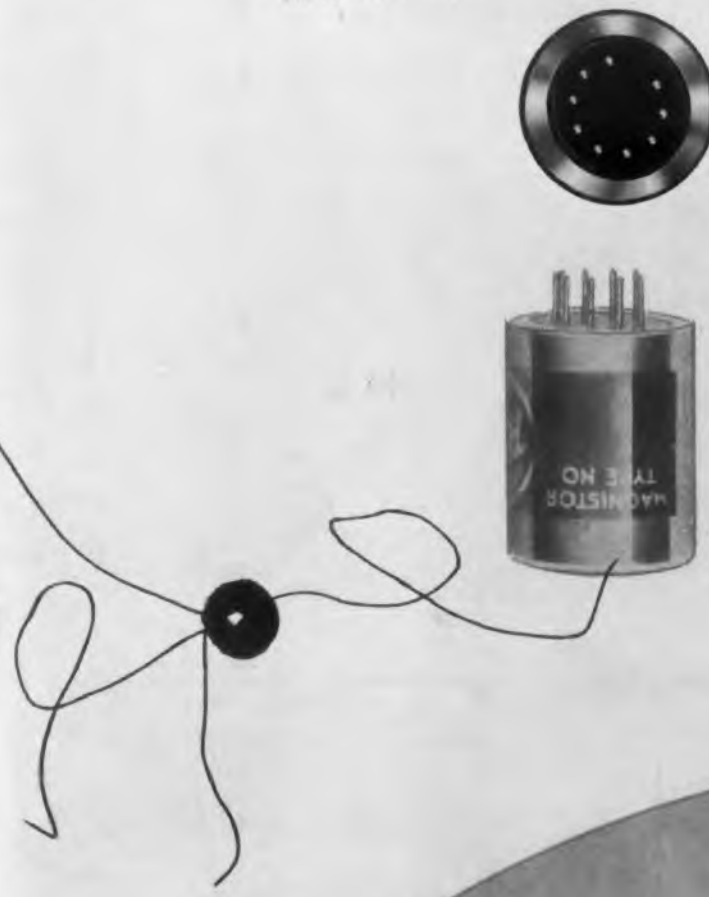
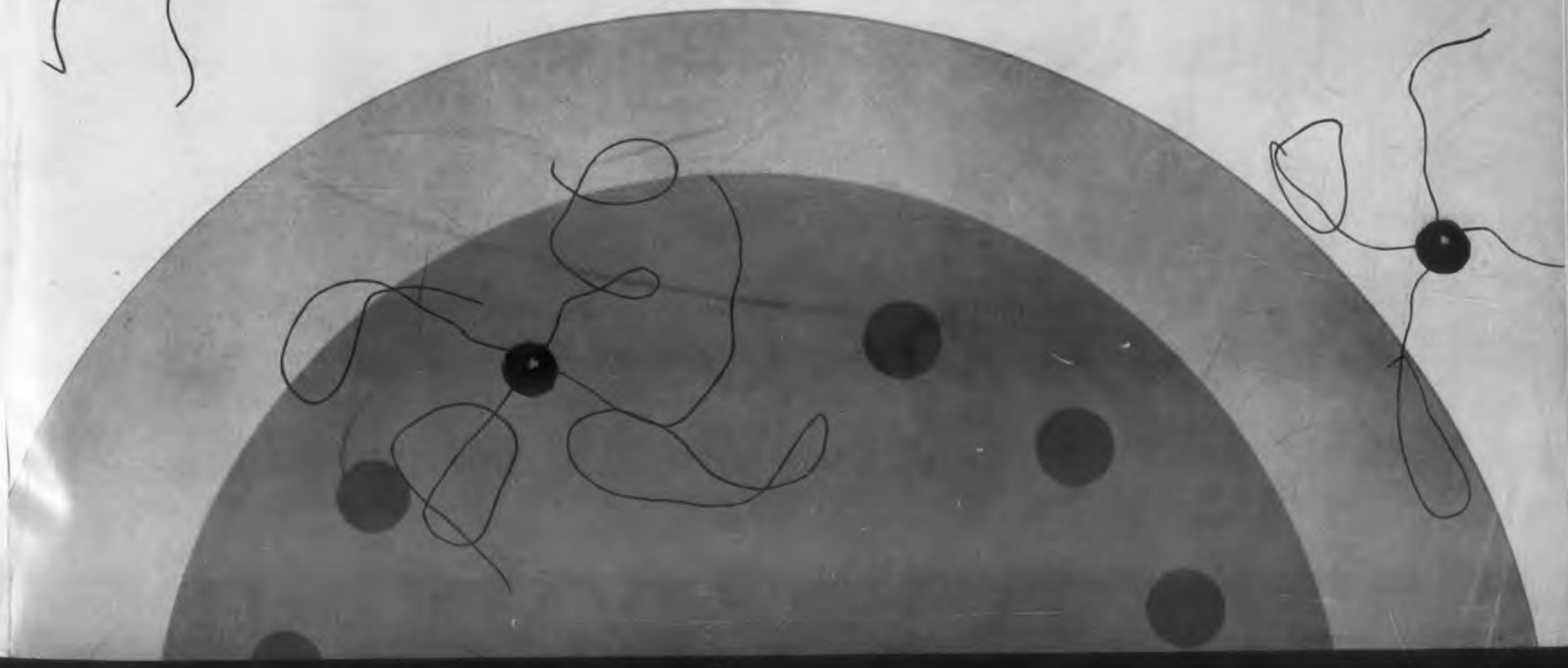
ELECTRONIC DESIGN

APRIL 1955



Amplification as well as information storage are applications for an unusual new ferroceramic element known as a "Magnistor". Shown at the left in actual size, these units can perform many of the functions of electron tubes, transistors, and other magnetic core devices. As amplifiers they have power gains up in the thousands. As memory units they can retain information indefinitely. Their life is long and not affected by temperature.



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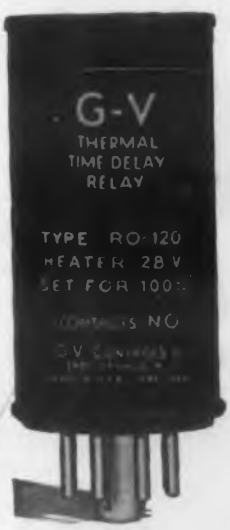

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CIRCLE ED-2 ON READER-SERVICE CARD FOR MORE INFORMATION

Editorial

Attack Now

Sometimes the answer to a problem can't be seen because it's right under your nose. Let us illustrate a case in point.

The engineering shortage problem certainly made news during the recent IRE Convention. Local papers carried several pages of engineering employment advertisements before, during, and after the convention. Employment notices by the dozens were posted on bulletin boards at the Waldorf Astoria Hotel where the meetings took place. In many booths at The Kingsbridge Armory and the "Annex" engineers were being approached with job offers.

With all this going on, we wonder how many people noticed that right at the show, dozens of devices displayed could do more to really alleviate the engineer shortage problem then all the employment recruiting activity put together. Computers, both large and small, digital as well as analog; building-block pulse generating systems; test equipment such as curve plotters and special purpose oscilloscopes; ingeniously designed chasses for prototype work;—these and other equipment displayed represented real time saving tools for making designers more effective.

It is management's responsibility to provide technical personnel with as many design aids as possible. It is up to designers to let management know that these tools are needed right now. This is an economical, frontal, and immediately effective attack on a problem that is becoming more acute every day. It is certainly a lot better than waiting for the number of engineering graduates to increase.

A New Service

Each month we receive letters and phone calls requesting various kinds of information. We do our best to answer these as soon as we can. It occurred to us that many of these inquiries can be better answered by our readers if they knew what information was desired. We would therefore like to make the pages of ELECTRONIC DESIGN available to expedite the exchange of such information.

If you need a special circuit, component, material, laboratory instrument, technical reference, etc., that you have had difficulty locating, send us your request on a company letterhead. We will publish it along with your name and address in the earliest issue possible. Interested readers can then answer your question directly by mail or phone.

Address requests to Information Department, ELECTRONIC DESIGN, 19 E. 62nd St., New York 21, N. Y. Please make requests as brief as possible.

Engineering Review . . .

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

Direct-Coupled Transistor Circuits . . . By taking advantage of certain characteristics of the "surface-barrier" transistor, a group of direct-coupled transistor computing circuits have been designed. As illustrated, the direct-coupled circuits require far fewer additional components than vacuum-tube or diode-and-vacuum-tube computer circuits. Of interest to all computer engineers, the circuits are particularly interesting to designers of airborne computers.

These circuits were developed by Philco Corp., Government & Industrial Div., 4700 Wissohickon Ave., Philadelphia 44, Pa. They employ this firm's *L-5106* surface-barrier transistors. An experimental computer called "TRANSAC" has been constructed by means of these circuits. The arithmetic section of TRANSAC is only 5-1/2" cubed in dimension. Incorporating 1242 transistors and only 322 resistors, TRANSAC adds or subtracts in 2.4microsec. Its power requirements are 5-3/4w at 3v. The section is constructed of 20 printed-circuit broads.

Among the direct-coupled circuits that have been developed in addition to the clocked or-and-or pyramid are flip-flops and binary adders. The surface-barrier transistor is not the only type that can be utilized in these circuits. Other manufacturers' alloy junction transistors have been employed in these circuits, but they operate much slower. The supply voltage for the surface-barrier transistor in these circuits is not critical. It can vary from 1.5 to 4.5v. In addition, noise is no problem.

Atoms-For-Peace Progress . . . The Atomic Energy Commission is urging American industry to be prepared to assist other nations in the design and fabrication of research reactors and components. Many foreign reactors should be constructed under the "atoms-for-peace" plan, for which 100 kilograms of Uranium 235 have been earmarked.

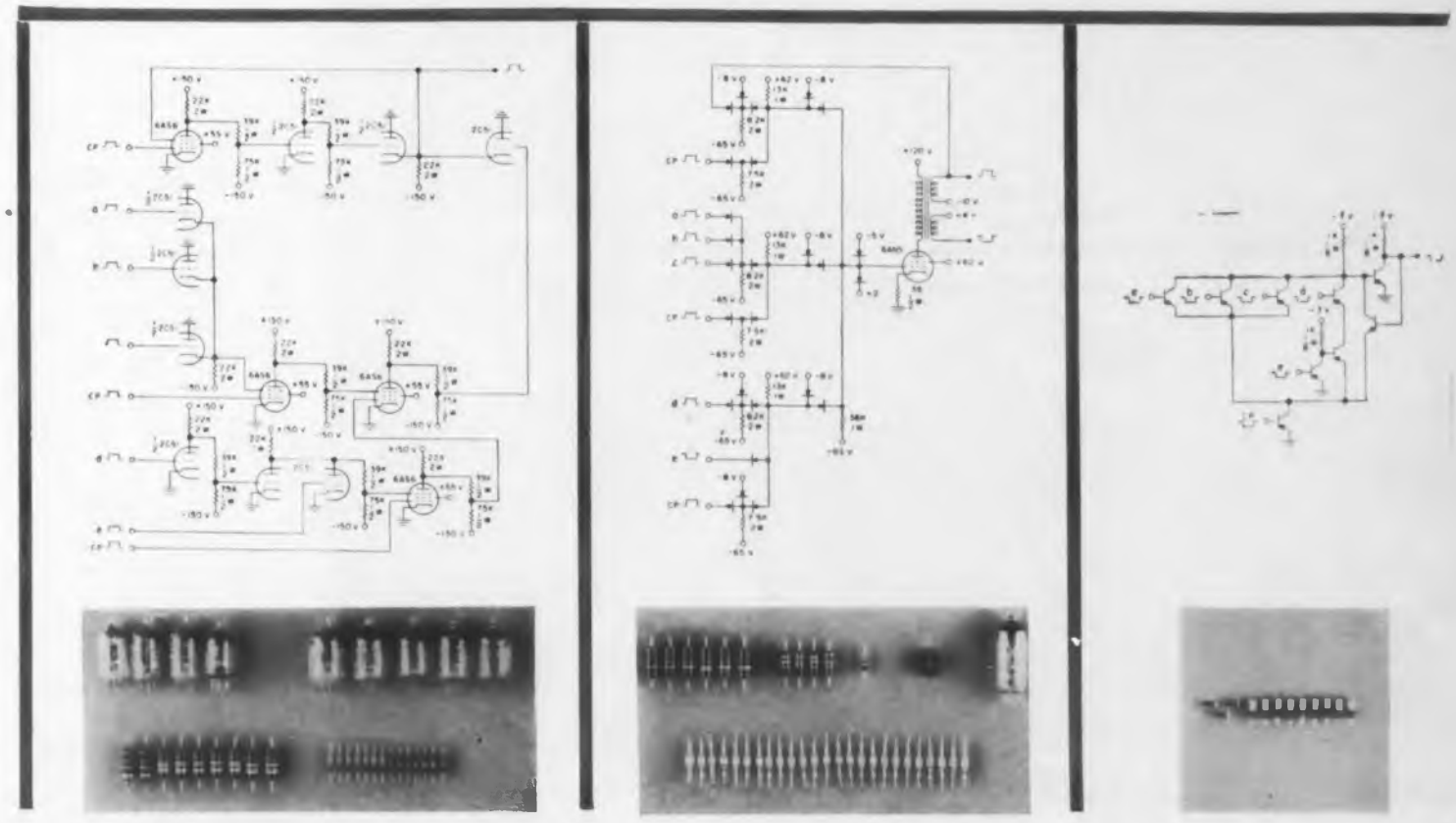
The construction of reactors for other nations should also provide a market for electronic radiation measuring and detecting instruments, both in the original installations and research laboratories.

The reactor fuel will be in the form of uranium enriched in varying percentages of the fissionable isotope. A maximum enrichment of 20% of U-235 by weight has been established by the AEC. In general, the greater degree of enrichment desired, the smaller will be the amount of U-235 that can be obtained by a single applicant. There are already several types of good research reactors that can be constructed well within the maximum enrichment of 20%. Additional designs are expected to be developed abroad and commercially in this country.

Camera Repair Aided Electronically . . . The exact point of malfunctioning of complex electronic motion picture cameras is indicated by a newly developed electronic device. Known as the Universal Camera Test Panel Model II, the instrument can be operated by relatively unskilled technicians. The development of such a device is another indication of the shortage of skilled technicians to service the ever growing total of increasingly complex electronic instruments.

Developed at Gordon Enterprises, North Hollywood, Calif., by a group of engineers led by David M. Stern, the panel is most frequently used for repair of aerial reconnaissance cameras. Among the tests that the panel makes are the measurement of pulse durations for all camera operating parts that utilize relays, all cyclic operations, and the recording of such parameters as noise level interference and the number of cycles. Camera shutter malfunction is shown by characteristic patterns on scope.

These circuits and photos indicate the small number of components required by the direct-coupled surface-barrier transistor circuit (far right) in comparison with vacuum-tube and diode-and-vacuum-tube computer circuits (left and middle, respectively). All of these circuits are clocked or-and-or pyramids.



30-Channel Recorder

The activities of 30 different production machines can be monitored and recorded by this device on electrosensitive paper. Made by Alden Electronic and Impulse Recording Equipment Co., Westboro, Mass., the recorder indicates "off" time by not making a mark in that machine's channel.

Microwaves Transmitted 200 Miles . . . By using larger antennas and far greater power, broadband transmission of microwaves as much as 200 miles has been accomplished. Conventional practice is line-of-sight transmission between radio relay stations mounted on towers about 30 miles apart. One of the new antennas is illustrated below.

The new development stemmed from studies conducted at both Massachusetts Institute of Technology, Cambridge, Mass., and Bell Telephone Laboratories, Holmdell, N. J. It has been previously known that u-h-f frequencies traveled over the horizon under certain conditions, but they were believed to be too weak and undependable for practical use. In the course of investigating occasional interference attributed to such signals, it was discovered that u-h-f signals arrive at points over the horizon with remarkable consistency.

By erecting larger antennas and using higher power reliable over-the-horizon transmission has been achieved. The 10kw transmitters used are 20,000 times more powerful than the transmitters in the present transcontinental microwave system. It was found necessary to employ the lower frequencies in the u-h-f band to develop the necessary power. Television signals have been transmitted between the Holmdel laboratory and the M.I.T. Round Hill Research Station near New Bedford, Mass., a distance of 188 miles.

The new method of transmission should be very valuable in overwater relaying or over rugged territory where it is difficult to establish the conventional type of radio relay system. The new method is expected to supplement than replace conventional equipment.

Automatic Code Copying . . . A robot that converts Morse code signals from a radio receiver into the proper pulses for operation of standard teletype printers has been developed. The machine discriminates between number and figure groups in order to shift the teleprinter to the upper-case figure keys. It also senses the space between letters and between words.

Developed largely by William Reid-Smith-Vaniz, Jr., C.G.S. Laboratories, 391 Ludlow St., Stamford, Conn., the robot accepts signals at any speed from 10 to 600 words per minute. Known as the "Trak" code converter, the unit accepts keyed audio tones, keyed d-c voltages, or an undulator-inked tape fed past a photocell that in turn delivers a keyed direct current.

The robot is actually a type of computer. It has certain memory features essential to proper recognition of a Morse code letter and for proper mating to a teleprinter.

If a character is sent that is not recognized as a normal Morse code character or is unintelligible, the converter refuses to translate. Instead it transmits a question mark character to the teleprinter. The Trak automatically adjusts to changes in rate of sending.

Over-the-horizon microwave transmission is accomplished with this 60' diameter experimental antenna. It has 30 times the surface area of the conventional antenna at left.

Satellite as TV Relay . . . The possibility of using man-made space satellites as a means of relaying television signals across the ocean was discussed at the recent IRE National Convention. Dr. John R. Pierce, director of electronic research, Bell Telephone Laboratories, New York, N. Y., proposed a 100′ diameter satellite in an orbit 22,000 miles above the earth to reflect signals.

The complete relay system would require antennas 250′ in diameter at the sending and receiving stations and transmitting power of only 50,000w, an achievable figure. If the satellite were constructed, the chief problem would be keeping the satellite's reflecting surface steadily aimed in the proper direction.

Dr. Pierce's disclosure was made at a symposium on space stations. Among the other possibilities discussed was a very small man-made satellite called the MOUSE (Minimum Orbital Unmanned Satellite of the Earth). Prof. S. F. Singer, physics department, Univ. of Maryland, reported that the technical problems connected with the launching, control, and instrumentation of MOUSE are well within the range of present techniques.

Among the many scientific instruments that would be installed in the satellite would be one that measures the sunlight reflected by the earth. Such measurements indicate total world cloud coverage, data that can be used to forecast long-range climatic changes.

This operatorless factory truck is moving along a path determined by wires strung overhead. The wires carry radio signals.

Electronically Guided Truck . . . Operatorless electric factory trucks guided to their destination electronically have been developed. As illustrated, the little trucks and tractors follow routes determined by wires strung overhead. The wires carry a-m radio signals. A detecting device mounted on the trucks detects and interprets these signals, and actuates a mechanism that steers the truck along a path directly under the wire and following all its turnings.

The energy level of the signals is low enough not to interfere with any communications channels, as required by the FCC. The control signals are fed to the wire from transmitters installed at desired locations throughout the plant. To call a truck, a worker simply presses a button on the transmitter and the truck will come directly to the station from which the signal originated. The wires can be strung indoors or out or laid in a small slot in the floor.

Known as the "Guide-O-Matic" truck, they are manufactured by Barrett-Cravens Co., 630 Dundee Rd., Northbrook, Ill. They can also be driven by human operators in the conventional manner. The operatorless truck will hit a person standing in its path unless a pole of the proper material can be placed in front of it, which stops it automatically. These trucks are another step in the direction of the automatic factory. They help solve one of the most difficult of all operations to control automatically—materials handling.

Portable Transistorized Scope . . . An experimental portable 3" oscilloscope has been developed that incorporates 16 transistors. The battery operated unit weighs 16 lb. If developed as a commercial product, it is hoped that the oscilloscope will be from one-quarter to one-third of its present size. The instrument and its battery case are illustrated.

Designed by William G. Reichert of Allen B. du Mont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N. J., the unit incorporates that firm's *3WP* cathode-ray tube. In order to make the instrument much smaller, a special cathode-ray tube with a low filament drain must be developed.

Five of the transistors are used in the vertical amplifier, while the remaining 11 are in the sweep and synch circuits. The transistor complement includes 13 Germanium Products *2N97's*, two Western Electric *1698's*, and one Raytheon *CK 722*.

Four 240v photoflash dry batteries are connected in series to provide 960v for the accelerator of the cathode-ray tube. Mr. Reichert is considering using an oscillator- or vibrator-type high-voltage power supply to save weight in future designs. At present the high-voltage supply has a life of about 100hr, and the low-voltage supplies last approximately 40hr.

The response of the instrument is 20cy to 150kc, down 3db. The sensitivity is 200mv per inch through the high-impedance input and 500mv per inch through the low. The unit has a rise time better than 2-microsec and a writing rate of 3 to 100,000microsec per inch.

Electronics in Medicine . . . An automatic blood pressure recorder which will summon a nurse when the patient's pressure reaches a critical level is one of a group of new electronic devices for the hospital. A device used to measure the flow of blood from the heart is also being made, and an instrument that will provide a moment-by-moment report of a patient's pulse rate, blood pressure, respiration, and other vital factors for use in surgery is being developed.

The blood pressure recording device automatically records pressure at selected intervals of from 30sec to 1 hr. It measures both diastolic and systolic pressure. By setting any pressure into the device, the nurse of a post-surgery or cardiac patient can be summoned to the patient if the pressure falls to the pre-set level. To warn the nurse, the machine is connected to a buzzer or light system. The recording device in operation is illustrated at the right.

In applying the device, the blood pressure cuff is wrapped aroud the patient's arm and inflated by automatic opening of an air storage supply valve. A microphone is strapped over the arm at the point where the physician holds his stethoscope in ordinary pressure reading. The sound-impulses detected by the microphone are amplified and then actuate a printer which records the air pressure in the system at the time it is equal to the blood pressure.

The instrument used in determining the flow of

The Du Mont experimental portable oscilloscope and its battery case, which is just as large as the instrument. The entire unit consumes about 5w.

blood from the heart is known as a cuvette densitometer. Determination of this factor is necessary in many types of research and important in the diagnosis of many cardiac cases. While a small amount of blue dye is injected into the heart through an arm vein, a sample of blood is drawn from an artery in the arm through a transparent cell in the instrument.

The change in opacity of the liquid, due to the decreasing concentration of the dye as it is diluted in the blood, is detected by a sensitive photocell. This change is converted to an electrical signal which is recorded. The signals are recorded as a function of time and used in a mathematical formula for computing the heart output.

Initially developed at the National Bureau of Standards, Washington 25, D. C., these instruments were redesigned and adapted for the commercial market by the Colson Corp., Elyria, Ohio.

More TV Stations Recommended . . . One of the important factors limiting TV receiver production and sales is the lack of TV stations in many parts of the nation. The FCC has received recommendations from one station equipment manufacturer and the Joint Committee for Educational Television, Washington, D. C., for approval of lower power stations (minimum effective radiated power of 100w).

Present federal regulations, specifying high-power requirements, make construction of new stations in small communities uneconomical. The lower-power stations can be constructed at a fraction of the cost of the high-power stations. The manufacturer, Dage Television Div., Thompson Products, Inc., Michigan City, Ind., estimated that there are about 900 communities with a population of less than 50,000 which still do not have any local TV operations.

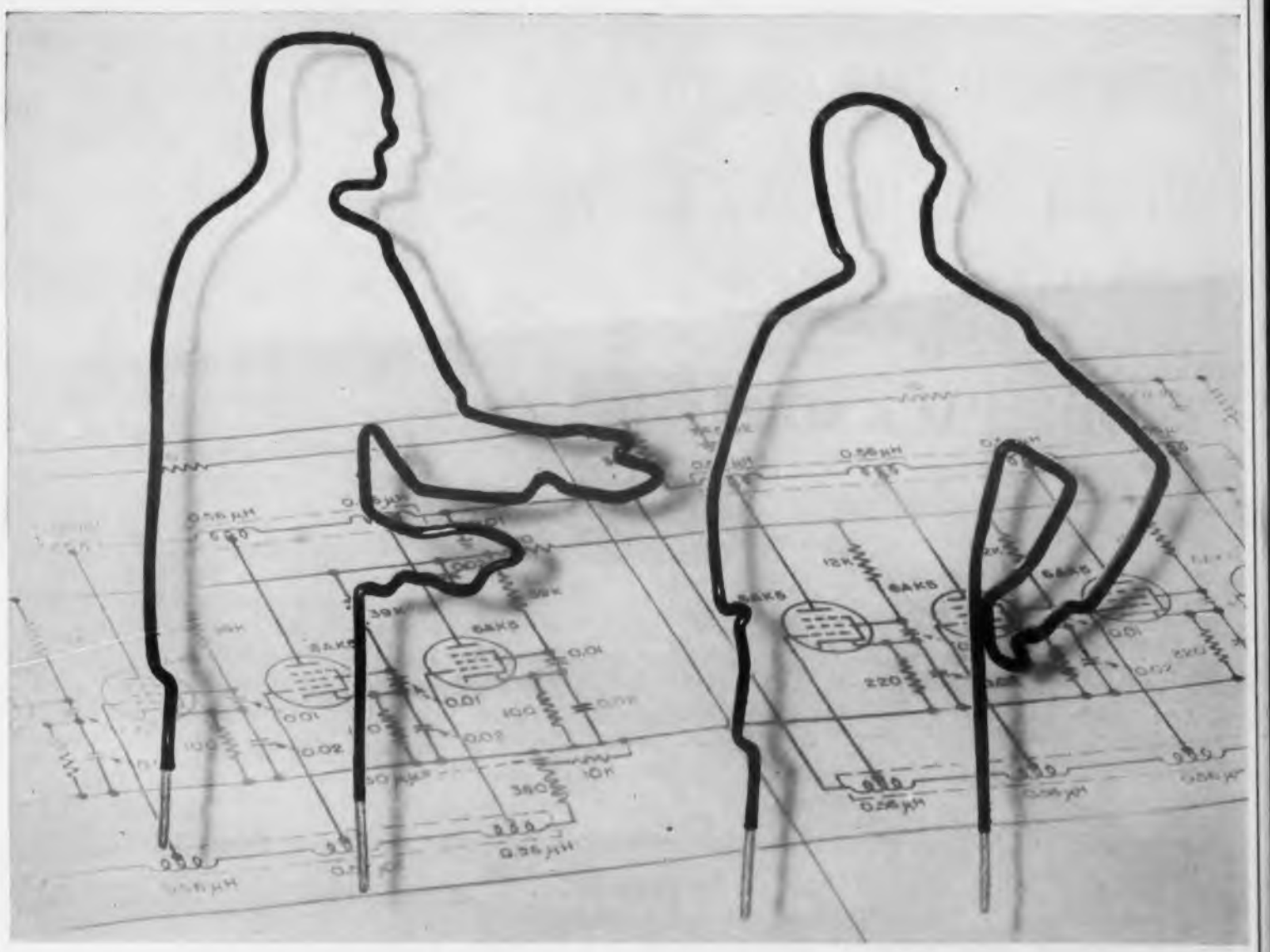
Many of the unused channels are in populous states. In Illinois, for example, there are 24 communities for which channels have been assigned and no applications filed for permission to build stations. New York has 20 open channels, and there are 19 in Ohio, 18 in Virginia, 17 in Indiana, and 12 in Pennsylvania.

All Transistor Computer . . . A digital transistor computer that will occupy only three cubic feet when made in a production version, has been developed for the U. S. Air Force. Known as "Tradic", the unit incorporates nearly 800 transistors and 11,000 germanium diodes. It requires less than 100w operation power.

A laboratory model of Tradic has been operating at Bell Telephone Laboratories, 463 West St., New York 14, N. Y., where it was developed, for some time. It can perform 60,000 additions or subtractions, or 3000 multiplications or divisions per second. The computer can handle, simultaneously, as many as 13 16-digit numbers. Although fundamentally a digital computer, it can also operate on analog data. The computer was developed under the direction of J. H. Felker of the Laboratories.

A transistor being inserted into one of the memory packages that is part of Tradic.

J. H. Felker is inserting instructions in this laboratory version of "Tradic" by means of a problem patch board while J. R. Harris places numbers into the machine by flipping switches.



Electronic Teaching Aid . . . A "Language Laboratory" containing 20 phonograph-equipped booths, each of which communicates with a master console, is improving the teaching of modern languages at Stephens College, Columbia, Mo. Students can play foreign language instruction records in the booth and then practice repeating the phrases, or the instructor at the console plays a tape and then can listen at random to each student.

Six of the partially sound-proofed booths are equipped with tape recorders so that students can record their classwork and then gage their progress by playbacks. The instructor can listen at the same time and make corrections.

Not only does the system speed language instruction, it also eliminates the embarassment of standing in front of a class and accepting corrections. The laboratory is so popular that students often spend extra time at their language studies.

The sound equipment was supplied by DuKane Corp., St. Charles, Ill. Such installations represent a potential market for sound reproduction equipment.

Have you returned your subscription renewal and qualification form?

See Page 96

This magnetometer "bird" is measuring the earth's magnetic field. The bird is nothing more than a streamlined case enclosing a bottle of water and a coil of wire. The aircraft's magnetic field does not influence the accuracy of the results.

Earth's Field Measured Easily . . . A bottle of tap water encircled by a coil of wire is the sensing element for detecting minute changes in the earth's magnetic field in a newly developed device. The "Varian Magnetometer", invented by Dr. Russel Varian, uses the inherent spin properties of the hydrogen nuclei to determine the earth's magnetic field variations and anomolies that indicate the presence of minerals or petroleum deposits.

The principle of the Magnetometer is extremely simple. Because hydrogen nuclei (abundant in tap water) are constantly spinning they may be likened to small gyroscopes. If the nuclei are polarized, the earth's magnetic field will cause the nuclei to precess at a rate proportional to the field strength. A surge of d-c current in the coil surrounding the bottle of water polarizes the nuclei. Standard counter equipment measures the frequency of precession (4200cy per gauss) and the results can be plotted by standard recorders. The device can measure precession at the rate of one cycle per second.

The frequency data can be telemetered to remote counters and recorders so that very little survey equipment need be transported. Required equipment can be easily carried by muleback or helicopter. The Magnetometer measures total earth's field; no gyro stabilization of the sensing element for orientation is necessary.

Hycon Aerial Surveys, Inc., 1020 S. Arroya Parkway, Passadena, Calif. has been granted rights to use the Magnetometer for making extensive magnetometric research explorations. It is predicted valuable mineral deposits previously out of the range of exist-

detecting equipment will be discovered. The probable presence of both ferrous and nonferrous minerals, petroleum, and even radioactive materials can be predicted. Significant variations in the earth's field are often as little as 0.1%. The magnetometer principle is credited with discovering the Venezuelan iron ore deposits, which dwarfs the Minnesota Mesabi Range in size.

Fast Printer for Computers . . . A new experimental process for printing the output of computers will print letters or numbers at speeds up to 5000 characters per second. A low-cost coated paper is employed. The letters or numbers are marked on the paper tape electrostatically.

The process requires three steps. In the first step, the tape is drawn past a group of electrodes that receive high-voltage pulses from an amplifier driven by the computer. The electrostatically charged paper is then drawn through a powdered dry ink bath. The particles of ink stick to the charged areas. In the final step, the inked paper is brought in contact with a hot plate that fixes the ink to the paper permanently. If only temporary records of computer output are required, the final step is omitted and the ink can be removed.

The process was developed at the Burroughs Research Center, Paoli, Pa. In addition to computer applications, the process could be used for high-speed addressing of magazines or labelling.

Ultrasonic Soldering Irons . . . Ultrasonic soldering irons have been placed on the market by both an American and a British firm. Both tools make it possible to solder to aluminum and magnesium without the use of fluxes. One of the units is illustrated.

In use the item to be soldered and the solder are heated by a heating coil in the transducer-soldering tip or by a gas heater mounted on the transducer. The ultrasonic vibrations spread the solder evenly and make it adhere to the material. A separate ultrasonic generator feeds the transducer. The manufacturers are Vibro-Ceramics Corp., Metuchen, N. J., and Mullard, Ltd., London, England. The ultrasonic generators can be utilized with other tools such as ultrasonic drills.

Bicycle Radio . . . A bicycle will be placed on the market shortly that will include a radio as standard equipment. Mounted in a waterproof container under the crossbar, the radio is powered by batteries mounted on a rack over the rear wheel. The antenna sticks out of the bottom of the radio enclosure.

Known as the "Radiobike", the bicycle is made by the Huffman Manufacturing Co., Dayton, Ohio. The radio was developed by the Yellow Springs Instrument Co., Yellow Springs, Ohio. This standard broadcast band radio is turned off and on by a key.

Radios for bicycles have already been manufactured by both German and Japanese firms. Unlike the Huffman radio, they are mounted on the handlebars in containers that resemble headlights.

Electronics Speds Gambling . . . Among the ever increasing uses for closed-circuit TV are the posting of odds at a race track and the reproduction of microscope images. Both uses are shown on this page.

The installation at Santa Anita race track, Arcadia, Calif., is used to send final prices marked on cards from the paramutuel calculator to monitors at the pay-off windows. The usual method of transmission is by runners.

By mounting a TV camera on the microscope and reproducing the image on a monitor, more than one person can observe the image. In addition, the observers, who could be a group of students in a classroom, do not have to be in the same room as the microscope. The method also reduces eye fatigue. It could have considerable use in the inspection of small parts on a production line.

The closed-circuit equipment for both of the above purposes is manufactured by Kay Lab, 5725 Kearny Villa Rd., San Diego, Calif.

Below race track odds are transmitted by closed-circuit TV to monitors at pay-off windows. Microscope image is picked up by TV camera for display before large audience at the right.

ECDA Spring Meeting . . . Only one out of five new products are successful according to a recent survey, which indicates a real need for intelligent product planning. This was brought out at the Spring meeting of the Electronic Commercial Development Association (ECDA) which was held March 22, 1955 at the New York Athletic Club in New York City. Mr. J. W. Birkenstock, Director of Product Planning and Market Analysis at International Business Machines Corp., speaker of the evening, explained how his company views this problem and what procedures they use in planning a new product.

Basic ideas for new products originate from IBM people, outside sources, as well as from a systematic and continuing study of the business world by an advance planning group. If deemed feasible, the ideas are then assigned to a group that gets down to the details of developing the product. Market analyses are made periodically to see if there is a continuing need for the product and contract relations are carefully examined to anticipate legal problems. Finally, a thorough product testing is made before the device is released to production.

The basic fundamentals of their organized planning activities can be applied to any company according to Mr. Birkenstock. Many small companies need not have as extensive a product planning program as does IBM, but some form of such activity is absolutely essential to assure future company growth and survival. A lively discussion period followed the conclusion of Mr. Birkenstock's very interesting talk.

The meeting was held under the auspices of the Electronic Commercial Development Association. This is a nonprofit, informal, independent group consisting of individuals responsible for new product development who have had at least five years of experience in this activity. Information on the organization can be obtained by writing to the Secretary, ECDA, J. S. Mulholland, 19 East 62nd St., New York 21, N. Y.

Smog Measured Electronically . . . An automatic photoelectric instrument for continous measurement of ozone in the earth's atmosphere at low altitudes will aid in smog studies at Los Angeles, Calif. Developed by the National Bureau of Standards, Washington 25, D. C., according to the March *Industrial Resarch Newsletter*, published by the Armour Research Foundation, Chicago, Ill., the selective ultraviolet absorption characteristic of ozone is used to determine the minute cocentrations present in the atmosphere. The ray is directed over a 1500′ path.

The *Newsletter* also reported a new type of scintillation counter developed at Argonne National Laboratory, Chicago, Ill. It was found that aplha particles shot into helium or argon, or mixtures of these gases with nitrogen, give pulses readily measured with photomultipliers. The chief advantages of this device are high speed and insensitivity to gamma rays. Another new development reported is a magnetic amplifier with a response time of one-half of a cycle. Designed specifically for control of two-phase motors in servomechanisms, the device needs no warm-up time. It was designed by the U. S. Navy.

Cloud-Altitude Indicator . . . Operating much like Radiosonde, a newly developed device indicates the altitude of clouds. Known as "Cloudsonde", the instrument is carried aloft by weather ballons and transmits information back by means of a small transmitter.

Although developed primarily for cloud information, the unit is also capable of detecting the presence of impurities in the atmosphere hardly visible to the naked eye, such as dust or smoke. It is manufactured by Lucian Laboratories Electronics Div., 220 Darby Rd., Havertown, Pa.

Usually indicating the presence or absence of clouds, the Cloudsonde can be modified when necessary to also transmit quantative data on varying densities.

◀ CIRCLE ED-13 ON READER-SERVICE CARD

Graduate Study Program . . . The Dalmo Victor Co., San Carlos, Calif., has become a participant in the Honors Cooperative Program of the School of Engineering, Stanford, Univ. Engineers appointed to the program will be put on the company payroll and given regular assignments in the Engineering Laboratory, except that working hours will be reduced by an amount about equal to the time spent in regular daytime graduate classes at Stanford. Time required for outside study and commuting between plant and university will be the student's contribution.

The company will appoint, during the first year of the five-year program, one microwave specialist, one servomechanism engineer, one mechanical engineer, and one industrial engineer.

New Transistor Application . . . Transistors are now being incorporated in power-line carrier communication equipment used by power utilities. In addition to transmitting voice communications over the power lines, the equipment is used for protective relaying, telemetering, and teletype.

Manufactured by Motorola, Inc., 4545 W. Augusta Blvd., Chicago 51, Ill., the transistorized equipment operates with only 500cy between channels. The transistors are of Motorola's own design.

Award to Honor Sperry . . . An award to commemorate the life and achievements of the late Elmer A. Sperry has been made possible by Dr. Sperry's daughter and son. The American Society of Mechanical Engineers will administer the award fund.

The Elmer A. Sperry Award will be bestowed in recognition of "a distinguished engineering contribution which through application, proved in actual service, has advanced the art of transportation, whether by land, sea, or air." The award may be made to an individual or to a group. The first award will be conferred this year.

CIRCLE ED-14 ON READER-SERVICE CARD ➤

TV-Controlled Cancer Treatment... The movements of a radioactive cobalt source employed to treat cancer in humans are being observed and controlled by television in a new application for closed-circuit TV. The system was developed to protect the medical personnel directing the treatment.

The cobalt source is encased in 2000 lb of lead shielding and housed in a room with an armor plate door and three-foot-thick concrete walls. The closed-circuit equipment consists of a camera, camera control, and synchronizing monitor. Developed by Kay Lab, 1090 Morena Blvd., San Diego 10, Calif., for industrial applications, the system is installed at Cedars of Lebanon Hospital, Los Angeles, Calif.

Electronics Aids Printing . . . An electronic device for insuring accurate "registration" of paper during rotary press printing has been placed on the market. Accurate placement of the sheets of paper is essential to proper printing of colors one on top of another.

Known as the "Registron", the unit is manufactured by Champlain Co., 88 Llewellyn Ave., Bloomfield, N. J. It incorporates a photocell that provides the signal for retarding or advancing the printing cylinder.

Supersonic Flight Simulator . . . An electronic simulator that trains pilots of F-100A jets at simulated supersonic speeds has been constructed for the U. S. Air Force. The instrument was made by Westinghouse Air Brake Co. at Melpar, Inc., Falls Church, Va., a subsidiary.

Consoliated Design Specs . . . Industry will soon have a single, central source for determining design requirements for the millions of dollars of ground equipment purchased annually by the U. S. Air Force. The "Handbook of Instructions for Ground

◄ CIRCLE ED-15 ON READER-SERVICE CARD

Equipment Designers" will be a companion handbook to the existing "Handbook of Instructions for Aircraft Designers".

The 400-page book will be available this summer. The chapter on "Communications and Navigation" will include much specific design information relating to communications, navigation, data-transmission, search, detection, tracing, and other radar gear, and electronic countermeasure equipment. The handbook was prepared by Becker & Becker Associates, 509 Madison Ave., New York 22, N. Y.

Italy Imports TV Sets . . . The Italian government will authorize the importation of an additional 5000 or 6000 TV receivers from the United States, it was reported in the *DuMont Dispatch* for March 1955, published by the International Div., Allen B. Du Mont Laboratories, Inc., Empire State Bldg., New York, N. Y. During 1953 some 11,500 TV receivers were set as the quota for importation. There are now more than 70,000 receivers in operation in Italy.

Marconi Medal Winner . . . Monte Cohen, president of General Instrument Corp., has received the Marconi Medal of Achievement from the Veteran Wireless Operators Association in recognition of his achievements in radio and TV. Mr. Cohen has been credited with the design and development of some valuable components in the wireless field.

Women Engineers . . . Women were urged to consider engineering as a career and industry was urged to search for engineering talent among women in a recent speech by a woman engineer. Estelle W. Elliot, on the engineering staff of the Lockheed Aircraft Corp. plant at Marietta, Ga., disclosed that there are only 1500 women performing engineering work in the nation. She urged parents to encourage their daughters to prepare for engineering studies to meet the great shortage of engineers.

CIRCLE ED-16 ON READER-SERVICE CARD ➤

Meetings

April 27-29: *Seventh Region Technical Conference and Trade Show,* Hotel Westward Ho, Phoenix, Ariz. Sponsored by the IRE. For information, write to A. M. Creighton, c/o Motorola, Inc., 3102 N. 56th St., Phoenix, Ariz.

April 29-30: *New England Radio-Electronics Meeting,* Sheraton Plaza Hotel, Boston, Mass. Sponsored by the Boston and Connecticut Valley Sections of the IRE. For information, write to Robert A. Waters, Robert A. Waters, Inc., 4 Gordon St., Waltham, Mass.

May 2-5: *Semiconductor Symposium,* Cincinnati, Ohio. For information, write to F. J. Biondi, Bell Telephone Laboratories, Murray Hill, N. J.

May 3-5: *First National Flight Test Instrumentation Symposium,* Allis Hotel, Wichita, Kans Sponsored by the Instrument Society of America For information, write to H. T. Noble, Jr., 6110 Oakwood Drive, Wichita, Kans.

May 4-6: *International Aviation Trade Show,* 69th Regiment Armory, New York, N. Y. For information, write to Aircraft Trade Shows, Inc., Hotel McAlpin, New York 1, N. Y.

May 5: *Conference on Cost Reduction and Methods Time Measurement,* Hotel Van Orman, Fort Wayne, Ind. Sponsored by the American Institute of Industrial Engineers. For information write F. J. Henry, Chamber of Commerce, Fort Wayne, Ind.

May 9-11: *National Aeronautical Electronics Conference,* Biltmore Hotel, Dayton, Ohio.

May 10-12: *Metal Powder Show and Metal Powder Association Annual Meeting,* Bellevue-Stratford Hotel, Philadelphia, Pa. For information, write to Metal Powder Association, 420 Lexington Ave., New York 17, N. Y.

May 16-19: *Electronics Parts Distributor Show,* Conrad Hilton Hotel, Chicago, Ill. For information, write to S. I. Neiman, 1 N. La Salle, Chicago 2, Ill.

May 18-20: *National Telemetering Conference,* Hotel Morrison, Chicago, Ill. For information, write to IRE, 1 E. 79th St., New York 21, N. Y.

May 19-21: *Global Communications Conference,* Hotel Commodore, New York, N. Y. Sponsored by the Armed Forces Communication Association.

May 23-25: *Ninth Annual Convention of the American Society for Quality Control,* Hotels Statler and New Yorker, New York, N. Y. For information, write to W. E. Gaunt, E. R. Squibb and Sons, New Brunswick, N. J.

May 26-27: *Electronic Components Conference,* Ambassador Hotel, Los Angeles, Calif. Abstracts of papers and requests for information should be addressed to Dr. Lester M. Field, 8820 Bellanca St., Los Angeles, Calif.

May 31-June 3: *Basic Materials Exposition,* Convention Hall, Philadelphia, Pa. For information, write to Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N. Y.

May 31: *Symposium on Elementary Particles,* Pisa, Italy. Sponsored by the International Union of Pure and Applied Physics. For information, write to Dr. H. A. Barton, Secretary, U. S. National Committee, International Union of Pure and Applied Physics, 57 E. 55th St., New York 22, N. Y.

June 14-16: *Conference and Exhibit on Magnetics,* William Penn Hotel, Pittsburgh, Pa. Sponsored by the AIEE, American Institute of Mining and Metallurgical Engineers, and American Physical Society. For information, write to A. C. Beiler, c/o Westinghouse Electric Corp., 2-F Materials Engineering Dept., E. Pittsburgh, Pa.

June 20-25: *International Symposium on Electromagnetic Wave Theory,* Univ. of Michigan, Ann Arbor, Mich. Sponsored by Commission VI of URSI. For information, write to J. W. Crispin, Jr., Univ. of Michigan, Ann Arbor, Mich.

June 27-29: *First Annual Nuclear Society Meeting,* Pennsylvania State University, State College, Pa. Sponsored by the American Nuclear Society. For information, write to Prof. W. W. Miller, Pennsylvania State University, State College, Pa.

June 27-July 1: *AIEE Summer General Meeting,* New Ocean House, Swampscott, Mass. For information, write to AIEE, 33 West 39th St., New York 19, N. Y.

August 24-26: *Western Electronics Show and Convention,* Civic Auditorium, San Francisco, Calif. Sponsored by the West Coast Electronic Manufacturers' Association and the Seventh Region of the IRE. For information on exhibits, write Mal Mobley, Jr., 344 N. LaBrea Ave., Los Angeles, Calif. Technical papers should be submitted to Dr. W. A. Edson, Applied Electronics Laboratory, Stanford, Calif.

Using Magnetic Cores in Computers

Robert D. Kodis

Head, Research and Development Section, Computer Dept.
Raytheon Manufacturing Co., Waltham, Mass.

MAGNETIC core circuits can be found performing the computer functions of storage, manipulation, control, amplification, regulation, and several minor special applications. This article will attempt to support the growing trend to the use of this two-state component by cost, specification, and circuit analyses. The use of the magnetic core will be discussed in function groups: internal memory; buffer memory or input-output memory; high speed logic; and finally low speed logic circuits.

Internal Memories

The internal memory is usually a major factor in controlling the overall system characteristics. Thus, the memory specifications are important and should include at least: (1) number of registers and their size; (2) mode of operation-parallel, serial or any combination; (3) initial and repeated access time; (4) cost; (5) environmental conditions; (6) operating margins.

The unwritten requirements for all the core circuits to be discussed include reliability, a combination of operating margins, life, and transient conditions. The reliability of magnetic core circuits has been demonstrated to be mainly dependent upon the equipment and components associated with the core rather than the core itself. Thus, it is the high ratio of cores to other components that provides such high reliability of large coincident current memories. Fig. 1 illustrates storage size for 44-bit words versus the amount of equipment for control, drive, selection and other functions considered to be part of the storage system (a unit of equipment is defined as one vacuum tube or twenty diodes). While in these memories, cores are used only in the main storage function, the use of cores in the selection, control, or drivé functions would not radically change the comparison shown. In fact, it would improve the reliability of all three memories.[1, 2, 3, 4] Fig. 1 presents a persuasive argument for using coincident current core storage in memories of 4000 bits or more. Consequently, we find the coincident current memory most often used in large, general-purpose storage where its great saving in equipment per unit of storage easily offsets its lack of flexibility. On the other hand, we find the shift register memory in small or special purpose systems, where it requires the least equipment. It becomes evident, then, that the combination of these two basic types of storage can provide useful circuits for special requirements, such as a memory using coincident current to write in and shift register techniques to read out.

The low cost involved in using coincident current techniques in memories of 35 words (1,500 bits) or more is demonstrated by Fig. 2. However, a qualification of this low number is usually required when fitting such a small memory into the system. Such qualifications might be a parallel memory in a serial system, certain decoding of address selection, or the flexibility required of a memory cycle. The additional equipment required usually pushes the dividing line closer to 50 words. The operating margins of coincident current memories lie in an area of 1 to 1.3, whereas shift register memories have margins greater than 1 to 3. Systems with operating margins in excess of 8:1 are available.

The core-diode memory has served useful purposes in several systems. At present, however, it does have the disadvantage of a high overhead cost in equipment, as shown by Fig. 1, and it is relatively poor in operat-

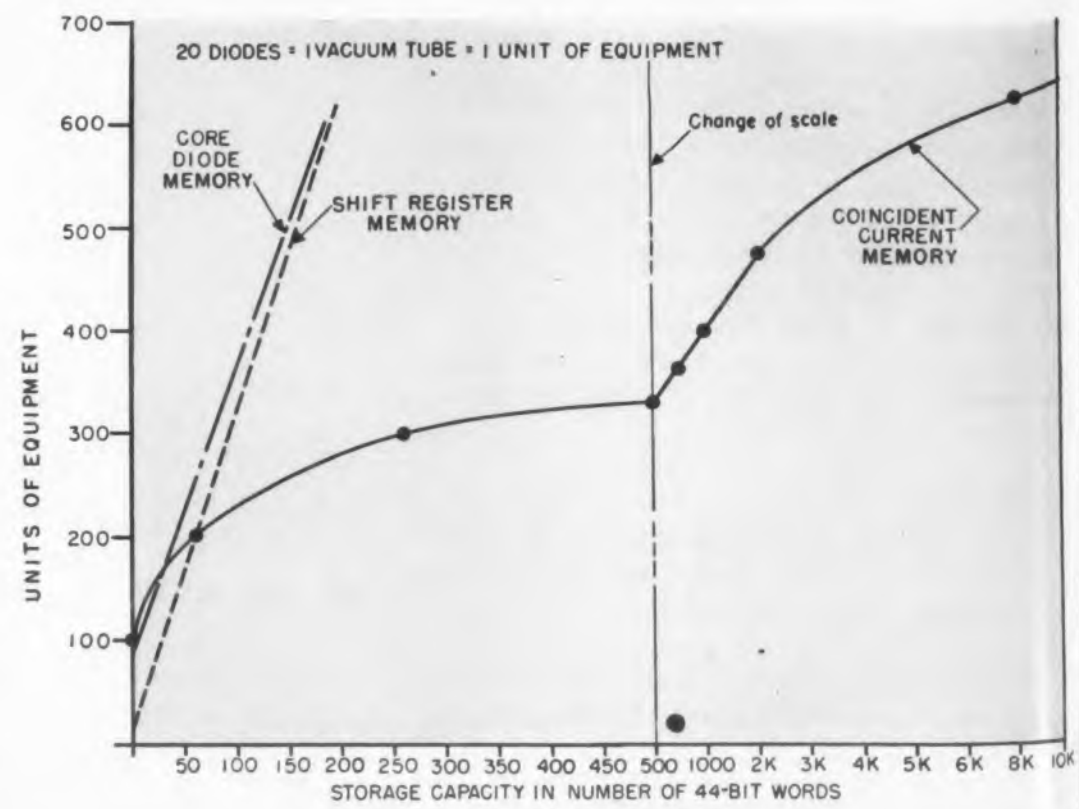


Fig. 1. This chart indicates which type of memory requires the least equipment for a specific size memory.

ing margins, life, and reliability due to the operating characteristics of the diodes.

