., Federal Telephone and Radio Co., Dept. ED, 100 Kingsland Rd., Clifton, N. J.

CIRCLE 64 ON READER-SERVICE CARD FOR MORE INFORMATION

Relay

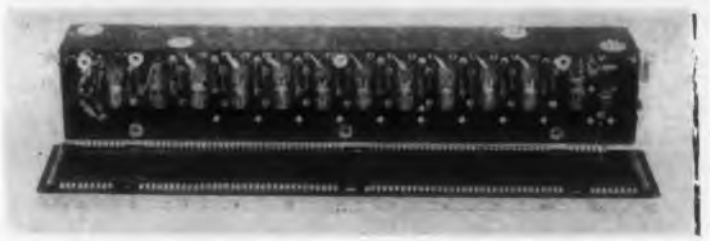
For Printed-Circuit Use

The construction of the Series SQD Printed-Circuit Relay permits direct insertion of the relay terminals into the printed circuit board, ready for immediate soldering. The plug-in terminals, instead of being brazed or welded together in sections, have been made integral parts of the coil terminals and contact springs to prevent internal loss in conductivity or continuity. The two contact arms of the relay permit two spring pile-ups of up to nine springs each. Automatic Electric Sales Corp., Dept. ED, 1033 W. Van Buren St., Chicago 7, Ill.

CIRCLE 65 ON READER-SERVICE CARD FOR MORE INFORMATION

I-F Amplifier

Measures Only 12" x 2" x 1"



A series of subminiature i-f amplifiers for airborne radar systems and broadband receivers is available from this firm. Gains of over 100db are obtained simultaneously with bandwidths over 12Mc at center frequencies of 20Mc, 60Mc, or 90Mc. The construction provides complete shielding and absence of regeneration even with covers removed.

Tubes having a rated life of over 5000hr. Reduction of weight and size (12" x 2" x 1") is accomplished by use of subminiature components and novel assembly techniques.

Each model consists of a cascode amplifier followed by three flat staggered triples. The last triple feeds an infinite impedance detector and a cathode follower output stage. A bias adjustment is incorporated in each unit to control the gain over a range of at least 40db. Provisions are made to monitor crystal current. Maxson Instruments, Div. of W. L. Maxson Corp., Dept. ED, 47-37 Austell Pl., Long Island City 1, N. Y.

CIRCLE 66 ON READER-SERVICE CARD FOR MORE INFORMATION

Impulse Counter

Has Preselection Feature

The "Ti" Series of "Sodeco" electrical impulse counters features preselection. They are available with either manual pushbutton reset or electric reset. They are furnished either with a front plate for flush mounting, or one for surface mounting. The counters are completely housed and sealed. Power requirements are low (0.8w to 3w), and speed is up to 12 impulses per sec.

The counters may be preset to any number up to 99,999 and then sealed to prevent tampering. As impulses come in, the upper (preset) register subtracts and the lower (counting) one adds. If desired, the counter will automatically reset to the original preselected figure at the end of each counting cycle. When the counting cycle is completed a built-in secondary contact can be actuated. Landis & Gyr, Inc., Dept. ED, 45 W. 45th St., New York 36, N. Y.

CIRCLE 67 ON READER-SERVICE CARD FOR MORE INFORMATION

High Vacuum Pump Oil

No Traps Needed

Diffusion Pump Oil, known as Bevins 8, enables the attainment of high vacuum without resorting to traps involving liquid air or charcoal. It is chemically and thermally stable. Inspection samples of Bevins 8 oil are available at no cost, to qualified users stating potential application. A.Daigger & Co., Dept. ED, 159 W. Kinzie St., Chicago 10, Ill.

CIRCLE 69 ON READER-SERVICE CARD

Heat Resistant Decals

Wide Selection of Colors

These Heat Resistant Decals are particularly suited to jet aircraft fuel lines because of their ability to resist active solvents. Other applications are electronic equipment, transformers, and any other situation involving extreme heat. Meyercord Co., Dept. ED, 5323 W. Lake St., Chicago 44, Ill.

CIRCLE 70 ON READER-SERVICE CARD

Miniature Screws

For Precision Instruments

Imported miniature screws in a complete range of sizes are available in the United States. Manufactured in Switzerland, the 0-80 and 1-72 screws range in size from 1/16 to 3/4", in length increments of 1/64". Heads and Threads, Inc., Dept. ED, 2816 Peterson Ave., Chicago 45, Ill.

CIRCLE 71 ON READER-SERVICE CARD

Characteristics Sheets

More Types Available

This firm is adding to the number of tube types for which it publishes large characteristics sheets. These 8-1/2" x 11" graphs aid in circuit design. The curves show plate characteristics, positive-grid characteristics, μ, g_m, and r_p. Some subminiature types are being added. Technical Publishing House, P. O. Box 61, Waltham 54, Mass.

CIRCLE 72 ON READER-SERVICE CARD

◀ CIRCLE 73 ON READER-SERVICE CARD

Taper Pin Terminal Board

For Solderless Connections

This taper pin terminal board is highly versatile and applicable to experimental work. Using new taper pin terminals that permit solderless connections, the boards are available in 5 sections with either 25 or 50 terminals. The 5-section boards may be easily cut to single sections of 5 or 10 terminals each, or may be used in any multiple desired. Boards are available with either single-end or double-end taper pin terminals. Lerco Div., Lynn-Deatrick, Inc., Dept. ED, 501 S. Varney St., Burbank, Calif.

CIRCLE 74 ON READER-SERVICE CARD

Screen Process Ink

Resist for Printed Circuits

P. C. Black is a free flowing screen process ink designed specifically to meet the requirements of printed electronic circuitry. Its opacity allows it to lay an unbroken resist line of hairline accuracy without blobing or breaking the circuit. Commonly used etching chemicals have no effect on this ink once it is applied to the printed blank. It reacts instantly to petroleum solvents and all traces of the resist vanish in seconds. Naz-Dar Co., Dept. ED, 461 Milwaukee Ave., Chicago 10, Ill.

CIRCLE 75 ON READER-SERVICE CARD

High Polymer Capacitors

Various Temperature Coefficients

These new high polymer capacitors can be obtained in any temperature coefficient of capacitance from —125-ppm per degree C to +60ppm per degree C within a temperature range of —60° to +200°C and a capacitance range of 0.001mfd to 1mfg 600v d-c. This range of temperature coefficients is the result of combining various dielectric properties into one unit. Condenser Products Co., Div. of New Haven Clock and Watch Co., Dept. ED, 140 Hamilton St., New Haven, Conn.

CIRCLE 76 ON READER-SERVICE CARD

CIRCLE 90 ON READER-SERVICE CARD ➤

Capacitors

Operate to 150° Without Derating

Series "X" Capacitors will operate from −65° to +150°C without derating and to +200°C with proper derating and adjustment. They use "Mylar" and other quality dielectric materials, including a solid polyester impregnant.

The units are available in a wide selection of hermetically sealed tubular, "Squeeze Seam", and bathtub cases with glass-to-metal closures for positive environmental protection. They also feature high insulation resistance, good capacitance stability, excellent r-f and retrace characteristics, and immunity from vibration or shock damage.

For ease of application, these capacitors are manufactured in a selection of tolerances with standard non-inductive, extended foil, as well as inserted tab constructions. Astron Corp., Dept. ED, 225 Grant Ave., East Newark, N. J.

CIRCLE 78 ON READER-SERVICE CARD FOR MORE INFORMATION

RC and L Network

In Plug-In Units

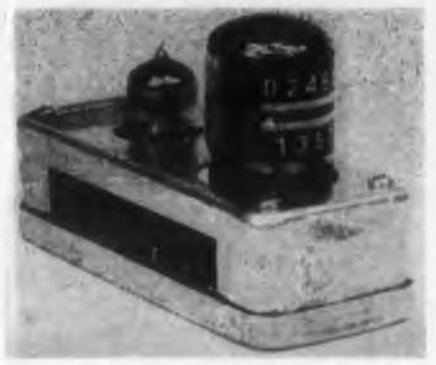
These RC and L networks are hermetically sealed to withstand extreme environmental and vibration conditions. Built to customer specification and matched to as close as 0.01%, they save valuable chassis space. Where needed, a built-in heater element and thermostat to control the operating temperature of the network is provided. The illustrated plug-in contains precision wire-wound resistors and polystyrene capacitors aged and matched to within 7 parts per million of each other. The built-in oven maintains a temperature of 75° +1°C.

Units from 1" x 1" with an octal base, to 12" x 18" with 48 standoffs and mounting studs are being manufactured in a choice of identifying colors. Eastern Precision Resistor Corp., Dept. ED, Richmond Hill 18, New York.

CIRCLE 79 ON READER-SERVICE CARD FOR MORE INFORMATION

Decade Counters

Extremely Compact Units



These electronic decade counters, employ the direct-reading EIT counter tube. Three types are available for immediate delivery, with ratings of 20kc, 100kc, and 250kc. The first two types weigh 7 oz and employ two tubes each. The third weighs 8 oz and employs three tubes. All three types deliver 15v and require an input signal of 15v. Electric power at 6.3v a-c and 275v d-c is required for operation.

These plug-in units employ printed circuitry and are only 2-1/16″ wide x 5-1/16″ long, and, with tubes in place, are only 3-1/2″ high. They can be arranged to provide a stairstep output voltage in ratio to count. Principal applications are in electronic and nucleonic measuring instruments, military and industrial electronic devices, and in automation as integral components of computers and counting devices. Ransom Research, Dept. ED, P. O. Box 382, San Pedro, Calif.

CIRCLE 80 ON READER-SERVICE CARD FOR MORE INFORMATION

Ratemeter

Counts at 100,000 per Second

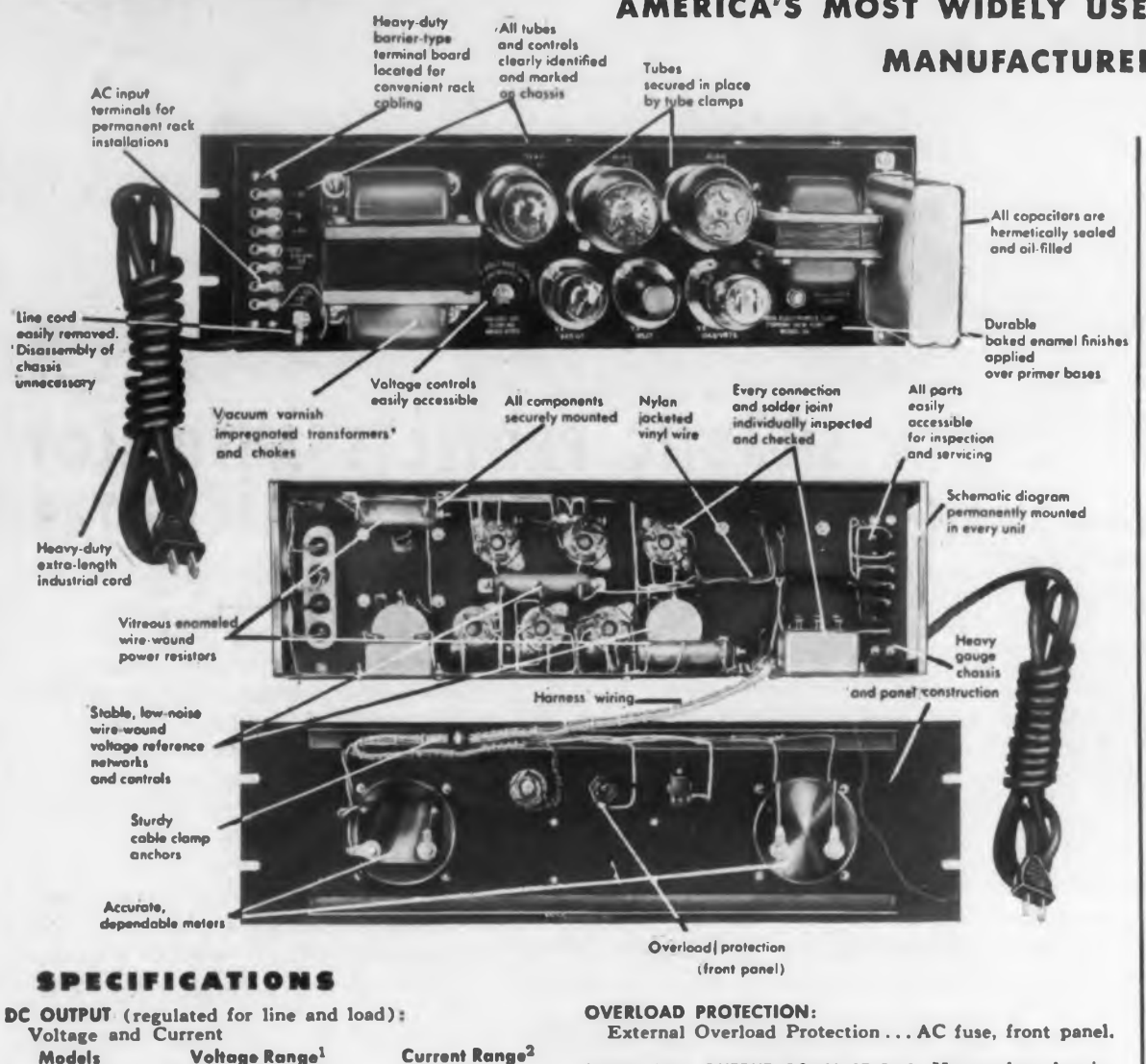
This Ratemeter, Type 12112, combines two decade scalers and a tuning fork mounted in a fan-cooled cabinet. It can be operated as a ratemeter to measure frequency on a fixed time basis; as a period meter for counts of 10,000, 100,000, or 1,000,000 on a fixed count basis; or as a ratio meter with two unknown signals. In the last case, the tuning fork is not used. The unit may also be used with diffractometers and spectrographs to obtain greater accuracy in rate measurement. Maximum counting rate is 100,000 per second. There is no minimum rate for fast waveforms and a minimum rate of 5cy for sine waves. Minimum resolving time is 10μsec.

The instrument will detect minimum signals of 2v peak, 1/2v rms sine waves. It requires a power input of 250w at 100-125v, 60cy. Research & Control Instruments Div., North American Philips Co., Inc., Dept. ED, 750 S. Fulton Ave., Mount Vernon, N. Y.

CIRCLE 81 ON READER-SERVICE CARD FOR MORE INFORMATION

COMPLETE POWER SUPPLY DEPENDABILITY FOR AS LITTLE AS $57.50

AMERICA'S MOST WIDELY USED POWER SUPPLIES, MANUFACTURED AND GUARANTEED BY LAMBDA



Model 28
200-325 VDC, 0-100 MA
$57.50

Model 29
100-200 VDC, 0-100 MA
$67.50

Model 28M (with meters)
200-325 VDC, 0-100 MA
$87.50

Model 29M (with meters)
100-200 VDC, 0-100 MA
$97.50

Rack models 28, 28M, 29 and 29M are long-lasting, dependable sources of power that deliver "workhorse" service . . . yet cost as little as $57.50 (for Model 28).

Intended primarily for fixed voltage use, these compact supplies are precision-built, as carefully engineered and quality-controlled as the most intricate models. They provide a convenient, low-cost power source for auxiliary equipment, also are well suited to production line applications.

SPECIFICATIONS

DC OUTPUT (regulated for line and load):
Voltage and Current

Models	Voltage Range[1]	Current Range[2]
28, 28M	200-325 VDC	0-100 MA
29, 29M	100-200 VDC	0-100 MA

[1]Voltage is continuously variable over entire range.
[2]Current rating applies over entire voltage range.

Regulation (line) . . . Better than 1%. For input variations from 105-125 VAC.

Regulation (load) . . . Better than 1%. For load variations from 0 to 100 MA.

Internal Impedance . . . Less than 10 ohms.

Ripple and Noise . . . Less than 10 millivolts rms for Models 28, 28M. Less than 5 millivolts rms for Models 29, 29M.

Polarity . . . Either positive or negative may be grounded.

AC OUTPUT (unregulated): 6.5 VAC at 3A (at 115 VAC input) . . . Allows for voltage drop in connecting leads. Isolated and ungrounded.

AC INPUT . . . 105-125 VAC, 50-60 CPS, 120 watts.[3]

[3]With all outputs loaded to full ratings and input at 125 VAC.

AMBIENT TEMPERATURE AND DUTY CYCLE . . . Continuous duty at full load up to 50°C (122°F) ambient.

OVERLOAD PROTECTION:
External Overload Protection . . . AC fuse, front panel.

INPUT AND OUTPUT CONNECTIONS: Heavy duty barrier terminal block, rear of chassis. 8 foot heavy duty rubber covered line cord with integral molded plug, also supplied.

METERS:
Output Voltage . . . 3½" rectangular voltmeter on meter models.
Output Current . . . 3½" rectangular milliameter on meter models.

CONTROLS:
DC Output Control . . . Screw driver adjusting control, rear of chassis.
AC Switch . . . Front panel.

PHYSICAL DATA: Mounting . . . Standard 19" rack mounting.
Size . . . 5¼" H x 19" W x 8" D.
Weight . . . 19 lbs. net, 23 lbs. shipping weight.

Panel Finish . . . Black ripple enamel (standard). Special finishes available to customer's specifications at moderate surcharge.

LAMBDA Electronics Corp.
THE FIRST NAME IN POWER SUPPLIES
103-02 NORTHERN BLVD. • CORONA 68, NEW YORK

Hydromagnet
Electric-Hydraulic Positioner

The AEG Hydromagnet is an imported electric-hydraulic positioner. Operation is as follows: a hydraulic pump is actuated by a "pumping" vibrator. The flow of hydraulic fluid from this vibrator is controlled by a "steering" vibrator into one or the other side of a power piston.

The product of output force and speed for this valve is a constant. The performance of the valve varies between full output stroke of 4" in 2sec for a 44 lb load and full output stroke of 4" in 8sec with a 172 lb load. By use of a lever connection, shorter strokes and bigger loads could be handled.

Speed of response is good because of the inherently low inertia of the device. Design simplicity also results in a maximum of reliability and minimum service requirements. Donald C. Seibert, Importer, Dept. ED, Box 281, Wilmington, Del.

CIRCLE 83 ON READER-SERVICE CARD

Conductive Lubricant
For Hinge Switches

Conducto-Lube is a highly conductive top-grade lubricant designed for use in conducting hinge joint switches. The lubricant can be used on knife blade switches to prevent their "balling up" and "freezing". It is ideal for high-speed air blast breakers where a lubricant is essential. Its conductivity will reduce resistance and heating. Cool Amp Co., Dept. ED, 8603 S. W. 17th Ave., Portland, Ore.

CIRCLE 84 ON READER-SERVICE CARD

Iron Cores
Low-Cost Units

Six new Economy Iron Cores have been added to expand this company's line to fourteen to cover most insert and threaded applications. Specification data is included in a booklet. Radio Cores, Inc., Dept. ED, 9540 Tulley Ave., Oak Lawn, Ill.

CIRCLE 85 ON READER-SERVICE CARD

◀ CIRCLE 86 ON READER-SERVICE CARD

Photodized Plates

Photosensitive Aluminum Plates

A new type photosensitive aluminum plate known as Photodized plates are designed for producing engineering templates, comparator charts, etc. All processing can be done without special equipment other than a sun lamp, a tray for developing, and a hot plate for sealing.

They differ from other metalphoto plates in that they can be processed in subdued light. Exposure of plates can be made through photographed film negatives, glass charts, tracing vellum, etc., placed in contact with Photodized plate.

Developing time is one minute; and the plate is washed in running water. Where utmost in permanence of legend is desired, the plate is heat sealed by immersion in boiling water for 30 minutes. However, the plates can also be sealed by spraying or brushing on a clear lacquer. Metalphoto Corp., Dept. ED, 2903 E. 79th St., Cleveland 4, Ohio.

CIRCLE 87 ON READER-SERVICE CARD

Toggle Switch Seal

Seals Switch to Panel

Model 3268 Panel Seal for Toggle Switches exceeds the requirements of Specification MIL-B-5423 in sealing out water, dust, moisture, explosive, or combustible liquids, vapors, and gases, and in resisting ozone attack. The seal also acts as a lock-nut in securing the toggle switch to the panel, minimizing the danger of loosening under shock and vibration.

It uses a silicone-base membrane configuration to grip the toggle lever firmly, yet allow full movement. The metal insert is of stainless steel #303 (withstands more than 96hr salt spray test). It is sized and shaped to provide thorough bonding to the rubber and affords complete sealing to the panel without an additional O ring. Its hexagonal shape permits adjustment with standard tools. Panseal, Inc., Dept. ED, 10 Main St., Little Ferry, N. J.

CIRCLE 88 ON READER-SERVICE CARD

CIRCLE 89 ON READER-SERVICE CARD ➤

Temperature Reference Junction

For Thermocouple Circuits

This device permits the measurement of temperatures with a strip chart recorder, thus eliminating the necessity for using a separate pyrometer. Its basic principle involves the maintenance of a constant, predetermined temperature at the thermocouple circuit reference junction, regardless of variations in the ambient temperatures. Control is provided by a high-sensitivity thermostat operating a relay which meters electric power to a constant-temperature zone heater. This reference junction may be introduced at any point in the thermocouple circuit, regardless of the location of the measuring instruments or thermocouples.

The junction may be used in ambient temperatures from −65° to +300°F. Any standard thermocouple materials may be specified for connectors. A small, lightweight version can be furnished for airborne uses. Thermo Electric Co., Inc., Dept. ED, Rochelle Park P. O., N. J.

CIRCLE 92 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Rectifiers

In Variety of Germanium Types

These diffused junction germanium rectifiers are recommended for a-c to d-c power conversion where high power output, high efficiency, no aging, and small unit size are required. Units can be supplied for voltage ranges from 10v to 100kv and from 10amp to 100,000amp by connecting junctions and assemblies in series or parallel.

Shown is a fan-cooled germanium unit, rated 750-amp at 40v output in a three-phase, half-wave circuit. Unlimited operating life can be expected over a temperature range of −55° to +75°C maximum when equipment is designed to operate within specified voltage, current, and temperature rise ratings. The rectifiers are available as natural convection, forced convection, and liquid cooled. International Rectifier Corp., Dept. ED, El Segundo, Calif.

CIRCLE 93 ON READER-SERVICE CARD FOR MORE INFORMATION

Oscillator

Has Highly Stable Output

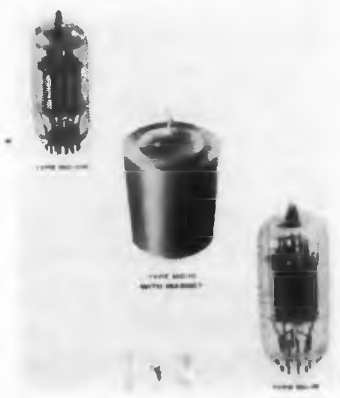
A constant-voltage precision oscillator, the DK-2 Series has low distortion and high stability under a wide range of working conditions. Properties of a 1000cy unit, typical of the DK-2 series, include a total harmonic content of less than 0.1% (60db down). Frequency shift from application of full load is less than 1/10cy out of 1000cy; from line voltage variation of 10v, shift is less than 1/20cy out of 1000cy.

Amplitude shift due to application of full load is less than 0.2%; and due to 10v line variation, less than 0.05%. The oscillator has a center-tapped output circuit particularly suitable for vibration pickups and other applications requiring balanced input. The practically zero internal impedance is useful with pressure pickups, strain gages, and similar applications where interaction between loads must be avoided. Neucor, Inc., Dept. ED, 45 W. Union St., Pasadena, Calif.

CIRCLE 94 ON READER-SERVICE CARD FOR MORE INFORMATION

Beam Switching Tubes

In Two New Types



The basic Magnetron Beam Switching Tube, type MO-10, was recently made available in production quantities by this firm. New types now available are the DC-1R and the MO-10R, which incorporate external magnets similar to type MO-10. The basic MO-10 is a high-vacuum tube with 10 discrete positions, each capable of forming, clearing, or switching an electron beam. Any desired type of sequential, simultaneous, or random switching may be obtained, at a frequency range from static to greater than 1Mc.

Type DC-1R is designed primarily as a high-speed decade counter (static to above 5Mc) on a standard 9-pin stem.

The MO-10R differs from the MO-10 in that it has internally mounted-spade load vacuum resistors to permit operation at higher frequencies. The number of external stem leads is also reduced from 26 to 20 pins. Switching speed is static to above 5Mc. Haydu Brothers of New Jersey, Dept. ED, c/o Burroughs Research Center, Paoli, Pa.

CIRCLE 95 ON READER-SERVICE CARD FOR MORE INFORMATION

Clear Thermoplastic

Resists Crazing, Easily Worked

Opening new fields for use of clear plastics and providing improved performance for present applications, thermoplastic Dura-lite is now manufactured in sheets.

Dura-lite thermoplast is outstanding for its high abrasion resistance—five times that of ordinary methacrylate. It resists crazing and is immune to most corrosive chemicals. Completely formable and machinable, it also withstands severe weather conditions.

Its flexural strength is nearly twice that of methacrylate, and its tensile and impact strength has also been improved. Its improved abrasion resistance, for example, makes it more suitable for formed instrument panels and dials. Dura-lite is available in sheets. Homalite Corp., Dept. ED, 15 Brookside Drive, Wilmington 166, Del.

CIRCLE 97 ON READER-SERVICE CARD

Zinc-Base Metals

For Soldering Aluminum

These new zinc-base metals permit the soldering of aluminum without flux at reduced temperatures. They can also be operated in frictional applications without lubrication or appreciable heat buildup. Further they can be used to electrify liquids so they may be evaluated on d-c or a-c electrical instruments.

The ability to homogenize zinc and lead by the introduction of muriatic acid at high temperatures results in all these special properties. It penetrates aluminum surface oxides through capillary action without special treatment of flux for soldering. The powdered cuttings in liquid break water down into hydrogen gaseous bubbles. Such a solution becomes a bi-polar d-c battery having as many positive and negative distinct d-c voltages and currents as there are metal grains in the battery cell. Chemalloy Electronics Corp., Dept. ED, Gillespie Airport, Santee, Calif.

CIRCLE 98 ON READER-SERVICE CARD

◀ CIRCLE 99 ON READER-SERVICE CARD

Test Chamber
For High and Low Range

Designed for high precision environmental testing of both individual components and entire systems, the Model D-102 high and low temperature test chamber operates over a range of —100°F to 300°F with —2°F accuracy. An inner working volume of 12 cu ft permits installation of large assemblies, and a group of 3″ access holes makes the attachment of instrumentation and power leads simple.

From room temperature, the test chamber can drop to —60°F in approximately 40 minutes or rise to 300°F in approximately 20 minutes. Mantec, Inc., Dept. ED, 130 Maryland St., El Segundo, Calif.

CIRCLE 100 ON READER-SERVICE CARD

Industrial Eraser
Cleans Metal Surfaces

This anodized aluminum case, complete with heavy duty FybRglass cartridges is useful for removing oxide from silver contacts. During storage, the silver lugs and contacts of the switch wafer become oxidized. This film is removed safely and a clean matte surface free from scratches remains which is ideal for soldering.

It may be used to remove varnish insulation from resistance wire as well as undesired resist and plate through on etched printed circuit boards. The Eraser Co., Dept. ED, 1068 S. Clinton St., Syracuse 4, N. Y.

CIRCLE 101 ON READER-SERVICE CARD

Anodized Metal Decal
Is Fade Resistant

This new anodized, etched aluminum "Metal-Cal" is a combination matte and shiny surfaced plate. The matte finish may be marked and erased as many times as desired.

The plates are backed by pressure-sensitive adhesive, and require no fastening devices. C & H Supply Co., Dept. ED, 415 E. Beach Ave., Inglewood 3, Calif.

CIRCLE 102 ON READER-SERVICE CARD

CIRCLE 103 ON READER-SERVICE CARD ➤

Non-Rigid Teflon Tubing

—90°C to +260°C

This "Temprene" non-rigid Teflon tubing features all of the outstanding combinations of properties offered by Teflon: noncombustible, inert to moisture and all known commercial solvents and chemicals; tensile strength of not less than 1500psi, minimum breakdown voltage of not less than 5000v rsm, plus complete flexibility to —90°C. Inside tubing diameter runs from a minimum of 0.014 to a maximum of 0.112, with wall thicknesses running from 0.008 to 0.012. It is 100% pin-hole checked for faults before shipment is made. Hitemp Wires, Inc., Dept. ED, 26 Windsor Ave., Mineola, N. Y.

CIRCLE 105 ON READER-SERVICE CARD

1 Mil Mylar Tape

With Adhesive

Constructed with a Polyester "Mylar" film, 1 mil thick backing and a rubber base adhesive which is free of corrosive agents and contains no sulfur, Tape P235 when cured is resistant to varnish and paint solvent. In addition it has a high tensile and tear strength, affording optimum performance in wire-holding applications. It also has a low moisture vapor permeability, making this tape a good moisture barrier when used in electrical component manufacture. P235 will withstand temperatures up to 150°C. Permacel Tape Corp., Dept. ED, New Brunswick, N. J.

CIRCLE 106 ON READER-SERVICE CARD

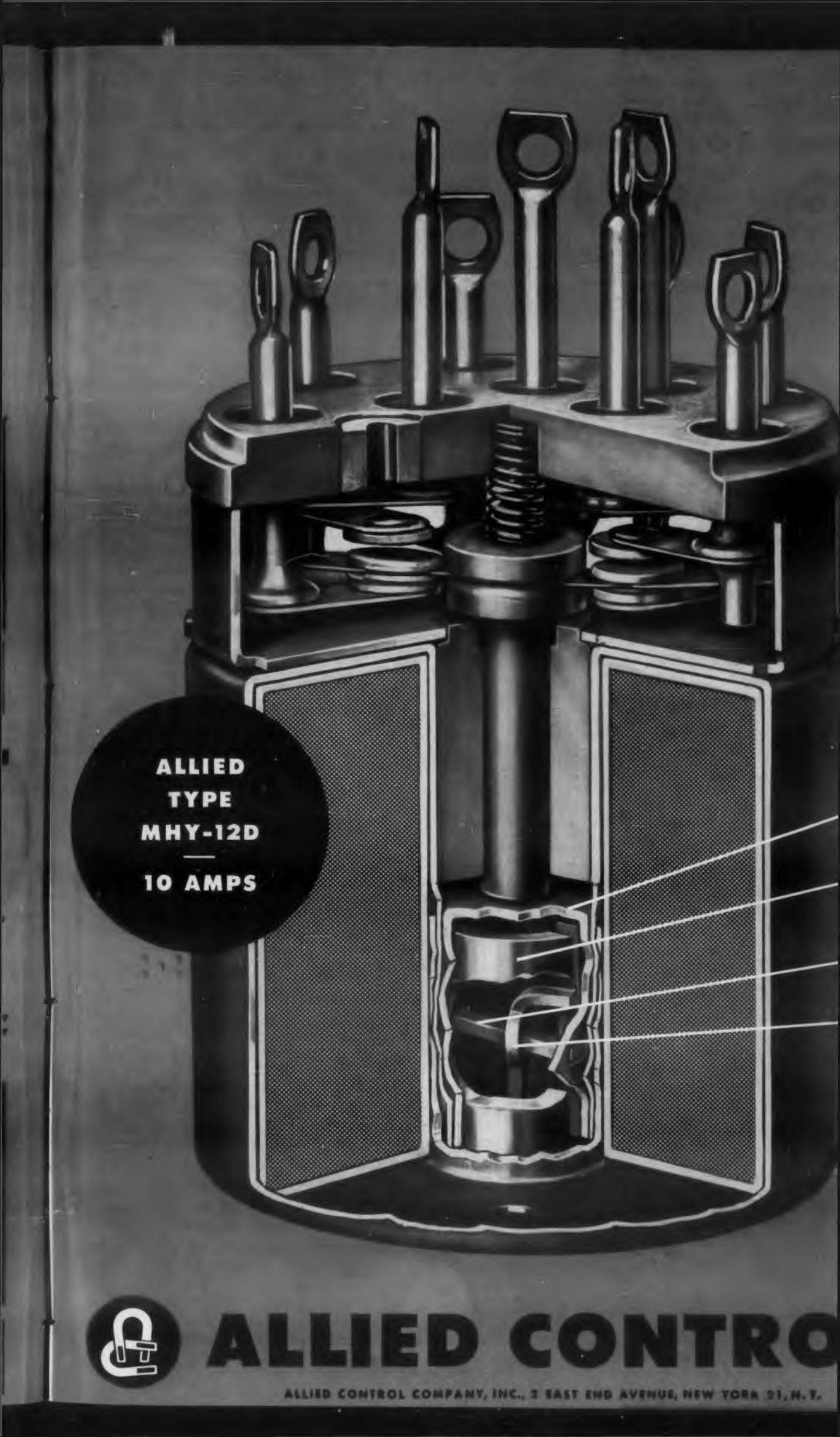
Transistor Kit

For Circuit Development

A kit of transistors which includes an assortment of seven of the most commonly used diffused p-n-p junction types is available for use in developing radio, hearing-aid, computer, Geiger-counter, and other instrument circuits. General Transistor Corp., Dept. ED, 95-18 Sutphin Blvd. Jamaica, N. Y.

CIRCLE 107 ON READER-SERVICE CARD

CIRCLE 108 ON READER-SERVICE CARD ➤



ALLIED CONTRO

ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, N. Y.

Microwave Attenuator

Covers 4000 to 12,400Mc

This continuously variable, stub-tuned, mutual inductance attenuator is designed for external use in making microwave measurements with spectrum analyzers, signal sources, receivers, and for power measurements.

The Model SIJ attenuator (waveguide beyond cut-off type) will insure r-f circuit isolation and may be used to convert a signal source or laboratory oscillator to perform many of the functions of a signal generator. Frequency range of the device 4000 to 12,400Mc. Polarad Electronics Corp., Dept. ED, 43-20 34th St., Long Island City 1, N. Y.

CIRCLE 109 ON READER-SERVICE CARD

Vinyl Compounds

For Wire Coating

Three new vinyl compounds designated as Opalon 1038, 72254, and 72217, are all excellently suited to wire and cable insulation. It retains its flexibility over long periods. Opalon 1038 is a primary insulation compound for Type T and TW uses and exposure to oil at 60°C. Opalon 72254 is a general purpose, flame retardant jacketing compound, recommended for sheathing applications. Opalon 72217 is specifically for switchboard cable jacketing. Plastics Div., Monsanto Chemical Co., Dept. ED, Springfield, Mass.

CIRCLE 110 ON READER-SERVICE CARD

Variable Inductance Kit

Includes 8 Coils

This kit of 8 permeability tuned coils covers an inductance range of 1 to 1000μhys. A curve sheet shows inductance values per turn of ferrite core for each of 8 coils. Complete data on L_{min}, L_{max}, Q, self resonant frequency, R and C_o, for each coil is included. They are precision wound with universal or solenoid windings and Q max impregnated for maximum protection against moisture. United Technical Laboratories, Dept. ED, Morristown, N. J.

CIRCLE 111 ON READER-SERVICE CARD

◀ CIRCLE 108 ON READER-SERVICE CARD

Printed Circuit Kit

For Pototype Development

This kit contains the latest information, materials, and methods for adapting products to etched-wire printed circuits. Designed primarily as an aid in prototype development, it enables laboratories to process their own etched-wire printed-circuit models.

By using the photographic method of resist application, projected savings can be determined from a pilot run made with the materials provided in this kit. Or, for development, the application of resist in the form of ink, or in the simple form of a special pressure-sensitive 1/16" wide tape, will permit frequent modifications to be made during prototype design. An assortment of sizes of XXXP copper-clad phenolic laminate is provided, including double-surfaced as well as single- surfaced boards. Special printed-circuit tube sockets of 10 different types allow engineers to experiment with numerous variations of model design. Special multi-contact printed circuit connectors are also provided. Printed Circuit Div., Techniques, Inc., Dept. ED, 135 Belmont St., Englewood, N. J.

CIRCLE 113 ON READER-SERVICE CARD FOR MORE INFORMATION

Ballistic Voltmeter

Measures Peak Amplitude

The Model PTM-7 Peak - Meter, with improved performance characteristics over earlier models, is a ballistic voltmeter for measuring crest amplitude of single voltage waveforms, handling pulses too fast for conventional voltmeters. It responds to peak regardless of waveform shape, and holds the reading until the reset button is depressed. Range is from 0.1v to 300v.

Response speed has been more than doubled to 2μsec, with accuracy improvement down to 2% of full scale. Although primarily intended for single pulses, the PTM-7 is more usable on repetitive signals than its predecessors. Control Devices, Inc., Dept. ED, 8299 E. 9 Mile Rd., Van Dyke, Mich.

CIRCLE 114 ON READER-SERVICE CARD FOR MORE INFORMATION

Transformer

Weighs only 0.004 lb

This "Miniformer" miniature transformer is designed primarily to meet the smaller space requirements of hearing aid components, but has additional applications where space and weight factors are of prime importance, such as computers, pocket radios, F-M transceivers, telephone recorders, and airborne equipment. Size is only 1/4" x 5/16" x 3/8", and weight is 0.004 lb (242 transformers per lb).

The unit illustrated has the following impedances: a-c primary, 20,000 ohms, secondary, 1000 ohms; d-c resistance, primary, 1030 ohms, secondary, 167 ohms.

Power rating for primary inputs from 1 to 7v is 2.5mw. Other impedance matches are also available. Leads are color-coded and high-temperature-plastic insulated. Gramer-Halldorson Transformer Corp. Dept. ED. 2734 N. Pulaski Rd., Chicago 39, Ill.

CIRCLE 115 ON READER-SERVICE CARD FOR MORE INFORMATION

Motor-Alternator

A 2-Phase 30cy Unit

For use in the laboratory and in precision electronic equipment designs, the Model HA-2, features 2-phase, 30cy output at 18.5v. The rotor shaft is extended at both ends. Power output is equivalent to 2.7w from the shaft and 1.37w of electrical power. Input is 115v, single-phase 60cy at 26w to 30w.

The unit features synchronous operation, dynamically balanced rotors on a common stainless steel shaft, and two-bearing (Class 5 or better throughout) construction. It conforms to AN-E19 specifications. Weight is only 6 lb, and size 7" long x 3-1/2" diam.

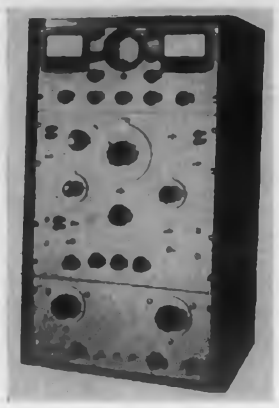
Applications include synchronizing a driven shaft rotation with a precise 2-phase electrical signal; driving 2-phase alternators; serving as an accurate phase standard; and driving pulse generator wheels in synchronism with 2-phase pure sine-wave voltages. It can also drive small resolvers at the same time without sacrifice of its other functions. Synchronism pull-out torque is 2 in-oz. A second unit, Model HA-1, features 120cy input and 60cy output. Electric Motors and Specialties, Inc., Dept. ED, Garrett, Ind.

CIRCLE 116 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 117 ON READER-SERVICE CARD FOR MORE INFORMATION

Inductance Bridge

With Owen-Hay-Maxwell Circuits



The Model 226 Incremental Inductance Bridge incorporates three different bridge circuits. A single rotary switch arranges branch arms according to Hay, Owen, or Maxwell. With the Hay arrangement, any inductance between 1mh and 2000h can be measured, provided the Q is larger than 5. With the Owen arrangement, the same inductance range can be covered, but the Q must be comparatively low and can have a value as low as 0.06 at 60cy. The Maxwell arrangement is suitable for the measurement of low Q coils (below 5 at 60cy) without superimposed d-c and particularly for the measurement of leakage inductance. Both the Owen and the Hay circuits can be used with or without superimposed d-c. Measurements can be made up to 5000cy. Industrial Transformer Corp., Dept. ED, Gouldsboro, Pa.

CIRCLE 118 ON READER'S SERVICE CARD FOR MORE DATA

Pressure Transmitter

With Outputs to 40v

The Model 47155 Pressure Transducer is designed for industrial applications requiring an electrical output proportional to pressure. It is an improved, low-cost version of this company's Pressure Transmitters that have been used in aircraft and missile applications.

Utilizing a pressure capsule that operates the wiper of a precision potentiometer in direct proportion to applied pressure, this instrument is available in ranges up to 100psi, for absolute, gage, and differencial measurements. Outputs up to 40v can be obtained.

Standard resistance is 2000ohms, with a power rating of 0.5w. Accuracies to 0.8%, and sensitivity to 0.4% can be obtained. The instrument is approximately 2.75" square x 3" deep. Electromechanical Div., G. M. Giannini & Co., Inc., Dept. ED, 918 E. Green St., Pasadena 1, Calif.

CIRCLE 119 ON READER'S SERVICE CARD FOR MORE DATA

Shaft Coupling

Takes 1/16" Misalignments

The 104-1 all-metal 1/4" to 1/4" Shaft Coupling compensates for up to 1/16" axial and/or angular shaft misalignment. An inexpensive unit, it minimizes the possibility of shaft binding and galling. Less expensive and with a higher torque rating than conventional flexible-type shaft couplings of comparable size, the coupling features beryllium-copper spring material, overall nickel plating, and heavy-duty hubs with two 8-32 setscrews on each hub. E. F. Johnson Co., Dept. ED, Waseca, Minn.

CIRCLE 121 ON READER'S SERVICE CARD FOR MORE DATA

Pentode

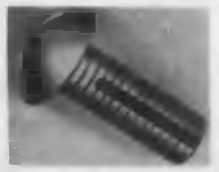
Gives Only 1.5μv Noise

The *EF86* audio frequency pentode is a low-hum, low-noise, high-gain tube for preamplifier stages. Under recommended circuit conditions, the hum and noise voltage referred to the grid is only 1.5μv, and distortion is negligible with small inputs. It is a miniature all-glass type with a noval base. Mullard, Ltd., Dept. ED, Century House, Shaftesbury Ave., London, W. C. 2, England.

CIRCLE 122 ON READER'S SERVICE CARD FOR MORE DATA

Locking Screw Fastener

Uses "Kel-F" Insert



The "Long-Lok" is a self-locking, vibration-resistant screw fastener, furnished in a variety of sizes, head types, materials, and finishes in both aircraft and commercial qualities. Present sizes range from No. 4 upward. The locking element is a longitudinal "Kel-F" insert which remains serviceable and stable from —320° to +400°F. The length of the insert is only limited by the threaded length of the fastener, a feature which provides full engagement of the locking material. The insert also presents an effective seal against fluid leakage. T. L. McKay & Co., Dept. ED, 8404 Melrose Ave., Los Angeles 46, Calif.

CIRCLE 123 ON READER'S SERVICE CARD FOR MORE DATA

CIRCLE 120 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 125 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnetic Amplifier

Drives D-C Relays

Designed to drive d-c relays, this two-stage, 60cy magnetic amplifier features low drift, fast response, and high sensitivity. It replaces the usual thyratron amplifiers for relay actuation. The output swings from 7v to 30v across a 2500 ohm load for a differential input signal of 17μamp. The latter signal may be reduced to as low as 3μamp by the use of a positive feedback connection provided with the amplifier.

The differential control signal is derived from the signal source and an externally connected, variable bias supply. The amplifier is suitable for industrial control purposes, such as temperature control about a set point. A bias current of 10ma is required. Relay may be opened and closed 10 times per sec.

Insensitive to 10% tolerances on voltage or frequency, the amplifier requires a 2w, 115v rms, 60cy supply. Potted construction and plug-in connector are additional features. Dynamics Research Associates. Dept. ED, 414 Times Square Bldg., Seattle 1, Wash.

CIRCLE 126 ON READER-SERVICE CARD FOR MORE INFORMATION

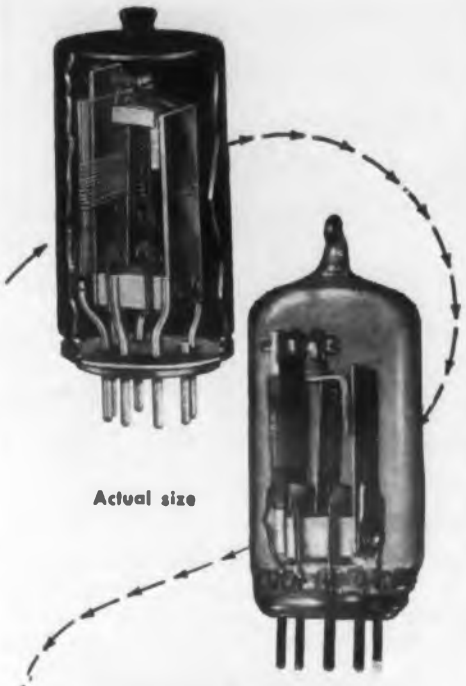
Time Interval Meter

Measures from 1/10,000sec to 3sec

This direct-reading, electronic, time-interval meter accurately measures intervals from 1/10,000 to 3sec. It will measure the duration of an electric pulse, the time between various combinations of positive and negative impulses, the time between two impulses with an impulse from a second source intervening, signals actuated from one or two sources, and the time various combinations of electric and light impulses. Accessories include a calibrator, which allows use of the instrument as an instantaneous frequency meter, a photoelectric receiver, and a light source. Sunshine Scientific Instrument, Dept. ED, 1810 Grant Ave., Philadelphia 15, Pa.

CIRCLE 127 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 128 ON READER-SERVICE CARD



Actual size

CURTISS-WRIGHT

now offers

THE "SNAPPER" THERMAL TIME DELAY RELAY

Relied on for positive action and long life in scores of applications involving time delay in electrical circuits, the "SNAPPER," formerly produced by Elly Electronics Corp., is now a Curtiss-Wright product.

Single pole, double throw contact action eliminates chatter. These unique relays feature snap action, double throw, reliability, small size. They are adaptable to military and commercial applications. Time delay periods: preset from 3 seconds up. Envelope: metal, miniature (7 and 9 pin) or octal (8 pin). Glass, 9 pin only.

High-Low Differential Thermostat

The "SNAPPER" Thermostat is a single pole, double throw snap action temperature sensitive switch. Its snap action principle has been extended to provide a low differential thermostat with precision characteristics, at low cost.

Write for detailed data

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION · CARLSTADT N J

CIRCLE 129 ON READER-SERVICE CARD

Chopper

Rated for 2000hr

A miniature 6.3v, 400cy mechanical modulator, the Type 300spdt chopper is rated for a life of 2000hr. Contacts are rated for a maximum of 1ma for signals from 0.1mv to 100v.

The chopper is constructed to operate in ambients from −65 to +100°C, and it is hermetically sealed for use in humid atmospheres and at altitudes to 50,000′. It withstands mechanical shocks of 100g and vibrations of 0.06″ total travel from 10 to 55cy.

Switching phase angle is 65±15°; dwell time on each pole is 145±20°; and balance betwen dwell times is 0±15°. Required driving frequency is 400±20cy; required coil voltage is 6.3±0.6v. Coil impedance is 230±60 ohms at 400cy with 6.3v rms applied at 25°C. Airpax Products Co., Dept. ED, Middle River, Baltimore 20, Md.

CIRCLE 130 ON READER-SERVICE CARD FOR MORE INFORMATION

A-C Magnetic Bridge

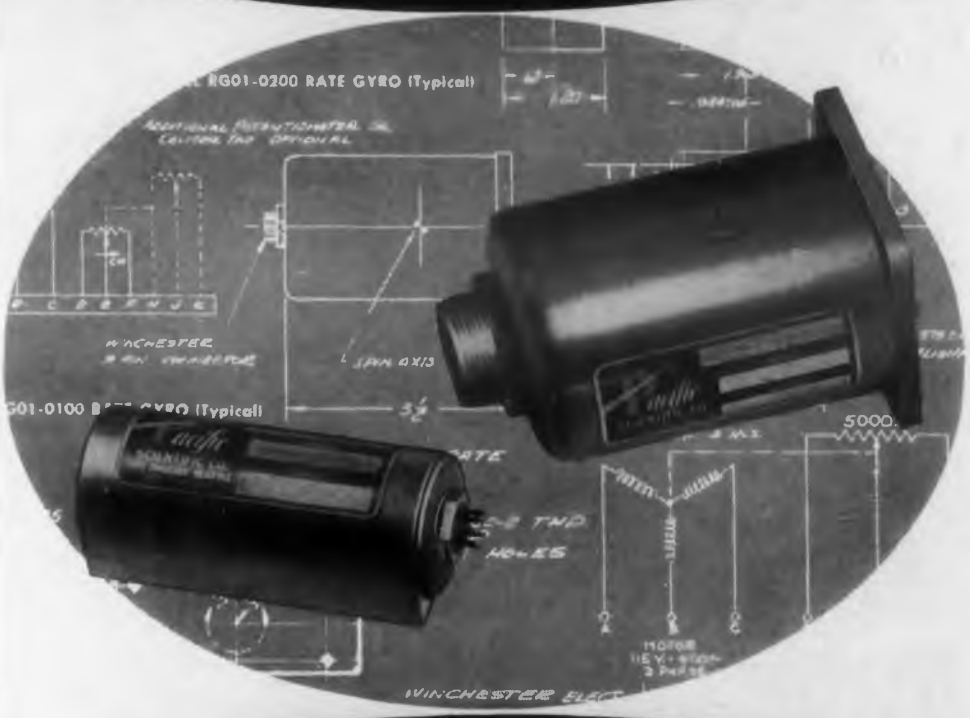
Tests Permeability and Core-Loss

The Model 6400A A-C Magnetic Bridge rapidly and accurately measures permeability and core losses at inductions up to 16 kilogausses. Basically, the unit is a modified Hay Bridge with extremely accurate resistor and capacitor decades, a complete switching network for ease of operation, and internal filters for 60cy, 400cy, and 1000cy measurements. A rugged, extremely accurate Epstein Frame is furnished with each instrument.

The bridge tests induction from less than 10 gausses to beyond 12 kilogausses on unoriented materials, and up to 15 gausses on oriented transformer-grade materials. Accuracy is equal to that of Epstein Methods, and all tests meet ASTM Standard 343-49. Through a unique arrangement of switching and binding posts, any component may be switched into any arm of the bridge in just a few seconds. Shallcross Manufacturing Co., Dept. ED, 10 Jackson Ave., Collingdale, Pa.

CIRCLE 131 ON READER-SERVICE CARD FOR MORE INFORMATION

*Pacific rate gyros

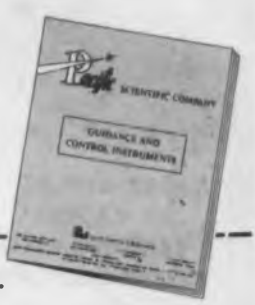


. . . advanced wheel design gives **higher natural frequency** over any rate range!

Now in production, an entirely new concept in wheel design provides Pacific Rate Gyros with unusually accurate and dependable performance. Combined with a special precision potentiometer, this advanced design Rate Gyro gives greater resolution and shock resistance...lower power consumption...light weight...and a higher natural frequency with any rate range!

A wide variety of Pacific Rate Gyros are built for any application. Production models from sub-miniature designs for use in stabilization or damper systems, to gyros for precision computer applications. Special models can be custom designed to your own specifications by Pacific's large staff of experienced gyro engineers.

For any Rate Gyro, Pacific's creative designs, complete manufacturing facilities and experience are backed by fully approved quality control. You're assured precision performance and rugged dependability in every unit.



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CIRCLE 132 ON READER-SERVICE CARD FOR MORE INFORMATION

Standing Wave Detector

For 100-1000Mc Range Measurements

The PRD 219 Standing Wave Detector was designed to supersede expensive and bulky slotted sections in the range of 100 to 1000Mc. It is a small-package, low-cost unit for making impedance measurements easily and accurately in this region. By connecting the output to a vswr indicator, such as the PRD Type 277, vswr may be read directly on the indicator meter. No special detection equipment is required.

Reflection coefficient angle is easily determined by rotating the top drum dial to a minimum indication on the meter and reading the angle on the dial directly in electrical degrees. No calculations are required. The probe and crystal detector are self-contained. Usually it is more convenient to work with vswr and reflection coefficient angle directly; when other quantities are also of interest, they can easily be read from a conventional impedance chart. Polytechnic Research & Development Co., Inc., Dept. ED, 202 Tillary St., Brooklyn 1, N. Y.

CIRCLE 318 ON READER-SERVICE CARD FOR MORE INFORMATION

Servo-Tachometer

Operates on 60cy

This combination servo motor and a-c tachometer generator operates on 60cy. Using a single-shaft mounting, it can be used to regulate the speed of a motor or to stabilize closed-loop circuits. With this integral mounting, backlash is zero.

Available with five different gear reduction ratios, the unit is especially suitable as either a differentiating or integrating component of analog computers, or as a component of recording and controlling instruments. Adjustment may be made after installation, so that in-phase residual voltage of the tachometer is essentially zero. Stator windings are potted in an epoxy resin, which also forms the end covers of the motor. Outer housing is of aluminum.

Motor ratings are 1, 5, or 10w output. The same tachometer-generator component would be used with each of the three motors, and has an input of 115v 60cy, an output of 5.5v/1000rpm, and a linearity of 1%. Diehl Manufacturing Co., Dept. ED, 1129 Finderne Ave., Somerville, N. J.

CIRCLE 319 ON READER-SERVICE CARD FOR MORE INFORMATION

Electrolytic Capacitors

For Low Ambient Temperatures

Two electrolytic capacitors, designed especially for service at low ambient temperatures, are offered by this firm. Both are made of etched aluminum foil in hermetically sealed metal cases. The positive terminal wire of one is connected through a rivet fastened to a vented rubber-Bakelite insulating washer which is spun-sealed into the case. The other unit's positive terminal is connected through a crimped stud which passes through the rubber-Bakelite insulating washer.

These capacitors have a temperature range from −55 to +65°C (and to +85°C for short operating periods) and are available at voltage ratings of 25, 50, and 150v d-c w. Case sizes range from 3/8 to 1" diam and 1-1/16 to 3" long. Cornell-Dubilier Electric Corp., Dept. ED, South Plainfield, N. J.

CIRCLE 324 ON READER-SERVICE CARD FOR MORE INFORMATION

Small Axial-Flow Blowers

In Capacities from 16-750cfm

A line of axial-flow blowers to provide highly efficient air delivery or exhaust is available for a wide variety of uses, including many industrial as well as aircraft applications. The blowers were developed and engineered by the English firm of Plannair, Ltd.; they are made under license in the United States by Pesco.

Standard sizes are at rated capacities from 16 to 750cfm. They are self-contained units incorporating a rotor coupled to an electric motor, either d-c or a-c. The smallest unit (illustrated) is a 1-3/8" diam blower which weighs 8 oz and delivers 16cfm at 0.75" pressure w.g. Other standard production units will vary up to 6" diam.

Intended for rugged duty, these blowers will withstand severe conditions of shock, temperature, pressure, altitude, humidity, and duty cycle. They are rated for continuous operation at high ambient temperatures. Pesco Products Div., Borg-Warner Corp., Dept. ED, 24700 N. Miles Rd., Bedford, Ohio.

CIRCLE 325 ON READER-SERVICE CARD FOR MORE INFORMATION

USE VICTOREEN HI-MEG RESISTORS

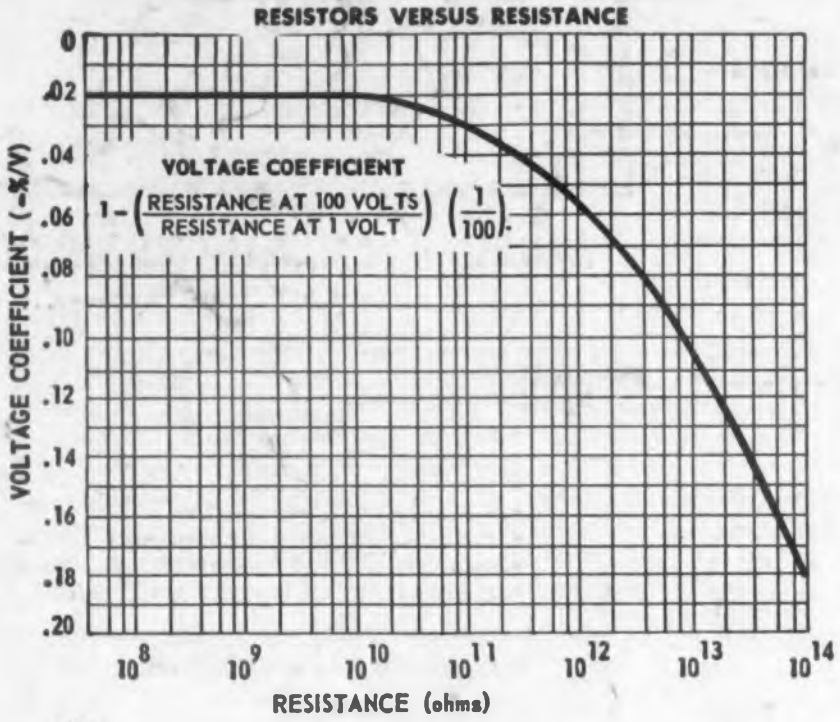
WHERE ACCURACY AND STABILITY ARE ESSENTIAL

Unit illustrated actual size.
Capacity 18,600 Megohms.

Victoreen Hi-Meg resistors are not intended to replace conventional type resistors used in ordinary applications. But, if your resistor application, requires accuracy and stability beyond the resistance limits of other type resistors then test Victoreen Hi-Meg resistors. Carbon coated glass base with silver banded contact ends, vacuum sealed in a glass envelope, which is specially treated with silicone varnish to assure a moisture-proof, impervious seal. Power rating for any Hi-Meg resistor is equal to one divided by the resistance in Megohms. Voltage limit 1000 volts.

Write for bulletin 3025.

AVERAGE VOLTAGE COEFFICIENT OF HI-MEG RESISTORS VERSUS RESISTANCE



COMPONENTS DIVISION

The Victoreen Instrument Co.

3811 PERKINS AVE. • CLEVELAND 14, OHIO

CIRCLE 140 ON READER-SERVICE CARD FOR MORE INFORMATION

Integrators

Ball-disk Units

This firm's 2-1/2" and 5" "DBR" integrators, originally developed for use in analog gunfire control computers, are now available commercially as the first standard units in an extensive group of integrators. Utilizing the "DBR" (disk, balls and roller) design, they employ two hardened steel balls in a carriage between the input disk and output roller to reduce friction to a minimum. A patented ball-roller-tilt device minimizes ball slip for all carriage positions, and is supplied as standard on both integrator sizes.

These integrators are high-precision units for an extremely wide variety of open and closed-loop applications. Maximum force to move carriage is 1/2 oz (approx), and maximum input torque at zero load is 1/2 oz-in (approx). Weights are 6.0 lb for the 2-1/2" unit, and 10.1 lb for the 5" unit. The 2-1/2" integrator is suitable for airborne systems. Ford Instrument Co., Div. of Sperry Rand Corp., Dept. ED, 31-10 Thomson Ave., Long Island City 1, N. Y.

CIRCLE 141 ON READER-SERVICE CARD FOR MORE INFORMATION

Size D Ignitron

Designed to be Repairable

The NL-10533 is a size D ignitron of stainless steel construction. It includes a mounting plate for a thermostat to provide thermal protection. It is described as first repairable welding control ignitron, and it has an internal cooling coil. The increased cooling efficiency permits a greatly increased averaging time: 11sec at 500v, and 22sec at 250v.

Other ratings are the same as the conventional size D ignitron: 2400kva max demand, 355amp d-c maximum anode current per tube, at any voltage between 250 and 600v rms at 25 to 60cy. Cooling water required is 3gpm at a minimum inlet temperature of 0°C. National Electronics, Inc., Dept. ED, Geneva, Ill.

CIRCLE 142 ON READER-SERVICE CARD FOR MORE INFORMATION

convert

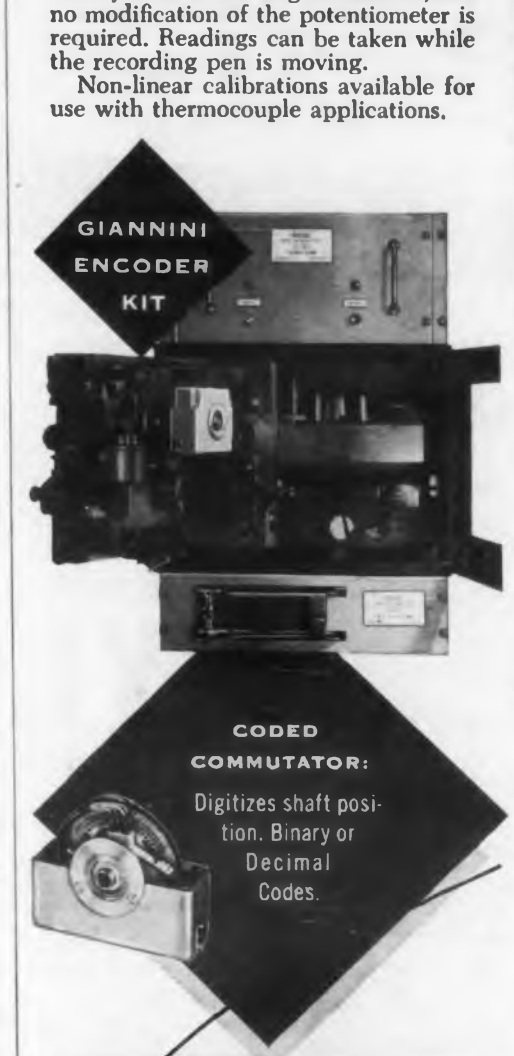
SELF-BALANCING POTENTIOMETERS TO

digital read-out

PRINTED TAPE • PUNCHED CARD PUNCHED TAPE

Complete... Easy to Install... Reads from 0-1000; Accuracy ±0.1%. A complete system kit for obtaining digital information from standard self-balancing potentiometers. Easy to install, complete with all necessary hardware, this conversion does not affect the accuracy of the recording instrument, and no modification of the potentiometer is required. Readings can be taken while the recording pen is moving.

Non-linear calibrations available for use with thermocouple applications.



Giannini

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Laboratory Apparatus Division

G. M. GIANNINI & CO., INC.
PASADENA 1, CALIF.

CIRCLE 143 ON READER-SERVICE CARD

Voltage Regulators

Plug-In D-C Units

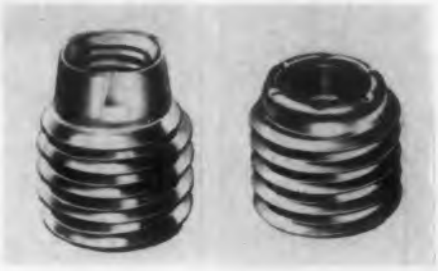
The Models 211 and 212 D-C Voltage Regulators have been added to the "Red Line Uniplug" line. They require unregulated d-c source and a filament supply, and little more chassis area than a *6AS7G*. Filtering action is better than a 10hy-30mfd combination.

Output voltage of the Model 211 is 150-225v d-c; for the Model 212, it is 205-305v d-c. Output current is 150ma maximum useable. Load regulation is adjustable to zero by means of the left potentiometer; without adjustment, the regulation will not exceed 1/4% for a 100ma load change. Line regulation is less than 1/2% for an input voltage change of 50% within the allowed limits. Filament supply is 6.3v a-c at 1.5amp. Output impedance is less than 15 ohms at all frequencies. Size is 3-1/8" x 3-3/8" chassis area; 5-1/4" high. C. J. Applegate & Co., Dept. ED, 1816 Grove St., Boulder, Colo.

CIRCLE 145 ON READER-SERVICE CARD FOR MORE INFORMATION

Self-Locking Bushing

Pulls AN Loads in Soft Materials



The Type 2424 is a self-locking, vibration - proof bushing for use in relatively soft castings, forgings, and extrusions, such as aluminum alloy, magnesium, mild steel, and some plastics. It is available in two designs, one a red nylon locking collar for temperatures up to 250°F, and the other with an all-metal locking device for temperatures between 250° and 550°F. Both elements provide complete locking torque protection and excellent re-use characteristics as required in AN-N-5b and AN-N-10a, respectively.

The bushings can be installed in any material whose hardness is less than Rc 25 by tapping the hole with a Class 2 controlled root tap. Installation of the bushing may be made by using a stepped bolt, or bolt and spacer, with any lubricating oil. The bushing may be readily removed by means of a standard screw extractor tool. Bushings are now available in 10-32, 1/4-28, 5/16-24, and 3/8-24 internal thread sizes. Elastic Stop Nut Corp. of America, Dept. ED, 2330 Vauxhall Rd., Union, N. J.

CIRCLE 146 ON READER-SERVICE CARD FOR MORE INFORMATION

PRESSURIZE ELECTRONIC EQUIPMENT

with Eastern UNITS

The extensive line of Eastern Pressurization Units for airborne electronic equipment accommodates a broad range of requirements, and meets appropriate government standards.

Units can be modified to meet your specific requirements. These modifications usually consist of: 1) Different compressors; 2) Motor change to meet your requirement; 3) Change in pressure switch settings; 4) Different mounting provisions. Eastern welcomes the opportunity to discuss and quote on your particular application problem.

MODEL E AP-100 TYPE 202

- Maintains a system pressure of 25 P.S.I.A. minimum.
- Motor is .03 H.P.—10,000 R.P.M., 208 V., 3 ph., 400 cy.
- Current draw is .7 amperes/phase maximum under normal operating conditions
- Unit operates continuously
- Weight is 4¾ lbs. maximum

MODEL E AP-150 TYPE 205

- Operating pressure switch maintains a system pressure of 17 P.S.I.A.
- Motor is 1/25 H.P. 7,500 R.P.M., 27 volts D.C. — T.E.B.B.
- Current draw is 2.0 amperes maximum under normal operating conditions
- Life is 500 operating hours
- Weight is 8 lbs. maximum

MODEL E AP-1500 TYPE 203

- Operating pressure switch maintains a system pressure of 30 P.S.I.A.
- Motor is 1/15 H.P. nominal 24-28 volts D.C., 5,000 R.P.M., continuous duty, shunt wound
- Current draw is 3.4 amperes maximum under normal operating conditions
- Life is 500 operating hours
- Weight is 12 lbs. maximum

MODEL E AP-2400 TYPE 201B

- Maintains system pressure of 31 P.S.I.A.
- Motor is 1/10 H.P., 24-28 volts D.C., 5,000 R.P.M. continuous duty
- Current draw is 5.5 amperes maximum
- Life is 500 operating hours
- Weight is 10-3/4 lbs. maximum

MODEL E AP-3600 TYPE 200

- Maintains system pressure of 31 P.S.I.A.
- Motor is 1/7 H.P., 10,000 R.P.M.
  { 208 V., 400 cy., 3 ph. } continuous operation
  { 24-28 V.D.C. }
- Current draw is { 1.3 amp./phase / 7.1 on D.C. } amperes maximum under normal operating conditions
- Life is 1,000 operating hours
- Weight is 8-1/2 lb. maximum

Eastern INDUSTRIES, INC.
100 SKIFF STREET
HAMDEN 14, CONN.

COMPLETE AVIATION CATALOG #330-P ON REQUEST.

CIRCLE 147 ON READER-SERVICE CARD FOR MORE INFORMATION

Q Meter

Accurate to 1%

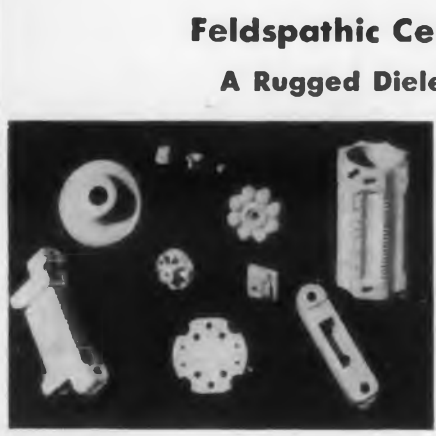
The "Kilo-Q" covers a range of 20cy to 1Mc. For ease of operation, the unit combines a direct-reading dial over the entire range, accurate to as low as 1%.

Two positions are provided on the Q Range Control with full scale Q readings of 0 to 125 and 0 to 250 respectively. For reading Q values between 250 and 500, it is necessary to set the lever control to the X2 position on the dial and double the reading on the 250 scale. Kay Electric Co., Dept. ED, 14 Maple Ave., Pine Brook, N. J.

CIRCLE 149 ON READER-SERVICE CARD FOR MORE INFORMATION

Feldspathic Ceramic

A Rugged Dielectric



"Vitrolain", a feldspathic type ceramic, is offered as a superior dielectric with high mechanical strength. Its pore volume and moisture absorption are extremely low (less than 0.25%). It is especially suited for parts used in the presence of moisture or chemical vapors.

This ceramic is available in white as well as a complete range of color glazes. Star Porcelain Co., Dept. ED, 151 Muirhead Ave., Trenton 9, N. J.

CIRCLE 150 ON READER-SERVICE CARD FOR MORE INFORMATION

Battery Motor

Uses Nylon Bearings

The BN Miniature Battery-Operated Motor is a quiet but inexpensive unit using nylon bearings to reduce motor noise and current drain. It draws as little as 40ma. Speed can be varied from 1300rpm to 12,000rpm, and voltage from 1v to 12v. Life is up to 1000 hours. Minitone, Inc., Dept. ED, 55 W. 13th St., New York, N. Y.

CIRCLE 151 ON READER-SERVICE CARD FOR MORE INFORMATION

1/10w Resistor

Highly Useful with Transistors

The Type TR is a molded resistor measuring 0.140" long x 0.015" diam with 1" leads and rated at 1/10w. It is a molded composition unit with an insulating coating. It is especially suitable for use with transistors, diodes, and other small components in miniaturized equipment. It may be used with or without encapsulating compounds or casting resins.

TR resistors are available in standard RETMA, JAN-R-11, and MIL-R-11 resistance values for standard tolerances of ±5%, 10%, and 20%, from 10 ohms to 22 megohms. Voltage rating is (max continuous) 150v rms or d-c. They can be operated continuously with the insulation subjected to a maximum potential of 200v d-c.

Maximum continuous wattage at 70°C is 0.1w and 40°C is 0.2w. They derate linearly from 0.1w at 70°C to zero at 100°C. Allen-Bradley Co., Dept. ED, 1326 S. 2nd St., Milwaukee 4, Wis.

CIRCLE 152 ON READER-SERVICE CARD FOR MORE INFORMATION

Motor-Generator

Weighs 6.2 oz

The type MG3013 is a subminiature motor-generator with an unusually high output in relation to its size. It measures only 1"OD x 2.625" long and weighs 6.2 oz. Output is 1.25v per 100rpm when operated into a load of 100,000 ohms. Speed is continuously

variable from 200rpm to 8700rpm. The output remains completely linear over the entire speed range. Harmonic distortion is under 5%. Magnetic detent stops the output shaft in any of four positions within five degrees accuracy.

The motor is a 115v, 400cy 2-phase drive motor with a stall torque of 0.15 oz-in. The unit has a stainless-steel housing with stainless-steel ball bearings and shaft and class "H" insulation for high-humidity and high-temperature applications. John Oster Manufacturing Co., Avionic Div., Dept. ED, 1 Main St., Racine, Wis.

CIRCLE 153 ON READER-SERVICE CARD FOR MORE INFORMATION

All wound up in wound cores?

We can't blame you, when there are so many claims being made by manufacturers regarding merits of their cores.

Rather than add to this confusion of claims, here are just a few pertinent *facts* that you should know about Thomas & Skinner OrthoSil tape wound cores.

1. Made from OrthoSil, oriented silicon-iron.
2. The high permeability with low core losses results in high efficiency cores.
3. Made in 12 mil OrthoSil for 60-cycle applications.
4. In 4 mil OrthoSil for 400-cycle and higher applications.
5. All cores are magnetically inspected at three flux densities . . . 5,000, 10,000 and 15,000 gauss.
6. Testing is based on minimum areas, using a 90% stacking factor for 4 mil 400 cycle applications—and a 95% stacking factor for 12 mil 60-cycle usage.
7. Immediate delivery.
8. Complete engineering service available.

For further facts on OrthoSil tape wound cores write direct to Thomas & Skinner today.

SPECIALISTS IN MAGNETIC MATERIALS . . .

Permanent Magnets *Laminations* *and Wound Cores*

Thomas & Skinner, Inc.

1157 E. 23rd STREET, INDIANAPOLIS 7, IND.

CIRCLE 154 ON READER-SERVICE CARD FOR MORE INFORMATION

Inverter

Weighs 7 lb in 100va Size

This miniature inverter is a precision permanent-magnet motor generator which converts 28v d-c direct to 400cy. Equipped with governors for maintaining constant speed, it operates over an input range of 18 to 30v d-c and an output of 90 to 150v a-c. The permanent-magnet construction makes the output voltage independent of the condition of the battery.

Available in 25, 100, and 250va ratings, units with standard winding put out 115v. However, the voltage can be varied to meet customer requirements. At a 0.9 power factor, the a-c voltage regulation is within ±5% and the frequency within ±1%.

Designed for 1000 hours of trouble-free service through an ambient range of —55 to +71°C, the units withstand 10g acceleration and meet military requirements for noise suppression. In the 100va size the inverter weighs 7 lb and occupies a space of 3.4" x 4.6" x 4.4". Arga Div., Beckman Instruments, Inc., Dept. ED, 220 Pasadena Ave., South Pasadena, Calif.

CIRCLE 155 ON READER-SERVICE CARD FOR MORE INFORMATION

Clutch Kit

For the Engineering Laboratory

An aid for designers and engineers in solving product design problems, the "Engineering Laboratory Kit" contains one complete clutch assembly, four clutch roller assemblies of various sizes, one ball-bearing mounted clutch, and one torque limiter.

The kit provides actual working samples that offer several possible answers to design problems involving infinitely adjustable ratchet feed, automatic cycling mechanisms, selective couplings, free wheeling of high inertia driven parts, dual or multiple drives, backstops or one-way brakes, and many other phenomena. The Miniclutch Co., Dept. ED, 375 Morse St., Hamden, Conn.

CIRCLE 156 ON READER-SERVICE CARD FOR MORE INFORMATION

New! SANDERS "MINIVALVE"

Compact
Lightweight
Non-Jamming
Low Input Power
Built-in Torque Motor
Wide Frequency Response

This miniature valve is an advanced design of a 2-stage hydraulic amplifier utilizing the "Bootstrap" principle to develop larger forces with low input power requirements. Its improved, self-clearing feature eliminates jamming.

SPECIFICATIONS:

Flow — 4 GPM for 1000 PSI drop across valve; System Pressure — 3000 PSI; Frequency Response — 100 cps. (Also available: "Minivalves" with flows up to 200 GPM.) Size — 1" x 1" x 3⅝"

For detailed specifications, write to Dept. ED-C

SANDERS ASSOCIATES INCORPORATED
NASHUA NEW HAMPSHIRE

CIRCLE 157 ON READER-SERVICE CARD

Permanent-Magnet Motors

Gives Minimum Radio Noise

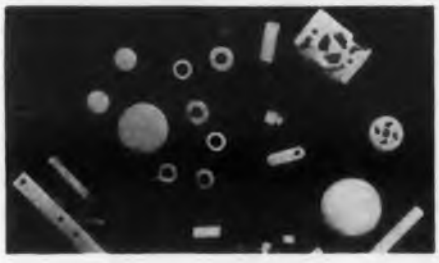
This line of efficient, 1-1/4" diam permanent-magnet motors is specially designed for minimum radio noise Type AM-215 is a typical example. It is designed to meet MIL-M-8609 specifications. The motor alone weighs only 5 oz and measures 1.25"-OD x 2.14" long. An exceptionally high torque is made possible by a unique, simple, magnet design. Radio noise is minimized by shielded leads. Altitude-treated bushes have exceptionally long life.

Temperature range is from —55 to +71°C. Motor speeds range from 6000 to 20,000rpm. Speeds are controllable to ±1% over a voltage range from 24 to 29v by using a governor. The motor is available with gear train, governor, brake, or any combination of these. When used with a gear train, gear ratios range from 6:1 to 4000:1. Avionic Div., John Oster Mfg. Co., Dept. ED, 1 Main St., Racine, Mich.

CIRCLE 159 ON READER-SERVICE CARD FOR MORE INFORMATION

Wollastonite Ceramic

For Ultra-High Frequency Uses



A wollastonite base ceramic is offered by this firm in dry pressed or extruded forms for a variety of electronic and electrical applications. A very high grade ceramic, it was developed mostly through research by the Rutgers School of Ceramics under the sponsorship of the Army Signal Corp., the aim being to develop a low-loss ceramic insulating material.

This ceramic carries an L-6A rating per JAN-1-10 specs, and it has superior electrical properties (low loss factor, high dielectric strength, etc.), high mechanical strength, high resistance to thermal shock, and high impact strength. Suggested uses for the material are bushings, tube sockets, tubing, lead-in assemblies, washers, strain and spreader insulators, and pillar insulators.

Also available are steatite and standard electrical porcelain, for average and low-frequency uses, respectively. R. Guastavino Co., Dept. ED, 660 Main St., Woburn, Mass.

CIRCLE 160 ON READER-SERVICE CARD FOR MORE INFORMATION

RADAR TRANSFORMERS AND INDUCTORS

SKILLED ASSEMBLERS AND DESIGN ENGINEERS work hand in hand to produce the prototype oil-filled radar transformers and inductors for your system development projects.

SEPARATE DESIGN DEPT. AND MODEL SHOP ASSURE

Quick shipment of prototype radar transformers

Once you've told us what you want, work begins at once. We've pooled design engineers and a team of skilled assemblers in a separate section . . . organized to deliver prototype oil-filled units for your radar experimental or system development projects *in a hurry*. Small orders are also filled in our high-speed model shop to avoid production-line delays. There's no waiting around for completion of larger projects. You're assured fast shipment on *all* orders.

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SEND ME YOUR NEW RADAR COMPONENT BULLETIN

General Electric Co., Section A434-2
Schenectady 5, New York

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Address.....

City.....

State.....

CIRCLE 161 ON READER-SERVICE CARD FOR MORE INFORMATION

Capacitors

For 125°C Operation

The Type 118P Subminiature "Metal-Clad" metallized paper capacitors are rated for operation at 125°C without voltage derating. They withstand a dielectric test of twice rated voltage. Other features include self-healing dielectric, complete hermetic sealing with glass-to-metal solder-seal terminals, and corrosion-resistant cases. Both standard wire leads and solder tab terminals are available. The units meet environmental tests of MIL-C-25A. Sprague Electric Co., Dept. ED, 347 Marshall St., North Adams, Mass.

CIRCLE 163 ON READER-SERVICE CARD FOR MORE INFORMATION

Vacuum Gage

With 1-1000 Micron Range

This electronically regulated thermocouple vacuum gage, the TC-104, has a pressure range from 1 to 1000 microns, and maintains its accuracy over wide variations of line voltage (95-125v). The entire instrument is only 5" x 9-1/2" x 3". It is regularly supplied with two rugged, calibrated, d-c heater thermocouple tubes with 1/8" IPS male thread. Electronic Research Laboratories, Dept. ED, 85 Surrey St., Brighton 35, Mass.

CIRCLE 164 ON READER-SERVICE CARD FOR MORE INFORMATION

Tube Retainer

Holds at 200cy, 20G

This tube retainer prevents parallel-mounted "flat press" or "button" base subminiature tubes from working loose from their sockets. It is mounted to the chassis by rivets. It is silver-plated both to prevent corrosion and insure good electrical contact with metallic coated tubes. The spring base is made of beryllium copper. It has been successfully tested with vibrational frequencies up to 2000cy at 20G. P. R. Mallory & Co., Inc., Dept. ED. Indianapolis, Ind.

CIRCLE 165 ON READER-SERVICE CARD FOR MORE INFORMATION

Clip-Type Rectifier

Requires No Assembly Tools

The "Qui-Klip" is a snap-in type rectifier featuring a clip arrangement which does not require tools for assembly. It is designed to speed assembly time and eliminate broken studs.

Developed by this firm in conjunction with the Tinnerman Products Corp., the unit does not require special sockets for mounting; it needs only two round holes to be snapped into place. In addition, solderless connectors are available for making electrical contact to the rectifier. Radio Receptor Co., Inc., Dept. ED, 240 Wythe Ave., Brooklyn, N. Y.

CIRCLE 166 ON READER-SERVICE CARD FOR MORE INFORMATION

Delay Line

Only 2" Long

This highly compact delay line is only 2" long. In spite of its size, it provides a 3.0μsec delay with a 0.4-μsec rise time at 2000 ohms impedance and 10% attenuation. Embedded in epoxy resin and hermetically sealed, it comes in a dust-proof case and meets all military specifications. E.S.C. Corp., Dept. ED, 534 Bergen Blvd., Palisades Park, N. J.

CIRCLE 167 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Supplies

Meet MIL-E-4158A Specs

Four power supplies are offered to meet MIL-4158A (USAF)—Electronic Equipment, Ground. They provide any fixed output voltage (adjustable ±25v) from 0-120v in three standard current ranges: 300, 600, or 1200ma max. Regulation is held to 0.25% line or load, and standard ripple is 4mv rms. NJE Corp., Dept. ED, 345 Carnegie Ave., Kenilworth, N. J.

CIRCLE 168 ON READER-SERVICE CARD FOR MORE INFORMATION

BIG NEWS...IN SEALED THERMOSTATS!

G-V's Series C8 is Undamaged By 150 G Shock, Vibration up to 2000 Cycles, Exposure to −100°F. and +300°F.

This new series of electrical thermostats is specially designed to meet the difficult operating conditions of electronic and aircraft applications. Operating points, regardless of setting, are not changed by exposure to temperatures from —100°F. to +300°F. Shocks up to 150 G for 3 milliseconds, vibration of 25 G up to 1000 cps, and vibration of 10 G up to 2000 cps do not damage these thermostats or change their setting.

Hermetically Sealed But Rapid in Response

Sealed in a metal shell which is also its sensing element, the G-V Series C8 Thermostat responds as rapidly as a laboratory thermometer. Temperature settings may be made at the factory or by the user. Contacts are rated at 5 amps. 115 volts AC, or 3 amps. 28 volts DC, non-inductive load. Differential is about 1°F. Insulation test is 1250 v. between circuit and shell, and insulation resistance is over 100 megohms. These thermostats are suitable for direct control of heaters and for over-temperature and under-temperature indication, alarm, or cut-off.

Available In Numerous Convenient Mounting Forms

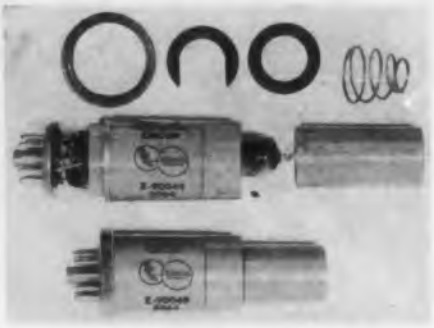
WRITE... for Bulletin with complete technical and application data.

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

CIRCLE 170 ON READER-SERVICE CARD FOR MORE INFORMATION

Squaring Circuit

In a Plug-In Unit



Squaring Circuit Z-90049 has been designed to operate from 0 to 1Mc. It is intended to square a sine or complex waveform input. It provides relatively fast rise and decay times, and may also be used as a base and peak clipper.

The Z-90049 is packaged as a plug-in unit with an 11-pin base. It has a 1-1/2″ overall diameter and a height of 4-5/32″. The plug-in unit is designed to be taken apart or assembled without any tools. It weighs approximately 3.25 oz and is provided with a removable tube shield.

The unit requires a peak-to-peak input signal of 25v. Greater sensitivity may be obtained by using an external positive bias depending upon the source impedance and frequency. It requires +200v d-c at 12ma, —200v d-c at 1ma, and 6.3v at 300ma. The circuit provides a 110v peak-to-peak square or rectangular wave output up to 200kc and 85v at 1Mc. It has a negative going rise time of 0.4μsec or less and a positive going decay time of 0.8μsec or less. It has an output impedance of less than 10,000 ohms. EECO Production Co., Dept. ED, 827 S. Vermont, Los Angeles 5, Calif.

CIRCLE 171 ON READER-SERVICE CARD FOR MORE INFORMATION

Synchronous Gear Motor

With Two Speeds

This 2-speed, synchronous gear motor, in which speeds are changed electrically, provides outputs of 1800 and 300-rpm. Speed reduction below the normal 1800-rpm is accomplished by electrically reversing the motor, and picking up a gear train through an internal over-riding clutch.

The basic motor is of the permanent split-capacitor type. It is designed for operation on 115v 60cy, and takes 10w at rated load. Designated Type RBC-2510, Model CS-4121, it is available with other speeds. Holtzer-Cabot Motor Div., National Pneumatic Co., Inc., Dept. ED, 125 Armory St., Boston 19, Mass.

CIRCLE 172 ON READER-SERVICE CARD FOR MORE INFORMATION

Drafting Desk

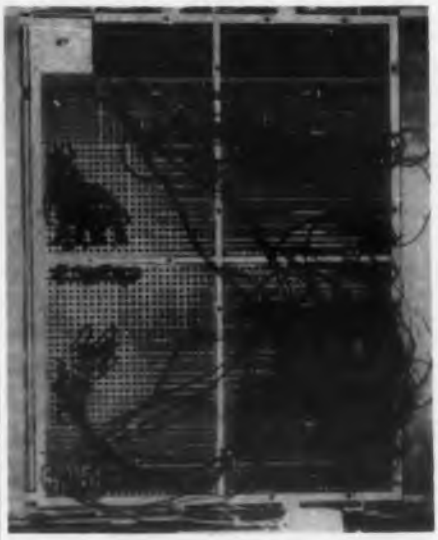
Uses Endless Belt

The "Draft-A-Matic" is a drafting desk which makes possible the performance of *all* drafting operations in a seated position. The drafting platform is equipped with an endless, vinyl plastic belt. The belt is 48″ wide and can accommodate a drawing 72″ long. It provides a firm drawing surface. The belt moves over aluminum rollers at each end of the drafting platform. By merely turning the wheel at either end of the front roller, the draftsman moves the belt and the drawing affixed to it, so that any part of the drawing is brought well within visibility and reach. The General Fireproofing Co., Dept. ED, Youngstown, Ohio.

CIRCLE 175 ON READER-SERVICE CARD FOR MORE INFORMATION

Panel Boards

For Programming Computers



A series of precise-tolerance panel boards is being made by this firm for programming digital computers. In one application, the "Univac", a series of eight boards, each 8″ x 10″, containing 816 cavities, serve as a stationary terminal block for the equipment. A small spring jack is attached to each cavity. Another series of eight boards serve as a terminal block for the electrical components which make up the problem analog.