The shift register memory has an initial access time of 0.2microsec and a repeated access of less than 2microsec. The coincident current memory has an initial access time of one and a repeated access time of less than 7microsec.

Buffer Memories

In buffer memories, additional specifications are usually required, such as the ability to operate over a range of pulse rates, accept either parallel or serial information, complement, insert, or shift stored information. The magnetic core shift register is the only component that can accomplish these functions directly. Thus, the shift register is highly practical for use in buffer memories as large as 10,000 bits. Buffers have also been built using core-diode type storage. The experience reported from these equipments showed usable operating margins, but relatively poor reliability and life, due again to the operating characteristics of commercially available diodes.

Flexibility of controls makes the shift register the only type of buffer which is usable with certain frequency modulation types of magnetic recording systems. A register is normally used in such manner so that all information is transferred upon command. However, the ability to transfer part of the information any number of times while the remainder is static is very useful in simplifying certain timing problems.

The two-core per-bit or Harvard-type[5] shift register has almost no system application that is not better implemented by one-core per-bit "Single Line" registers[6]. The principle of the "Single Line" register can best be understood by referring to Fig. 3. As may be seen from the illustration, all the magnetic cores are driven from a common shift line. In this application, the read out of the n^{th} core is delayed from writing into the $n+1$ core for a period greater than the shift pulse duration.

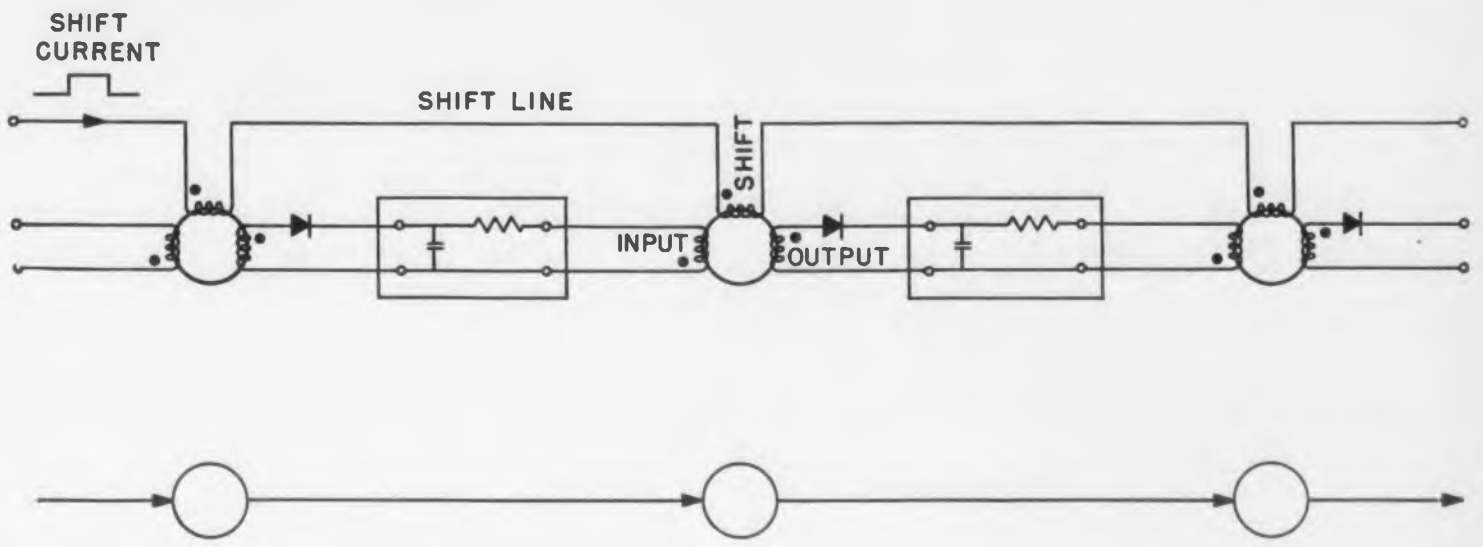


Fig. 3. The "Single-Line" shift register and its symbolic representation.

Magnetic shift registers using selenium diodes are still doing useful work after 20,000hr. However, a continual increase in forward resistance of the diode has taken place until the resistance has about doubled at 18,000hr. The designer of long-life registers using selenium diodes must recognize this situation. Magnetic shift registers employing germanium, gold-bonded diodes have had over 8,000hr operation with no measurable changes in their operating characteristics or their output signals.

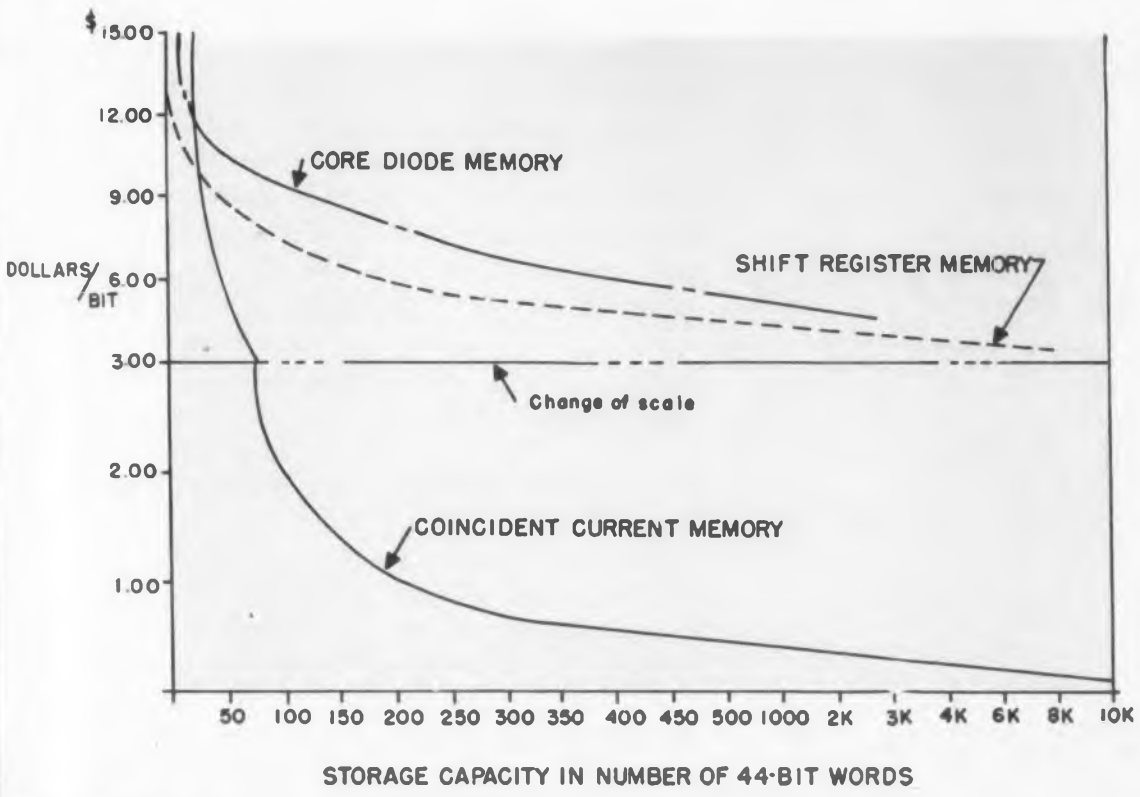


Fig. 2. The engineering economics of memory design are simplified by this unusual chart.

High Speed Logic

The logic required for control and data manipulation in computing systems can be handled in many cases by magnetic core logical elements. For pluse rates in the megacycle range the core logic must still be considered merely a laboratory device. However, for pulse rates up to 500 kc, the cores should definitely be considered for logical structures. The types of circuits that are being studied for this purpose are too numerous for recounting here.[7,8,9] Also, since we are comparing only practical devices, this reduces the discussion to ones now being used in workaday systems

The "Single Line" magnetic core shift register is the basic type of circuit used in the "Single Line" Magnetic Core Logical Element[10]. Since these are relatively new techniques, a brief description is in order. Fig. 5 illustrates a circuit diagram in which one core feeds two others. In theory, this type of branching may be done for any number of cores. The inhibit function can be accomplished by reversing the polarity of the input winding, as shown in Fig. 4. At present, the magnetic core logical element should be limited to a combination of three inhibit or input windings. However, more affirmations may be made on one logical stage by buffering the outputs of several elements together on the diode, as shown in Fig. 6. As a matter of fact, the output from one element can be used to drive three other stages.

The combination of these circuits permits the accomplishment of any logical function. For example, the "Exclusive Or" function is easily constructed with three cores, as shown in Fig. 7. The simplicity with which many other functions are implemented suits it for use in moderate and low speed systems. For example, a serial arithmetic unit capable of handling 24 digit binary numbers and sign, has actually been built. It uses only 150 magnetic cores, 150 diodes, and 8 vacuum tubes to perform all the manipulative func-

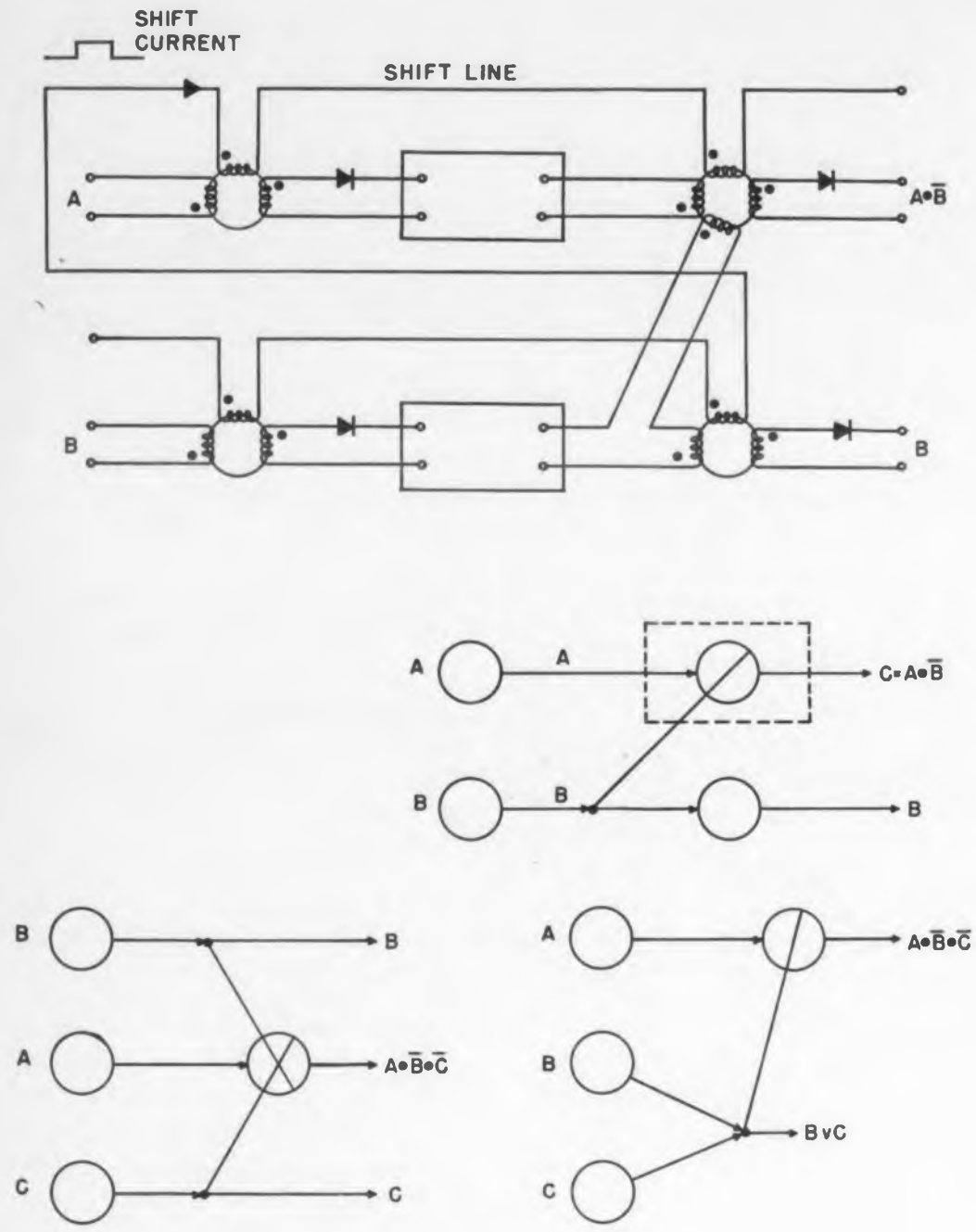


Fig. 4. A magnetic-core inhibit circuit, its symbolic representation, and two other symbolic inhibit circuits are used for high-speed logic in computers.

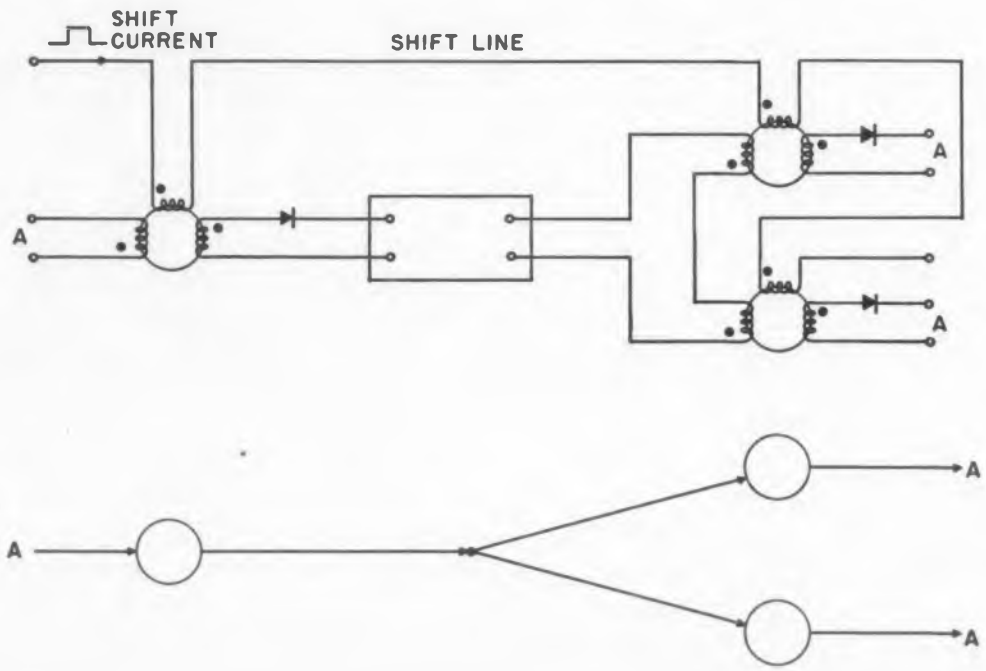


Fig. 5. A magnetic-core branching circuit for a high-speed logic.

tions, controls, and storage and operates at 0.25Mc pulse rates. It requires only 0.25 cubic feet of space, weighs 15 lb, and consumes a mere 130w, including filament power. A unit of this type would have obvious application to airborne problems where volume, weight, and power requirements are prime considerations. The range of environmental conditions over which this type of component will operate is quite useful even though they are still not all that is desired. For example, good operation can be held over the ambient temperature range from −80°C to +85°C.

The magnetic core logical element is designed to be a low impedance, low power device. This charactertistic enhances the core circuits, but leaves them at too low a voltage level to satisfy the requirements of vacuum tube circuits. The limitations on the usage of a magnetic core logical element still depend upon pulse rate, power level and choice of diodes. (On the other hand transistors work well with this type of magnetic core circuit[11].)

Low Speed Logic

In the low speed portion of computing systems the magnetic core logical element may be required to control mechanical equipment. If the logical statements require many cores for their implementation, the low power cores would be used and power amplification provided for the output. However, where the control function is simple a magnetic core of suitable size may be employed to provide the power directly. The cores themselves can be used for power gain to operate thyratrons or relays. Perhaps of even more significance is the direct read in and control of magnetic cores from mechanical and electro-mechanical sources. This elimination of all vacuum tubes and transistors places the reliability problem squarely on the diode. On the other hand, magnetic core-transistor circuits that can perform all of the above logical functions employ no tubes or diodes. Thus, we have a basic choice: diodes with a few tubes versus transistors.

The "Single Line" magnetic core logical element has a reliability close to the "Single Line" magnetic shift register. The number of elements driven from one tube depends upon the maximum density of positive information, power level of the driving tube, repetition rate of the information, power level of the cores, and the high-voltage supply used. The range of 16 to 65 cores per driving tube is common. Tube types such as *6AU5*, *5881*, and *6293* are being used as drivers. The driver can be considered as a pulsed power supply, since it does not normally enter into the logical structure.

The magnetic core is also being used as a different type of logical element or gate in selection systems. Several laboratories have developed saturable transformers, biased cores, and time-pulse sequence gates. These techniques are useful as driving source for other magnetic circuits, and magnetic recording, writing, and reading selection systems.[11,12,13]

The type of equipment required to transfer information from card to tape or tape to printer is especially susceptible to implementation by magnetic core circuits. The shift register storage eases the requirements of reading into storage from card reading brushes or other mechanical contacts. This characteristic is due to the ability to make the read-in to each core independent, and to combine parallel read-in with serial transfer. These equipments may be required to perform the functions of code conversion, speed conversion, radix conversion as well as format controls and checking. These functions, when accomplished by magnetic core logical elements, are best accompanied by shift register type storage.

A simple example is a binary-to-binary coded decimal converter and binary coded decimal to binary. This unit uses 100 cores to convert over 1000 decimal digits per second.

The promise of unusual reliability and long life of the magnetic core has been the motivating factor in most of the new developments using this component. The possibility of reduction in cost, weight, and power requirements has its measure of attraction. It is quite safe to predict that most computers designed in 1955 will use more magnetic cores than any other two-state component.

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14. H. Moffat, "Saturable Transformers as Gates" Quarterly Report, Second Series of the Computer Fellowship No. 347, March 31, 1954—Mellon Institute of Industrial Research.

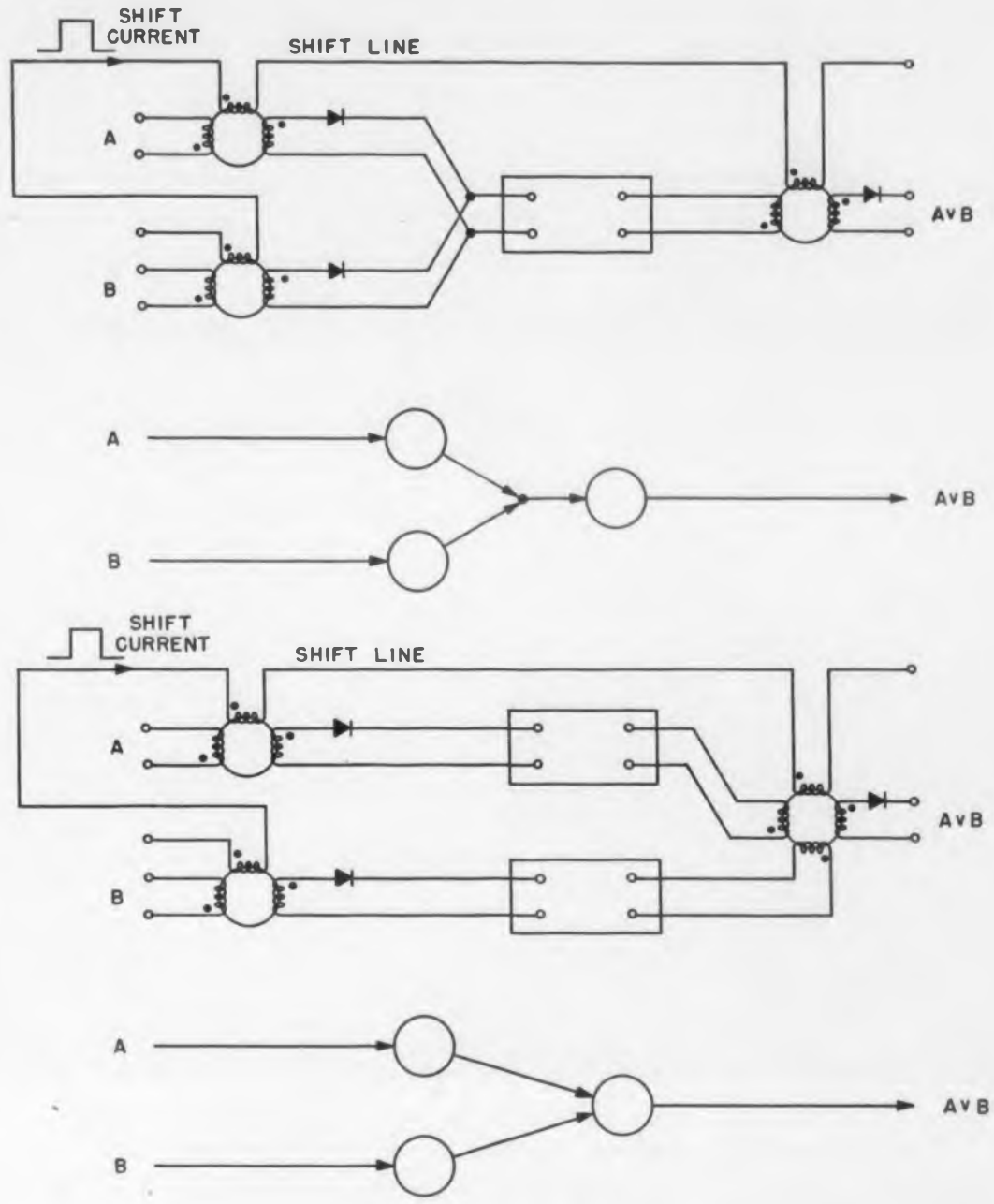


Fig. 6. High-speed logic mixing or buffer circuits utilizing magnetic cores.

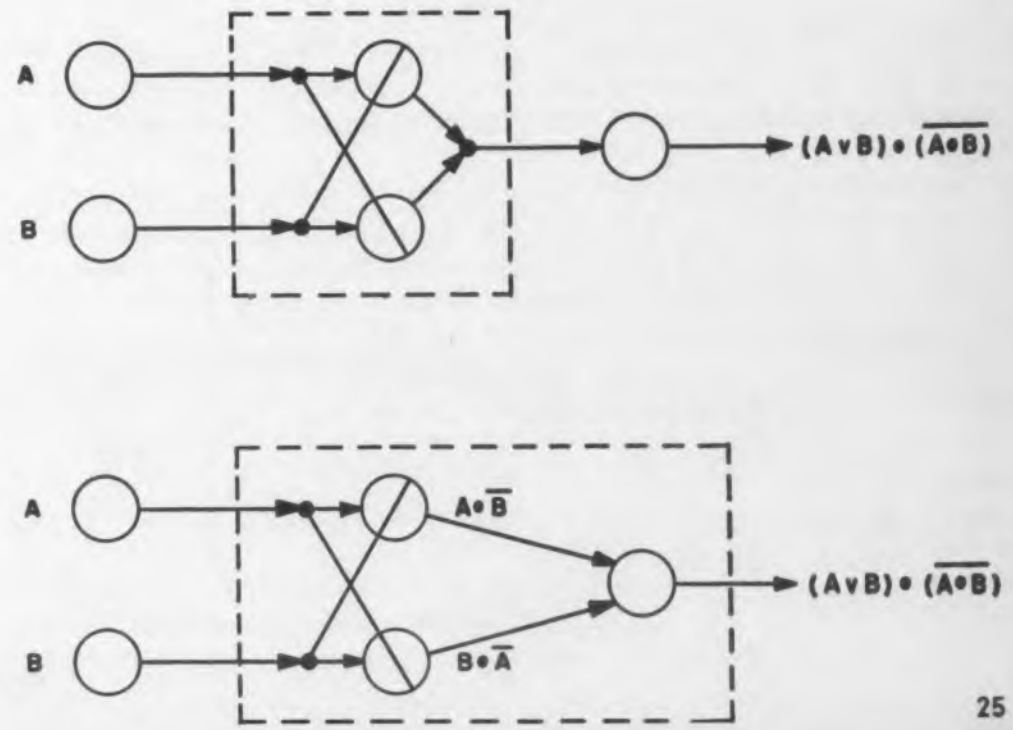
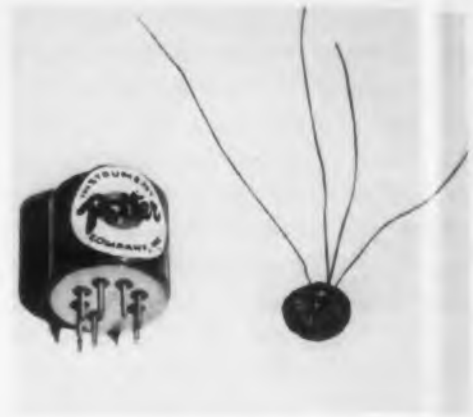


Fig. 7. The "exclusive or" function is readily performed by magnetic core circuits as shown.

Magnistors—

Amplifiers or Storage Elements



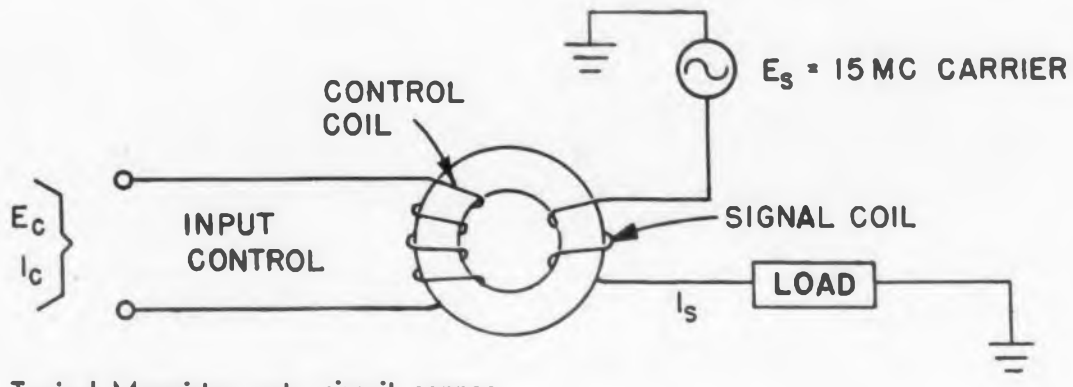
Both the complete sealed unit and Magnistor wound-core are shown.

MAGNISTORS are small saturable reactors which may be classified as amplifier types or two-state storage types. As amplifiers, a small electrical signal in the Magnistor control winding controls a load circuit handling several thousand times as much power. As storage devices, the Magnistor will remember its "set" or "reset" condition indefinitely even if all power is removed. Magnistors are made of a ferro-ceramic material having special shapes, coils, and flux patterns.

The Magnistor amplifier element contains, in its simplest form, two windings. One winding called the signal coil is used to carry a sine wave signal in the range from 100kc to 15Mc or pulses having a repetition rate from 0 to 10Mc. By varying the d-c current applied to the second winding (called the control coil), the impedance of the signal winding to the carrier frequency or pulses can be varied over a ratio as high as 500 to 1, if desired. Power levels in the range of microwatts to tens of watts can be controlled. Another form of this type of Magnistor contains single or multiple "inhibit" windings which have the property of destroying the influence of the control coil if they are energized but have no influence otherwise. The controlled currents passing through the signal coil have little or no effect on the control winding.

The storage-type Magnistor basically contains two control windings normally designated as "set" and "reset" coils. The signal winding has two impedance conditions: low, if the "set" coil has previously passed a specified minimum current in either direction, and high, if the "reset" coil has previously passed a specified minimum current. Either condition persists until the other is established regardless of the presence or absence of energy anywhere in the system. In other words, the Magnistor is a static storage device with a non-destructive readout and has the capability of handling power in the readout circuit in the order of watts.

Magnistors are used to gate, switch, amplify, count, and record as well as to form logical arrays for adding, subtracting, shifting, and other computing functions. They have been developed to meet the need for a non-deteriorating device capable of performing the above functions at speeds comparable or in excess of electronic devices.

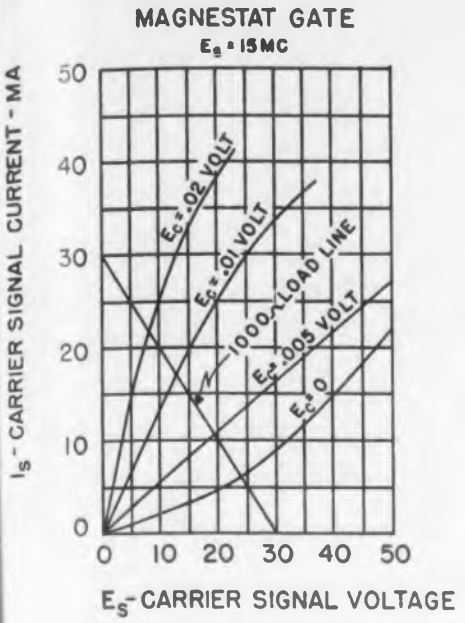


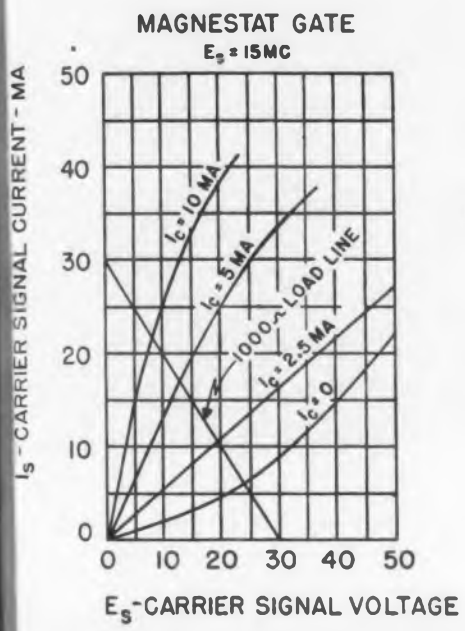
Typical Magnistor gate circuit connections showing control and signal coils.

Developed by Mr. R. L. Snyder and manufactured by Potter Instrument Co., Inc., 115 Cutter Mill Rd., Great Neck, N. Y., Magnistors are different from other components in that they perform functions previously accomplished only by electronic tubes and transistors. They have indefinite shelf life, the controlled and controlling elements are independent, they are undisturbed at temperature ranges existing in commercial and military equipment and are inherently rugged in construction. They can be designed to operate over a wide range of power levels, require no warm-up time, and are supplied in hermetically-sealed metal cases which plug into standard 9-pin sockets.

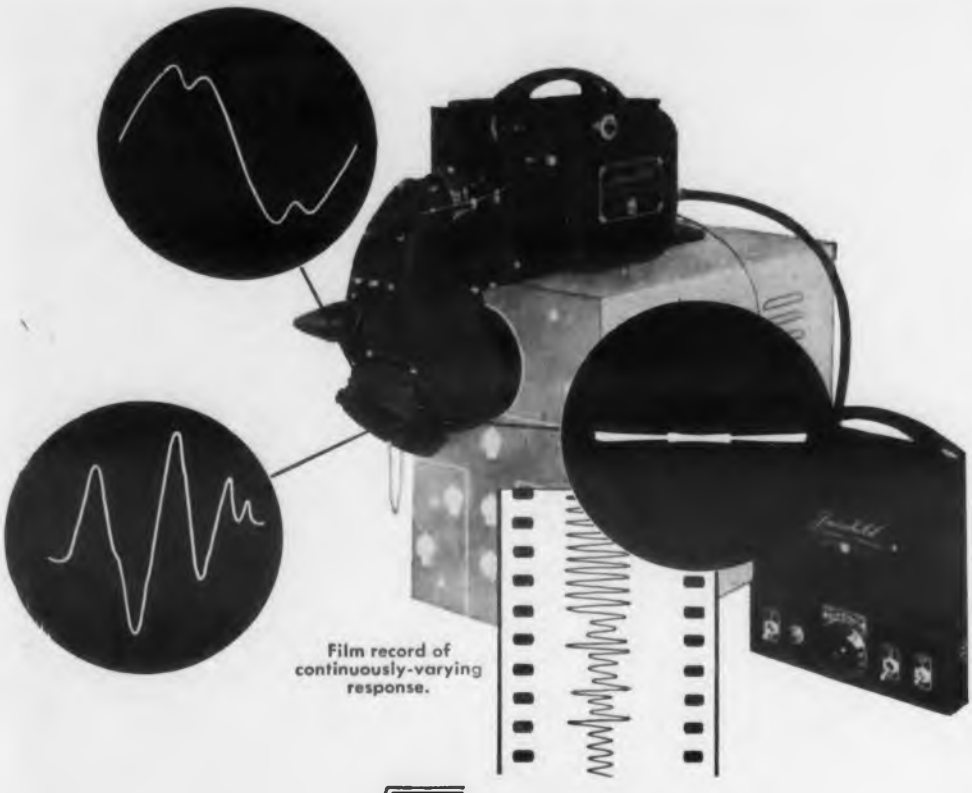
The characteristics of basic Magnistors can be most easily presented in much the same way as plate characteristic curves for vacuum tubes are given. Typical curves for a representative Magnistor gate circuit are illustrated. The signal coil current, I_s, is plotted as a function of the 15Mc carrier signal voltage, E_s, for various control coil input voltages E_c normally employed in the operating range. It is thus possible to predict the performance of the Magnistor in a circuit by drawing a load line in the conventional manner. As an example, a load line representing a 1000-ohm load has been indicated. For an input control voltage, E_c, change of 0.01v (from 0 to 0.01v), the output signal current will change 11ma (6 to 16ma) or a voltage change of 11v across the 1000-ohm load. This represents a voltage gain of 1100 at d-c control voltages. As would be expected, the gain decreases with the input frequency. However, this example is presented to emphasize the potentialities of Magnistors. For easier calculation at the higher frequencies the characteristic curves are normally plotted for different values of input control current I_c rather than input control voltage at low signal levels. The control coil is not appreciably dependent on the magnetization characteristic but behaves essentially as linear inductance. Due to the inductance, control currents with fast rise times require relatively high voltages to produce the required control current, whereas slowly varying control currents require little more voltage above that necessary to overcome the resistance.

In comparing Magnistors and vacuum tubes, the latter, at low frequencies, require relative high voltages and negligible currents whereas Magnistors re-





quire relatively high current and negligible voltages. At higher frequencies the capacity inherent in controlling a stream of electrons causes a vacuum tube to draw considerable current in developing its voltage. In the Magnistors the inductance of the control coil requires considerable voltage to develop its current. Over narrow frequency bands both effects can be made unimportant. For small signal levels both the vacuum tube and Magnistor are essentially linear whereas for large signals both may become highly nonlinear—the tube because electrons are collected and the Magnistor because saturation becomes severe. The Magnistors are available as individual components, amplifiers, gates, switches and flip-flops. They will also be available in complete assemblies of counters, shift registers, switching matrices and similar data handling components. For more information, turn to the Reader's Service Card and circle **ED-19.**



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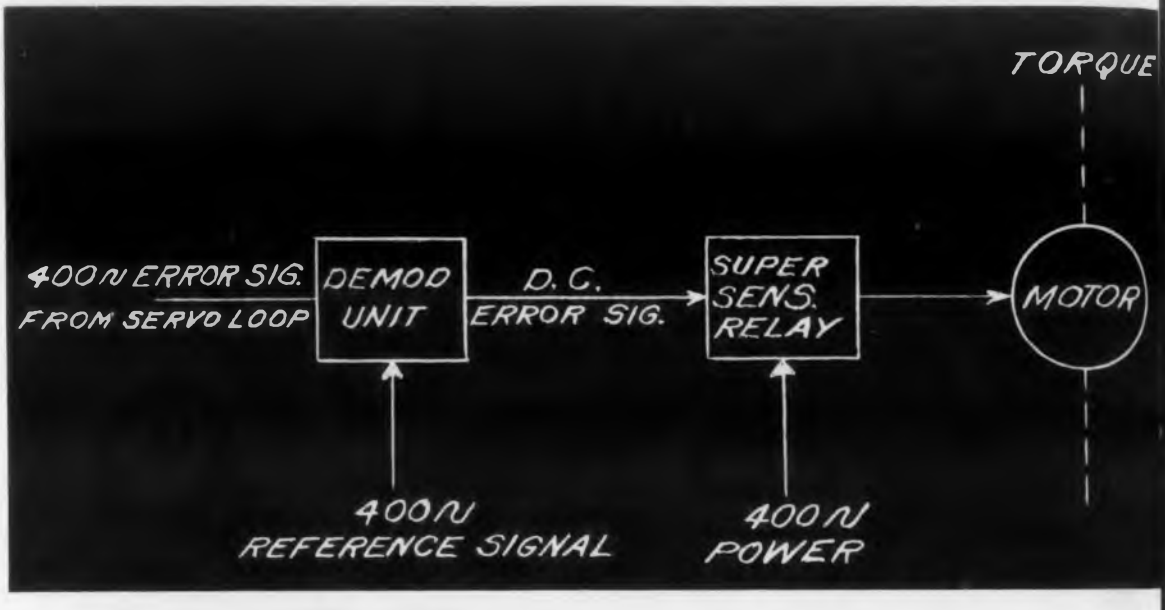
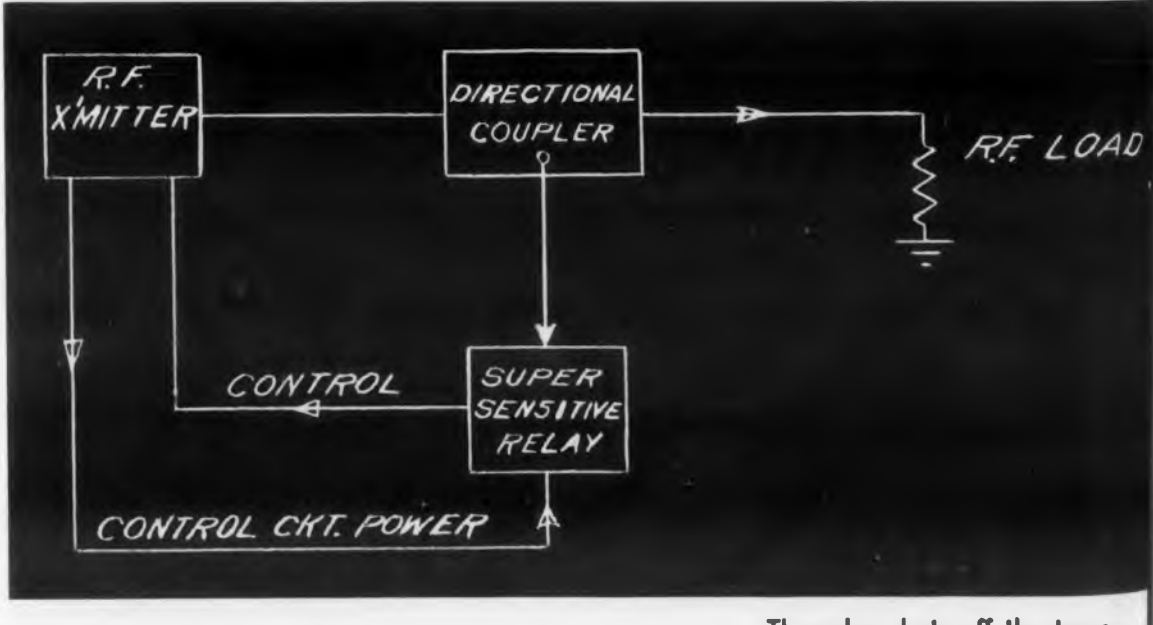
High-Frequency Relay



The relay controlling a high-powered motor in a non-proportional servo system.



The relay shuts off the transmitter if load mismatch rises above a set level.

Shown here actual size, the relay is also made in a wire-connection version.

ACTUATED by low-level signals ranging in frequency from direct current to 50Mc, the Model RL-120 Relay can be employed in new and unusual designs or to simplify present equipment. Auxiliary equipment can be controlled remotely by a carrier signal without the need for demodulation. It can function as a warning device if a transmitter's r-f signal output drops too much. Another unusual use is in the control of automatic tuning mechanisms: the relay will sense the magnitude of r-f voltage across the tuning circuit and stop the mechanism at the appropriate level.

Operating from as little as 20 microwatts of control power, the relay's contacts can handle up to 10amp at 115v, a-c, or 24v, d-c. Higher d-c contact ratings are available. An auxiliary a-c power source of less than 1w, 50 to 2000cy, is required for operation. Maximum reverse input voltage is 40v, d-c. The maximum input power is 60mw. Input impedances are 2000 and 4000 ohms for direct and alternating current applications, respectively. Standard contact ratings are spst and spdt, but other contact arrangements are available.

The hermetically sealed unit can stand shocks to 10g and vibration to 10g at 10 to 500cy. It operates at temperatures from −60°C to +85°C. The relay is made by Olympic Radio & Television, Inc., 34-01 38th Ave., Long Island City 1, N. Y.

The unit is made in two main sizes. The smaller relay, which is illustrated, is 1-5/8" diam x 2-1/4" long and weighs 4-1/4 oz. It is packaged with either a standard octal base or with wire leads for solder connection. A polarized type is available in slightly larger containers.

In d-c applications, it can be actuated by low-level transducers such as strain gages and thermocouples. It closes in 10millisec. For more information and specifications on this sensitive relay, turn to the Reader's Service Card and circle **ED-22.**

Design Forum

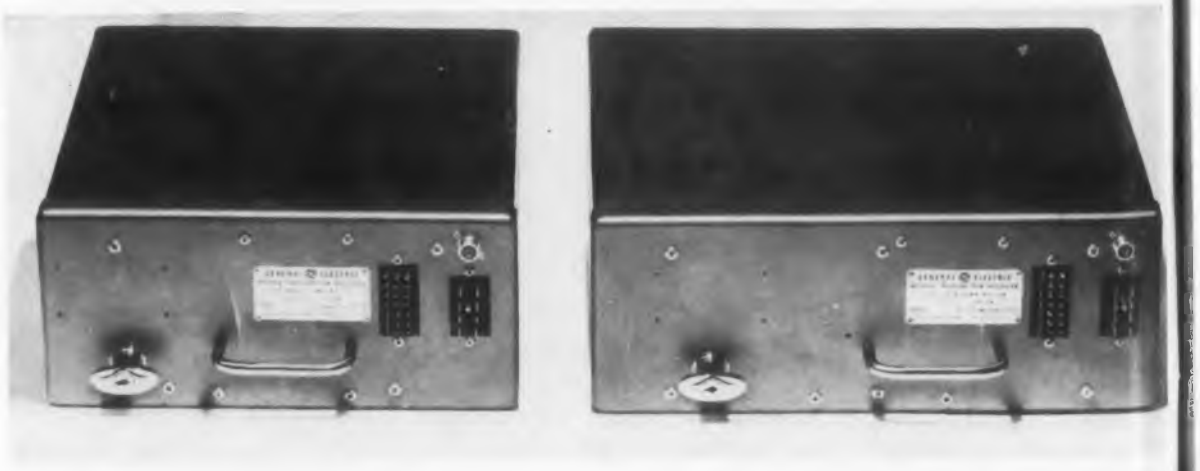
Standardized Communication Equipment

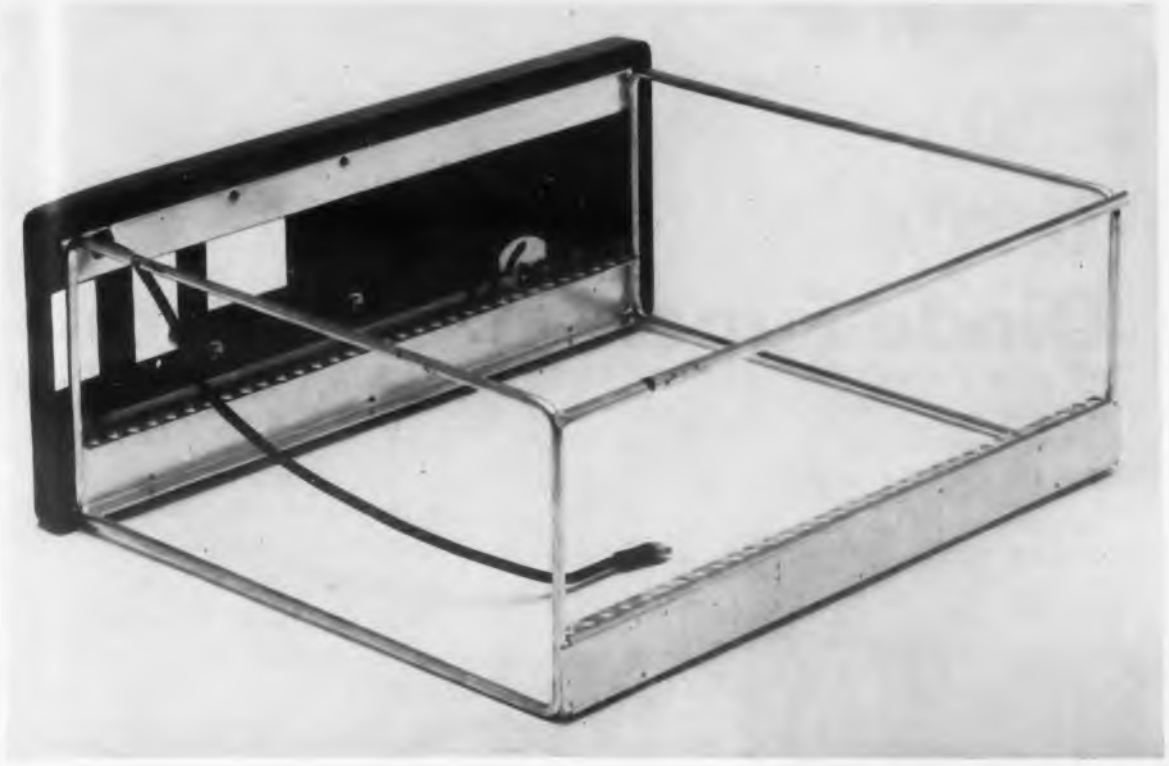
GREATLY simplified maintenance and installation has been achieved in the design of a new line of two-way f-m communication equipment. Featuring the use of plug-in chassis, the equipment was designed around 12 basic building blocks of standardized physical dimensions. These consist of two receiver, four transmitter, and six power supply chassis. By connecting the chassis in various combinations, 60 different mobile 2-way installations are available as standard units. The equipment has 25-54Mc and 144-174Mc ranges.

Two standard housings, shown at the left, differing from one another only in width, were designed to enclose the chassis. Support for the chassis is supplied by the illustrated internal relay rack arrangement instead of the enclosure. This construction affords the greater rigidity necessary for mobile installations. Known as the "Progress Line", this equipment is made by General Electric Co., Syracuse, N. Y.

All of the receivers will operate from either a 6 or 12v d-c source or from 117v, a-c, without any modification. Receivers in mobile use can thus be serviced on a bench by using the base station a-c supply, eliminating the need for any storage batteries or rectifier power supplies. Delayed auto-

Both standard enclosures are 6-3/4" high x 14-7/8" deep. The left unit is 14-3/8" wide, while the other is 17-3/8".





The chassis are mounted in a type of universal relay rack inside the enclosure for greater rigidity.

matic gain control has been provided in the high-band receiver so that full r-f gain is possible for the reception of threshold signals. The delayed a g c also reduces high level intermodulation interference.

In the high-band receiver, i-f selectivity is determined by a 6-coil, 290kc transformer and two such units in the low-band receiver. Space is provided in the high-band receiver for an additional 6-coil transformer if the present 60kc channels are split into either 15kc or 20kc channels. The low i-f of 290kc was chosen because it provides greater "skirt", selectivity, and wider band-pass for weak signals, or split channel operation, which the FCC is proposing.

The transmitters may be used in base station or mobile installations interchangeably. Layout and circuitry are similar in both the high and low frequency chassis. The medium and high power units in each frequency band are identical in design except for the final stages. In the medium-power transmitters, a single, new, beam-power tetrode, the *GL G146*, is employed.

Although provisions are made for the use of either heated or unheated crystals, an over-all frequency stability of ±0.003% over the temperature range of —30°C to 60 C has been achieved without the use of heated crystals.

To provide protection against over-modulation, a double triode modulation limiter and triode phase modulator combination are used. The audio amplifier stages are designed to take the input of a controlled reluctance microphone. Normal intermodulation distortion is less than 1%. The filament wiring of all the transmitters is arranged for either 6 or 12v operation. The type of operation is determined by the cable that is plugged into the unit.

Six mobile and two base station power supplies have been designed. For both types of transmitters, there are medium and high power vibrator and high power dynamotor power supplies for use in mobile radio units. To convert mobile radios to inexpensive base station units, there are medium power and high power a-c supplies.

The medium power vibrator power supply uses a tapped, full-wave bridge circuit with one transformer and one split-reed, dual interrupter-type vibrator plus industrial-type, high-temperature selenium cells. Under normal service conditions, the estimated vibrator life is 6000hr or better.

By attacking the problem of designing communication equipment with the needs of an entire market in mind, the designers of this line have achieved some worthwhile economies. The ease of servicing gained is important in view of the growing shortage of technicians and the unpredictable needs of the defense establishment for trained electronic technicians.

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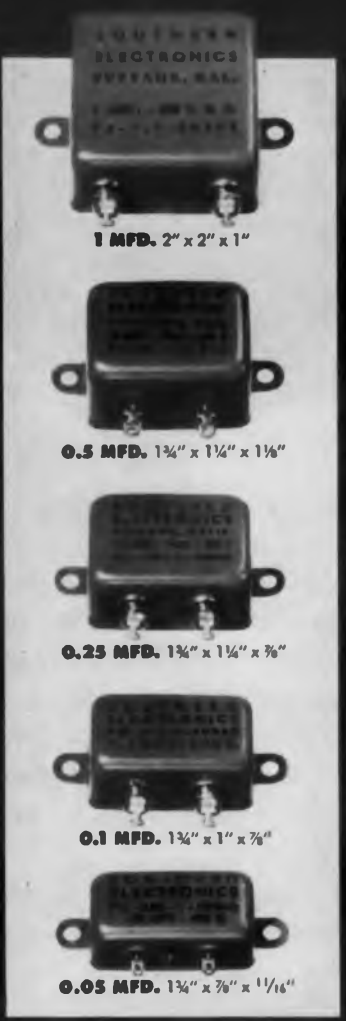

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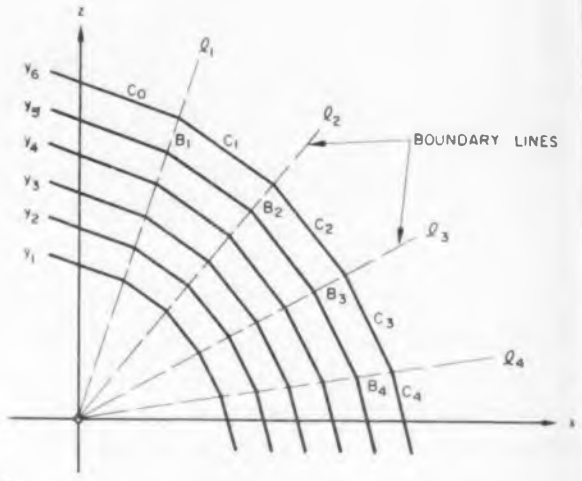
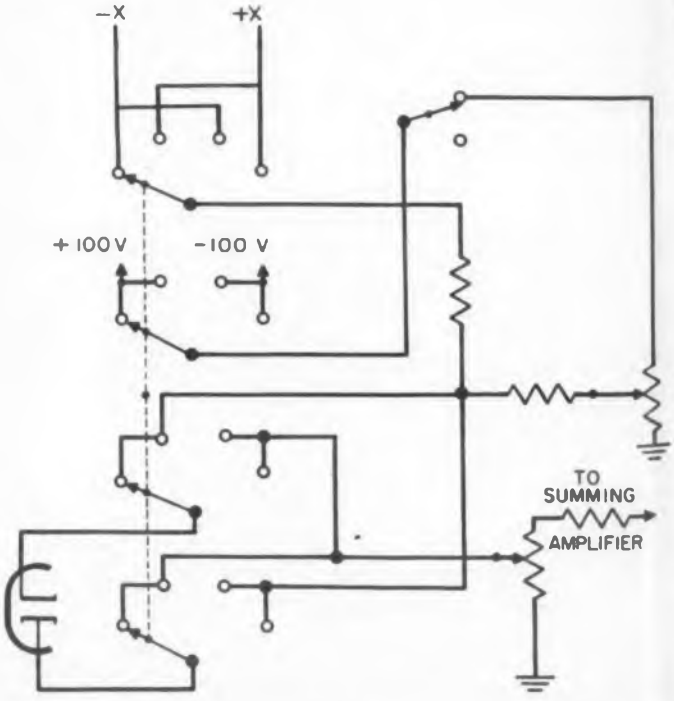
Diode Function Generator

Generator has 5 channels and 40 line segments. Accuracy depends on number of diodes used.



Simple function z=f(x,y) where y, as fixed by boundary lines, is linear.

Schematic shows basic building block. A channel comprises a group of these basic elements.



FUNCTIONS having two variables can be generated with this all-electronic computer unit which uses diode shaping networks. High operating speed is inherent without disadvantages of cost and complexity attendant with cathode-ray tube devices. The Diode Function Generator is simpler and more flexible than servo-driven distributed-tap potentiometer units.

In operation, a function is set up by dividing it into straight line segments. The slopes and breakpoints between segments are independently set by two ten-turn potentiometers. The slopes of segments are algebraically added progressing from the origin. Input quantities, or independent variables, below breakpoint levels produce no output. Settings may be recorded and used later to reproduce the function quickly and easily. A four-position selector switch on the Model DEFG-201 built by Reeves Instrument Co., 215 E. 91st St., New York 28, N. Y., determines the quadrant in which a line segment falls.

Breakpoints are ordinarily set by establishing bias voltages. By replacing this usually-constant bias voltage with a variable bias, y, or some function of y, the network represents a varying impedance over different intervals of the input variable x and y approximating $w = f(x, y)$. The general procedures for setting up functions of two variables is to divide each curve of the family of curves into segments chosen so that corresponding segments of different curves of the family have equal slopes. Proper breakpoints in x, as a function of y, are indicated by boundary lines separating adjoining sets of equal-slope segments. The configuration of the boundary lines for a given function $f(x,y)$ indicates the type y input required. Often a single linear y-input function is sufficient. After setting breakpoint and slope potentiometers to fit a representative curve of the family, $f(x, y)$, y-input function(s) can be inserted to yield proper variation of output with respect to y. The method can be extended to functions of more than two variables.

A total of 40 diodes are available, flexibly arranged so that they may be distributed in various combinations among the generator's five channels. The unit is completely self-contained except for a 100v reference supply. Sixteen automatically-balanced d-c amplifiers are used. For more data, turn to Reader's Service Card and circle **ED-27.**

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Bulletin L-35

High-quality, yet moderately-priced precision resistors suitable for the majority of applications. Reverse-pi wound on accurately-machined ceramic bobbins. Coated, if desired, with moisture-resistant varnish. Std. tolerance—1%, 0.5%, 0.25%, 0.1%, and 0.05%. Meets MIL-R-93A. Five mounting styles available.

"P" TYPE Encapsulated Wirewounds

Bulletin L-30

Small, hermetically-sealed resistors at a truly low price. Unmatched stability for critical applications. Std. tolerance—same as Akra-Ohm types above. Meet and exceed MIL-R-93A requirements including salt water immersion tests. Radial leads, axial leads, or lug type terminals.

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Small, low-temperature-coefficient resistors. Exceptional stability achieved through deposition of uniform, uncontaminated, soot-free carbon film. Std. tolerance—1%, 2%, and 5%. Meet characteristic R of MIL-R-10509A. ½, 1, and 2 watt sizes.

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Unusually light-weight wirewound power resistors with a unique integral core and coating having exceptional resistance to thermal shock and excellent heat conductivity. Ten humidity-resistant, tab-terminal styles available with ratings from 8 to 225 watts at 350°C. hot-spot. Meet MIL-R-10566, Amendment 1.

CMP and **MP** Miniature Power Wirewounds

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Lead-mounting, miniature power wirewounds for crowded chassis or printed circuits. MP types enclosed in a Fiberglas sleeve and coated with silicone-impregnated ceramic. CMP types encased in ceramic tube with ends hermetically sealed with silicone cement. Designed to MIL-R-26B. 3 to 10 watt sizes available.

SPECIALS . . . . . .

Bulletin L-37

Hermetically-sealed Steatite resistors, Ayrton-Perry resistors, high-voltage surge resistors, card-type resistors, multi-section bobbin resistors, and many other special types are regularly produced to individual specifications.

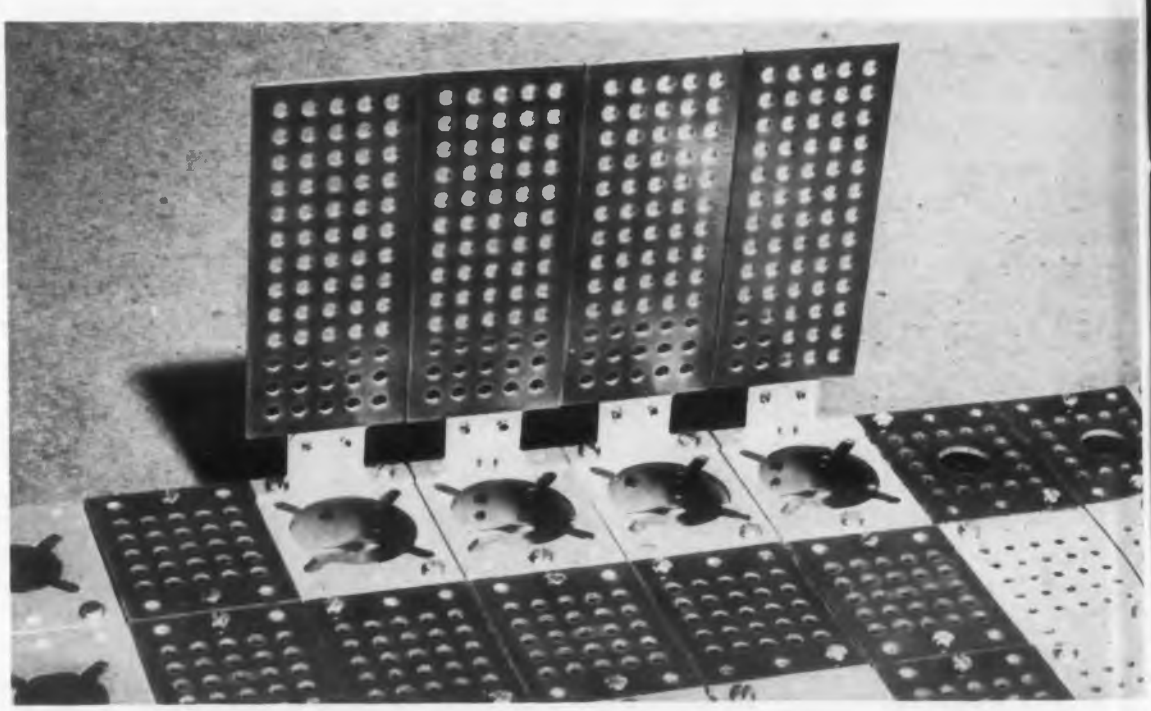
SHALLCROSS MANUFACTURING CO., 526 Pusey Ave., Collingdale, Pa.

CIRCLE ED-29 ON READER-SERVICE CARD FOR MORE INFORMATION

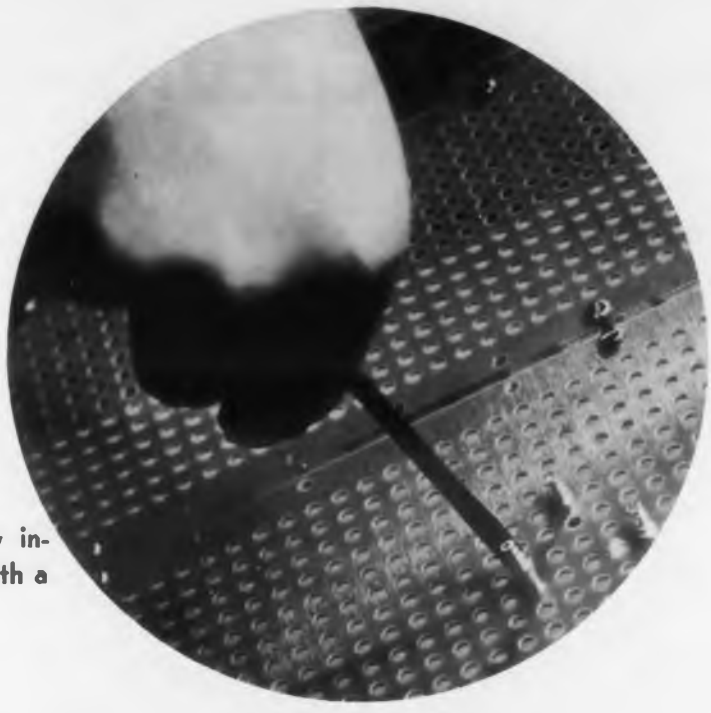
Expandable Breadboard Chassis

BREADBOARD and prototype circuit design is greatly implemented by the "Circuit Assembler" illustrated on these pages. The basic size panels can be mounted on frames of various sizes to simulate any size chassis. Modular design arrangements are readily tested by means of this expandable breadboard system.

The various size tube sockets are easily inserted into aluminum panels with matching holes. Components are mounted in and soldered to little terminals that are simply pushed into the holes in the phenolic panels. The vertical panels are very useful to



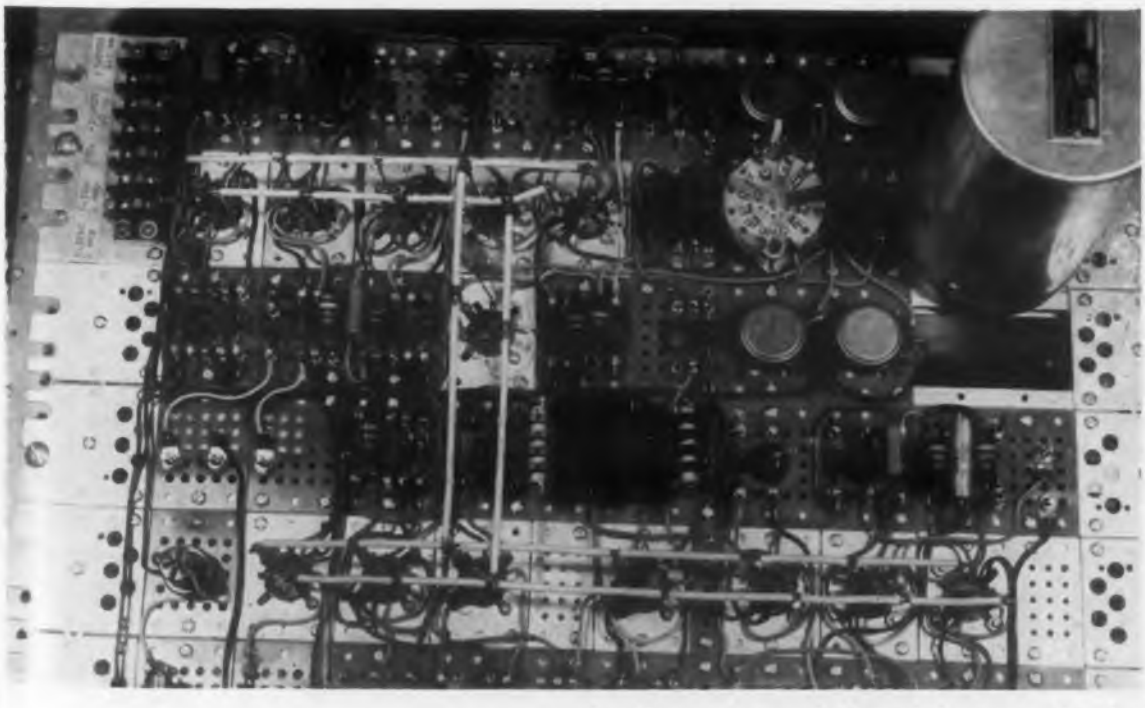
These are some of the panels that can be used in this breadboard system.



The terminals are easily inserted into the panels with a screwdriver.

achieve a variety of circuit designs. The Circuit Assembler is made by U. M. & F. Manufacturing Corp., 10929 Van Owen St., N. Hollywood, Calif.

The panels are mounted on the frames by No. 4 self-tapping screws. The complete chassis is made in a size that fits standard relay racks. The end brackets have holes that can accommodate various components. The system is available in a starter kit to which additional parts may be added as needed. For more information on the Circuit Assembler, turn to the Reader's Service Card and circle **ED-30.**



A relay-rack-mounted prototype constructed with the Circuit Assembler.

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Model REL-12

SPECIFICATIONS

Size	7/8" x 2-5/16" x 4-3/8"
Weight	7 ounces
Frequency Response	5 to 20,000 cps with less than ±1% deviation
Voltage Gain	Adjustable 5 to 500
Linearity	Within ±1%
Output	5 v rms maximum
Input Impedance	Over 100 megohms
Output Impedance	Less than 100 ohms
Load	33,000 ohms minimum

Will maintain a constant output with B+ and filament variations of ±15%.

Different models available with variations of frequency response and recovery time. Recovery time as low as 30 milliseconds.

RHEEM R. F. POWER MINIATURE AMPLIFIER

Model REL-09

SPECIFICATIONS

Size	4.90 x 3.37 x 2"
Weight	16 ounces
Controls	Plate tuning Grid tuning
Filter	85-db attenuation filter on all power leads
Tuning Range	215 to 235 megacycles
Power Output	12 watts nominal
Required Drive	1.4 watts minimum
Plate	250 V dc @ 90 ma
Filaments	12.6 V @ 0.41 amp or 6.3 V @ 0.82 amp
Bias	None Required

RHEEM SUBMINIATURE VOLTAGE REGULATOR

Model REL-11

SPECIFICATIONS

Size	1-3/4" x 2-5/16" x 4-3/8"
Weight	14 ounces
Output Voltage	Any nominal voltage from 130 to 235 volts, adjustable range ±10% of the nominal voltage
Current	Up to 200 milliamperes
Ripple Reduction Factor	5×10^{-4}
Output Impedance	Will not exceed 2 ohms from 1 cps to 200,000 cps
Regulation	Within .05% for load variations of ±25% and input variations of ±20%
Minimum DC Input Voltage	Equal to 100 volts greater than the regulated output voltage

for complete information on these and other units or on specialized electronic design problems, contact

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Designing Reliable Transistor Circuits—II

by Norman B. Saunders
Circuit Engineering Consultant
Weston, Massachusetts

General design considerations allowing for transistor variations including swamping stabilization techniques were discussed last month in Part I. This final part describes a variety of specific stabilization methods for achieving utmost reliability.

TRANSISTORS selected for a particular job must have adequate ratings. Power level and alpha cut-off frequency are probably most important for radio circuits with collector capacitance following. Low reverse transfer voltage ratio and low collector cut-off current are of secondary importance.

Emitter Bias Stabilization—There are many schemes for achieving bias stabilization. Most of them are designed to keep the total emitter current nearly constant[1]. The techniques used for audio circuits are equally applicable to radio circuits. The use of a split battery with a bypassed emitter resistor is a very basic technique, Fig. 1. The lower portion of the battery, usually one to two volts, effectively determines the potential drop across the emitter resistor, since the base to emitter drop is normally one to two tenths of a volt. The value of this resistor then determines the emitter current. A potential divider formed from two resistors with a bypass capacitor serves as a virtual battery tap[2], Fig. 2. The ratio of bleeder current to maximum collector cut-off current determines the effectiveness of this apparent battery. As another possible variant, one of the resistors and perhaps the capacitor, can be replaced by a Townsend diode,[3] Fig. 3. These diodes are available rated at about 1v and up. Both resistors could be replaced, of course, by supplying the excess base current through the diode, Fig. 4, but the circuit would then be unduly sensitive to power supply variations because the total variation would be applied to the base.

A further refinement is to choose a diode whose temperature coefficient just compensates for the residual current change after such stabilization. Such temperature compensation has been obtained with a germanium junction diode biased in the forward direction[4], Fig. 5. Since both transistor and diode are junctions biased in the forward direction, their thermal effects are equal with the diode's voltage drop at constant current thereby changing the 2.5mv per celsius degree required to maintain, in this reference, constant collector current in the detector and the push-pull class B output. A thermistor could be incorporated into the circuit in many ways, Fig. 6. A shunt network may be used in the base potential divider scheme to absorb and pass off the increase of collector cut-off current with temperature.[5] The series and parallel resistors are proportioned to reduce the thermistor's effective resistance change with temperature to that required to most nearly compensate, over the desired temperature range, for the transistor's increase in collector cut-off current. This reduces the bleeder current required for a given amount of bias stability. Alternatively, a positive temperature coefficient thermistor can be substituted for the emitter current controlling resistor[6] as shown in Fig. 7. A point diode, biased in the reverse direction, might also be used as a thermistor[7]. Another method, suitable when the collector load has considerable series d-c resistance, is to return the upper end of the base potential divider to the collector instead of the collector supply, Fig. 8. Any other d-c amplifying circuit incorporating large feedback would be useable. Bias other than fixed emitter current bias may be used. On a converter it is desirable to control both the d-c current bias and the a-c voltage bias[8]. If the a-c bias is large, the d-c bias may be generated by "emitter leak" rectification of the a-c bias[9], Fig. 9. Often, however, it is most important to emphasize minimization of noise in the convertor design. This can usually be done with biases from 50 to 1000μamp and 100 to 1000mv provided the radio frequency input impedance is matched.

Controlled Bias Variation—Bias may also be deliberately varied to maintain some other factor constant. Most usually this is done in automatic level control circuits. The signal level at some subsequent stage, usually the detector, is fed-back as a d-c bias to one of the amplifying stages. The emitter current can be varied either by substituting detector current for emitter current, Fig. 10, or by varying the potential applied to the base[9], Fig. 11. Either varies the impedances of the amplifying stages, but such variation can easily be handled by the technique of swamping mentioned in Part I. The collector voltage can also be varied to vary the gain, but the consequent change in collector capacitance may have graver effects upon the circuit than those effects of varying the emitter current. A combination of these methods can also be used[8] as illustrated in Fig. 12.

Still other simple techniques have produced avc circuits having only 6db change in output for 80db change in input with good performance in all other respects. Amplification of the returned signal is desirable and may be accomplished by a separate transistor[5] or by the dual use of other circuit transistors[9], Fig. 13. In the latter circuit, a gain controlled i-f stage is used as a current amplifier.

Temperature Compensation—It is easy to become engrossed in bias effects and thus forget that temperature has other effects. Compensation for change of gain with temperature may be achieved in low frequency amplifiers, for example, by cascading n-p-n and p-n-p stages[6], Fig. 14. The gain of the n-p-n tends to increase with temperature while that of the p-n-p tends to decrease. It would also be possible to introduce a deliberate change of bias with temperature to offset this change in gain.

Minimizing Noise—Noise is minimized by choosing transistors which can be expected to have a minimum of surface leakage, i.e., low collector cut-off current, throughout life. Low temperature of operation is also helpful in keeping noise down. The operating voltages should be kept well away from the Townsend voltages since the noise may be considerable in the region of incipient breakdown. A current chosen for high gain will generally minimize noise since that noise generated in the collector circuit is generally constant[10]. In convertors noise is perhaps the main consideration. The optimum current has often been in the vicinity of 100μamp. In r-f stages noise may be a more important factor than gain or frequency stability and hence input and output may both be matched. The use of radio frequency stages may be a means of swamping of convertor noise.

Neutralization—Neutralization by bridge stabilization was discovered independently by several workers. The external capacitor and resistor are chosen to form bridge arms, or a potential divider, equivalent to the collector capacitance and base resistance, Fig. 15. This amounts to either positive or negative feedback depending upon the frequency and the terminations. The important point is that the external feedback sufficiently offset the internal feedback so the net loop gain through the transistor is less than one. It is always possible to neutralize a given transistor over a limited frequency range. If the loop gain before neutralization was more than two, it is highly likely, as can be seen from the distribution of coeffi-

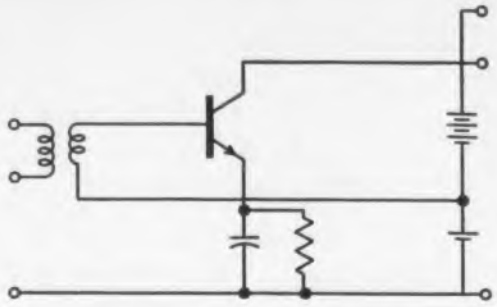

Fig. 1. Split battery current stabilization.

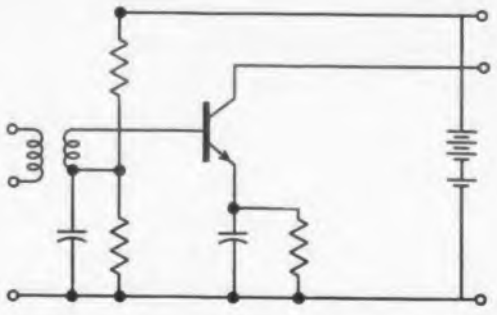

Fig. 2. Bias stabilization from potential divider.

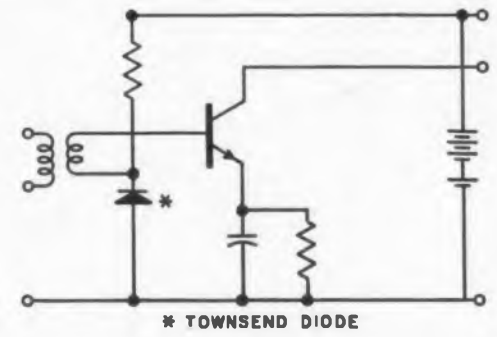

Fig. 3. Townsend diode provides bias stabilization.

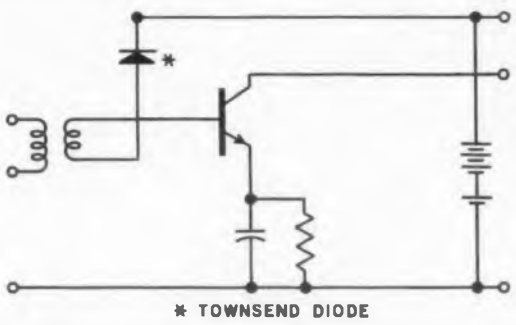

Fig. 4. Diode stabilization with steady power supply.

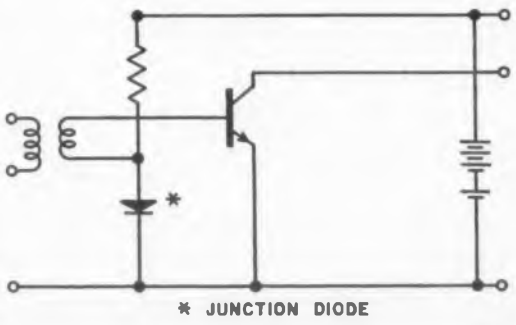

Fig. 5. Junction diode for temperature compensation.

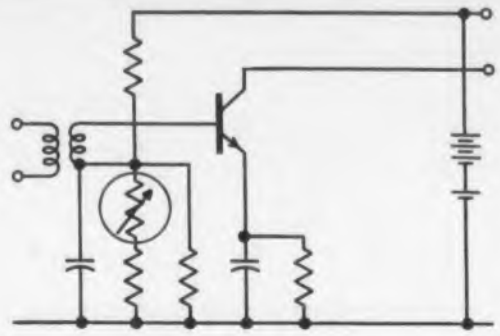

Fig. 6. Thermistor absorbs excess cut-off I_c.

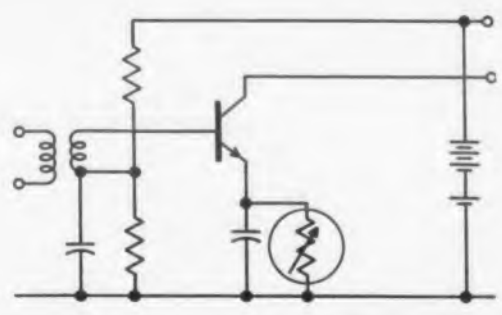

Fig. 7. Positive temperature coefficient thermistor.

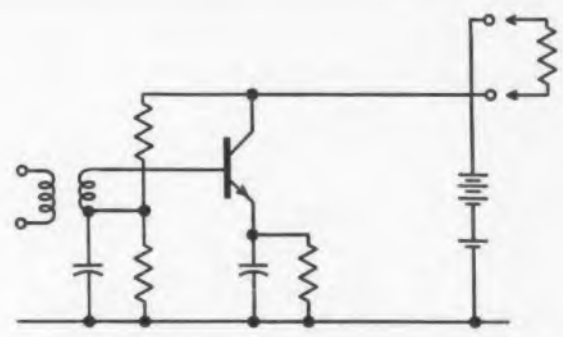

Fig. 8. D-c voltage feedback to stabilize I_c.

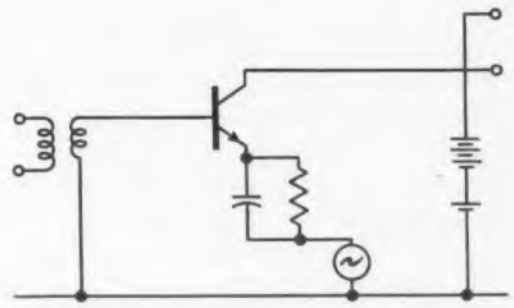

Fig. 9. Converter bias obtained from "emitter bias".

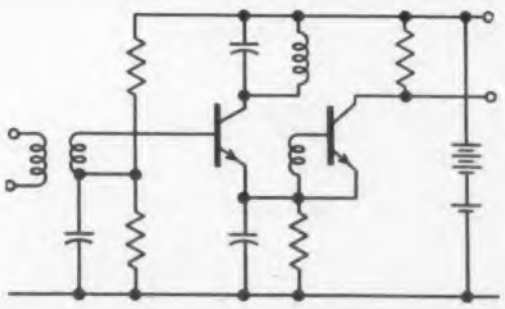

Fig. 10. I_e varied by detector current for avc.

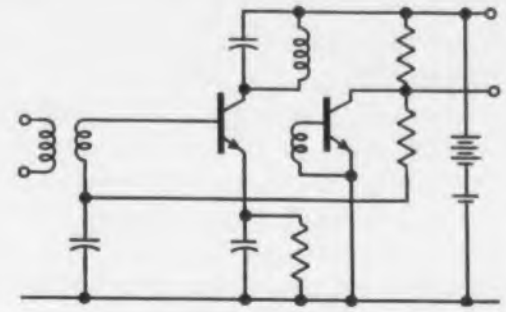

Fig. 11. Variable input voltage to base for avc.

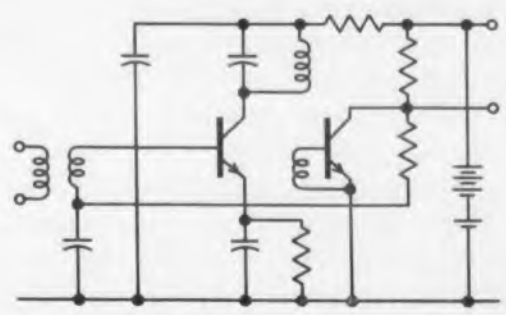

Fig. 12. Combining I_e and V_c for avc action.

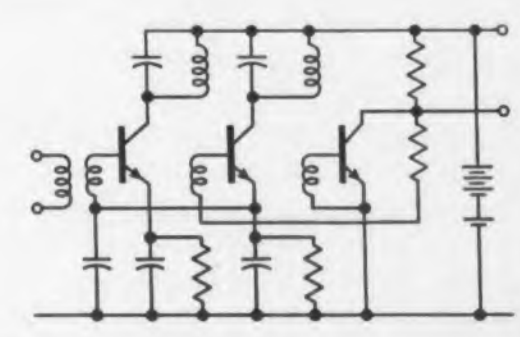

Fig. 13. Gain-controlled i-f stage as current amplifier.

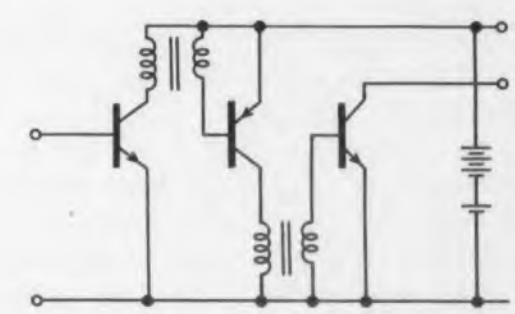

Fig. 14. Compensation for alpha change with temperature.

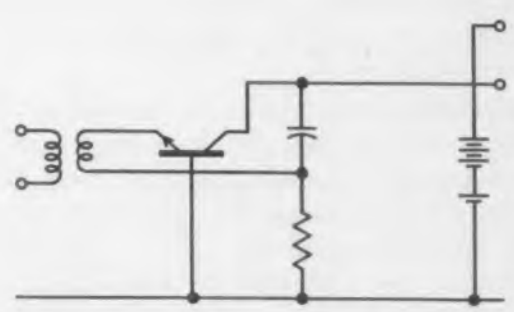

Fig. 15. Stabilization from a bridge-type connection.

cients of transistors (Part I), that substitution of another transistor will cause instability. Furthermore, if the reverse voltage ratio varies by two to one or more, stabilization by loading will give more gain. It is possible to supply a separate neutralizing capacitor with each transistor but it is far better to use a transistor with small enough internal feedback not to require neutralization. It is interesting to note that the reverse transfer voltage ratio, h^{12}, for the common emitter circuit is practically the same as that for the common base circuit, Fig. 16. With the transistor terminated, the common base circuit is reputed to be the more stable[8,9]. On the other hand, by substituting these relative parameters into the stability criteria one discovers that the common emitter circuit is favored. Definitive experiments are needed.

Negative Feedback—Negative feedback is seldom used in radio frequency circuits when selectivity is required[2,11]. There has, however, been some work done with the transistors grouped together to give lumped gain, possibly stabilized with feedback, and preceded and followed by lumped selectivity, Fig. 17. This approach is susceptible to noise and is probably not justified with available transistors.

Oscillator Stabilization—Oscillator amplitude stabilization is usually accomplished on a voltage basis. If the emitter diode is used, starting difficulties will probably be encountered. An oscillator will often have a resistor between the collector supply and base to achieve fixed base current bias, and to insure its starting, Fig. 18. The current lost in limiting the voltage swing at the emitter, base, or collector absorbs any extra current supplied[9], Fig. 19. The collector diode could be used by allowing the peak swings to reverse its polarity so that it is biased in the forward direction over enough of the cycle to absorb the current representing the excess energy delivered to the tank. This is commonly done[9] but it results in a flooding of the base with minority carriers and a high instantaneous capacitance being added to the collector circuit. This is shown by the low apparent frequency of the half cycle during which clipping occurs, Fig. 20. The effective collector capacitance over the cycle is then quite high and is strongly dependent upon the circuit losses. This tends toward frequency instability. Therefore, for best frequency stability a point contact diode or a variable gain element should be used for amplitude limiting[5], Fig. 21. This "hole storage" effect is analogous to that which affects computer circuits and the treatment is essentially the same; namely, do not allow the carriers to be stored[12].

If equipment is to operate for the longest possible period of time, a system of preventing maintenance, such as marginal checking might be desirable[13]. As a word of caution, the added circuitry may equally well increase the complexity and hence chance of failure. However, the designer might consider the

$$\begin{vmatrix} h'_{11} & h'_{12} \\ h'_{21} & h'_{22} \end{vmatrix} = \begin{vmatrix} \dfrac{h_{11}}{1+h_{21}} & -h_{12} \\ -\dfrac{h_{21}}{1+h_{21}} & \dfrac{h_{22}}{1+h_{21}} \end{vmatrix}$$

Fig. 16. Common emitter in terms of common base.

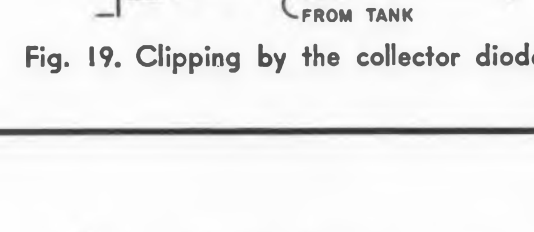

Fig. 17. Stabilization of lumped elements by feedback.

Fig. 18. Fixed base current insures oscillator starting.

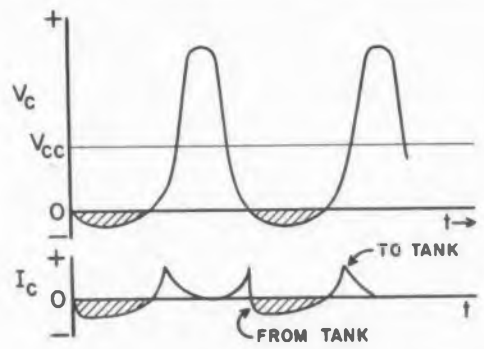

Fig. 19. Clipping by the collector diode.

Fig. 20. Effect of carrier storage on oscillator frequency.

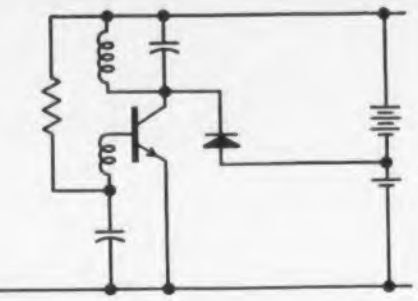

Fig. 21. Diode used for oscillator amplitude limiting.

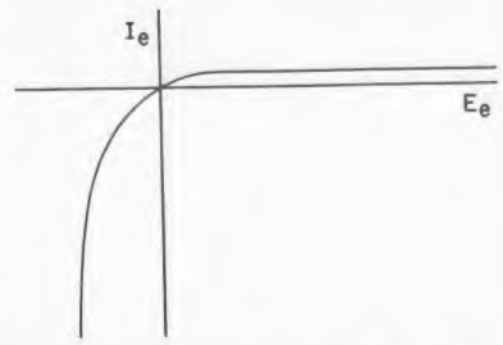

Fig. 22. Logarithmic characteristics for large signals.

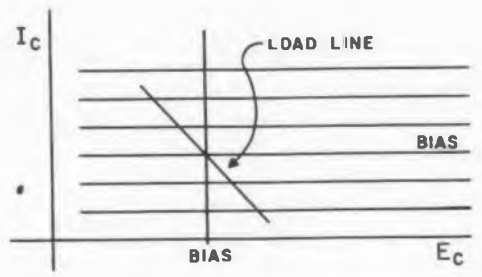

Fig. 23. Very linear characteristics for small signals.

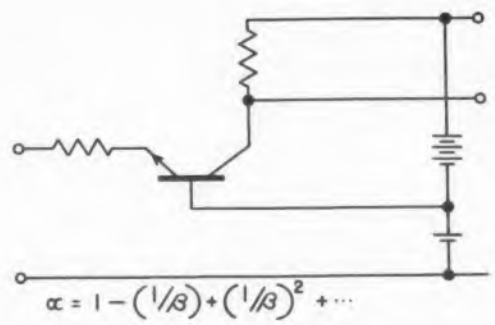

Fig. 24. Criteria for a very stable amplifier.

Fig. 25. D-c amplification by carrier techniques.

techniques used in computer circuits, which are well worked out to achieve long trouble-free operation.

Related Factors

The fact that the junction transistor, in many ways closely approaches its theoretical characteristics simplifies the problem of designing circuits for long life. When the signal voltage applied between emitter and base is large with respect to the d-c bias voltage so applied, the characteristic is very nearly logarithmic, Fig. 22. By emphasizing this effect, superior converters and detectors can be made. These are dependent upon the forward characteristics of the transistor and so are probably free from surface effect difficulties and need no special design for long life. Stabilization against changes in collector cut-off current is probably desirable[9], but such stabilization increases circuit complexity considerably.

On the other hand, with the signal voltages and currents much less than bias voltages and currents, the junction transistor characteristics are very nearly linear, in fact much more so than those of vacuum tubes, Fig. 23. When biased in this fashion, with input from a source of impedance several times the input impedance, with emitter input and collector output, and with the load admittance an order of magnitude or so larger than the output admittance, the transistor is as stable as a rock—of course it is essentially a piece of rock, Fig. 24. This stability comes because the gain of a transistor so connected is dependent only upon alpha, which is a forward or body characteristic and is remarkably stable. Alpha departs from unity only by the reciprocal of beta, which is small and whose variations are only a small part of its value.

The low voltages and powers used with transistors appear to give long life to most other components. Until such times as the component designers are persuaded to design their parts down to the power and voltage levels associated with transistors (for miniaturization, reduction of cost, etc.) such reliability will come nearly automatically. Remember, however, the self-healing characteristics of the metalized foil capacitor are lost when it is operated at low voltages. Also, diodes may fail faster in transistor circuits than in vacuum tube circuits[14]. Some components might well be redesigned to improve the overall reliability of the device. If the small loudspeaker with four parts in a thousand efficiency and 5w power handling capability were replaced with a similar loudspeaker with only a half watt power capability but a four per cent efficiency, much output transistor strain could be eliminated. Then the loudspeaker might be the weakest link rather than the overloaded output transistors.

With present day transistors direct current amplification is probably best accomplished for control circuits by using carrier techniques, Fig. 25. The high frequency portion of the design such as the amplifier, oscillator, and output mixer, can be carried out just as for radio sets. The input mixer should be chosen from those having good d-c stability. The reason for d-c drifts, apparently found even in silicon transistors, may be that, after all, the desired currents are multiples of the saturation currents, which are sensitive to temperature and other conditions.

Removing the Human Element

The problem of improper installation might be ameliorated if the installer were aware of the designer's assumptions as to the operating environment. Maximum permissible ambient temperature and minimum rate of heat removal and/or maximum chassis temperature should be specified. Even so, possibilities as reversal of power potential or other interchange of terminals may take place on installation. A few hours thought on the designer's part will uncover many such possibilities. The case of reversed potential is easily met by having sufficient resistance either in the transformer windings for the collectors or in decoupling resistors to protect the transistors in case of reversal. If the transistors are in sockets, the maintenance man may manage to reverse a transistor in its socket. If the transistors are protected against supply reversal, they are probably protected against reversal in the socket. If sockets are used, some thought should be given to protecting their springs from solder fill. If sockets are not used, a change of transistors or other components involves the problem of simultaneous-multiple-point-release of all leads of components from the foil of printed wiring and the problem of lifting of foils when components are changed. The designer would do well, however, to specify the use of a grounded soldering iron on surface barrier, high frequency p-n-p, and point contact transistors. Obtaining and maintaining tight connections may be a greater problem than the reliability of transistors themselves.

It may well be that the equipment is too complex for efficient maintenance in the field; maintenance personnel do not have sufficient time or training to do the job; or the maintenance shop does not have the proper instruments to evaluate the faults in the equipment[13]. Therefore, the design should be maintenance-man-proof. If he is to handle it, make it easy: if he isn't,—"pot" it. The smaller the unit, the less often it will be checked at overall breakdown. "In the design of highly complex equipments, the most important aim should be simplicity of operation and servicing. This objective can be accomplished by careful consideration of each subassembly as a separate unit and by inclusion of some malfunction indicator or automatic device for eliminating the malfunctioning unit . . ."[10].

Summary

The physicist and manufacturer have different viewpoints from that of the circuit designer. It contributes to the designer's competence to understand their viewpoints. The characteristics arising within the body are as stable as a rock. The characteristics influenced by the surface are as stable as the protection of the surface is good. The circuit designer can choose the transistor, bias, and frequency. These are his parameters. The small signal coefficients are then fixed. These constants will vary somewhat from transistor to transistor, with bias, frequency, environment, the life; and, because of what people do. The design engineer is almost completely responsible for controlling or negating these variations. The possible maximum temperature of, and hence power input to, the transistor must be limited even though certain expected component changes take place during the life of the equipment. The designer can swamp transistor weaknesses to most any desired degree to obtain performance within his preset limits over the desired life.

The transistor will do reliably and cheaply almost anything it is designed to do. Either linear or logarithmic performance can be reliably obtained. When the circuit is designed to the transistor, the other components are almost automatically given long life. The element of greatest importance in the long life of transistor radio circuits is the human element. Current design mistakes often stem from the belief that anyone knowing vacuum tubes can throw together transistor circuits. Because of finite input impedance, internal feedback, and limited temperature capabilities, the design of transistor circuits, even after surface effects have been banished, requires care and thought. This effort will be well repaid by dependable performance.

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Output is available at socket end or at plug end if solid cap terminates the unit.

sealed and are useable over wide ranges of temperatures without altering the delay. They may be used in field equipment when plug-in techniques for changing delays are advantageous.

Known as "Pluglines," these delays are manufactured by the Jacobs Instrument Co., Bethesda 14, Md. They are classed into four series. Designated P10, P20, P40, and P80, they differ in complexity of construction and, hence, ratio of delay time to rise time. Any one of five characteristic impedances are available. As long as the characteristic impedances of units are the same, any of the series can be plugged together.

Typical delay and bandwidth ratings, over characteristic impedances of 50 to 2000 ohms are: P10 series—0.1μsec and 32Mc, 10μsec and 0.3Mc; P20 series—0.1μsec and 64Mc, 20μsec and 0.3Mc; P40 series—0.1μsec and 127Mc, 40μsec and 0.3Mc; P80 series—0.2μsec and 127Mc, 80μsec and 0.3Mc. There are 186 values manufactured; additional intermediate values are available upon request.

These delay lines have good rise time and low distortion characteristics. Desirable characteristics are achieved by properly matching inductances between all, and not just adjacent, sections and by using phase equalization networks. Pluglines are designed so that when two are plugged together, connections made through the socket pins change the phase equalization so that it is correct for the total number of sections.

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Using Built-In VTVM's

By Jay Salz

Trio Laboratories, Inc. Wantagh, New York

Miniature VTVM is 3-1/2" in diam and only 4-1/2" deep.

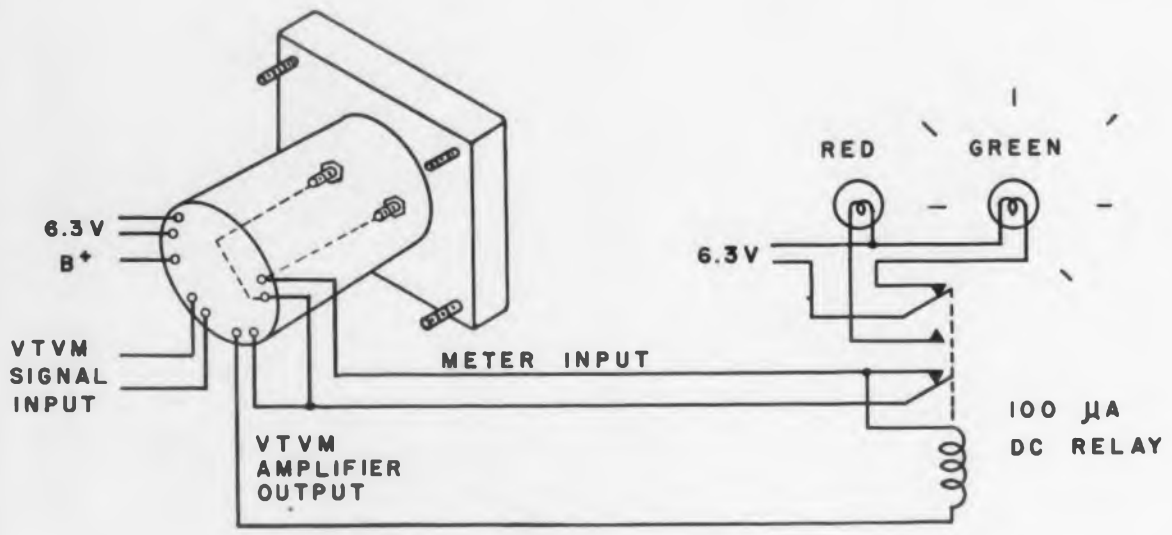
MINIATURIZATION techniques have made it possible to produce vacuum tube voltmeters that are small enough and light enough to be included as a part of the actual operating equipment. Rapid sequential or continuous metering of critical circuits is practical. These panel-mounting VTVM's give new scope to the design engineer's ingenuity.

In a recent poll of military maintenance experts, six out of seven field engineers felt built-in test equipment would simplify maintenance problems. General reasons for their conclusions include: inaccessibility of existing test points, awkwardness of working with even the most compact general-purpose equipment, and inappropriateness of general test equipment to simply, efficiently, and unmistakeably indicate correct values. Specific reasons listed for including integrated test equipment aim at improving reliability and performance by providing means for repetitive checks.

A VTVM consists essentially of a power supply plus three major sections: scale selector, amplifier, and meter-rectifier. The brief examples that follow are intended to illustrate how these sections can be combined into equipment test set-ups to become an integral part of the measuring and switching circuits. In every case, the instrument used represents only a minor variation of a standard panel-mounting VTVM.

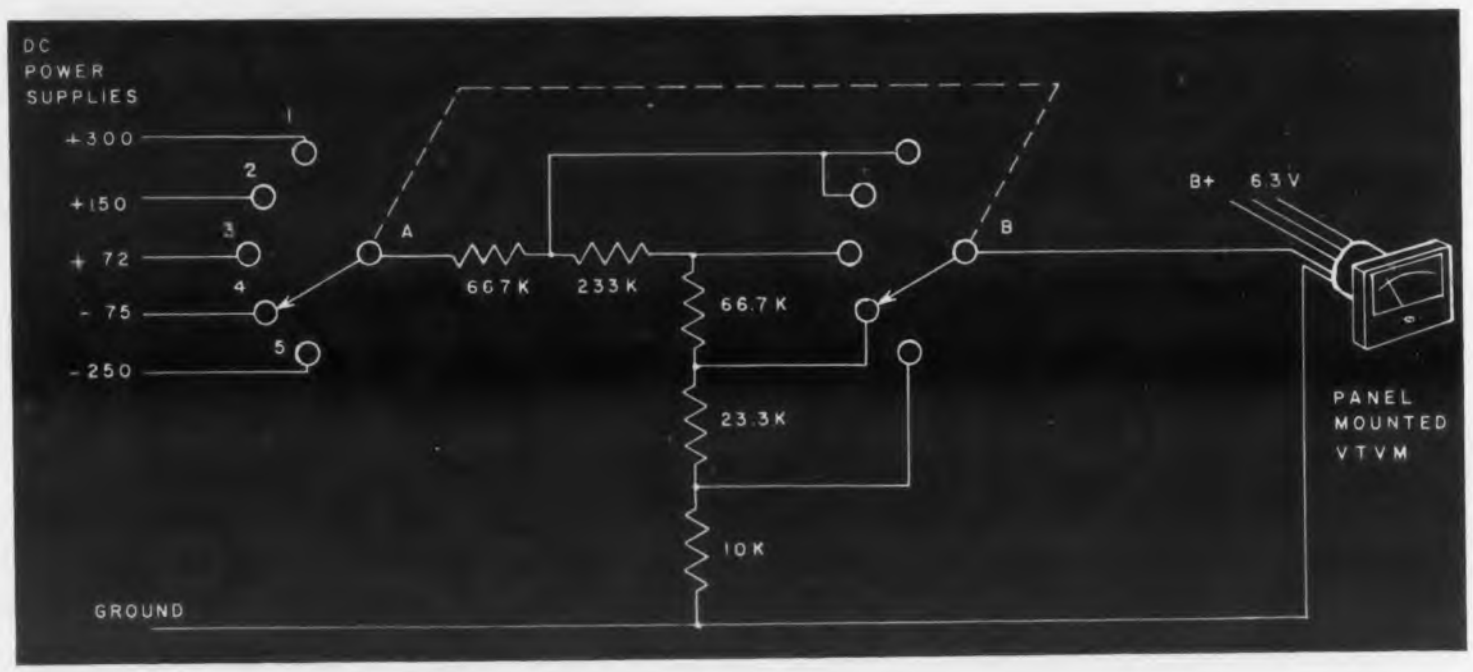
The circuit illustrating the monitoring of ripple voltage shows a direct way of automatically switching scales and test points in a series of measurements. It is based on combining the scale selector network with the test point selector switch and using a 10mv full-scale VTVM. This particular example involves the monitoring of ripple voltage from a series of d-c supplies that are part of a large computer assembly.

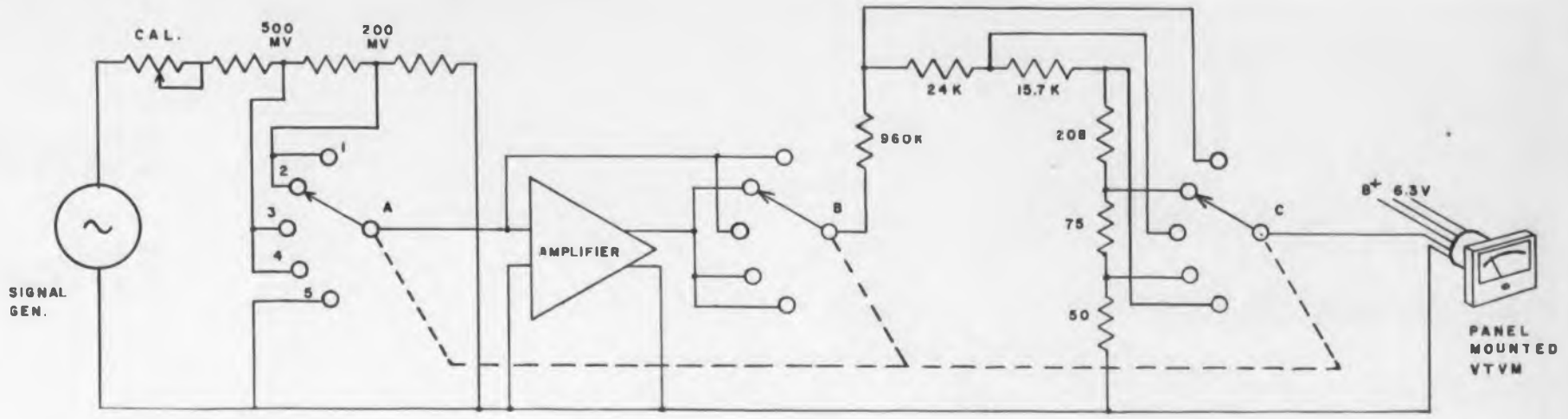
To minimize potential differences between switch contacts, the leads from the power supplies are wired to the first deck of a rotary switch (deck A) in order of descending voltages. The wiper of this deck connects to the top of the resistive scale selector chain. For convenience, the scale resistors are mounted directly onto the switch deck. Each switch position, then, represents two things: the test point to be measured, and the correct meter scale for that particular measurement.