These control panels are made of phenolic and are quantity molded to precise tolerances. Hole locations are held to ±0.007″ from center to either end, and hole diameters are held to +0.002″, −0.000″. The dimensional accuracy required to mold boards complete with holes and slots is achieved by a special blend of phenolic compound, by a unique mold to promote uniform curing, and by controlled cooling. Auburn Button Works, Inc., Dept. ED, Auburn, N. Y.

CIRCLE 176 ON READER-SERVICE CARD FOR MORE INFORMATION

new... precision **Continental Connectors**

40 Contacts... spring loaded for quick release

Quick Release

PRESSURIZED CONNECTORS

for guided missile and similar applications

Here's the connector you can specify for pressurized equipment without fear of dangerous air leakage. The Series "GA" plug is molded from Orlon filled Diallyl Phthalate. When subjected to a pressure differential of 30 PSI at 25° C, leakage is less than 1 cubic inch of air per hour. This series is available with hood and cable clamp. Gold plated, nickel silver contacts take #16 AWG wire, and each is spring loaded for easy release. A spring action center screwlock permits quick, easy release or engagement without damage to the unit.

Write for complete technical data without obligation.

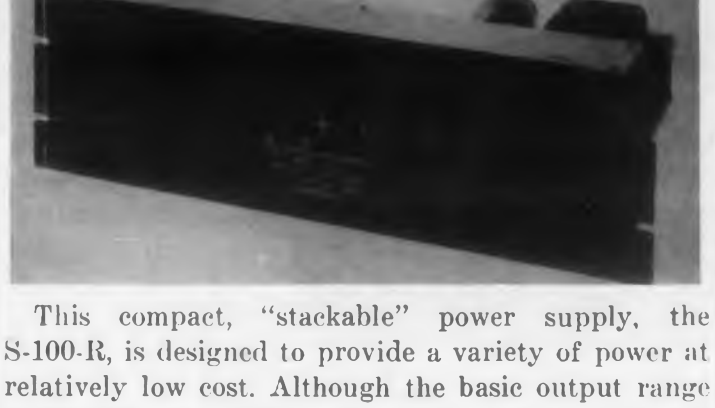
Note: Complete Continental Connector Catalog, covering subminiature, printed circuit, hermetic seal, pressurized, high voltage and power connectors, is available on request. Send us your name and title on your company letterhead.

Electronic Sales Division
DeJUR-Amsco Corporation,
45-01 Northern Boulevard, Long Island City 1, N. Y.

DeJUR

CIRCLE 177 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Supply
Can Stacked for Varied Outputs

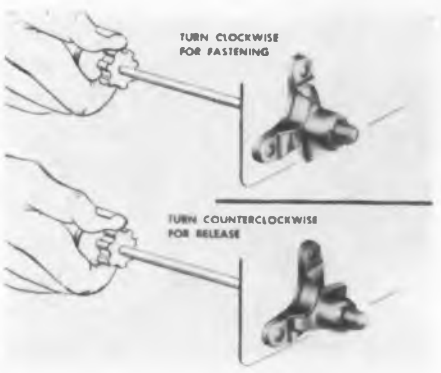


This compact, "stackable" power supply, the S-100-R, is designed to provide a variety of power at relatively low cost. Although the basic output range is 200-325v at 0-100ma, two, three, or four units can be stacked in parallel to furnish 0-200, 0-300, or 0-400ma.

In stacking, the junction between the pass-tube grids and the error-amplifier plate is brought to the rear terminal strip, permitting several units to be interconnected so that one error amplifier controls all the pass-tubes in use while the other error amplifiers remain inactive. In addition, this setup permits the use of one voltage control to set all the supplies to the desired output. Load division is uniform to 10%. The supply can be used in series (aiding or bucking), parallel, or isolated. New Jersey Electronics Corp., Dept. ED, 345 Carnegie Ave., Kenilworth, N. J.

CIRCLE 179 ON READER-SERVICE CARD FOR MORE INFORMATION

Rotary Latch
Operates with 1/4 Turn



The "Paneloc" Rotary Latch is a strong and durable fastener for use on hinged or removable parts, such as inspection doors, access panels, covers, and electrical control panels. Made of cadmium-plated steel, it consists of four parts: latch-screw, shim plate, anchor block, and latch-nut. The entire latch is assembled on the acess panel only, which eliminates several of the operations required to install other types of fasteners.

Operating with a quarter turn, the latch cuts down on removal time of panels, doors, and covers. Three standard sizes are currently available, with more to be added. Scovill Manufacturing Co., Dept. ED, Waterbury 20, Conn.

CIRCLE 180 ON READER-SERVICE CARD FOR MORE INFORMATION

Blower

Weighs Less than 2-3/4 oz

L-R No. 1, a self-contained motor-blower, uses a 1" diam impeller. It will efficiently move large volumes of air (36.8-cfm at 20,000rpm). Total weight of blower and motor is less than 2-3/4 oz. Designed to meet military specifications, it is available in clockwise or counter-clockwise rotation. Ripley Co., Inc., Dept. ED, Middletown, Conn.

CIRCLE 183 ON READER-SERVICE CARD FOR MORE INFORMATION

Gear-Box Adapters

Kit for Servo Motors

A series of adapter kits is available for coupling this firm's high-precision gear boxes to many of the most widely used servo motors. Six kits for direct, in-line mounting to various type servo motors, and a special adapter kit for coupling the gear box to a flexible shaft are offered. Each kit contains an anodized aluminum adapter plate, coupling disk, and all necessary attaching parts. The gear boxes are available in speed ratios ranging from 10:1 to 3125:1. Link Aviation, Inc., Dept. ED, Binghamton, N. Y.

CIRCLE 184 ON READER-SERVICE CARD FOR MORE INFORMATION

Binding Post

Takes Five Connection Types

The Model No 260 is a 5-way all-molded binding post designed to accept standard phone tips, banana plugs, spade lugs, alligator clips, and most wire sizes. Mounting in a 5/16" hole, it locks securely in panels from 1/16" to 1/4" thick, and assures complete insulation from all surfaces at 3000v a-c. Herman H. Smith, Inc., Dept. ED, 2326 Nostrand Ave., Brooklyn 1, N. Y.

CIRCLE 185 ON READER-SERVICE CARD FOR MORE INFORMATION

TO THE FINE ENGINEERING MIND SEEKING THE CHALLENGING PROJECTS IN

TEST EQUIPMENT

TEST EQUIPMENT ENGINEERS (Senior Electronic Engineers and Electronic Engineers) are urgently needed for design and development of test equipment for aircraft and missile application at Convair. Unusual career opportunities are here now for engineers qualified in these fields: *telemeter equipment; auto pilot; rocket propulsion; system engineering; electronic packaging and cabling; electrical, hydraulic and pneumatic power distribution; data reduction systems, radar beacon, remote control systems, specification writers, test procedures, component test, inertial guidance.*

CONVAIR offers you an imaginative, explorative, energetic engineering department to challenge your mind, your skills, and your abilities in solving the complex problems of vital, new, immediate and long-range programs. You will find salaries, facilities, engineering policies, educational opportunities and personal advantages excellent.

Generous travel allowances to engineers who are accepted. Write at once enclosing full resume to:

H. T. Brooks, Engineering Personnel, Dept. 1009

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A Division of General Dynamics Corporation

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SMOG-FREE SAN DIEGO, lovely city on the coast of Southern California, offers you and your family a wonderful new way of life... a way of life judged by most as the Nation's finest for climate, natural beauty and easy (indoor-outdoor) living.

TUNG-SOL "Magic Mirror" ALUMINIZED PICTURE TUBE

BRIGHTER-SHARPER MORE DETAIL MORE CONTRAST

The "Magic Mirror" Aluminized Picture Tube creates the brightest, most realistic TV picture ever seen in the American home. The "Magic Mirror" Tube effectively utilizes *all* the light generated by the phosphor screen.

Tung-Sol has developed a unique method of backing the phosphor screen with a mirror-like aluminum reflector: Light is prevented from radiating uselessly back into the Tube. All of the intense detail of which the receiver is capable is brought out by the full light.

Tung-Sol's exacting standards of quality control, manufacture and testing further guarantee the high uniformity and maximum performance of the "Magic-Mirror" TV Picture Tube.

Let the superior qualities of "Magic-Mirror" Picture Tubes add selling advantages to your set.

TUNG-SOL ELECTRIC INC., Newark 4, N. J.

Sales Offices: Atlanta, Chicago, Columbus, Culver City (Los Angeles), Dallas, Denver, Detroit, Montreal (Canada), Newark, Seattle.

ORDINARY TUBE—Only *half* the light produced by the phosphor screen is utilized in the picture. Other half radiates wastefully back into tube.

RESULT—A light background within the tube which reduces picture contrast.

MAGIC-MIRROR ALUMINIZED TUBE—Aluminized reflector allows electron beam through. Blocks wasted light from backing up into tube. Reflects *all* the light into picture.

RESULT—Pronounced increase in contrast to make a bright, clear, more realistic picture.

CIRCLE 186 ON READER-SERVICE CARD FOR MORE INFORMATION

Microscope

For TV Tube Dot Alignment

The Color TV "Tubescope" is a microscope to assist and simplify alignment of the dot pattern on picture tubes. A working distance of 4-1/4" is ample to view the periphery of the TV tube; the safety glass shield need not be removed. Five different eyepieces are available and can be easily interchanged to give powers from 10X to 33X. The instrument is 7-1/4" long with OD of 1-1/2". Edmund Scientific Corp., Dept. ED, Barrington 3, N. J.

CIRCLE 187 ON READER-SERVICE CARD FOR MORE INFORMATION

Printed-Circuit Connectors

For Coaxial Cable

The "EC" Series miniature printed-circuit connectors consist of a coaxial plug assembly and a receptacle that can be mounted on a printed or etched card by five terminal points using the solder dip method. The plug assembly is approximately 3/4" long x 9/32" diam. The receptacle has a mounting base 7/16" square.

Two receptacles can be mounted side-by-side without loss of printed or etched circuit lines. Terminals can be furnished for 1/16", 1/8" and 1/4" card thicknesses. H. H. Buggie, Inc., Dept. ED, 726 Stanton St., Toledo, Ohio.

CIRCLE 188 ON READER-SERVICE CARD FOR MORE INFORMATION

Delay Line

With 20μsec Period

This lumped parameter 20μsec delay line, XN-1, has a rise time of 1μsec. Impedance is 600 ohms. The unit is hermetically sealed in epoxy resin, and operates through the temperature range from —70° to 135°C. Size is 10-1/4" (including terminal lugs) x 3-5/16" x 15/16". The Gudeman Co. of California, Inc., Dept. ED, 2661 S. Myrtle Ave., Monrovia, Calif.

CIRCLE 189 ON READER-SERVICE CARD FOR MORE INFORMATION

UHF Klystron

Delivers 2kw, 375-600Mc

The 3K3000LA delivers 2kw CW power output in 375-600Mc operation. Typical narrow band output is 2kw at 525Mc with 42% efficiency, obtained with a beam voltage of 8000v, 0.60amp, and a power gain of 1000X with 2w driving power.

The unit features resonant cavities completed outside the vacuum system, which is free of r-f circuitry, permitting wide-range tuning and easy input and output coupling adjustment. It is constructed entirely of metal and ceramic, has an oxide cathode, and is forced-air cooled. Eitel-McCullough, Inc., Dept. ED, San Bruno, Calif.

CIRCLE 192 ON READER-SERVICE CARD FOR MORE INFORMATION

Mercury Pulse Generator

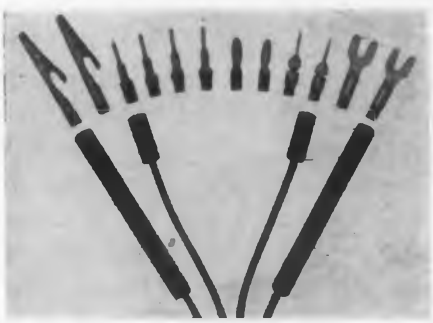
With 10mv to 100v Range

For testing amplifiers and pulse height analyzers, and numerous other applications, the Model M-60 Mercury Pulse Generator provides a range of 10mv to 100v, negative or positive pulses. Pulse shape is exponential rise to ex-potential decay. Rise time is better than 5 x 10^{-8}sec, variable over a range of 1000:1 in steps of ten. Decay time constant is 1, 10, or 100μsec on a selector switch. Radiation Instrument Development Laboratory, Dept. ED, 2337 W. 67th St., Chicago 36, Ill.

CIRCLE 193 ON READER-SERVICE CARD FOR MORE INFORMATION

Test Lead Kit

Has Universal Leads



This kit contains completely interchangeable test leads. Tips, clips, plugs, and lugs with threaded inserts can be interchanged easily and quickly into one pair of leads at both prod and meter ends. The one pair of test leads does the work of 50 different pairs. Herman H. Smith, Dept. ED, 2326 Nostrand Ave., Brooklyn, N. Y.

CIRCLE 194 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW DEVELOPMENTS

Broadband Sweep Generators

845 TO 1950 Mcs.

SIMULTANEOUS DISPLAY

As another step in the advancement in the field of Instrumentation, A.R.I. introduces its new Type HFS Broadband Sweep Generators.

From the Research Engineer to the Production Engineer, these NEW A.R.I. generators make instantly available a panoramic display of several hundreds megacycles. Now the advantages of RAPID . . . design, alignment and test of systems and components within the L Band frequency are realized.

Through the use of these NEW A.R.I. Sweep Generators the development and use of broadband multiple-tuned resonant circuits are made possible. Now the concept of lumped constant and distributed constant multiple-tuned circuits leave the realm of theory and become practical working units, and the typical Tschebycheff or Butterworth response curves are available at the discretion of the engineer.

The selectivities which can only be obtained from Quadruple, Sextuple and even Decatuple tuned circuits now becomes available. The response of a broadband antenna system is made visible instantly. The channeling of multiplexing systems becomes obvious, and the field of panoramic search of broadbands of frequency is realizable.

MODELS HFS — #1319 AND #813

SPECIFICATIONS

Frequency Range #1319	1350-1950 Mcs. (Min.)	Marker Frequency Range #1319	1200 to 2000 Mcs.
Frequency Range #813	845-1375 Mcs. (Min.)	Marker Frequency Range #813	750 to 1450 Mcs.
Power Output #1319	0.5 milliwatts (Min.)	Marker Accuracy	+ or − 1%
Power Output #813	1.0 milliwatts (Min.)	Sweep Frequency	60 Cycles
Source Impedance	50 ohms.	Sizes	14" h x 12" w x 8" d
Source Vswr #1319	1.5/1 (Max.)		
Source Vswr # 813	1.3/1 (Max.)		

MAXIMUM TO MINIMUM OUTPUT AMPLITUDE RATIO + or − 1 db. (Max.)

Applied Research INC.

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MANUFACTURERS OF: BNC Attenuators and Coaxial Terminations Bandpass and Bandreject Filters Broadband Sweep Generators Community TV Components R F Amplifiers & Mixers (100-2000 Mcs.)

CIRCLE 195 ON READER-SERVICE CARD FOR MORE INFORMATION

Stupakoff

CERAMIC MATERIALS

At your fingertips . . .

NEW TECHNICAL DATA on *Stupakoff* CERAMIC MATERIALS

The very latest technical information on a wide range of ceramic materials is given in the new Stupakoff Technical Data Chart. Electrical and physical characteristics and the chemical composition of various grades of the following ceramic materials are included:

ALUMINA	PORCELAIN	ZIRCON
ALUMINUM SILICATE	STUPALITH	ZIRCITE
STEATITE	CORDIERITE	FORSTERITE
	MAGNESIA	

Valuable design and application suggestions included in the Stupakoff Data Chart help you engineer your ceramic parts for lowest cost and greatest satisfaction.

Send **today for your free copy of the new Stupakoff Data Chart. Arranged for ready reference.**

Stupakoff

Write Dept. ED.

Division of The CARBORUNDUM Company

LATROBE, PENNSYLVANIA

CIRCLE 196 ON READER-SERVICE CARD FOR MORE INFORMATION

VHF Balun

Operates Over 50-220Mc

The Model VB-1 UHF Balun was designed to operate in the frequency range of 50 to 220-Mc. It is actually a matching device that couples a signal from a 300-ohm balanced line to a 72-ohm unbalanced line, or vice versa. While it was primarily designed for 72-ohm coaxial cable, it can also be used for 52-ohm coaxial cable. American Electronics Co., Dept. ED, 1203 Bryant Ave., New York 59, N. Y.

CIRCLE 197 ON READER-SERVICE CARD FOR MORE INFORMATION

Anchor Nut

In No. 2 Size

A 2-56 thread size has been added to the "Kaylock line" of self-locking anchor nuts. It is of special value in electronics and guided missiles applications because its overall envelope dimensions are so tiny.

Locking design utilizes a simple positive principle, wherein the upper threads are made elliptical and highly resilient, eliminating the necessity of an auxiliary locking device. It can be used in temperature ranges up to 550°F. The Kaynar Co., Kaylock Div., Dept. ED, 820 E. 16th St., Los Angeles, Calif.

CIRCLE 198 ON READER-SERVICE CARD FOR MORE INFORMATION

Signal Generator

With 10-500Mc Range

The Model TF-801B Signal Generator, with a frequency range of 10-500Mc, features long oscillator tube life, high output (2v down to 0.1-μv), low f-m ensured by a tuned amplifier, and a 50-ohm output from piston attenuation calibrated in volts, db, and dbm. Internal modulation is 0-90% metered, external modulation from d-c to 3Mc maximum. The unit has capacity-coupled, contactless coil turrets. Marconi Instruments, Dept. ED, 44 New St., New York, N. Y.

CIRCLE 199 ON READER-SERVICE CARD FOR MORE INFORMATION

Gear Motor

With Parallel Output Shaft

To provide a universal gear motor with a parallel output shaft, this firm has developed the G-8 Gear Reducer, which can be adapted to its various motors. This unit is available in any voltage up to 250v, and in speeds as low as 1rpm. It is designed to meet loads to 15 in-lb.

The motor can also be built with electric governor speed control. It can be rheostat controlled, dynamically or mechanically braked. The particular unit shown is the M-G-8. RAE Motor Corp., Dept. ED, P. O. Box 291, Racine, Wis.

CIRCLE 202 ON READER-SERVICE CARD FOR MORE INFORMATION

Wire-Wound Controls

Wiper-Arm Insulated

A wiper arm insulated from the shaft and mounting bushing is now available on the Series MII Controls. These units are low-cost conventional bushing mounted type insulated wire-wound controls rated at 1w and available in resistance values from 2 ohms to 1000 ohms. Clarostat Mfg. Co., Inc., Dept. ED, Dover, N. H.

CIRCLE 203 ON READER-SERVICE CARD FOR MORE INFORMATION

Pulse Transformer

Has 0.02μsec Rise Time

This magnetron pulse modulator transformer has a rise time of only 0.02μsec from 10% to 90%. Pulse width is 0.1-μsec. Primary voltage is 1250v peak across 50 ohms. Secondary voltage is 5000v peak in the original application.

The transformer is encapsulated in epoxy resin and has a temperature range from $-65°$ to $+150°$C. Size is 1-1/4" x 2" x 2-1/4". Weight is 6-3/4 oz. California Magnetic Control Corp., Dept. ED, 7245 Atoll Ave., North Hollywood, Calif.

CIRCLE 204 ON READER-SERVICE CARD FOR MORE INFORMATION

To Wind Coils of "INVISIBLE WIRE"

(or other minute precision operations)

At the Hathaway Instrument Company, tiny galvanometer coils are wound with wire so fine that it is almost invisible to the unaided eye. Ingenious tooling and use of an AO Stereoscopic Microscope assure fast, precise workmanship.

These unique AO Microscopes provide *two* complete optical systems (one for each eye) to enhance the perception of depth and to provide *three-dimensional* reality plus an exceptionally wide field of view. Unlike ordinary microscopes, objects and movements are *not* inverted. Instead they appear in their natural directions. Because AO Stereoscopic Microscopes are unequalled for fabrication, assembly, inspection of minute precision parts, they are widely used in electronics, metal working, food and many other industries.

Let AO Stereoscopic Microscopes help *you* achieve high precision at low cost. Mail coupon below.

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Instrument Division
Buffalo 15, New York

Gentlemen:

Please send me further information on AO Stereoscopic Microscopes.

Signed .....

Organization .....

Address .....

City..... Zone..... State.....

CIRCLE 205 ON READER-SERVICE CARD FOR MORE INFORMATION

How BURROUGHS PULSE UNITS help engineers get more done

1. Save time getting started

Lose no time designing and building special pulse test equipment. To form the pulse system you need —simple or complex—simply connect together Burroughs Pulse Units. Units mount in a standard rack. Use standard cables. It only takes minutes.

2. Try new ideas

Burroughs Pulse Units are so easy to use you can try many new ideas you might otherwise never find time for. If you work with pulses, you need these new engineering tools.

3. Correct errors fast

Now if you discover an error in planning your pulse system, you lose none of your equipment investment. Simply reconnect the cables and correct the error. Burroughs units let you experiment with different arrangements.

4. Speed completion of engineering

Every day lost in engineering postpones product delivery. Save valuable engineering time. Equip your laboratory with Burroughs pre-engineered pulse units. Make it easier to meet your deadlines.

5. Use equipment over and over again

There's no waste with Burroughs Pulse Units. Usually you save on the first application. Then you can use them over and over again on different future projects—saving many times more over the life of the equipment.

Burroughs CORPORATION

ELECTRONIC INSTRUMENTS DIVISION

Dept. 4-J, 1209 Vine St., Phila. 7, Pa.

Send me literature on Burroughs Pulse Units.

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Position.....

Company.....

Street.....

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CAN BURROUGHS HELP YOU?

If you have an engineering problem involving pulses, write Burroughs. Without charge, we'll engineer your system for you, showing what Burroughs Pulse Units you need and how much they cost. Prove to your management how much you can save and how much more you can get done. Write today or send coupon.

ENGINEERS: The Electronic Instruments Division of the Burroughs Corporation now offers excellent opportunities to experienced electronic development engineers. Write Engineering Manager.

CIRCLE 206 ON READER-SERVICE CARD FOR MORE INFORMATION

Crystal Microphone

Has Selective Base Boost

This crystal microphone, Model CR BB, acoustically amplifies frequencies between 40cy and 150cy up to 12db. The 60cy hum picked up in some equipment can be reduced considerably by adding 60cy base boost to the microphone and turning down the base tone control of the equipment. The frequency band to be amplified is selected by a control knob on the microphone. The acoustically amplified bass can be set to compensate for deficiencies inherent in many recording and PA systems. It has a smooth bass response to below 60cy without the accompanying 60cy hum. It exceeds the boost of the expensive velocity (ribbon) microphones in the ability to bring out the low frequencies in the voice. With this microphone, it is not necessary to speak "close-in" as it is with the velocity type.

Although it can be set to amplify the lowest piano notes, when desired, its sharp-cut off characteristics below 40cy eliminate the pick-up of rumble and other similar extraneous sounds. Frequency response is 30-12,000cy, output is —52db. Dimensions are 1-1/2" x 6-1/2". Frank L. Capps & Co., Inc., Dept. ED, 20 Addison Pl., Valley Stream, N. Y.

CIRCLE 207 ON READER-SERVICE CARD FOR MORE INFORMATION

Ceramic Disk Capacitors

For Automation

These three ceramic disk capacitors are intended specifically for automation. Closest to the conventional disk ceramic is a pin-terminal type which has short, stiff terminals 3/16" long held at predetermined lead spacings. (upper right in photograph). This capacitor is furnished either in bulk or in "Tube-Paks" for direct magazine loading in component insertion machines.

The taper tab terminal unit (shown at lower right) is also intended for automatic insertion machines and is furnished in "Tub-Paks" if required, the flat terminals are designed to jam into chassis slots so the capacitors will be held firmly during subsequent operations prior to dip soldering. The diametral lead disk capacitor (shown at left) is intended for tape loading in magazines; tape-loaded capacitors then have their leads precut to size and are automatically inserted by machinery. Sprague Electric Co., Dept. ED, 347 Marshall St., North Adams, Mass.

CIRCLE 208 ON READER-SERVICE CARD FOR MORE INFORMATION

Lab Amplifier

With Bandwidth of 1cy to 10Mc

The "10Mc Laboratory Amplifier" is designed for application in color T V development, nuclear instrumentation, digital computer circuit development, and general wideband circuit problems. It has built-in, front panel, controlled options of high or low output and input impedances, and continuous variable gain control. Provision is also made for external line terminations.

Bandwidth is from less than 1cy to 10Mc (3db), with overshoot less than 5% and compression maximum of 5% at maximum output. Tilt is less than 1% for 60cy square wave input. Maximum output is 150v peak-to-peak with gain of 40db. The unit is supplied complete with electronically regulated power supply and packaged suitable for rack or bench use. American Electronic Laboratories, Inc., Dept. ED, 641 Arch St., Philadelphia 6, Pa.

CIRCLE 211 ON READER-SERVICE CARD FOR MORE INFORMATION

Potentiometers

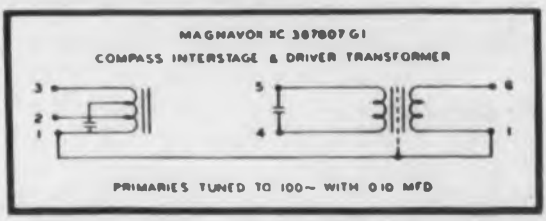
In Nine Single-Turn Models

The "S1" Series is a complete line of single-turn potentiometers, including nine models with a wide range of specifications, in diameters from 1/2 to 3". They are gangable continuous mechanical rotation units. The illustration shows five units coupled together. Mechanical stops are available on all models.

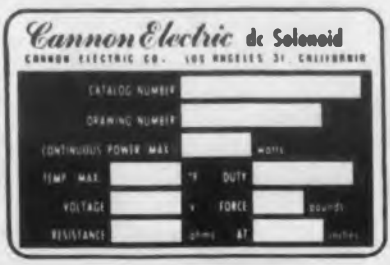
Specifications of the S1-5000 units include: housing diameter of 1"; housing length, 5/8"; mechanical rotation, 360°; electrical rotation, 352° ±5°; resistance range, 5 ohm to 50k; standard resistance tolerance, ±5%; linearity tolerance ±2%; wattage rating 1.5w; ambient temperature range, 55° to +85°C; weight per section, 1.3 oz; starting torque (max), 0.75 oz-in; and running torque (max), 0.7 oz-in. All housings are aluminum alloy, precision machined, black aluminited. General Scientific Corp., Dept. ED, 12027 Vose St., North Hollywood, Calif.

CIRCLE 212 ON READER-SERVICE CARD FOR MORE INFORMATION

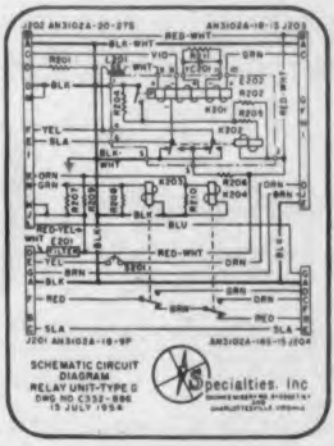
SYSTEM TRACERS



SPECIFICATION DATA



WIRING DIAGRAM



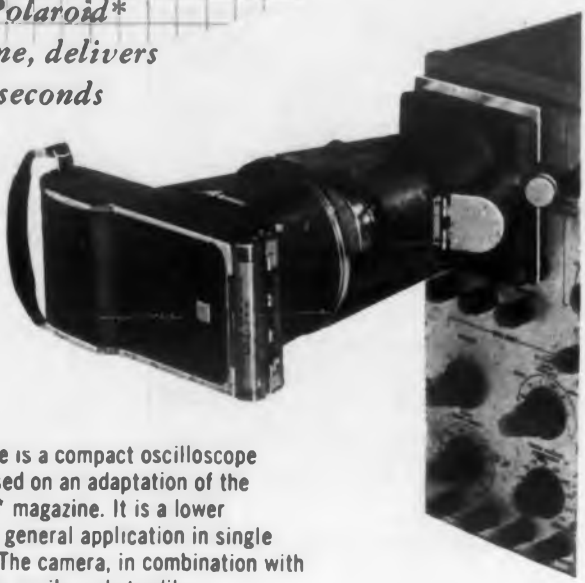
SERIAL NUMBERS

PRODUCT IDENTIFICATION

a new lower cost precision camera for economical single-frame oscilloscope recording

THE AREMAC RECORDOSCOPE 1414

utilizes the new small Polaroid self-developing magazine, delivers black-field prints in 60 seconds*



The new Aremac 1414 Recordoscope is a compact oscilloscope camera of special configuration based on an adaptation of the 60-second self-developing Polaroid* magazine. It is a lower cost model designed principally for general application in single frame oscilloscope data recording. The camera, in combination with a packaged accessory group, mounts easily and sturdily on any standard 3" or 5" scope.

A single camera is capable of servicing several scopes of different manufacture when used in conjunction with scope-mounted Aremac swing-away hoods. Overall versatility, plus fine technical performance at a new lower cost, makes the 1414 Recordoscope a standard engineering instrument requirement for electrical, electronic, industrial and basic r & d laboratories.

*POLAROID IS THE REGISTERED TRADE NAME OF THE POLAROID CORPORATION

1185-C MANUAL RECORDOSCOPE

1185-B AUTOMATIC RECORDOSCOPE

The 1185-B RECORDOSCOPE features automatic magazine-shifting operation. Camera pre-sets to record from 3-to-16 traces on each 3" x 4" print. Automatic movement is triggered by remote control, cable or manual shutter release. The 1185-C . . . a manually operated version for use where applications do not justify the automatic-magazine shifting feature.

Write for complete technical literature on Aremac's Oscilloscope Data Recording Cameras.

Aremac ASSOCIATES

Manufacturers of Precision Mechanical and Optical Instruments

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AREMAC SALES REPRESENTATIVES IN PRINCIPLE U. S. CITIES

CIRCLE 214 ON READER-SERVICE CARD FOR MORE INFORMATION

Lettering Machine

For Prototypes; Short Runs

The Model 304 lettering machine is for marking chasses, panels, resistor sub-assemblies, and related items. It is designed for the manufacturer of prototype and other limited production models, and provides high quality lettering and line art without the expense, time, and trouble involved with silk screen and rubber stamp methods.

Used with ordinary mechanical lettering pens and templets, only a few minutes' practice are necessary for its operation by unskilled personnel. Attachments are available for marking on a radius at any angle and for lettering below the templet plane. It is capable of marking chasses up to 20" square x 4" deep. Jansky & Bailey, Inc., Dept. ED, 1339 Wisconsin Ave., N. W., Washington 7, D. C.

CIRCLE 215 ON READER-SERVICE CARD FOR MORE INFORMATION

Ceramic Rotary Switch

In Miniature Size

Series M Ceramic Rotary Switch, a miniature unit, has numerous applications on guided missiles, airborne equipment, and portable and mobile ground equipment. It occupies a panel area of less than 1-1/2 sq in and incorporates features that ensure long life and trouble-free operation. Coin silver contacts, rotors, and slip rings are provided for low contact resistance and excellent electrical characteristics.

Ceramic parts are silicone impregnated to withstand extreme humidity. Sturdy solder terminals are supplied for wiring.

The single-pole style has 18 shorting-type contact positions available in many combinations; several sections may be ganged by adding supplementary wafers. Two or three poles per deck may also be obtained. Flash-over voltage at 60cy is 1000v peak, and the current carrying capacity is 2amp. The Daven Co., Dept. SZ, 191 Central Ave., Newark, N. J.

CIRCLE 216 ON READER-SERVICE CARD FOR MORE INFORMATION

Torque Tester

For Instrument Bearings

This ball-bearing torque tester meets the requirements of Military Standard MIL-STD-206, as well as the recommendations of the American Ordnance Association. It will measure positive and negative torques, with a sensitivity as low as 7mg-mm. Full scale ranges are adjustable from 700-0-700mg-mm to 50,000-0-50mg-mm. The tester will indicate torques ranging from those having low frequency due to errors in race geometry to those having high frequency due to race roughness.

With experience in analyzing records, an operator is able to distinguish such torques as caused by rough bearing races, geometrical errors in races, Brinell marks, and separator friction. The unit accommodates almost any instrument ball bearing size. The overall accuracy is within 5%, and readings are independent of line voltage variations. Sunshine Scientific Instrument, Dept. ED, 1810 Grant Ave., Philadelphia 15, Pa.

CIRCLE 219 ON READER-SERVICE CARD FOR MORE INFORMATION

Turns-Counting Dial

Weighs only 3 oz

The "Duodial" Series R turns-counting dial, with a diameter of only 2", provides 25 and 40-turn count-capacities for setting and indicating the revolutions of multi-turn components. Total weight is 3 oz.

Two coaxial dials form the uint: the inner dial counts hundredths of each turn; the outer dial counts the number of completed turns. The knob of the "Duodial" is part of the inner dial and connects directly to the shaft of the device, eliminating backlash.

The device is suitable for use with any multi-turn unit that has a 1/4" shaft. A built-in locking device to prevent rotation of the dials and driven unit is available at small extra cost. Helipot Corp., Dept. ED, 916 Meridian Ave., S. Pasadena, Calif.

CIRCLE 220 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 221 ON READER-SERVICE CARD ➤

GENERAL ELECTRIC ANNOUNCES . . .

NEW, faster, smaller micro-miniature relay

LIGHT WEIGHT, SMALL SIZE: Weighs only .35 ounces and measures .34" x .781" x .84". This tiny relay utilizes balanced armature and simple design, giving you quality and more reliable operation at a consistently high level.

HIGH CONTACT RATING: For low contact resistance and long life, fine silver is used . . . contact rating is 2 amps resistive load at 30 V d-c or 115 V a-c . . . contact arrangement is 2PDT.

FAST OPERATION: With rated voltage on coil, operating time is 1.5 milliseconds. By adding series resistance in coil circuit or by applying high voltage pulse to coil . . . pickup time will be less than 1 millisecond!

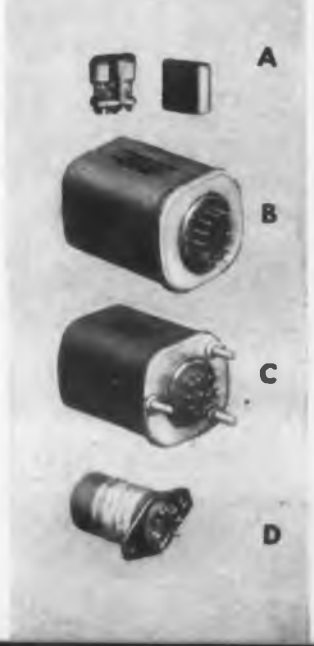
LOW OPERATING POWER: 300 milliwatts for standard model . . . 150 milliwatts for current sensitive model.

HIGH SHOCK: VIBRATION RESISTANT: G.E.'s balanced armature and high tip forces withstand shock of over 50 g's and vibration of 10-55 cp's at .12" maximum excursion and 55–500 cp's at 20 g's acceleration.

HIGH TEMP OPERATION: This new micro-miniature relay gives you continuous and efficient operation at ambient temperatures of 125° C.

G.E.'s line of aircraft-type relays will help solve your space-weight problems. Contact your G-E Apparatus Sales office for more application information. General Electric Company, Schenectady 5, New York.

MAIL THIS COUPON FOR G-E RELAY DATA . . .



- ☐ A: Micro-miniature Relay—Bulletin GEA-6346
- ☐ B: High Speed Relay—Bulletin GEA-6212
- ☐ C: Miniature Relay—Bulletin GEA-6213
- ☐ D: Subminiature Relay—Bulletin GEA-6211
- ☐ E: Have Sales Engineer contact me.

Section E792-2, General Electric Company, Schenectady 5, New York

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COMPANY.....

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

GENERAL ELECTRIC

Large Screen Oscilloscope

With 40 Input Channels

This large screen oscilloscope provides a vertical line graph 9" high x 12" wide on a 17" cylindrical-face cathode ray tube. Each vertical line terminates in a dot to permit rapid and accurate readability. The output of each of 40 amplifiers is scanned each 1/4sec. The vertical length of each line indicates the peak value of the maximum a-c input voltage which existed during the previous 1/4sec. A calibrated graticule is provided in front of the cathode ray tube for easy reading of voltage values and channel identification.

The frequency response of each channel is within 2% from 10cy to 10kc and down no more than 3db at 50kc. Each channel input is high impedance, single ended with one side grounded. The maximum sensitivity for each channel is 45mv peak for full 9" vertical deflection. An attenuator and a "remote" switch is provided for each channel. Channel switching is accomplished with a motor-driven switch.

All equipment and power supplies are self contained, operate from 115v 60cy single phase, and are mounted in a sturdy relay rack 23-1/2" wide x 23" deep x 68" high. Net weight is 435 lbs. Electromec, Inc., Oscilloscope Dept. ED, 5121 San Fernando Rd., Los Angeles 39, Calif.

CIRCLE 223 ON READER-SERVICE CARD FOR MORE INFORMATION

Sealed Relay

6PDT Unit Withstands 60g Shock

The Type FC-6 6pdt Relay withstands 0 to 2000cy vibration to 30g, and withstands 60g shock without contact opening. It is designed to exceed MIL-R-5757B and to meet MIL-R-25018 and MS-24115 specifications. It is available for both 85°C and 125°C ambients. Nominal coil voltage is 26.5v d-c.

Features include: simplicity of moving parts; extreme rigidity; high contact pressures; low contact bounce; plenty of contact over-travel; and a complete absence of internal gaseous materials which might vaporize and cause contact unreliability. The construction, which permits lower price, incorporates varied safety factors. Struthers-Dunn, Inc., Dept. ED, Pitman, N. J.

CIRCLE 530 ON READER-SERVICE CARD FOR MORE INFORMATION

Transmitting Tetrode

Dissipates 65w

The *QY3-65* is a transmitting tetrode with a rated anode dissipation of 65w and a maximum operating frequency of 250Mc (150Mc full rating). The tube is of compact all-glass construction (seated height 4″). It has a quick-heating thoriated tungsten filament (6.3v, 3.5amp), which makes it suitable for aircraft and marine mobile applications where conservation of power during standby periods is important.

The tube is suitable for use as an r-f drive, power amplifier, or power oscillator, or as an a-f power amplifier. It may also be used as a linear r-f amplifier for single sideband working. R-f power outputs up to 280w are obtainable under CW conditions, and power gain is high. Plate voltages ranging from 600v to 3000v may be employed. Mullard, Ltd., Dept. ED, Century House, Shaftesbury Ave., London, W.C.2, England.

CIRCLE 531 ON READER-SERVICE CARD FOR MORE INFORMATION

Field Intensity Meter

Covers 14-250kc Range

The NM-10A Radio Interference and Field Intensity Meter covers a 14-250kc frequency range. Designed for lab or field use, it is available with a complete selection of accessories. It measures field intensity of carrier current systems, and signal levels in such

equipment. It can be used to survey conducted or radiated interference. The supply permits operation from 105-125v or 210-250v, 50-1600cy. The NM-10A is identical to the Navy AN/URM-6B, a Class One Instrument. Stoddart Aircraft Radio Co., Inc., Dept. ED, 6644 Santa Monica Blvd., Hollywood 38, Calif.

CIRCLE 532 ON READER-SERVICE CARD FOR MORE INFORMATION

If you need a special component, send a brief statement of your specifications addressed to Bulletin Board, Electronic Design, 19 E. 62nd St., New York 21, N. Y. Include your complete address.

Gain-Standard Antennas

Cover 100-50,000Mc Spectrum

Parabolas (as illustrated), horns, dipoles, and dipole arrays with precision gain calibration to 0.2db are offered by this form as accurate laboratory tools to be used in the determination of propagation gain. The various types cover the frequency spectrum from 100Mc to 50,000Mc.

From 2600Mc to 50,000Mc, and for gains of 20db and more, parabolas are generally used. For lower gains in the same frequency region, horns are most widely useful, and can be supplied on short delivery in a series of nine sizes covering the commonly-used microwave frequencies.

For the frequency spectrum down to 100Mc, dipoles and dipole arrays are provided. Special requirements as to frequency, gain, and mechanical design can be met. Color Television, Inc., Dept. ED, 932 E. San Carlos Ave., San Carlos, Calif.

CIRCLE 225 ON READER-SERVICE CARD FOR MORE INFORMATION

Tone Units

For Remote Control and Metering

"Audio-Tone" Signaling Units are available in a completely new physical package of modular design. These units are used for transmitting and receiving signaling, dialing, telemetering, supervisory controls, and other information. Up to 48 on-off or raise-lower functions can be controlled over a single circuit—telephone line, microwave, or v-h-f radio—by the use of these devices, which operate in the range of 425 to 6025cy at intervals of 100 or 150cy.

The units are available in various combinations of transmitters and receivers. The frequency determining element of the tone generator is a separately mounted small unit, as is the filter for each receiver. Hammarlund Manufacturing Co., Inc., Dept. ED, 460 W. 34th St., New York 1, N. Y.

CIRCLE 226 ON READER-SERVICE CARD FOR MORE INFORMATION

Precision INSTRUMENT SWITCHES

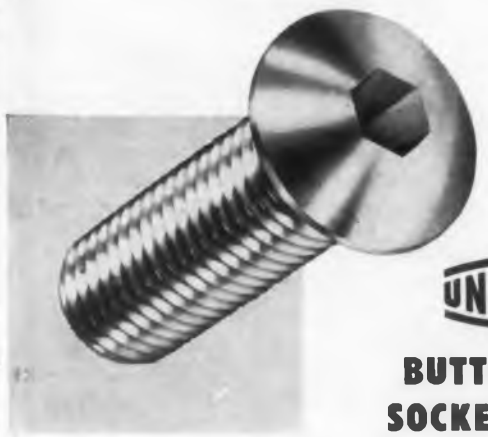
STOCK MODELS FOR *YOUR* JOB

There's nothing like stock models of Shallcross Instrument Switches for cutting equipment cost and design problems. For over 20 years Shallcross has made scores of basic switch types with countless variations for practically every electric-electronic application. Many unique types—usually "Special items" with other manufacturers—can quickly be supplied by Shallcross from stock. For a fast solution to any problem involving rotary switches, drop a line to SHALLCROSS MANUFACTURING CO., 526 Pusey Ave., Collingdale, Pa.

Shallcross

CIRCLE 229 ON READER-SERVICE CARD FOR MORE INFORMATION

save with standard



UNBRAKO

BUTTON HEAD SOCKET SCREWS

BUTTON HEAD FEATURES

- designed for applications where countersinking is not practicable
- heat treated alloy steel for strength
- low head height for streamlining designs
- accurate hex sockets for nonslip drive and freedom from marred heads or mutilated work
- fully formed threads—Class 3 fit

Save time and money by using standard UNBRAKO Button Head Socket Screws. Stocked in standard sizes—#8 through 5/8"—by your authorized UNBRAKO industrial distributor. Ask him for Bulletin 856. Or write STANDARD PRESSED STEEL Co., Jenkintown 12, Pa.