Amplifier section is used for go—no-go indication. Meter switches in automatically indicating exact deviation of rejects.

Test point to be monitored and scale selection is obtained simultaneously.



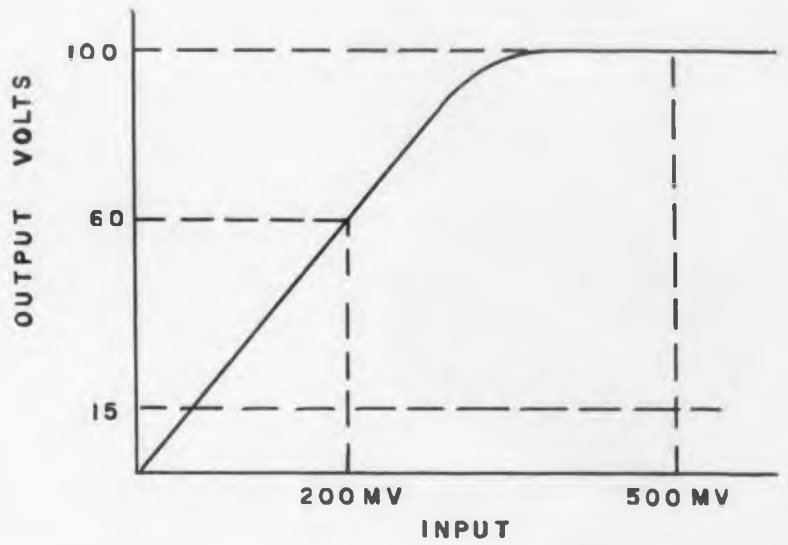


The scaleplate of the meter movement has two arcs, 0-3 and 0-10, and contains the legend "RIPPLE VOLTAGE". The equipment panel is marked at each switch position with the nominal voltage being measured plus the full-scale value (or multiplying factor) to be used in reading. The operator merely switches to the supply he wishes to measure and reads the voltage directly from the scale indicated on the panel. Thus, with a minimum increase in equipment size, the operator has a continuous assurance that the equipment is operating satisfactorily.

The amplifier gain test circuit is somewhat more complex, but the principles are the same: scale selector and switching circuits are combined, and the meter face has special scaleplate markings. For purposes of this example, the amplifier characteristics shown in the accompanying graph have been assumed. Each amplifier is to be checked for gain at the center of its linear range, for gain in the saturation region, and for residual output (zero input).

The measuring circuit consists of three main sections, each wired to a different deck of the three-deck rotary switch. The first section selects the input signal to the amplifier and includes a potentiometer to compensate for signal source variations. The input signal is fed to both the amplifier under test and to alternate terminals of the second switch deck. This second deck selects the VTVM signal by simply switching from amplifier input to amplifier output whichever is appropriate for the measuring sequence. The signal to be measured is then fed to the third deck—the VTVM scale selector circuit.

The scaleplate of the meter has an arc plus two special index marks. The arc is marked "GAIN" and reads from 0 to 400. One index mark, at 50% of full scale, is labeled "MAX. RESID." and the other one, at 80% of full scale, is labeled "CAL.". The five panel switch positions are marked "CAL GAIN", "READ GAIN", "CAL SATURATION", "READ SATURATION", AND "RESIDUAL". The operator turns to CAL GAIN and adjusts the calibration potentiometer until the meter reads at the CAL mark. He then switches to READ GAIN and records the gain directly from the arc. This procedure is continued until all three test points have been recorded.



Switch Position	Operation	Meter Scale
1	Cal. 200 MV	250 MV
2	Read Gain	80 V
3	Cal. 500 MV	625 MV
4	Read Saturation	200 V
5	Read Residual	30 V

Amplifier gain test circuit, above, indicates gain at three points and allows for calibration adjustment.

It may be seen that by a judicious selection of full-scale sensitivities, it is possible to have the arc marked only "GO" and "NO GO" on red and green sectors. In this way, if actual numerical records are not required, test operations can be even further simplified and operating time reduced.

A basically different approach is shown in the modified go—no-go test circuit. Here, maximum design flexibility is achieved by first using the amplifier section of the VTVM independently, and then using it normally with the rest of the instrument.

For simplicity, it is assumed that the test signal must not exceed 5mv. The signal may represent any test quantity: ripple voltage, audio level, synchro output, etc. While it is desired to evaluate this signal on a go—no-go basis, it is also necessary to double-check the rejections by having a record of deviation from spec limits. To achieve this, a pair of red and green indicating lamps are used, and the meter movement is put into the circuit by a relay only when the 5mv level is exceeded.

The VTVM has a 10mv full-scale sensitivity and contains a 200μa d-c meter movement. The 5mv signal, therefore, represents an average-value current of 100μa coming from the full-wave rectifier bridge output of the amplifier section.

A 100μa relay is connected in series with the meter movement across the amplifier section output. If the signal level remains below 5mv, the green lamp remains lit, and the meter movement is shorted out of the circuit. When the 5mv level is reached, however, the green lamp is extinguished, the red lamp is lit, and the meter is put back into the circuit to read the input signal. The reading may be established in any scale units: millivolts, percentage, or even arbitrary go—no-go units.

Many other combinations are possible. For example, the amplifier section may be used to supply both a recording oscillograph and the meter movement of the VTVM. In this way it is possible to use the VTVM proper to establish boundary conditions or pre-set reference levels before switching to the recorder for a permanent record of the data.

Still another approach would be to use the meter movement separately in other test circuits in the equipment. In a servo computer, for example, it is possible to visualize a signal tracing procedure that would automatically and sequentially evaluate transducer output, synchro or bucking pot output, synchro or pot excitation, amplifier input and output, and motor excitation. Where reliability and compactness present key problems in equipment design, integrated monitoring operations may be the best answer.

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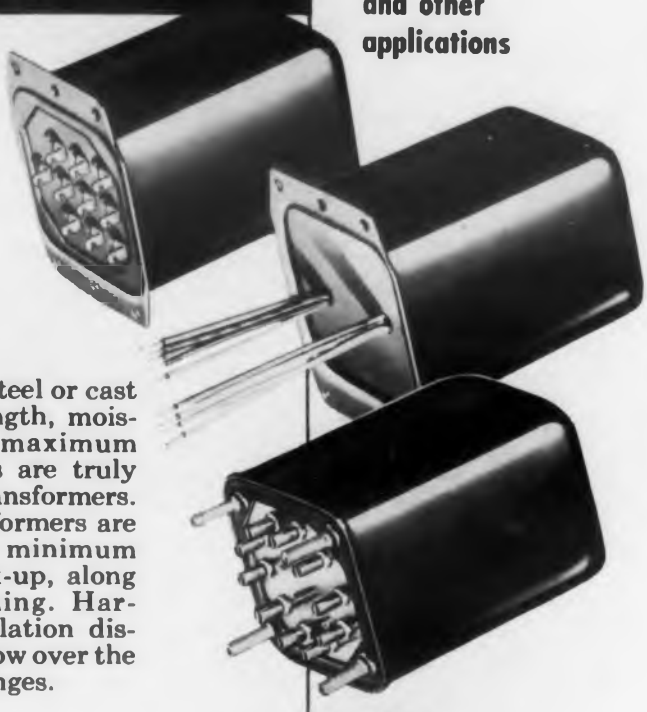

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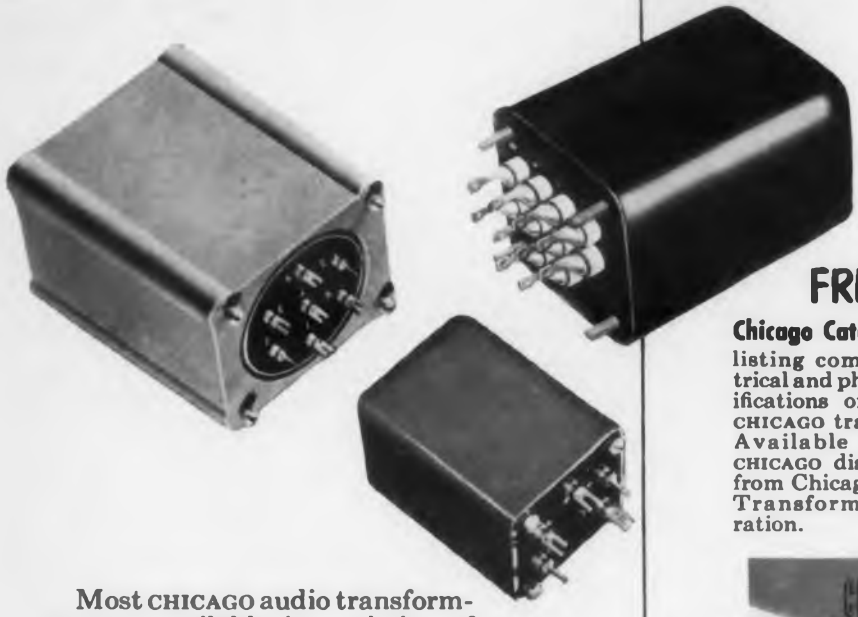

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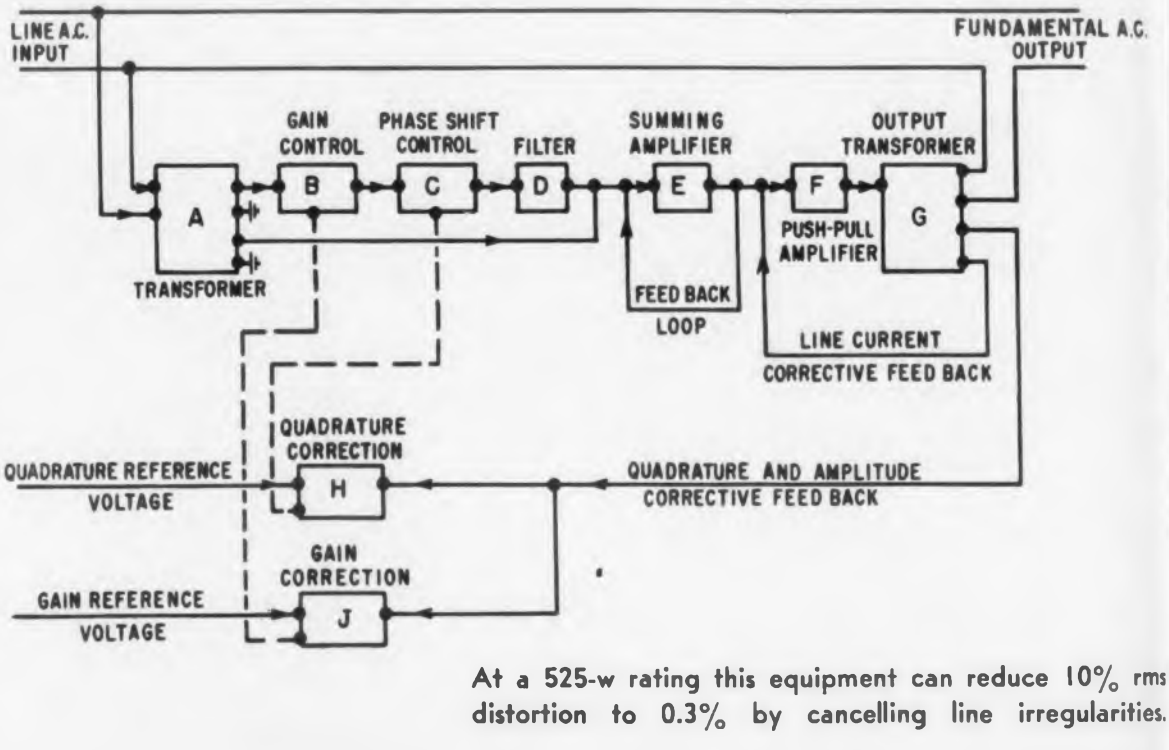
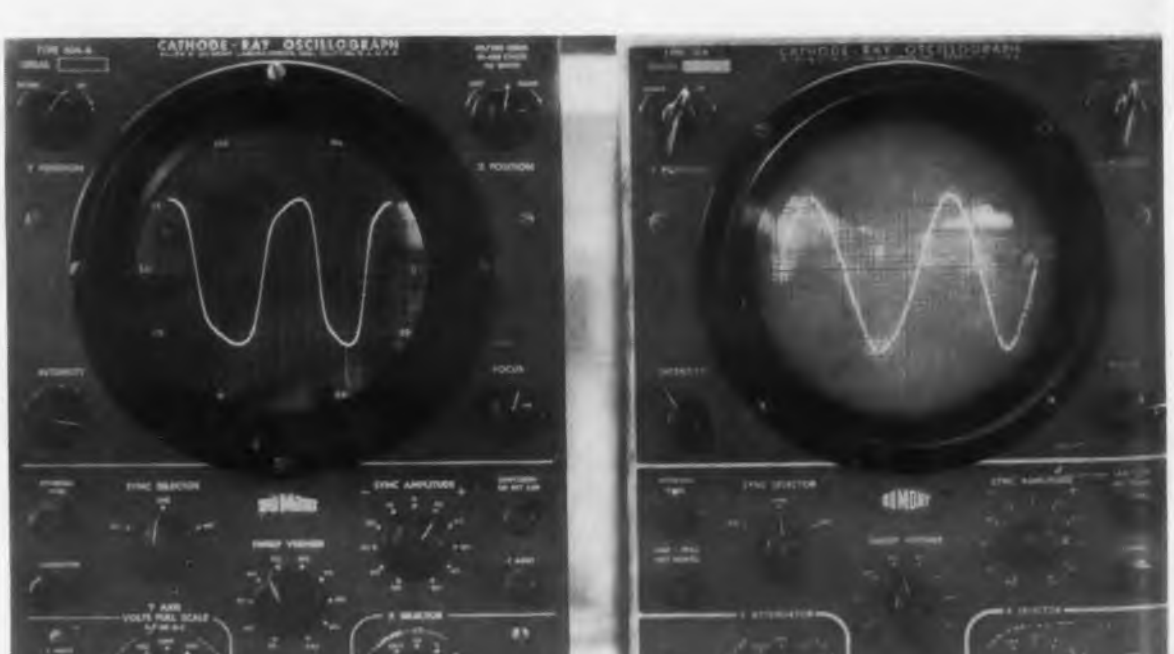
Harmonic Eliminator



At a 525-w rating this equipment can reduce 10% rms distortion to 0.3% by cancelling line irregularities.



Before and after waveforms show effect of Harmonic Eliminator.

PURE sine wave power is delivered by this harmonic eliminating device. Low-frequency harmonics and noise created by power tools and equipment in the industrial plant is suppressed, leaving a pure sine wave. A unique circuit samples the incoming waveform and obtains from it a separate noise and harmonic signal. This signal is amplified and fed back into the line, but out-of-phase. As a result, line noise and harmonics are cancelled leaving only a pure 60cy sine wave.

Heretofore it has been difficult to obtain pure a-c power acceptable for precision measuring techniques, because of the difficulty in removing l-f harmonics by normal filtering. The Harmonic Eliminator, manufactured by the Electronic Div. of Curtiss-Wright Corp., Carlstadt, N. J., works most efficiently in the 100 to 3000cy range where most noise occurs.

Use of the unit permits reliable results to be obtained from accurate a-c computers and high-precision testing equipment. It is also useful as a power source for precise a-c servos. It provides a pure waveform for master oscillators and high-accuracy timers.

The overall operating principles are inferred by the block diagram. A sample of the input voltage which includes distortion is divided into two signals in transformer *A*. One signal passes, via the phase shift control, through filter *D* which delivers the fundamental frequency only. The pure fundamental signal and the signal containing distortion are summed and since the two fundamental frequencies are opposite in phase, they cancel out leaving only harmonics and noise. This distortion signal is then amplified in two successive stages. The output signal is fed into the line through output transformer *G* to cancel the harmonic and noise in the original line input.

Line current corrective feedback overcomes any tendency for voltage drop in the output transformer to change. Filter phase and attenuation tolerances, which might cause imperfect cancellation of the fundamental at the summing amplifier, are compensated for by two servomotor feedback loops. One servomotor operates a phase shift control to eliminate any quadrature component. Similarly, the other servomotor operates a gain control, *B*, to adjust the filter input correctly.

The unit illustrated can supply over 500w of pure sine wave 60cy power from a 220v line. The maximum power rating is determined by the peak "corrective" harmonic voltage that the amplifier can supply and by the maximum 60cy load current in the output transformer.

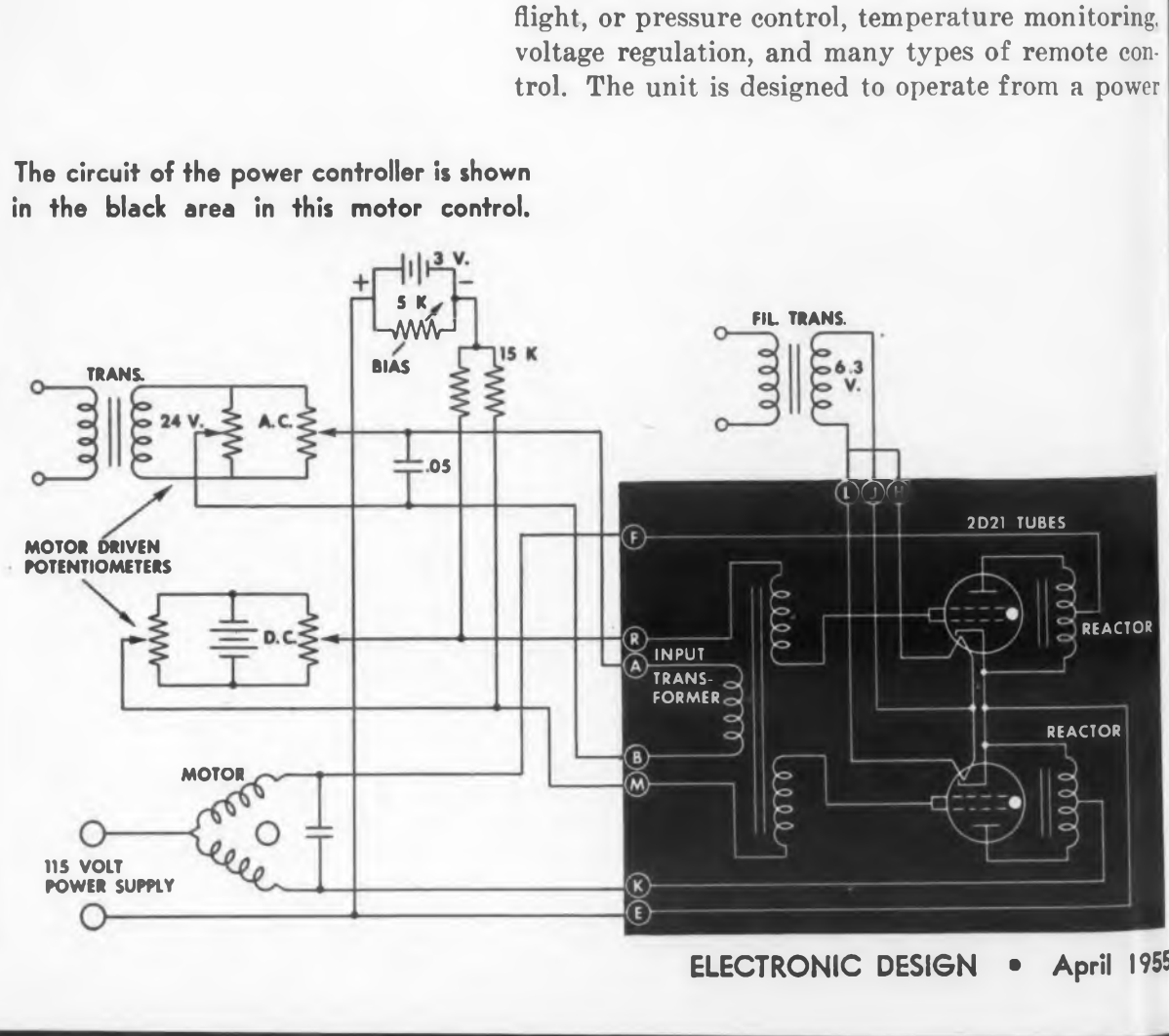
Typical distortion reductions are 30db in the 200 to 1400cy range and 20db in the 100 to 3000cy range. Some reduction is effected in the overall range of 65 to 19,000cy. For more information, turn to the Reader's Service Card and circle **ED-36.**

High-Output Power Controller

TAKING the place of relays in many applications, the Spelco-Serv Power Controller delivers an output of 100w or more for inputs down to 50mv. The plug-in unit will accept a-c, d-c, or phase-shift error or control signals. No power is supplied to the load in the null or standby condition.

Applications of the device include machine, flight, or pressure control, temperature monitoring, voltage regulation, and many types of remote control. The unit is designed to operate from a power

The circuit of the power controller is shown in the black area in this motor control.



The thyratron tubes can be removed from this version of the unit.

supply with a frequency range from 200 to 800cy, but a 60cy version is also available. The controller is made by Standard Plastics and Electronics Co., 1540 S. Robertson Blvd., Los Angeles 35, Calif.

The unit is made in two versions. In one version, illustrated, the circuit is hermetically sealed in a potting compound, but the tubes can be removed. In the second version, the entire circuit, including the tubes, is encapsulated. This method of construction enables the units to operate in temperatures from —90° to +300°F, and under high shock. The units meet military requirements.

The circuit of the controller is shown in white in the illustrated application circuit. It consists of a pair of saturable reactors paralleled by thyratron tubes such that the plates of the tubes are in phase with each other. The error signal entering the center-tapped input transformer swings the grid of one thyratron or another depending on the phase of the signal. When a thyratron fires, the output passing through the anodic winding of the associated reactor saturates the core in phase with the anodic current allowing power to be passed to the load. By using an autotransformer type of reactor, the power drawn by the load passes primarily through the reactor permitting the use of smaller tubes for higher power output.

Many circuit combinations are possible: a-c error signal with d-c bias; d-c error signal with d-c bias; a-c signal error with a-c bias; d-c error signal with a-c bias; and combinations of both types of error signals with either a-c or d-c bias. Output to the load is a good sine wave. For more information, turn to the Reader's Service Card and circle **ED-39.**

Choosing the Proper Type of Fan

J. Constant Van Rijn, Chief Engineer
Rotron Manufacturing Co., Woodstock, N. Y.

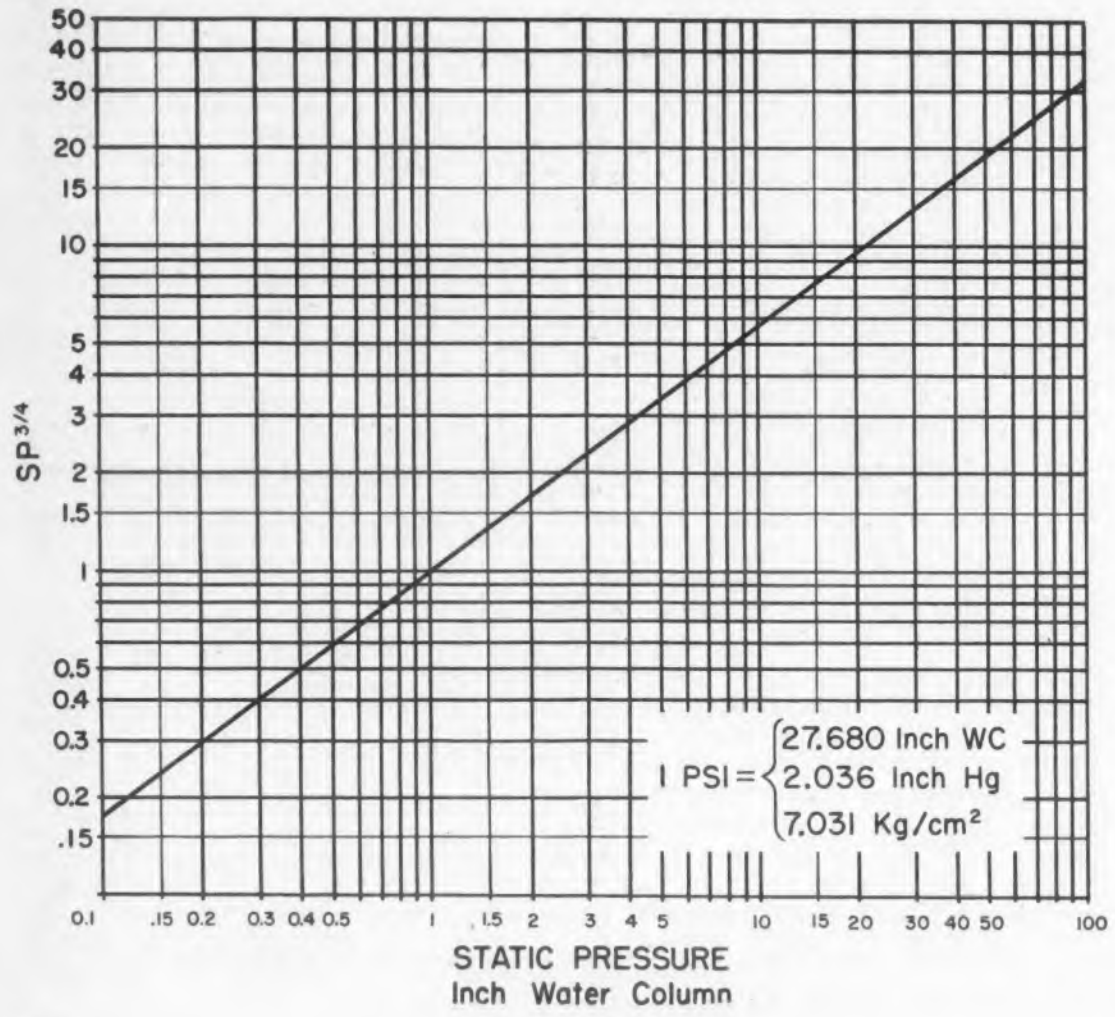


Fig. 1. The value obtained from this chart is used in formula for "load-speed characteristic figure".

EACH of the six types of fans discussed and illustrated in this article operates most efficiently within certain ranges of pressure/volume ratios. Available or allowable shaft speed is another important factor limiting the choice of a fan. By introducing a new concept, known as the "load-speed characteristic figure", the procedure for selecting the most efficient type of fan is greatly simplified.

A fan is normally defined by these parameters:

Airflow: Volume of airflow is determined by the requirements of the load (cooling requirements).

Pressure: Pressure is determined by the physical properties of the piping system.

Shaft Speed: Limited by the type of power supply (electrical driving motor) and by acceptable level of noise.

To the above three parameters we may add one more physical consideration, which often affects the fan type choice, that is:

Airflow Configuration: This resolves to a choice between axial (straight-through) and right-angle flow between fan inlet and outlet.

These parameters can be used to assign a characteristic figure to a fan by combining them into the following equation, which leads to the "Specific Speed" of the fan, a term used by the designers of fans. (*SP*

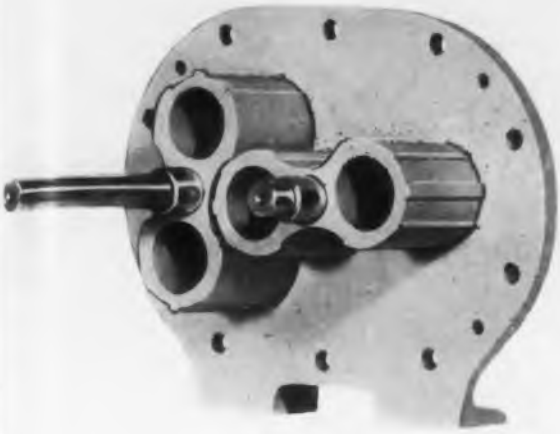


Fig. 2. These are typical impellers for (left to right) propeller and vaneaxial fans, and squirrel-cage, radial-wheel, multistage, and positive-displacement blowers. The sizes are not to be taken as relative.

Fig. 3. By determining which fan has a Specific Speed equal to the "load speed characteristic figure", the proper fan for that application is selected. For multistage blowers the Specific Speed has been taken for 3 to 7 stage. This is a more significant figure than the equivalent figure for a single stage. The values given are for the most useful fan sizes.

stands for static pressure in inches of water column.)

$$Ns = (rpm\sqrt{cfm})/SP^{3/4} \qquad (1)$$

This expression does nothing but classify the fan as belonging to a series of homologous fans (having the same proportions but not size) all of which have the same Specific Speed. The Specific Speed figure therefore remains the same if we increase or decrease all fan dimensions in the same proportion. It also remains unchanged when we change the fan speed. Specific Speed is actually the shaft speed at which the fan will have to operate, after having been reduced proportionally in size, to move 1cfm against a static pressure of 1" W. C.

When determining the Specific Speed of a fan, those cfm and *SP* figures are taken that correspond to the point of maximum static efficiency, and this relationship holds at any shaft speed. Example: Select a small squirrel-cage type blower of the "100 cfm free-delivery" variety, a common type. When measured at a constant shaft speed of 3300rpm (an arbitrary speed—see above), we find that the peak static efficiency is at 30cfm and 0.45" W. C. Applying the value of $SP^{3/4}$ from Fig. 1 to formula (1), N_s = 32,700.

Specific Speed determination is a method of classifying "fans", and this classification deserves to be

Specific Speed
400,000
300,000
200,000
150,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
15,000
10,000
9000
8000
7000
6000
5000
4000
3000
2000
1500
1000
900
800
700
600
500
400
300
200
150
100
Propeller Fans
Vaneaxial Fans
Squirrel – Cage Blowers
Forward Curved
"Loose" Scroll
"Tight" Scroll
Radial – Wheel Blowers
Multistage Blowers (3 to 7 stages)
Positive Displacement Blowers

used more widely. It would be well if all fan manufacturers gave, as routine information, the Specific Speed figure for each type of fan in their catalog.

The load on the fan is classified by two parameters: volume flow through the load; and back pressure on the load, or static head at the fan exit for that particular flow. Here again may be added a third physical consideration that could affect the choice of fan: the entrance area of the load. This parameter determines the air speed or velocity at which the fan must deliver the air to the load.

We shall now introduce a new concept, termed "load-speed characteristic figure", or L_s, defined:

$$Ls = (rpm\sqrt{cfm})/SP^{3/4} \qquad (2)$$

wherein *cfm* and *SP* are the requirements of the load and *rpm* is the shaft speed that is chosen (see below) to drive the fan that delivers into this load.

It will be noted that L_s has the same equation as N_s, but each stands for a different concept. Specific Speed is a dimensionless type characteristic of the fan, independent of fan dimensions and fan speed. On the other hand, load-speed characteristic figure, as the name implies, stands for the known characteristics of the load combined with the shaft speed at which the fan will be driven. By determining L_s and selecting a fan with a Specific Speed matching L_s, the most efficient fan for that application can be chosen.

Example: we have a finned anode transmitting tube requiring 200cfm at 2.5″ W. C. and our power supply is 60cy. If we wish to use an induction motor, as we are most likely to do, our shaft speed is limited to 3450rpm. Hence our L_s figure becomes 24,400. By matching L_s to N_s, we see from Fig. 3 that this load can be best satisfied by using a squirrel-cage type blower of the tight-scroll variety. In proceeding in this manner, the choice of the proper fan type for any application will be greatly simplified. It will also eliminate the danger of choosing a type of fan that is not properly suited for the characteristics of the load, notwithstanding the fact that, by consulting the published *cfm* versus *SP* figures for that type of fan, the required load may be found to lie on the published performance curve. For example, if we are required to move 50cfm against 5.5″ W. C. at a shaft speed of 3400rpm, we may consult a manufacturer's catalog and find that this air movement can be realized by using a squirrel-cage type blower with a 7-3/4″ diam wheel of 3-3/8″ width. If we determine, however, that the L_s amounts to 7000 and consult Fig. 3, we find that a radial-wheel blower is preferable. Indeed, a typical radial-wheel blower with a 10″ diameter wheel of 3/4″ width will give the above performance

at its peak mechanical efficiency of 63%, whereas the squirrel-cage blower would be working at 11% efficiency. The shaft load for the radial blower would be 0.07hp and that for the squirrel-cage blower 0.4hp.

The following additional consideration may now be presented. By changing the dimensions, but retaining the proportions of a fan, any type of fan regardless of the Specific Speed of the particular type, can be made to work at peak efficiency into any load, if the fan runs at the shaft speed required by the situation.

Sample Problem

An example will aid in understanding the significance of this statement. In our previous example, we assumed a load requirement of 50cfm at 5.5″ W. C., and it was shown that a radial type blower would be most suitable for the assumed shaft speed of 3450rpm. In accordance with the above statement, we could also have used, for example, a propeller fan of certain physical dimensions and driven at a certain speed. Let us see how this would work out, if we should use a propeller fan of average type characteristics with a Specific Speed of $N_s = 20{,}000$. Consulting a manufacturer's catalog, we find that a propeller fan having this Specific Speed, would, for example, be one with a 16″ diameter propeller moving 1530cfm at 0.2″ W. C. when driven at 1725rpm. Inasmuch as the volume moved by a "fan" is directly proportional to its speed and proportional to the 3rd power of its impeller diameter (all other dimensions being changed at the same time in a homologous manner), we find that our propeller fan would have to have a diameter of 1.2″ and would have to turn at a speed of 100,000rpm. We see, therefore, that if we start out to use a fan type with a Specific Speed outside of the limits given in Fig. 3, we are confronted with impractical dimensions and/or shaft speeds. If high shaft speeds are available, as in the case where the power line frequency is 400cy, physically smaller fans might suffice, and this is one of the advantages of using 400cy power for airborne applications.

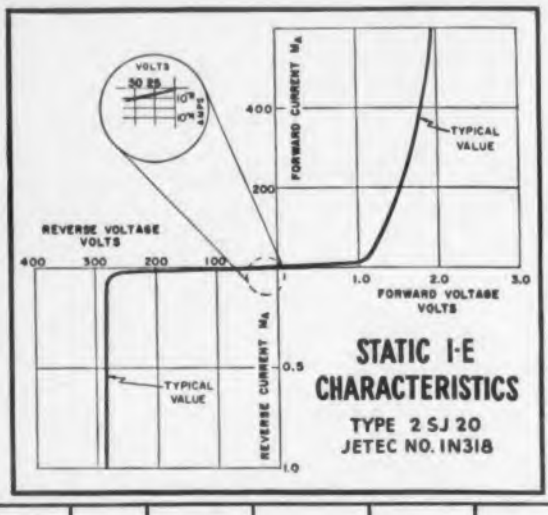
When selecting a fan and calculating L_s, it is necessary to adopt a shaft speed. This shaft speed will be dictated by practical considerations. If induction motors are used, the maximum obtainable shaft speed is 3450rpm for 60cy and 2875rpm for 50cy. With a 400cy supply there is generally a choice between 3700rpm, 5400rpm, 7200rpm, 10,500rpm, and 21,000rpm. If a commutator type motor is used, either a-c or d-c, the maximum shaft speed is roughly 10,000rpm for "miniature" motors and roughly 5000rpm for small motors; but commutator-type motors are generally avoided because of maintenance.

If the designer chooses the highest shaft speed that can be obtained with the available power supply, he will be able to use the physically smallest fan. However, the smaller the blower he selects as a result of choosing a higher shaft speed, the greater is the noise level and the shorter the bearing life and brush life.

An Important Announcement to Industry

New SILICON POWER RECTIFIERS

AVAILABLE FOR THE FIRST TIME IN PRODUCTION QUANTITIES



Jetec No.	TYPE	Forward Drop @ 200 MA	Forward Current Continuous	Power Current Peak	Peak Inverse
IN 316	2SJ5	2V Max	200 MA	2A	50V
IN 317	2SJ10	2V Max	200 MA	2A	100V
IN 318	2SJ20	2V Max	200 MA	2A	200V
IN 319	2SJ30	2V Max	200 MA	2A	350V
IN 320	2SJ50	2V Max	200 MA	2A	500V

Units with peak inverse rating of 850 volts available in sample quantities.

PRECISION ELECTRICAL EQUIPMENT Bogue SINCE 1892

Characteristics:

1. **Highest Efficiency**
2. **High Current**
3. **High Voltage**
4. **High Ambient Operation**
5. **Hermetically Sealed**
6. **Small in Size**
7. **Light in Weight**
8. **Rugged — All Welded**
9. **Low Forward Drop**
10. **Low Leakage**

Performance:

1. Rectification Efficiency Over 99%
2. Forward Voltage Drops Averaging 1.5 Volts at 200 MA
3. Peak Inverse Voltages to 1,000 Volts
4. Operates Continuously up to 200° C
5. Leakage Current as Low as 10-10 amperes
6. Rectification Ratios as High as 10°
7. Practically Flat Zener Characteristics

Write for fully illustrated and informative Bulletin SR-18-4

BOGUE

BOGUE ELECTRIC MANUFACTURING COMPANY

PATERSON 3, NEW JERSEY

CIRCLE ED-43 ON READER-SERVICE CARD FOR MORE INFORMATION

Signal Generator with Oscilloscope

The sides of the unit are tilted to permit good air circulation even if placed beside another laboratory instrument.

RESULTS of swept frequency tests on bandwidths of 100Mc or less at up to 2000Mc can be viewed on the built-in oscilloscope on the Model 7105 Wobbulator Signal Generator. Useful in many circuit development projects, the unit measures frequency response in double and triple tuned circuits, cascode input amplifiers, detectors, discriminators, and measures i-f rejection in wide-band networks, for example. It measures gain and high-frequency response in video amplifiers.

The frequency range of the generator is 2 to 1000Mc. During the continuously variable sweeping, amplitude variation of the signal is less than 0.01db/Mc. The sensitivity of the 5" oscilloscope is adequate for measurements of networks with as

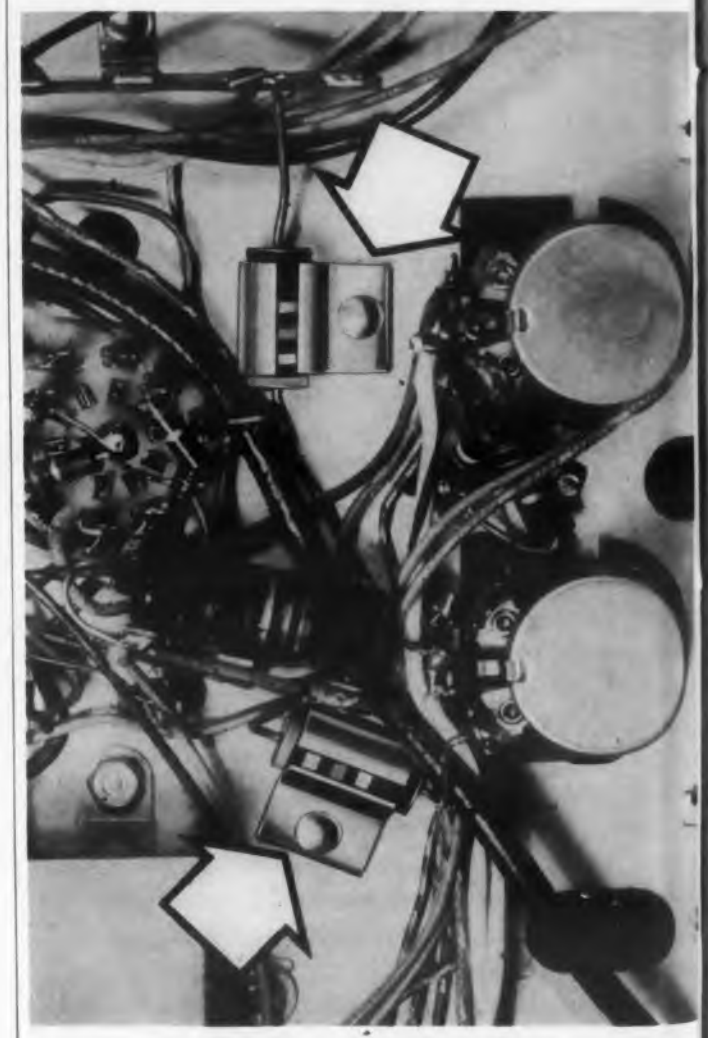
Three typical readings as seen on the Wobbulator's oscilloscope. The top photo concerns a double-tuned input circuit of a cascode amplifier. The second photo shows the image response of a 54Mc receiver with a 21Mc i-f of 2Mc bandwidth. The bottom photo indicates an improper coaxial line output termination on a v-h-f distributed amplifier.

much as 60db loss. The frequency of the generator is continuously variable over its range. The attenuator is calibrated in 1db divisions.

A detachable broadband detector is supplied with the instrument. The detector has low capacity and high shunt resistance for use with high impedance circuits. An adapter is included that matches the detector to low impedance co-axial lines. The unit is manufactured by Canoga Corp., 5955 Sepulveda Blvd., Van Nuys, Calif.

Input voltage can vary as much as 105-125v, and the unit operates on 50-400cy power. Its dimensions are 12" x 13" x 7", and it weighs about 30 lb. For more information on this instrument, turn to the Reader's Service Card and circle **ED-44.**

Copper Clad Resistors



COPPER clamps encircling a standard composition resistor increase its heat transfer capabilities. These copper clad resistors are considerably smaller than wire-wound units of comparable rating and are relatively non-inductive. All standard values and tolerances for composition resistors are available starting at 2.7 ohms in one instance and extending to 22 megohms.

Manufactured by the Allen-Bradley Company, 136 West Greenfield Ave., Milwaukee 4, Wisconsin, the copper clad units incorporate standard A-B one and two-watt resistors. When mounted on a 0.050" steel panel having an area of at least four inches square and in an ambient of 70°C, type GM resistors have a continuous wattage rating of 3w. Type HM resistors have a continuous rating of 4w. In low resistance values, increased wattage ratings are feasible.

Standard color code is used to indicate nominal resistance values and tolerances. For more information about these component's characteristics, turn to the Reader's Service Card and circle **ED-47.**

Stable copper-clad resistors used in a critical color balancing network of a 19" color TV receiver to maintain constant picture contrast.

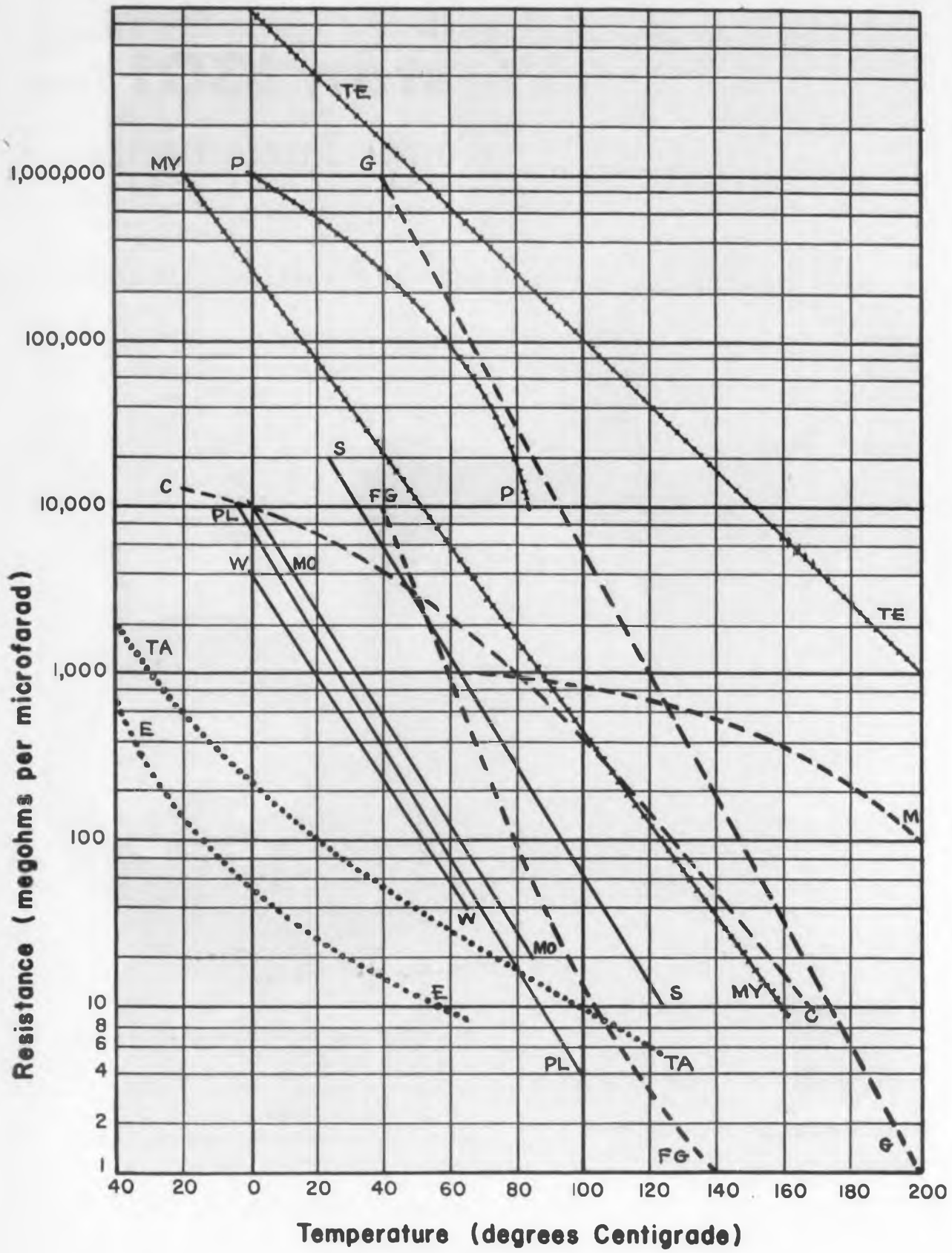
Capacitor-Selection Chart

R. G. Lindstrom
Associated Missile Products Co.
Pomona, Calif.

SELECTING capacitors of low leakage characteristic is aided by the chart shown on this page. Where a charge on a capacitor is desired to be held for an appreciable length of time, these curves should indicate the types to be investigated dependent upon the temperature operation range.

These curves of insulation resistance vs temperature are derived from manufacturers' literature. There were quite wide variances of values for some materials as presented by the different vendors. Therefore, these curves give only general values of magnitude. The curves shown should not be extrapolated, especially in the upper temperature ranges. These curves are all nominal and are only representative of what may be expected in the various insulation materials considered in this article.

When insulation resistance measurements reach 10,000megohmmfd, and especially over 100,000-megohmmfd, not only do the measuring conditions become very critical, but the encasing material and cleanliness of the capacitor in general are also governing factors. The characteristics of a capacitor when used at temperature over 100°C also begin to



Capacitors with low leakage characteristics can be chosen by means of this chart. 13 insulations given.

E	Electrolytic, Aluminum	o o o o o o o o o
TA	Electrolytic, Tantalum	
MY	Foil; Plastic, Mylar	
P	Foil; Plastic, Polystyrene	+++++++++++++
TE	Foil; Plastic, Teflon	
C	Laminate; Ceramic K1200	
FG	Laminate; Fritted glass and silver (laminated porcelain)	— — — — — —
G	Laminate; Glass (Monolythic)	
M	Laminate; Mica (Std)	-
MO	Foil; Paper, Mineral Oil	
PL	Foil; Paper, Plastic Dielectric (Molded)	_____
S	Foil; Paper, Silicone	
W	Foil; Paper, Wax	

require a closer scrutiny by the electronic designer.

Measurements and required usage of capacitors having insulation factors of 100,000megohmmfd require clean, dry conditions. Any film of dirt or moisture, or both, will substantially reduce the insulation resistance between terminals alone and between terminals and case where the case is metallic.

Mica capacitors become quite dependent on the molding material. The general types of mica capacitors are limited to operation at temperatures below 85°C primarily due to this factor. Some recent mica capacitor developments allow for operations at full ratings to 150°C.

The use of polystyrene capacitors around and slightly above 80°C (not over 90°C) would require much verification. Operation at these temperatures is very close to the thermoplastic or heat distortion point of the material, and where there are physical disturbances, the electrical characteristics could vary quite drastically.

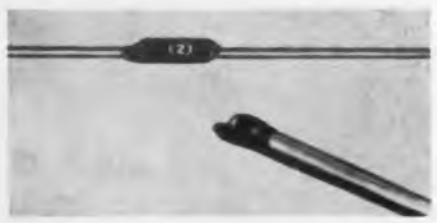
"Mylar", as used in capacitors, has been indicated to have excellent characteristics to 160°C; however, the material is so relatively new, especially in capacitor applications, that to date not enough time has passed for adequate life tests. It is apparent, therefore, that this type of capacitor should be thoroughly investigated in relation to all operation above 85°C, especially in terms of life.

"Teflon" also should be carefully analyzed above room temperatures, since it is a thermoplastic material and subject to deformation under pressure as the temperature is increased. The National Bureau of Standards has reported finding three different transition points in Teflon occurring at three different temperatures and the corresponding three different pressures. One of these points in noted at 68°F at a pressure of one atmosphere. The other two are at higher temperatures and much higher pressures. Therefore, there are liable to be wide variances between capacitors with Teflon insulation due to winding techniques and tensions.

New Products...

Wire-Wound Resistor

Ultra-Miniature 3w Unit



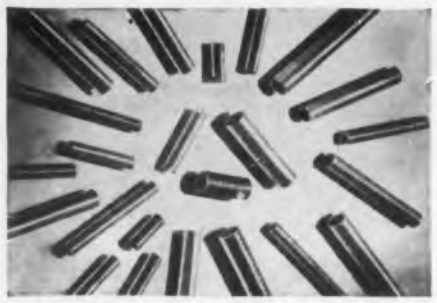
This "Blue Jacket" subminiature 3w wire-wound resistor is the same size as conventional 1/2w molded carbon resistors. Developed especially for use in military and industrial electronic equipment, this tiny unit, hardly bigger than a match head, is expected to find wide application in point-to-point and terminal board wiring, as well as on printed wiring boards.

The resistor is only 13/64" diam x 17/32" long and has a maximum resistance value of 10,000 ohms. Like other members of the "Blue Jacket" family of resistors, it is provided with a tough blue vitreous enamel coating which will withstand stringent humidity tests. Sprague Electric Co., Dept. ED, 347 Marshall St., North Adams, Mass.

CIRCLE ED-51 ON READER-SERVICE CARD FOR MORE INFORMATION

Embossed Coil Forms

Prevents Cross Threading and Binding



An embossed design is used in these threaded coil forms to prevent stripping, breakage, and freezing due to crossthreading or improper starting of the iron core insert. Production efficiency in inserting iron cores is increased by 20% in some instances.

The embossed coil forms are custom made to particular iron core specifications. Torque characteristics are fitted to the job application. There is no decreasing or deforming of the form diameter during manufacture and binding due to oversize cores is minimized. The three-row embossed design prevents looseness or stripping. Resinite Corp., Dept. EXW, 2035 W. Charleston St., Chicago 47, Ill.

CIRCLE ED-52 ON READER-SERVICE CARD FOR MORE INFORMATION

Potentiometer

Highly Accurate Miniature Type

The Miniature Model 106 has been added to this firm's regular line of precision wire-wound potentiometers. The combination of small size, lightweight, wide choice of resistance values or functions and ganging features, facilitates the application of the unit to fire control, navigational, guided missile, or other computer uses where compactness and precision are mandatory.

This unit retains the advantageous features of linear or non-linear functions of high accuracy in regular production within the shell size of 1-1/16". It is a high-precision, wire-wound single turn unit. Linearities of 0.15% have been made on particular applications, and non-linear functions with a slope ratio of 150:1 can be achieved. George Rattray & Co., Inc., Dept. ED, 116-08 Myrtle Ave., Richmond Hill 18, N. Y.

CIRCLE ED-53 ON READER-SERVICE CARD FOR MORE INFORMATION

Capacitors

For Printed Circuit Applications

These miniature capacitors are available with paper or "Mylar" dielectric in hermetically sealed, ceramic tubular, plastic-impregnated paper, phenolic, metal, or metal-paper laminated enclosures. They are designed to eliminate costly pull-outs, and for maximum adaptability to most printed circuit production. Solder shorts and most problems connected with vibration are eliminated.

A special pack has been designed to prevent damage to these pin type mountings during shipment. Good-All Electric Manufacturing Co., Dept. ED, Good-All Bldg., Ogallala, Neb.

CIRCLE ED-54 ON READER-SERVICE CARD FOR MORE INFORMATION

X-Band Mixer Diode

Point Contact Germanium Type

The Type 1N263 is a hermetically sealed germanium crystal diode specifically designed for exceptionally low noise performance in the X-band. This crystal is capable of superior performance at any frequency below 12,000Mc. It may be used for wide-band mixer applications in the range from 8600-9600Mc with the crystal fixed-tuned over the complete range. This crystal maintains outstanding performance under high temperature operation with a degradation of about 1db of noise figure at 90°C.

The diode is symmetrical, allowing reversal of polarity so that the same crystal may be used in either side of a balanced mixer. It may be mounted in any position. This crystal is designed to meet shock, vibration, torque, and strain specifications in excess of present military requirements. Size is 0.219"diam (max) x 0.78" long. Philco Corp., Government and Industrial Div., Dept. ED, 4700 Wissahickon Ave., Philadelphia 44, Pa.

CIRCLE ED-55 ON READER-SERVICE CARD FOR MORE INFORMATION

Quartz Crystal Unit

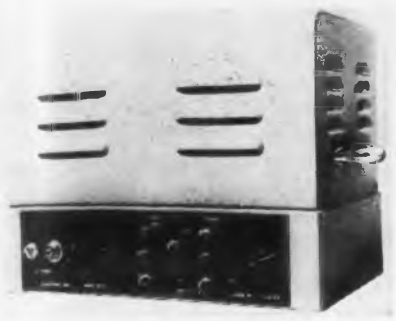
Completely Sealed in Glass

The "Cryst-O-glas" quartz crystal unit features an all-glass case and holder, providing a perfectly hermetically sealed container. Because heat alone is used in the bonding operation, the crystal itself is never subjected to the chemical fumes given off by conventional sealing compounds. This absence of contamination results in assured crystal stability and virtually eliminates the possibility of slight frequency changes. McCoy Electronics Co., Dept. ED, Mt. Holly Springs, Pa.

CIRCLE ED-56 ON READER-SERVICE CARD FOR MORE INFORMATION

Electronic Load

For Static and Dynamic Tests



This Electronic Load for both static and dynamic measurements provides a direct and convenient method of measuring the internal impedance of a regulated d-c power supply as a function of frequency, and determining the range of load over which the regulation is effective. The instrument contains two individual channels with independent static load adjustments. Channels may be interconnected, however, for a total average power range of 150w. A wide range of currents may be drawn at various applied voltages so long as the maximum ratings of tubes are not exceeded.

Provision is made for both external and internal modulation of load tubes for dynamic regulation checks. Also provided is a 1 ohm resistor to allow a voltage output proportional to load current to be obtained for observing voltage current waveforms on an oscilloscope. The instrument is housed in a 12″ x 8″ x 9″ cabinet with carrying handles, and obtains necessary internal voltages from a 115v, 60cy line. American Electronic Laboratories, Inc., Dept. ED, 641 Arch St., Philadelphia 6, Pa.

CIRCLE ED-57 ON READER-SERVICE CARD FOR MORE INFORMATION

Resistance Networks

With No Wattage Derating at 125°C

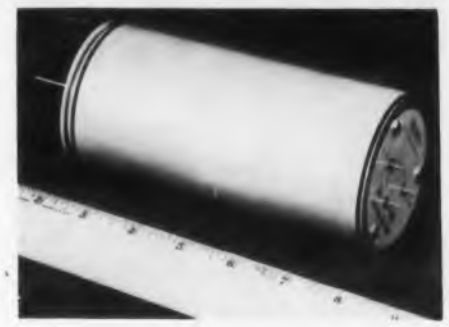
These hermetically sealed wire-wound resistance and resistance-capacitance networks can be supplied with resistance values to ±0.02% and temperature coefficients matched to within ±3 parts per million per degree centigrade. The networks are encased in "Sealed-Ohm" cases with plug-in or solder terminals.

All units are hermetically sealed to insure protection against moisture, humidity, sand, dust, salt spray, and similar agents. They can track and maintain constant voltage division or null over a full temperature range of −65° to +125°C, with no derating of wattage at 125°C. Resistors can be had with specific temperature coefficients to compensate for the temperature coefficient of the capacitors in the network. The Daven Co., Dept. ED-RE, 191 Central Ave., Newark 4, N. J.

CIRCLE ED-58 ON READER-SERVICE CARD FOR MORE INFORMATION

Potentiometer

Infinite Resolution



The "Resomax" Potentiometer, a highly accurate unit with infinite resolution for close servo follow - up loops, provides a linear resistance change with rotation rather than an incremental change as found in helically wound types. When used in servomechanisms where high accuracy is required, its linear resistance feature prevents "hunting" or "chatter". Other areas of application are in analog computers, test equipment, industrial instruments, and process control equipment.

The potentiometer provides resistance ranges from 500 ohms to 2000 ohms in steps of 500 ohms, infinite resolution, and a normal and zero base linearity of 0.02%. Other specifications include a shaft rotation of 60 turns +10°, —0°; a power rating of 5w at 25°C, and a resistance element life in excess of one million complete cycles of wiper through total travel and return. Link Aviation, Inc., Dept. ED, Binghamton, N. Y.

CIRCLE ED-61 ON READER-SERVICE CARD FOR MORE INFORMATION

Variable Resistor

Miniature Size

This new low cost Type F Control is only 5/8" in diameter and is used where space is limited, as in midget portable radios, television receivers, audio equipment, instruments, and compact printed circuits of all kinds. Miniature line switches complementing the small size of the control itself, will soon be available.

Using the company's standard deposited carbon resistance element and gold plated ring spring contactor, the Type F control gives unusually quiet and stable operation even under wide humidity variations. The control has a 1/8 inch diameter shaft which can be equipped with screwdriver slot, flat, knurl, or plain finish to suit individual requirements. The control has a 1/4-32 threaded bushing for easy panel mounting.

All resistance ranges, tapers, and other specifications according to RETMA standards are available. Electronic Components Division, Dept. ED, Stackpole Carbon Company, St. Marys, Pa.

CIRCLE ED-62 ON READER-SERVICE CARD FOR MORE INFORMATION

D-C Amplifier

Gain of 80,000

The Model D-1 Direct-Coupled Amplifier can be used for many applications formerly requiring specialized instruments. Maximum useful overall gain is 80,000, while frequency response flat from zero to more than 100kc is available at gain settings up to 10,000.

Excellent signal-to-noise ratio, low drift, and wide dynamic range are achieved through advanced circuitry and careful mechanical design. High input impedance, with either single-ended or differential connection, enables the unit to amplify signals from a wide variety of input transducers and other sources for presentation and recording on cathode-ray tubes, direct-writing recorders, galvanometer oscillographs, and magnetic media. A fully regulated power supply is in the instrument, and the complete unit is designed for rack or bench mounting at user's option. Southwestern Industrial Electronics Co., Dept. ED, 2831 Post Oak Rd., Houston, Tex.

CIRCLE ED-63 ON READER-SERVICE CARD FOR MORE INFORMATION

Iconoscope

Matches Orthicon Tube Performance

Known as the Super Iconoscope, this tube has a continuously coated surface replacing the standard mica mosaic of the more costly image orthicon-type tubes. The Super Iconoscope requires a simpler power supply (—1200v) and provides up to 1000-line rasters. The resolution and sensitivity approaches that of orthicon tubes. The tube enlarges pictures up to four times electronically without detracting from their quality. Tubes sensitive to infra-red can be ordered. The tube was developed in West Germany by Dr. W. Heimann of Physikalisch Technische Werkstatten. Curtiss-Wright Corp., Dept. ED, Wood-Ridge, N. J.

CIRCLE ED-64 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Monitor

In 25-1,000Mc Range

This bi-directional power monitor, Model 164, is designed to simplify measurement of incident or reflected power and to speed matching of loads to line. A twist of the wrist selects incident or reflected power, or any power range, without requiring removal of power. No exchange of plug-in units is necessary to read low levels of reflected power.

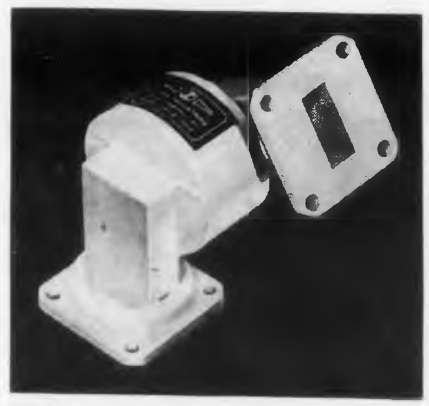
Of compact size, the unit operates at all frequencies from 25Mc to 1000Mc, employing only two plug-in elements. Both inserts have direct-reading full-scale power ranges of 10w, 50w, 100w, and 500w. Accuracy is ±5% full scale on all ranges and frequencies. Vswr is less than 1.08, and no auxiliary power is required.

The instrument is valuable for both portable (mobile, aircraft, etc.) and laboratory uses. It is supplied in a sturdy carrying case (one or both plug-in inserts supplied as ordered), and both meter and directional coupler may be removed from the case for remote monitoring. The monitor may be equipped for most connectors normally employed with 50 ohm lines. Sierra Electronic Corp., Dept. ED, 1050 Britan Ave., San Carlos 2, Calif.

CIRCLE ED-67 ON READER-SERVICE CARD FOR MORE INFORMATION

Rotary Joint

For X-Band Systems



The Model X25-OR Rotary Joint is designed for operation in 250kw X-band systems, is a compact, rugged unit which eases antenna packaging problems where space is at a premium. The joint eliminates any blind soldering or extra flange connections and provides waveguide runs to special requirements as an integral part of the assembly.

A maximum vswr of 1.15 is maintained over the 8.6kMc to 9.6kMc band, and variations of vswr and phase with rotation are negligible. It is available with either RG51/U or RG/U waveguides. Litton Industries, Component Div., Dept. ED, 336 N. Foothill Rd., Beverly Hills, Calif.

CIRCLE ED-68 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE ED-500 ON READER-SERVICE CARD

Typical characteristics of some of the units in mass production by Norden-K

400 and 60 cycle Servo Motors. High torque to inertia servos are available as small as a penny and up to Size 23. Torques of 0.1 in. – oz. to 7.5 in. – oz.

Synchro Receivers are used with Norden-Ketay synchro torque transmitters in position indicating systems. Accuracies of one degree or better are available in 60 and 400 cycle units, and in sizes from 10 to 37.

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TWO PHASE SERVO MOTORS

TYPE NO.	GOVT. DESIG NATION	FRAME SIZE	FREQUENCY	MIN. TORQUE AT STALL (IN OZ.)	NO LOAD SPEED (MIN.)	POWER PHASE AT STALL (WATTS)	NO OF POLES	RATED FIXED PHASE	VOLTAGE CONTROL SERIES	EXCITATION PHASE PARALLEL
K402390		10	400	.3	6500	3.1	6	26	26 (1)	
K402350		10	400	.13	9800	3	4	18	18 (1)	
K402300	MK 14 MOD 2	11	400	.60	6200	3.5	6	115	115	57.5
K402370	MK 14 MOD 3	14	400	.63	6200	4.6	6	115	180	90
K101600-6	MK 7 MOD 0	15	400	1.45	4800	6.1	8	115	115	57.5
K101660	MK 7 MOD 1	15	400	1.45	4800	6.1	8	115	115	57.5
K101650-5	MK 7 MOD 2	15	400	1.45	4800	6.1	8	115	230	115
K402150		15	400	1.3	6200	6.1	6	115	26*(1)	
K101720		15	400	1.4	5000	7		115	115	57.5
K402470		15	60	1.3	1600	6.1	4	24	24*(1)	
K402380		15	60	1.45	3200	6.1	2	115	115	57.5
K402560-1	MK 8 MOD 2	18	400	2.35	4800	9.2 9.5	8	115	282	141
K402550-1	MK 8 MOD 0	18	400	2.35	4800	9.1	8	115	115	57.5
K101780		18	400	1.4	9800	9/8	4	115	115*(1)	
K402550-2	MK 8 MOD 1	18	400	2.35	4800	9.1	8	115	115	57.5
K402600		18	400	1.8	9800	18/8	4	115	115	57.5
113E1Y		23	60	7	3300	16	2	115	115	57.5
113E1Y1		23	60	7	3300	16	2	115	230	115

*(1) Control phase having only one winding.

(1) Also for 115 or 230 operation on control phase.
*Denominator refers to control phase excitation.

SYNCHRO RECEIVERS

TYPE NO.	GOVT. DESIG. NATION	FRAME SIZE	FREQUENCY	FUNCTION	VOLTAGE RATING (VAC)	RECEIVER ERROR (MAXIMUM)
K101540		10	400	Torque Receiver	26/11.8	±1¼°
105C2A	15TR4a	15	400	Torque Receiver	115/90	±1.0°
K101430		15	400	Torque Receiver	26/11.8	±1.0°
106K2A	16TRB4	16	400	Torque Receiver	115/90	±1.0°
108C1C	18TR6a	18	60	Torque Receiver	115/90	±1.0°
108C2B	18TR4a	18	400	Torque Receiver	115/90	±1.0°
109K2A	19TRB4a	19	400	Torque Receiver	115/90	±1.0°
112A1C	1F	**1	60	Torque Receiver	115/90	±1.5°
113C2A	23TR4a	23	400	Torque Receiver	115/90	±1.0°
113C1B	23TR6a	23	60	Torque Receiver	115/90	±1.0°
121C1A	31TR6	31	60	Torque Receiver	115/90	±1.0°
121J1A	31TDR6	31	60	Torque Differential Receiver	90/90	±1.0°
121J1C	31TDR6S1	31	60	Torque Differential Receiver	90/90	(1)
121C2B	31TR4a	31	400	Torque Receiver	115/90	±0.8°
121J2B	31TDR4	31	400	Torque Differential Receiver	90/90	±0.8°
121C2C	31TR4C	31	400	Torque Receiver	115/90	±0.8°

(1) Pigtail Unit Sensitivity 10'

*(1) 31TDR6S1—Pigtail Unit, Sensitivity 10'

SY

TYPE NO.	GOVT. DESIG. NATION
K101560	
K101530	
101A2K	
101A2S	11CT4a
105A2A	15CT4a
K101300	
K101750	
K101300-20	
106L2A	16CTB4
(1) K402100	
108A1A	18CT6a
108A2B	18CT4a
109L2A	19CTB4
109L1B	19CTB6
112A1A	1 HCT
113A2B	23CT4a
113A1A	23CT6a

(1) Hig
(2) Lin
(3) Wh

Synchro Transmitters for use in position indicating (torque) systems and data transmission (control) systems. 60 and 400 cycle models, and sizes from 10 to 37 are available. Electrical accuracies of 7 min. in standard units.

Norden-Ketay Induction Motors are available in sizes 18, 20, and 23 frames. Three phase, 2 pole; 2 phase, 4 pole; and 3 phase, 2 pole models for 60 cycle operations are available.

INDUCTION MOTORS

TYPE NO.	GOVT. DESIG-NATION	FRAME SIZE	FREQUENCY	DUTY	OPERATING VOLTAGE	MINIMUM NO LOAD SPEED (RPM)	MINIMUM STALL TORQUE (OZ. IN.)
D11940		18	60	Continuous	3 Phase 115 V.	3300	3
E11590	1G-60	20	60	Intermittent	2 Phase 115/40	1500	2.7
E11600	1F-60	**1	60	Intermittent	3 Phase 115 V.	3400	16

SYNCHRO TRANSMITTERS

TYPE NO.	GOVT. DESIG-NATION	FRAME SIZE	FREQUENCY	FUNCTION	VOLTAGE RATING (VAC)	ELECTRICAL ACCURACY MAX. ERROR
K101570		10	400	Control Differential Transm.	11.8/10.5	30' SPD.
K101550		10	400	Control Transm.	26/11.8	24' SPD.
101B2A	11CX4a	11	400	Control Transm.	115/90	±7'
101B2A1	11CX4a-26V	11	400	Control Transm.	26/11.8	±7'
101B2J		11	400	Control Transm.	26/11.8	20' SPD.
105B2A	15CX4a	15	400	Control Transm.	115/90	±12'
105H2A	15CDX4a	15	400	Control Differential Transm.	90/90	±10'
105G2A	15TDX4a	15	400	Torque Differential Transm.	90/90	±10'
K101480		15	400	Torque Differential Transm.	11.8/11.8	20' SPD.
K101420		15	400	Torque Transm.	26/11.8	20' SPD.
K101400		15	400	Torque Transm.	26/11.8	20' SPD.
K101350		15	400	Control Differential Transm.	11.8/11.8	20' SPD.
106M2A	16CXB4A	16	400	Control Transm.	115/90	±12'
108B1B	18CX6A	18	60	Control Transm.	115/90	±8'
108B2A	18CX4A	18	400	Control Transm.	115/90	±8'
108H1A	18CDX6	18	60	Control Differential Transm.	90/90	±10'
108G2A	18TDX4a	18	400	Torque Differential Transm.	90/90	±10'
108H2B	18CDX4a	18	400	Control Differential Transm.	90/90	±8'
109M2A	19CXB4a	19	400	Control Transm.	115/90	±8'
112A1B	1 HG	** 1	60	Torque Transm.	115/90	±18'
113H2B	23CDX4a	23	400	Control Differential Transm.	90/90	±8'
113G2A	23TDX4a	23	400	Torque Differential Transm.	90/90	±8'
113F2B	23TX4a	23	400	Torque Transm.	115/90	±8'
113B2B	23CX4a	23	400	Control Transm.	115/90	±8'
113F1A	23TX6a	23	60	Torque Transm.	115/90	±8'
113B1A	23CX6a	23	60	Control Transm.	115/90	±8'
113G1B	23TDX6a	23	60	Torque Differential Transm.	90/90	±8'
113H1A	23CDX6a	23	60	Control Differential Transm.	90/90	±8'
121F1A	31TX6	31	60	Torque Transm.	115/90	±8'
121G1A	31TDX6	31	60	Torque Differential Transm.	90/90	±8'
121F2B	31TX4a	31	400	Torque Differential Transm.	115/90	±8'
121G2B	31TDX4	31	400	Torque Differential Transm.	90/90	±8'
121F2C	31TX4C	31	400	Torque Transm.	115/90	±8'

**Diameter same as size 23 units

Frame size indicates approximate diameter in tenths of inches

Write for additional copies of this bulletin No. 355 for your catalog files.

Norden-Ketay offers precise tachometer generators for 60 and 400 cycle excitation. Units with linecrity of 0.1% are available in production quantities. Zero speed voltages are held to 5 millivolts in phase, 5 millivolts quadrature, and 15 millivolts third harmonic.

Norden-Ketay also offers servo motor driven tachometer generators with or without integrally mounted gear trains. Built for extreme ambient requirements, these units assure dependability and long life. Special requirements and adaptations can generally be supplied.

MOTOR DRIVEN, TACHOMETER-GENERATORS

*For motor characteristics applicable to these units, see corresponding motors as indicated.

KETAY TYPE NO.	GOVT. DESIG-NATION	POWER INPUT (WATTS)	OUTPUT VOLTS @ 1000 R.P.M.	NULL VOLTS @ 0 R.P.M. FUND. MAX.	LINEARITY (WITH RESPECT TO VOLTAGES @ 1000 R.P.M.)	MAXIMUM SPEED FOR LINEAR OUTPUT	ROTOR MOMENT OF INERTIA
(1) 105P2C		5.4	3.2 R.M.S.	.025	±1%	4500	5.26 GM.CM.²
(2) 105P2D		5.4	3.2 R.M.S.	.025	±1%	4500	5.26 GM.CM.²
(1) 105P2C1	MK 12 MOD 0	5.4	3.2 R.M.S.	.008	±1%	4500	5.26 GM.CM.²
(2) 105P2D1	MK 12 MOD 1	5.4	3.2 R.M.S.	.008	±1%	4500	5.26 GM.CM.²
(3) 108P2A	MK 16 MOD 0	5.4	3.2 R.M.S.	.008	±1%	4500	5.73 GM.CM.²
(4) 108P2G	MK 16 MOD 2	5.4	3.2 R.M.S.	.008	±1%	4500	5.73 GM.CM.²

*(1) K101600-6 (2) K101660 (3) K402560-1 (4) K402550-1

TYPE NO.	GOVT. DESIG-NATION	FRAME
(1) K101590		10
K101580-5		10
101D2A		11
101D2C		11
105D2C	15RS4L	15
K101450		15
K101340		15
(2) 105D2A2		15
(2) 105D2K1	MK 4 MOD 0	15
(2) 105D2K2		15
(2) 105D2K3		15
(2) 105D8D		15
105D2Z		15
105D9E		15
113D1F	23RS6A	23
113D2G	23RS4A	23
113D1D	23RS6	23
113D2E	23RS4	23
113D3T1		23
113D3T2		23
113D3S1		23
113D3S2		23
113D3S3		23
(3) 113D2P1		23
(3) 113D2P2		23
(2) 113D2R1	23RS4D	23
(2) 113D2R2		23
113D1B	23RS6S	23
113D3J		23
(2) 113D1N		23
(2) 113D8H		23
113D1Q1	23RS6B	23
113D1Q2		23
113D2A	23RS4B	23
113D2C	23RS4C	23
105D2F	D-13310	15

(1) High impedance unit
(2) Feedback Resolver
(3) Geared housing

Norden-Ketay pancake synchros, with maximum thickness as little as 0.5 in. or less, are available for applications where minimum thickness is essential, as in gyro pickoffs. Control transmitters, control transformers, and resolver models are available.

PANCAKE SYNCHRO

KETAY TYPE NO.	FUNCTION	INPUT VOLTAGE	INPUT CURRENT	INPUT POWER	OUTPUT VOLTAGE	ANGULAR ACCURACY
B-14335 CX4	Synchro Control Transmitter	26 V, 400 CPS	155 Ma.	2.1 W.	11.8 V.	±20'
B-14336 CT4	Synchro Control Transformer	26 V, 400 CPS	80 Ma.	1.0 W.	11.8 V.	±20' 0.4 V./Deg.
B-14335-1 CX4	Synchro Control Transmitter	115 V, 400 CPS	80 Ma.	5.1 W.	90 V.	±20'
D-13718	Synchro, Resolver	40 V, 900 CPS	6 Ma.		40 V.	±.20%

orden-Ketay

Used with Norden-Ketay synchro control transmitters in closed cycle servo systems, Norden-Ketay synchro control transformers develop a voltage gradient of one volt per degree of system error. They are available with null voltages as low as 60 millivolts total and 30 millivolts fundamental and with accuracies as great as 6 min. in standard models which match Norden-Ketay synchro control transmitters.

SYNCHRO CONTROL TRANSFORMERS

	GOVT. DESIG-NATION	FRAME SIZE	FREQUENCY	VOLTAGE RATING	ELECTRICAL ACCURACY MAX. ERROR
60		10	400	26/11.8	30' SPD.
80		10	400	12/11.8	24' SPD.
K		11	400	11.8/0.4 V. per deg.	20' SPD.
S	11CT4a	11	400	90/1 V. per deg.	± 7'
A	15CT4a	15	400	90/1 V. per deg.	± 10'
00		15	400	26/11.8	20' SPD.
50		15	400	11.8/22	15' SPD.
00-20		15	400	10.2/26	17' SPD.
A	16CTB4a	16	400	90/1 V. per deg.	± 10'
00		17	400	13.4/10 V. per deg.	
A	18CT6a	18	60	90/1 V. per deg.	± 8'
B	18CT4a	18	400	90/1 V. per deg.	± 8'
A	19CTB4a	19	400	90/1 V. per deg.	± 8'
3	19CTB6a	19	60	90/1 V. per deg.	± 8'
A	1 HCT	**1	60	90/1 V. per deg.	± 18'
B	23CT4a	23	400	90/1 V. per deg.	± 6'
A	23CT6a	23	60	90/1 V. per deg.	± 6'

(1) Linear Synchro

(1) High Impedance unit
(2) Linear synchro
(3) When used as control transmitter 26/11.8 VAC

Norden-Ketay Resolvers ... from Coarse ±0.2% to Precision ±0.05% ... for use in computers, radar sweep circuits, phase shifters, and accurate data transmission systems.

SYNCHRO RESOLVERS

	GOVT. DESIG-NATION	FRAME SIZE	FREQUENCY	TOTAL NULL VOLTAGE MAX. AT TEST VOLTAGE	TEST VOLTAGE	INPUT IMPEDANCE OHMS	VOLTAGE RATING (VAC)	ANGULAR DISTANCE BETWEEN NULL VOLTAGE	MAXIMUM ANGULAR ACCURACY
90		10	400	200 MV	26/12	2380/67.7°	26/11.8	90° ± 5'	30' SPD.
80-5		10	400	50 MV	26	560/62°	26/11.8		30' SPD.
2A		11	400	60 MV	26	1510/71°	26/22	90° ± 15'	± 10'
2C		11	400	60 MV	26	440/76°	26/11.8	90° ± 15'	± 10'
2C	15RS4L	15	400	25 MV	26	585/81°	26/11.8	90° ± 10'	20' SPD.
50		15	400	50 MV	26	2000/72.5°	26/18	90° ± 10'	40' SPD.
40		15	400	50 MV	26/12	465/61.3°	26/11.6	90° ± 5'	20' SPD.
A2		15	400	10 MV	10	3280/82.1°	90/90	90° ± 5'	± 0.1%
2K1	MK 4 MOD O	15	400	15 MV	15	890/78°	26/26	90° ± 5'	± 0.1%
2K2		15	400	15 MV	15	890/78°	26/26	90° ± 5'	± 0.15%
2K3		15	400	23 MV	15	890/78°	26/26	90° ± 5'	± 0.20%
3D		15	1000 (Test)	30 MV	24	(4) 24.6 mh.	0-30	90° ± 5'	± 0.2%
2Z		15	400	40 MV	26	950/82°	26/26	90° ± 20'	± 20'
9E		15	500	75 MV	50	15,000 (Tuned)	50/50	90° ± 5'	± 0.15%
1F	23RS6A	23	60	30 MV	24	570/79°	45/45	90° ± 5'	± .2%
2G	23RS4A	23	400	60 MV	60	234/83°	90/90	90° ± 5'	± .2%
1D	23RS6	23	60	60 MV	60	585/61°	90/90	90° ± 5'	± .2%
2E	23RS4	23	400	60 MV	60	720/80°	90/90	90° ± 5'	± .2%
3T1		23	400	16 MV	8	975/86° @ 10V	8/16	90° ± 5'	± 8'
3T2		23	400	20 MV	8	975/86° @ 10V	8/16	90° ± 7'	± 15'
3S1		23	350	30 MV	30	3200/86°	30/30	90° ± 5'	± 8'
3S2		23	350	30 MV	30	3200/86°	30/30	90° ± 5'	± 8'
3S3		23	350	50 MV	30	3200/86°	30/30	90° ± 7'	± 15'
2P1		23	500	50 MV	50	7000	50/50	90° ± 5'	± 5'
2P2		23	500	50 MV	50	7000	50/50	90° ± 5'	± 10'
2R1	23RS4D	23	400	30 MV	60	3000/86°	90/90	90° ± 2.5'	± 0.05%
2R2		23	400	60 MV	60	3000/86°	90/90	90° ± 5'	± 0.10%
1B	23RS6S	23	60	30 MV	24	480/78°	24/24	90° ± 5'	± .2%
3J		23	350	30 MV	30	3200/85.7°	30/30	90° ± 5'	± 0.15%
1N		23	60	26 MV	26	1140/76.3°	26/26	90° ± 5'	± 0.1%
8H		23	1,000 (Test)	30 MV	24	(4) 16.25 mh.	0-30 V	90° ± 5'	± .2%
1Q1	23RS6B	23	60	13 MV	26	1020/81.6°	26/26	90° ± 2.5'	± .1%
1Q2		23	60	26 MV	26	1020/81.6°	26/26	90° ± 5'	± .15%
2A	23RS4B	23	400	20 MV	26	550/86°	26/26	90° ± 5'	± .10%
2C	23RS4C	23	400	30 MV	60	3200/86°	90/90	90° ± 5'	± .10%
2F	D-13310	15	400	30 MV	26	740/80°	26/26	90° ± 5'	± .10%

mpedance unit
ack Resolver
d housing

(4) For these Sweep Resolvers input impedance is not considered. Instead, inductance at 1000 c.p.s. is important.

Inductance at 1000 c.p.s.	113D8H	105D8D
Rotor winding	17.7 Mh	27 Mh
Main Stator winding	16.2 Mh	24.6 Mh
Feedback Stator winding	16.2 Mh	24.6 Mh

FOR

- **SYNCHROS**
- **SERVO MOTORS**
- **RESOLVERS**
- **TACHOMETER GENERATORS**
- **AMPLIFIERS**
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AMPLIFIERS AND

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They can be individually designed and modified t
environmental specifications. Gears an
miniaturized types are available to meet the

MAGNETIC AMPLIFIERS

Magnetic Amplifiers are designed for use in Servo Systems employing two phase low inertia induction motors. They require no external tubes or separate bias, and operate directly from a line supply. They employ the latest half-wave self-saturating circuitry, insuring low response time, high gain and compactness. The half wave reset mode of operation of these units supplies very desirable quadrature rejection. These Magnetic Amplifiers are noted for long life, ruggedness, and dependability.

RESOLVER AMPLIFIE

Resolver Amplifier Syste
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winding signal and fed to
of the high gain amplifie

CONTROL

Many control devices, designed and deve
being produced in mass quantities. Custom engi
corrosion and high temperatures, or having sp
characteristics, will be made to meet the

Norden-Ketay designs and manufactures a large variety of airborne instruments for engine and flight operation, for many aircraft, missile, marine, ordnance and civilian applications. Included are many special designs insuring a high level of performance, while meeting limitations of space and operating conditions. Norden-Ketay research laboratories are staffed and equipped to co-operate with engineers that find a need for electronic control devices in their particular project.

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can be made in open, dust-proof or hermetically sealed packages. dually designed and modified to meet customer's electrical, mechanical and mental specifications. Gears and gear trains of conventional and ypes are available to meet the most demanding of design requirements.

RESOLVER AMPLIFIERS

Resolver Amplifier Systems are made for precision resolver applications where accuracy, isolation, and reliable operation under severe environmental conditions is paramount. Subminiature packaging techniques, preferred type tubes and quality components assure reliability, compactness and long life. Two basic system types are standard: a system connection employing summing resistors; the other, where the input signals are series summed with the compensating winding signal and fed to the grid of the high gain amplifier.

SERVO AMPLIFIERS

Dual Channel Servo-Amplifier, Type SEA 4-310, is made for servo-systems using miniature two-phase servo motors. Each amplifier channel is capable of accepting input error information, either in-phase or 90 degrees out of phase with the line of reference. Separate input terminals are provided for these inputs. For in-phase signals, the amplifier circuits provide the required 90 degrees phase shift for operation of the servo motor. Hence, the motor fixed field can operate without external phasing capacitors. Tuning capacitors for motor control fields are provided as integral part of each amplifier for power factor correction.

CONTROL DEVICES

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FIRE CONTROL SYSTEMS • NAVIGATIONAL SYSTEMS

Digital Computer

For General-Purpose Applications

The "Readix" is a decimal, serial, single-address machine with a magnetic storage capacity of 4000 words. Each word consists of 10 decimal digits with sign, or two commands, complete with addresses. Use of the decimal system makes the unit directly compatible with standard arithmetic systems.

The "Readix" utilizes over 50 basic commands to solve, by means of internally stored routines, any problem which can be reduced to arithmetic. The operations of addition, subtraction, multiplication, division, and square-root are performed by a single command. Alphabetical material can also be stored and sorted.

Ease of programming is one of the features. The unit can modify its own instructions, permitting the operator to program complex operations with relatively simple commands. Only one address is needed with each command. An electric typewriter is provided for data input and output, and automatic punch card machinees, photo-electric tape readers, magnetic tape, or other data-handling equipment may be adapted with little difficulty. J. B. Rea Co., Inc., Dept. ED, 1723 Cloverfield Blvd., Santa Monica, Calif.

CIRCLE ED-69 ON READER-SERVICE CARD FOR MORE INFORMATION

Integrating Gyro

Extremely Small Size Unit

The HIG-3 Hermetically sealed Integrating Gyro is a 400cy unit. It has an angular momentum of 10^3 gram cm^2/sec. Gimbal travel is $\pm 6°$ max. Input rate is 2 radians per sec and drift rate is 0.1 milliradians per sec. The complete unit has a 1″ diam and is only a little more than 2″ long. It weighs 4-1/2 oz. Pre-production quantities are not available. It should be of special value in fire control systems and missile applications where it can radically reduce space and weight requirements. The Greenleaf Mfg. Co., Dept. ED, 7814 Maplewood-Industrial Court, St. Louis, Mo.

CIRCLE ED-70 ON READER-SERVICE CARD FOR MORE INFORMATION

* CIRCLE ED-500 ON READER-SERVICE CARD

Voltage Supply

Regulates Line Within 0.01%

The Model 2004A Regulated Voltage Supply features high stability, compact size, and a wide range of test potentials. Line regulation is within 0.01%; output is 0 to 1 ma. Six taps of 500v, 250v, 100v, 50v, 25v, and 10v are furnished, accurate within 2%. In addition, the potential can be continuously varied from 5v to 500v.

A polarity switch is provided, so that the test voltage can be either positive or negative. Also included is a zero-output switch, permitting connections to be made while the instrument is on, and facilitating the timing of measurements.

The supply is used with this firm's Electrometer equipment in measuring ultra-high resistance, furnishing excitation voltage to photocells and ion chambers, and supplying a buck-out potential for precise voltage measurements by the null method. It is also useful separately as a test potential in checking d-c amplifier gains and in calibrating meters. Keithley Instruments, Dept. ED, 3868 Carnegie Ave., Cleveland, Ohio.

CIRCLE ED-72 ON READER'S SERVICE CARD FOR MORE DATA

Socket-Hole Punch

Makes "D" Shaped Hole

This "D" shaped radio chassis punch is designed to facilitate the punching of holes for mounting miniature sockets having a flat on their shanks. Sockets mounted in this manner cannot twist in the chassis and may be located in any convenient position.

The use of the punch eliminates hand filing. It is screw-operated. The positive locating between punch in die is achieved by means of locating flats on the drive screw. Clean, accurate holes can be obtained in less than a minute. It is made from high-grade tool steel and carefully heat treated for hardness. It is available in the 1/2" size, complete with punch, die, drive screw, and nut.

"D" punch-and-die sets are also available for the hand-operated punch presses made by this company. Chase Manufacturing Co., Dept. ED, 5008 W. Jefferson Blvd., Los Angeles 16, Calif.

CIRCLE ED-73 ON READER'S SERVICE CARD FOR MORE DATA

Capacitance Bridge

With Dual Null Indicator

Capacitance Bridge Model C-10 has been added to the line of "Signa-Glow" instruments. It incorporates a newly designed visual null indicator consisting of a pair of glow lamps which indicate both the degree and direction of unbalance at a glance. The null detector is sensitive over the entire range of 10mmfd to 200mfd.

The bridge is sufficiently compact to be held in the user's hand. It includes a three-position range switch, and a 5-1/8" easy-to-read scale with large numerals and convenient scale divisions. The unit uses no batteries, and operates from 115v 60cy power.

The voltage across the capacitor under test is less than 18v a-c. The test terminals may be shorted indefinitely without damage to the instrument. Operation is shockproof. Industrial Development Laboratories, Inc., Dept. ED, 17 Pollack Ave., Jersey City, N. J.

CIRCLE ED-75 ON READER'S SERVICE CARD FOR MORE DATA

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See Page 96

Relays

Sensitive Subminiatures

The subminiature "CPL" series miniature relays are designed for application where size, sensitivity, and low and high temperatures are a major factor. These units are hermetically sealed and are only 3/4" x 15/16" x 1-3/8"; they weigh 1 oz.

Relays are available in spdt and dpdt, in contacting ratings to 5amp resistive at 28v d-c, 115v a-c, or 3amp inductive. They function over a wide temperature range, withstand vibration of 15g through 500cy, and withstand 50g shock. Operational life is in excess of 1 million cycles under 1amp resistive load. Pacific Relays, Inc., Dept. ED, 6819 Melrose Ave., Los Angeles 38, Calif.

CIRCLE ED-76 ON READER'S SERVICE CARD FOR MORE DATA

Terminal Blocks

Easily Assembled Sectional Units

Series N "Alpha Blocks" are sectionalized, easily hand-assembled, terminal blocks designed to provide a variety of combinations with only five major interchangeable parts. Blocks having from one to 100 or more terminal pairs, with or without insulating barriers, can be made from a small box of parts. Any combination of single circuits and distribution strips can be assembled on the spot.

Dovetail lugs and slots for joining units are located in the base of terminal blocks, insulating barriers, and end pieces to give automatic self-alignment and strong mechanical connection upon assembly. Dovetail slots are tapered slightly to provide a light press fit between units. Clear plastic insulating covers snap over blocks and fit snugly between insulating barriers.

Mounted dimensions are: blocks, 1-1/2" x 11/16" x 17/32" high; barriers, 1-3/4" x 5/32" x 1-1/8" high; ends, 1-3/4" x 21/32" x 1-1/8" high. The blocks are conservatively rated at 50amp, 750v. Alpha Electrical Products Co., Dept. ED, P. O. Box 202, Little Rock, Ark.

CIRCLE ED-79 ON READER-SERVICE CARD FOR MORE INFORMATION

One-Piece Fastener

Acts as Vibration Dampener

Expanding rubber provides a sturdy, locking mechanism for the multi-function "Vibrex" Fastener. The use of rubber results in a combination quick-action fastener and vibration isolator. Floating the assembly in live rubber, the fastener effectively suppresses noise, rattles, and vibration.

The unit locks in metal, plastic, and even glass or composition board. It consists of a single unit, requires no separate receiver, and locks in a plain hole. It is water, dust, and pressure proof. A simple half turn either locks or disengages it. It is made in a variety of types, including latches for cabinet doors and drawers. The General Tire & Rubber Co., Industrial Products Div., Dept. ED, Wabash, Ind.

CIRCLE ED-80 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnetic Amplifier

Features High Efficiency

The "Constrained Bridge" Magnetic Amplifier features high power efficiency, low quiescent power consumption, and freedom from zero drift due to change in rectifier characteristics. The unit is especially suitable for the control of large power devices where efficiency and stand-by power considerations are paramount. It is also applicable to instrument servo applications where close packaging requires minimum size and where unit force cooling is not possible.

Efficiencies up to 90% are possible for response lags of a few cycles of the power frequency. Bias current is not needed in this system, and, hence, further stability is achieved.

Specifications of the Model 505-1, a typical unit, include: Power requirements: 115v, 400cy. Consumption: stand-by, 1w; full output, 3.5w. Input voltage: d-c, 0-1v, or pulsating; a-c, 0-1v, phase angle 60° leading. Input impedance: 10,000 ohms. Nominal power gain: 30,000. Voltage gain: 55v. Response time: 8cy. Stability: 5% zero drift full scale at ambient. Gain variation: 20% of full scale at ambient. Dimensions: 1-7/8" x 2-3/4" x 3-3/4". Librascope, Inc., Dept. ED, 808 Western Ave., Glendale, Calif.

CIRCLE ED-81 ON READER-SERVICE CARD FOR MORE INFORMATION

Upset Pins

Variety of Styles for Contacts

This firm produces upset pins to precise dimensions and in uniform temper, at low cost. The pins have found wide application in the electrical contact field. The basic designs illustrated can be varied to suit individual requirements.

Pins are available in all workable metals, in diameters from 0.010" to 0.090", on straight wires or on formed wires. Heads and flanges are rounded. Flanges can be positioned to any specified distance from the end of the wire. Position of flanges can be held to close tolerance. Variation in the shape of the head is possible within limits. Art Wire & Stamping Co., Dept. ED, 227 High St., Newark, N. J.

CIRCLE ED-82 ON READER-SERVICE CARD FOR MORE INFORMATION

Laminate

Epoxy-Paper

This new paper laminate known as Epinate is available in 1/32" to 1/2" thicknesses, 18" x 18" sheets.

Epinate successfully uses an epoxy binder in producing a high pressure paper laminate. It possesses greater mechanical strength than presently available paper laminates of electrical grade; has very low water absorption and lower thermal expansion with four times the arc resistance of triple X; and has a high 60cy power factor with improved chemical resistance. American Printed Circuits Co., Dept. ED, Metuchen, N. J.

CIRCLE ED-96 ON READER-SERVICE CARD

Reinforced Plastic

Can Be Molded

A moldable, high-strength, glass-reinforced plastic sheeting "Scotchply" is suited for parts requiring high structural strength. The new plastic, designed for mass production of reinforced plastic parts such as printed circuit boards, consists of one or more uncured (unhardened) moldable sheets of plastic, each of which is integrally reinforced with lineally-aligned continuous glass filaments; the filaments reinforcing the sheets. Minnesota Mining & Manufacturing Co., 900 Fouquier St., Dept. ED, St. Paul, Minn.

CIRCLE ED-97 ON READER-SERVICE CARD

Fiberglas Sleeving

Vinyl Coated

By adding silicone to the vinyl-coated fibrous glass sleeving, a highly heat resistant and non-corrosive product is formed.

Known as Vinyl-Sil8000, the tough sleeving has increased electrical insulating properties. It meets class B-A-1 tests of MIL-I-3190. Short time dielectric breakdown is 8000v minimum. Bentley, Harris Mfg. Co., Dept. ED, Conshohocken, Pa.

CIRCLE ED-98 ON READER-SERVICE CARD

◀ CIRCLE ED-99 ON READER-SERVICE CARD

Silicone Varnish

Increases Insulation Durability

A modified silicone dipping and impregnating varnish, identified as Sylkyd 1400 Varnish, substantially increases the durability of electrical equipment insulated with Class B components. It combines good heat stability with excellent bond strength and outstanding resistance to moisture, oil and solvents.

Tests indicate that Sylkyd 1400 has an insulating life expectancy of 25 to 50 times that of good organic varnishes at the Class B hottest temperature of 130°C. Dow Corning Corp., Dept. ED, Midland, Mich.

CIRCLE ED-100 ON READER-SERVICE CARD

Insulator

Highly Adhesive

Pliobond is a mixture of a synthetic plastic resin and an elastomer, having good dielectric properties. As a coating, it has unusually high adhesive properties, is easy to apply, and has toughness and chip resistance.

Pliobond films are oil resistant, and coils "doped" with Pliobond can be overcoated with microcrystalline waxes or ceresin if desired, without encountering softening. Chemical Div., Goodyear Tire & Rubber Co., Inc., Dept. ED, Akron 16, Ohio.

CIRCLE ED-101 ON READER-SERVICE CARD

Color TV Component

Reactance Tube Oscillator

The MC-103C crystal-controlled reactance tube oscillator is designed to synchronize the sub-carrier in color television receivers. All circuit elements are mounted on the tube socket to make an extremely compact unit. It is easy to install and replace.

R-f output exceeds 20v rms and sensitivity is 200cy per volt minimum. Frequency deviation and phase drift as a function of temperature are extremely low. Midland Manufacturing Co., Dept. ED, 3155 Fiberglas Rd., Kansas City, Kans.

CIRCLE ED-102 ON READER-SERVICE CARD

CIRCLE ED-103 ON READER-SERVICE CARD ➤

Shaker System

Gives 100 lb over 40-3000cy

The "68" Electrodynamic Shaker-System, for vibration - testing assemblies and components, is capable of developing 100 lb peak force output over the 40cy to 3000cy range, and displacement amplitudes in excess 0.4" peak-to-peak in the 5cy to 40cy range.

A new flexure system insures truly linear motion of the armature. Another feature is a built-in calibrated velocity signal generator for monitoring the amplitude of vibratory motion. Controls, indicators, and power for operation are all contained in a single unit, housed in a standard relay rack cabinet. Panel space is also provided so that accessories for monitoring vibratory levels and performing automatic cycling tests required in many MIL and JAN specifications may be added. The Calidyne Co., Dept. ED, 120 Cross St., Winchester, Mass.

CIRCLE ED-91 ON READER-SERVICE CARD FOR MORE INFORMATION

Capacitors

In Rugged, Miniature Styles

This firm's line of concentric high-ratio air capacitors has been extended to include two smaller models. The new units feature convenient ranges of capacitance; high Q; voltage breakdown over 750v d-c; and a high degree of stability. The Type 1800 capacitor has a minimum of 0.6mmfd and a maximum of 30mmfd.

Mechanically, the capacitors have the advantage of being miniature in size and rugged in construction. They feature an improved stop and double spring fingers which give a high degree of stability and eliminate backlash. The materials used in the capacitors are silver-plated brass and Pyrex glass. The contact surfaces of the rotor are rhodium plated for smooth action.

These capacitors also are available with Invar construction where a lower temperature coefficient of capacitance is required. Johanson Manufacturing Corp., Dept. ED, Boonton, N. J.

CIRCLE ED-92 ON READER-SERVICE CARD FOR MORE INFORMATION

Analog-Digital Translator

Provides 50,000 Samples/Sec

For use with single or multiplexed sources of analog data, this "Datrac" Translator can provide 50,000 digital samples per second. Every 20μsec, or on demand, a programmed digit - by - digit encoding cycle starts over, independent of the previous code.

Translators are accurate to $\pm 0.05\%$ on bipolar input voltages ranging from 20mv to 10,000v. A variety of output data codes are available, depending on the application. This translator is supplied complete with standard cell reference and is completely self-calibrating. Epsco, Inc., Dept. ED, 588 Commonwealth Ave., Boston 15, Mass.

CIRCLE ED-93 ON READER-SERVICE CARD FOR MORE INFORMATION

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Differential Voltmeter

0.1% Accuracy

The Model 800 Differential Vacuum Tube Voltmeter is a 0 to 500v potentiometer of better than 0.1% accuracy. Resolution is 0.01v over the entire range. The output of an exceptionally stable 500v supply, referenced against a self-contained standard cell, is attenuated to the level of the voltage under measurement by a precision five-decade attenuator. A two-range (1v-0-1v and 10v-0-10v) zero-center vacuum tube voltmeter serves as both a sensitive null indicator and a calibrated deviation meter for observing excursions of the voltage under measurement about its nominal value.

Input resistance is infinite at null and 2000 megohms/volt of input when 0.005v off null. A third range of 500v-0-500v permits use of the unit as a conventional vtvm with 10 megohms input resistance.

Printed circuits and aluminum construction are used throughout. Dimensions are 10-1/2" x 13-3/4" x 14-1/4"; weight is 21 lb. John Fluke Mfg. Co., Dept. ED, 1111 W. Nickerson St., Seattle 99, Wash.

CIRCLE ED-94 ON READER-SERVICE CARD FOR MORE INFORMATION

Gas Phototube

Sensitive to Red

The *6405/1640* gas phototube is designed for use in industrial applications critical as to microphonics and sensitivity gradient. Among such applications are electronic beverage-inspection equipment and ampul-inspection equipment.

The spectral response of the tube is characterized by high sensitivity to red and near-infrared radiant energy. Because of its spectral response it is especially suitable for use with an incandescent light source. Dimensions are 1-1/8″ diam (amx) x 3-11/16″ seated length. Tube Div., Radio Corp. of America, Dept. ED, Harrison, N. J.

CIRCLE ED-84 ON READER'S SERVICE CARD FOR MORE DATA

R-F Power Amplifier

Compact for Airborne Use

The 865C is an extremely sturdy and compact r-f power amplifier providing high dependability in performance and featuring outstanding design simplicity. Designed primarily to extend the effective range of airborne telemetering transmitters by substantially increasing their power output, it also may be used with other low-powered transmitters that are operating anywhere in the 215-235Mc band.

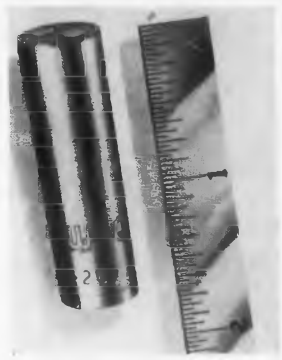
This amplifier is particularly adaptable to installations employing crystal-controlled phase-modulated transmitters of low power where considerations of space and weight are paramount. It will provide a minimum output of 25w to 35w to a 52 ohm load with a 1w to 3 w drive.

No blower is required with this design. It measures 8-1/2″ x 3-1/4″ x 4-3/4″. Raymond Rosen Engineering Products, Inc. 32nd & Walnut Sts., Philadelphia 4, Pa.

CIRCLE ED-85 ON READER'S SERVICE CARD FOR MORE DATA

D-C Solenoids

Fit Into Small Spaces



This line of efficient miniature d-c solenoids is suitable for many small space applications. Some of the units weigh only 1-1/2oz. Model A-205 (illustrated) has a push-pull capacity of 9oz with a 1/6″ stroke; 7-1/2oz with a 1/8″ stroke; 6oz with a 3/16″ stroke, and 5oz with a 1/4″ stroke West Coast Electrical Mfg. Corp., Dept. ED, 233 West 116th Pl., Los Angeles 61, Calif.