UNBRAKO SOCKET SCREW DIVISION **SPS**

JENKINTOWN PENNSYLVANIA

CIRCLE 230 ON READER-SERVICE CARD FOR MORE INFORMATION

Guided Missile Timer

Spring-Wound Unit

This small timer is specifically suited for airborne equipment or missiles. It contains a spring-wound timer and an spdt switch which is thrown at the end of the set time.

The unit is available with three different types of starting actuators: pull wire, dimple (explosive) motor, or G weight actuators; a dimple unit is shown. The timer is suitable for mounting on a panel or plate in a manner similar to the way small potentiometers are mounted. Maximum time delays vary from 1sec to 6 minutes in the various models. The switch is rated at 5amp 250v non-inductive.

This timer will operate at 40g, —60 to +200°F, with an accuracy of ±10%. It measures 1-1/2" diam x 1-3/16" deep behind the panel. Finishes and materials conform to military specifications. Raymond Engineering Laboratory, Inc., Dept. ED, Smith St., Middletown, Conn.

CIRCLE 231 ON READER-SERVICE CARD FOR MORE INFORMATION

Thermal Time Delays

Adjustable Hot-Wire Units

Time delay intervals from 1/10 up to 5sec are provided by the Series II Thermal Relays, using the hot-wire operating principle. Although the relays are completely hermetically sealed, their time delay intervals are adjustable by means of a screw accessible from the top. Recovery rate is rapid, and the units are ready to time a new cycle after cooling only a few seconds. Standard energizing voltages range from 6.3 to 28v, and the relays may be energized interchangeably on d-c or a-c of any frequency.

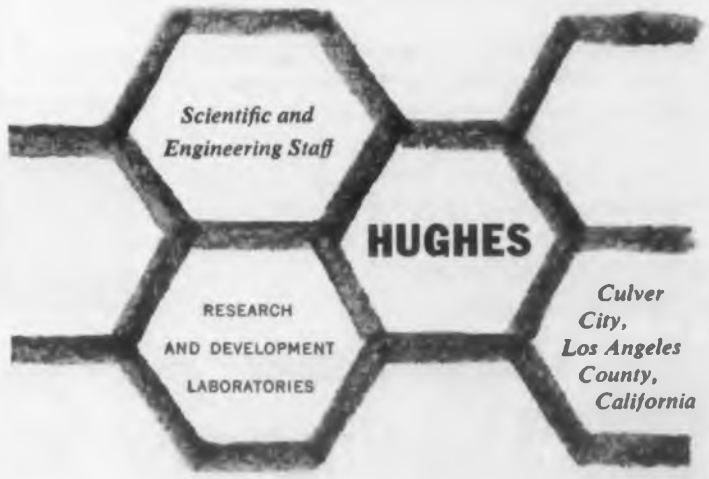
Size is 3/4" diam x 2-3/8" high. Both flanged and 7-pin miniature plug-in forms are available. Weight is 1 oz. Contacts are spst, either normally open or normally closed. Contact rating is 3amp at 115v a-c. Relays are compensated for ambient temperatures from —70 to +100°C, and are designed to withstand the shock and vibration encountered in many military applications. G-V Controls Inc., Dept. ED, 28 Hollywood Plaza, East Orange, N. J.

CIRCLE 232 ON READER-SERVICE CARD FOR MORE INFORMATION

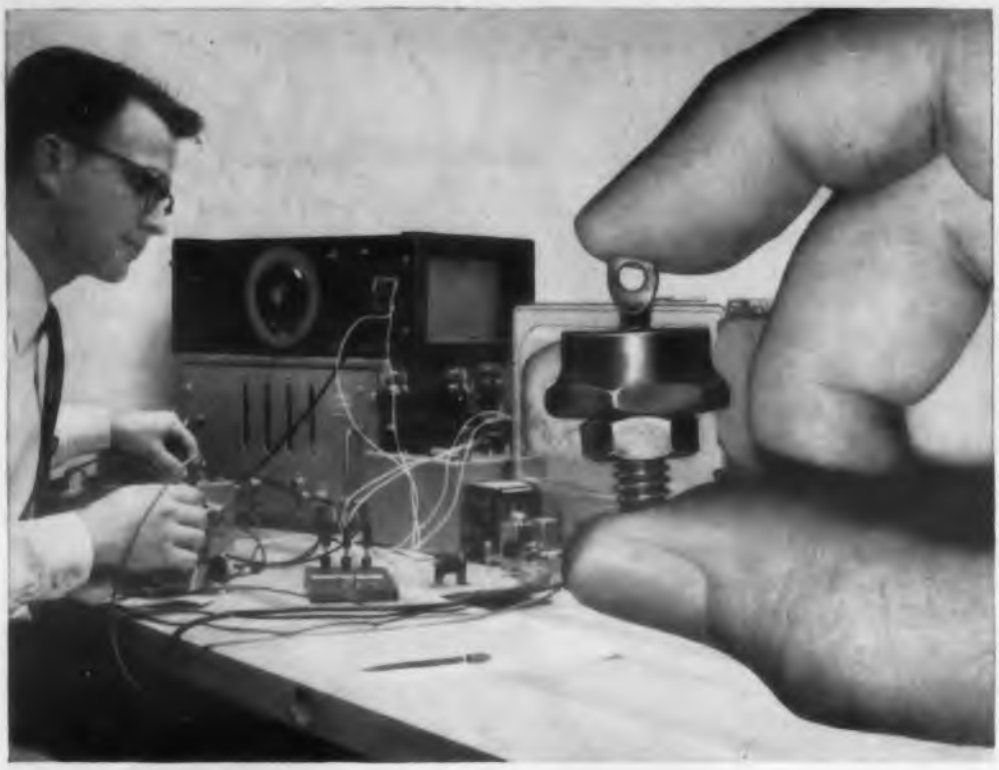
The most advanced developments in electronics are being made in the sphere of airborne radar and related ground control systems because of military emphasis. Further applications of electromechanical techniques in these fields are creating new openings in the Systems Division of Hughes Research and Development Laboratories.

Engineers who have demonstrated ingenuity and inventive ability will find interest in areas of work that call for devising reliable, maintainable, manufacturable designs for precision equipment developed at Hughes Research and Development Laboratories.

The design of this equipment, manufactured at Hughes, involves mechanical, electromechanical, electronic, microwave and computing problems. Design also requires the use of such advanced techniques as subminiaturization, unitized "plug-in" construction, with emphasis on design for volume production. Knowledge of electronic components, materials, finishes and military specifications is useful.



CIRCLE 233 ON READER-SERVICE CARD FOR MORE INFORMATION



WESTINGHOUSE
NEW SILICON POWER RECTIFIER puts you ahead...

High-temperature operation. Exhaustive tests have shown that these units are capable of operation up to 200°C with *no* detectable aging in their characteristics.

In rectifier efficiency. Forward voltage drop reaches only *0.85* volts at 40 amperes, 190°C junction temperature. Efficiency is over 99%. Ratings up to 200 volts maximum peak inverse are available in four classifications: 50, 100, 150 and 200 volts.

In compact design. Westinghouse silicon power rectifier (shown actual size above) takes only 1/50th the volume of the comparable selenium rectifier.

Write today for your free application *Facts Folder* describing the full range of silicon power rectifier characteristics. These rectifiers are available for immediate delivery. Call your local Westinghouse sales office, or write: Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa. J-80002

YOU CAN BE **SURE**...IF IT'S

Westinghouse

CIRCLE 234 ON READER-SERVICE CARD FOR MORE INFORMATION

Electric Counters

For Base and Panel Mounting

The PIC-600 Series of medium-size electric counters is offered in basemount and panel mount models. Features include 50 million count life, 1000cpm rating, 7w power consumption, balanced armatures for reliable operation on airborne equipment, and quiet operation with no a-c hum when energized. The units are made in 6-digit models. They are reset to zero by a single turn of the knob, and are available for practically any voltage up to 120v, a-c or d-c.

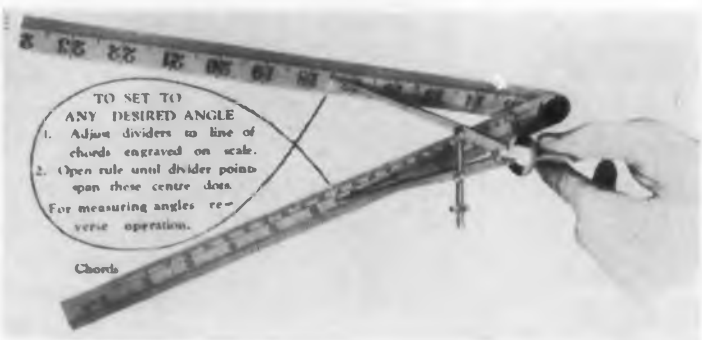
The basement model measures 2-1/2" high x 3-1/2" x 1.668", less reset knob. The panel mount model has overall panel dimensions of 4-7/8" x 1-7/8"; overall depth behind panel is 2-23/32". Production Instrument Co., Dept. ED, 706-34 W. Jackson Blvd., Chicago 6, Ill.

CIRCLE 235 ON READER-SERVICE CARD FOR MORE INFORMATION

Jointed Rule

Also Serves as Protractor

This jointed stainless-steel 2' rule also serves as a protractor. It is a practical and useful aid for measuring longitudinal as well as angular dimensions, avoiding the difficulty of counting fine graduations.



The jointed rule has an accurate scale of chords engraved on one side from 0° to 120°, advancing by half degrees. It is also provided with two center dots, one on each blade, by which, when using a pair of ordinary dividers, the rule can be set to any desired angle; similarly, any angle can be determined. George Scherr Co., Inc., Dept. ED, 200 Lafayette St., New York 12, N. Y.

CIRCLE 236 ON READER-SERVICE CARD FOR MORE INFORMATION

If you need a special component, send a brief statement of your specifications addressed to Bulletin Board, Electronic Design, 19 E. 62nd St., New York 21, N. Y. Include your complete address.

Northrup Engineers use

E-I DIGITAL IN-LINE READ-OUTS to visually display computer test positions

Small, compact decades save space; provide digital accuracy at a glance

The test console shown above is used by Northrup engineers to test missile-borne computer resistance values on a "go, no go" basis. Electrical positioning of the "go, no go" switching is displayed on two E-I Digital In-line Read-outs, to aid in locating any "no go" values which appear during the automatic cycling of the tester.

Two E-I decades, mounted in the center of the console, enable 99 positions to be displayed. Old style techniques would have required 99 pilot lights or 99 front panel switches. Important too, use of E-I In-line Read-outs assures unambiguous readings. Since test positions are displayed digitally, no interpretation is required, minimizing chance of reading error.

Adaptable to a Variety of Uses!

NO MOVING PARTS—Numbers engraved on lucite plates, arranged in depth. Only number or symbol which is edge-lighted appears in window.

GOOD READABILITY—Special techniques minimize incident lighting effects. 1-inch numerals are easily read at 30 feet.

FAST RESPONSE—Limited only by bulb response.

SMALL IN SIZE—1-inch and ½-inch models available.

NO MAINTENANCE—Other than occasional bulb replacement.

EASILY MOUNTED—Tapped holes provided for panel mounting.

1-, 2-, 3-, 4- & 5-decade models available. Write for complete information.

ELECTRO INSTRUMENTS INCORPORATED

3794 Rosecrans Street, San Diego 10, Calif.

Engineering representatives throughout the United States and Canada

CIRCLE 238 ON READER-SERVICE CARD

Bridge Amplifier Meter

Use Transistor Pre-Amplifier

The BAM-1 Bridge Amplifier and Meter is handy for both dynamic and static work from d-c to 25,000 cy with SR-4 strain gages, Statham pickups, and similar resistance-type transducers.

For static measurements, the meter on the unit is used. It is calibrated to read tension. The scales are arbitrary with a simple system of calibration to make them read directly in terms of units being measured.

For dynamic measurements, a d-c cathode-ray oscilloscope is plugged directly into the front panel. The d-c stability is within 100mv per hour. Frequency response is flat within 5% from d-c up to 25,000cy and slowly drops off at high frequencies. Further, the instrument will drive up to 100μamp into external meters, strip chart recorders, automatic controllers, and strain galvanometers. Ellis Associates, Dept. ED, Box 77, Pelham, N. Y.

CIRCLE 239 ON READER-SERVICE CARD FOR MORE INFORMATION

Tape-Wound Core Box

Made of Spun-Aluminum

A spun-aluminum core box is available for this firm's tape-wound cores, providing wall strength that assures that cores will be free from distortion and deflection after winding. The core box, together with its silicone glass insert, is suitable for vacuum impregnating; no varnish can get into the core. These cores are unaffected by temperatures as high as 450°F.

The construction, with an inert cushioning material, makes the cores unusually shock and vibration proof. Available in 108 standard sizes, other sizes can be made to the customer specifications. They are available with Orthonol, Magnesil, Hy-Mu 80, and 48 Alloy, or other commercially available similar materials. Magnetics, Inc., Dept. ED, P. O. Box 230-E, Butler, Pa.

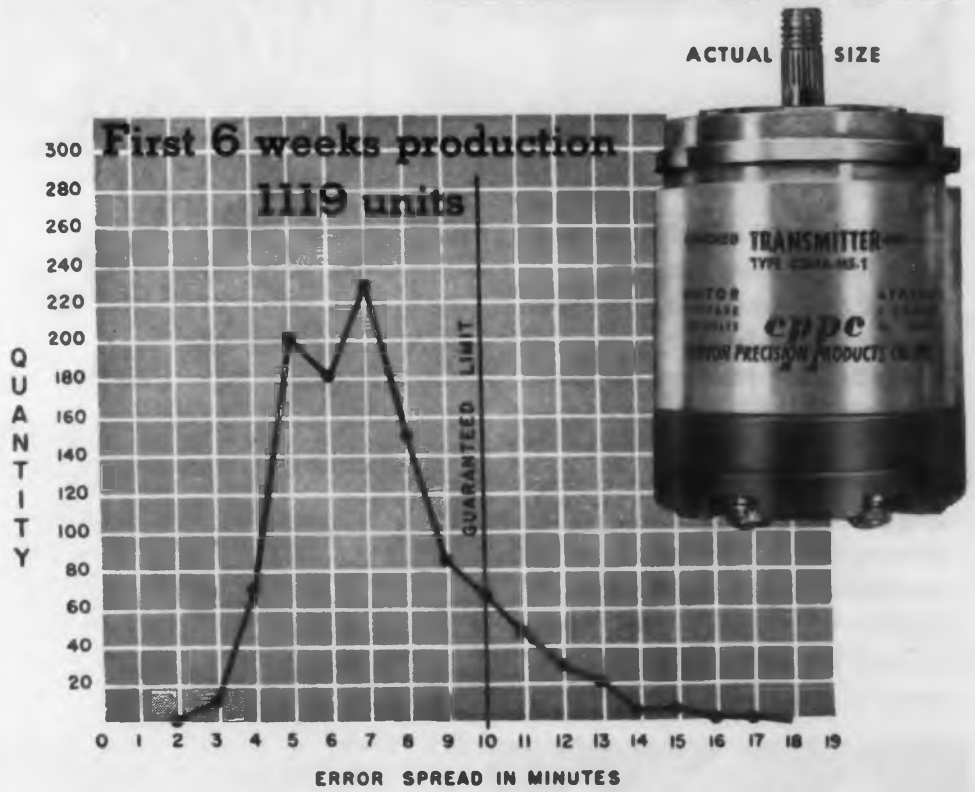
CIRCLE 240 ON READER-SERVICE CARD FOR MORE INFORMATION

CLIFTON PRECISION OFFERS A SIZE 15 SYNCHRO TRANSMITTER

identical to BuOrd type 15CX4a

Except

ACCURACY SPREAD GUARANTEED 10′ or LESS



The CG-15-MS-1 transmitter is interchangeable part for part with the U.S. Navy Bureau of Ordnance type 15CX4a synchro transmitter (Mark 22 Mod. 1) in every respect.

Because of quality workmanship in this unit we are able to guarantee accuracy spreads not to exceed 10′. From the chart it will be noted the majority of production units have error spreads between 5′ and 8′—yet price remains exceedingly low.

Stainless steel bearings are provided for better environmental resistance.

FOR SALES INFORMATION, CONTACT:

New England: The Darbury Corp., 99 Elm St., W. Newton 65, Mass.
Southwest: Ammon & Woods Asso., 4163 Glenwick Lane, Dallas, Tex.
West Coast: Enright Engineering Co., 988 W. Kensington Rd., Los Angeles
Home Office: T. W. Shoop, Sales Mgr., Telephone (Phila.) MAdison 6-2101

LOOK TO CPPC FOR SYNCHRO PROGRESS

CLIFTON PRECISION PRODUCTS CO. Inc.

CLIFTON HEIGHTS
PENNSYLVANIA

cppc

CIRCLE 241 ON READER-SERVICE CARD FOR MORE INFORMATION

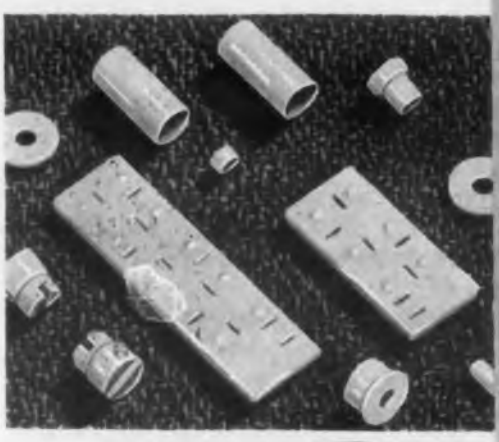
GLASS MULTIFORMS

Did you know that multiforms in glass have greater inherent elasticity to make them more shock resistant than glass tubing or pressed glass? Here are the ideal multiforms for *Iron Sealing* and *Kovar Sealing*, matching the expansion of these metals over their entire working range. They resist mercury attack, have ample mechanical strength and seal readily. Our laboratory is prepared to assist you in selecting the proper glass for any metal.

NOW USED IN MAKING OF:

Hermetic Seals, Gun Mounts, Thyratron Tubes, Diodes, transistors, Connectors, sealed-TERMINALS, Insulators and Dial Lights.

MANSOL can produce MULTIFORMS to seal to the following: Dumet, Kovar, Fernico, Rodar, Molybdenum, Mica, Platinum, #4 Alloy, Tungsten and Stainless Steel.



***MANSOL also makes MULTIFORMS of* STEATITE**

We specialize in small die-pressed ceramic parts held to the closest tolerances. All tools and dies are made in our shop to assure quick delivery.

- *If you are still making your own multiforms, let Mansol help you with your multiform problems.*
- *Write to Dept. ED for the complete story about Multiforms, Steatite and our production facilities. No obligation, of course.*

mansol

MANSOL CERAMICS COMPANY

142 LITTLE STREET ● BELLEVILLE, N. J. Cable Address: MANSOL

CIRCLE 242 ON READER-SERVICE CARD FOR MORE INFORMATION

Beam Power Tube

For Color TV

The *6CB5* is a high-perveance beam power tube of the glass-octal type designed especially for use as a horizontal-deflection amplifier tube in color TV receivers. It has a maximum plate-dissipation rating of 23w and a maximum grid-No. 2 input of 3.6w. These ratings, in addition to a peak positive-pulse plate-voltage rating of 6800v and a peak negative-pulse plate-voltage rating of 15v, enable a single *6CB5* to provide full deflection for the RCA-*21AXP22* color picture tube.

Other electrical features are low-mu-factor, high plate current at low plate voltage, and a high operating ratio of plate current to grid-No. 2 current. Construction permits cool operation of both grids No. 1 and No. 2, with the result that emission from them is minimized. The structure also provides for maximum distribution of heat in order to prevent hot spots on the plate. Radio Corp., of America, Tube Div., Dept. ED, Harrison, N. J.

CIRCLE 243 ON READER-SERVICE CARD FOR MORE INFORMATION

30Mc Receiver

Measures Microwave Signals

The Type 110 Precision Test Receiver combines a high-gain, low-noise-figure, 30Mc receiver; a secondary standard of attenuation; and means for testing the i-f output of a wide variety of microwave mixers. When combined with a suitable local oscillator, it

becomes a sensitive detector of microwave energy. It may be used for accurate measurements of the differences in r-f and i-f power levels. Some of the applications are: noise-figure measurement, directional-coupler characteristics, SWR measurements, calibration of r-f attenuators, and selectivity characteristics of r-f filters, preselectors, etc. Airborne Instruments Laboratory, Dept. ED, 160 Old Country Rd., Mineola, N. Y.

CIRCLE 244 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 246 ON READER-SERVICE CARD

Power Supply

Offers Variable Frequency

The Variable Frequency Power Supply, Model No. VP-400, is used for testing electrical and electronic equipment requiring line frequencies not available where the equipment is being tested. It has no moving parts and is not subject to mechanical wear and tear.

The frequency range is 47 to 6000cy, continuously variable in two ranges. A jack for external drive is provided. The power output (continuous operation) is 400w, into resistive load. The harmonic distortion is 5% maximum, total, into resistive load. Voltage regulation is 2% from no-load to full load.

Output ranges are from 75v to 150v and 150v to 300v. The primary power required is 115v, 60cy, (1300v-a). Dimensions are 42″ x 22″ x 18″ deep. Empire Devices Products Corp., Dept. ED, 38-15 Bell Blvd., Bayside, N.Y.

CIRCLE 247 ON READER-SERVICE CARD FOR MORE INFORMATION

FM/AM Signal Generator

With 2-220 Mc Range

Signal Generator Model TF-.995A/1 provides continuous frequency coverage from 2 to 220Mc. Normal deviation is continuously variable for 0-25 and 0-75kc on all bands. High deviation of X2 normal is also available on the 2-13.5 and 27-54Mc bands; X4 normal on the 54-108Mc band; and X8 normal on the 108-220Mc band. The output may be continuous-wave, frequency-modulated, amplitude-modulated, or simultaneously both frequency and amplitude modulated.

Modulation distortion is less than 2%. Amplitude modulation, both internal or external, is variable up to 50%. The r-f level is variable from 0.1μv to 200mv, and the output impedances are 52 and 75 ohms. The generator enables measurements at i-f and carrier frequencies to be made with a single instrument. Marconi Instruments, Ltd., 23 Beaver St., New York 4, N. Y.

CIRCLE 248 ON READER-SERVICE CARD FOR MORE INFORMATION

PANELOC announces a new rotary latch

Saves Cost • Saves Time
Saves Space • Saves Weight

This new Paneloc Rotary Latch is a simple and economical, strong and durable fastener for access panels, electrical control panels, inspection doors, machinery doors, and other hinged or removable covers. It permits a larger access opening, operates quickly with a quarter-turn. Entire assembly on access panel itself, eliminating many installation steps; no special tools required. Only four simple parts; made of steel, cadmium plated. Three standard sizes now available, more to be added. Special sizes and finishes available on order. Cost very low, performance unsurpassed. Write for a catalog and price list for your file.

PANELOC...America's most versatile line of aircraft fasteners . . . Rotary Latches, Styles 1, 2, and 3 Panel Fasteners, High Performance Fasteners, Snap Fasteners.

PANELOC—A product of Scovill

Scovill Manufacturing Company, Aircraft Fastener Div.
99 Mill Street, Waterbury 20, Connecticut

Please send me fastener catalogs checked:

( ) Rotary Latch ( ) Style 3 (MIL-F-5591A)
( ) Styles 1 & 2 (MIL-F-5591A) ( ) High Performance (NAS-547)
( ) Snap Fasteners (AN 227)

Send to:

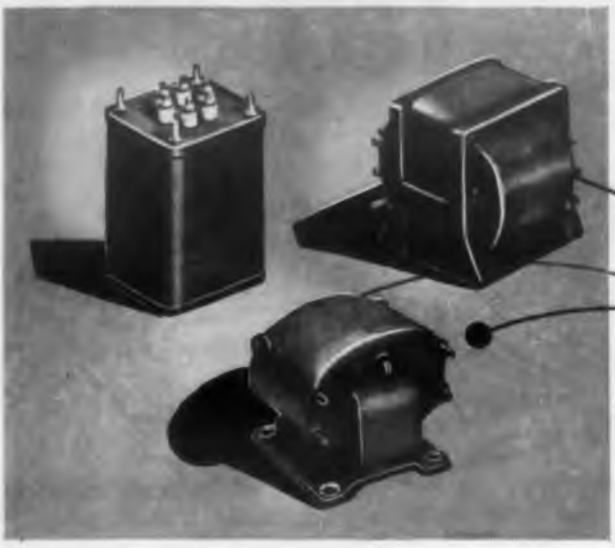
Name_____ Title_____

Company_____

Address_____

CIRCLE 249 ON READER-SERVICE CARD FOR MORE INFORMATION

Do you have source spots?



Every design engineer or production man we ever met makes mental notes of good places to get quick aid on needs out of the ordinary.

You might like to know, therefore, that a great deal of the work we do here at Wheeler on transformers, coils, harnesses, custom-built electronic assemblies, and communications components is just that kind of assignment.

We publish no catalog of the everyday standard items . . . they present no problem to anyone. We do serve an increasing group of engineering and production departments that require competent help . . . backed by ample manufacturing facilities . . . in producing components that are "a little (or a lot) different." Call or write us for an interesting story.

TRANSFORMERS • COILS • AMPLIFIERS
CUSTOM ELECTRONIC AND WIRING ASSEMBLIES
COMMUNICATIONS EQUIPMENT • MAGNET WIRE

Wheeler is constantly adding to its staff of engineers. If you are available and qualify in this field, call us now.

THE **WHEELER**
INSULATED WIRE COMPANY, INC.
Division of Sperry Rand Corp.
1131 EAST AURORA STREET
WATERBURY 20, CONNECTICUT

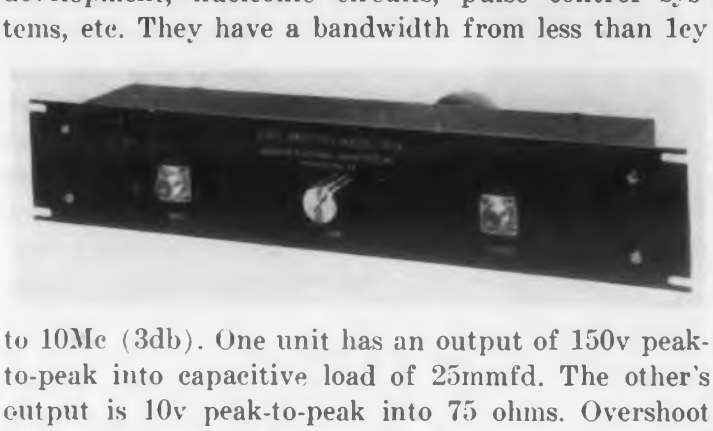
BWH55

CIRCLE 250 ON READER-SERVICE CARD FOR MORE INFORMATION

Video Amplifiers

Bandwidth of 1cy to 10Mc

These low-cost video amplifying units are for use in distribution systems, color TV systems, computer development, nucleonic circuits, pulse control systems, etc. They have a bandwidth from less than 1cy



to 10Mc (3db). One unit has an output of 150v peak-to-peak into capacitive load of 25mmfd. The other's output is 10v peak-to-peak into 75 ohms. Overshoot is less than 5% on both units, and compression less than 3% on the former and less than 5% on the latter. Both units have a continuously variable gain control

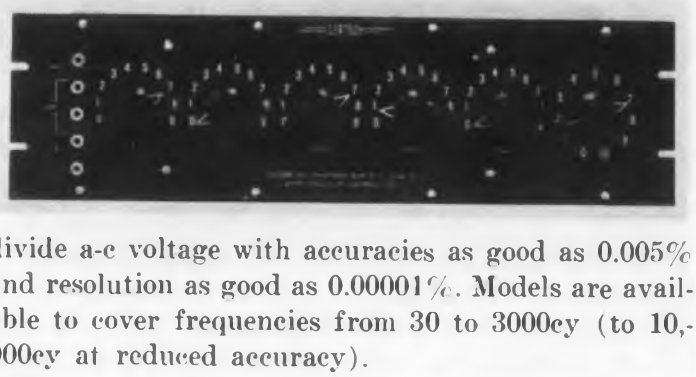
Both units take up to 1.5v peak-to-peak input and are supplied with input impedances of 500k and 10mmf, 90 ohms, 75 ohms, or 50 ohms at option of user. Power requirements are 350v, 150ma and 6.3v, 2.5a. Size is 19" x 3-1/4" x 9". American Electronic Laboratories, Inc., Dept. ED, 641 Arch St., Philadelphia 6, Pa.

CIRCLE 251 ON READER-SERVICE CARD FOR MORE INFORMATION

Ratio Transformers

With Accuracy to 0.005%

Four ruggedized versions of this firm's Standard Ratio Transformers have been added to the "PT" Series, which now consists of nine models of both rack mounted and case types, specifically designed to



divide a-c voltage with accuracies as good as 0.005% and resolution as good as 0.00001%. Models are available to cover frequencies from 30 to 3000cy (to 10,000cy at reduced accuracy).

Uses include core material investigation, a-c meter calibration, transformer turns investigation, checking resolvers, servos, computers, synchros, selsyns, and a-c transducers, bridge ratio arm, a-c potentiometer checking, and ratio standard. Gertsch Products, Inc., Dept. ED, 11846 Mississippi Ave., Los Angeles 25, Calif.

CIRCLE 252 ON READER-SERVICE CARD FOR MORE INFORMATION

Sweeping Oscillator

For HF and VHF Range

The Radaligner sweeping oscillator provides an instantaneous check of the entire bandpass of any equipment in the 10-169Mc range. Two or four bands are available. The unit offers a choice of four center frequencies for aligning radar i-f amplifiers. It also provides a variable marker and choice of 10 narrow, plus-type crystal-controlled markers.

The unit has extremely low amplitude modulation while sweeping—less than 0.05-db/Mc. The sweeping oscillators are completely electronic, with no mechanically driven elements. Kay Electric Company, Dept. ED, 14 Maple Ave., Pine Brook, N. J.

CIRCLE 597 ON READER'S SERVICE CARD

Printed Circuit Kit

Includes Etching Trays

Inclusion of items such as heating apparatus, thermometer, etching trays and the necessary handling equipment as well as the copper laminate, resist ink and conductive paint makes this a complete printed circuit kit.

Complete, easily followed step-by-step instructions and suggestions concerning printed circuit design are included. A description of each process as it is accomplished in automatic mass production is also furnished. Tele-Diagnosis Co., Dept. ED, 155 West 72nd Street, New York 23, N. Y.

CIRCLE 598 ON READER'S SERVICE CARD

Compression End Seals

Hermetically-Sealed Types

Additional types of compression end seals offer a broad range of dimensions in flared tube or pierced terminals with single or multiple lead terminations. These terminations are widely used for hermetically sealing capacitors, resistors and other tubular components.

In this exclusive compression construction, the glass remains under constant compression and is therefore extremely strong and difficult to put under stress. They possess extraordinary immunity to shock, vibration and pressure changes. Assembly is rapid as all metal parts are tin dipped for easy soldering. Electrical Industries, Dept. ED, Div. of Amperex Electronic Corp., 44 Summer Ave., Newark 4, N. J.

CIRCLE 599 ON READER'S SERVICE CARD

Phosphor for Radar Tubes

Bright, But Fades Rapidly

For short-range radar, tubes are needed which give a picture which persists brightly for two or three seconds and then fades rapidly before the next picture is painted. Further, the picture should be sharp and clear as possible. A single layer screen made of a special grade of magnesium fluoride has the required afterglow characteristics and at the same time gives the sharply defined picture necessary for short-range radar work.

The new phosphor has the advantage that the initial brightness is greater than that of double-layer screens. Electrostatically-focused radar tubes *AL22-10* and *AL31-10* which incorporate the new phosphor are available. Mullard Ltd., Dept. ED, Century House, Shaftesbury Ave., London, WC3.

CIRCLE 254 ON READER'S SERVICE CARD

Packaging Paper

Prevents Silver Tarnish

This new paper product, called Nox-Tarnish, is chemically treated to prevent silver from tarnishing. The chemicals impregnated in the paper neutralize the tarnishing sulfides thus preventing their action upon silver.

Nox-Tarnish can be used for the protection of bearings, and electonic components. Elimination of tarnish makes soldering easier. Protective Packaging Div., Dept. ED, Daubert Chemical Co., 333 N. Michigan Ave., Chicago 1, Ill.

CIRCLE 255 ON READER'S SERVICE CARD

Silicone Rubber

Is Flexible at 600° F

Designated Class 700, these new materials have been designed to extend the application range of silicone rubber to 600°F. The new materials are capable of remaining flexible for 150hr or longer during continuous peak-temperature exposure. Previously available types of silicone rubber became brittle in less than 24hr exposure to this heat.

The improvements have been obtained without sacrifice of other outstanding silicone rubber properties such as ozone, aging, and weathering resistance, low temperature flexibility and low moisture absorption. Silicone Products Dept., General Electric Co., Waterford, N. Y.

CIRCLE 256 ON READER'S SERVICE CARD

IMMEDIATELY AVAILABLE FROM STOCK ...

magnetic servo amplifier series

Shown above Model MA-6-400
Actual size: 2-9/16" x 1-3/4" x 1-7/16". Wt. less than 12 oz.
Hermetically Sealed • 7-Pin Header

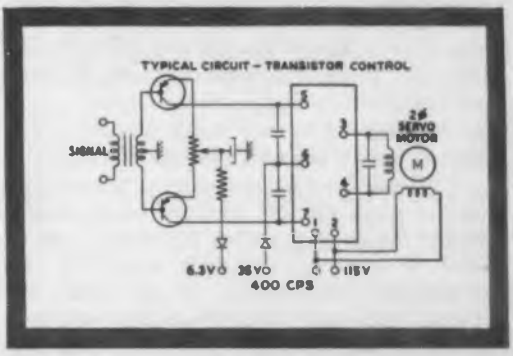
MODELS
400 cps Series

MA-3-400
MA-6-400
MA-10-400
MA-15-400
MA-18-400
MA-40-400

This complete series of precisely engineered Magnetic Servo Amplifiers is immediately available from stock, as standard components for servo systems application. Furnishes in compact form all the salient features of a high quality, hermetically sealed transformer.

OUTSTANDING PERFORMANCE CHARACTERISTICS ...

- Sinusoidal Phase Reversing Output
- Transistor or Tube Control ... AC or DC Input
- Ambient Temperature Range −55°C. to +100°C.
- Low Cost, Rugged, Compact, Efficient, Long Service Life
- Meets Military Specifications



MAGNETIC SERVO AMPLIFIER SERIES

*400 cps Models**	*Applications*
MA-3-400	MK-14 (3-watt)
MA-6-400	MK-7 (6-watt)
MA-10-400	MK-8 (10-watt)
MA-15-400	16-watt
MA-18-400	18-watt
MA-40-400	40-watt

** Equivalent 60 cps Series also available*

If you are confronted with circuitry design or engineering problems involving magnetic components for servo system or other application, your inquiry directed to our engineering staff for information will receive prompt, courteous attention.

For complete technical data and performance curves ... request Engineering Bulletin on Magnetic Servo Amplifier Series.

MAGNETIC RESEARCH CORP.
200 CENTER STREET • EL SEGUNDO, CALIFORNIA

Mfrs. of Magnetic Amplifiers and Converters, Magnetically Regulated DC Power Supplies, Magnetic Pulse Generators

CIRCLE 257 ON READER-SERVICE CARD FOR MORE INFORMATION

How Fafnir is prepared to meet MIL-STD-206 Standards of Torque Measurement for Instrument Ball Bearings.

NEW AUTOMATIC TORQUE TESTER FOR BALL BEARINGS

This Fafnir-developed torque testing equipment for instrument ball bearings automatically records in a matter of seconds a continuous series of starting torque peaks, from which maximum torque, average torque, and the frequency distribution of successive torque peaks are quickly determined. In addition, the trace distinctly reveals how torque is affected by dirt, race finish, race geometry, load, scratches, nicks, and retainer condition. By providing a multiplicity of readings in a very short span of time, inspection is simplified and chances of error minimized.

This continuous-rotation type torque tester is but one of many devices used for testing ball bearings in the Fafnir Instrument Division . . . all are operated to assure the highest standards of quality. Additional information on the manufacture of Fafnir Instrument Ball Bearings is contained in the newly-revised catalog. Write for a copy. The Fafnir Bearing Company, New Britain, Connecticut.

As a service to customers, Fafnir has been supplying the automatic torque tester. A manual giving complete detailed information on the torque tester is available upon request.

CIRCLE 258 ON READER-SERVICE CARD FOR MORE INFORMATION

Vacuum Relays

Exceptionally High Ratings

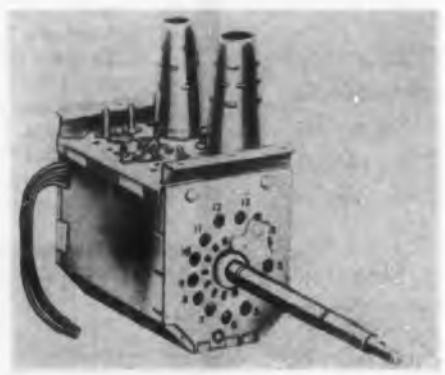
These multiple-pole vacuum transfer relays are for switching antennas, pulse networks, and many d-c circuits. They are offered in dpdt and 4pdt models with removable 24v d-c actuating coils built into flanged bases. An efficient magnetic circuit penetrates the vacuum seal. Vacuum-enclosed contacts are rated at 12kv peak and are capable of continuously carrying 30Mc currents of 10amp rms.

Contact resistance is only 0.005 ohms, and it remains low even when broken under load, due to the complete absence of any contaminating materials within the vacuum enclosure. Switch capacitance between contacts is 0.33mmfd, and operate time is less than 30millisec. Size is 4-1/2″ x 4″ diam. The units withstand test voltages of 18kv between contact terminals and from the terminals to the base. Jennings Radio Mfg. Corp., Dept. ED, P. O. Box 1278, San Jose, Calif.

CIRCLE 259 ON READER-SERVICE CARD FOR MORE INFORMATION

TV Tuners

For V-H-F, U-H-F, or Both



These v-h-f, u-h-f, and all - channel combination v-h-f/u-h-f TV tuners are adaptable to virtually all makes of black and white receivers, and are smaller than this firm's previous models. All tuners include a special radiation-suppression features meetings FCC limits.

The unit shown is a v-h-f switch-type tuner (Model 100) less than 4″ long, 3″ wide, and 3″ high. It will be available in pentode or cascade amplifier designs, for sets using either parallel or series string tubes. It comes with 12 detent positions for straight v-h-f operations, or 13 positions for use with u-h-f tuners.

A small dual pre-selector u-h-f tuner (Model 202) is available for combination v-h-f/u-h-f sets. General Instrument Corp., Dept. ED, 829 Newark Ave., Elizabeth 3, N. J.

CIRCLE 260 ON READER-SERVICE CARD FOR MORE INFORMATION

Correction. Tone oscillators manufactured by Pacific Div. of Bendix Aviation Corp. (*ED*, July 1955 p 76) are available for frequency ranges from 500 to 600cy —not 600cy as reported earlier.

Electrical Indicating Panel Meters and Pyrometers

Model 261 shown, Price $11.50

White-face, Black-face, or Colored Dials. Can be calibrated in any units: (Amps, KV, FPM, Angstrom Units)

Pyrometers are medium resistance (4 ohms per millivolt). Accuracy 2%. Automatic, bimetal cold junction correction. Compensated for copper error. (Ranges from −400 to +3000°F.)

Large dial area—clearly visible. Less waste panel space. Easily lighted transparent plastic front and case. Anti-static treated. Tubing pointer normally supplied. Knife-edge and other types available. D'Arsonval movement in Alnico permanent magnet. Snap-fit construction, virtually dust-tight case. AC meters are rectifier type. Model 451 is 4½"; Model 351 is 3½"; Model 261 is 2½". Meters with Zero Right, Zero Center or up to two-thirds of range suppressed can be supplied. AC and DC meters can be furnished in multiple ranges. Meter ranges: DC or AC 0/20 Microamps to 0/50 Amps. 0/5 Millivolts to 0/500 Volts. (Minimum AC Range 0/250 Millivolts). Panel meters and pyrometers with black Bakelite cases also available. Model 301 shown. Write for Bulletin G-9, Assembly Products, Inc., Chesterland 1 Ohio. Phone: (Cleveland, O.) HAmilton 3-4436.

Other products: meter-relays, VHS relays, Simplytrol Controls (temperature), and Versatrol Controls (for any variable which can be measured electrically.)

Booth A 150, Instrument Show, Sept. 12-16, Los Angeles

CIRCLE 263 ON READER-SERVICE CARD FOR MORE INFORMATION

Resistance Analyzer

With 0.1% Accuracy

This Resistance Analyzer, Model KED-15, is designed to check such characteristics as d-c resistance, temperature coefficient, and voltage coefficient of resistors according to JAN specifications. The voltage coefficient of any resistor up to a capacity of 2w can be determined down to as low as 0.0002%/volt. Voltage across the measured resistance is continuously variable in three ranges from 0-500v by a self-contained regulated power supply. Resistors can be readily measured with good sensitivity with voltages as low as 0.5v. The unit is designed for 1115v 60cy operation and measures 19-1/2" x 11" x 12".

The analyzer is capable of measuring the voltage coefficient of resistors over a range from 1000 ohms to 111 megohms to within 0.1%. Electronic Div., The Kuljian Corp., Dept. ED, 1200 N. Broad St., Philadelphia 21, Pa.

CIRCLE 265 ON READER-SERVICE CARD FOR MORE INFORMATION

If you need a special component, send a brief statement of your specifications addressed to Bulletin Board, Electronic Design, 19 East 62nd St., New York 21, N. Y. Include your complete address.

Selenium Rectifiers

In Aluminum Cans

These selenium rectifiers, manufactured by the Allgemeine Elektricitaets - Gesellschaft of Frankfurt/Main, are supplied in aluminum cans and are similar in appearance to electrolytic capacitors. This type has been extremely popular in Germany and is available in units with octal sockets for the replacement of thermionic diodes. Only a very small area of the chassis is required for mounting.

The rectifiers are especially designed to furnish anode voltage in radio sets. Outstanding features are: long life, low losses, high direct voltage independent of load, high efficiency, no heating current required, and compact shock-proof construction. Donald C. Seibert, Importer, Dept. ED, Box 281, Wilmington, Del.

CIRCLE 266 ON READER-SERVICE CARD FOR MORE INFORMATION

TO ELABORATE....

This brush assembly conducts signal and power current through slip rings between stationary and rotating equipment.

a *Superior* Willingness to ELABORATE

"Elaborate"? Yes, that's exactly what we mean. For, actually, "elaborate" means to *work* something *out.* Always, we at Superior are most willing to *work out* exactly what your application calls for... the right answer to perform a brand new operation most efficiently, to make your present equipment function more profitably, or to bring down the cost of manufacturing your product. *Please turn us loose on that next brush assembly problem.*

SUPERIOR CARBON PRODUCTS, INC.
9115 GEORGE AVENUE CLEVELAND 5, OHIO

SCP
SUPERIOR CARBON BRUSHES
"Since 1919"

CIRCLE 267 ON READER-SERVICE CARD FOR MORE INFORMATION

for

made-to-order precision at mass-production prices

Illustrated Actual Size

See GRC SMALL NYLON COIL BOBBINS

GRC Nylon Bobbins serve you better because they are made to your exact specifications. Yet they cost far less, thanks to Gries' mass-production methods. Bobbins are automatically produced, ready-for-use, in one swift, cost-saving operation. And Gries' unique single-cavity molding technique assures accuracy and uniformly—at prices that afford substantial savings. Send specification for Prompt Quotations on Production runs of 25,000 or more.