CIRCLE ED-87 ON READER'S SERVICE CARD FOR MORE DATA

Toggle Switch

Meets Aircraft Specifications

Originally designed to meet the requirements of Air Force—Navy Aeronautical Standard AN-3021, in conformity with specifications MIL-S-6745, these aircraft toggle switches are available in 2- and 3-position models. They are 1-1/8″ long x 5/8″ wide x 1-3/64″ high. Arrow-Hart & Hegeman Electric Co., Dept. ED, 103 Hawthorn St., Hartford 6, Conn.

CIRCLE ED-88 ON READER'S SERVICE CARD FOR MORE DATA

Toroidal Inductors

Wide Variety Available

A wide variety of standard and sub-miniature toroidal inductors feature a standard tolerance of ±1%, with frequency ranges up to 200kc and inductance values up to 50hy. They are available in stabilized and non-stabilized types.

Subminiature toroidal inductors include four types covering frequency ranges from 500cy 200kc with inductance values to 2hy. These are supplied cased or uncased. Freed Transformer Co., Inc., Dept. ED, 1713 Weirfield St., Brooklyn 27, N. Y.

CIRCLE ED-89 ON READER'S SERVICE CARD FOR MORE DATA

Oscilloscope Camera

Employs Polaroid Principle

This oscilloscope camera delivers a permanent photographically accurate record of single transients or identical repetitive phenomena that appear on the cathode-ray tube in the shortest possible time after they have occurred. It records phenomena from a 5″ cathode tube at a 1:1 ratio on Polaroid-Land Camera film.

Some applications include sonic analysis, TV signal certification, and TV transmission quality control, in addition to conventional uses. The camera is designed to mount on any scope type electronic device having a 5″ tube and a bezel measuring 5-5/8″ OD. It offers a single image per print of a high quality due largely to the special f/1.9 oscillo-anastigmat lens.

No focusing is required, nor is darkroom processing necessary. The camera is equipped with a No. 3 Alphax shutter having speeds of 1sec to 1/1000sec. Print area is 3″ x 4″. Commercial Cameras, Fairchild Camera and Instrument Corp., Dept. ED, Robbins Lane, Syosset, L. I., N. Y.

CIRCLE ED-148 ON READER-SERVICE CARD FOR MORE INFORMATION

Meter Controller

Will Actuate Control Systems

Almost any electrical indicating or recording instrument can be quickly converted into an automatic controller or monitor using the Model 360 Meter Controller. Such quantities as radiation, pH, pressure, flow, strain, vibration, and voltage can be caused to actuate alarms, counters, or complete closed-loop control systems upon approaching or deviating from preset limits.

The unit features an improved, low-impedance, positive-locking, contact meter movement which can be placed in series with standard movements of most indicating instruments or Esterline-Angus type recorders with negligible effect on accuracy. Isolated dpdt output relay contacts, convenient terminals, a panel signal lamp, and all necessary circuits and adjustments for a variety of automatic control applications are provided. Daytronic Crp., Dept. ED, 216 South Main St., Dayton 2, Ohio.

CIRCLE ED-149 ON READER-SERVICE CARD FOR MORE INFORMATION

Counter

Both Adds and Subtracts

This type counter, which not only adds but subtracts, is practicable for many operations, including those that require the maintaining of a set capacity, such as controlling flow of materials to machinery or conveyors, production and inventory, and control of physical capacity in areas. It will count or subtract at a rate of 400cpm, up or down, in any sequence, one count per impulse, maximum 999. It can be set at a predetermined figure to automatically shut off at zero. Special counters can be furnished to requirements.

Size is 6-1/2" x 3-1/2" x 6-1/2" high. Weight is 2lb 5oz. The unit has black letters on opaque white nylon plastic rolls. Electrical coils are intermittent duty; 6v to 110v a-c operation may be specified. Black oxide finish is standard, with other finishes on quantity orders. The unit mounts easily, usually vertically for best results. It can be actuated by photoelectric cell, tube, relay, or contact switch. Spencer Manufacturing Co., Dept. ED, 3253 N. Cicero Ave., Chicago 41, Ill.

CIRCLE ED-107 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Supply

With 0.001% Regulation

The Model UHR-220 is a compact (7-1/2" wide x 10" high) power supply for applications requiring ultra-high regulation, extremely low ripple, and unusual stabilization under severe input line voltage transients. The regulation of 0.001% applies over the entire operating range.

The unit shown is rated 0-500v, 0-200ma; 0.1mw ripple; and 0.003% stabilization. Full rated maximum current can be drawn at any output voltage from a 105v to 125v line. The internal impedance is less than 0.01 ohm for low frequencies and d-c, and less than 0.1 ohm for frequencies as high as 100kc.

A 0-150v, 0-5ma, bias supply with 0.05% stabilization and 0.002% ripple is available, in addition to two 6.3v unregulated a-c outputs of 5amp capacity. Krohn-Hite Instrument Co., Dept. ED, Cambridge 29, Mass.

CIRCLE ED-108 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Supply

High-Current, High-Voltage Design

The Model 306 regulated d-c power supply is designed to deliver high-current, high-voltage power for microwave and nuclear applications. It features high stability and regulation. Originally developed to supply a traveling wave tube, the unit can easily be adapted to other microwave applications within its range.

Output current is 25-60ma. It will deliver 2950-3750v d-c output voltage, ungrounded, with less than ±0.5% regulation and 50mv ripple. Bias range is 0-150v d-c at 10ma, max. Ambient temperatures from 0-50°C will not adversely affect its performance.

Furnished for rack or table mounting, the instrument will operate on 105-125v, single-phase power, 60cy or 400cy. The 4-1/2″ diam meters (0-5kv and 0-100ma) monitor the output. The case measures 14″ x 19″ x 17-1/2″; weight is 70lb. Allied Engineering Div., Allied International, Inc., Dept. ED, South Norwalk, Conn.

CIRCLE ED-156 ON READER-SERVICE CARD FOR MORE INFORMATION

Tube Holders

Withstand 5G at 500cy

These vertical subminiature tube holders are especially designed for application in printed circuitry and similar limited-space conditions where it is necessary to hold tubes and components securely. Developed to meet severe shock and vibration problems incurred in guided missile design, they will hold tubes up to 5G vibration at 500cy.

The holders are made in the basic component-holder cross section with a mounting tab at right angles to the axis of the component, and are available for 0.375″ and 0.500″ diameters. They are made of irridite-dipped cadmium-plated spring steel (per MIL Spec QQ-P-416-B-II) for military use, or commercial finish for general industrial use. Atlas E-E Corp., Dept. ED, Bedford Airport, Bedford, Mass.

CIRCLE ED-157 ON READER-SERVICE CARD FOR MORE INFORMATION

Transducer

Gives High Linearity

The Model 154 Linear Displacement Transducer, a variable reluctance pickup, is completely free from changes in scale factor with variations in frequency, excitation voltage, and temperature — over wide ranges of these parameters. Thus a highly linear relationship between armature displacement and output voltage is produced for displacements.

The unit is designed for application in industrial automation as an electronic gage, monitor, and control system sensor. It is ruggedly packaged and is offered in a military design for use in pressure transducers and accelerometers for aircraft and missiles.

It operates from excitation voltages of 28v to 115v 50-600cy; output voltage is a function of input voltage and ranges from maximums of 3v for 28v input to 30v for 115v input. This high output voltage precludes the need for intermediate amplification in some applications. Operational temperatures from $-65°$ to $+165°F$ produce less than 0.55% change in scale factor over this entire range. Changes in excitation frequency of 100% (about 400cy), i.e. from 200cy to 600cy produce less than 0.2% change in scale factor over the entire range.

Output voltage is linear with armature translational displacement from 0 to 0.12", with 0.25% accuracy, and from 0 to 0.25", with 0.50% accuracy. The output can be symmetrical about a zero position or in one direction. General Cybernetics Associates, Dept. ED, P. O. Box 987, Beverly Hills, Calif.

CIRCLE ED-115 ON READER-SERVICE CARD FOR MORE INFORMATION

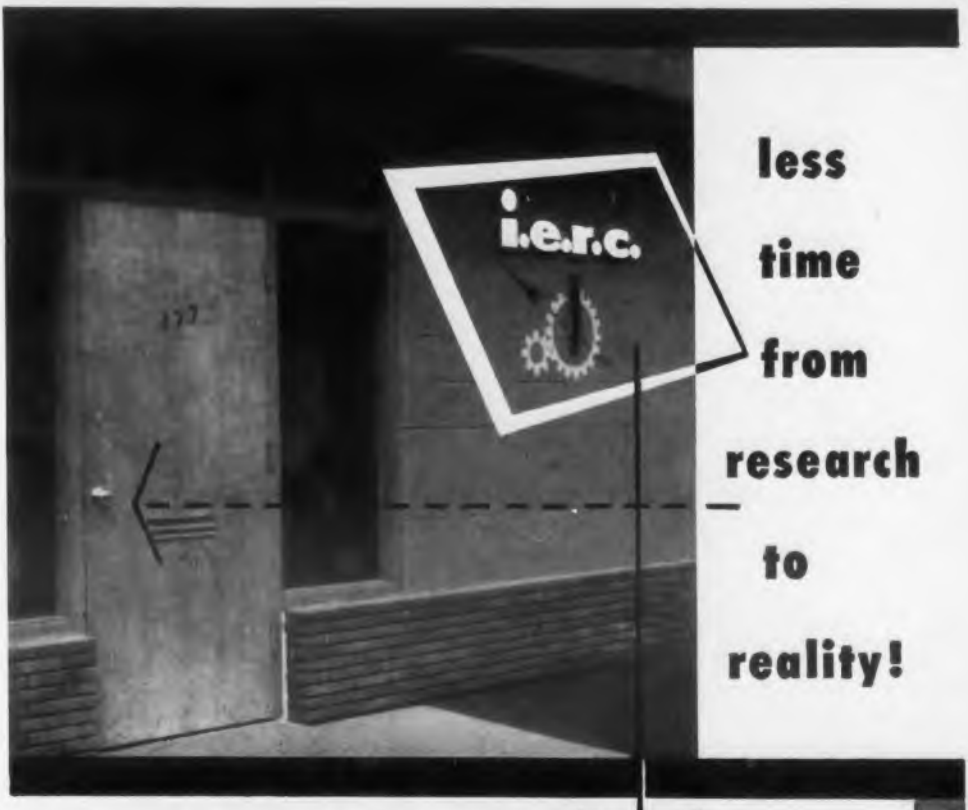
Wrench

Handles Variety of Nuts, Bolts

The new "Inca Quickie" Wrench is made of high tensile strength alloys and accommodates 95% of all nuts and bolts up to 19/32" wide, in 10 different sizes. The small head enables the user to use this wrench in inaccessible areas, such as over shafts, and on very small objects.

The handle is made of solid metal in order to provide support, and wrenches are nickel and chrome plated. Overall size is 4" long x 1" wide, and weight is only 2-1/2 oz. The J. E. S. Co., Dept. ED, 111-49 Lefferts Blvd., South Ozone Park 20, L. I., N. Y.

CIRCLE ED-116 ON READER-SERVICE CARD FOR MORE INFORMATION



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ELECTRONIC SYSTEMS ENGINEERS, to create guidance system design for missile control applications, will find unequalled career opportunities within the advanced Convair Engineering Department now. These opportunities include the development and application of data utilization systems for control purposes. Techniques currently under consideration consist of digital and analogue computation, cw and pulse transmission, analogue to digital to analogue conversion, and frequency and phase measurements. Engineers who apply should have a minimum of five years experience including circuit and system design from VLF through EHF. In addition, a strong theoretical background in circuit analysis, control or servo theory, plus a good foundation in physics is desirable.

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Delay Lines

In 1-6μsec Periods

This series of Miniature Distributed Constant Delay Lines is especially suited for use in delaying trigger tubes or blocking oscillators, pulse width discrimination, and many other applications. Each unit can be sturdily mounted to withstand all rigid vibration and shock requirements of Specification MIL-T-27. They also meet this specfication's requirements for humidity, temperature cycling, etc.

At an impedance level of 500 ohms, the units are available in 1, 2, 4 and 6μsec time delay. Unusually short rise times of 0.1, 0.15, 0.25, and 0.3μsec accompany attenuations from 0.416db to 3.208db. The units can withstand a maximum d-c pulse voltage of 700v and a maximum operating temperature of 125°C without breaking down.

These lines are a standard 4-1/16" long, height varying from 1-5/6" to 2-9/16", width from 5/8" to 1-9/32". Each unit comes with mounting feet or studs for bolting to chassis. PCA Electronics Inc., Dept. ED, 2180 Colorado Ave., Santa Monica, Calif.

CIRCLE ED-118 ON READER-SERVICE CARD FOR MORE INFORMATION

Have you returned your subscription renewal and qualification form?
See Page 96

Diode Clips

For 0.075-0.080" diam Shafts

Three types of diode clips have been made available, capable of holding crystal diodes with shaft diameters of 0.075" to 0.080". Model No. 9000 is designed for front panel mounting and Model No. X9000 is for front panel mounting with a blind hole for dip solder application. Model No. 9020 is for rear-of-panel connections. Each model of terminal clip is available for standard terminal board thicknesses, or to specifications.

Silver plate on half-hard brass assures good contact resistance. Mechanically, the clips retain excellent grip after multiple insertions. They are available from stock separately, or mounted per specifications. Lerco Div., Lynn-Deatrick, Inc., Dept. ED, 501 S. Varney, Burbank, Calif.

CIRCLE ED-119 ON READER-SERVICE CARD FOR MORE INFORMATION

Intensity Meter

Measures Signals and Interference

The NM-30A-Radio Interference-Field Intensity Meter is a precision-made equipment for the accurate measurement of field intensities of signals and r-f disturbances within the frequency range of 20Mc to 400Mc. Radio signals or interference, either radiated or conducted, may be measured through the use of accessories which are available for the equipment. Sine wave, pulsed r-f, and impulsive and random noise may be readily measured. Average, quasi-peak, or peak values of complex waveforms can be selected. The unit may also be used as a two-terminal frequency selective voltmeter.

Field intensity surveys, antenna radiation pattern studies, and interference location and measurement are a few of the many uses of the unit. The equipment uses printed circuits and miniaturized components. It operates from either 105-125v or 210-250v a-c, single phase, at any frequency between 50cy and 1000cy. Stoddart Aircraft Radio Co., Inc., Dept. ED, 6644 Santa Monica Blvd., Hollywood 38, Calif.

CIRCLE ED-122 ON READER-SERVICE CARD FOR MORE INFORMATION

Digital Voltmeters

Includes Moving Decimal Point

These "Automatic Digital Voltmeters" are designed for reliability, flexibility, and precision. Standard models are available ranging from two to five in-line digits, in voltage ranges from 1mw to 1000v, with automatic ranging indicated by a moving decimal point. Input impedance is 1000 megohms, accuracy is 1 digit, and average time for reading is less than 1sec. Models may be specified to operate printers, electric typewriters, or IBM punches.

The voltmeters use only 10 vacuum tubes controlling stepping switches to balance input voltage against a reference. The entire package fits in a 7" x 19" standard rack and panel. Electro Instruments, Dept. ED, Box S, Old San Diego Sta., San Diego 10, Calif.

CIRCLE ED-123 ON READER-SERVICE CARD FOR MORE INFORMATION

Bridge Balance

With 18 Channels, Weighs 2.4 lb

The Model BP-18A Eighteen Channel Bridge Balance has provisions for controlling the electrical balance, sensitivity, and calibration of resistance bridge sensing devices, such as strain gages, accelerometers, and pressure pickups. It weighs only 2.4 lb, and its overall dimensions are 7-1/8″ x 3-1/2″ x 3-1/2″.

The components of the unit are of high precision and rugged construction to provide the same degree of accuracy and ruggedness as much larger, laboratory models. Ten-turn potentiometers with shaft locks are employed for circuit balancing. Calibration resistors are accurate to within ±0.1% operating over a −40° to +200°F range with a temperature coefficient of 0.00002/°C.

The bridge balance is especially suited for use in aircraft and guided missile flight instrumentation, as well as a laboratory instrument. Optional features of other models which can be supplied include additional (or fewer) channels, continuously variable or step sensitivity controls, and a zero balance (null) indicator. American Helicopter, Div. of Fairchild Engine and Airplane Corp., Dept. ED, 1800 Rosecrans Ave., Manhattan Beach, Calif.

CIRCLE ED-126 ON READER-SERVICE CARD FOR MORE INFORMATION

Breadboard Sockets

For Experimental Work

"Breadboard Sockets" are for use in electronic experimental and development work. Mounting is a simple procedure, requiring only a 3/32″diam hole in the breadboard chassis. Circuits can be wired on top of the chassis with ease and speed, thus cutting the cost considerably on experimental projects. Each socket is equipped with a ground lug attached to the socket mounting, further simplifying circuit wiring.

The silver-plated phosphor bronze socket connections are numbered for easy identification. The sockets come in two different sizes: XS-7 Seven-Pin Miniature, and XS-9 Nine-Pin Miniature. They are complete with mounting. Pomona Electronics Co., Inc., Dept. ED, 524 W. 5th Ave., Pomona, Calif.

CIRCLE ED-127 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Supplies

For Wide Range of Applications

These closely regulated d-c power supplies are designed to have unusually wide ranges. The models are designated as 5-200-C (a single unit) and D5-200-C (a dual unit).

Designed to be utility power supplies for laboratory and development use, the units have ratings ranging up to 500v d-c at 200ma. The dual unit has a switch for series or parallel connection, thus making possible combined ratings to 1000v or 40ma.

The single unit provides five different outputs. The dual unit provides eight output combinations. Regulation on all units is 0.15% per 10% line voltage, and 50mv no load to full load. Ripple is less than 2mv. Recovery time is 0.1 millisec maximum when full load is applied. Maximum transient voltage is 1v.

The supplies have been designed to be as compact as possible. Net weight of the single unit is 45lb; the dual unit, 60lb. Units are designed for rack mounting. Dressen-Barnes Corp., Dept. ED, 250 N. Vinedo Ave., Pasadena 8, Calif.

CIRCLE ED-129 ON READER-SERVICE CARD FOR MORE INFORMATION

Color Phase Analyzer

Measures Phase Delay Over 360°

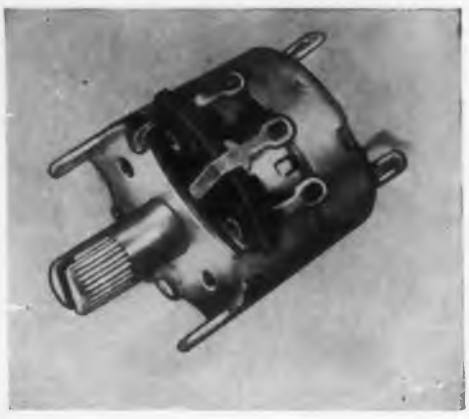
The CPA-1 Color Phase Analyzer is designed to analyze the chrominance components of composite color video signals. The unit compares the phase of chrominance components with respect to a reference subcarrier, or between any two portions of a color signal. It measures phase delay over the entire range of 0 to 36°.

The instrument facilitates alignment of color coders, and checks the accuracy of color signals. It can also be used to measure differential gain of any amplifier or system. Its switching circuitry permits comprehensive analysis of composite color signals. The complete equipment includes a CPS-1 Calibrated Phase Shifter, a CSD-1 Color Signal Demodulator, and a PS-7 Regulated Power Supply, plus cabinet rack and interconnecting cables. Wickes Engineering and Construction Co., Dept. ED, Camden, N. J.

CIRCLE ED-130 ON READER-SERVICE CARD FOR MORE INFORMATION

Controls

Low-Cost Tab-Mounted Units



Series 47 controls are designed for twisted-tab mounting, resulting in time, labor, and money savings. Materials saving is accomplished by the elimination of such items as bushings, mounting nuts, and lockwashers. By utilizing a tool that is readily available, the mounting of a control onto a chassis is completed in one operation.

Controls are available with or without power switches. Controls utilizing plastic shafts are adjustable from front or rear. When switches are specified, controls are constructed with metal shafts. Clarostat Mfg. Co., Inc., Dept. ED, Dover, N. H.

CIRCLE ED-132 ON READER-SERVICE CARD FOR MORE INFORMATION

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Power Supply

Has Two Ranges to 28v 5amp

The Model EF Dual Range D-C Power Supply is for operation and testing of electronic equipment that requires a medium-duty d-c power source. A-c hum or ripple is less than 1% at 5amp.

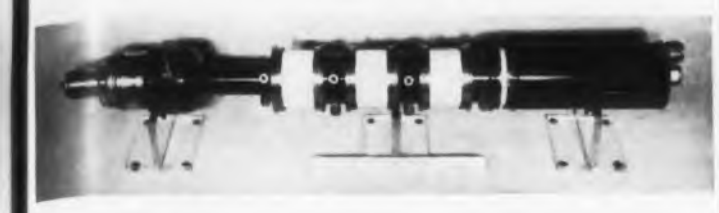
The unit provides a filtered power supply with continuously variable voltages from 0 to 14v and 0 to 28v for all current loads from 0 to 5amp. Intermittent loads up to 10amp can be obtained. Exact current and voltages are indicated on D'Arsonval-type meters.

A single control offers continuous voltage adjustments for different load conditions over the specified range. The unit takes 115v 50/60cy input, 265w at 28v, 5amp. It has less than 1% a-c ripple at 5amp. Bridge-type selenium rectifiers are employed. Size is 12" x 7" x 8-1/2", and weight is 28 lb. Electro Products Laboratories, Inc., Dept. ED, 4503 N. Ravenswood, Chicago 40, Ill.

CIRCLE ED-133 ON READER-SERVICE CARD FOR MORE INFORMATION

U-h-f Amplifier Klystron

850-1050Mc Range



The 3K50,000LQ is a high-power u-h-f amplifier klystron. In CW operation at 850-1050Mc, it delivers 10kw output with only 10w drive, a power of gain of one thousand times.

The klystron features resonant cavities outside the vacuum system permitting easy wide-range tuning and uncomplicated input and output coupling adjustment. The tube added to the line of power klystrons extends the range from 470Mc to 1050Mc. Eitel-McCullough, Inc., Dept. ED, San Bruno, Calif.

CIRCLE ED-135 ON READER-SERVICE CARD FOR MORE INFORMATION

Geiger Counter

Neon Lights Register Count

The "Countmaster" is a portable lightweight Geiger counter that permits field assay of radioactive substance and gives an accurate timed count. The unit weighs 7-1/4 lb, including probe and shield.

An accurate counting range is claimed up to 12,000cpm. The find is flashed on four rows of small neon lights where it remains until erased by the operator. Hoffman Radio Corp., Dept. ED, 3761 S. Hill St., Los Angeles 7, Calif.

CIRCLE ED-136 ON READER-SERVICE CARD FOR MORE INFORMATION

AN Relay

Hermetically Sealed 8-Pole Unit

An AN-approved 3311-1 relay for military use, this unit is a dpdt, hermetically sealed device with eight screw terminals. Nominal coil voltage is 24-28v d-c. Rated load (contacts) at 29v d-c is 10amp resistive; at 115v a-c 400cy, 10amp resistive, 10amp inductive; motor 6amp. U. S. Relay Co., Dept. ED, 1744 Albion St., Los Angeles 31, Calif.

CIRCLE ED-137 ON READER-SERVICE CARD FOR MORE INFORMATION

Variable Scale

With Expandable Decimal Range

The "Variable Scale" is basically an infinitely variable decimal scale, employing a highly accurate calibrated triangular spring fixed at the left end. As this spring is expanded along the rule, its calibration also expands accordingly. Hence a 2-1/5" section (for example) can be marked off into decimal components as well as a 10" section. A second, or round spring, fastened in a similar manner carries numbered disks to make triangular spring graduation easier to read.

The "Variable Scale" can be used to measure any drawing or graph to any arbitrary scale. These abilities enable this device to save engineers and draftsmen an immense amount of time in a wide range of tasks such as on recordings, plotting, reading and interpolating graphs or curves.

In addition to the two scales on an older model—reciprocal (scale factor) scale, and the linear (percentage scale—the surface of the model has a third, logarithmic scale used for logarithmic interpretation. Hence the "Variable Scale" operates on graphical linear functions or standard linear graph paper, and also on graphical logarithmic functions. The unit is light, portable, well-protected and inexpensive. The Gerber Scientific Instrument Co., Dept. ED, 162 State St., Hartford 1, Conn.

CIRCLE ED-140 ON READER-SERVICE CARD FOR MORE INFORMATION

D-C Supply

Tubeless Design

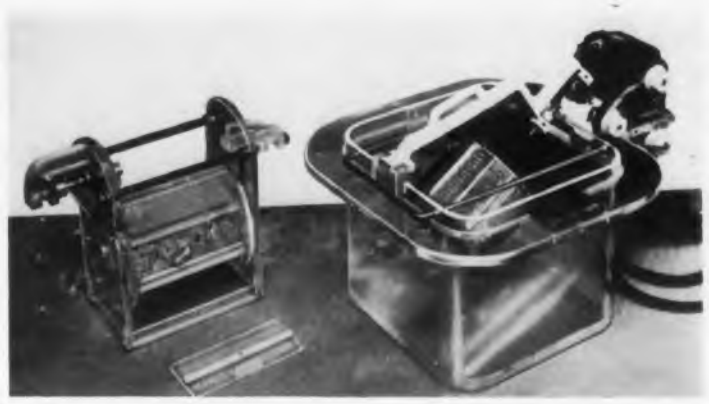
The "Nobatron" Model MA640 tubeless, regulated d-c supply uses magnetic amplifier principles. Its tubeless circuit makes it highly valuable where accuracy and high capacity must be combined with extreme reliability.

Specifications include: input of 105-125v a-c, single-phase, 60cy; output of 4.5 to 7.7v d-c (adjustable); load range of 0-40amp; ripple of 1% max; regulation of ±1.0% for any combination of line and load conditions; recovery time of 0.2sec under worst conditions; and dimensions of 17" x 12-1/4" x 15" deep. Sorensen & Co., Inc., Dept. ED, 375 Fairfield Ave., Stamford, Conn.

CIRCLE ED-141 ON READER-SERVICE CARD FOR MORE INFORMATION

Plating Barrel

Valuable Laboratory Equipment



The 3II miniature oblique plating barrel has a cylinder 3″ in diameter x 3″ deep, with approximately 1/4 lb load capacity. It is a complete bulk plating machine, consisting of a high temperature plexiglass tank and cylinder and a 110v 60cy single-phase motor drive. Because tank capacity is only 1 gal, the unit is well suited for precious metal plating where solution volumes must be kept small. In addition, it is useful for cleaning, pickling, and deplating of precious metal parts for reclamation

Standard optional equipment includes a cathode rod for still tank plating, which can be installed within 5sec. A further innovation is an optional horizontal plating cylinder construction of high temperature plexiglass, with dangler type negative contacts and single drop—in door. This cylinder is 3″ diam x 4″ long. The horizontal type is interchangeable with the oblique type cylinder; both are illustrated. Daniels Plating Barrel & Supply Co., Dept. ED, 129 Oliver St., Newark 5, N. J.

CIRCLE ED-144 ON READER-SERVICE CARD FOR MORE INFORMATION

T-Box Gear Drive

Rated 1000 in-lb at 20rpm

A series of high-precision high-torque T-boxes and angle drives is available from this firm. The typical unit illustrated, Model 1799E2 T-Box, is rated at 1,000 in-lb torque at 20rpm and 400 in-lb at 40rpm. Maximum static torque is 1200 in-lb, with ultimate static torque 1800 in-lb, 1400rpm no-load speed. The unit has been life cycled under various load tests up to 12 million revolutions; it is lubricated for life. Aviation and Electro Products, Western Gear, Dept. ED, P. O. Box 192, Lynwood, Calif.

CIRCLE ED-145 ON READER-SERVICE CARD FOR MORE INFORMATION

Traveling-Wave Tube

For X-Band

This broadband low-power traveling-wave tube amplifier is designed to operate over the 7000Mc to 14,000Mc band. It is made especially for use in applications where wideband width and high gain are required at a low level, such as r-f preamplifiers, untuned r-f receivers, and in laboratory microwave measurement work. Grid control is provided for modulation and automatic gain control applications.

The approximate operating characteristics are 30db gain and 5mw output. The unit requires a 400 gauss field and a 1200v regulated power supply. Huggins Laboratories, Inc., Dept. ED, 711 Hamilton Ave., Menlo Park, Calif.

CIRCLE ED-105 ON READER-SERVICE CARD FOR MORE INFORMATION

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See Page 96

Tension Lock Nuts

To Hold Adjusting Screws

Tension Type Lock Nuts make it possible to easily and quickly change the setting of an adjusting screw to any desired position. Once assembled, repeated adjustments of the screw can be made with a screwdriver, without ever readjusting or changing the position of the tension nut.

The nuts exert a resilient spring locking action on the threads of the adjusting screw, holding them to the adjusted position, despite vibration. Screws turn smoothly with minimum wear on threads at maximum torque, even after repeated readjustments. Back-off torque of the tension nut is twice the installation torque. No serrations, special holes, or other auxiliary holding means are necessary. Easy, fast assembly is obtained with ordinary deep socket wrenches, special manual torque wrench or with small air guns.

Nuts are available in sizes for Nos. 2-56, 4-36, 6-32, 6-56, and 10-32 screw threads. The Palnut Co., Dept. ED, 61 Cordier St., Irvington 11, N. J.

CIRCLE ED-106 ON READER-SERVICE CARD FOR MORE INFORMATION

Potentiometer

For Linear or Non-Linear Outputs

The Model 36000 miniature low torque precision potentiometer is less than 1" in diameter, yet is as accurate as standard pots up to several times that size. It is designed for either linear or non-linear output functions, with accuracies of $\pm 0.1\%$ for linear and $\pm 0.25\%$ for sine or similar functions. Initial length is 0.8" max, with an increase of 0.35" per extra section

The unit may be obtained with a resistance value from 200 ohms up to 50,000 ohms. Non-linear functions and ranges are dependent on individual requirements. Maximum linear and functional resolution of the new potentiometer is 0.034%. Starting torque is 0.05 in-oz max for one section, 0.03 in-oz for each additional section. A special heat dissipating design permits it to function accurately over a range of $-50°$ to $+90°$C.

The potentiometer weighs 1 oz for one section, 0.25 oz for each additional section. It has been constructed to withstand vibration of 10g to 500cy, shock to 60g. Mechanical rotation is continuous; electrical rotation is 358° maximum (360° continuous for types with a precious metal wiping surface). Gyromechanisms, Inc., Dept. ED, Halesite, L. I., N. Y.

CIRCLE ED-152 ON READER-SERVICE CARD FOR MORE INFORMATION

Counter

Can Be Remotely Located

The "Miniature Numerical Indicator", a high speed instrument, provides accurate, direct reading of many analog measurements with no interpolation necessary. It is designed to meet the requirements of research, testing, and production applications.

The counter is geared to a servo motor and can be installed long distances from the measuring point without lag difficulties. It can also be used in conjunction with recording units in applications where continuous readings must be available to facilitate batching and processing operations. Streeter-Amet Co., Dept. ED, 4101 Ravenswood Ave., Chicago 13, Ill.

CIRCLE ED-154 ON READER-SERVICE CARD FOR MORE INFORMATION

EDGE-LIT PANEL MOUNTING
Series L2000

Designed for MIL-P-7788 panels. Sturdily constructed with integral molded-in terminal and snug-fitting plastic lens that will not vibrate loose. Easy to mount. Write for Hetherington Bulletin L1.

REGULAR PANEL MOUNTING
Series L1000

Combines exceptionally small size and light weight with durable construction. Unaffected by heavy shock or vibration. Effectively sealed against moisture. Terminal is molded into the assembly. Write today for Hetherington Bulletin L1.

for maximum dependability

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HETHERINGTON

INDICATOR LIGHTS

In addition to the standard indicator lights illustrated, Hetherington produces many adaptations and "specials" for military as well as commercial needs. Write for details on any type.

"PUSH-TO-TEST" INDICATORS
Series L3000

Widely used in military aircraft and ideally adapted to many industrial uses. Bulb is lit by pressing spring-mounted plastic lens button. Supplied with or without silicone rubber boot for moisture protection. Write for Hetherington Bulletin L1.

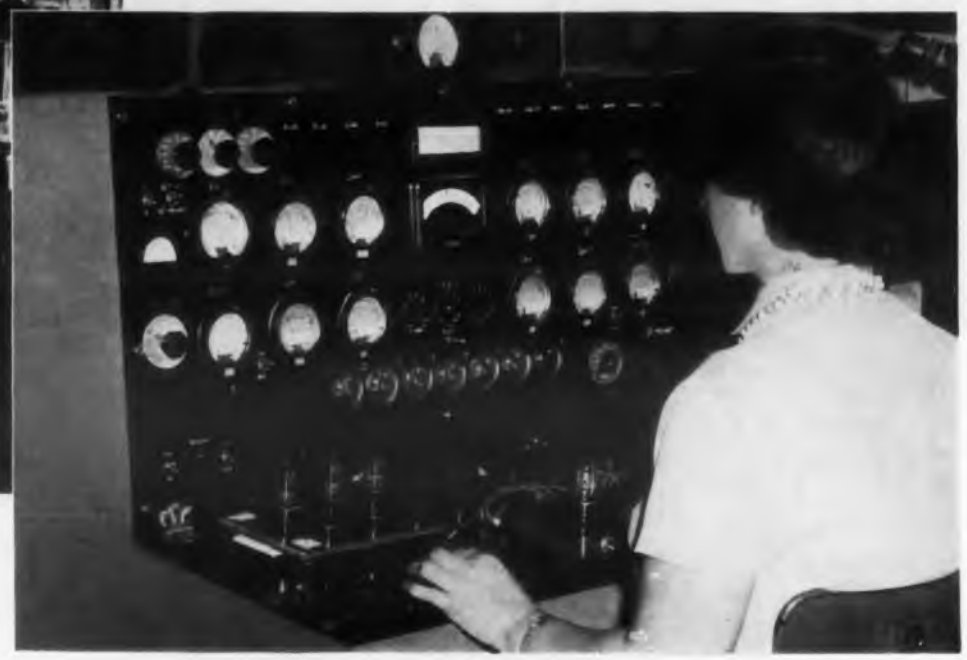
SWITCHES
WITH BUILT-IN LIGHTS . . .

in a variety of types and switching arrangements save weight and panel space. Write for Hetherington catalog.

HETHERINGTON, INC.
SHARON HILL, PA.
West Coast Division, 8568 W. Washington Blvd., Culver City, Cal.

CIRCLE ED-153 ON READER-SERVICE CARD FOR MORE INFORMATION

LEFT: G-E computer tubes undergo a cut-off life test. The tubes are operated for long intervals with their grids biased to cut-off. Periodically the tubes are given a cathode interface check, to make sure no "sleeping sickness", or failure to respond to changed grid voltage, has developed during inactivity.



RIGHT: extensive instrumentation is used to test tube electrical qualities that closely affect operation in computer circuits. Zero-bias plate current; cut-off performance; any difference in cut-off between twin-triode sections—these are three of many characteristics checked.

G-E Computer Tubes are specially tested for qualities that safeguard computer reliability!

General Electric pioneered special tubes for computers . . . also developed tests such as those above, which assure that G-E tubes in your computer circuit can be relied on to meet designers' aims in all respects.

The tests are specific in purpose. Each covers one or more tube characteristics important in computer use, and which closely influence the accuracy and reliability of the equipment.

There is no substitute for G-E computer-tube quality, which starts with special tube design—extends through precision manufacture—concludes with exhaustive tube tests that relate directly to computer service.

Also . . . there is no counterpart to G.E.'s range of special computer tubes *now in production.* You have a choice of proved G-E types available for your present circuit needs, with new tubes constantly being added.

Ask for "G-E Computer Tubes And Their Applications" (ETD-1140). 54 pages—just off the press. A book every designer and builder will find useful! *Tube Department, General Electric Company, Schenectady 5, New York.*

* * *

● G-E computer-tube development is a continuing process, with new types being added regularly for faster, more advanced equipment, or to meet special customer requirements where volume warrants. Five types—proved, popular—already are in full production:

GL-5844 **GL-6211**
GL-5965
GL-5915A **GL-6463**

Progress Is Our Most Important Product

GENERAL ELECTRIC

162-101

Silicon Rectifiers

Power Type

These tiny silicon rectifiers provide reliable and efficient power rectification at high temperatures. Typical ratings for the 1N341 at 125°C are: forward current 400ma; forward voltage 3v; inverse current 0.5ma. There is only 0.5% voltage variation between −55°C and +125° ambient.

Forward currents as high as 1amp are possible from some types in this series. These rectifiers are hermetically sealed. Transitron Electronic Corp., Dept. ED, Melrose, Mass.

CIRCLE ED-110 ON READER-SERVICE CARD

Recorder

For Missile Work

The Type M-6 oscillographic recorder is particularly useful under wide environmental conditions found in aircraft and missiles. The M-6 features remote control selection of any of 8 recording speeds, a drawer-type record magazine, and an 18 or 27 element magnet structure. The unit is 9-1/4" wide, 9-1/8" deep and 13" high. It weighs 55 lbs. William Miller Instruments, Inc., Dept. ED, 325 H. Halstead Ave., Pasadena 8, Calif.

CIRCLE ED-111 ON READER-SERVICE CARD

Casting Resin

Easily Machined

A two-part casting resin known as Stycast 2340M requires no additional catalyst. It has excellent electrical and mechanical properties. Warming the two components to about 125°F results in an easy-to-mix and easy-to-pour material that quickly cures to a tack-free, brown, opaque, resin which is extremely tough yet quite flexible. Its adhesion to metals, plastics, and glass is excellent. The resin is easily machined and is useable over a temperature range of −100°F to +400°F without loss of physical or electrical properties. Emerson & Cuming, Inc., Dept. ED, 869 Washington St., Canton, Mass.

CIRCLE ED-112 ON READER-SERVICE CARD

◀ CIRCLE ED-113 ON READER-SERVICE CARD

Frequency Counter

For Electrical, Mechanical Events

The DS-6100 Frequency Counter will count and display any electrical or mechanical events that can be converted to electrical impulses. The range is from 10 to 100,000 events per second. Its time base consists of a very accurate 100kc crystal-controlled oscillator circuit with five highly stable divider stages. The unit was especially designed to be used as a lightweight accurate frequency counter, straight counter, or as a tachometer. It is not a miniaturization of existing design but is, instead, a new approach in circuitry. This new circuit has brought about a reduction in the number of component parts, providing less trouble and power consumption, plus reduced size.

Among the many features are: self-checking; automatic and manual gate control; automatic and manual reset, 0.5sec to 6sec display time variable in one step; lightweight and small size; standard plug-in decades; direct read out from 0-100,000 events (5 decades); and fan cooling. Size of the complete unit is 14-1/4" wide x 7-1/2" high x 13-1/2" deep, with weight only 28 lb. Accessories offered include a tachometer pickup and photo cell, both available at slight extra cost. Detectron Corp., Dept. ED, 5420 Vineland Ave., North Hollywood, Calif.

CIRCLE ED-160 ON READER-SERVICE CARD FOR MORE INFORMATION

Transformer

Oil-Immersed Hi-Voltage Unit

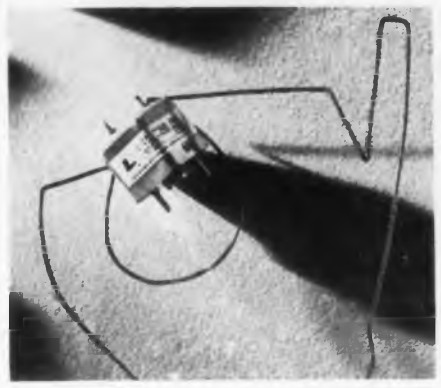
This oil-immersed a-c transformer is for use in high-voltage test equipment and high-voltage power supplies. At present, its production is limited to custom business, including prototype and large production orders.

Transformers are made in both 60cy and 400cy types up to a 5kva power level. The transformers are impregnated with conventional types of high-dielectric-strength transformer oils, as well as with silicone oil for high temperature uses. Condenser Products Co., Division of New Haven Clock and Watch Co., Dept. ED, 140 Hamilton St., New Haven, Conn.

CIRCLE ED-161 ON READER-SERVICE CARD FOR MORE INFORMATION

I-F Transformers

Meet Missile Requirements



Capable of meeting the requirements of instrumentation, missile, and aircraft applications, this line of Intermediate-Frequency Transformers is available for 262kc, 455kc, and 1525kc. The units are capable of withstanding large amplitude vibration and shock because of their construction: their powdered carbonyl-iron cup cores are completely embedded in epoxy resin.

Electrically, these double-permeability-tuned units feature unusually constant inductance, free from non-linear effects; a wide tuning range; and high resistance to moisture and chemical attack. Their operating temperature range is from −50° to +100°C, with a temperature coefficient of inductance less than 50ppm/°C.

Housed in 1-1/8" cubical cans, the standard units are supplied with zero internal coupling, although specified couplings can be supplied on special order. Levinthal Electronic Products, Inc., Dept. ED, 2758 Fair Oaks Ave., Redwood City, Calif.

CIRCLE ED-165 ON READER-SERVICE CARD FOR MORE INFORMATION

Relay

Compact 10kv Unit

This firm's smallest high-voltage vacuum relay, the Type R5-E, is designed for pulse network, antenna transfer, and guided missile applications. Size is only 3" long x 2" diam, including a 12v or 24v d-c actuating solenoid located in the base.

The vacuum dielectric has over 30 times the dielectric strength of air, making possible a fast-acting 10kv relay of compact design. Current rating of 10amp rms is obtained by the use of tungsten contacts and by not depending on flexible leads to carry current. Series-break contacts include normally open, normally closed, and spdt types. Break time is approximately 10millisec, and make time about 25millisec.

The relay is easily mounted by means of a flange located in the center of the unit. Jennings Radio Mfg. Corp., Dept. ED, P. O. Box 1278, San Jose 8, Calif.

CIRCLE ED-166 ON READER-SERVICE CARD FOR MORE INFORMATION

Bunsen Burner

Gives 850°C of Electric Heat

The "Horo" Electro-Bunsen Burner, is capable of achieving temperatures of 850°C under continuous operation, yet eliminates the hazard of fire and explosion. Operation is clean and odorless, because heating is accomplished by a stream of hot air, and no soot is deposited on the heated object. Heat is even, with no local overheating or chemical reduction of the work piece by the flame.

The spiral interior of the porcelain chimney is a heat and acid resistant alloy which acts as a radiator. Heat-up time is less than 1 minute.

Crucibles may be placed on the six support knobs, on a nickel-plated stand, or supported in a special holder made of heat-resistant wire. The device is useful for sterilizing, evaporating, pre-ashing, drying, smelting (even metals), softening plastics, or heating soldering irons.

The unit is supplied for either 110v or 220v a-c operation. It requires about 500w. An optional voltage regulator can be provided. Modern Laboratory Equipment Co., Dept. ED, 1809-11 First Ave., New York 28, N. Y.

CIRCLE ED-170 ON READER-SERVICE CARD FOR MORE INFORMATION

D-C Supply

Utilizes Magnetic Amplifier

The Model MA65 has been added to this firm's line of magnetic - amplifier regulated d-c supplies. The new unit is compact, inexpensive, and tubeless. It is designed particularly for telephone and telegraph systems, radio and TV applications, and other situations where utmost reliability is a requirement.

Input is 105-125v a-c, single phase, 60cy. Output is 6v d-c adjustable ±10%. Load range is 0.5amp. Ripple is 1%. Regulation accuracy is ±1.0% for any combination of line and load conditions. Recovery time is 0.15sec under worst conditions.

For relay rack mounting, it is 19" wide x 5-1/4" high x 12" deep. A cabinet is available for bench use. Sorensen & Co., Inc., Dept. ED, 375 Fairfield Ave., Stamford, Conn.

CIRCLE ED-171 ON READER-SERVICE CARD FOR MORE INFORMATION

NOW—ROTH RESEARCH DEVELOPS A

NEW, NON-POROUS RUBBER WITH A SOFTNESS OF ONLY 5 DUROMETER!

- Makes an excellent seal for many gases and liquids.
- Cushioning range from Shore "A" Durometer readings of 5 and up.
- Can be molded to suit your requirements, or to meet those formulated for you by ROTH technicians.
- Sample and specifications available to engineers and rubber buyers. Write today.

BASIC SPECIFICATIONS

(Sample: Hardness 10 to 15 Durometer)

Tensile Strength (PSI)	560
Elongation	800%
Compression Set 22 hrs. @ 158°F.	41%

ROTH CAN MEET YOUR CUSTOM MOLDED RUBBER REQUIREMENTS

RUBBER BONDED TO METAL | GASKETS | IMPELLERS | TRANSFORMER CASES

VIEWING HOODS | SHOCK MOUNTS | SANDING MACHINE PADS

WRITE—WIRE—PHONE

RR ROTH RUBBER COMPANY

1860 S. 54th Avenue, Chicago 50, Illinois

CIRCLE ED-168 ON READER-SERVICE CARD FOR MORE INFORMATION

Milli-Micro-Microammeter

With 15 Ranges

The Model D-C 151 Milli-Micro-Microammeter is an a-c operated instrument for measurement of d-c from 3 x 10^{-15}amp to 10^{-7}amp. The low input voltage required (0.25mv full scale on all ranges) is particularly useful when measuring currents in circuits having a low driving emf.

The unit utilizes a direct-coupled vacuum tube amplifier with a voltage gain of approximately 400, output negative with respect to input. Inverse feedback produces an equal and opposite current through the feedback resistor. Voltage output is therefore equal to feedback resistance multiplied by input current. Current gain is substantially independent of the amplifier gain and is therefore independent of the characteristics of the amplifier tubes. Dynamic input resistance rises from 2500 ohms on the 10^{-8}amp range to 25,000 megohms on the 10^{-14} range.

Fifteen ranges from 10^{-14} to 10^{-7}amp full scale are provided. Alternative ranges up to 10^{-4}amp may be substituted for any range specified. Accuracy is better than 5% from the 3 x 10^{-13} range through the 10^{-7} range and better than 10% from the 10^{-14} through the 10^{-13} range. Power supply is 115v a-c, 60cy, approximately 70w. Scientific Specialties Corp., Dept. ED, Boston 35, Mass.

CIRCLE ED-173 ON READER-SERVICE CARD FOR MORE INFORMATION

Crimped Eyelets

Can Be Applied at 2000/hr Rate

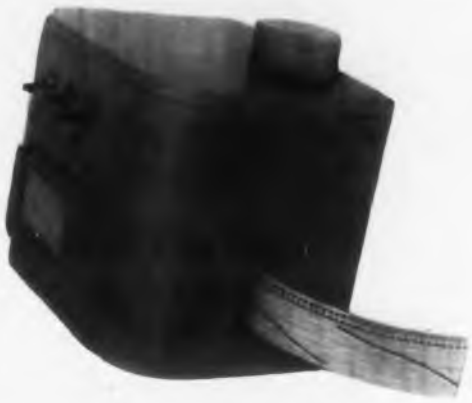
The "Crown Crimp" eyelet has been added to this firm's line of solderless wire terminations. It features fast application, greater reliability, and easy handling. The eyelets are supplied in strip form on reels for use with the firm's automatic machines and can be applied at speeds upwards of 2000 per hour.

The crimped eyelets have even distribution of wire strands around the eyelet and afford ample tensile strength without solder. They save wire because of shorter strip lengths required. Aircraft-Marine Products, Inc., Dept. ED, Harrisburg, Pa.

CIRCLE ED-174 ON READER-SERVICE CARD FOR MORE INFORMATION

Graphical-Numerical Recorder

Uses Multiple Traverses



This recorder is designed for accurately recording temperature, pressure, humidity, torques, and other electrical and physical properties. It is particularly adaptable for recording of the analog computers outputs and production process information.

The recorder uses standard cash-register tape, but achieves graphical large-scale record without loss in accuracy through multiple traverses of the tape. The chart drive can be synchronized with time or can be servo driven to represent other variables. The chart drive variable is numerically printed on the tape.

A single unit measures approximately 9" x 6" x 7". Multiple-channel units can be furnished in a stacked form. The basic unit is furnished for mechanical shaft input to fit the customer's own servo follow-up system. However, a unit package is available consisting of one or more channels complete with servo amplifiers, control transformers or potentiometers, motors, and gear trains to meet the customer's requirements. L & O Research and Development Corp., Dept. ED, 134 N. Wayne Ave., Wayne, Pa.

CIRCLE ED-177 ON READER-SERVICE CARD FOR MORE INFORMATION

Toggle Switch

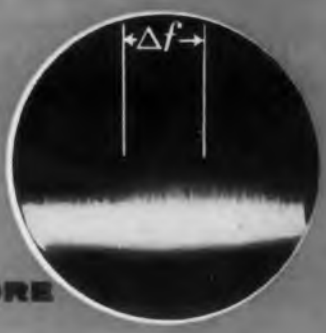
Miniature Variety

This miniature toggle switch features smooth operation, long life span and positive detent action. It operates with precise repeatability in well over 100,000 cycles. Other than the berylium-copper spring, all parts of the toggle actuator are made of stainless steel.

The switch component consists of the E4-3MIL approved basic switch. It is available in normally open or normally closed spst and spdt. It is electrically rated at 5amp, 125/250v a-c, or 4amp, 30v d-c resistive. Electro-Snap Switch & Mfg. Co., Dept. ED, 4218-30 W. Lake St., Chicago 24, Ill.

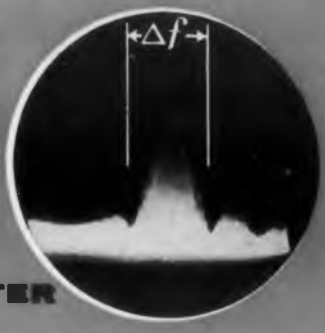
CIRCLE ED-178 ON READER-SERVICE CARD FOR MORE INFORMATION

IT'S GOOD FOR YOUR SYSTEM



BEFORE

tone up your spectrum with a LITTON *High Power* MAGNETRON ISOLATOR



AFTER

Use a Litton Magnetron Isolator to insure concentration of energy in the useful pass band of your system. Without this device mismatched loads coupled with long lines spread transmitted energy into unused portions of the spectrum, seriously impairing system performance. By employing the unidirectional properties of magnetically polarized ferrites at microwave frequencies, these new circuit elements isolate the microwave source from load reflections, permitting *high power* magnetrons or klystrons to operate satisfactorily into long lines terminated in poorly matched loads. With a particular VSWR usable length of line for stable magnetron operation may be increased four to five times by incorporating a Litton Load Isolator with isolation of 10 db or more.

In addition, Litton Magnetron Load Isolators...

- Reduce frequency pulling.
- Provide broad band operation with high isolation.
- Present low input VSWR.
- Reduce moding.
- Decrease AFC requirements.
- Minimize variation in power output with changing loads.
- Require no separate cooling system.
- Require no external power supply.

New ferrite circuit elements are designed to improve system operation by minimizing long-line effects and other loading problems.

Developed and manufactured by specialists in the production of microwave systems and components, Litton Magnetron Isolators greatly improve tube performance.

LITTON MODEL X250

LITTON MODEL X-101

MAGNETRON LOAD ISOLATOR

for improved performance in high-power radar and other microwave systems.

CONDENSED SPECIFICATIONS

	X250	X101	X20L
Frequency Range	8.6-9.6 kmcs	8.6-9.6 kmcs	8.6-9.6 kmcs
Isolation (minimum) (Attenuation in reverse direction)	10 db	10 db	18 db
Insertion Loss (maximum)	0.5 db	1 db	1.5 db
Power Handling Capacity	300 KW peak 300 W average	100 KW peak 100 W average	20 watts (output terminated)
Magnetic Field	Permanent magnet	Permanent magnet	Permanent magnet
Input VSWR (output terminated)	1.05 max.	1.10 max.	1.2 max.
Flange	UG-51/U	UG-39/U	UG-39/U*
Weight	Less than 2 lbs.		

*Special flanging upon request.

LITTON MODEL X20L

LABORATORY LOAD ISOLATOR

for laboratory use, to obtain maximum performance from your "X" band test equipment.

Other precision products of the Litton Components Division include: Microwave Rotary Joints, multi-turn Potentiometers, single-turn Potentiometers, Metal Film Resistors, Delay Lines.

LITTON industries

COMPONENTS DIVISION

Write for complete data and name of nearest representative...

336 N. FOOTHILL ROAD, BEVERLY HILLS, CALIFORNIA • CRESTVIEW 4-7344

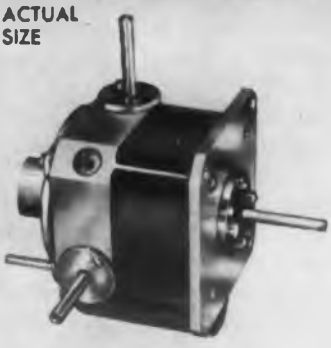
215 S. FULTON AVE., MOUNT VERNON, NEW YORK • MOUNT VERNON 7-8600

CIRCLE ED-179 ON READER-SERVICE CARD FOR MORE INFORMATION

TWO NEW KEARFOTT COMPUTER COMPONENTS

MINIATURE MECHANICAL RESOLVER

1/2 ACTUAL SIZE



An extremely compact unit measuring only 1 15/16" high, 1 3/4" wide and 2 1/8" long. It combines the functions of a ball and disc integrator and a spherical resolver. Will integrate the sine and cosine functions of an angle or resolve a vector displacement into its horizontal and vertical components.

INTEGRATING FILTER

Used to integrate a voltage signal from a specified minimum integration period to one approaching an infinite period of time. Available for DC to AC or AC to AC applications. These units eliminate harmonic and quadrature voltages to the servo motor driving a tachometer generator. Permits the use of a low gain, non-critical amplifier by effectively providing infinite gain.

DIMENSIONS:

AC-AC Filter 1.437" diam. x 2.484" long.
DC-AC Filter 1.969" diam. x 2.938" long.

1/2 ACTUAL SIZE

The close attention to details that has made Kearfott one of the leading producers of servo system components goes into the design and production of these devices. Detailed descriptions sent on request.

KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

ENGINEERS:

Many opportunities in the above fields are open—please write for details today.

Kearfott

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

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

Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J.
Midwest Office: 188 W. Randolph Street, Chicago, Ill. South Central Office: 6115 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

CIRCLE ED-180 ON READER-SERVICE CARD FOR MORE INFORMATION

Servo Amplifiers

Magnetic Amplifier Type

These magnetic servo amplifiers are designed for operation at high temperatures and use no rectifiers. Output power ratings of 3, 6, 10, 15, 18 and 40w at 400cy, delivering voltages of 0-26v, 0-38v, 0-115v, and 0-220v, are available from stock. In addition, 60cy amplifiers are available in similar power ratings.

The output wave form of these models is sinusoidal and phase reversing according to the input. The input signal may be either a-c or d-c. The amplifiers are hermetically sealed and conform to MIL-T-27 specifications. All are rated for a continuous-duty cycle and can be qualification-tested to comply with requirements as set forth in aircraft and missile control systems.

These units are precisely engineered to function as standard components for servo systems application, and operate over an ambient temperature range of −55° to +100°C. All units can be controlled by a transistor or proper tube, and come with a seven-pin header. Magnetic Research Corp., Dept. ED, 200 Center St., El Segundo, Calif.

CIRCLE ED-181 ON READER-SERVICE CARD FOR MORE INFORMATION

Decade Amplifier

For General Laboratory Use

The "Glennite" F 408 decade amplifier is designed for general laboratory use and is provided with an input cathode follower probe. The probe is mounted on a 9′ connecting cable, making the instrument particularly useful for measurement of high impedance devices such as crystal transducers, as well as normal electronic measurements.

An a-c operated instrument, it draws about 10.5w. It features anti-microphonic construction, with the amplifier section and the cathode follower tube individually shock mounted. Special provision is made on the front panel for the convenient insertion of filters or padders between the cathode follower and the decade amplifier section. Gulton Mfg. Corp., Dept. ED, Metuchen, N. J.

CIRCLE ED-182 ON READER-SERVICE CARD FOR MORE INFORMATION

Process Camera

For Printed Circuits Work

Available in 3 sizes (11" x 14", 16" x 20", and 24" x 24") and wired for 100v d-c, this Process Camera is a completely equipped, heavy-duty, professional type unit. It should be of value to manufacturers who print circuits.

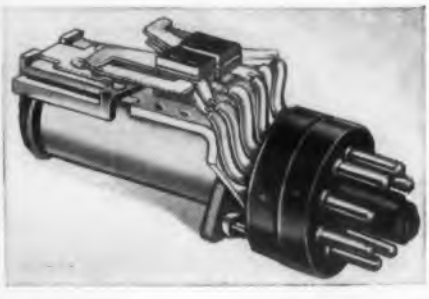
The camera moves on a heavy steel track, keeping copy board, lens board, and file holder in accurate position. All controls are at the back of the camera, and are illuminated by small pilot lights.

Special features include percentage focusing scales and a magnifying window for easy focusing. A choice of Goerz or Wollensak lens with diaphragm control and electrically operated solenoid shutter is available. The unit has twin 1500w, 3200°K lamps controlled by an automatic preset timer or light integrator; a vacuum frame, powered by a 1/4hp pump, that swings into a horizontal position for loading; a transparent vacuum back that permits direct focusing on the vacuum back holder; a long-life Naugahyde bellows; and a selector valve that permits use of film from 4" x 5" up to 24". Miller-Trojan Co., Inc., Dept. ED, 501 Ridge Ave., Troy, Ohio.

CIRCLE ED-185 ON READER-SERVICE CARD FOR MORE INFORMATION

Relays

Plug-in Type



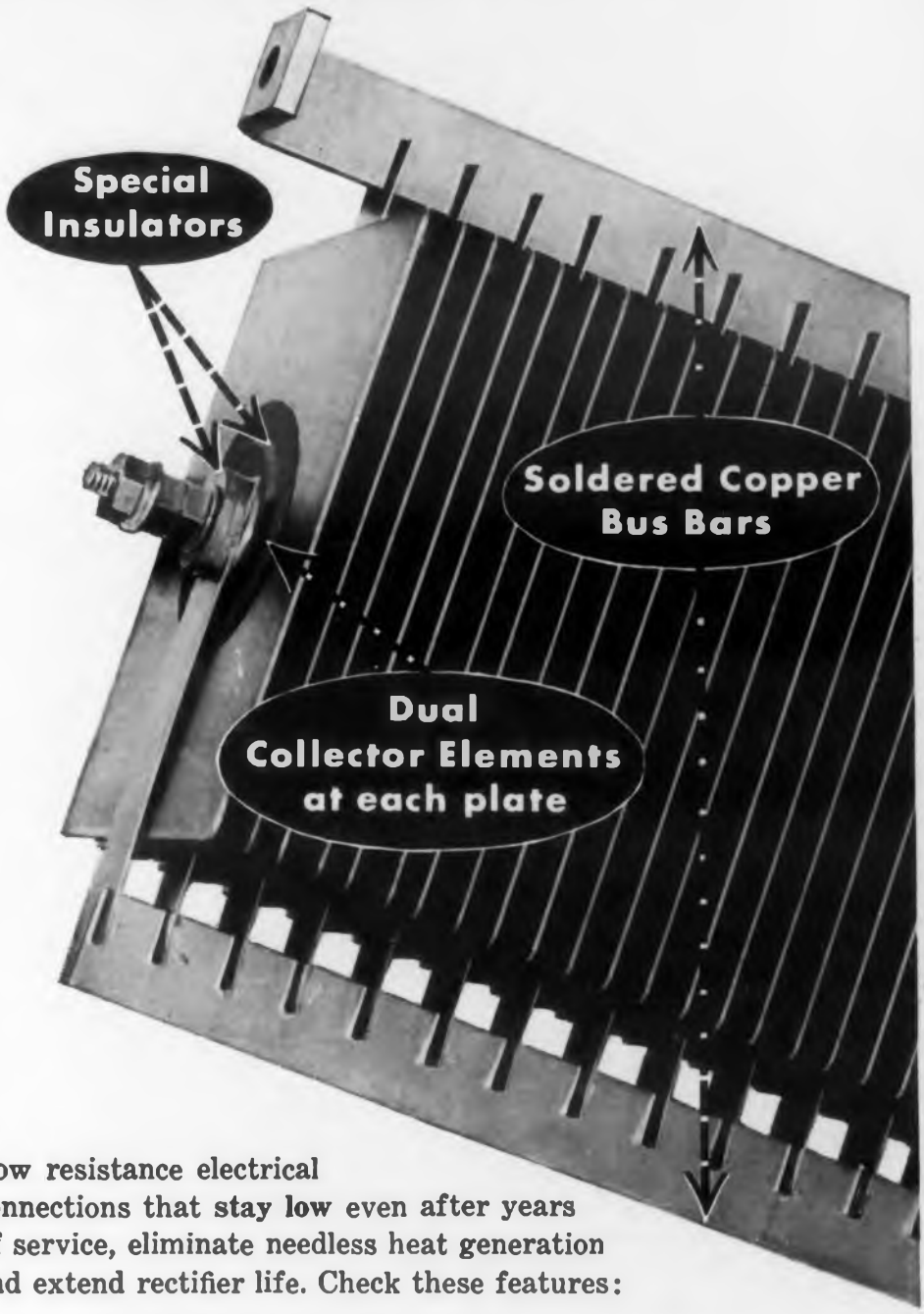
A series of open-type plug-in relays can be installed, inspected, or replaced without disturbing the wiring. When used in portable equipment, the relays can be removed readily for protection in transit.

The relays can be furnished with standard contact combinations up to 24 arms per relay. Standard contact ratings are 2amp at 24v d-c, or 115v a-c. Bifuricated contacts for extremely low voltage and low current, or heavier contacts rated up to 5amp, can be furnished.

Operating voltages available range from 6v to 230v a-c or d-c. Dimensions including plugs, are 3-1/2" long x 1-1/8" wide. Height varies with number of contact arms required. Magnecraft Electric Co., Dept. ED, 1442-A W. Van Buren St., Chicago 7, Ill.

CIRCLE ED-186 ON READER-SERVICE CARD FOR MORE INFORMATION

Look what you get!



Low resistance electrical connections that **stay low** even after years of service, eliminate needless heat generation and extend rectifier life. Check these features:

1. **Soldered** copper bus bars.
2. **Dual** collector elements at each plate.
3. **Special insulators** that do not compress with age and cause loose assemblies.

Let us consider **your** power conversion problems or requirements. Write, wire or phone (Bloomington 2-1435).

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In Canada: 700 Weston Rd., Toronto 9, Tel. Murray 7535
Export: Ad Auriema, Inc., New York City

CIRCLE ED-187 ON READER-SERVICE CARD FOR MORE INFORMATION

Numbering Device

Portable, Easily Used

The "Stampmaster" is for random or selective numbering on all types of products where a permanent legible impression is to be applied by hand. Part numbers, heat code numbers, and similar identifying data can be set up quickly and easily by indexing individual wheels. The head is small and compact, and the unit can easily be carried to the work.

This device is currently available in 3/32" and 1/8" character sizes, with additional sizes to be introduced at a later date. Heads are available in various wheel capacities, and the more popular sizes will be stocked for immediate delivery.

Construction of the unit eliminates spring-loaded retaining pawls or locking levers. A single locking pin which maintains stamping alignment is withdrawn to rotate wheels for set up. The locking pin also supplements the main shaft in absorbing shock when stamping. On standard units, 11 division wheels are used with engraved characters 1 through 0 and one blank space. The Noble & Westbrook Manufacturing Co., Dept. ED, East Hartford, Conn.

CIRCLE ED-189 ON READER-SERVICE CARD FOR MORE INFORMATION

Voltage Regulators

Magnetic Units

The first four models of what will be an extensive line of magnetic voltage regulators, or regulating transformers, have capacities of 15va, 30va, 60va and 120va. Soon to be added will be units of 250va, 500va, and 1000va. The units are primarily intended for incorporation into other equipment, where performance becomes more effective when the incoming line voltage is stabilized. They can also be used as auxiliary line stabilizers.

Electrical specifications include: input voltage range, 95-130v a-c, single phase, 60cy; output range, 115v a-c rms, single phase; regulation accuracy, ±0.5% against line changes; load conditions, ±0.5% against line at any given load from 0 to full; and time constant, from 2cy to 6cy for line changes. Sorensen & Co., Inc., Dept. ED, 375 Fairfield Ave., Stamford, Conn.

CIRCLE ED-190 ON READER-SERVICE CARD FOR MORE INFORMATION

R-F Heads

Include R-F Assembly and Mixer

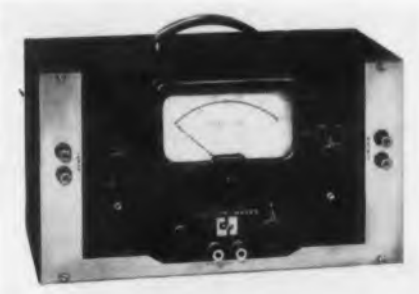
These K-Band R-F Heads, covering the microwave spectrum from 12,400-Mc to 40,000Mc, are complete microwave tuning units which include an r-f assembly and a K-band mixer. The heads were specifically designed for use with the Vectron SA25 Microwave Spectrum Analyzer, but earlier models of the Vectron Analyzer, as well as other analyzers, can be modified or adapted to use them.

The broad range requires three K-band mixers, with different size waveguides, to cover the full range in conjunction with special r-f assemblies. Standard heads permit economical coverage of the most actively used portions of the spectrum; the 25K1 tunes from 15,300Mc to 17,700Mc, the 25K2 from 22,800Mc to 26,400Mc, and the 25KQ1 from 34,000Mc to 38,600Mc. Other portions of the band are covered by special combinations as required. Vectron, Inc., Dept. ED, 380 Main St., Waltham 54, Mass.

CIRCLE ED-192 ON READER-SERVICE CARD FOR MORE INFORMATION

Flutter and Wow Meter

Has 3kc Oscillator



This portable, low-cost Flutter and Wow Meter, Model FL-3B, measures flutter and wow at 3kc in tape, film, wire, and disk recording and reproducing equipment. The instrument incorporates an internal 3kc oscillator which eliminates the need for additional equipment to initiate a measuring signal. The oscillator is factory-adjusted to a secondary frequency standard and needs no further adjustment. A further feature of the meter is the fact that it will give full limiting with an input signal of 0.4v rms, thus permitting measurements to be taken from a standard 0 dbm program line.

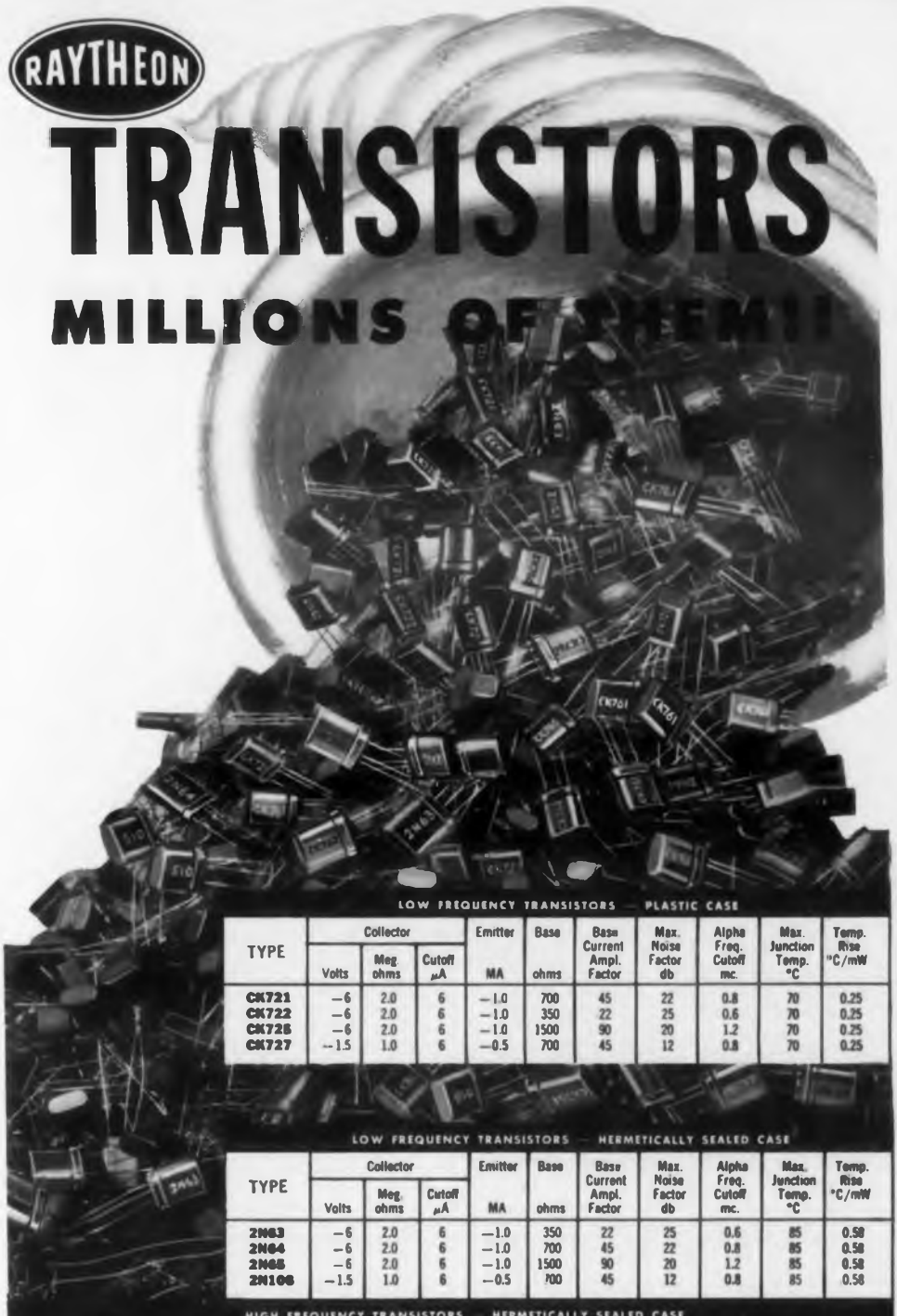
Specifications include: operating frequency, 3000cy; input impedance, 250,000 ohms, one side grounded; input signal, 0.4v minimum; scale reading, 0.5% and 2% full scale; power, 117v 60cy, 20w. Dimensions are 7" x 12" x 6", and weight is 9-3/4 lb. D & R Ltd., Dept. ED, 402 East Gutierrez St., Santa Barbara, Calif.

CIRCLE ED-193 ON READER-SERVICE CARD FOR MORE INFORMATION

RAYTHEON

TRANSISTORS

MILLIONS OF THEM!!



LOW FREQUENCY TRANSISTORS — PLASTIC CASE

TYPE	Collector			Emitter	Base	Base Current Ampl. Factor	Max. Noise Factor db	Alpha Freq. Cutoff mc.	Max. Junction Temp. °C	Temp. Rise °C/mW
	Volts	Meg. ohms	Cutoff μA	MA	ohms					
CK721	−6	2.0	6	−1.0	700	45	22	0.8	70	0.25
CK722	−6	2.0	6	−1.0	350	22	25	0.6	70	0.25
CK725	−6	2.0	6	−1.0	1500	90	20	1.2	70	0.25
CK727	−1.5	1.0	6	−0.5	700	45	12	0.8	70	0.25

LOW FREQUENCY TRANSISTORS — HERMETICALLY SEALED CASE

TYPE	Collector			Emitter	Base	Base Current Ampl. Factor	Max. Noise Factor db	Alpha Freq. Cutoff mc.	Max. Junction Temp. °C	Temp. Rise °C/mW
	Volts	Meg. ohms	Cutoff μA	MA	ohms					
2N63	−6	2.0	6	−1.0	350	22	25	0.6	85	0.58
2N64	−6	2.0	6	−1.0	700	45	22	0.8	85	0.58
2N65	−6	2.0	6	−1.0	1500	90	20	1.2	85	0.58
2N106	−1.5	1.0	6	−0.5	700	45	12	0.8	85	0.58

HIGH FREQUENCY TRANSISTORS — HERMETICALLY SEALED CASE

TYPE	Collector		Emitter	Extrin. Base Resis. ohms	Base Current Ampl. Factor	Alpha Freq. Cutoff mc.	Max. Junc. Temp. °C	Temp. Rise °C/mW	Coll. Capac. μμf	Gain at 455kc db	Gain at 2 mc db	Rise time* μsecs	Decay time* μsecs
	Volts	Cutoff μA	MA										
CK760	−6	1	−1.0	75	40	5	85	0.62	14	32	18	0.05	0.06
CK761	−6	1	−1.0	75	45	10	85	0.62	14	33	20	0.04	0.05
CK762	−6	1	−1.0	75	65	20	85	0.62	14	33	22	0.02	0.03

*measured in circuit which will be supplied on request

Note: above characteristics are average except where noted

RAYTHEON IS FIRST AND FOREMOST IN

— **mass production.** Raytheon is long past the experiment and development stage in Germanium PNP Junction Transistors — for over 2 years has had the quantity production and quality control techniques and resources

— **proved reliability in commercial application,** based on billions of hours of actual field performance and a record of success exceeding that of many reliable vacuum tubes

— **range of characteristics.** Look at the chart. You'll find one or more Raytheon Transistors that meet your specific requirements, however exacting.

RAYTHEON

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Excellence in Electronics

Semiconductor Division — Home Office: 55 Chapel St., Newton 58, Mass. Bigelow 4-7500

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RAYTHEON MAKES ALL THESE

RELIABLE SUBMINIATURE AND MINIATURE TUBES · SEMICONDUCTOR DIODES AND TRANSISTORS · NUCLEONIC TUBES · MICROWAVE TUBES · RECEIVING AND PICTURE TUBES

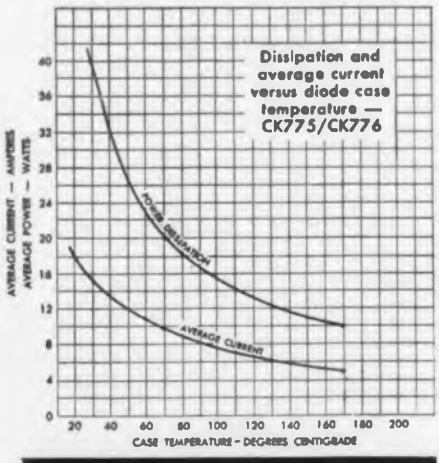
CIRCLE ED-194 ON READER-SERVICE CARD FOR MORE INFORMATION

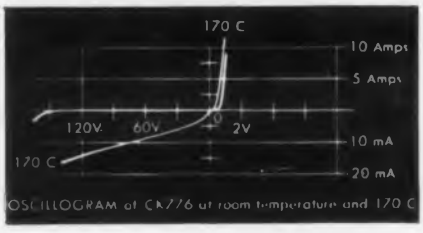
Raytheon presents a new and more efficient

SILICON POWER RECTIFIER

with 95 to 99% EFFICIENCY

ACTUAL SIZE





OSCILLOGRAM of CK776 at room temperature and 170 C

HIGH CURRENT - to 15A
HIGH VOLTAGE RATINGS
HIGH TEMPERATURE - 175°C

HERMETICALLY SEALED

MECHANICALLY STABLE

REDUCED COOLING REQUIRED

EXTENDED FREQUENCY RANGE
better than 100kc

RAYTHEON SILICON POWER RECTIFIER CHARACTERISTICS

	MAXIMUM VOLTAGE RMS VOLTS	MAXIMUM VOLTAGE PEAK VOLTS	MAXIMUM CURRENT PEAK AMPERES	MAXIMUM CURRENT AVERAGE AMPERES	TYPICAL DISSIPATION WATTS
TYPE CK775					
CASE TEMP. 30°C*	40	60	50	15	40
CASE TEMP. 170°C*	40	60	15	5	10
NO HEAT RADIATOR					
AMBIENT TEMP. 25°C	40	60	6	2.0	3.0
AMBIENT TEMP. 170°C	40	60	2.0	0.5	2.0
TYPE CK776					
CASE TEMP. 30°C*	125	200	50	15	40
CASE TEMP. 170°C*	125	200	15	5	10
NO HEAT RADIATOR					
AMBIENT TEMP. 25°C	125	200	6	2.0	3.0
AMBIENT TEMP. 170°C	125	200	2.0	0.5	2.0

*maintained by external heat radiator

ADDITIONAL RATINGS (25°C)

Both CK775 and CK776 have maximum drop at 5 amperes of 1.5 volts
CK775 has maximum reverse current at −60 volts of 25 mA
CK776 has maximum reverse current at −200 volts of 25 mA

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RAYTHEON MANUFACTURING COMPANY

Semiconductor Division — Home Office: 55 Chapel St., Newton 58, Mass. Bigelow 4-7500

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CIRCLE ED-195 ON READER-SERVICE CARD FOR MORE INFORMATION

Servo Amplifier

To Drive Servovalves

This 8-tube servoamplifier, the Model 32, is designed to drive pneumatic or hydraulic servovalves in power servo applications. Features include: excellent dynamic response, a variable freqency dither oscillator, a 4kc oscillator to excite variable reluctance or E-type transformer pickoffs, and provision for plug-in compensating networks to alter servo systems dynamic response where required.

The unit produces a d-c differential current proportional to a d-c signal in the push-pull output stage, which operates at high impedance level to minimize inductance lags from the coils in the servovalve electro-mechanical actuator. The dither oscillator (110cy to 400cy) supplies a signal superimposed on the control signal to reduce the effect of static friction when prevalent. Because of the servoamplifier's excellent response, very high natural freqencies of the servo system are possible with suitable supplementary components.

Designed for panel mounting, the meter indicates either output current level or system balance, with output current level adjustable from 8ma to 20ma. The panel contains five controls; gain, dither frequency, dither level, balance, and output level.

A typical laboratory use is as a component in testing operating characteristics of hydraulic servovalves before installation. Raymond Atchley, Inc., Dept. ED, 12012 W. Pico Blvd., Los Angeles 64, Calif.

CIRCLE ED-196 ON READER-SERVICE CARD FOR MORE INFORMATION

Voltage Converter

3 oz Unit Delivers up to 7000v

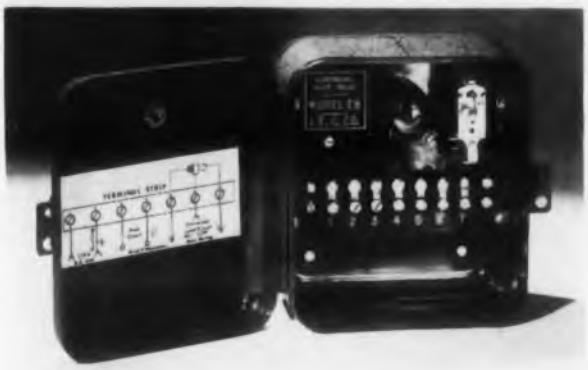
This miniature high-voltage converter weighs less than 3 oz and is small enough to fit in the palm of the hand. It delivers any voltage from 0 to 7000v by simply connecting one or two dry cells to the input. It works equally well on a-c current.

Circuit diagrams supplied with each unit show suggested hookups, including stabilizer circuits that provide a regulation of 2% or better and use only a few simple components. Applications include Geiger counters, phototubes, photoflash outfits, dust collectors, megohmmeters, etc. Precise Measurements Co., Dept. ED, 942 Kings Highway, Brooklyn 23, N. Y.

CIRCLE ED-197 ON READER-SERVICE CARD FOR MORE INFORMATION

Pilot Relay

Can Control from 2μamp



The Model EB Electronic Pilot Relay is able to control large values of current and power with a current flow of 2μamp. It permits delicate mechanisms with extremely light contact pressures to control larger electrical currents. Its unusual cold cathode triode tube design and construction gives instantaneous action, unlimited lead lengths, and a current amplification up to 2.5×10^6.

Sensitive to high-speed impulses, the relay operates with an actuating pilot circuit resistivity from 0 to 10 megohms. A visible jewel operational indicator permits visibility for off/on operation even while the pilot relay case is locked.

Supply is 115v, 60cy (other voltages and frequencies to order). Power consumption is 2w. Contacts are spdt. Contact rating is 5amp at 115v a-c. Weight is 3 lb, 2 oz, and size is 7″ x 6″ x 4″. Industrial Electronic Controls Co., Dept. ED, 2271 E. 14th St., Brooklyn 29, N. Y.

CIRCLE ED-200 ON READER-SERVICE CARD FOR MORE INFORMATION

Slip Ring Assemblies

In 10 Combinations

"Eldec" standard slip ring and spring loaded brush contact assemblies are available in 10 combinations of either 2, 4, 6, 8, 10, 12, 14, 16, 18, or 20 silver rings, 4μinch finish, with 1, 2, 3, or 4 silver graphite brush contacts per ring, as desired. Ring diameter is 1-3/8″ with 1″ ID.

For use in low-current applications, the assemblies offer low noise levels at reasonably high speeds. Electro Development Co., Dept. ED, 14701 Keswick St., Van Nuys, Calif.

CIRCLE ED-201 ON READER-SERVICE CARD FOR MORE INFORMATION

ENVIRONMENT* CONTROL

is an important part of

QUALITY CONTROL

in the manufacture of all

RAYTHEON

RELIABLE SUBMINIATURE TUBES

HOSPITAL-CLEAN conditions minimize danger of contamination from air borne lint or dust particles that might lead to catastrophic tube failures.

***ENVIRONMENT Control at Raytheon Involves:**

- filtered intake air } in pressurized mount
- humidity control } assembly and parts
- temperature control } manufacturing areas
- lintless clothing for personnel
- "air lock" room entrance chambers
- restricted movement of personnel
- elimination of lint-producing paper work
- elimination of "lint-traps" through deliberate employment of smooth floors, walls, ceilings and work area surfaces
- restricted material flow
- daily vacuum cleaning of area and of containers

Raytheon Reliable Subminiature Tubes include Dual and Rectifier Diodes; High, Medium and Low Mu Triodes; High and Medium Mu Dual Triodes; High Frequency Triodes; Low Microphonic Triodes; Output, RF Amplifier and RF Mixer Pentodes; Voltage Regulator and Voltage Reference Tubes. Write for Data Sheets.

Long, flat press, glass to metal seals with in-line leads are used in Raytheon Reliable Subminiatures. This means:

- *no buttons to crack*
- *reduced glass strain*
- *no lead burning or corrosion*
- *easier socketing*
- *easier wiring*
- *superior adaptability to printed circuits*
- *extra insurance against catastrophic glass failures*

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RAYTHEON MANUFACTURING COMPANY

Receiving Tube Division — Home Office: 55 Chapel St., Newton 58, Mass. Bigelow 4-7500

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CIRCLE ED-202 ON READER-SERVICE CARD FOR MORE INFORMATION

- aircraft servo
- computors
- mechanical filters
- navigation equipment
- guided missiles
- d. c. amplifiers
- laboratory instruments
- mechanical gating switches

applications limited only by the imagination

MINIATURIZED

NEW JAMES DPDT CHOPPER

FOR INCREASED RELIABILITY ADDED LIFE

BURTON BROWNE ADVERTISING

Models are available with these features:

- Frequency—20 cps through 420 cps.
- Contact Rating—Micro volts to 100 volts including dual circuit design for modulator/demodulator applications.
- Meets mil specs.
- Sealed or unsealed for field adjustment.
- Temperature: −55° to +85°C.
- Electrical connections—Available with octal and miniature 9 pin header, with or without external coil connection.
- Moderate cost.

JAMES VIBRAPOWR COMPANY
4036 N. Rockwell St. • Chicago 18, Ill.

Write for engineering specifications and catalog.

86-7379

CIRCLE ED-203 ON READER-SERVICE CARD FOR MORE INFORMATION

Microwave Absorbing Material

Light and Flexible

Type T microwave absorbing material, recently declassified by the government, is especially suited to aircraft and antenna applications. It is an improved version of this company's F-89VF material, and gives excellent performance over a wide range of incidence angles. Due to light weight and flexibility, its major application has been in aircraft. It has been used to prevent side lobe reflection, and reflection from aircraft fuselage and other antenna obstructions within a radome.

The material can be designed for any particular frequency within a range from K-band through L-band. It is broad-banded within approximately ±7% of the specified frequency and has a power-reflection coefficient of less than 1% (20db) within this band. Typical X-band material, supplied in 18" x 36" sheets, weighs 0.25 lb per sq ft and is approximately 0.100" thick.

The material is aluminum-backed and is easily mounted with standard adhesives. It can be designed to have the same absorption characteristics at two unrelated frequencies, such as 22,000Mc and 9500Mc. For special applications, where thickness is an important consideration, it can be supplied to a particular dimension practically independent of frequency. McMillan Industrial Corp., Dept. ED, Brownville Ave., Ipswich, Mass.

CIRCLE ED-204 ON READER-SERVICE CARD FOR MORE INFORMATION

Have you returned your subscription renewal and qualification form?

See Page 96

Repair Kit

For Printed Circuits

The "G-C Printed Circuit Repair Kit" includes the necessary silver print material and silicone resin for protecting the silver coating, plus special tools designed to expedite repair of printed circuits. Full instructions are also included. General Cement Mfg. Co., Dept. ED, 919 Taylor Ave., Rockford, Ill.

CIRCLE ED-205 ON READER-SERVICE CARD FOR MORE INFORMATION

Thermal Relays

Sense Currents, Voltages

This complete series of current-sensing and voltage-sensing relays of the thermal type utilizes hermetic sealing and operating points adjustable by means of a screw outside the sealed space. Applications include overload protection, over- and under-voltage alarm or cut-off, voltage regulation, and battery charge control.

The relays operate their contact circuits when current or voltage to their heaters exceeds the operating point for which the relay is set, and they release their contacts when the current or voltage drops below this value. This operating point is adjustable for each relay, either at the factory or by the user, over a 2:1 range. Nine different internal structures are available with time constants ranging from 1 sec to 2-1/2 min.

The relays operate interchangeably on d-c or on a-c of any frequency. Operating setting can be made to ±4% or closer and will not change with ambient temperature by more than ±5% over the range of −70° to +100°C. Weight is 1 oz to 1-1/2 oz. Diameter is 3/4" and length 2-3/8". Contact rating is 3amp at 115v a-c non-inductive load or at 28v d-c non-inductive. Relays are available for operating currents from 0.015amp to 5amp and for voltages from 1v to 230v. G-V Controls, Inc., Dept. ED, 28 Hollywood Plaza, East Orange, N. J.

CIRCLE ED-208 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnetic Amplifiers

400cy Self-Saturating Type

For use with BuOrd Mark 7, Mark 8, and Mark 14 Mod 2 Servo motors, this 400cy self-saturating magnetic amplifier uses half-wave circuits for inherently high speed of response. This enables them to be used in systems with required bandwidths up to 20cy. Standard units are hermetically sealed with gain and compensation fixed for a given system. Units with adjustable gain and compensation also can be supplied. Dimensions are 3.06" x 3.56" x 3.87". Feedback Controls, Inc., Dept. ED, 1332 N. Henry St., Alexandria, Va.

CIRCLE ED-209 ON READER-SERVICE CARD FOR MORE INFORMATION

TUNG-SOL

Series String TUBES

For the TV Set Manufacturer . . .

building series string sets, Tung-Sol can provide the "series string" tube types, the quality and the service needed for a successful competitive program.

2AF4 (Prototype—6AF4) Heater Current 0.6 A Heater Volts 2.35	**3CB6** (Prototype—6CB6) Heater Current 0.6 A Heater Volts 3.15	**5V6GT** (Prototype—6V6GT) Heater Current 0.6 A Heater Volts 4.7	**12BQ6GA** (Prototype—6BQ6GA) Heater Current 0.6 A Heater Volts 12.6
3AL5 (Prototype—6AL5) Heater Current 0.6 A Heater Volts 3.15	**4BQ7A** (Prototype—6BQ7A) Heater Current 0.6 A Heater Volts 4.2	**6AU7** (Prototype—12AU7) Heater Current 0.6 A Heater Volts 3.15*	**12BQ6GT** (Prototype—6BQ6GT) Heater Current 0.6 A Heater Volts 12.6
3AU6 (Prototype—6AU6) Heater Current 0.6 A Heater Volts 3.15	**4BZ7** (Prototype—6BZ7) Heater Current 0.6 A Heater Volts 4.2	**6AX7** (Prototype—12AX7) Heater Current 0.6 A Heater Volts 3.15*	**12BY7A** (Prototype—12BY7) Heater Current 0.6 A Heater Volts 6.3*
3AV6 (Prototype—6AV6) Heater Current 0.6 A Heater Volts 3.15	**5AN8** (Prototype—6AN8) Heater Current 0.6 A Heater Volts 4.7	**6S4A** (Prototype—6S4) Heater Current 0.6 A Heater Volts 6.3	**12L6GT** (Prototype—25L6GT) Heater Current 0.6 A Heater Volts 12.6
3BC5 (Prototype—6BC5) Heater Current 0.6 A Heater Volts 3.15	**5AQ5** (Prototype—6AQ5) Heater Current 0.6 A Heater Volts 4.7	**6SN7GTB** (Prototype—6SN7GTA) Heater Current 0.6 A Heater Volts 6.3	**12W6GT** (Prototype—6W6GT) Heater Current 0.6 A Heater Volts 12.6
3BE6 (Prototype—6BE6) Heater Current 0.6 A Heater Volts 3.15	**5BK7A** (Prototype—6BK7A) Heater Current 0.6 A Heater Volts 4.7	**12AX4GTA** (Prototype—12AX4GT) Heater Current 0.6 A Heater Volts 12.6	**19AU4** (Prototype—6AU4GT) Heater Current 0.6 A Heater Volts 18.9
3BN6 (Prototype—6BN6) Heater Current 0.6 A Heater Volts 3.15	**5T8** (Prototype—6T8) Heater Current 0.6 A Heater Volts 4.7	**12B4A** (Prototype—12B4) Heater Current 0.6 A Heater Volts 6.3*	**25CD6GA** (Prototype—25CD6G) Heater Current 0.6 A Heater Volts 25
3BY6 (Prototype—6BY6) Heater Current 0.6 A Heater Volts 3.15	**5U8** (Prototype—6U8) Heater Current 0.6 A Heater Volts 4.7	**12BH7A** (Prototype—12BH7) Heater Current 0.6 A Heater Volts 6.3*	**Using heaters connected in parallel.* *Other Series String Tube Types in Development.*

All Tung-Sol Series String Tubes have uniform heater warm-up time to safeguard against failures from initial voltage surge.

Heater ratings are based on 600 milliamperes of current with the heater voltage adjusted for the same power as in the prototype. All other characteristics and ratings are identical to those of the prototype.

Use of these tubes provides completely satisfactory receiver characteristics during warm-up.

For more information about Tung-Sol "Series String" TV Tubes, write to Commercial Engineering Department, Tung-Sol Electric Inc., Newark 4, New Jersey.

SALES OFFICES

Atlanta, Chicago, Columbus, Culver City (Los Angeles), Dallas, Denver, Detroit, Newark, Philadelphia, Seattle.

Tung-Sol makes All-Glass Sealed Beam Lamps, Miniature Lamps, Signal Flashers, Picture Tubes, Radio, TV and Special Purpose Electron Tubes and Semiconductor Products.

TUNG-SOL®

Radio, TV Tubes, Dial Lamps

CIRCLE ED-210 ON READER-SERVICE CARD FOR MORE INFORMATION

Tube Clamp

For 1-1/4"-6" OD Tubes

Made of type 302 stainless steel, the Type 22 tube clamp is specifically designed to exert a minimum 4lb retention pressure on tube and component bases over the entire range of the 0.040" tolerance allowed tube manufacturers under JAN specifications. Being flexible in range, the clamp exerts a minimum of 4lb retention pressure on a minimum diameter base while never exerting so much pressure on maximum size bases as to cause breakage. This flexibility eliminates the need in assembly to match clamps to tube bases.

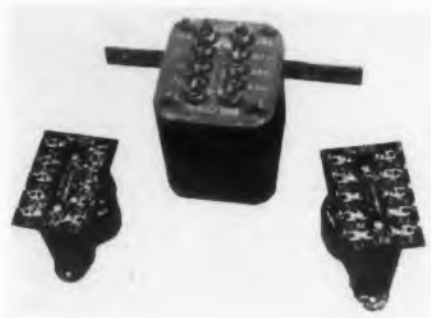
In field maintenance, the clamp is particularly valuable because the two tension loops and the temper of the stainless steel give it the ability to hold with a minimum of 4lb retention on a minimum size tube-base even after having been used on a maximum size base.

The Type 22 is made in sizes ranging from 1-1/4" ID to 6" ID with several variations in location and height of the mounting bracket. Birtcher Corp., Dept. ED, 4371 Valley Blvd., Los Angeles 32, Calif.

CIRCLE ED-212 ON READER-SERVICE CARD FOR MORE INFORMATION

Transformers

For Matching Lines to Speakers



These line-to-speaker matching transformers, for commercial sound systems, are designed for 70v distribution lines. Three sizes are available for feeding individual loudspeakers, or banks of loudspeakers, requiring up to 5w, 15w, or 50w. Transformers are also available for outdoor applications; they are hermetically sealed, and require no additional weather protection.

The transformers have an efficiency of 90% to 95% and are intended for use in constant-level sound systems. Taps on the secondary of the matching transformers permit adjustment of the sound level of individual speakers or groups of speakers in 2.5db steps without affecting the level of other speakers on the line. Electronic Communication Equipment Co., Dept. ED, 1249 W. Loyola Ave., Chicago 26, Ill.

CIRCLE ED-213 ON READER-SERVICE CARD FOR MORE INFORMATION

Vacuum Tube Voltmeter

Has Widely Applicable Design

The "302 Polymeter" is a vacuum tube voltmeter that offers a subminiature vacuum tube r-f probe, a peak-to-peak scale, a new 7" meter movement, a lighted scale, a patented linearity circuit, an input impedance of 17 megohms, shielded a-c and r-f leads, and screw-on connectors. The brushed aluminum panel has etched panel lettering, providing easier reading. Changes in control arrangements facilitate and speed switching; these changes include a new selector switch sequence and range switches.

The instrument reads peak-to-peak voltages from 200mv to 2,800v; d-c voltages from 200mv to 2,800v; d-c voltages of plus or minus polarity from 50mv to 1,000v; a-c voltages from 50mv to 1,000v; r-f voltages from 100mv to 300v in the band of 10kc to 300Mc; resistance from 0.5 ohm to 1,000 megohm; and decibels from —20db to +61.4db. The d-c voltage range may be extended to 30,000v by using this firm's Type 225 (30kv) d-c voltage multiplier probe. Sylvania Electric Products, Inc., Dept. ED, 1221 W. 3rd St., Williamsport, Pa.

CIRCLE ED-218 ON READER-SERVICE CARD FOR MORE INFORMATION

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See Page 96

Panel Meter

Measures Ratio of Two Currents

This panel meter has the capacity to handle 50ma in either coil, and will accurately indicate a ratio on an input of 2ma minimum. Scale tolerances are based on an angular tolerance of 1°.

The movement uses a pair of fixed coils surrounding a small alnico magnet attached to a pivoted pointer shaft. With equal current in both coils, the pointer will indicate unity ratio (1). An increase in strength of one current over the other will pull the pointer right or left of center to indicate a ratio. Instrument Div., Thomas A. Edison, Inc., Dept. ED, West Orange, N. J.

CIRCLE ED-219 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Supply

Highly Accurate Unit

The PS-171 Power Supply was developed expressly for use in high accuracy transistor measurements. The regulated output current of 1-amp max is high enough to accommodate power transistors; in addition, its regulating characteristics and wide range make it useful in many other applications where constant current or voltage source is needed. It has seven regulated current ranges from 1ma to 1amp and four regulated voltage ranges from 10v to 100v.

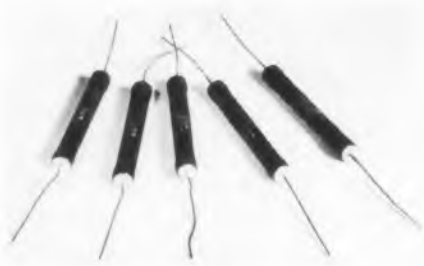
The instrument contains a high-gain vacuum-tube regulator circuit which keeps the output current or voltage constant, and which also maintains high output impedance (when used as a constant current supply) or low impedance (when used as a constant voltage supply).

The front panel meter indicates voltage or current output directly. Absolute accuracy is better than 0.25%. Precise setting to 0.1% is made by a 10-turn Helipot. Regulation is better than 0.1% for load changes from zero to full load and line voltage changes from 105v to 125v. Hum is below 0.05% of full scale on all ranges. Scientific Specialties Corp., Dept. ED, Brighton 35, Boston, Mass.

CIRCLE ED-222 ON READER-SERVICE CARD FOR MORE INFORMATION

5w Resistor

In Ratings to 60,000 Ohms



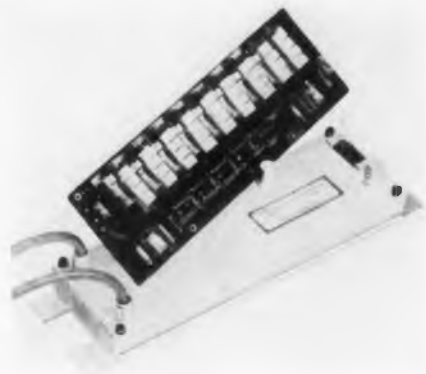
The LP-5 is a 5w glass resistor unit available in ratings from 200 ohms to 60,000 ohms and should be especially valuable for color TV. It is manufactured by having a metallic-oxide film permanently bonded by Pyrex brand glass rod.

Essentially non-inductive, the unit has a tolerance of ±10% with ±5% available at a slightly higher price. The power rating is based on 40°C ambient temperature and an average hot spot of 240°C. Permanent changes in resistance due to normal soldering techniques are less than 0.5%. Corning Glass Works, Corning, N. Y.

CIRCLE ED-223 ON READER-SERVICE CARD FOR MORE INFORMATION

Radar Amplifiers

Available in Miniature Sizes



Standard miniature lightweight I-F Radar Amplifiers incorporating low noise front ends are now being produced by this firm. New techniques, materials, and methods are employed to provide, for example, a 9-tube, completely enclosed amplifier that measures only 8-1/2" x 3" x 3/4" and weighs only 1 lb.

General specifications typical of these amplifiers are: center frequency 20 to 100Mc; bandwidth, 2 to 12Mc; gain, up to 120db; automatic and/or manual gain control 100db or greater; noise figures better than 2db; and ambient temperature operating range −65° to +100°C. The amplifiers will operate under 30G shock and 10G vibration for extended periods.

Standard circuits are available to provide for low impedance output, video detection, fast time constant, tuning detection, video amplification, video limiting, etc. Variations of standard circuits are available on special order. Government source inspection to military specifications is available. RS Electronics Corp., Dept. ED, 435 Portage Ave., Palo Alto, Calif.

CIRCLE ED-228 ON READER-SERVICE CARD FOR MORE INFORMATION

Coaxial Cable

With Low-Noise Characteristic

The "Glennite Blue Line" Coaxial Cable is designed to meet the need for an extremely low noise characteristic in a subminiature size cable for connecting electromechanical transducers. Developed particularly for use with transducers in the field of shock and vibration, it is extremely flexible and consequently not easily damaged mechanically. It has been treated to reduce self-noise generation to a minimum.

The cable has a low capacity of 38mmfd/ft and is usually equipped with a new subminiature coaxial screw type connector (Type C5-P). Overall diameter of the cable is only 0.017". This cable may also be used for r-f work, having a characteristic impedance of 40 ohms and an insulation strength of 1200v d-c. Gulton Mfg. Corp., Dept. ED, Metuchen, N. J.

CIRCLE ED-229 ON READER-SERVICE CARD FOR MORE INFORMATION

Two-Way Converter

With 0.05% Linearity

The Model 300 Precision A-C to D-C and D-C to A-C Converter has a linearity better than 0.05%, so that it can be used for direct conversion of unknown a-c voltages and currents to d-c for measurement to the precision of five-place, standard-cell-controlled potentiometers. D-c may also be changed to a-c, so that the linearity of a-c laboratory standards can be checked with only a battery and a good decade divider.

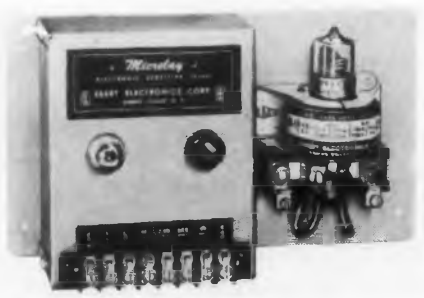
Other typical uses are calibration and linearity testing of resolvers and synchros, a-c instruments and controllers, and a-c output transducers such as pressure pickups. It can also be used as a high precision a-c reference with variable-phase output.

In operation, a variable-phase exciter drives a special temperature compensated synchronous chopper. The a-c and d-c voltages are electrically isolated, and both are isolated from the chassis ground. Quare Associates, Dept. ED, P. O. Box 95, Canton, Mass.

CIRCLE ED-232 ON READER-SERVICE CARD FOR MORE INFORMATION

High-Power Relay

Electronically Controlled



The "Micrelay" is designed for control of high-power, high-current loads up to 60amp or 3hp from very low-current, low-power devices or circuits. Typical activating devices are: photocells; thermostats and other thermal instruments; meter-type contacts; and circuits controlled by resistivity of fluids and capacitance of dielectrics.

The "Micrelay" is a simple, rugged, and compact electronically-controlled unit, completely a-c operated from 125/230v 60cy. It employs one commercial, rugged, long-life, Type 2D21 miniature thyratron tube, and also includes the Ebert Mercury Plunger Relay with 35amp or 60 amp contact rating at 115v a-c as required. Current amplification is (standard) 11,666,666 times, or (heavy duty) 20,000,000 times. Dimensions are 2-1/4" x 5" x 8-3/4". A variety of contact ratings is available. Ebert Electronics Corp., Dept. ED, 212 Jamaica Ave., Queens Village 28, N. Y.