MAX. Weight .03 oz.
Length 1¼"
NO MINIMUM SIZE!

WRITE TODAY FOR FULL INFORMATION AND SAMPLES

GRC **GRIES REPRODUCER CORP.**

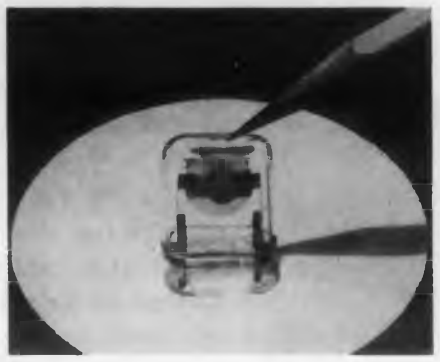
World's Foremost Producer of Small Die Castings

40 Second St., New Rochelle, N.Y. • Phone NEw Rochelle 3-8600

CIRCLE 264 ON READER-SERVICE CARD FOR MORE INFORMATION

Quartz Crystal

Sealed in Vacuum



This all-glass, military-type quartz crystal will overcome electronic equipment failures due to crystal aging. Its production in commercial quantities is made possible through the development of machinery which evacuates the glass envelope containing the quartz crystal and provides an air-tight glass seal between the envelope and glass base. The crystal is contained in a high vacuum where it maintains its activity and frequency stability under external operating conditions which cause frequent failure to crystals in metal type containers.

The crystal is interchangeable mechanically and electrically with the most commonly used types of military crystals. It has the same shape and dimension as the metal HC6/U holder which encloses types CR18/U, CR23/U, and CR27/U. Rogers Majestic Electronics, Ltd., Dept. ED, Leaside, Ontario.

CIRCLE 269 ON READER-SERVICE CARD FOR MORE INFORMATION

Galvanometer Element

Withstands Up to 25G Shock

A series of light-beam galvanometer elements of exceptional ruggedness and compactness is offered with sensitivities up to 0.0085μamp/mm at 1 meter. They are designed for field work as well as for laboratory and industrial services. They may be installed as integral parts of instrumentation in the fields of colorimetry and densitometry, or for measurement of electrical potentials, conductivity, light flux, or temperature (Wheatstone bridge or thermocouple).

When suitably housed with a light source and indicating scale, these movements comprise extremely sensitive instruments of minute currents and voltages.

Overall dimensions are only 3.36″ x 1.75″ x 1.32″. They feature short period and high-speed response. Coil resistances of 20, 100, 500, and 1000 ohms are offered. A 14-k gold suspension is used. Howell Instrument Co., Dept. ED, 1106 Norwood, Fort Worth 7, Tex.

CIRCLE 270 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW LOW FREQUENCY OSCILLATOR

0.35 to 52,000 cps.

Model 420-A

Krohn-Hite announces the new Low Frequency Oscillator Model 420-A which provides both sine and square wave voltages simultaneously at any frequency between 0.35 and 52,000 cps. Special circuitry is employed to minimize tuning and band switching transients. The unit features low distortion and hum at any setting of the calibrated output level control and excellent amplitude constancy over the entire frequency range. Other features include fast AVC action, vernier tuning control, and a single scale logarithmic dial. This exceptionally reliable oscillator is especially useful wherever an accurate source of low frequencies is needed. Price $290.00 f.o.b. factory.

For Further Details Write

KROHN-HITE INSTRUMENT CO.

Dept. ED, 580 Massachusetts Ave., Cambridge 39, Mass.

CIRCLE 271 ON READER-SERVICE CARD FOR MORE INFORMATION

1% Resistor

Takes Full Load at 120°C

The "Polyohm", a 1% resistor, offers performance exceeding all MIL-R-10509A specifications. Taking full power at ambient temperatures up to 120°C, it is valuable for use in aircraft, guided missiles, and other applications where high ambient temperatures rule out ordinary 1% resistors. At the same time, operation at normal temperatures results in a much longer life than can usually be expected from resistors with lower temperature ratings.

The unit is also well suited for appications where wire-wound resistors are too expensive or bulky or the effect of their inductive and capacitive reactance cannot be tolerated.

The resistor will remain well within its 1% tolerance even under conditions of high humidity. Its temperature coefficient is only —150ppm/°C. The resistive element is an evaporated metal film.

The resistor is made in 1/2w, 1w, and 2w sizes, with facilities controlled by the Signal Corps. They are presently available only for government end use. Polytechnic Research & Development Co., Inc., Dept. ED, 202 Tillary St., Brooklyn 1, N. Y.

CIRCLE 275 ON READER-SERVICE CARD FOR MORE INFORMATION

Absolute Pressure Indicator

With 0.1-20mm Hg Range

This Absolute Pressure Indicator, with a range from 0.1 to 20mm Hg, has an expanded scale in the 0.5-5mm range. A direct-reading instrument, it operates on 115v a-c and incorporates a heated thermopile principle. Noble-metal thermocouples are housed in nickel-plated gage tubes, affording freedom from outgassing, system contamination, and corrosion. The tube is extremely rugged, has quick response, and is not damaged by release to atmospheric or positive pressures.

Dimensions of the gage tube are 1-1/2" long x 3/8"OD, with a 1/8" IPS male thread coupling. Internal volume of the tube is less than 0.05 cu in.

Any standard strip-chart millivolt recording instrument capable of operating from 10mv or less is suitable for recording pressure data from this instrument. The unit is practical for remote installation and may be calibrated for any length cable from the indicator to the gage tubes. Hastings Instrument Co., Inc., Dept. ED, Hampton, Va.

CIRCLE 276 ON READER-SERVICE CARD FOR MORE INFORMATION

Tube Axial Blowers

Use 1"diam Motors

These lightweight miniature tube axial blower units are powered by a 1" diam motor. Designed for long life, they are for spot cooling of electronic equipment and for air changing in small, equipment-filled boxes.

These tube axial blowers have no brushes, and operate without arcing and without radio interference. At speeds of 11,000 and 20,000rpm, standard 400cy blowers produce 32 and 58cfm (at 0" of static pressure). Variable frequency 360 and 1600cy units produce a minimum of about 25cfm at 0" of static pressure. All blowers meet applicable MIL specs for aircraft use.

Typical blowers measure 2" diam x 3-3/8" overall length. Eastern Air Devices, Inc., Dept. ED, 391 Central Ave., Dover, N. H.

CIRCLE 279 ON READER-SERVICE CARD FOR MORE INFORMATION

Pulse Transformers

For Use in Printed Circuitry

This miniature pulse transformer, for use in printed circuitry, is carried in stock in pulse widths ranging from 0.1 to 16.0μsec, and in most popular 2, 3, and 4 winding turns ratios. Custom sizes can be built quickly to order. With low rise time and leakage inductances, the transformers are valuable for use in blocking oscillators; impedance matching; linear oscillators; as wide band input and output transformers; low voltage interstage coupling; triggering and counting circuits; d-c isolation; inversion pulse shaping; and pulse transmission circuits.

The transformers come with standard 7 and 9-pin pattern headers. Can sizes range from 13/32" height x 1/2"OD, to 5/8" height x 3/4"OD. All units are epoxy impregnated in hermetically sealed cans, and will withstand shock, temperature cycling, vibration, and humidity requirements of MIL-T-27, where applicable. PCA Electronics, Inc., Dept. ED, 2180 Colorado Ave., Santa Monica, Calif.

CIRCLE 280 ON READER-SERVICE CARD FOR MORE INFORMATION

specify standard

FLEXLOC SELF-LOCKING NUTS

FLEXLOC DESIGN FEATURES	one-piece, all-metal construction	lock and stop nut in one
	resilient locking segments	every thread carries its full share of load
	controlled locking torques	

DO YOU KNOW? Because they are of one-piece, all-metal construction, FLEXLOCS can be used in temperatures to 550° F. Nuts lacking this design feature have more restricted temperature ranges and applications. And FLEXLOCS are stocked in a full range of sizes from #4 to 2" by authorized industrial distributors. Write for Bulletin 866. STANDARD PRESSED STEEL CO., Jenkintown 12, Pa.

FLEXLOC LOCKNUT DIVISION **SPS** JENKINTOWN PENNSYLVANIA

CIRCLE 283 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW SWITCH CATALOG

ALL NEW

ALL NEW

24 PAGES

Saves time in selecting the right switch

GIVES COMPLETE ENGINEERING DATA

- Photo of each switch type
- Detail drawing of each type
- Base and terminal data
- Operating characteristics
- Electrical ratings

Catalog gives detailed data on all these snap-acting switches: high-sensitivity, sub-miniature, low-cost, general-purpose, metal-cased, open-type, immersion-proof, and AN/JAN types.

Write today for your free copy.

UNIMAX

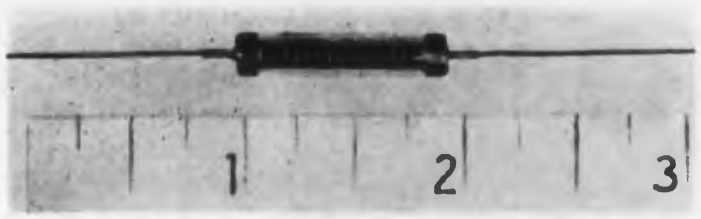
Division of the W. L. Maxson Corporation

460 WEST 34th STREET, NEW YORK 1, NEW YORK

CIRCLE 284 ON READER-SERVICE CARD FOR MORE INFORMATION

Resistor

With ±0.03%/Year Stability



The PT1000 is a glass-sealed carbon film resistor which combines ruggedness and small size with high stability. Under low-power use, at any ambient temperature up to 125°C, these resistors are virtually unchanging for very long periods of time. Stability is better than ±0.03% per year at 0.5w rating and derating to zero power at 140°C. With a 1w rating, derating to 160°C, stability is better than ±0.1% in 1000 hours. Three months storage at 500°C has shown the seals to be completely vacuum tight.

Resistance values range from 1 ohm to 30 megohms. The units are available in sets with temperature coefficients matched to 1ppm/°C for higher precision use over wide temperature ranges. Mounting may be done on leads. Size is 3/16" diam x 15/16" body. Overall size, including weldable end studs, is 1-3/16" with 1-1/2" tinned leads. Other types available are in 0.5 and 2w ratings. Pyrofilm Resistor Co., Dept. ED, 8 Whippany St., Morristown, N. J.

CIRCLE 285 ON READER-SERVICE CARD FOR MORE INFORMATION

Size 11 Resolver

A Winding-Compensated Unit

This Size 11 winding-compensated resolver has a frame diameter of only 1.062". The smaller diameter reduces weight and makes installations more compact. The resolver can be supplied with Mark 4 Mod 0 electrical characteristics, possesses temperature stabilization, and is equipped with a closed loop path.

Stator winding excitation is 400cy, 60v. Input impedance is 200 ±10% +*j*885 ±10%. Test voltage is 10v rms. When resonated, input impedance is 3.6k. Low corner frequency is 20cy. Peaking frequency is 150kc. Maximum perpendicularity of axes is ±5 minutes. Maximum total null voltage is 1mv/v. Maximum functional error is ±0.1%. Transformation ratio: rotor/stator 0.975 ±0.020, compensator/rotor 0.250 ±0.010. Time phase shift, rotor/stator 6.0° ±1.5°. Inequality of rotor T.R.'s is 0.1%. American Electronic Mfg., Inc., Dept. ED, 9503 W. Jefferson Blvd., Culver City, Calif.

CIRCLE 286 ON READER-SERVICE CARD FOR MORE INFORMATION

You save money

ON SMALL PRECISION PARTS

With almost 90 years of precision metalworking experience, Torrington has developed many automatic machines and techniques to produce small precision parts in quantities, large or small, at real savings to you.

This experience and equipment enables us to give you temper, hardness, finish and tolerances exactly to your specifications—*faster, better and for less* than you could produce them yourself. Why not send a sample part or blueprint for our quotation. Ask for our Condensed Catalog which shows the many types of parts we can make economically.

THE TORRINGTON COMPANY
Specialties Division
37 Field Street, Torrington, Conn.

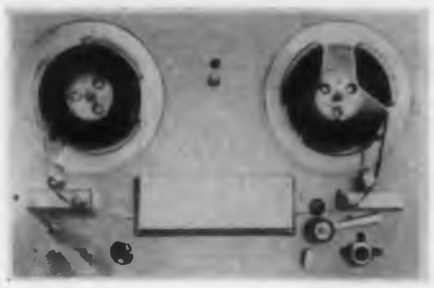
TORRINGTON *SPECIAL* METAL PARTS

Makers of Torrington Needle Bearings

CIRCLE 287 ON READER-SERVICE CARD FOR MORE INFORMATION

Tape Transport

Uses No Clutches, Brakes



This tape transport uses the "Isimetric Drive", a magnetic differential drive, to operate the tape-handling mechanism without frictional clutches or brakes. A single knob controls all reel motions. The drive is based on a multi-poled Alnico VI permanent magnet whirling freely between two drag cups and positioned axially by a sensitive feedback system. This arrangement automatically applies balanced relative torque to the reels for constant tape tension and continuously variable drive for editing and high-speed transport, as well as smooth, instant brake action.

The "Isimetric" drive maintains static and dynamic control of the magnetic fields to provide stable performance under all operating conditions. When either reel is empty or tension is released across the heads, motors are automatically turned off. The mechanism also slows down slightly at the end of each reel to avoid whipping the tape. International Scientific Instruments Corp., Dept. ED, 3101 E. 42nd St., Minneapolis 6, Minn.

CIRCLE 289 ON READER-SERVICE CARD FOR MORE INFORMATION

Machine Screws

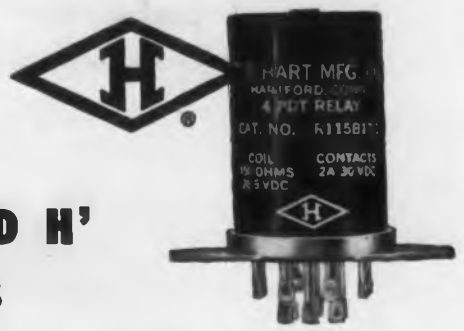
Self-Sealing and Shake-Proof

This line of machine screws is designed for use on hermetically-sealed cabinetry or under conditions of severe vibration and are known as "Seelscrews".

The construction employs an "O-rib" made of silicone rubber, neoprene, or plastic, depending on the end use of the screw. The rib is held in a circular groove under the screw head. When the screw is tightened, the material is compressed under the head to form a positive hermetic seal. Wherever a "locking" or "shakeproof" screw is required, a plastic is used in place of the rubber.

The screws are made of brass or steel, plain or nickel-plated, in three sizes: 6-32, 8-32, and 10-32. Other sizes and materials may be obtained on special order. Automatic & Precision Manufacturing Co., Dept. ED, 252 Hawthorne Ave., Yonkers, 5, N. Y.

CIRCLE 290 ON READER-SERVICE CARD FOR MORE INFORMATION



Versatile 'DIAMOND H' Relays

Handle Many Different Jobs

"Diamond H" Series R hermetically sealed aircraft type relays perform outstandingly over such a broad area that they are frequently used to do many different types of jobs in a given application. For example, they give excellent reliability in dry circuits yet will carry up to 10 amperes in power circuits . . . or even 20 amperes for reduced life requirements.

Savings inherent in uniform size and mounting arrangements for one relay family can be multiplied by the lower inventory of spare parts needed when a single model is used for two or more functions. Matching or surpassing requirements of USAF Spec. MIL-R-5757B as well as important provisions of MIL-R-25018, tens of thousands of Series R 4 PDT and DPDT relays are in use, engineered for:

Various brackets of vibration resistance from 10 to 2,000 cps, temperature ranges from —65° to +200° C, coil resistances from 1 to 50,000 ohms, operational shock resistance of 30, 40 or over 50 "G" and mechanical shock resistance to 1,000 "G", contact capacities from 350 V., D. C., 400 MA, to 10 A., at 30 V., D. C., as well as signal circuits.

For complete information, send for a copy of Bulletin R-250.

THE HART MANUFACTURING COMPANY
210 Bartholomew Avenue, Hartford, Conn.

CIRCLE 293 ON READER-SERVICE CARD FOR MORE INFORMATION

DATA SHEET

FAIRCHILD PRECISION POTENTIOMETERS

Type 747 — E
Linear
Potentiometer

Available with windings covering resistance range of 50 to 70,000 ohms; standard linearity tolerance of ± 0.15%. Clamp band provides unrestricted tapping area allowing up to 19 taps and simplifies phasing units in ganged assembly without disassembling units. Up to 6 units can be ganged on a single shaft. Cup width of .984 inches. Furnished with welded taps and end leads. Low starting torque only 1.0 oz-in per cup section. Low noise level and high resolution recommend units for computor assemblies, calibration controls, servo mechanisms, etc.

SAMPLES AVAILABLE ON ORDER

Fairchild's more complete line can help solve all your precision potentiometer problems. For more information write Fairchild Controls Corp., Potentiometer Division, 225 Park Avenue, Hicksville, L. I., N. Y., or 6111 E. Washington Blvd., Los Angeles, Cal., Dept. 140-68N.

CIRCLE 294 ON READER-SERVICE CARD FOR MORE INFORMATION

Shielding Material

Uses Ferrite Powders

This new approach to shielding employs ferrite and ferrous powders coated on base materials by means of binders. The product can be obtained in coated and uncoated sheets and fabricated forms. In their coated state, the materials can be spun, bent, stamped, or drawn before being coated. Its non-sensitivity to shock, its non-retentivity, and its durability, are outstanding features. Furthermore, the materials can support rough manhandling without suffering any deterioration in its shielding effectiveness. It has been useful in applications ranging from d-c to 300Mc.

Typical shielding applications are TV picture tubes, cathode-ray tubes, and photomultipliers. Transformer shielding made of this material cuts down hum effects. Shielded containers protect instruments from magnetic interference. Complete screen rooms can be built from the product. Magnetic Shield Div., Perfection Mica Co., 1322 N. Elston Ave., Chicago 22, Ill.

CIRCLE 295 ON READER-SERVICE CARD FOR MORE INFORMATION

Counter

Reads Events Per Unit Time

The Model 1005 Events-per-Unit-Time Meter is a five-digit unit which counts up to 100,000 in 1sec with an accuracy of ±1 count. The instrument is intended for industrial, military, and laboratory applications for measuring the rate of occurrence of mechanical or electrical phenomenon during a 1sec period. It is especially suited to frequency measurements as required in telephone carrier maintenance.

A crystal-controlled timing circuit, accurate to 0.001% at room temperature, gates the second counter for the 1sec interval. The count is directly displayed on the faces of direct-reading decade scaler tubes. When required, the instrument may be provided with an automatic reset circuit.

The instrument will operate at —20dbm level from 60cy to 100kc. Input impedance is 100,000 ohms. It is designed for rack mounting. Ransom Research, Dept. ED, P. O. Box 382, San Pedro, Calif.

CIRCLE 296 ON READER-SERVICE CARD FOR MORE INFORMATION

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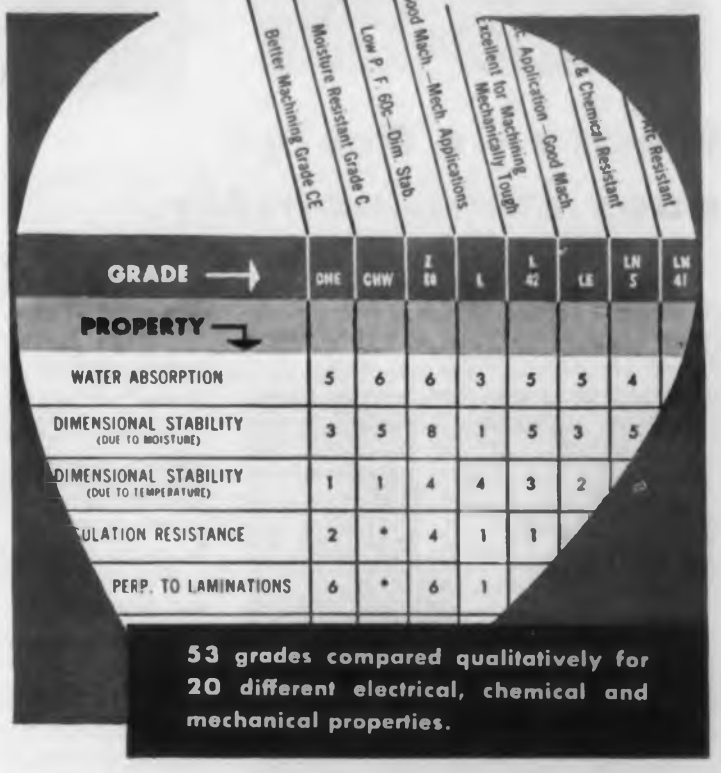
laminated plastic grade selection now made easy and dependable with the NEW

FORMICA® COMPARATOR



Here's how you can use the Comparator Chart:

1. To select the Formica® grade with the most outstanding properties to fit your requirements.
2. To determine secondary properties that might be desirable in any given grade.
3. To compare quickly the properties of any grade in the entire Formica line, without checking every data sheet.

Send for your
FREE FORMICA COMPARATOR
today

Start simplifying your job of laminated plastic selection and purchasing now.

The Formica Co., 4642 Spring Grove Ave., Cincinnati 32, Ohio

Gentlemen: Please send me at once a free copy of the new Formica Comparator (form 578).

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Formica, the most famous name in laminated plastics— engineered for industry, Beauty Bonded for the home

CIRCLE 297 ON READER-SERVICE CARD FOR MORE INFORMATION

Electronic Design goes semi-monthly

What are the reasons behind this publishing move? What is the significance to advertiser as well as reader? These are some of the questions that have been fired at both editor and publishers of *Electronic Design* since the decision to go semi-monthly was first announced in the June 17th issue of *Printers' Ink*.

"New product innovation", said Editor Edward E. Grazda, "is at its highest in the electronic industries. It is our policy to publish that type of material which is of *direct*, *immediate*, and *practical interest* to electronic design and development engineers. By coming out twice a month, the timeliness of our reporting will be more than doubled."

Although there will be additional editors and staff, the publication will remain the same—except there will be two issues instead of one each month. Each issue will offer top visibility for every advertiser.

No change in concept or philosophy contemplated

According to T. Richard Gascoigne and James S. Mulholland, Jr., co-publishers of three-year-old *Electronic Design*, the only modification in publishing philosophy will be to strengthen present editorial concepts. These will continue:

- To promote the progress of the electronic manufacturing industry by serving the key technical function—design.
- To make the electronic designers' task easier, more efficient and more productive.
- To provide a central source of electronic information pre-selected and concisely presented for convenient readership and use.
- To encourage two-way communication between electronic designer and manufacturer.

This is the publishing philosophy that has been responsible for *Electronic Design's* almost phenomenal rise . . . now *leader* in advertising page growth among *all* business publications.

Two issues will mean that the communication time between manufacturer and designer will be cut in half . . . new material can reach the design market faster and with greater frequency, and advertisers, already accustomed to the *immediate readership* offered by *Electronic Design*, will benefit from the increased visibility of a thinner book.

Here is the *basic* medium in a *basic* market which offers a *proven* record of immediate reader response. It is the only electronics publication in which you can accomplish both your short range and long range advertising objectives with equal effectiveness. *Electronic Design* is the only publication equipped to keep pace with the rapid expansion and constantly changing technology of the industry!

Study reveals immediate readership

- **When queried, the vast majority of *Electronic Design* subscribers say they read the magazine immediately on receipt—there is very little deferred readership**

POINT OF DECISION. Reader survey (above) indicates an "immediate decision to read" . . . another proof of *Electronic Design's* time value and service to the reader.

Advertising messages in *Electronic Design* receive immediate attention—according to surveys among readers. Two issues each month will continue to provide immediate readership because all material is of immediate usefulness!

85% of *Electronic Design's* inquiries are received within 15 days. Here is immediate readership—that will soon be available to advertisers twice each month . . . Hayden Publishing Co., Inc., 19 East 62nd St., New York 21, N.Y.

Capacitors

High Stability Polystryenes

Using polystyrene dielectric, the standard "ST" line consists of 200v, 400v, and 600v units in "bathtub" and rectangular metal cases with capacities ranging from 0.05mfd to 25mfd. They can be had in tolerances of ±5, ±2, ±1, ±0.5, and ±0.1%. Temperature operating range is −80° to +75°C with no voltage derating to 75°C. Temperature coefficient is −100 parts per million per °C.

The insulation resistance with a 2-minute charge at 25°C is 1 x 10^6 megohms per mfd, and at 75°C is 5 x 10^4 megohms per mfd. The power factor at 1000cy at 25°C is 0.01-0.05%. Dielectric absorption is 0.01% maximum. Retrace is 0.1% (approx). Q at 1000cy at 25°C is 10,000. A variety of special units in the same series is available with special features such as glass tubular housings, extra low temperature coefficient, lower retrace, lower power factor, higher insulation resistance, silicone impregnation.

CIRCLE 299 ON READER-SERVICE CARD FOR MORE INFORMATION

If you need a special component, send a brief statement of your specifications addressed to Bulletin Board, Electronic Design, 19 East 62nd St., New York 21, N. Y. Include your complete address.

R-F Wattmeter

With ±2% Accuracy

The 641N is a calorimetric type wattmeter that measures r-f power with the precision of a primary standard. It can be used to check the accuracy of other types of r-f wattmeters, and to determine the actual output of an r-f power source, the approximate magnitude of which is known. Frequency range is 0 to 3000Mc, and accuracy is better than ±2% of full scale. It measures power in the 0-300w range. To establish an accuracy of better than 1%, it is calibrated by the user at d-c or 60cy with a 1/4% wattmeter. VSWR is 1.1 to 1000Mc and 1.2 to 3000Mc. Time required for one reading is 2min. Recycling is 20min. The impedance is 52 ohms. M. C. Jones Electronics Co., Inc., Dept. ED, 185 N. Main St., Bristol, Conn.

CIRCLE 300 ON READER-SERVICE CARD FOR MORE INFORMATION

Circuit Selector

For Remote Control Uses

This Ledex circuit selector, the "Experimentor I", can be used for circuit selecting, programming, homing, sequence operation, or remote selection. It is designed for remote control operation through a five wire master-slave circuit. The solenoid-operated slave switch will "home" to any one of twelve positions selected by the manual switch. The wafer-type circuit switch is a single-pole, twelve-position switch with shorting (make before break) type contacts. This switch may be used in an indicator circuit or to switch various types of loads. Additional wafer switches may be added, depending on the requirements of the appliction.

This unit is designed for a 110v 60cy single-phase input. The rectifier is a half-wave rectifier and acts as a filter so that the rectified a-c pulses the selector switch to the selected position. G. H. Leland, Inc., Dept. ED, 123 Webster St., Dayton 2, Ohio.

CIRCLE 301 ON READER-SERVICE CARD FOR MORE INFORMATION

Potentiometers

Low-Torque 2" Units

A high-precision series of ball-bearing 2" potentiometers, the Series BC-200, features lower starting and running torque, improved linearity due to reduced radial shaft play, and minimized backlash between ganged sections for more accurate function repetition or solution of mathematical equations. Average starting torques do not exceed 0.5 oz-in per unit which is especially advantageous in multiple servo assemblies.

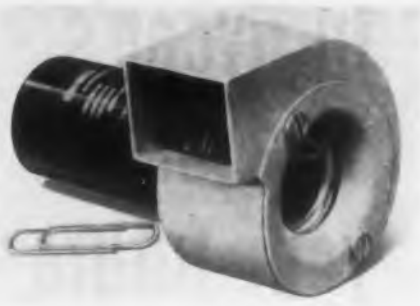
The extended terminal board design (illustrated) increases the area between tap terminals to provide space for mounting shunts and resistors directly to the potentiometer body itself without additional wiring or space.

A universal tap mounting ring permits up to 8 taps to be mounted on the same potentiometer unit. Completely enclosed ganged multiple assemblies also permit precise 360° external phasing and independent rotation of each section even after installation. DeJur-Amsco Corp., Dept. ED, 45-01 Northern Blvd., Long Island City 1, N. Y.

CIRCLE 302 ON READER-SERVICE CARD FOR MORE INFORMATION

Centrifugal Blower

For Airborne Equipment



This high-velocity, subminiature centrifugal blower for cooling airborne electronic equipment is only 2-7/8″ long and weighs less than 6 oz. It meets all applicable MIL specifications.

It is available in either rotation and in single or double-ended models. Air delivery of the single-ended blower is 12cfm at 0″ static pressure (20,000rpm) and 7cfm at 0″ static pressure (11,000rpm). Velocity of the 20,000rpm model is 3000fpm. Eastern Air Devices, Inc., Dept. ED, 391 Central Ave., Dover, N. H.

CIRCLE 306 ON READER-SERVICE CARD FOR MORE INFORMATION

Miniature Clutches

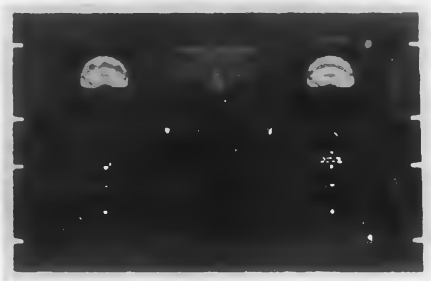
Torque of 10 in-lb

These precision miniature clutches feature a positive displacement drive that will transmit up to 10 in-lb of torque at speeds up to 1800rpm without external lubrication, and at higher speeds in an oil bath. The clutches are available in four basic types: single revolution, over-running, non-reversing, and indexing. Both sleeve mounts and through-shaft mounts are available in the four types. Length of the unit shown is 1-3/4″. Precision Specialties, Dept. ED, 1342 E. 58th St., Kansas City, Mo.

CIRCLE 307 ON READER-SERVICE CARD FOR MORE INFORMATION

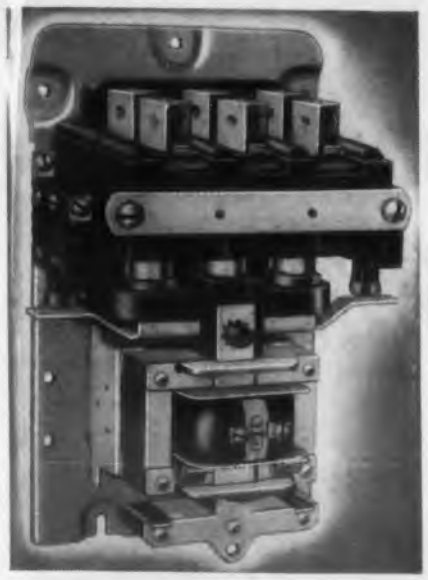
Power Supplies

Wide Series of 1.5amp Units



The "1500" line of 1.5amp regulated d-c heavy-duty power supplies is intended primarily for component use in original equipment. They are available in three ranges: wide (0-400v d-c), intermediate (125v band), and narrow (50v band, centered at 25v intervals from 25v to 375v d-c). In terms of d-c output voltage range, the series includes 28 basic models. Lambda Electronics Corp., Dept. ED, 103-02 Northern Blvd., Corona 68, N. Y.

CIRCLE 308 ON READER-SERVICE CARD FOR MORE INFORMATION



1000 contactors in 1

You're looking at the most versatile solenoid contactor ever developed for building electrical controls.

This Ward Leonard Size 2 contactor is available in *three* basic models, *six* major variations, *one thousand* combinations.

Your savings: reduced stock, minimum panel space, lower assembly costs, less layout and drafting time. Write for Bulletin 4450 to Ward Leonard Electric Co., 77 South St., Mount Vernon. N.Y. 4.15

WARD LEONARD ELECTRIC CO.

Result-Engineered Controls Since 1892

RESISTORS • RELAYS • MOTOR CONTROLS • CHROMASTER

CIRCLE 311 ON READER-SERVICE CARD FOR MORE INFORMATION

LOOK

in this book... over 7,000 STAINLESS STEEL FASTENINGS

RIGHT-OFF-THE-SHELF for immediate delivery

STAINLESS STEEL

- Bolts & Cap Screws
- Socket, Set & Cap
- Nuts, Washers
- Machine Screws
- Sheet Metal Screws
- Wood Screws
- Pipe Fittings
- Dowel, Taper, Cotter Pins
- AN Drilled Fillisters
- Stud Bolts

• Avoid costly production and experimental delays! • Brand new edition of Star Catalog now available.

Stainless Stan says "Star's screws have clean, bright-and-shiny heads"

Write, wire or phone for your copy today!

CORROSION RESISTANT

STAR STAINLESS SCREW CO.

663 Union Blvd., Paterson 2, N. J.
Telephone: Little Falls 4-2300
Direct New York Tel. Wisconsin 7-9041.

CIRCLE 312 ON READER-SERVICE CARD FOR MORE INFORMATION

Indicator

A Universal Unit

The HCM 3/4 Universal Annunciator is a 1.3 oz, 3/4" diam D'Arsonval type indicator utilizing the Marion Coaxial Mechanism. This glass-to-metal hermetically sealed unit is available in all typical panel instrument ranges, such as μamp, ma, mv, volts, etc. It meets vibration requirements of MIL-E-5272A, Procedure I. Marion Electrical Instrument Co., Dept. ED, Manchester, N. H.

CIRCLE 313 ON READER-SERVICE CARD FOR MORE INFORMATION

Microwave Oscillator

With Automatic Stabilization

Featuring an automatic stabilization indicator, this microwave oscillator, the Model 814, is a frequency generator in the X-band region which makes use of a discriminator and feedback loop to secure short term stabilization in the order of five parts per hundred million. It also features simplified tuning. The tuning range is 8500Mc to 10,000Mc. Laboratory for Electronics, Inc., Dept. ED, 75 Pitts St., Boston 14, Mass.

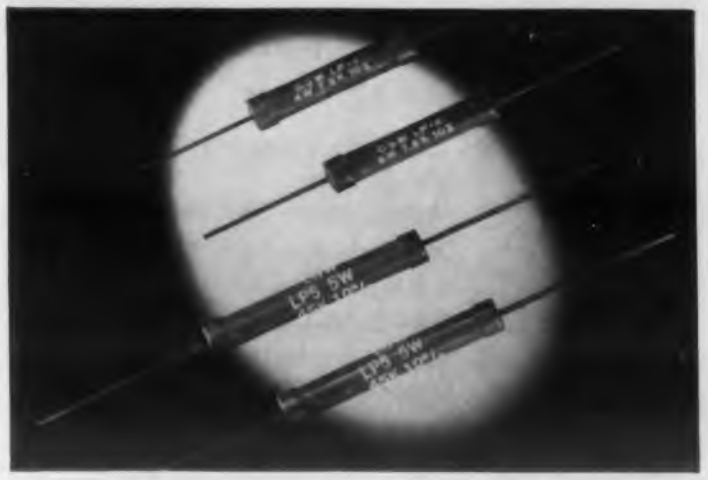
CIRCLE 314 ON READER-SERVICE CARD FOR MORE INFORMATION

Spectrophotometer

For Precise Measurements

The Model 1602-A Tristimulus Spectrophotometer is for precise color measurements from various light sources. Small, light, and portable, this unit has sensitivity insured by the use of three built-in high-gain amplifiers having gains of over a million times. Light is split by means of semi-transparent mirrors and special filters into three photomultiplier tubes producing taking characteristics which closely approximate the X, Y, Z distribution curves. Telechrome, Inc., Dept. ED, 632 Merrick Rd., Amityville, N. Y.

CIRCLE 315 ON READER-SERVICE CARD F[illegible]RE INFORMATION



Types LP4—4 W. and LP5—5 W. shown. Also LP7—7 W. and LP10—10 W

Corning Low-Power Resistors *for Radio and TV*

You'll find that Corning Low-Power Resistors perform admirably under the most adverse radio and TV operating conditions. Their resistance range is the highest of any low-power resistor.

Small and compact, they save space. They are non-inductive and exceptionally stable.

The fired-in film of metallic oxides on glass forms is tough, abrasion-resistant, difficult to scratch. No need for special handling to prevent damage during installation.

The automatic resistance spiralling of these LP-type resistors is electronically controlled. Press-fitted caps with axial tinned leads ready to solder complete the assembly. This guarantees reliable uniformity of the following characteristics.

CHARACTERISTICS

Range—The LP4 resistors are available from 200 to 40,000 Ω; LP5 from 200 to 45,000Ω; LP7 from 200 to 36,000Ω; LP10 from 200 to 50,000Ω, with a ±10% tolerance.

Power Rating is based on 40° C. ambient temperature for the LP4 and LP5 resistors and 25° C. ambient for the LP7 and LP10 with an average hot spot of 275° C.

Derating—With suitable derating, resistors can be operated at ambient temperatures over 120° C.

Overload—Operated at 10 times the rated wattage for 5 seconds, resistance change is less than 2%.

Soldering—Permanent change in resistance due to normal soldering technique is less than ½%.

Moisture—Resistance change is less than 1% after 100 hours at an ambient temperature of 40° C. and 95% relative humidity.

At Radio Frequencies—The LP resistors are essentially non-inductive.

Mechanical Protection—A high temperature lacquer coating provides added protection during handling.

Availability—Immediately through Corning Glass Works or authorized distributors of Erie Resistor Corp. For new low prices and other information send the coupon, or write to Corning Glass Works, Corning, N. Y.

Corning means research in Glass

CORNING GLASS WORKS
39-9 CRYSTAL STREET, CORNING, NEW YORK
New Products Division

Please send me descriptive catalog sheet on Corning Low-Power Resistors.

Name ..... Title .....
Company .....
Address .....
City ..... Zone ..... State .....

CIRCLE 534 ON READER-SERVICE CARD FOR MORE INFORMATION

Pulse Forming Network

Weighs 47 Grams

The hermetically sealed "Pulse Expanding Network" GPEN-3K-5 will generate, in a simple circuit, a 5μsec pulse with input pulse widths from 0.05 to 2μsec. Output amplitude may be made to follow input amplitude variations, or the output amplitude may be made to change in proportion to the input pulse duration. Slight additional circuitry makes it possible to obtain constant output amplitude with varying input pulse width. Gudeman Co. of California, Inc., Dept. ED, 2661 S. Myrtle Ave., Monrovia, Calif.

CIRCLE 133 ON READER'S SERVICE CARD FOR MORE DATA

Line Filter

Cuts Down Radiation

The C-728 Filter is designed as a component for high frequency units such as diathermy and ultrasonic oscillators. Its use enables units of this type to meet FCC radiation requirements of 15μv per meter at 100ft.

The filter meets requirements of 5ma current to ground, and is for 115-120v a-c operation. It is available for any current rating and in a wide variety of shapes and mounting arrangements. Potter Co., Dept. ED, 1950 Sheridan Rd., North Chicago, Ill.

CIRCLE 134 ON READER'S SERVICE CARD FOR MORE DATA

Dipped Mica Capacitor

Meets MIL-C-5 Specs

This miniature dipped mica capacitor with parallel leads, the "Dur-Mica" DM-20, meets all humidity, temperature, and electrical requirements of MIL-C-5. It is available in capacities up to 5100mmfd at 300v d-c(w) and up to 3900mmfd at 500v d-c(w) with operating temperatures up to 125°C.

Performance characteristics of the DM-20 in the lowest and highest capacities are better than the characteristic C limit throughout temperature ranges from —55° to 125°C. Electro-Motive Mfg. Co., Inc., Dept. ED, Willimantic, Conn.

CIRCLE 135 ON READER'S SERVICE CARD FOR MORE DATA

Vibration Indicator Meter

With High Sensitivity

The Vibration Indicator Meter Model 156, incorporates integrating amplifiers and reads amplitude in thousands of an inch. Small enough to allow four meters to be installed in a panel space of less than one foot square, each meter has a self-contained regulated power supply. Plug-in high pass frequency filters are available for any given application. Filters can be chosen to pass rotor-unbalance frequency and to eliminate lower frequency vibrations. Eastern Precision Resistor Corp., Dept. ED, 130-11 90 Ave., Richmond Hill 18, N. Y.

CIRCLE 137 ON READER'S SERVICE CARD FOR MORE DATA

Instrument Knobs

Lock on Shafts Without Damage

A line of collet-fitting instrument knobs produced by this firm permits positive locking on all standard shaft diameters with no damaging effect, even on soft metals. The knobs are available in three sizes: 1-3/4", 2-1/4" and 3". The collets are interchangeable among the different knob sizes and accommodate all shaft sizes from 1/8" through 3/8". Dale Products, Inc., Dept. ED, Columbus, Nebr.

CIRCLE 138 ON READER'S SERVICE CARD FOR MORE DATA

Mercury Plunger Relay

Withstands Rough Conditions

This mercury plunger relay has a protective fibre cylinder, combining the efficiency of glass with the ruggedness of metal. Heavy tungsten contacts are hermetically sealed within the tube, and mercury is used to make and break the coil circuit in inert gas. The relay takes 60millisec to close, 40millisec to open. It is available in a wide range of coil voltages, and its contacts handle motor loads up to 2hp. Size is 2-5/8" x 4-1/2" x 2-1/4". Mack Electric Devices, Inc., Dept. ED, 43 Glensick Ave., Wyncote, Pa.

CIRCLE 139 ON READER'S SERVICE CARD FOR MORE DATA

Solenoid Actuator

In Push or Pull Types

The electromagnetic Solenoid Actuator, Model L22A, features a linkage system available in either a push or pull arrangement, which magnifies the original air gap movement in an 8:1 ratio. The actuator itself is extremely compact, displacing 1.4 cu in and weighing 50gr. It operates on 1.8w input, within 7millisec at normal voltage. The linkage design permits even motion with minimum friction-induced loss of energy. The actuator remains cool in continuous operation.

The unit has a wide range of applications, including reciprocating motion, vibration generators, rotary step motion, model actuators, valve actuators, remote switches, release catch mechanisms, and operation of camera shutters. Coil specifications are 1260 ohms, 7400 turns, 48v d-c, 0.038amp, 1.8w; stroke 0.125"; pull 100 to 550gr. Other coils for 12 and 24v d-c, and special voltages up to 120v, are also offered. James Cunningham, Son & Co., Inc., Dept. ED, 13 Canal St., Rochester, N. Y.

CIRCLE 330 ON READER-SERVICE CARD FOR MORE INFORMATION

Thermistor Radiometer

Rapidly Measures Temperature

This wide-range thermistor radiometer is for direct measurement of surface temperatures and environmental radiant temperatures. It is available in the HL2 battery-powered d-c model for portable field use, and the HD2 a-c model for laboratory or clinical applications. Contact with the surface being measured is not necessary, and temperature readings are made at a distance by merely directing the radiometer at the desired object.

The use of sensitive, rapid-response thermistors permits quick scanning of surfaces to measure temperature differences as small as 0.1°C. Radiometer metering circuits provide full-scale readings of 10, 30, and 100°C, which can be calibrated for either relative or absolute temperature readings. Williamson Development Co., Dept. ED, 317 Main St., West Concord, Mass.

CIRCLE 331 ON READER-SERVICE CARD FOR MORE INFORMATION

the **ONLY** *instrument in the field that offers* **ALL** *these features at*

NO EXTRA COST!

- **FREQUENCY** Measurement
- **1 and 10 SECOND** Time Base
- **PERIOD** Measurement
- **1 and 10 CYCLE** Gate Time
- **PRECISION ACCURACY** Over 1-100,000 cps range
- **EASILY PORTABLE** Only 28 Pounds
- **SMALL SIZE** 14¼"W x 7½"H x 13½"D

NEW *Improved Sensitivity*

the new

DS-6100-T
FREQUENCY-PERIOD electronic counter

A compact frequency-period counter designed for direct measurement of any mechanical, electrical or optical phenomena which can be converted to a varying voltage. Read-out in direct digital form. Ideal for use by skilled or unskilled personnel. Price $700.00.

Write for complete catalog data TODAY!

Representatives in all major areas.

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Superior Quality, Automatic and Continuous Operation

What does it cost you to buy distilled water?*
Precision Midget Water Stills can save you money and provide the convenience of...

Fresh pyrogen-free distilled water WHEN and WHERE you want it.
At a half gallon per hour rate — trouble-free operation.

Easy to install and maintain.
No plumbing connections required, compact, portable, automatic operation, easily cleaned.

Thousands of applications under varying conditions have proved their utility and performance.

Smaller than a 5-gallon bottle
Tinned copper parts in vital areas
Gas-free water at all times
Low current consumption
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**The Midget costs only 7½c per gal. at 3c per kilowatt hour.*

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Precision Scientific Company

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CIRCLE 335 ON READER-SERVICE CARD FOR MORE INFORMATION

Digital Voltmeter
Reads Analog Outputs

The Model 450 Digital Voltmeter provides accurate and rapid digital readout for analog computers at low cost. Operating as a self-balancing digital potentiometer, its switching circuit utilizes oil-immersed stepping switches, life tested for 20 million readings. The measured voltages are displayed in a horizontal line of four luminous numerals 1" high, plus the decimal point and polarity sign.

Range is ±00.01v to ±99.99v d-c, accurate to ±10mv. Resolution is 00.01v. Rate of operation is one reading per sec. External reference of ±100v d-c is required. Input impedance is 1000 megohms. Printer control through a 50-pin connector is standard. No switching or adjusting is necessary during the process of making measurements.

Bench and rack mounting models are available. Weight is 25 lb. The power source is 115v 60cy. Non-Linear Systems, Inc., Dept. ED, Del Mar Airport, Del Mar, Calif.

CIRCLE 336 ON READER-SERVICE CARD FOR MORE INFORMATION

Midget Thermostats
Cover −50° to +500°F

The midget "Thermoswitches" in this new line measure 1/4"diam x less than 2-1/2"long and weigh approximately 1 oz. They are designed for precise temperature control or heat detection applications in heated equipment, bearings, pumps, etc., wherever installation space is at a premium.

Thermostats may be set to actuate at any specified temperature between −50 to +500°F. Contacts open when the temperature exceeds this set point; inverse action models are also available in which the contacts close above set point temperature. Units are available in a variety of head styles to meet various mounting requirements.

The thermostats are rated to handle an electrical load of 1amp, 115v a-c. Larger loads can be handled with a relay. Cartridge bodies and mounting accessories are of polished stainless steel; wiring leads are Teflon coated for long service life. Fenwal Inc., Dept. ED, 60 Pleasant St., Ashland, Mass.

CIRCLE 337 ON READER-SERVICE CARD FOR MORE INFORMATION

Standardized

CORD SETS

Ready for Your **APPLICATION**

Cords manufactures a complete line of U.L. approved cord sets for any application. Through their extensive standardization, Cords Ltd. can reduce both your engineering and inventory costs . . . and at the same time furnish quality cord sets at a competitive price. Sales offices in principal cities.

Write Cords today for free catalog outlining complete specifications of standard cord sets . . . or for Bulletin C442 on new 3 conductor U.L. approved cord sets.

CORD SETS

CORDS LIMITED
DIVISION ESSEX WIRE CORPORATION
121 DODGE STREET, DEKALB, ILLINOIS

CIRCLE 338 ON READER-SERVICE CARD FOR MORE INFORMATION

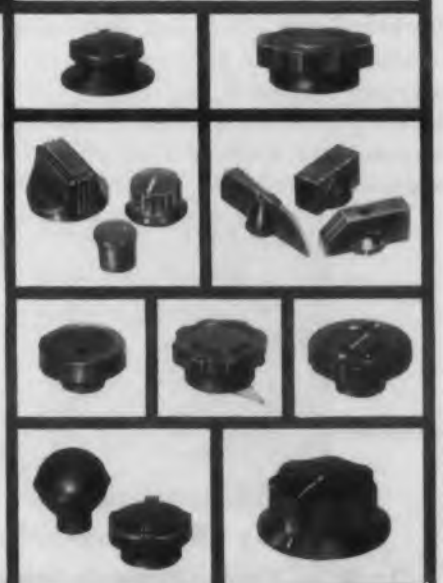
No Fooling with Tooling

Instrument and Control Knobs—PRICED RIGHT

High quality—low cost standard parts

Hard finish thermosetting plastic. Available fast—often from stock

Many more designs than shown—complete size range in most



Send for complete catalog

KURZ-KASCH, INC.

Standard Parts Division
1422 S. Broadway, Dayton 1, Ohio

CIRCLE 339 ON READER-SERVICE CARD FOR MORE INFORMATION

High mechanical properties are obtained in these springs, diaphragms, wire. They're made of heat-treatable constant modulus alloy, Ni-Span-C, supplied by H. A. Wilson Company.

Designing precision instruments?

Look into Ni-Span C constant modulus alloy

Ni-Span-C* iron-nickel alloy has a constant modulus of elasticity between —50°F. and 150°F.

Heat-treatment produces excellent hardness, excellent mechanical properties . . . and a thermoelastic coefficient of zero or any desired value near zero.

This Ni-Span-C alloy does away with auxiliary temperature compensation in precision instruments. It assures constant frequencies, spring rates . . . above average corrosion resistance. Use this alloy in tuning forks, precision springs, diaphragms, bourdon tubes —*wherever* temperature change affects accuracy.

*Registered Trademark

Get this FREE *fact-filled Booklet*

The H. A. Wilson Company's 20-page booklet, "Wilco Ni-Span-C" gives you complete information about composition, properties, fabrication, and uses. Charts and data summaries, too. Circle the number below on the reply card of this magazine for your free copy of this booklet, or write to them in Union, N. J.

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street — New York 5, N. Y.

INCO TRADE MARK

CIRCLE 340 ON READER-SERVICE CARD FOR MORE INFORMATION

Generator
With 100-1700cy Range

The Model 1460, while intended primarily to cover the 360-440cy range, has an external oscillator which extends this range from 100cy to 1700cy. It is intended for use as a bench testing source of power for 400cy devices which require observation of performance over ±10% of this frequency. It allows observation of the performance of individual pieces of equipment under test at any point within this range without disturbing test operations on the rest of the line.

Rated power output is 100va at 120v with a frequency stability of 1/4% and total harmonic distortion of less than 2%. Voltage regulation is 1% from no-load to full load. Output voltage is adjustable over the range of 100-130v. Operation is from a 117v line ±10%. Communication Measurements Laboratory, Inc., Dept. ED, 350 Leland Ave., Plainfield, N. J.

CIRCLE 341 ON READER-SERVICE CARD FOR MORE INFORMATION

Displacement Controller
For Differential Pick-Ups

This unit provides automatic alarm or closed-loop control involving pressure, weight, stress, motion, or any other quantity measurable by differential transformer transducers. Features include regulated excitation voltage for the transducer, electrical zero and sensitivity adjustments, a 4-1/2″ contact-making meter with adjustable limit contact, and a spdt output relay for operation of external alarm or control devices.

In operation, the relay is energized whenever the measured quantity equals or exceeds the preset limit and opens when the quantity falls below the limit. A pilot light indicates the relay position at all times. Relay contacts are rated at 5amp 250v a-c. Maximum full scale sensitivity is 0-0.020″ using a typical differential transformer, or 0-5 lb using Daytronic Series 140 Load Transducers. Daytronic Corp., Dept. ED, 216 S. Main St., Dayton 2, Ohio.

CIRCLE 342 ON READER-SERVICE CARD FOR MORE INFORMATION

FOR HIGH FREQUENCY—HIGH VOLTAGE
SPACE SAVING APPLICATIONS

GARDE Miniature & Sub-Miniature
INSULATED STAND-OFFS, FEED THROUGHS & SPACERS

For users to properly assess the outstanding features and advantages of Garde Components, samples will be sent on request. A detailed technical catalog is now available. Be sure your name is on our mailing list.

We have complete facilities to accommodate your special requirements, ranging from Engineering Consulting Service to Precision Design and Production.

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MOLDERS OF THERMOPLASTIC AND THERMOSETTING MATERIALS
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Sales Representatives in Principal Cities

CIRCLE 343 ON READER-SERVICE CARD FOR MORE INFORMATION

MICROWAVE 6334 DUAL TR TUBE DELIVERS LONG LIFE AT HIGH POWER

Now you can improve X-Band radar performance with a dual TR tube that features long life at high power levels . . . Microwave Associates' 6334 Dual TR Tube.

A new high has been scored in dependable tube performance with built-in Microwave features . . .

Heavy duty extra thick flanges hard soldered to the TR body insure mechanical rigidity and maintain electrical balance within slot hybrid duplexers.

Optimum balance for broadband response, maximum crystal protection and receiver isolation are insured by adjusting each tube in precision hybrids fed by a sweep oscillator. THE NEW LARGE X TO SMALL X TR TUBE TYPE MA-306 protects diodes at 300 KW and features long-life extra-duty performance. It is highly recommended for high power X-Band radar systems where weight and space considerations are paramount. The input and output flanges of the MA-306 mate with hybrid couplers in RG-51/U and RG-52/U waveguide respectively. No transformer is necessary.

The 6334 dual TR tube is normally supplied with thick flanges drilled with 4 holes. The older thin flange, 6 hole version is also available. For optimum TR-Tube performance, specify Microwave Associates.

ATR · TR · AND MAGNETRON TUBES
WAVEGUIDE COMPONENTS AND
TEST EQUIPMENT · SILICON DIODES

MICROWAVE

22 CUMMINGTON STREET
BOSTON 15, MASSACHUSETTS
COpley 7-7577

CIRCLE 344 ON READER-SERVICE CARD FOR MORE INFORMATION

MORE THAN 50,000,000 IMPULSES COUNTED WITHOUT A MISS

We've been testing a SODECO Electric Impulse Counter out of a recent production run to find out how long it would last. The count has now reached the fifty million mark without the slightest indication of trouble. This is pretty good proof of rugged long-lasting quality built into all SODECO Counters.

Apart from long dependable service, you get many other plus values when you specify SODECO for your counting problems. For instance:

- SPEED—up to 25 impulses /sec.
- COMPACTNESS — The model illustrated measures only 1⅜" x 2⅜" x 4⅜" and is suitable for flush mounting
- ELECTRIC RESET—Permitting simultaneous remote resetting of an entire bank.
- LOW POWER REQUIREMENT—These counters have been operated in electronic circuits.

A SODECO Counter may be the answer to your counting problem. Write for full information.

LANDIS & GYR, Inc.

45 WEST 45TH STREET, NEW YORK 36, N. Y.

CIRCLE 345 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 346 ON READER-SERVICE CARD FOR MORE INFORMATION

UHF Thermocouples

Ranging from 5ma Upward

A number of uhf type vacuo junctions (thermocouples) ranging from 5ma upwards have been added to this firm's line of standard types. Extremely small in size, they feature both minimum capacitance and inductance.

The thermocouples are electrically insulated from the heaters and tested to 100v d-c. Resistance tolerances for heater or thermocouple are ±10%. Nominal output is 7mv. Over-all temperature coefficient does not exceed 0.2%. Dimensions do not exceed 5/8" approx. Current ratings can be exceeded by a 50% overload for long periods of time without damage to thermocouple. Heaters will withstand transient overloads of 100%. Special ranges and outputs can be made to user requirements. Beam Instruments Corp., Dept. ED, 350 5th Ave., New York 1, N. Y.

CIRCLE 347 ON READER-SERVICE CARD FOR MORE INFORMATION

Electric Counter

Built to be Tamper-Proof

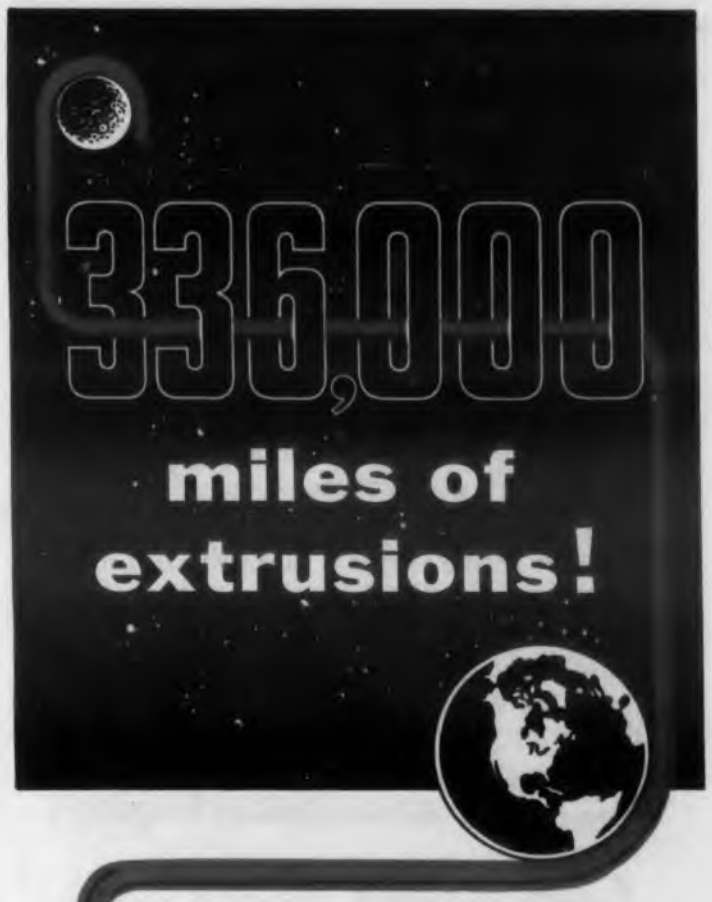
The tamper-proof, tumbler-lock reset electric counter, Model 6-Y-1-2-MF, has been added to this firm's line of electrically operated "Productimeters." Figures cannot be reset without a key.

The unit is designed for panel mounting, and comes equipped with mounting plate, the lock reset being at the right of the plate. The entire assembly can be placed into a panel directly from the front and securely fastened from the front. The counter is totally enclosed, affording protection against dust and moisture conditions.

Overall dimensions are 5-1/2" long x 2-1/16" deep x 2-1/8" high. Figures are 9/64" wide x 3/16" high, white on dark background. The number wheels are high in the window for maximum visibility.

Operating speed is up to 1000cpm. Standard voltage is 110v, 60cy. Voltage fluctuations on normal industrial circuits have no effect on accuracy. Durant Manufacturing Co., Dept. ED, 1993 N. Buffum St., Milwaukee 1, Wis.

CIRCLE 348 ON READER-SERVICE CARD FOR MORE INFORMATION



Our extruders have turned out enough plastic and rubber extrusions to reach to the moon and halfway back. In compiling this vast experience General Tire's Industrial Products Division has supplied thousands of original equipment manufacturers with just about every known type of extrusion. No job is too large, too small or too complicated for our design and production staff. Perhaps *you* can benefit from the fantastic extrusion mileage we've accumulated down through the years.

For literature or further information write to The General Tire & Rubber Company, Wabash, Indiana, Department I-2.

"From Plans to Products in Plastics and Rubber"

THE GENERAL TIRE
Industrial Products Division
WABASH INDIANA

CIRCLE 349 ON READER-SERVICE CARD FOR MORE INFORMATION

Where to get transformers for atomic submarines

Like General Dynamics' Stromberg-Carlson Division, you may at times need transformers that operate in a new circuit design under unusual and rugged conditions.

The shipboard announcing equipment Stromberg designed for the U.S.S. Nautilus, for example, must be 100% trouble-free because of the sub's ability to remain submerged indefinitely. It must also be able to withstand the terrific shock of depth bombs during battle.

Stromberg asked us to design and produce transformers that fit the system's advanced circuitry. The transformers we supplied them meet all the high standards of both Stromberg and the US Navy. They are now operating on the Nautilus and the second atomic sub, the U.S.S. Sea Wolf.

Just off the press! 16-page, illustrated brochure describing Caledonia's services and facilities for custom-designing and manufacturing transformers.

CALEDONIA
ELECTRONICS AND TRANSFORMER CORPORATION

Dept. ED-9, Caledonia, New York

CIRCLE 352 ON READER-SERVICE CARD FOR MORE INFORMATION

Capacitors and Filters

Miniature Special Types

This firm has established a Miniature Components Division to design and manufacture special capacitors and radio noise filters. It builds foil and metallized paper capacitors to order in extremely small sizes and light weights. Typical is the 0.75-mfd miniature phase-correction capacitor illustrated. Rated at 600v d-c w, it stands only 1-1/4" high, and operates successfully at 350°F. Glass-to-metal seals are provided, and the dielectric is epoxy resin.

In designing special radio noise filters, the division serves manufacturers who require miniature-sized units which carry heavier currents at higher temperatures than most units currently available. Electronic Specialty Co., Miniature Components Div., Dept. ED, 5121 San Fernando Rd., Los Angeles, Calif.

CIRCLE 354 ON READER-SERVICE CARD FOR MORE INFORMATION

PRINTED CIRCUITS

can simplify your design . . . speed output . . . cut costs

Eliminate wires! With Du Pont Conductive Coatings, you can print circuits for capacitors and couplings; for static shielding to replace foils and cans; for resistors and solder seals. Streamline your designs in television sets and radios, electronic equipment, meters and switchboards.

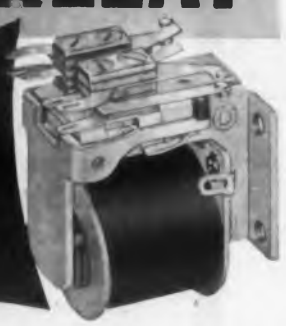
Coatings are easily applied by spray, brush, dip or stencil on metals or non-conductors. Fit right into high-speed assembly-line operation. Save you money. For up-to-date, descriptive bulletin write to: E. I. du Pont de Nemours & Co. (Inc.), Electrochemicals Department, Wilmington 98, Delaware.

DU PONT
CONDUCTIVE COATINGS
—Best for printed circuits!

DU PONT
BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

CIRCLE 356 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW AC RELAY



Cool-Running
Ideal for use where hermetic sealing and dust covers are required

TYPE "R"

Withstands Vibration Up to 10G at 5 to 55cps.

•

Shock Resistance 20G, energized 15G, non-energized

COILS: For all standard voltages up to 220 volts, AC. Average coil consumption, 2.5 VA.

CONTACTS: 6PDT up to 5 amps. at average 7.5 VA; 4PDT up to 5 amps. at average 2.5 VA; DPDT up to 10 amps. at average 7.5 VA; fine silver. Other contact materials available.

SIZE: 1½" x 1 11/16" x 2¼", depending on contact combinations.

Available hermetically sealed or with dust covers.

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RELAYS • SOLENOIDS • COILS • TRANSFORMERS • SWITCHES • HERMETIC SEALING

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260 pages of the newest developments in test instruments, tubes, capacitors, transformers and everything you need in Electronics, Radio, TV, Amateur and High Fidelity.

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CIRCLE 355 ON READER-SERVICE CARD FOR MORE INFORMATION

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another miniature instrument TO SAVE SPACE

IMPROVE PERFORMANCE AND CUT COSTS

MODEL 153
ACTUAL SIZE

1½ INCH *miniature meters*

Model 153-W has successfully met the requirements of specification *MIL-M-3823*. For commercial applications order Model 153-C.

• RANGES: D.C. AMPS, 0-100 UA to 0-15 AA — D.C. VOLTS. 0-50 MV to 0-500 VV — A.C. VOLTS, 0-1 VV to 0-500 VV
• SPECIAL SCALES, RANGES AND OTHER CHARACTERISTICS TO MEET YOUR REQUIREMENTS

write FOR ENGINEERING DATA SHEETS ON: 1½" Ruggedized Meters; 1" and 1½" Panel Meters; 1½" VU, DB and Illuminated Meters; Miniature Multitesters and Side Indicators.

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P.O. BOX 2954, NEW HAVEN 15, CONN.

CIRCLE 357 ON READER-SERVICE CARD FOR MORE INFORMATION

BOURNS NEW CARBON TRIMPOT®

Providing: INFINITE RESOLUTION

Resistances 20,000 to 1 Megohm • Power Rating 0.2 Watt

Bourns new carbon *TRIMPOT* is identical in sizes and configuration to the popular wirewound *TRIMPOT* which is approved as a standard component by engineers in aircraft, missile and electronic industries. Outstanding features are:

Compact size.....1/4" x 5/16" x 1-1/4"
Adjustment.....25-turn, self-locking
Mounting..Single or stacked with #2-25 screws
Vibration.....10-20 G; 10-2,000 cps
Acceleration (steady state).....100 G
Optional features..Teflon leads, extended shaft

Bourns manufactures other precision potentiometers to measure Linear Motion, Gage, Absolute and Differential Pressure and Acceleration

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6135 MAGNOLIA AVE. • RIVERSIDE, CALIFORNIA

Technical Bulletin on Request, Dept. 172 ©B.L.

CIRCLE 358 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnetic Cartridge

Has 8-Poles

The "B&O Lo-Z" Magnetic Cartridge, made in Denmark, has a very small mass and negligible inertia, freedom from resonance over the whole audible range, high compliance, and low record wear. Frequency response is flat from 20 to 16,000cy ±2db, then gradually rising to over 20,000cy. Eight pole shoes surround the coil. A twisted armature turns around a vertical axis. The cartridge itself snaps into spring loaded mounting hardware made to American standards. Four models are available: single and dual stylii, with sapphire or diamond micro tip for microgroove or standard records. Fenton Co., Dept. ED, 15 Moore St., New York 4, N. Y.

CIRCLE 360 ON READER-SERVICE CARD FOR MORE INFORMATION

SQUARE AND SINE WAVES

20 Cycles to 500 kc

Type 1210-B . . . $140.00

New GR Unit R-C Oscillator

★ **Three outputs**
Low Voltage: 0 to 7 v, 50 Ω; constant to ± 1 db to 200 kc
High Voltage: 0 to 45 v, 12.5 KΩ; constant to ± 1 db from 200 c to 20 kc
Square Waves: 0 to 30 v, peak-to-peak; 2500Ω impedance —less than 0.25μs rise time and 1% overshoot — hum at least 60 db down

★ **Precision Slow-Motion Dial** can be motor driven (Type 908-P Drive: $27.50) for automatic display

★ **AVC System** provides fast response for constant output with fluctuating line

★ **Several Types of Unit Power Supplies Available**

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CIRCLE 362 ON READER-SERVICE CARD FOR MORE INFORMATION

Partners . . . . YOU AND YOUR

NO. 50 POCKET PAL

$1.00 AT YOUR LOCAL DEALER

CATALOGUE NO. 49 AVAILABLE UPON REQUEST

.030 MATTE FINISH MATHEMATICAL QUALITY DOUBLE-CURED PLASTIC. ALL HOLES SMOOTH-MILLED TO ENGRAVING MACHINE ACCURACY.

ONE OF MORE THAN 30 RAPIDESIGN TIME-SAVER TEMPLATES — ALL OF WHICH ARE BETTER MADE, MORE USEFUL AND LESSER PRICED.

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P. O. BOX 592 GLENDALE, CALIF.

CIRCLE 359 ON READER-SERVICE CARD FOR MORE INFORMATION

(Advertisement)

New Trio of Shielded Coil Forms

Ideal for IF Strips, RF Coils, Oscillator Coils, etc.

Shown ¾ size

Now there are three CTC shielded coil forms available to you! New LS-10 and 11 have just joined CTC's LS-9 coil form to give you three size ranges from which to choose.

All three rugged coil forms are shock-resistant with mechanically enclosed, protected coils. Windings may be universal or layer wound to fit your application. Forms may be ordered disassembled, ready for winding, or CTC will wind to specification.

Electrical and mechanical shielding is complete, since the assemblies are comprised of brass shells enclosing powdered iron cup-cores, tuning slugs, phenolic coil forms and silicone fiberglas terminal boards. Three terminal board layouts are available: either two, three or four terminals with type X2089 silver plated solder terminals. For complete specifications and data on prices, write direct. Cambridge Thermionic Corporation, 457 Concord Ave., Cambridge 38, Mass.

CIRCLE 361 ON READER-SERVICE CARD FOR MORE INFORMATION

New Beryllium Copper ROLLPIN

Now . . . extend the proved advantages of Rollpin to a wide variety of applications where resistance to corrosion, good electrical properties and nonsparking or nonmagnetic characteristics are required.

Use it as you use carbon steel Rollpins—to replace taper pins, straight pins and set screws; to serve as a rivet, dowel, hinge pin or stop pin—to cut production costs by eliminating special machining, tapping, and the need for hole reaming or precision tolerances. Driven into a hole drilled to normal production standards, Rollpin locks securely in place, yet can be readily drifted out and reused whenever necessary. Beryllium Copper Rollpins are available from .062"-diameter to .250".

For all the information you need, write Elastic Stop Nut Corporation of America, 2330 Vauxhall Road, Union, New Jersey, Dept. R-36-957.

ROLLPIN TRADEMARK

ESNA

ELASTIC STOP NUT
CORPORATION OF AMERICA

CIRCLE 363 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW

NYLON INSULATED SOLDERLESS TIP PLUGS

1. Tough, durable molded nylon sleeve—won't chip or crack.

2. New, simplified solderless connection—up to 16 gauge wire held securely with positive electrical contact.

3. No exposed metal surfaces—pin assembly is recessed, providing positive insulation.

Completely insulated, this rugged tip plug is the pertect "mate" to the Johnson nylon tip jack. Sleeve is molded of tough, durable nylon and will not chip or crack even when subjected to rapid or extreme temperature changes. Recessed construction prevents the exposure of metal surfaces when plug is engaged with any standard tip jack. These new Johnson nylon tip plugs are available in 11 bright colors to match the Johnson nylon tip jack series. Standard .081" diameter pin projects, 9/16"; sleeve length, 7/8"; sleeve diameter, 3/8".

ALSO NEW!

NYLON INSULATED BANANA PLUGS

New nylon insulated banana plugs are also available. Made of high grade, nickel plated brass with nickel-silver springs and a rugged nylon insulating sleeve. Designed for solderless connection—accommodates up to 16 gauge stranded wire.

NYLON TIP JACK AND INSULATING SLEEVE

Complete assembly includes standard nylon tip jack with threaded nylon insulating sleeve. This assembly may be used for patch cords or sleeve may be used instead of a nut to mount tip jack on panels, providing insulation for the rear connection.

For complete information on these or other Johnson quality components write for your free copy of Components Catalog 976.

E. F. JOHNSON COMPANY

3423 Second Avenue Southwest • Waseca, Minnesota

CIRCLE 364 ON READER-SERVICE CARD FOR MORE INFORMATION

D-C Power Supply

Regulated, Low Noise

The Model R-10 power supply combines low noise level with "super voltage" regulation at low cost. Under most conditions of operation, the noise is less than 150μv. Low internal impedance (0.05 ohms over most of band for most operating conditions) eliminates the need for usual de-coupling circuits. Ripple and noise are so low that no additional filtering is needed when supplying most low level preamplifier stages.

D-c output is continuously variable from 200v to 325v at 100ma maximum load current; positive or negative ground. Regulation is better than 0.01% for line voltage variation of 105v to 125v. Voltage is constant to better than 0.07% from zero to full load. Laboratory of Electronic Engineering, Inc., Dept. ED, 413 L St., N. W., Washington, D.C.

CIRCLE 365 ON READER-SERVICE CARD FOR MORE INFORMATION

Signal Generator

For 7-70Mc Range

The Model 131 Signal Generator, is for testing i-f amplifiers and other circuits operating in the 7-70Mc range. Capable of CW, pulse, or standard operation, with a built-in 5000Mc crystal frequency standard, a completely electronic linear frequency sweep, and a continuously tunable frequency marker, the signal generator weighs 99 lb and is housed with an 11" x 16-3/8" x 18-1/4" cabinet.

Other features include: frequency deviation up to ±30%; choice of two types of markers (spike or blanking); zero amplitude reference for sweep output; calibrated 0.5v rms output to 50 ohm impedance; a 0 to 101db step attenuator; choice of continuous-wave, pulse, or sweep operation; continuously tunable frequency marker; linear frequency sweep; built-in VTVM output calibration; fully shielded cabinet; r-f pulse characteristics identical to external pulse generator and independent use of the attenuator. Avion Instrument Corp., Dept. ED, 299 State Highway No. 17, Paramus, N. J.

CIRCLE 366 ON READER-SERVICE CARD FOR MORE INFORMATION

Diode Clip

Solderless and Widely Applicable

This solderless diode clip is designed to hold 90% of all standard diodes. Made with a beryllium-copper base, it is plated in 0.00002" gold, 0.0002" silver, or electro-tin and three styles are available: push-in, stake-in, and eyelet rivet. Size is 13/64" wide x 1" high (overall). Thickness is 0.0253" beryllium-copper. Diode mounting height is 1/2" above panel.

Designed to meet AN specifications, these clips may be used in printed circuits and other electronic components for missiles, computers, etc. The snap-in area places ferrules firmly in seating point, and prevents distortion of the clip. The diode ferrule held in place by this clip will remain tight after repeated uses. Metal Products Engineering, Inc., Dept. ED, 4000 Long Beach Ave., Los Angeles 58, Calif.

CIRCLE 369 ON READER-SERVICE CARD FOR MORE INFORMATION

If you need a special component, send a brief statement of your specifications addressed to Bulletin Board, Electronic Design, 19 East 62nd St., New York 21, N. Y. Include your complete address.

Pulse Instruments

Measure Time to ±1/500μsec

The B4-100 Marker Generator (shown) and the B4-200 Oscillator, when used with this firm's B-2A Pulse Generator and the required power supply, provide accurate scope markers and pulse delays by means of which time intervals can be measured to ±1/500μsec. The marker generator provides 0.1 and 1μsec marker signals of either positive or negative polarity. Marker accuracy is 0.01%. These signals are designed for use as intensity markers on a scope. The oscillator consists of a free-running blocking oscillator which is phase locked to the 1μsec marker pulses. The repetition rate can be varied from 1 to 10kc. These units, in conjunction with a pulse generator and a synchroscope, provide a system to measure delay line lengths to ±2 millimicroseconds. Rutherford Electronics Co., Dept. ED, 3707 S. Robertson Blvd., Culver City, Calif.

CIRCLE 370 ON READER-SERVICE CARD FOR MORE INFORMATION

Model 2301 Servoscope with Cathode Ray Indicator

Engineers Call This the Ideal Test Instrument

Here's why.

Servoscope® is a multiple signal generator that provides a *direct* method for measuring gain and phase shifts of any component or system in the subsonic frequency ranges.

With just a few flicks of the phase dial, you get the values for plotting magnitude and phase curves. The dial actually shifts the Servoscope output signal an amount equal and opposite to the phase shift in the system under test. The phase lead or lag is then obtained by reading the big phase dial directly!

Servoscope replaces expensive and inefficient home rigs to save you time and costly errors in design and development and production testing. It is a well-designed, compact instrument that requires virtually no maintenance at all.

You'll find Servoscope now serving industry in the laboratory and on the production line in such diverse assignments as:

- automatic flight control design
- airborne weapons development
- autopilot and damper testing
- simulating rate gyro
- radar systems testing
- antenna servo analysis
- testing servo amplifiers
- solving frequency problems of servosystems
- phase angle measurement of servosystems
- testing computer response
- driving oscillating test table
- checking vibration
- checking frequency response of tachometer feedback loop
- providing unmodulated frequency signal
- testing frequency response of electro-hydraulic servosystem
- network response testing
- training

For further information, or to arrange for a demonstration of Servoscope in your laboratory or production line, clip coupon below and mail it today.

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ED-9

CIRCLE 371 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Cylinder

Uses Controlled Explosives

These cylinders use a controlled explosives force to lift, and momentarily hold, various weights through a varied range of distances. The cylinders, with one type of cartridge, can lift and momentarily hold a 100 lb weight through a distance of 2-½″ in an elapsed lifting time of 82millisec. Using another cartridge, a cylinder can lift and momentarily hold a 45 lb weight through a distance of 1/2″ in 42millisec. Ordnance Material Div., Atlas Powder Co., Dept. ED, Wilmington 99, Del.

CIRCLE 375 ON READER-SERVICE CARD FOR MORE INFORMATION

Speed Reducers

For Anti-Backlash Applications

The Series 107 Miniature Speed Reducers, with servo-mount ends, are available for anti-backlash applications in controls, computers, oscillographs, etc. They come in 448 different ratios from 1:1 to 531,441:1 Anti-backlash results from two parallel gear trains that are spring loaded against each other; thus backlash is contnuously taken up whether running or not. Metron Instrument Co., Dept. ED, 432 Lincoln St., Denver 3, Colo.

CIRCLE 376 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnetic Clutch

With Concentric Shafts

The torque characteristics and high-speed engagement and disengagement times of the Model T507-1 miniature magnetic clutch make it valuable for application in guided missiles, computers and miniature servo systems. It has the same case size as a MK 14 Mod O servo motor. Single-ended concentric input and output shafts are located at the mounting end of the unit, permitting all gearing to be located at this end. Sterling Precision Instrument Corp., Instrument Div., Dept. ED, 34-17 Lawrence St., Flushing 54, N. Y.

CIRCLE 377 ON READER-SERVICE CARD FOR MORE INFORMATION

Pulse Generator

An All-Magnetic Unit

The MP-85 is an all-magnetic pulse generator for commerical radar and use as laboratory testing equipment. It uses saturable reactors instead of thyratrons as discharge devices. The unit is basically a capacitor-type pulser in which electrical energy storage is achieved by means of a-c resonant charging. High pulse powers are obtained by rapid discharge of the condenser through saturable reactors. These reactors are in appearance and construction similar to transformers and act as static magnetic switches.

Typical specifications include: peak pulse power, 80-100kw; peak pulse voltage, 13.5-14.5kv, pulse width, fixed, 2μsec; repetition rate, fixed, 400pps; input, 230-300w 115v 400cy, 2.2-3amp; power factor, 0.85 to 1.0; peak output power (X-band), 45kw. Magnetic Research Corp., Dept. ED, 200-202 Center St., El Segundo, Calif.

CIRCLE 380 ON READER-SERVICE CARD FOR MORE INFORMATION

D-C Relay

Features Complete Wiping Action

Combining high sensitivity with thorough wiping action on each contact, the Relay 100-B is available hermetically sealed or with dust cover. This unit has a wattage consumption of only 25mw, together with a genuine wiping action. Bounce and chatter are consequently eliminated by the built-in wiping action in the contact movement.

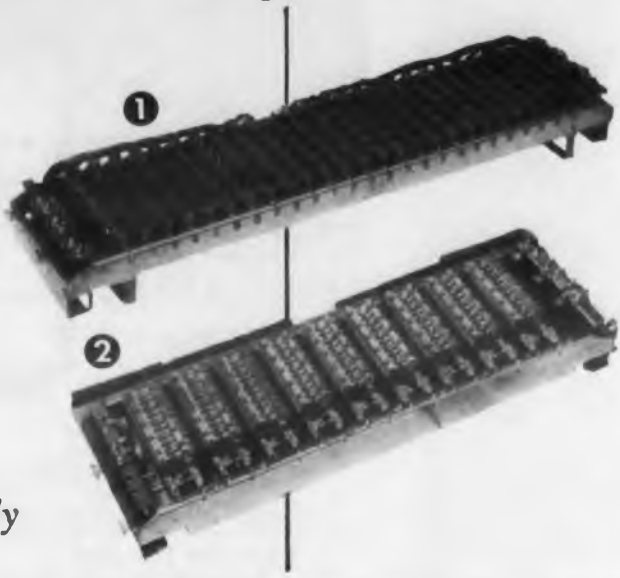
Designed for d-c applications, the relay has the advantage of an extremely long operating life. If desired, drop-out can be adjusted to about 65% of the pick-up. Capacity is to 1amp inductive and 3amp resistive load with coil resistance to a maximum of 30,000 ohms. The effect of residual magnetism and iron aging are eliminated by non-ferrous metals and hydrogen annealing of the magnetic components. The unit is available in spst up to dpdt contacts. Size is 1-1/4" diam x 3-5/8" above mounting line. Hedin Tele Technical Corp., Dept. ED, 640 W. Mt. Pleasant Ave., Livingston, N. J.

CIRCLE 381 ON READER-SERVICE CARD FOR MORE INFORMATION

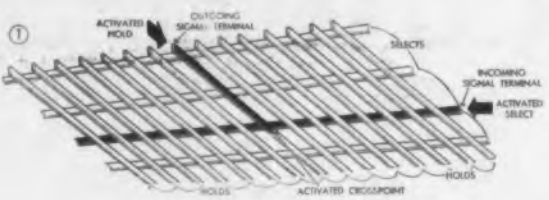
"Up a Tree" with a Relay Tree?...

KELLOGG CROSSBAR

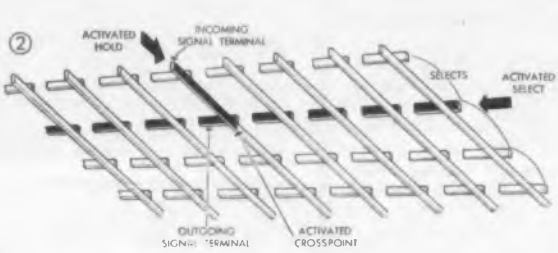
solves complex switching problems quickly, easily and inexpensively



The Kellogg *Crossbar Switch* illustrated below establishes the different types of electrical connections possible. Any cross point can be activated in less than 50 milliseconds by energizing one select magnet and one hold magnet. Standard contact material used in the Kellogg *Crossbar Switch* is palladium (gold can also be provided). Mounting brackets are available which provide drawer-like removal for easy inspection. Circuits can be maintained while the Kellogg *Crossbar Switch* is in the process of switching other circuits.



1 Drawing No. 1 illustrates the basic Crossbar principle which permits any of several incoming circuits to be connected to any of several output circuits. This type of switch can connect any of 60 circuits, 3 at a time, to any of 75.



2 Drawing No. 2 shows a means of switching one incoming circuit to many possible outgoing circuits—accomplished by removing every other vertical. Thus, instead of having one cable terminal at one end of the switch, each remaining vertical has its own cable connection. This type of switch can easily be adapted to switch one circuit to any of 936.

Write for Technical Bulletin Today! Dept. 68-J

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KELLOGG SWITCHBOARD AND SUPPLY COMPANY

A Division of International Telephone and Telegraph Corporation

CIRCLE 384 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature . . .

Rotary Machines 385

Bulletin No. 75-B catalogs this company's line of hand and power operated rotary machines, rolls, and accessories. An illustrated selection chart, showing various job operations, is included to simplify selection of machines and rolls. Niagara Machine and Tool Works, 683 Northland Ave., Buffalo 11, N. Y.

Adhesive Bonding 386

"Adhesive Bonding" is the title of an 8-page illustrated manual. The booklet features illustrations of such typical adhesive applications as aircraft aluminum honeycomb construction, fin tubing heat exchanger assemblies; new advances in printed circuitry. Rubber & Asbestos Corp., Dept. P, 225 Belleville Ave., Bloomfield, N. J.

Speed Sensitive Switches 387

This 8-page bulletin gives full information on this firm's line of speed sensitive switches and overspeed governors. The bulletin includes dimensional drawings of the overspeed, underspeed, one, two, and three switch governors with explanations of the various types of take-off and connectors. Synchro-Start Products, Inc., 8151 N. Ridgeway Ave., Skokie, Ill.

Carbide Blanks 388

Information concerning standard carbide blanks for mechanically held tools is included in an 8-page catalog. The publication (No. GT-292) covers carbide blanks for clamp-on style tools, solid carbide on-end inserts, round and square inserts, and triangular and square throw-away insert blanks. Carboloy Dept., General Electric Co., Detroit, Mich.

Radar Transformers 389

Oil-filled transformers and inductors for radar and other electronic applications are described in Bulletin No. GEA-5963. The bulletin cites the radar transformer model shop, where prototype units can be designed and built quickly. Design features of the regular production models are described. General Electric Co., 1 River Rd., Schenectady 5, N. Y.

Digital Converter 390

This 4-page bulletin has applications, specifications, characteristics, and an installation drawing of this company's ADC-1 digital converter. The ADC-1 has an unambiguous output of 13 binary digits and operates at high speed in clockwise or counterclockwise operation. Norden-Ketay Corp., 555 Broadway, New York 12, N. Y.

Silicone Rubber 391

A 4-page, 2-color bulletin on silicone rubber details properties and performance as affected by extreme temperatures, weathering, compression, chemicals, and dielectric service. It is illustrated with charts, tables, graphs, and actual application photographs. Dow Corning Corp., Midland, Mich.

Program Controls 392

Bulletin No. 1130, "Program Control of Process Variables", describes the methods and advantages of employing automatic, time-conditions control for many industrial processes and tests. A selection chart aids in choosing the right instruments for any program control application. Industrial Div., Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Pa.

Magnified-Scale Voltmeters 394

Indicating and recording magnified-scale voltmeters are described in a new technical data sheet. Advantages and features of these instruments are discussed and a schematic diagram is included. Specifications and applications are given. Allgemeine Elektricitaets-Gesellschaft, U. S. representative, Donald C. Seibert, Box 281. Wilmington, Del.

Lighting Equipment 395

Battery-powered emergency lighting equipment is described in an 8-page catalog. The catalog contains diagrams, charts, and specifications. Exide Industrial Div., Electric Storage Battery Co., Box 8109, Philadelphia 1, Pa.

Reproducers 396

This 4-page catalog describes new microgroove heads made to plug in on tone arms, automatically providing correct record pressure for long-playing records. Radio Music Corp., 84 S. Water St., Port Chester, N. Y.

High Speed Typer 397

A high speed electronic typer which will type up to 15 lines per second is illustrated and described in a 4-page brochure. Applications, specifications, and dimensional drawings are given. Shepard Laboratories, 480 Morris Ave., Summit, N. J.

D-C Power Supply 398

A new bulletin describes a magnetic amplifier tubeless regulated d-c power supply. Advantages of the use of tubeless power supply units are outlined. Theory of operation, typical features, and components are described and illustrated. Complete characteristics are included. Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.

Electric Counters 399

A 4-page bulletin describes heavy duty electric counters designed for 200 million count life; tested at 1000cpm. The counters are made for 25, 40-50, 60cy and d-c service. Production Instrument Co., 706-34 W. Jackson Blvd., Chicago 6, Ill.

Cramped quarters don't cramp the style of ADVANCE midgets and miniatures. You can use them on loads up to 5 amperes continuously... and at three times their rating intermittently—with complete safety. They'll resist shock and vibration... stand up under temperature extremes. You'll find them readily adaptable to any mounting need... any type of duty. Some examples:

"Tiny Mite"
MM & MP SERIES
This ultra-small dc relay occupies less than ½ cu. in. mounting space! It's stable under vibration and shock ...plated to prevent corrosion. Operate time is 5 milli-seconds. Contact rating: .5 amp. or 1 amp.

Miniature Telephone Type
TQ SERIES
Only .94 cu. inches in size, yet this relay carries 5-amp. loads in any combination up to 4 PDT. Mechanically secured throughout, it's extremely efficient. Non-gassing insulation. Withstands 10G vibration. Temp. range: −55° to +125°C.

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Endless uses for this midget ADVANCE relay. It's engineered for high efficiency and low price. Operates in any position, with positive contact. Light vibration and shock resistance. Two-amp. or 5-amp. contacts.

Hermetic enclosures on these types are impervious to varying climatic conditions...are sealed and carefully checked against leakage.

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2435-M NORTH NAOMI STREET, BURBANK, CALIFORNIA

Sales Representatives in Principal Cities of U.S. and Canada

CIRCLE 401 ON READER-SERVICE CARD FOR MORE INFORMATION

Shaped Tubing 406

Shaped tubing is illustrated and described in Data Memorandum No. 17. The memorandum gives complete information on analyses available, tool charges. size range, commercial tolerances, lengths, and temper. Cross sections include squares, rectangles, hexagons, flat ovals, ellipticals, and partial rounds. Such shaped tubing is used for aircraft structural parts, radar screens and electrical equipment. Superior Tube Co., 1521 Germantown Ave., Norristown, Pa.

Arc-Cast Molybdenum 407

A compilation of all available technical and fabricating data on arc-cast molybdenum is presented in a 72-page booklet. Among the high temperature applications of molybdenum of special interest to electronic engineers are vacuum tube grids and high temperature thremocouples. Climax Molybdenum Co., 500 Fifth Ave., New York 36, N. Y.

Tables and Data 409

This 112-page book, "Selected Scientific and Engineering Tables and Data", contains selected chemical and physical, engineering plastics, bacteriological, leather, psychometric, and textile tables and charts. The book provides standard formulas, charts, and definitions in brief and concise form. United States Testing Co., Inc., 1415 Park Ave., Hoboken, N. J.

Radiation Measuring Equpiment 416

A 48-page catalog describes a complete line of radiation measuring equipment for medical, industrial, and research applications. Included are photographs and descriptions of individual instruments as well as suggested groupings of units for specific applications. Scalers, count rate meters, portable instruments, Geiger, proportional, and scintillation counters are described. Nuclear Instrument and Chemical Corp., 229 W. Erie St., Chicago 10, Ill.

Power Supplies 417

A 2-page catalog sheet describes this firm's line of low cost, general purpose d-c power supplies. In addition to listing the electrical ratings and their corresponding model numbers for the 22 models, the bulletin includes information on the minimum general specifications to which all units conform. Opad Electric Co., 69 Murray St., New York 7, N. Y.

Materials Handling Equipment 418

Lightweight vulcanized fibre materials handling containers that can be used for transport of radio and electronic components are described and illustrated in Catalog No. 54. These tote boxes, trays, and other receptacles can be supplied with removable compartments sized to fit all types of electrical parts and assemblies. National Vulcanized Fibre Co., 1055 Beech St., Wilmington 99, Del.

Delay Lines 426

The passive, jitter-free, continuously variable Helidel delay line is the subject of this technical paper. Entitled, "A Precise, Wide-band, Continuously Variable Delay Line," the paper includes performance curves, graphs, and delay line configurations. Helipot Corp., 916 Meridian Ave., S. Pasadena, Calif.

Automatic Processing Protection 427

A 12-page brochure describes the technical aspects of the "Shur-flo" automatic interlock for processing plants. The interlock is a device to protect equipment when fluid flow is below the desired minimum or above a desired maximum. The brochure contains fluid flow charts wiring diagrams, and application information. Industrial Sales Div., Dept. No. 413, Hays Manufacturing Co., 818 W. 12th St., Erie, Pa.

Electrical Control System 428

A new electrical control system for predetermined repeat or non-repeat cycle on any machine with a mechanical tripping mechanism is described in Bulletin No. 55-1. A typical installation is illustrated and mounting dimensions are shown. Security Controls, Inc., 255 Franklin St., Buffalo 2, N. Y.

Dispersions 436

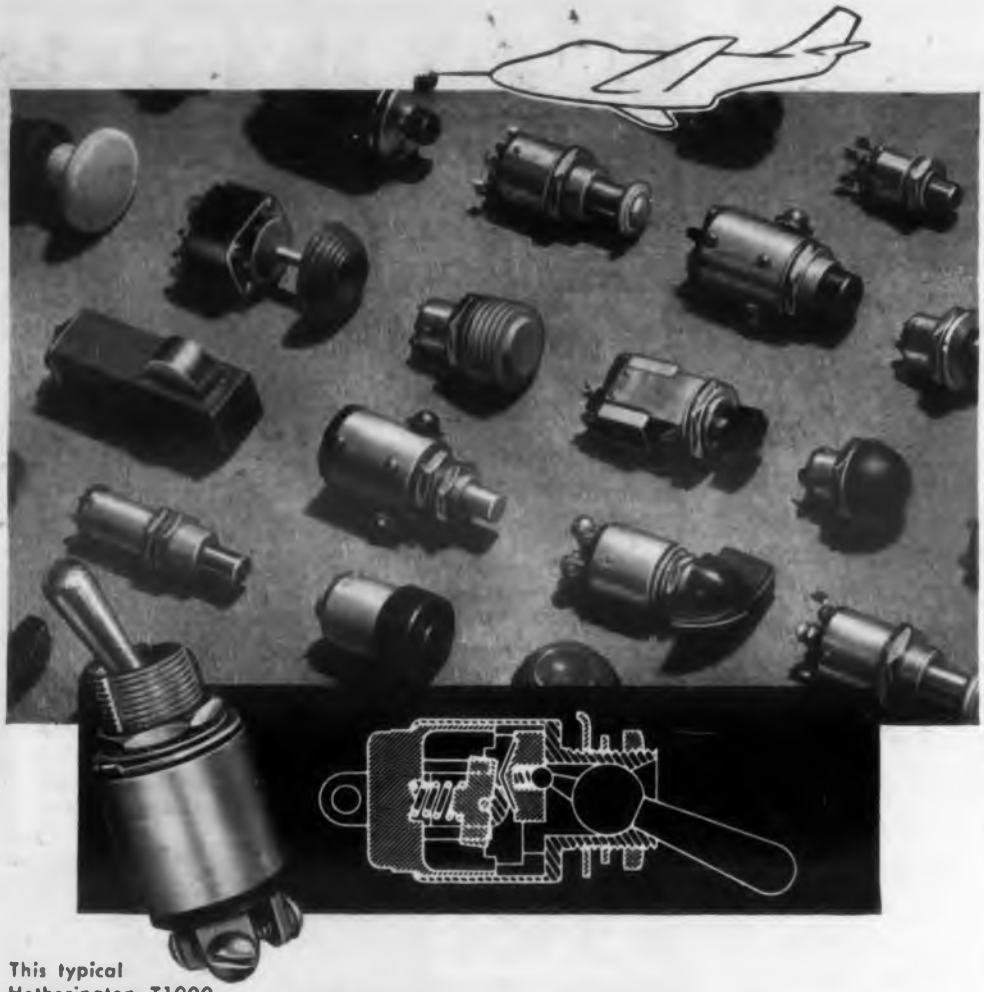
A revised 4-page booklet lists 44 colloidal and semi-colloidal dispersions for electronics, electrical manufacturing, and related industries. These products include dispersions of graphite, molybdenum disulfide, mica, vermiculite, zinc oxide, and acetylene black. Carriers and diluents are given for each product, along with typical applications and physical data. Acheson Colloids Co., Div. of Acheson Industries, Inc., 1950 Washington Ave., Port Huron, Mich.

Molding Compound 437

Molding characteristics and physical properties of Plaskon Nylon 8200 are presented in a new booklet. The booklet, containing tabular data and charts, discusses the ease of moldability of this material, its relatively low molten viscosity, and its controllable crystalline structure. It is suitable for electrical insulation applications. Barret-Div., Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y.

Development Facilities 438

"Specialized Development" is the title of a brochure which illustrates the scope of development problems solved by this company in the field of electrical and mechanical controls and components. Curtis Development & Mfg. Co., 3266 N. 33rd St., Milwaukee 16, Wis.



This typical Hetherington T1000 Switch designed for MIL-S-6745 uses reduces size by 25%.

Built to meet your TOUGHEST PERFORMANCE STANDARDS

...with weight and space savings in the bargain...

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Fire detection indicators
Trim tab control
Seat positioning
Auto pilot release
Tank jettison
Microphone circuits
Audible signal silencers
Equipment testing
Fire detection test
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Whether for MIL or for the toughest commercial uses, Hetherington Switches and Switch-Pilot Light combinations are designed to do the job—with safety margin to spare. Unique, patented design provides positive switching (to exceed military life cycle requirements) in less space with less weight. Dozens of special aviation types in the 15-50 ampere range plus adaptations for exacting commercial jobs.

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West Coast Division: 8568 W. Washington Blvd., Culver City, Calif.
CIRCLE 444 ON READER-SERVICE CARD FOR MORE INFORMATION

Wire Stripping 445

The use of high-frequency induction heat generators in conjunction with many wire stripping operations is discussed in this 4-page bulletin. Types of wires and strippings are described and combinations of strippers and heat generators in actual use are illustrated. Rush Wire Stripper Div., The Eraser Co., Inc., 1068 S. Clinton St., Syracuse 4, N. Y.

Flexible Electrical Insulations 446

A revised catalog describes this firm's line of flexible electrical insulation materials. The catalog is divided into three categories: coated products, varnishes, and plastic products. Included are charts and conversion tables. Irvington Varnish & Insulator, Div. of Minnesota Mining & Manufacturing Co., Irvington, N. J.

Magnetic Cores 447

Magnetic properties of Ferramic "H" cores are given in a series of graphs in this bulletin. A table of comparisons with other Ferramic bodies is also included. General Ceramics Corp., Keasbey, N. J.

Panel Instruments 448

Catalog No. A38B illustrates and describes ruggedized and sealed panel instruments, a-c, d-c, r-f, and thermo, in both commercial and military types. Information is included on design and construction and on test procedures. Weston Electrical Instrument Corp., Newark 5, N. J.

Socket Screws 449

A data file contains complete information on seven types of socket screws plus hex-socket keys. Data is provided on dimension standards, standard sizes, physical properties, recommended tightening torque, applications and uses. Mac-it Screw Div., Strong, Carlisle & Hammond Co., 1392 W. 3rd St., Cleveland 13, Ohio.

Industrial Fibers 450

Industrial fibers for thermal insulation, filtering agents, fillers, and reinforcing are described and illustrated in Bulletin No. F-39A1. Physical and chemical properties are charted and potential applications outlined. Pacific Lumber Co., 100 Bush St., San Francisco 4, Calif.

Panel Instruments 454

A new series of ruggedized panel instruments designed for size and weight reduction in electronic equipment subject to shock, vibration, or temperature extremes is described in a 2-page, 2-color bulletin. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Forming Sheet Metal 455

A bulletin describes in detail methods of fabricating boxes, brackets, and chassis from sheet metal. The bulletin should be of particular interest to designers and experimenters. Television Accessories Co., Dept. L, 1412 Great Northern Bldg., Chicago 4, Ill.

Epoxy Resin Selection Chart 456

A new epoxy resin selection chart will enable manufacturers to choose an epoxy resin for impregnating, insulating, or potting requirements. The chart is divided into room temperature, moderate temperature, and high temperature setting systems. Furane Plastics, Inc., 4516 Brazil St., Los Angeles 39, Calif.

Control Instruments 457

This condensed catalog describes this firm's line of signal generators VSWR indicators, incidental FM meters, and digital pressure gages and accessories. Information given includes instrument model number, frequency range, characteristics, and uses. Byron Jackson Co., Electronic Div., 492 E. Union St., Pasadena, Calif.

Hand Riveter 458

Bulletin No. 86P illustrates and describes each of the five models in this firm's series of spinner-riveter hand guns. Applications and specifications are given. Lemert Engineering Co., Inc., 204 E. Jefferson St., Plymouth, Ind.

Production Facilities 459

These companies' facilities for the production of precious and non-precious laminated metals and fabricated precision parts are described and illustrated in a 2-color, 8-page brochure. Forms of laminated sheets, alloys, wires, and tubing are discussed and examples of various precision parts are shown. Leach & Garner Co., and General Findings and Supply Co., Attleboro, Mass.

R·B·M General Purpose Relays··

have solved many specific relay problems with no development or tooling cost to the customer. RBM has produced hundreds of thousands of magnetic relays from standard parts—designed and initially produced over seven years ago—to fulfill the need for dependable relays at low cost.

The many variations of contact form and ratings, as well as terminal arrangements and mounting brackets, may well provide just the right relay for you. WRITE FOR BULLETIN 570—or better yet, tell us your requirements. Bulletin 570 shows only a few of the many variations.

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Whether a single relay or a relay panel complete with wire assemblies and cord sets, RBM may help you lower your costs.

R-B-M DIVISION
ESSEX WIRE CORPORATION
Logansport, Indiana

Controls for Electronic, Refrigeration, Industrial, Appliance, Communication and Automotive Industries

RBM

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NEWEST PRINCIPLE

No wonder the new Silic-O-Netic Time Delay Relay has aroused such interest. It offers basic advantages as a delay device unequalled in its low price range.

The Silic-O-Netic Relay provides delay with no mechanical linkages . . . no mechanism to speak of. . . only one moving part, and that part is hermetically sealed, forever free of dirt and dust. It operates on a positive change in magnetic flux which is sharply defined as the movable core touches the pole piece. Moreover, the new Type A model has high speed contacts, affords good contact pressure.

in TIME DELAY RELAYS

Heinemann Silic-O-Netic Relays are already being used in dozens of volume applications where absolute dependability is essential. They are well worth your investigation.

Write for Bulletin T-5002

IT'S DIFFERENT...

No thermal elements . . . no aging, no fatigue . . . long-life stability.

Small size . . . Overall dimensions: $2\frac{1}{16}''$ x $1\frac{3}{16}''$ x $2''$.

Delay periods . . . $\frac{1}{4}$ to 120 seconds.

Low cost . . . achieved in 20 years of solenoid manufacturing experience.

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ELECTRIC COMPANY
156 Plum St., Trenton 2, N. J.

CIRCLE 464 ON READER-SERVICE CARD FOR MORE INFORMATION

Drafting Equipment 465

A new 32-page illustrated catalog features a line of drafting equipment. It provides a buying guide for drafting machines, drawing boards, T-squares, parallel rules, triangles, templates, curves, and lettering aids. Frederick Post Co., 3650 N. Avondale Ave., Chicago 18, Ill.

Recording 466

A new company paper describes recording techniques and applications. Visual recording, monitoring recording, curve plotting, facsimile recording, etc., are discussed and applications illustrated. Alfax Paper and Engineering Co., Alden Research Center, Westboro, Mass.

Viscosity Measurement 467

This folder describes a viscosity measurement instrument for continuous process quality control. The instrument may be used as a sensing element in an automatically controlled process. Brookfield Engineering Laboratories, Inc., 240 Cushing St., Stoughton, Mass.

Microwave Equipment 468

A series of catalog sheets describes this firm's line of ferrite microwave equipment. Curves and characteristics, dimensional drawings, and specifications for unidirectional transmission lines and microwave amplitude modulators are given. Features and applications are discussed and illustrated. Cascade Research Corp., 53 Victory Lane, Los Gatos, Calif.

Hermetic Seals 469

Hermetic seals for withstanding high-temperatures and severe thermal shock are illustrated and described in this booklet. Illustrations, dimensional drawings and ratings are given. Advanced Vacuum Products, Inc., 18 Liberty St., Stamford, Conn.

Resistance Welding 470

A new bulletin describes "Three Phase", a new power-saving principle of resistance welding operation. The advantages, operating principles, and applications are discussed and illustrated. Sciaky Bros., Inc., 4915 W. 67th St., Chicago, Ill.

Standard Broadcasts 474

Bulletin No. G-2 discusses the uses of standard time and frequency broadcasts. Diagrams show the transmission cycle of stations WWV and WWVH, calibration of i-f signal source, methods of audio comparison, and method of extrapolating WWV standards. Specific Products, 14515 Dickens St., Sherman Oaks, Calif.

Selenium Rectifier Units 475

Catalog No. 127, "A Guide to Better Plating Power", describes selenium rectifier units and the use of selenium rectifiers to provide d-c power for electroplating, electropolishing, electrocleaning, and other electrochemical needs. Bart Messing Corp., 229 Main St., Belleville 9, N. J.

Portable Gear Tester 476

A portable precision gear tester for rapid production check of helical, spur, and worm gears is described in a 4-page bulletin. Charts of test runs are shown and the various models are illustrated. Arch Instrument Co., Inc., 101 Holmes St., North Quincy, Mass.

Electrical Connectors 477

A new bulletin on AN electrical connectors describes the fields of application for this type of electrical connector, and provides general information on performance requirements, size and capacity, basic parts, and the numbering system used. Deutsch Co., 7000 Avalon Blvd., Los Angeles, Calif.

Miniature Relay 478

A catalog sheet gives technical data, specifications, and dimensional drawings of a double-pole double-throw miniature sensitive hermetically sealed relay. The relay is built to comply with MIL-R-5757-B specifications. Magadyne Co., 84 S. Water St., Port Chester, N. Y.

Seals 479

A new catalog, "Designed for Sealing", illustrates and describes this firm's line of fluid fitting, orifice, closure, fastener, and electro-fluid seals and "O" rings. Dimensions, specifications, features, and applications are given. Franklin C. Wolfe Co., Inc., 3644 Eastham Dr., Culver City, Calif.

CIRCLE 481 ON READER-SERVICE CARD FOR MORE INFORMATION

new concept of dependability and convenience

the magnificent Dynacord®

new professional ***Tape Recorder*** *by Pentron*

WHY DYNACORD IS THE NEW STANDARD OF PROFESSIONAL RECORDING

Finest for custom installation, exacting industrial use

Push-buttons actuate computing interlock which cycles Dynacord through "stop" into any operating position automatically. Direct capstan drive . . . 3 motors . . . exclusive dynamic braking, fast, fool-proof . . . reversible reel seats . . . frequency response: ±2 DB 30-15,000 CPS at 15 in./sec. . . . signal to noise ratio: better than 55 DB. For standard rack mounting or installation in console. Specifications on request.

Model DTM Tape Transport Mechanism, $395.00 net
Model DP-100 Broadcast Amplifier, $150.00 net
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Thousands have heard Dynacord's fabulous performance as a 6-channel stereophonic recorder in the All-Electronic Orchestra.

Now Dynacord Recorders are available for many critical industrial applications upon special order (from 1 to 6 channels on ¼" tape).

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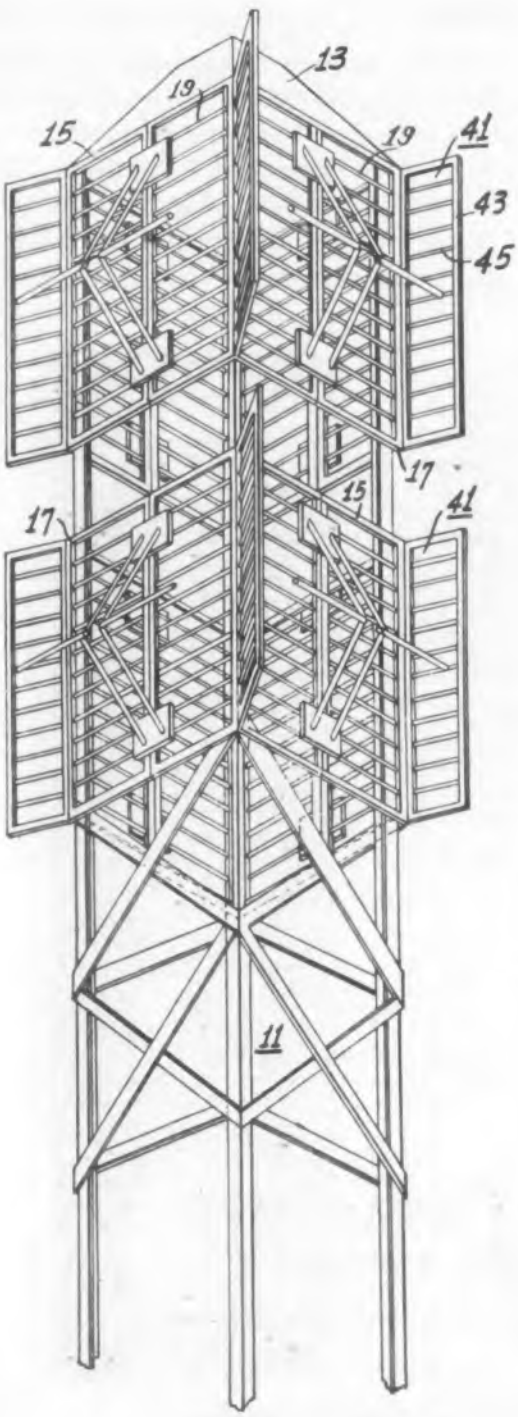
Patents

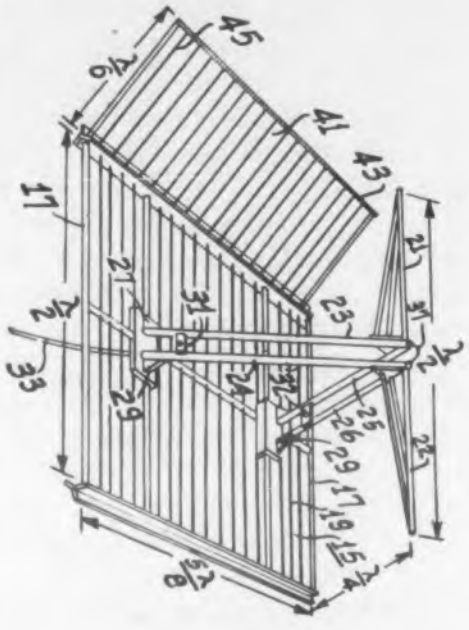
John Montstream



High Gain VHF Antenna System . . . *Patent No. 2,691,102. R. W. Masters. (Assigned to Radio Corp. of America, New York, N. Y.)*

The tower structure for v-h-f antennas described in this patent avoids interaction between the radiator elements. The illustrated antenna tower includes the usual type of framework. Reflectors of conductive material are mounted on the periphery of the tower, which may be a permanent part of the tower structure. It is more desirable, however, if the reflectors are screens having rectangular framework (*17*) with horizontal bars (*19*) welded to the frame. The screens are provided on all sides of the tower even though an antenna is not to be mounted on each side. These screens should be 1/2 wavelength wide and about 5/8 wevelength high. It is important that the width be accurate with respect to the wavelength. In addition to the screens (*15*), wings (*41*) are provided extending at an angle with respect to screens *15* serving to stop interaction between dipoles.

A dipole antenna shown at right is carried by screens *15* and spaced therefrom by about 0.25 to 0.30 of a wavelength. The dipoles (*21*, *22*) are fastened to the screen by inclined pairs of braces (*23*, *24* and *25*, *26*). Shorting bars (*31* and *32*) are adjustable between the respective pairs of inclined supporting bars to trim the impedance of the radiators. For a square tower, four assemblies make up one turnstyle layer, and since they are all identical, they are easily made and assembled by unskilled workers. Antennas may be placed on any of the faces of the tower, and in that manner secure various directional patterns. By



proper phasing of the antennas, the beam may be directed downwardly or upwardly to improve the signal strength in a particular area. Preferably the transmission line to the dipole is not directly connected to it, but passes through one of the antenna supporting tubes. In this way, matching of the dipole to the transmission line is done by series impedance tuning.

Means for Controlling Antenna Characteristics in Object Locating Systems of the Reflection Type . . . *Patent No. 2,688,744. D. E. Sunstein. (Assigned to Philco Corp., Philadelphia, Pa.)*

An improved antenna for search radar is presented in this patent. In the conventional search radar, a directional antenna serves both as the transmission antenna and the reception antenna for the signal reflected from the target. Usually the antenna is rotated on a vertical axis and widely spaced pulses of short duration are radiated from it. The electromagnetic wave strikes the target and is reflected back to the antenna, where it appears on an indicator. It is desirable that the antenna rotate at high speed so that as many observations as possible of a target may be secured. A highly directional antenna is used so that good resolution of a target is secured even when the angular displacement of the target on the screen is small. There is a difficulty, however, with a highly directive antenna when it is rotated at high speed and the target is distant. With such antennas, the reflection signal from the distant target returns after the an-

NEW CHEMELEC CONNECTORS

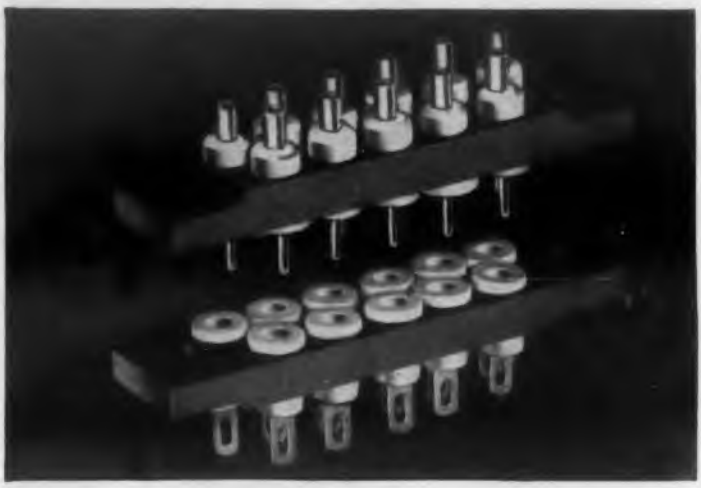
Aluminum Base Type CNA

Compression Mounted, TEFLON-Insulated Terminals

2 to 34 Pins

Lower Cost . . . High Performance

These Chemelec Connectors are designed for low loss, high frequency service in interconnection of radio, radar and other electronic equipment—where connectors must be unaffected by a wide range in ambient temperatures, pressure altitudes, humidity and mechanical shock and vibration.



Current rating is 3 amp. for .040 pins and 5 amp. for .063 pins. Voltage rating is 3,300 V. RMS (short time test at sea level).

The TEFLON insulation is serviceable at temperatures from minus 110°F to plus 500°F, for operation in pressure altitudes from 0 ft. to 60,000 ft. Water absorption is zero by ASTM Test.

TEFLON will not carbonize under arcing, and will not support combustion. Its dielectric strength is greater than 500 Volts/Mil.

Lower prices are accomplished by individual compression-mounted, TEFLON-Insulated Terminals in low-cost aluminum bases.

These same terminals are also available for compression-mounting, directly into drilled or punched holes in the chassis itself, without need of additional hardware. (see below).

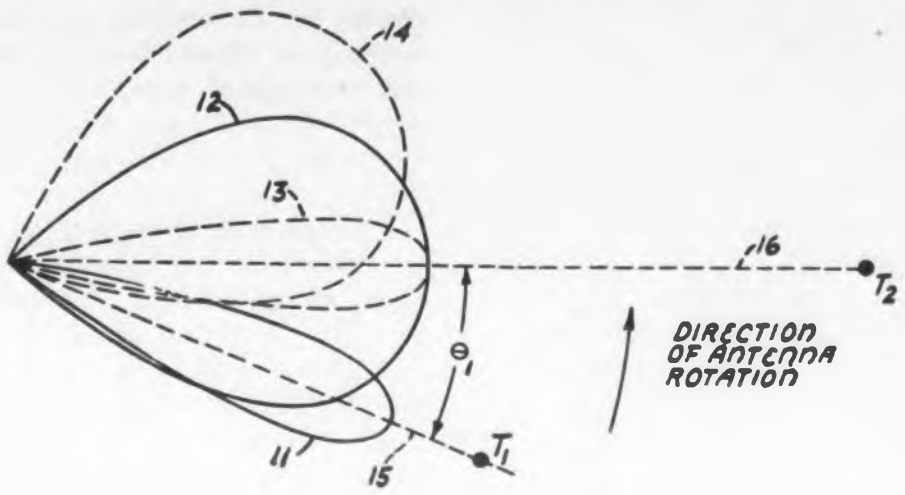
Write for Catalog EC-455.

Fluorocarbon Products, Inc. Division of
UNITED STATES GASKET CO., CAMDEN 1, NEW JERSEY

FABRICATORS OF FLUOROCARBONS AND OTHER PLASTICS

Representatives in principal cities throughout the world

CIRCLE 487 ON READER-SERVICE CARD FOR MORE INFORMATION



tenna has turned to a position where its sensitivity pattern or response is low or indeed to a position where the reflected signal is incapable of energizing the antenna. The patentee overcomes this difficulty by the design of an antenna with a transmitting horn having a wide directional pattern (*12* and *14*).

Another form of the invention may use horns of such shape that they have a highly directive characteristic. The receiving horn, however, is so shaped that its maximum reception characteristic or pattern lags or is angularly displaced with respect to the pattern of the transmitting horn. The antennas can be rotated at high speed and still secure an accurate and clear response from a distant target. This characteristic is particularly important with respect to moving target radar systems.

The impulses emitted radiate outwardly from the reflector (*21*). A separate receiving horn (*34*) is mounted with horn *33* and receives the echo or reflection from the

get. This receiving horn is relatively narrow and, therefore, has a narrow directional pattern *11* and *13*. The horn *34* is located relatively to horn *33* so that its response pattern follows that of the latter in recognition of the fact that the reflected signal is delayed some time after the transmitted signal. Preferably it has a high directive characteristic and its pattern overlaps part of the transmitting pattern as shown.

The antenna structure including horns *33* and *34* and the reflector *21* are rotated at a constant speed by motor *30*. The transmitter (*40*) and receiver (*41*) are connected with the antenna through a rotary coupling. This coupling uses a stationary waveguide (*36*) from the transmitter which passes the transmitted signal to circualr track *49* of relatively large diameter and a waveguide *31* on the rotating antenna structure is coupled to circular track *49* throughout the rotation. The receiving horn (*34*) is coupled by the waveguide (*32*) to circular track *48* of smaller diameter in the stationary member (*27*) of the rotary coupling. The circular track and waveguide *37* transmits the received reflection signal to receiver *41*.

Oscillation Generator . . . *Patent No. 2,692,337. R. L. Hanson (Assigned to Bell Telephone Laboratories, Inc., N.Y.C.)* The oscillation frequency of this transistor circuit is independent of the values of the residual resistances in this circuit. As a result it does not require additional circuit elements to hold the frequency constant as in many other oscillation circuits. Two circuits are shown on the next page.

The circuit uses a transistor (*1*) having a base electrode (*2*), an emitter electrode (*3*), and a collector electrode (*4*). A battery (*5*) with suitable resistances (*6*, *7*) in the base and emitter connections provides proper operating bias for these electrodes. The resistor (*14*) in the collector connection with resistor *7* prevents excessive direct current flow through the transistor. The output may be connected with the load through a transformer (*13*) in the collector circuit as shown in the left-hand illustration or a coil (*22*) may be coupled to the coil (*12*) in the feedback circuit as shown in the other circuit.

Oscillation of the circuit is secured primarily by a series resonant circuit comprising the capacitor (*11*) and coil *12* which connects the collector with the emitter.

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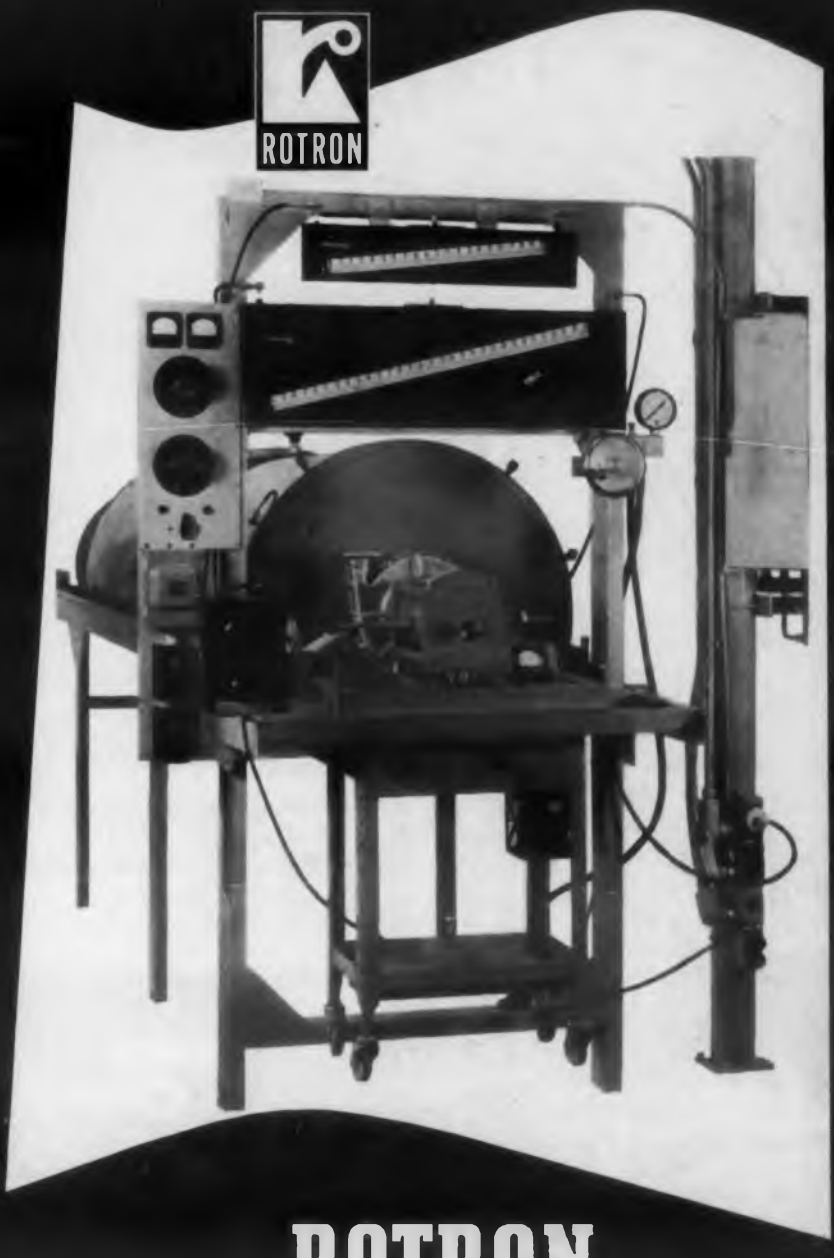

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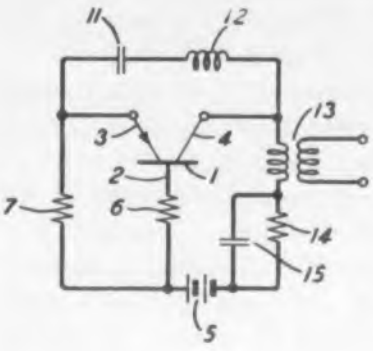
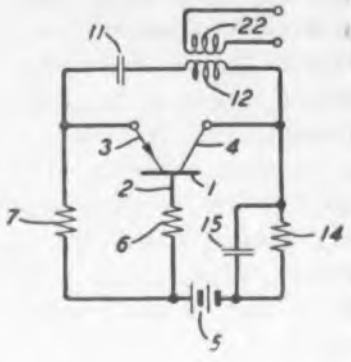


Collector circuit (left) and feedback circuit (right) for oscillation generator.

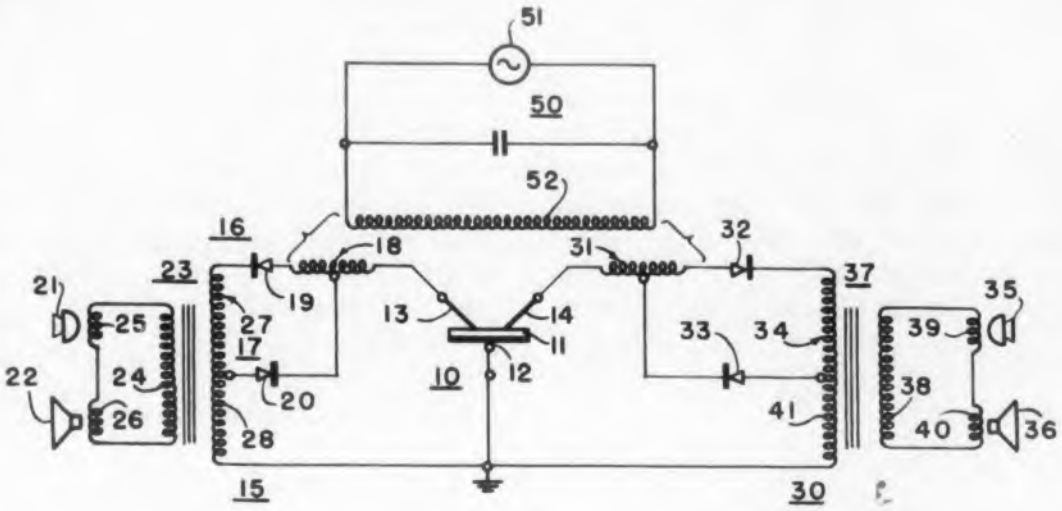


Any electrical disturbance in the emitter circuit will set the generator into oscillation. At the selected oscillation frequency, which is the resonant frequency of the feedback connection, the feedback impedance is only the residual value of the resistance of the capacitor and coil, which is negligible. So long as the feedback current is equal to the input current, the oscillator becomes self oscillating. In this transistor amplifier, electrode current in the emitter circuit is amplified. So long as this current is greater than the emitter current, sufficient current may be fed back to the emitter to maintain oscillations. The balance of the current in the collector circuit is supplied to the load. The oscillation, therefore, continues even though the current source to the emitter is removed.

At frequencies higher or lower than the resonant frequency of the back coupling connection, the feedback is reduced substantially because of the increased impedance of the tuned circuit at these other frequencies and also because a phase shift is introduced with respect to the emitter current. The oscillation is maintained, therefore, at the frequency to which the couping connection is tuned. With this oscillator any variation in the magnitude of residual resistances such as caused by changes in temperation is of no effect.

Transistor System for Translating Signals in Two Directions . . . *Patent No. 2,691,073 R. V. Lowman (Assigned to Hazeltine Research, Inc., Chicago, Ill.)*

A single transistor is the amplifier in this two-way signal translating circuit suitable for an inter-office communications system. Each electrode (*13* and *14*) serves alternately as an emitter and collector electrode. A high impedance circuit including the transformer windings (*27* and *28*), the rectifier (*19*) and the entire winding (*18*), which is connected with electrode *13* when it is an emitter. A low impedance circuit is provided for electrode *13* when it serves as a collector in winding *28*, rectifier *20* and that portion of winding *18* between the tap and electrode *13*. Electrode *11* is part of an identical high impedance circuit when it serves as an emitter and an identical low impedance circuit when electrode *11* is a collector.



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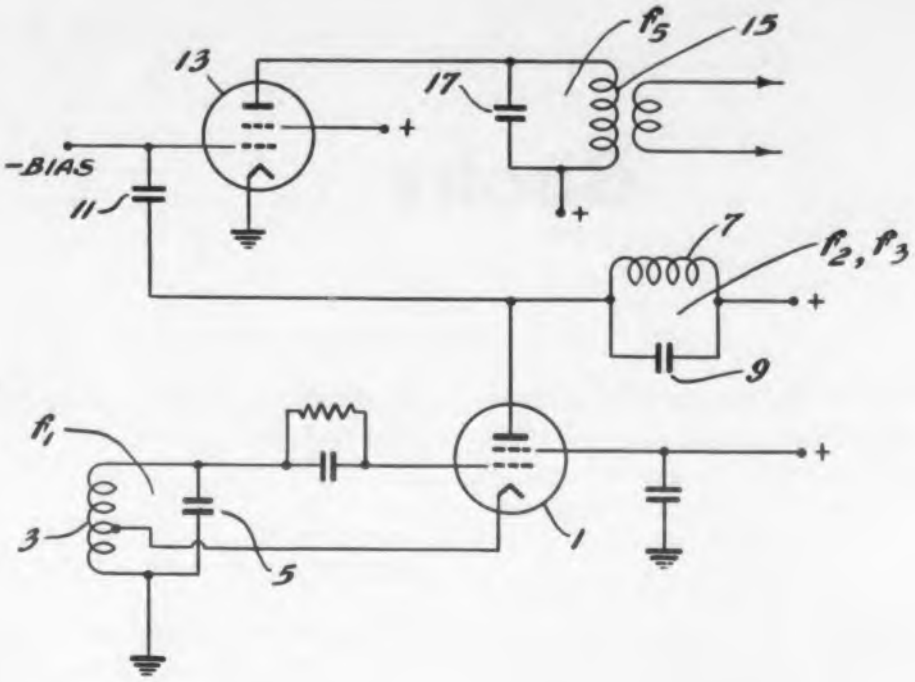
A source of alternating potential (*51*) is applied to a winding (*52*) that is coupled to windings *18* and *31* so that electrodes *13* and *14* are of opposite polarity and the conductivity is constantly changing. The alternating potential is at least twice that of the highest audio frequency to be transmitted. When a positive potential is applied to electrode *13*, it serves as an emitter. This positive potential also biases rectifier *19* so that the high impedance circuit becomes operative. At the same time, the potential on electrode *14* is negative so that it functions as a collector. This negative potential also biases rectifier *33* so that the low impedance circuit is operative. It will be seen, therefore, that for each full wave of the potential applied to winding *52*, electrodes *13* and *14* serve alternately as emitter and collector electrodes and the circuits operative as a result are alternately high impedance and low impedance circuits. The circuit, therefore, will carry transmission in both directions so that a two-way conversation may be held.

Frequency Multiplication System . . . *Patent No. 2,698,385. E. F. Carter (Assigned to Sylvania Electric Products, New York, N. Y.)*

Meeting carrier frequency needs, this circuit generates a signal frequency with a high fifth harmonic content. The circuit can be designed so that the output frequency is some other large numbered multiple of the fundamental frequency.

The circuit consists of a well-known oscillator such as a pentode tube (*1*) and an oscillating circuit (*3, 5*) which generates a frequency (f_1). This oscillator is designed to produce multiple harmonic frequencies such as the second and third harmonic. The output circuit of the pentode includes a coil (*7*) and capacitor (*9*) having a low Q and broadly tuned to pass the second and third harmonic, but to suppress the fundamental frequency. These harmonic frequencies are mixed in a pentode (*13*) that serves as a mixer, a heterodyne detector, or a cross modulator. This mixer circuit is non-linear in its characteristics so that the



output frequency is the sum of the second and third harmonics, which results in an output frequency of the fifth harmonic of the fundamental. The output circuit of tube *13* is a sharply tuned circuit that passes the fifth harmonic only.

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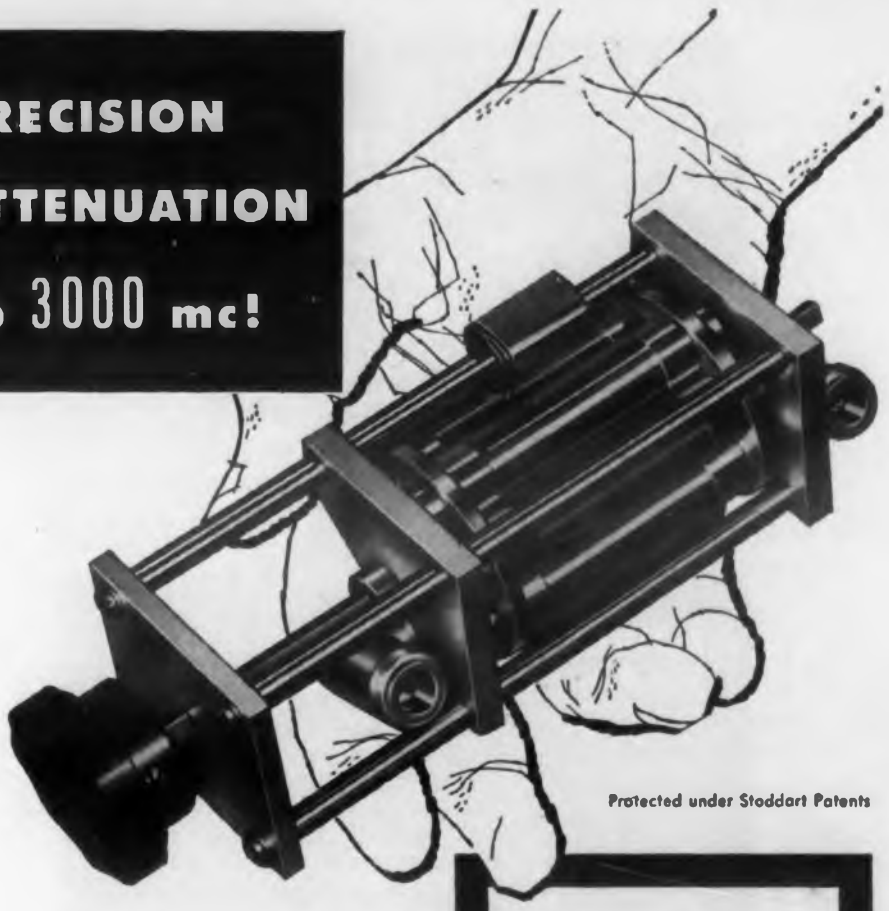

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Books . . .

The Elements of the Theory of Real Functions, third edition. . . . *J. E. Littlewood, 71 pages, Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. $1.35 paper-bound, $2.85 cloth-bound.*

Every so often the electronic engineer finds there are no nomographs or tables available to help solve a mathematical problem. At this point the engineer must rely on his mathematical training. This slim volume provides a ready means of reviewing the nature of functions. It is based on notes for a series of lectures to senior undergraduates at Cambridge University.

Chapter headings are: "Classes and Cardinal Numbers", "Well-ordered Series", "Other Types of Series", and "Elements of the Theory of Sets of Points".

Applications of Transistors to Electronic Counting Equipment . . . *Richard E. Kimes, 75 pages, paper-bound. Available from Office of Technical Services, Department of Commerce, Washington 25, D. C. (Publication No. PB 111610) $2.00.*

This report covers the development of a transistorized counter that would duplicate the performance of an existing vacuum-tube model. Unfortunately, the work was performed in 1952 and early 1953 when less reliable transistors were available. However, electronic design engineers using or planning to use transistors will find much valuable information and many useful switching and counting circuits.

The vacuum-tube counter incorporates 45 tubes and consumes 175w. The much

more compact transistor version required 85 *2N23* and three *2517* point contact transistors and consumes 15w. The development work was undertaken at the Berkeley Div., Beckman Instruments, Inc., Richmond, Calif.

International Radio Tube Encyclopedia: 2nd Edition . . . *edited by Bernard B. Babani, 501 pages. Bernards Ltd., London, England. Available from British Industries Corp., 164 Duane St., New York 13, N. Y. $9.00.*

Designers of electronic equipment for overseas sale will find this work to be of great value. Among the 18,000 tubes listed, are many foreign equivalents to American types. The tubes listed—receiving, transmitting, rectifiers, thyratrons, regulators, tuning indicators, cathode ray, and photo —are the products of 101 different manufacturers from nearly 20 nations, including Japan and Russia.

In addition to the vital characteristics of each tube, the base connections are given. The bases are illustrated in a separate section. Another section lists equivalents for rare types. The addresses of the manufacturers, if available, are also listed.

Since the first edition of this work was published in 1949, some three thousand new tubes have been developed. These are placed in a supplement at the end of the book. It is hoped that diodes and transistors will be listed in the next revision. This work is recomended for every design laboratory library.

Dictionary of Television, Radar and Antennas . . . *Compiled by W. E. Clason. 760 pages. Elsevier Press, Inc., 2330 Holcombe Blvd., Houston, Tex. $21.50.*

This volume defines television, radar, and antenna terms and lists them in six languages. The basic word list is English (British and American usages being clearly distinguished), and definitions in English are included for each subject. The other languages have alphabetical word lists numerically keyed to the English list. Languages have been arranged in Anglo-Saxon, Latin, and Germanic groups. The dictionary is in English/American, French, Spanish, Italian, Dutch, and German.

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Abstracts

Pertinent condensations from foreign journals, house organs, reports, and periodicals of related technologies that frequently miss the attention of electronic designers.

Last month (ED Aug 1955, p. 20) we featured Russian translations of articles appearing in USSR electronic journals. We announced our plans of performing this service regularly so that our readers could get some insight into the status of USSR technology. On these pages are a variety of topics taken from several scientific and technical journals. The more theoretical articles, which often are mathematical analyses of hypothetical or practical circuits, have been passed over in favor of information which appears to reflect information put to use or available for use by electronic designers. Also included this month is an editorial which indicates some of the persistent emphasis put on efficiency and technological progress.

USSR Transistor Data Chart

SEVERAL Soviet radio circuits employing transistors have been included last month and again this month. It is interesting to compare the Russians' ratings of transistors and circuit design with US practice. To further aid in the comparison, the chart at the right should help. So far as we know this chart, which appeared in Radio, June 1955, list all types available for consumer products. Both the variety available and the ratings can be checked against our own types included in the ED Transistor Data Chart, July 1955. Symbols and footnotes which explain various ratings found in the chart are included in the extreme-right-hand column. The following paragraph includes operating instructions:

The maximum allowable temperature of the surrounding environment is +50°C. The maximum allowable ratings of voltage, current and power dissipated by the collector must not be exceeded in all static, dynamic and non-fixed operations (as for example, switching). In switching, the base contact must be joined first. Transistors must not be placed near to parts that heat up. A good heat tap from the body of the transistor is desirable. Solder that melts below 150°C is used.

Point Contact Transistors

Type	Application	Operation Ratings[3] I_e ma	V_c v	Parameters R_{11} ohm max.	R_{12} ohm max.	R_{22} Kohm min.	α min.	α max. f	PG[2] db	VG	Maximum Ratings I_e[3] ma	I_c[3] ma	V_c[3] v	W_c mw
S1A	Amplification to 500 kc.	0.3	−20	750	200	7	1.2	1.0	15-19	—	10	10	−40	100
S1B	Amplification to 500 kc.	0.3	−20	750	200	7	1.5	1.2	18-22	—	10	6	−40	50
S1V	Amplification to 1500 kc.	0.3	−20	750	200	7	1.5	1.2	15-19	—	10	10	−40	100
S1G	Amplification to 1500 kc.	0.3	−20	750	200	7	1.5	1.2	18-22	—	10	6	−40	50
S1D	Amplification to 5000 kc.	0.3	−20	750	200	7	1.5	1.2	15-22	30	10	6	−40	50
S2A	Oscillator to 500 kc.	0.3	−10	1500	1000	7	1.5	1.2	—	—	10	10	−30	100
S2B	Oscillator to 1500 kc.	0.3	−10	1500	700	7	1.6	1.5	—	—	10	6	−20	50
S2V	Oscillator to 5000 kc.	0.3	−10	1500	1000	7	1.6	1.5	—	—	10	6	−20	50

Junction Transistors

Type	Application	Operation Ratings I_e[3] ma	I_c[3] ma	V_c[3] v	Parameters R_e ohm	R_c meg-ohm	R_b ohm max.	α[5]	α max. f	PG[6] db min.	NF[6] db max.	PG[7] mw min.	DF[7] % max.	C_c mmf max.	Maximum Ratings I_e[3] ma	I_c[3] v	V_c[3] v	W_c mw
P1A	amplification to 100 kc	1.0	—	−10	30	min 0.3	—	min 0.9	0.7	30	—	—	—	—	5	5	−20	50
P1B	amplification to 100 kc	1.0	—	−10	30	0.5-1.2	400	0.93-0.97	0.7	33	35	—	—	—	5	5	−20	50
P1V	amplification to 100 kc	1.0	—	−10	30	min 0.1	400	0.93-0.97	0.7	37	35	—	—	—	5	5	−20	50
P1G	amplification to 100 kc	1.0	—	−10	30	min 0.5	600	min 0.96	0.7	37	—	—	—	—	5	5	−20	50
P1D	amplification to 100 kc	1.0	—	−10	30	min 0.5	600	min 0.94	0.7	33	18	—	—	—	5	5	−20	50
P1E	amplification to 465 kc	1.0	—	−10	30	min 0.3	1000	0.94-1.0	0.7	30	35	—	—	60	5	5	−20	50
P2	amplification of r-f	—	−5	−50	—	—	—	min 0.85	—	17	—	100	15	—	10	10	−100	250

Footnotes

(1) Parameters are measured with the base grounded for class "A" amplification operation at a frequency of not more than 20kc, +20° ±5°C.

(2) With generator resistance 500 ohms, R_L 10K.

(3) Direction of current from the emitter and collector to the base is taken as positive.

(4) Parameters are measured at a temperature of $+20° \pm 5°C$.

(5) α is measured with grounded base at a frequency of 1000cy.

(6) DF and NF are measured with grounded emitter for class "A" amplification operation at a frequency of 1000cy with internal generator resistance of 600 ohms and load resistance of 30K.

(7) PO and DF are measured in a circuit with a grounded base at a frequency of 400cy with internal generator resistance of 100 ohms and load resistance of 10K.

Abbreviations:

I_e	emitter current
I_c	collector current
V_c	collector voltage
R_{11}	input resistance with open output
R_{12}	resistance of reverse coupling with open input
R_{22}	output resistance with open input
R_e	resistance of emitter
R_c	resistance of collector
R_b	resistance of base
α	current amplification factor with shorted output
α max	α measured at highest operating frequency
PG	power amplification factor
VG	voltage amplification factor
PO	power output
W_c	maximum power dissipated by collector
NF	noise factor
DF	non-linear distortion factor
C_c	collector capacitance

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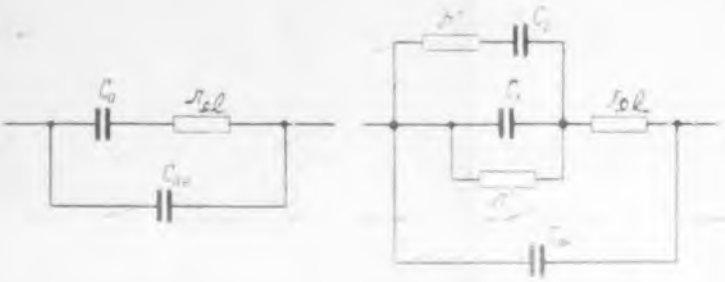
Temperature-Frequency Characteristics of Electrolytic Capacitors



Large changes of capacitance and loss angle are observed in aluminum electrolytic capacitors of the dry type, within the operating temperature range of −60 to +60°C, and in the frequency range of 50cy to 20kc. Thus, at a frequency of 50cy with −60°C temperature, capacitance is diminished by 30 to 50% and the loss angle reaches a value of 0.5 to 1. At a frequency of 20kc with +20°C temperature, capacitance is diminished by 15 to 40% and the loss angle reaches a value of 0.2 to 0.5. These changes cannot be ascribed to properties of the dielectric, the thin layer of aluminum oxide. The influence of the lining with the viscous operating electrolyte is doubtlessly significant in this variation.

Since the conventional equivalent circuit (left) fails to explain observed phenomena, a new equivalent circuit (right) is proposed. It is consistent with qualitative explanations describing the dependence of capacitance and loss angle on temperature and frequency to 20kc. C_o is the capacitance of the layer of alumina, C_{AK} is the capacitance of the lining between the anode and cathode, and r_{el} is the resistance of the lining with the electrolyte. In the new circuit, C_o is divided into two parts: capacitance C_1 of the smooth surface, shunted with resistance r′, equivalent loss in the oxide layer on account of porous leakage of current; and capacitance C_2 resulting from contact of the electrolyte in shallow pores and micropits in the layer of oxide, with the associated resistancer″ of the electrolyte.

Observations showed that the general capacitance of the aluminum anode, $C_o = C_1 - C_2$, depends not only on the thickness of the layer of alumina, the state of the anode surface and area, but also on the kind of working electrolyte and lining. Bearing in mind the temperature dependence of C_o, that is peculiar to the given sytem "layer of oxide—lining with electrolyte" and the new equivalent circuit, the observed dependence of capacitance and loss angle on temperature and frequency of alternating current can be explained.

It is concluded [after tests with various electro-

lytes, and anode smoothnesses,] that the efficiency of the active surface of the layer of oxide diminshes with the rise in frequency, but in a different degree for every system: that is, component C_2 is diminished with a rise of frequency. With rise of frequency the reduction of capacitance is especially marked at temperatures of $-40°C$ and $-60°C$. In such cases, the component C_2 practically is absent, but the component C^1 also diminishes because of contact breaks of the lining with the layer of oxide along the smooth surface. The marked rise of lining resistance r_{el} has a substantial influence on reduction of capacitance with rise of frequency.

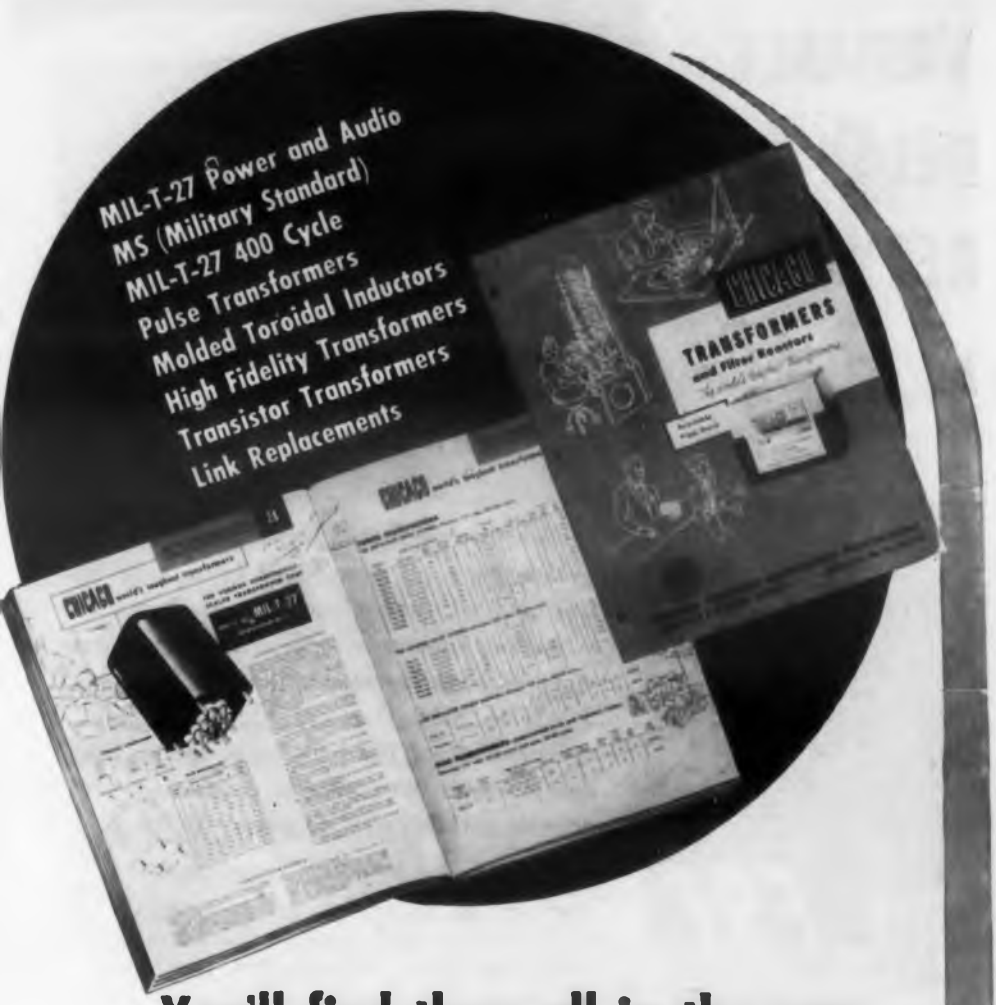
High-voltage electrolytic capacitors (300 to 500v) with smooth anodes and linings of cloth saturated with frost-resistance electrolyte of ethylene-glycol and alcohol give the most favorable dependence of capacitance and loss angle on temperature and frequency. At 60°C at 50cy, their effective capacitance is reduced by 40 to 45%. The worst dependence is found in low-voltage capacitors (up to 100v) with corroded anodes and linings of paper. At $-40°C$ at 50cy, their effective capacitance is diminished two to three times.

At frequencies higher than 20kc, the reduction of effective capacitance of electrolytic capacitors is accompanied by the influence of self-inductance. The particular inductance of electrolytic capacitors depends primarily on the spread of leads of anode and cathode. If the spread of leads be minimal, within the limits of 0.5 to 1cm, which is fully possible and permissible in design, then minimal inductance (0.03 to 0.06μh) results and the resonance is displaced to the side of higher frequencies. In this case the frequency of resonance is higher than 200kc for capacitors with capacitance up to 100μfd.

At high frequencies the permissible magnitude of capacitance is determined from the conditions that with a particular inductance of 0.060μh there be no resonance. In the range of low frequencies the permissible magnitude of capacitance is limited by the condition that impedance cannot be less than 0.1 to 0.2 ohm in practice. In the regions of low temperatures and high frequencies, the effectiveness of electrolytic capacitors sharply drops since z rises.

Electrolytic capacitors can be applied in high frequency interference-shielding filters, connected in parallel to paper capacitors of the by-pass type. In these cases, the following demands must be made on the electrolytic capacitors: they must have smooth anodes; the lining thickness must be minimal for the given working voltage (use of thin cloth lining is desirable for capacitors of 300 to 500v); the working electrolyte for the capacitor must be frost-resistant to the maximum; the spread of leads from anode to cathode must be minimal, within limits of 0.5 to 1 cm.

These demands can be met in the process of producing standard types of capacitors. *Condensed from an article by member I. I. Morozov,* Radiotekhnika, *No. 5, 1955, page 69-75.*



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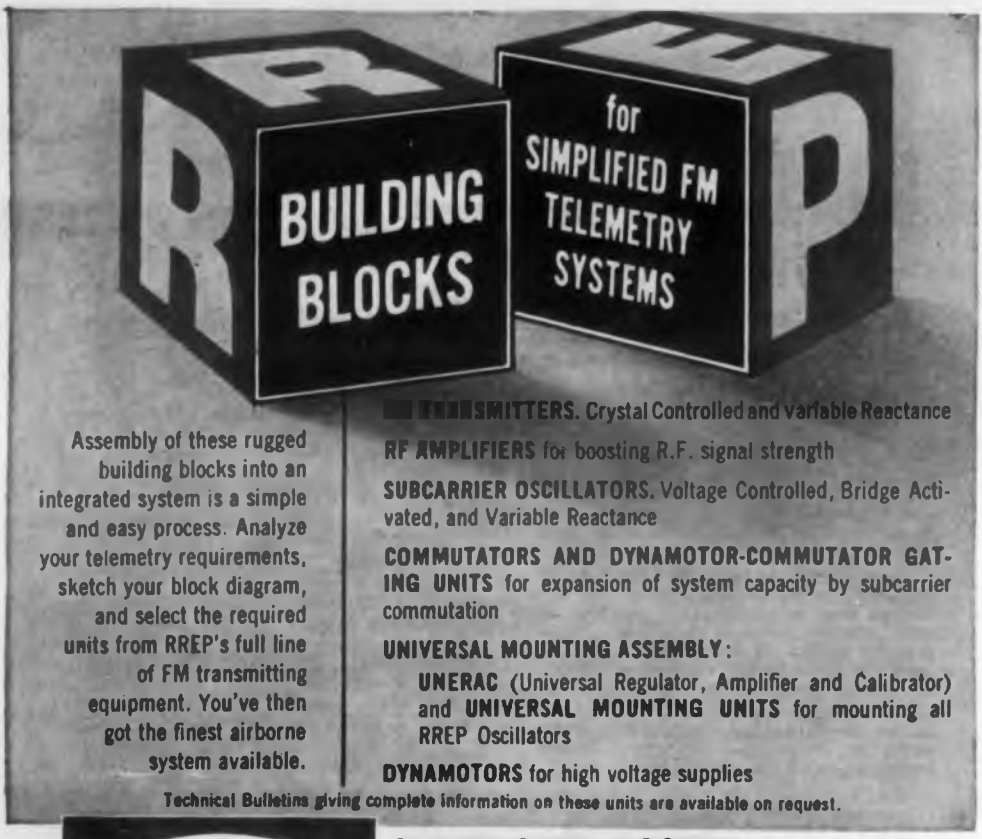
Temperature Limits For Various Materials In °F

Synthetic mica melts	2550
Electrical porcelain—firing temperature	2400
Glaze for porcelain—firing temperature	2250
Raw lead pottery glazes—firing temperature	2000-2060
Copper melts	1981
Furnace temperatures in glass manufacture	1900-2800
Natural phlogopite mica—maximum heat resistance	1800
Silver melts	1762
Aluminum melts	1220
Silver solders melt	1165-1450
Supramica 500—maximum heat resistance	1000
Cold-molded refractory and phosphoasbestos—maximum heat resistance	900-1300
Calcium aluminum silicate—maximum heat resistance	900
Aluminum alloy melting points	850-1225
Muscovite mica—maximum heat resistance	800-1000
Supramica 555—maximum heat resistance	950
Zinc melts	786
Mycalex 400—sustained service	700
Magnesium alloy melting points	650-1200
Mycalex 410—sustained service	650
Mycalex 410X—sustained service	650
Lead melts	621
Cadmium melts	610
Silicone-glass heat distortion	575
Cold-molded plastic (organic)—sustained service	500
Polytetrafluorethylene—sustained service, no load	500
Silicone-glass sustained service	480
Tin melts	450
Silicone rubber—sustained service	425
Cold-molded plastic (organic) heat distortion	400
Polyester-glass heat distortion	400
Cellulose-filled melamine heat distortion	400
Polymonochlorotrifluoroethylene—sustained service, no load	390
Mercury boils	357
"Hottest spot"—Class H insulation	356
Polyester, mineral-filled, putty—heat distortion	375-425
Alkyd: polyester, mineral-filled, granular—heat distortion	350-400
Epoxy-glass cloth—maximum temperature	315
Silicone elastomer—sustained service	300-500
Nylon (polyamide) heat distortion (66psi)	300-360
Casein heat distortion	300
Urea-formaldehyde heat distortion	275
Polytetrafluoroethylene heat distortion (66psi)	270
"Hottest spot"—Class B insulation	266

Melamine-formaldehyde (filled) heat distortion	266-400
Diallylphthalate (alpha cellulose filler) heat distortion	265-310
Phenol-formaldehyde (mica) heat distortion	260-350
Phenol-formaldehyde (wood flour) heat distortion	260-340
Hard rubber (mineral-filled) heat distortion	260
Sulfur (rhombic) melts	235
"Hottest spot"—Class A insulation	221
Paper/Phenolic laminate—sustained service	212-250
Styrene elastomer—upper limit	212
Epoxy—maximum recommended use	212
Water boils	212
Polyvinyl carbazole heat distortion	210-300
Vulcanized fiber—upper limit	200
"Hottest spot"— Class O insulation	194
Polydichlorostyrene heat distortion	185-230
Polymonochlorotrifluoroethylene heat distortion (66psi)	160
Polystyrene heat distortion	152-210
Methyl methacrylate heat distortion	150-210
Styrene copolymer heat distortion	148-235
Vinyl chloride heat distortion	140-185
Cellulose nitrate heat distortion	140-160
Hard rubber (no filler) heat distortion	140
Vinylidene chloride heat distortion	130-150
Cellulose acetate butyrate heat distortion	120-210
Cellulose acetate heat distortion	115-235
Ethyl cellulose heat distortion	115-190
Vinyl butyral heat distortion	115-140
Polyethylene heat distortion (66psi)	107
Temperature of human body	98
Normal room temperature	72
Water freezes	32
Lower limit for ethyl cellulose	0
Lower limit for vinyl chloride elastomer	—38
Mercury freezes	—38
Silicone elastomer loses flexibility	—60
Lower limit for polyisobutylene	—80
Lower limit for polytetrafluoroethylene	—90
Lower limit for polychlorotrifluoroethylene	—100
Dry ice (CO_2) sublimes	—109

This table was abstracted from a bulletin of the Mycalex Corp. of America, Clifton, N. J., written by J. Harry DuBois, vice-president, engineering, entitled "Use the Right Material".



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Invention and Creativeness

An editorial in *Vestnik Svyazi* (Communication Herald) has this to say on the increase of invention and creative initiative:

"Mass invention and rationalization work are the inexhaustible source of technical progress. The number of inventions, technical improvements and rationalization proposals [suggestion-box ideas] effected in industry, construction and transport amounted to 900,000 in 1954 alone. At many big plants every sixth worker is a rationaliser."

The Minister of Communications USSR, says the editorial, pointed to further development of inventive work as among "the basic tasks of soviet communication workers in 1955." The 1954 summary of activity in this field showed a 4% increase in the number of creative people to reach 17,300, who made 30,500 proposals for technical improvements in communications. Many of these have been put into practice, including uses of mechanical cable-layers, experimental automation of relaying telegrams, automatic underground cable-line amplifiers, etc. But, the editorial criticizes shortcomings. Branch offices neglect to check up and follow through on proposals, and fail to "pay enough attention to carrying out directives" of the minister. The ministry itself is charged with failure to review all proposals within the established four-month period, allowing some to be pigeon-holed for eight months to a year.

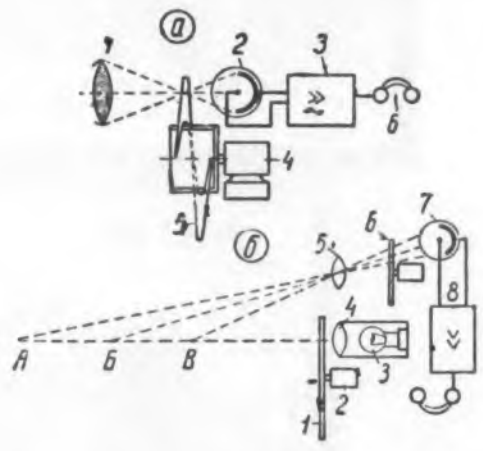
The editorial demands that administrators of communication and trade-union leaders combine efforts to promote mass rationalization work through technical conferences and exchange of experiences in the field.

Light Locator for the Blind

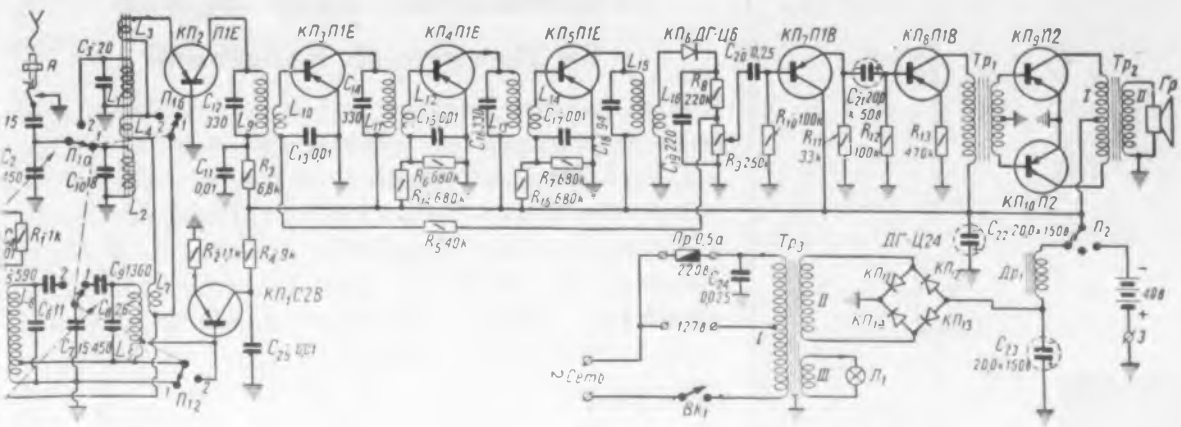
CONVERTING light variations into variable sounds for earphone reception, these devices are walking aids for the blind. It helps a blind person to distinguish walls, fences, trees, stones and other obstacles in his path.

Two models are illustrated and described briefly. Model *a* (upper) has no light source of its own and uses reflected light. It operates on the principle that light reflected from an obstacle has a changing modulation as the distance from the obstacle changes. If the teeth of disc *5* are placed exactly in the plane of a sharp image, the depth of modulation is a maximum. The compounding of the disc teeth along the optic axis of the lens to any side relative to the sharp image results in an unfocused bundle of light rays passing through the disc and the depth of modulation diminishes. The teeth of the disc are placed as illustrated along a screw line so that the frequency of modulated lights changes with a change in the distance from the obstacle. This unit made with miniature parts weighs 2 lb and needs 100mw.

Model *b* (lower) has its own light source, a 3w lamp that triggers specific earphone signals fixing distances from the obstacle at 1.5, 2, 3, and 6 meters from the person. By moving the device up and down and sideways, some idea of the proportions of the obstacle are obtained. [We're not sure that this gives practical clues to the blind, but the idea sounds clever.]—*Short article by N. Chechik*, Radio, *June 1955, p 63.*



Upper: *1* lens, *2* photo-cell, *3* amplifier, *4* motor, *5* toothed disc, *6* ear phones. Lower: *1* modulating disc, *2* motor, *3* light source, *4* lens of light source, *5* lens of reflected light, *6* coding disc geared to motor *2*, *7* photo cell [described as a gas-filled oxygen cesium type], *8* amplifier, *9* earphones.



Transistor Receiver Circuit

This transistor superheterodyne receiver is intended for reception of radio stations working on long waves (150 to 420kc) and medium waves (520 to 1600kc). Its sensitivity is in the range of 50 to 80μv and 20 to 160μv respectively. The frequency response, based on sound pressure, is nominally 200-300cy. The last three digits of transistor nomenclature refers to type. *N* is translated *P* in the table on p. 162; C is S. The first two digits refer to location in the circuit. The article describing the superhet receiver (see last month's issue of ED for a complete story on a t-r-f transistor radio) is headed "Amateur Design." It is taken from *Radio*, June 1955. p26.

Standards and Specs

By 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.

Capacitors

MIL-C-25A, CAPACITORS, FIXED, PAPER-DIELECTRIC, DIRECT CURRENT (HERMETICALLY SEALED IN METALLIC CASES) AMENDMENT 2, 14 APRIL, 1955 . . . The list of referenced specifications and publications, the requirements for packing, packaging and marking for shipment have been revised. The characteristic table is now included in the spec proper and has been deleted from the spec sheets. Supplement 1D to spec sheets MIL-C-25/1C, MIL-C-25/2A through MIL-C-25/7A was issued at the same time as a revision.

R-F Lines

ASESA INFORMATION BULLETIN 46, CROSS-INDEX OF R.F. TRANSMISSION LINE COMPONENT NOMENCLATURES VERSUS APPLICABLE SERVICE DRAWINGS AVAILABLE FROM ASESA, 31 MAY, 1955 . . . This bulletin lists the latest types of RF transmission line components for which Service drawings are available from ASESA. The index lists the components by type number and drawing number. This bulletin supersedes ASESA Bulletin 31, dated 31 January 1955.

Waveguides

MIL-W-287A, WAVEGUIDE ASSEMBLIES, FLEXIBLE, 17 MAY 1955 . . . This revision supersedes JAN-W-287. A new type designation has been adopted which indicates the matching waveguide system into which the flexible guide is designed to operate, the performance characteristics, and the lengths. These waveguides have been standardized so that equivalent sizes correspond with standard rigid waveguide sizes specified in spec MIL-W-85, and mate electrically and mechanically with the standard flanges specified in spec MIL-F-3922. In addition, the assemblies are now available in standard lengths in multiples of 6 inches from 6 to 72 inches and one length of 96 inches. Two spec sheets were listed with this revision.

Television

55IRE23.S1 DEFINITIONS OF TELEVISION SIGNAL MEASUREMENT TERMS, 1955 . . . This newly released standard lists and defines all the technical terms used in the broadcasting of television signals. Copies of this standard may be obtained from IRE, 1 East 79th St., New York 21, N. Y. for $1.00 per copy.

Resistors

MIL-R-94A RESISTORS, VARIABLE, COMPOSITION 17 JUNE 1955 . . . This revision supersedes JAN-R-94. Provision has been made so that locking and sealing type bushings may be added to the resistors. The type designation has been changed to include a letter covering bushings immediately after the style designation (for example: RV1NATSD103B). Style RV1 has been reinserted in the spec, but its size is physically smaller than the previous version. Style RV3 has been deleted. Switch type "C", DPST, for attachment to these variable resistors has been deleted. Temperature and moisture-resistance characteristic U has been deleted and characteristics V and Y have been added. Qualification Approval submission and test procedure has been completely revised so that it is in accord with current standard practices for other components.

Electrical Indicators

MIL-M-17275A METERS, ELECTRICAL INDICATING DIRECT CURRENT, ONE INCH, 16 MAY 1955 . . . This issue supersedes MIL-M-17275(SHIPS) and is now a three service spec. One-inch barrel diameter, round flange, d-c meters of low current and voltage magnitudes, in the order of millivolts, milliamperes, and microamperes, are covered. The requirements, tests, and pertinent details of this spec closely parallel those of spec MIL-M-6A. Only one MS standard MS-90212, covering five types of meters, is included with this spec.

Preferred Parts List

ASESA 49-1, ARMED SERVICES PREFERRED PARTS LIST . . . A new index to the Preferred Parts Lists, dated 16 May 1955, has been issued by ASESA. The following sheets were also revised:

Component	PPL No. & Date
Capacitors, Fixed Ceramic	11015-CK 16 May 1955
Capacitors, Fixed, Mica	5-CM 16 May 1955
Capacitors, Fixed, Mica (Button Style)	10950-CB 16 May 1955
Capacitors, Fixed, Paper, Metallic Case	25-CP 16 May 1955
Insulators, Glass	9-NA 1 April 1955
Insulators, Porcelain	21-NP 1 April 1955
Insulators, Steatite	8-NS 1 April 1955
Resistors, Fixed, Film	10509-RN 16 May 1955
Wire and Cable, Hook-Up	76-HF 16 May 1955

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.

Meetings

Sept. 23-24: *Fifth Annual Symposium of the IRE Professional Group on Broadcast Transmission Systems,* Hamilton Hotel, Washington, D. C. "New Perspectives in the Field of Broadcasting" will be the theme of the meeting. The technical program will be built around the new techniques developing in the field of broadcasting and a consideration of TV signal propagation factors as related to TV allocation engineering. For information, write to IRE, 1 E. 79th St., New York 21, N. Y.

Sept. 26-27: *Sixth Annual Meeting and Conference of the IRE Professional Group on Vehicular Communications,* Multnomah Hotel, Portland, Ore. An industrial exhibit will be held in conjunction with the technical sessions. For information, write to IRE, 1 E. 79th St., New York, N. Y.

Sept. 26-27: *Symposium on Electronics for Automation and Automation for Electronics,* Irvine Auditorium, University of Pennsylvania, Philadelphia, Pa. Sponsored by the Radio-Electronics-Television Manufacturers Association. Papers will be presented on the status of development of systems, machinery, and components to aid in automatic fabrication of electronic equipment and the parts played by electronics in automation of other industries. For information, write to RETMA, 777 14th St., N. W., Washington 5, D. C.

Sept. 26-30: *Meeting on Marketing the Products of Atomic Energy and Trade Fair,* Sheraton-Park Hotel, Washington, D. C. Sponsored by the Atomic Industrial Forum. The Fair will demonstrate the extent to which atomic energy has been advanced, with displays of control systems, package power, reactors, and components. For information, write to Atomic Industrial Forum, Inc., 260 Madison Ave., New York 16, N. Y.

Sept. 28-29: *Industrial Electronics Conference,* Rackham Memorial Auditorium, Detroit, Mich. Sponsored jointly by the Michigan Section of the AIEE and the Professional Group on Industrial Electronics of the IRE. Sixteen papers have been scheduled for the four technical sessions which will discuss automation, industrial measurement problems, and new control system applications. For information, write to AIEE, 33 W. 39th St., New York, N. Y.

Sept. 29-Oct. 1: *Fourth Annual Meeting of Standards Engineers Society,* Statler Hotel, Hartford, Conn. Sessions will discuss potentials of standards, standards in automation, national strength and standards, and the future of standards. For information, write to S. H. Hubelbank, 30 Cumpstone Dr., Hamden, Conn.

Sept. 30-Oct 2: *High Fidelity Show,* Palmer House, Chicago, Ill. Exhibits will include tuners, amplifiers, speakers, recorders, turntables of both American and foreign manufacturers. For information, write to International Sight & Sound Exposition, Inc., 1 N. La Salle St., Chicago 2, Ill.

Oct. 3-5: *Eleventh Annual National Electronics Conference,* Hotel Sherman, Chicago, Ill. Ninety-six technical papers and 180 exhibits will be featured. For information, write to C. G. Miller, c/o Weston Electric Instrument Co., Chicago 6, Ill.

Oct. 3-7: *AIEE Fall General Meeting,* Morrison Hotel, Chicago, Ill. Sessions are planned on electronics, computing devices, nucleonics, feedback control systems, and aural and TV broadcasting. For information, write to AIEE, 33 W. 39th St., New York, N. Y.

Oct. 5-9: *World Plastics Fair and Trade Exposition,* National Guard Armory, Los Angeles, Calif. Oct. 6 will be Electronics, Military and Industrial Day, featuring applications of plastics in electronics, including tooling, instruments, and machinery. For information, write to Philip M. Kent, managing director, World Plastics Fair and Trade Exposition, 8762 Holloway Drive, Los Angeles 46, Calif.

Oct. 6-7: *Eleventh Annual Meeting and Design Conference of the Society of Industrial Designers,* the Woodner, Washington, D. C. The impact of automation on industrial design will be among the topics discussed. For information, write to the Society of Industrial Designers, 48 E. 49th St., New York 17, N. Y.

Oct. 12-15: *1955 Convention and Audio Fair,* Hotel New Yorker, New York, N. Y. Sponsored by the Audio Engineering Society. The convention will include panel discussions on transistors, amplifier design, and tape recording. For information, write to G. K. Dahl, 230 W. 41st St., New York 36, N. Y.

Oct. 17-19: *1955 Radio Fall Meeting,* Hotel Syracuse, Syracuse, N. Y. Sponsored by the Engineering Dept. of RETMA and the Professional Groups Committee of the IRE. For information, write to RETMA, 777 14th St., N. W., Washington 5, D. C.

Oct. 20-Nov. 3: *International Atomic Energy Exhibit*, Carnegie Endowment International Center, New York, N. Y. Sponsored by the Atomic Industrial Forum, the Fund for Peaceful Atomic Development, and the Carnegie Endowment for International Peace. The exhibit will be entitled "Man, the Atom, and the Future" and will stress the use of atomic energy for the advancement of human welfare. For information, write to Atomic Industrial Forum, Inc., 260 Madison Ave., New York 16, N. Y.

Oct. 24-25: *First Annual Technical Meeting of the Professional Group on Electron Devices of the IRE*, Shoreham Hotel, Washington, D. C. Developments and applications of electron tubes and transistors in radio, TV, business machines, and military equipment will be discussed. For information, write to IRE, 1 E. 79th St., New York, N. Y.

Oct. 24-26: *Sixth National Conference on Standards*, Sheraton Park Hotel, Washington, D. C. Sponsored jointly by the American Standards Association and the National Bureau of Standards. Co-ordination of Government and industry requirements for manufactured products will be discussed. A series of exhibits will show how standardization programs may be coordinated. For information, write to the American Standards Association, 70 E. 45th St., New York 17, N. Y.

Oct. 31-Nov. 1: *1955 East Coast Conference on Aeronautical and Navigational Electronics*, Lord Baltimore Hotel, Baltimore, Md. Sponsored by the Baltimore Section of the IRE and the IRE Professional Group on Aeronautical and Navigational Electronics. For information, write to IRE, 1 E. 79th St., New York 21, N. Y.

Nov. 1-5: *World Symposium on Applied Solar Energy*, Westward Ho Hotel, Phoenix, Ariz. Sponsored by the Association for Applied Solar Energy, Stanford Research Institute, and the University of Arizona. Conversion techniques and applications of solar energy will be discussed. An exhibit is planned. For information, write to W. C. Estler, Stanford Research Institute, Stanford, Calif.

Nov. 2-4: *Classified Symposium on Guided Missile Reliability*, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio. Topics to be covered include problems in establishing and implementing missile reliability programs; responsibilities for reliability during development and production; establishing requirements for predicting and measuring the reliability of systems and components. Organizations or indi-

viduals desiring to present papers at the symposium should contact R. L. Dingle, Directorate of Weapon Systems Operations, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio.

Nov. 3-4: *Eighth Annual Electronics Conference,* Town House, Kansas City, Kans. Sponsored by the Kansas City Section of the IRE. The conference will discuss components, microwave, automation, and audio. For information, write to IRE, P. O. Box 391, Kansas City, Mo.

Nov. 7-9: *Eastern Joint Computer Conference and Exhibition,* Hotel Statler, Boston, Mass. Sponsored by the AIEE, IRE, and the Association for Computing Machinery. Theme of the conference is "Computers in Business and Industrial Systems". Papers will be presented covering the role of computers in business, trends in system design, and communication and compatability among electronic computers in business and industrial use. Exhibits will incude data processing systems, process control systems, input-output equipment, conversion devices, sensing devices, and storage devices. For information, write to AIEE, 33 W. 39th St., New York, N. Y.

Nov. 14-17: *Second International Automation Exposition,* Navy Pier, Chicago, Ill. The exhibition will feature automatic controls, materials handling devices, etc. The electronic computer clinic will be repeated. For information, write to Second International Automation Exposition, 845 Ridge Ave., Pittsburgh 12, Pa.

Nov. 17: *Conference on the A-B and Industry —a Prescription for Survival,* Illinois Institute of Technology, Chicago, Ill. Sponsored by Armour Research Foundation of Illinois Institute of Technology. Subjects scheduled for discussion include economics of A-bomb and H-bomb protection, protection possibilities, and industry operations under emegency conditions. For information, write to Illinois Institute of Technology, 35 W. 33rd St., Chicago, Ill.

Dec. 12-17: *Nuclear Engineering and Science Congress and Atomic Exposition,* Cleveland Municipal Auditorium, Cleveland, Ohio. Fifty technical sessions will cover every phase of peace-time uses of atomic energy and its by-products. Nuclear developments for applications in industry, science, and agriculture will be exhibited. For information, write to Atomic Exposition, 931 Book Bldg., Detroit 26, Mich.