CIRCLE ED-233 ON READER-SERVICE CARD FOR MORE INFORMATION

Voltage Ratio Comparator

Accurate to 0.01%

The Model 592 Standard Voltage Ratio Comparator is used for setting accurate voltage ratios, both a-c and d-c, by means of an accurately calibrated voltage divider network and a zero-center microammeter. It is capable of measuring ratios from 1:1 to 10,000:1 with an accuracy of 0.01% in an operating temperature range of −4° to +160°F.

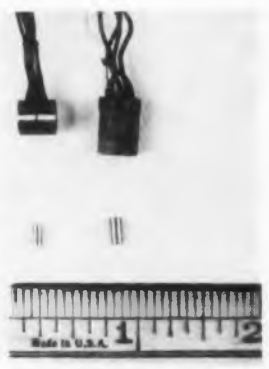
The unit compares voltage ratios in the range of +150v to −150v d-c; compares voltages across 120v a-c 350cy source; and can be supplied to compare a-c voltage ratios at any frequency. It has three sensitivity ranges, and polarity or phase selector switches.

This portable equipment is housed in a gray wrinkle-finish aluminum-alloy case, 18″ x 11″ x 11″ in size, and weighs 25 lb. Telectro Industries Corp., Dept. ED, 35-18 37th St., Long Island City 1, N. Y.

CIRCLE ED-238 ON READER-SERVICE CARD FOR MORE INFORMATION

Transducers

For Sensing Rectilinear Motions



"Lyn-A-Syn" Linear Motion Displacement Transducers, featuring minimum size and high sensitivity, are available in 32 models with linear displacement ranges from 0.003″ to 2″. They are highly accurate and sensitive inductive components for precise sensing of rectilinear motion.

Operation of these units is based on the linear change in flux linkage between the primary coil and secondary coils with displacement of the high-permeability metal core. Displacement of the core in either direction from the center null position causes a linear increase in output voltage.

Units are inductively and resistively balanced for minimum null signals. All models may be obtained magnetically shielded or wound for high-temperature operation. Units are available for power frequency or medium audio frequency operation, and at input voltages of 0.5v to 10v. Size ranges from 15/64″OD x 15/64″ long to 3/4″OD x 9-1/2″. Shown are a 0.005″ magnetically shielded unit (left) and a 0.010″ standard miniature model. Minatron Corp., Dept. ED, 1 Cliveden Pl., Belle Mead, N. J.

CIRCLE ED-239 ON READER-SERVICE CARD FOR MORE INFORMATION

Wire Thread Inserts

With Extra-Large Diameters

These wire thread inserts of extra-large pitch diameter and wire size provide strong, permanent threads in soft materials such as aluminum, magnesium, plastics, and wood, as well as in iron and steel. Inserts in standard stock sizes run from 4-40 up to 1-1/2-12, serving most applications. Special inserts have been formed up to 6-11/16″diam with 12 threads per inch.

The large diameter inserts can be formed of wire from 3/16″diam down to a minimum of 0.015″diam. N.C. and N.F. pipe threads, and other thread series can be formed. Inserts for left-hand threads can be formed, as well as for double, triple or quadruple lead threads.

Tolerances are held to 0.0002″, and surface finishes from 8-15μinch can be produced. Hardness up to Rockwell 50C can be obtained in 18-8 stainless steel which is the standard material used. Inserts can be formed of phosphor bronze, Hastelloy "C", music wire (0.75% C) and other metals. Heli-Coil Corp., Dept. ED, Danbury, Conn.

CIRCLE ED-242 ON READER-SERVICE CARD FOR MORE INFORMATION

Rotary Converter

For Analog-Digital Use

The Type 15 "Digitometer", an analog-digital rotary converter is offered with a shaft torque of only 0.15oz-in. It provides an accurate means of transposing rotary motion into an equivalent binary numerical notation.

Originally developed for the Air Force, the unit has unambiguous output using a reflected binary, or Gray Code, of 8 digits. It may be adjusted for clockwise or counterclockwise rotation with increasing code sequence. Special code disks are available.

The unit functions satisfactorily at vibrations up to 500cy at 7G. Accuracy of segment location is $\pm 0°$ —10′. It is of the direct-drive, gearless variety with a maximum recommended rotational speed of 650rpm. Size is 1.9″ long x 1.5″diam and, with a 0.125″diam shaft, weight is only 3 oz. All parts are of non-corrosive materials, or suitably protected. Electro-Mec Laboratory, Inc., Dept. ED, 21-09 43rd Ave., Long Island City 1, N. Y.

CIRCLE ED-243 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnetic Resolver

Provides Fast Response

The Series 1800 Magnetic Resolver provides an unusually rapid response to step function waves due to a specially processed high permeability steel core. A typical production test requirement is as follows: when checking null voltage output, the voltage decays to 2mv within 175μsec after switchover with a 13v 1000cy square wave at the primary.

The unit can be supplied with rotor and stator inductance values held within ±3% when desired. Minimum brush noise level makes it specially suited for driving circular sweep radar presentations. The resolver is also designed for other applications requiring exceptionally fast recovery time to a step function voltage wave.

The vector sum of the output voltages of the quadrature rotor windings is constant in amplitude within ±0.5% and at an electrical angle within 30′ of the resolver shaft. Bifilar or quadrature windings are available in the stator. Nominal input voltage is 26v 400cy with a transformation ratio of 0.29±5%. John Oster Manufacturing Co., Avionic Div., Dept. ED, Racine, Wis.

CIRCLE ED-248 ON READER-SERVICE CARD FOR MORE INFORMATION

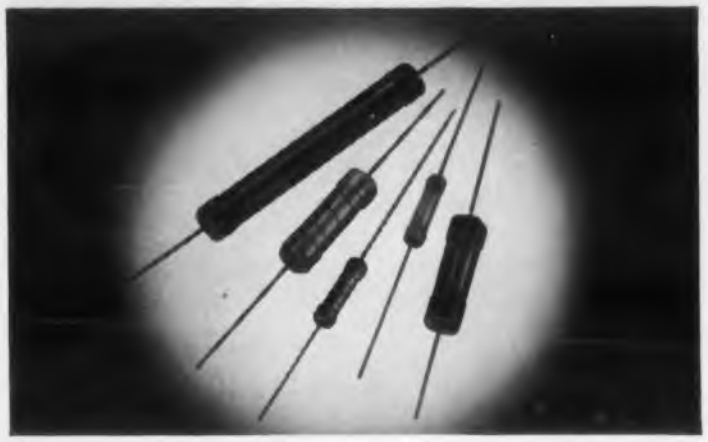
Frequency Standard

Short Time Accuracy of 1/1,000,000

This compact signal generator, the Model F5-1, acts as a secondary frequency standard with a short-time accuracy of one part per million. Generating twelve selected standard frequencies between 100kc and 20cy, the unit has a long-time accuracy for the stabilized characteristic 100kc standard crystal of 20 parts per million over normal room temperature ambient range.

Eleven sine wave frequencies, available at approximately 1 v level, selected by front-panel controls are: 20, 15, 10, 5, 3, and 1 kc; 400, 300, 100, 60, and 20cy. In addition, a constant 100kc signal may be used for reference to a primary standard or to WWV for precise correlation. All frequencies delivered have the same accuracy as the 100kc crystal. D & R, Ltd., Dept. ED, 402 E. Gutierrez St., P. O. Box 1500, Santa Barbara, Calif.

CIRCLE ED-249 ON READER-SERVICE CARD FOR MORE INFORMATION



Corning Type N Precision Resistors. Rugged. Stable. And Economical.

For critical accuracy, extreme stability...

Rugged Corning Type N Film-Type Resistors

When you need a precision resistor for really hard work, our Type N accurate grade is a likely job candidate.

We make it to a standard tolerance of 1% but we can tighten up if you wish. You can operate Type N's at ambient temperatures up to 140°C. with derating. Their noise level is so low, you'll have difficulty measuring it.

They have a negligible voltage coefficient averaging less than .001% per volt. You needn't worry about moisture because both core and film are absolutely impervious.

Stability means that the average change of resistance after 500 hours at maximum dissipation is less than 0.5%. A standard 5-second overload of 6.25 times rated power causes a permanent resistance change of less than .001%. Type N resistors have low capacitive and inductive reactance, too.

These accurate grade resistors overcome the inadequacies of conventional resistors in many advanced circuits. We recommend them to you for use in circuits where other resistors aren't up to the task or cost too much.

Specifically, you'll find these resistors most useful for radio and TV equipment, HF circuits, test equipment and low-signal, hi-gain amplifier stages. Their stability and ruggedness make special handling unnecessary. Made to MIL-R-10509A Specifications.

Fine as they are, Corning Type N Resistors cost remarkably little. For complete technical information and price lists, use the coupon.

Corning Type R High-Power Resistors—Range from 25 to 1,000,000 ohms, ratings from 7 to 115W, are non-inductive. Exceptionally good noise and frequency characteristics. Excellent moisture resistance and overload capacity recommend them for stable long-life service under adverse conditions. Meet MIL-R-11804A Specifications.

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New Products Division

Please send me descriptive catalog sheet on Corning Type N Film-Type Resistors.

Name.....
Title.....
Company.....
Address.....
City..... Zone..... State.....

CIRCLE ED-251 ON READER-SERVICE CARD FOR MORE INFORMATION

Four Digit Voltmeter

For High-Speed D-C Measurement

The Model 419 Digital Voltmeter is a self-balancing, digital potentiometer for measuring d-c voltages from 0.001v to 999.9v. Maximum error is less than 0.1% of the applied voltage. Resolution is 0.001v in low range. This instrument makes an average of 100 zero-to-full-scale readings per minute, with automatic indication of polarity and decimal position. Input resistance is in the order of 1000 megohms on the low range (up to 9.999v) and 11 megohms on the high range (100.0v to 999.9v).

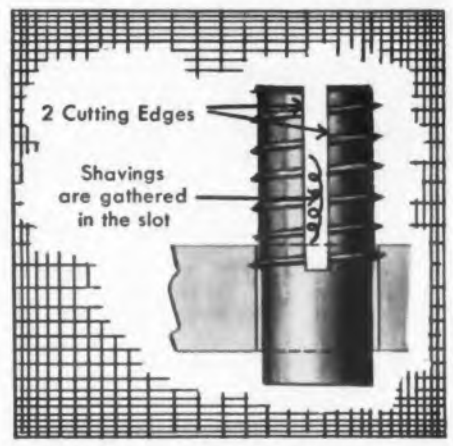
The measured voltages are displayed as a single, horizontal line of four illumined numerals and polarity sign 1" high, with the decimal point positioned automatically. Accessories are available for transmitting this information to remote readouts, as well as for printing, typing, or punching permanent records. An internal 1.018v direct current Weston Standard Cell is switched manually into the input circuit for calibration adjustment. No switching or adjusting is necessary during the process of making measurements.

Dimensions are 19" wide x 9" high for the standard instrument or 10-1/2" high if buffer relays for printing are required: depth is 14". Weight is 49lb for the standard unit. The instrument is designed for 115v, 60cy operation. Non-Linear Systems, Inc., Dept. ED, Del Mar Airport, Del Mar, Calif.

CIRCLE ED-252 ON READER-SERVICE CARD FOR MORE INFORMATION

Set Screws

Self-Tapping Units



These Self-Tapping Set Screws are offered in a full range of sizes down to as small as No. 2 x 3/32". In addition to being self-tapping, they are self-aligning and self-locking, yet easily removable when desired.

The cutting thread extends only around the top or slotted section and offers two cutting edges, which enables it to cut both sides of the hole; the shavings, instead of accumulating below, are gathered in the slot. The screw can be supplied with any type set screw point. Set Screw & Mfg. Co., Dept. ED, 265 Main St., Bartlett, Ill.

CIRCLE ED-253 ON READER-SERVICE CARD FOR MORE INFORMATION

Need a relay for AUTOMATION controls?

Whether it's for automation, traffic, elevator or instrument control, Ward Leonard's Bulletin 110 relays provide the millions of trouble-free operations required.

Our mechanical design, quality-controlled manufacturing methods and materials, and ample safety factors (both electrical and mechanical) insure this exceptionally long life.

Write today for Relay Bulletin 110. Ward Leonard Electric Co., 77 South St., Mount Vernon, N.Y. 4.11

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RHEOSTATS • RESISTORS • MOTOR CONTROLS • CHROMASTER

CIRCLE ED-254 ON READER-SERVICE CARD FOR MORE INFORMATION

New Complete Lab Coil Kit

Boon to "Designing" Engineers

THIS KIT TYPE X2060 answers a long-felt need among working design engineers and laboratory technicians.

Kit includes 10 coils on LS-6 ceramic coil forms, type C, all slug tuned with silicone fibreglas collars, all with necessary mounting hardware. They cover a range of from 2 Microhenries to 800 Microhenries, with slight overlap in each range in the scale.

Inside top cover has chart of listed coil data such as inductance range, wire size, number of turns, Q value, etc. Coils are color-coded for easy use or ordering. No design engineer or developer of prototypes or pilot models should be without this handy C.T.C. Coil Kit. Send for *your kit today* . . . only $7.95 F.O.B., Cambridge, net 30.

On any of your component problems, let C.T.C.'s consulting engineers help you, without charge. Just write Cambridge Thermionic Corporation, 457 Concord Avenue, Cambridge 38, Massachusetts.

CIRCLE ED-255 ON READER-SERVICE CARD FOR MORE INFORMATION

Slotted Line

Covers 300-5000Mc Range

Operating over the frequency range from below 300Mc to 5000Mc, the Type 874-LBA Slotted Line is a convenient and accurate instrument for measurements of impedance, standing-wave ratio, and attenuation. Measurements on dielectric materials, lumped components, coaxial elements, and networks, and antennas in the u-h-f range can be made.

The unit has an improved mechanism for driving the electrostatic pickup probe, a more constant probe coupling along the line (within ±1-1/2% along entire 50cm of travel), a sturdier supporting structure, negligible backlash, felt lubricating and cleaning washers, improved center conductor and probe support, and is adaptable for a motor drive. The Type 874-LV Micrometer Vernier Attachment also is available, as an accessory. General Radio Co., Dept. ED, 275 Massachusetts Ave., Cambridge 39, Mass.

CIRCLE ED-258 ON READER-SERVICE CARD FOR MORE INFORMATION

Have you returned your subscription renewal and qualification form?

See Page 96

Electromagnet

Produces Variety of Configurations

The V-4004 Laboratory Electromagnet embodies convenient features for varying magnetic field configurations. It has two fixed energizing coils with adjustable poles and readily changeable pole caps. A wide range of field contours can be set with ease. By a simple adjustment of each pole, any air gap width up to 4.3" can be achieved.

A variety of cylindrical, conical, or specially-shaped pole caps are available for wide choice of flux patterns. Despite the comparatively small size of this magnet, a gap field flux density as high as 28,600 gauss can be attained. Special Products Div., Varian Associates, Dept. ED, 611 Hansen Way, Palo Alto, Calif.

CIRCLE ED-259 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Resistors

Mounted Above Chassis

"Standee" or above - chassis - mounted power resistors have been simplified by the use of wire leads, when preferred to solder-lug terminals. These components feature a resistance element wound on a glass fiber core, which is inserted and sealed in a ceramic tube.

The resistors are mounted by ring brackets which can be fastened by use of rivets, screws, etc. They protrude above the chassis for maximum heat dissipation, while "hot" terminals (approved Underwriters' Laboratories requirement) are accessible below the chassis.

Resistors are available in 10, 15, 20, 25, and 30w ratings, and in resistance values up to 6000, 9000, 12,000, 15,000, and 20,000 ohms respectively. Intermediate taps can be provided, as well as a maximum of two resistance sections. Clarostat Mfg. Co., Inc., Dept. ED, Dover, N. H.

CIRCLE ED-262 ON READER-SERVICE CARD FOR MORE INFORMATION

Powder Cores

Of Molybdenum Permalloy

This firm is now manufacturing Molybdenum Permalloy Powder Cores under a license agreement with Western Electric Company. These cores are immediately available in a range of sizes covering most demands for unstabilized units.

The cores are suitable for use as filters in communications circuits. A few typical uses are: high Q applications, such as high, low, and band pass filters; and noise suppression filters at frequencies up to 1000Mc. Molybdenum permalloy was developed for loading coil purposes, and gives several major advantages in audio and carrier frequency ranges. Some of these are: low hysteresis and eddy current losses; high electric resistivity; constant permeability over widely varying flux densities; and magnetic stability under d-c magnetization. Magnetics, Inc., Dept. ED, Butler, Pa.

CIRCLE ED-263 ON READER-SERVICE CARD FOR MORE INFORMATION

Load Isolators

Operate up to 300kw

This series of "Uniline" Microwave Load Isolators is capable of operation at peak powers up to 300kw. The units provide substantial load isolation with very low vswr and negligible loss in transmitted microwave power. The greatly increased power ratings are made possible by a construction which lessens cooling by conduction.

Power "Unilines" utilize the resonant absorption properties of ferrites at microwave frequencies, the required transverse magnetic field being supplied by heavy-duty permanent magnets which are an integral part of the assembly. No external power supply is required.

Four new models are available: Model H16-17, 16 to 17kMc, 100kw peak, 100w average; Model H86-96, 8.6 to 9.6kMc, 150kw peak, 125w average; Model HL86-96, 8.6 to 9.6kMc, 300kw peak, 300w average; and Model H28-32, 2.8 to 3.2kMc, 150kw peak, 150w average. Cascade Research Corp., Dept. ED, 53 Victory Lane, Los Gatos, Calif.

CIRCLE ED-268 ON READER-SERVICE CARD FOR MORE INFORMATION

Potentiometer

Miniature Sine-Cosine Version

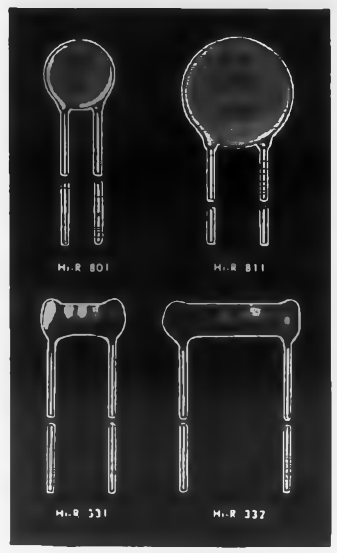
A miniature version of the conventional RL-11 and RL-14 sinusoidal potentiometers, this unit provides accurately and smoothly developed functions. Four brush contacts move circularly over a uniformly wound rectanglar card and pick off output voltages that are proportional to the sine and cosine of the input angle at speeds up to 60rpm. Standard resistance value is 16,000 ohms. Resistances from 4000 ohms to 25,000 ohms can be supplied. Accuracy at higher values is 1%. Power rating is 1w at 40°C.

The envelope is 1-1/16"diam x 1-7/16" long with standard servo mounting flange, 1/8" shaft in all bearings, and with six turret-type terminals on rear. The case is black anodized aluminum. The unit meets or exceeds applicable sections of MIL-E-5272A for high and low temperature and vibration. The Gamewell Co., Dept. ED, Newton Upper Falls 64, Mass.

CIRCLE ED-269 ON READER-SERVICE CARD FOR MORE INFORMATION

Capacitors

With 0.01% Failure Rate



This line of custom designed and manufactured "Hi - Reliability Ceramicons" has a failure rate approaching 1/100 of 1 per cent or 1 in 10,000. The line is for equipment where continuous uninterrupted operation is essential and includes such applications as guided missiles, military and civilian communications, computers, industrial controls and aviation and radar equipment. It includes temperature compensating and "Hi - K" types in both disk and tubular "Ceramicon" styles.

The capacitors are thoroughly tested to insure required reliability standards, including extreme low moisture resistance, maintained stability, low failure rate, and high temperature performance up to 125°C. An unusually wide variety of designs tailored to meet individual needs is available. Electronics Div., Erie Resistor Corp., Dept. ED, Erie, Pa.

CIRCLE ED-274 ON READER-SERVICE CARD FOR MORE INFORMATION

Have you returned your subscription renewal and qualification form?
See Page 96

Transmitting Pentode

Valuable for Mobile Uses

The PL-6549 Transmitting Type Pentode offers good performance even at low plate voltage, and requires very little driving power. As a Class C amplifier, it will deliver an output of 60w at 600v, 74w at 750v, and 110w at 1000v. Driving power is less than 3/4w, in each case. For higher-power use, an output of 250w at 2000v is obtained with only 0.8w drive.

The tube is an aligned-grid pentode, conservatively rated at 75w plate dissipation. Its quick-heating, 6v thoriated tungsten filament, combined with rugged construction, make it ideal for mobile applications. The suppressor grid of the tube gives excellent current-division characteristics; thus screen power requirements are very low. Penta Laboratories, Inc., Dept. ED, Santa Barbara, Calif.

CIRCLE ED-275 ON READER-SERVICE CARD FOR MORE INFORMATION

L-Band Wavemeter

Gives ±0.02% Accuracy

The Model 228 "L" Band Wavemeter, a coaxial line instrument, covers the freqency range from 900Mc to 2400Mc by transmission. The instrument features: high frequency stability through the temperature range ±10° to ±40°C; extreme mechanical stability; high accuracy of measurement (±0.02%); tri-plating of all surfaces; and rugged electrical components for long life. The unit has a sloping panel for easy observation, with a direct-reading frequency control dial. A counter-to-frequency graph is provided for extremely accurate readings.

Specifications include: Type "N" constant-impedance input connectors; BNC or u-h-f coaxial fitting for external video connection; power handling capability 1mw to 1w (transmission); peak power of 25w (transmission); approximate loaded Q of 1000; and dimensions of 15" x 9-3/4" x 7-3/4" high. Weight is 13-1/2lb. The cabinet is made of walnut, with a gold-anodized aluminum panel. Amerac, Inc., Dept. ED, 116 Topsfield Rd., Wenham, Mass.

CIRCLE ED-276 ON READER-SERVICE CARD FOR MORE INFORMATION

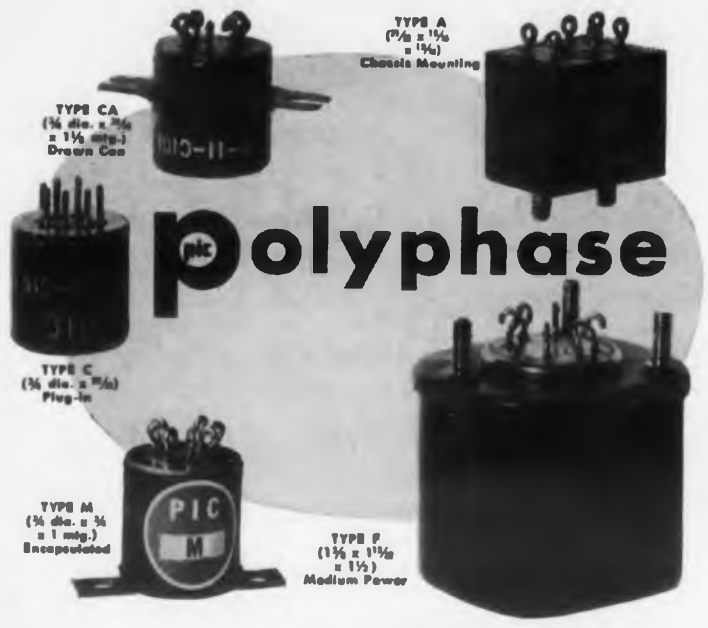
Potentiometer

With ±0.05% Linearity

The "Linpot" precision wire-wound linear-motion potentiometer is designed for recording and control instrumentation, and its primary function is to translate accurately mechanical position into an electrical signal. The unit has a zero-based linearity of ±0.05% with only a 4" stroke (shaft displacement). This is attained with a total resistance of 10,000 ohms.

Other features include: operating force only of 1 oz, making the unit ideally suited for use in servo systems; a high resolution factor of less than 0.001"; multiple windings: 1, 2, 3, or 4 within one case; individual phasing of windings ±3/16"; a resistance range of 500 ohms to 50,000 ohms; free shaft rotation; and a life rating of 1,000,000 cy. Benson-Lehner Corp., Dept. ED, 2340 Sawtelle Blvd., Los Angeles, Calif.

CIRCLE ED-277 ON READER-SERVICE CARD FOR MORE INFORMATION



polyphase

FERRITE PULSE TRANSFORMERS

- **WITH**—short rise time and flat top pulses.
- **FOR**—blocking oscillator, impedance matching, or isolation applications.
- **AT**—low or medium average power.
- **IN**—plug-in or chassis mounting, hermetically sealed or encapsulated units.

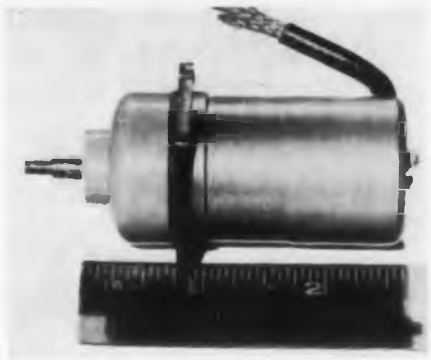
MIL-T-27 or COMMERCIAL

POLYPHASE INSTRUMENT CO.
BRYN MAWR, PENNSYLVANIA

CIRCLE ED-281 ON READER-SERVICE CARD FOR MORE INFORMATION

Permanent Magnet Motor

With or Without Gear Reducers



This Miniature Permanent Magnet Motor, when equipped with a new type gear train that reduces as high as 1600:1, can replace motors several times its size. It is used in high-speed aircraft and guided missiles.

Available in six different models with or without gear-reduction units, the motor operates with a smaller air gap than is customary, without any deterioration of commutation and without increasing the loss in field shoes, due to specially shaped and laminated field shoes. Longer life and better motor performance is assured by mica insulated commutators.

The motor, weighing only 3-3/4oz and 2″ in overall length, is so designed that modifications of speed, torque, and other performance characteristics can be made to make it available at moderate cost. Airquipment Co., Inc., Dept. ED, 2248 E. 37th St., Los Angeles, Calif.

CIRCLE ED-283 ON READER-SERVICE CARD FOR MORE INFORMATION

Tube Clamps

Improve Heat Dissipation

These "Kool-Klamps" feature a slotted construction which improves heat-transmitting properties, simplifies tube insertion, and reduces tube breakage. They are made with multiple "fingers" which compensate for tube irregularities and eliminate air spaces and destructive "pressure points" between tube and shield.

The "fingers" are designed to contact specific areas of the tube more intimately than can be achieved with the solid shield, providing more surface area to collect heat from the tube. Stress encountered in inserting the tube is distributed over several fingers progressively, instead of all at once, as in a solid clamp, reducing breakage.

The clamps are made of heat-treated silver alloy in a variety of sizes for miniature and subminiature tubes as well as in berylium copper No. 25. Industrial Div., The Birtcher Corp., Dept. ED, 4371 Valley Blvd., Los Angeles 32, Calif.

CIRCLE ED-284 ON READER-SERVICE CARD FOR MORE INFORMATION

GUIDE TO
VOLTAGE
SPEED
CURRENT
SERVO
CONTROL

ON REQUEST

This new 12-page illustrated bulletin describes the wide variety of control situations to which the REGOHM electro-mechanical controller is adaptable.

Learn how REGOHM will provide sensitivity, speed of response and system stabilization under severe operating conditions in your control system.

Circuit diagrams illustrating the many applications of this versatile, automatic controller, are given.

Text and illustrations describe the functions, design advantages, operation and control characteristics of this small size, lightweight, plug-in device.

Write for Bulletin 505.00. Address Dept. G, Electric Regulator Corporation, Norwalk, Conn.

REGOHM

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Electronics Division

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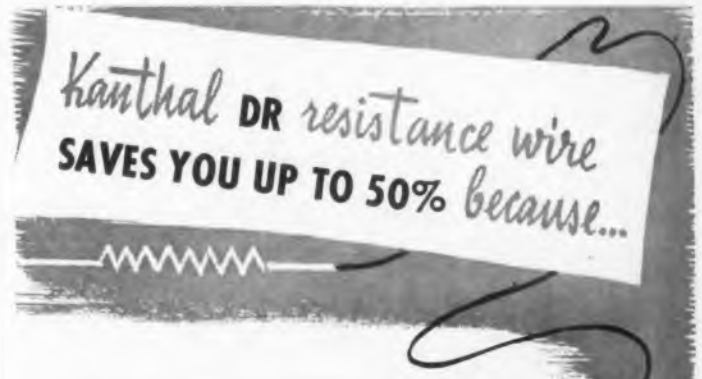

. . . it is lighter in weight (more feet per pound), and the per pound price is low. Total savings approximately 50%.

. . . Kanthal DR improves the performance of resistors and precision equipment. Its electrical resistivity is high — 812 ohms per circular mil foot — its temperature coefficient is low (±.00002°C between −50° and +150°C), and it has a low thermal EMF to copper.

Available in fine gages and all types of insulation.

WRITE FOR FURTHER INFORMATION AND PRICES TODAY

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8 AMELIA PLACE, STAMFORD, CONN.

CIRCLE ED-286 ON READER-SERVICE CARD FOR MORE INFORMATION

Capacitors

Easily Mounted on Wiring Boards

"Push-Lok" 28D dry electrolytic capacitors have a mounting design which makes assembly-line connection in printed wiring boards easier, faster, and fool-proof. They are mounted merely by inserting their connecting lugs into the slots. Strong spring action of the lugs can hold relatively heavy capacitors in place securely until the chassis is ready for dip soldering, even when the board is carried sideways or upside-down on a conveyor.

Lugs are positioned so that the capacitor can only be mounted properly, and a wide terminal on the mounting ring permits easy indexing. Shoulders on the lugs keep the capacitor clear of the chassis, permitting wiring boards to be printed on both sides. Yet, because of a circular shield, tools cannot be easily inserted between the bottom of the capacitor and the chassis. Sprague Electric Co., Dept. ED, 347 Marshall St., North Adams, Mass.

CIRCLE ED-289 ON READER-SERVICE CARD FOR MORE INFORMATION

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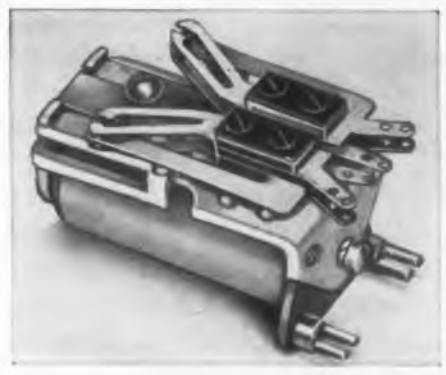
Relays

For Low Voltages, Currents



Series 22 Relays have bifurcated (twin) contacts for reliable switching of extremely low voltage and low current. Flexibility of the long bifurcated contact springs enables the twin points to make contact independently, thus permitting one point to make contact, even when the other is blocked by dust or grit.

Bifurcated contacts are available for a-c or d-c in open types, as well as with a wide selection of hermetically sealed and dust-tight enclosures. Magnecraft Electric Co., Dept. ED, Chicago 7, Ill.

CIRCLE ED-290 ON READER-SERVICE CARD FOR MORE INFORMATION

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FASTER, MORE ACCURATE INSPECTION WITH

FLASH-O-LENS Illuminated Magnifiers

In industrial inspection departments, on production lines, in foundries and laboratories, wherever close visual inspection is important, FLASH-O-LENS gets the job done better, faster. FLASH-O-LENS spots minute defects by spotlighting the area it magnifies.

Battery models, powered by standard flashlight cells, and AC-DC plug-in models are available with 5, 7, 20 or 40 power precision lenses to meet a wide range of inspection needs. Prices start from $10.95.

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E. W. PIKE & COMPANY, Inc.
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CIRCLE ED-299 ON READER-SERVICE CARD FOR MORE INFORMATION

NEWLY-DEVELOPED Sub Miniature Type 10 H-SERIES

hermetically sealed resistors

The "H" Series Precision Resistors are encapsulated in a tough plastic compound. The result is a solid, homogeneous unit with unparalleled ruggedness, **impervious to the effects of moisture, thermal shock and mechanical shock.** The plastic is filled with heat conducting mineral which dissipates the heat and equalizes the "hot spots" in the resistor winding. The sealed-in terminal connections are welded.

SPECIFICATIONS:

MILITARY SPECIFICATIONS: Performance characteristics satisfy all requirements of MIL-R-93A & JAN-R-93.
TEMPERATURE COEFFICIENT: ±0.0022% per degree C.
OPERATING TEMPERATURE: −65°C. to +125°C.
RESISTANCE ACCURACY: Standard resistance tolerances are 1%, 0.5%, 0.25% and 0.1%.
TYPE 10 (illustrated): ¼" dia. x ½" long. Resistance range: 1.0 ohm −0.35 meg.

Send for Bulletin H for complete description on other physical sizes and wattage ranges.

HYCOR Company, Inc.
11423 VANOWEN ST., N. HOLLYWOOD 4, CALIF.
Subsidiary of International Resistance Company

CIRCLE ED-300 ON READER-SERVICE CARD FOR MORE INFORMATION

Delay Line

With Drifts Less Than ±0.15%

The Model No. DL0390 - 200LTC Ultra Stable Delay Line has a maximum overall delay drift of less than ±0.15% over a temperature range of −65° to +125°C and under all combinations of aging and environmental conditions. Originally developed to withstand the severe requirements of guided missile flight, it has found wide application in pulse encoders and decoders.

The unit is a 100-section lumped-constant line with an overall delay of 200μsec, tapped every 2μsec, and has a rise time of 6μsec. Characteristic impedance is 390 ohms; d-c attenuation is 0.12db per section; pulse attenuation is 0.14db per section; and package size is 7-1/4" x 4-5/8" x 1-1/2".

Lines having the same stable characteristics can be supplied in a variety of impedance levels, delays, and package forms. Epsco, Inc., Dept. ED, 588 Commonwealth Ave., Boston 15, Mass.

CIRCLE ED-301 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Supply

Encapsulated 30w Unit

This Encapsulated High Voltage Power Supply is designed for aircraft installations meeting the requirements of MIL-E-5400. It operates from a 115v 400cy source, and delivers 5.1kv at 7.5ma as well as 6.3v a-c at 1.5amp and 6.3v a-c at 0.5amp.

The unit's high voltage transformer, full-wave bridge selenium rectifiers, filter capacitor, and bleeder resistors are all encapsulated in one easy-to-install package. The encapsulating techniques used reduce size and weight and eliminate the hazards of corona, especially at high altitudes. A special feature is a fin construction which assures a minimum temperature rise due to internal heating effects.

The supply will operate over the range of −62° to +85°C with good regulation. It measures 4" x 4" x 6" and weighs less than 6-1/2 lb. Telectro Industries Corp., Dept. ED, 35-18 37th St., Long Island City 1, N. Y.

CIRCLE ED-302 ON READER-SERVICE CARD FOR MORE INFORMATION

New Microwave Silicon Diodes

Microwave Associates, Inc. announces the development of several new silicon diodes of use to the designer of microwave receivers. The MA-400 is a small cartridge type diode designed for mixer operation in RG-91/U waveguide in the region of 13,000 mcs. In the MA-574 holder, a performance of better than 6 db conversion loss, 2.0 times noise temperature ratio, and a RF match of better than 1.5 to 1 can be expected. In addition, this diode is ruggedized to operate under conditions of shock and vibration.

Two cartridge type video detectors identical in size to the 1N23C have been developed for operation at X-Band. Both units require 50 microamperes of positive bias and under these conditions the MA-408 has a figure of merit of better than 130 and the MA-408-A better than 160. This gives 2 and 3 db improvement respectively over limit 1N23C diodes used as video detectors! In addition, both units have relatively low video impedances between 1700-3100 ohms which do not degrade short pulses as do higher impedance types.

For further information, contact D. W. Atchley, Jr., Sales Dept., Microwave Associates, Inc., 22 Cummington Street, Boston 16, Massachusetts. Phone, COpley 7-7577.

μA MICROWAVE Associates INCORPORATED

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NEW VECTRON
VFS 250
Variable Frequency Power Supply

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Airborne Electrical Systems
Servo Amplifiers and Equipment
Synchro and Selsyn Systems
Transformers and Inductors
Export and Foreign Equipment

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FOR CONTROLLING
Synchronous Motors
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- **Full negative feedback networks for instantaneous voltage control.**
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- **Grounded output with polarized receptacle for maximum safety.**
- **Compact, semi-portable package for bench use.**

Output Power at 100 to 130 V	250VA continuous, 300VA intermittent
Output Frequency	45-2,000 cycles
Output Voltage	0-130 Volts
Output Regulation zero to full load	± 1% to 1,000 cycles, ± 2% to 2,000 cycles
Line Regulation at 250VA	± 1% maximum change for 105-125V input

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Computing with
Servo-Driven Potentiometers

BY F. R. BRADLEY & R. D. MC COY
Reeves Instrument Corp.

Reprinted from TELE-TECH & ELECTRONIC INDUSTRIES

385

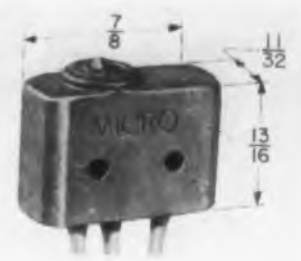
Helipot *first in precision potentiometers*

Helipot Corporation / South Pasadena, California
a division of BECKMAN INSTRUMENTS, INC.

CIRCLE ED-305 ON READER-SERVICE CARD FOR MORE INFORMATION

Miniature Switch

Fully Sealed Snap-Action



The "ISEI", a complete-sealed subminiature snap-action switch, is designed for mobile, marine, aircraft, and other applications where small size, light-weight and environmental-proof construction are required. The unit gives trouble-free operation in temperatures ranging from −65° to +180°F.

Complete sealing is accomplished with a silicone rubber plunger seal, bonded both to the pin plunger and the metal housing, and by embedment in an epoxy casting resin inside the housing. The exterior is corrosion-resistant treated aluminum. The switch incorporates the "Micro Switch" long-life snap-acting spring principle.

Tentative electrical rating is: 30v d-c, 2.5amp inductive, 4amp resistive. Maximum inrush is 15amp. The case measures only 7/8" x 21/64" x 11/32". Operating characteristics are: operating force, 5-17oz; release force, 4oz minimum; differential travel 0.004" max; overtravel, 0.003" minimum. Contact arrangement is spdt. Spst normally closed and normally-open variations are also available. Micro Switch, Dept. ED, Freeport, Ill.

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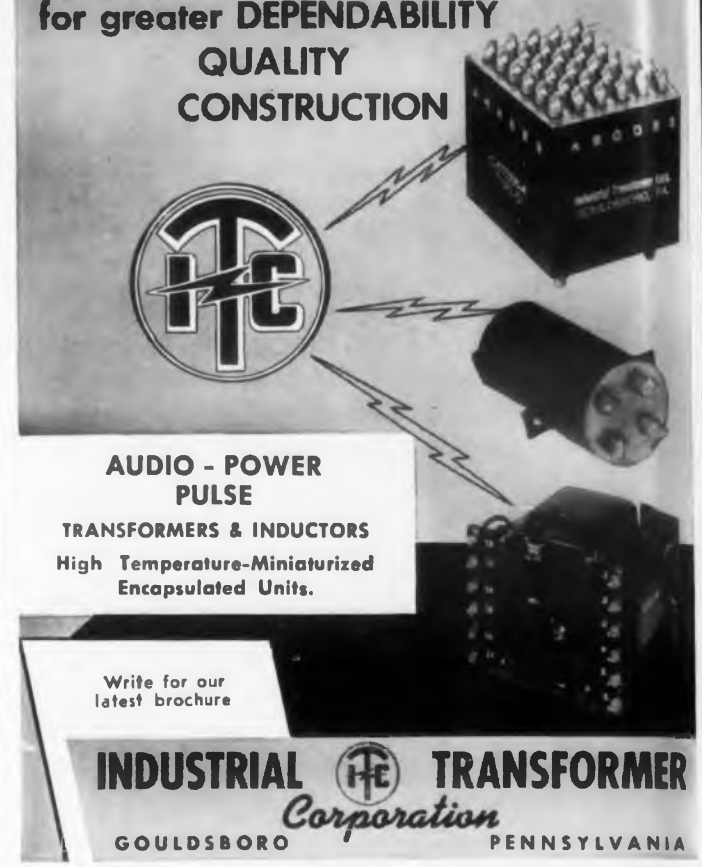
TRANSFORMERS
for greater DEPENDABILITY
QUALITY
CONSTRUCTION



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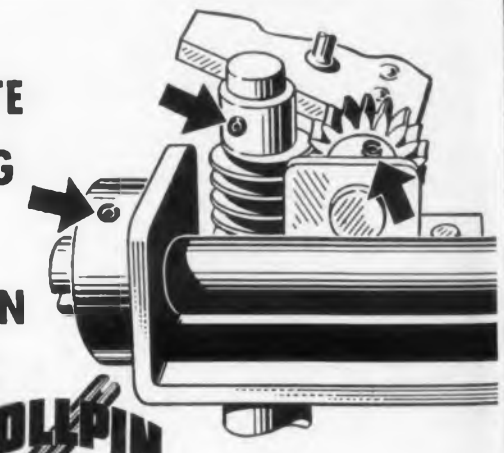
CIRCLE ED-308 ON READER-SERVICE CARD FOR MORE INFORMATION

FAST, ACCURATE PINNING OF PRECISION SHAFTS WITH ROLLPIN TRADEMARK



Rollpin speeds production alignment of close tolerance shafts. The slotted, hollow steel spring pin, with chamfered ends, is simply pressed or driven into holes drilled to normal production tolerances. It compresses as driven, is self-locking and vibration-proof. Rollpin is light, easily removable, reusable and has a shear strength greater than a solid pin of the same diameter. Diameters from 1/16" to 1/2".

Rollpin, in place of rivets, set screws, dowels and stop pins can cut production costs as much as 90%. For detailed information on any electronic fastening problem, write: Elastic Stop Nut Corporation of America, 2330 Vauxhall Road, Union, New Jersey. Address Dept. R26-457.

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2330 Vauxhall Road, Union, N. J.

DESIGN HEADQUARTERS FOR SELF-LOCKING FASTENERS

CIRCLE ED-310 ON READER-SERVICE CARD FOR MORE INFORMATION

Coaxial Switch

Permits Remote Control of 4 Circuits

This miniature broad-band r-f coaxial switch permits switching of four circuits by remote control. Only 12 oz in weight, it occupies only 3" x 3-1/2" x 2-1/2" space, thus providing designers wide latitude. Performance is excellent for frequencies up through the X-band.

A sp4t unit has an actuator power rating of 18-30v d-c at 0.18amp max per coil. Ambient operating temperature range is −65° to +225°F. Actuating time is 10 millisec. Life duration is 500,000 operations minimum. The unit is designed to meet MIL-E-5272 specs. Transco Products, Inc., Dept. ED, 12210 Nebraska Ave., Los Angeles 25, Calif.

CIRCLE ED-313 ON READER-SERVICE CARD FOR MORE INFORMATION

Have you returned your subscription renewal and qualification form?

See Page 96

New Literature...

Piston Capacitors 319

Four specifications sheets provide accurate physical and electrical measurements, capacitance range charts and graphs, and schematic drawings of variable trimmer piston capacitors. These capacitors are stable, have a high dielectric strength, wide operating temperature range, zero temperature coefficients, no tuning backlash, and are free from microphonics. JFD Mfg. Co., Inc., 601 16th Ave., Brooklyn 4, N. Y.

Switches, Relays 320

This 32-page catalog describes precision snap-action basic switches with actuators; snap action rotary switches; miniature, midget, heavy-duty, industrial type relays; continuous rotation, electrical reset, add-subtract steppers; solenoids, and multiple control units. Emphasis is placed upon hermetic sealed switches and controls. Suggested applications are included. Sealectric Switch and Relay Div., Williams Mfg. Co., 4200 W. Fillmore St., Chicago 24, Ill.

Internal Brake Motor 321

Details on a small 28v d-c motor recommended for continuous duty applications requiring high torque and good speed regulation together with a built-in magnetic brake are given in leaflet Form No. PM4-954. Besides illustrating the unit, the publication shows dimensional outline drawings and full standard application specifications. A performance chart gives the relationship between torque output and input amperes, speed, output watts, and percent efficiency. Dalmotor Co., 1326 Clay St., Santa Clara, Calif.

Solenoid Contactors 322

This 8-page Bulletin (No. SC-9) features a wide range of enclosed and sealed solenoid contactors with power ranges up to 250amp. Fully illustrated, the bulletin includes dimensional drawings and complete technical data. It also provides military specification numbers, type number, and specific approval information. Guardian Electric Manufacturing Co., 1621 W. Walnut St., Chicago 12, Ill.

Electronic Components 323

Electronic components for use in industrial electronics, TV and radio servicing are illustrated and described in Catalog No. 29. Detailed information is provided on volume controls, switches, capacitors, printed electronic circuits, and steatite insulators. A price list is included. Centralab, Div. of Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

Contract Production Facilities 324

An illustrated 4-page folder describes this firm's facilities available for producing precision parts on contract basis either rough castings, or fully machined, heat-treated parts incorporated into assemblies. The text explains the operations that can be performed, from the gray iron and non-ferrous foundries and pattern shops, through tool making, machining, and heat-treating. Equipment roster of the machine shops is included. Watertown Div., New York Air Brake Co., Starbuck Ave., Watertown, N. Y.

Scientific Developments 325

Products of the latest developments in materials research, electronic equipment, precision instruments, and systems engineering are described in an 8-page brochure. Products include accelerometers, cathode followers, filters, amplifiers, delay lines, piezoelectric transducers, low noise cable, subminiature connectors, ultrasonic generators, capacitors, subminiature resistors, nonlinear dielectrics, memory units, and all types of electro-ceramic thermistors. Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J.

Vibration Isolators 326

An 8-page fully illustrated bulletin gives complete information on construction details, load ranges, application, and vibration characteristics of series M24 miniature All-Metl vibration isolators. Performance curves are included with data on transmissability, performances at extreme temperatures, and performance after shock. Barry Corp., 1000 Pleasant St., Watertown, Mass.

Resistance Units 329

Data sheet No. 54-86 describes precision variable resistance units which have practically instantaneous setting features. Designed for use as potentiometers or rheostats in experimental circuits, series T-10-A laboratory models are described and illustrated in detail, including specifications and characteristics of coils. Technical Information Service, Helipot Corp., 916 Meridian Ave., S. Pasadena, Calif.

Re-Usable Containers 330

A 16-page bulletin, "Re-Usable Containers and Special Products", describes the advantages of this method of packaging, storing, and shipping industrial materials. The booklet points out how the lightness and compactness of scientific design, can be combined with re-usability to reduce weight and save space. Peters-Dalton, Inc., 17900 Ryan Rd., Detroit 12, Mich.

Millivoltmeter Controllers 331

Bulletin No. 1060 describes the latest addition to the line of Brown millivolt-meters. This controller introduces a new three-zone control form that is adjustable from 0 to 100% or from 0 to 10% of full scale, as desired. The bulletin also gives complete specifications, descriptive list of control forms, drilling dimensions, and ordering information. Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne & Windrim Aves., Philadelphia 44, Pa.

Job Directory

Engineers Job Directory, a new annual publication, is directed specifically to help the young engineer research the better job market. The 129 participating companies cooperated in giving information about their company, products, number of employees, and whom to contact. The index section indicates the types of engineers wanted by the companies and also the plant, sales, and research laboratory locations by cities and states. $2.25. Decision, Inc., 105 E. Fourth St., Cincinnati 2, Ohio.

Microwave-Radio Systems 332

A complete description of 2000Mc microwave-radio systems for a variety of applications is given in an 8-page booklet. Features of type FR microwave radio and type FJ multiplexing equipment and their importance to the overall system are discussed. Points covered include frequency-division multiplexing, crystal frequency control, standby equipment, maintenance features, etc. Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.

CIRCLE ED-334 ON READER-SERVICE CARD FOR MORE INFORMATION

Germanium Rectifiers 335

"Presenting Germanium Rectifiers" describes new rectifiers designed to offer 95% efficiency at full load and to outlive conventional types of d-c power supplies. Typical efficiency and voltage stabilization curves are shown. Rapid Electric Co., 2881 Middletown Rd., Bronx 61, N. Y.

Slide Rule Catalog 336

Catalog No. 164-A illustrates and describes various types of slide rules. Among the varieties listed are dual base log log slide rules, modern and traditional log log slide rules, and trigonometric and special purpose slide rules. Pickett & Eckel, Inc., 5 S. Wabash Ave., Chicago, Ill.

Coupling 337

A catalog and data sheets describe and illustrate flexible couplings. Dimensional drawings and performance curves are provided. Naugler Engineering, 153 Cabot St., Beverly, Mass.

Closures and Stampings 338

This index lists engineering and business data sheets available from this company. Among the subjects covered are electrical engineering, chemistry, physics, mathematics, and communications. Lefax, Sheridan Bldg., 9th & Sanson Sts., Philadelphia 7, Pa.

Transformers 339

A 12-page catalog describes and illustrates various types of transformers made by this firm. Charts show operating characteristics. Microtran Co., 84-11 Boulevard, Rockaway Beach, N. Y.

Technical Data Index 340

A new catalog gives detailed information on the precision drawn closures and quality metal stampings made by this firm. Various components are illustrated and dimensional drawings provided. Hudson Tool & Die Co., Inc., 118-122 S. 14th St., Newark 7, N. J.

Industrial Catalog 342

Among the items listed in this catalog are a wireless inter-communication system and plastic drawer cabinets which may be used for storing electronic components. General Industrial Co., 5725 N. Elston, Chicago 30, Ill.

Duplicating Process 343

This bulletin gives complete information on the "Hectograph" duplicating process, including supplies needed, method of preparation, and operation of the duplicator. Columbia Ribbon & Carbon Mfg. Co., Inc., Glen Cove, N. Y.

Metal Housings 344

Catalog No. 550 describes various types of precision built metal housings. Enclosed relay racks, multiple rack units, transmitter racks, chassis mounting brackets, blank chassis, and meter panels are among the articles listed. Premier Metal Products Co., 3160 Webster Ave., New York 67, N. Y.

Spectrophotometer Recorder 345

A 20-page booklet describes the Spectracord, an instrument for automatic spectrophotometric recording. Circuit diagrams illustrate operating principles and graphs show performance characteristics. Warren Electronics, Inc., Bound Brook, N. J.

American Standards 346

The 1955 edition of American Standards lists and indexes about 1500 American standards. There are 272 electrical, 210 construction and civil engineering, 153 mechanical, 158 safety. American Standards Assn., 70 E. 45th St., New York 17, N. Y.

Engineered Ceramics 347

This technical bulletin gives electrical, thermal, and physical properties of ceramics for use as electronic components, tube socket bases, etc. Charts show material specifications, and recommended uses. Centralab, Div. of Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

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Heavy Duty Motors 351

Bulletin No. F3959-2 describes the features and performance characteristics of heavy duty type YAR motors. Standard motors can be supplied with either high-starting torque or high-running torque rotors in four stack thicknesses. Ratings are available up to 1/20hp at 3000rpm. Small Motors Div., Barber-Colman Co., 1200 Rock St., Rockford, Ill.

Casting Compounds 352

Starting formulations and resultant properties of liquid polymer/epoxy resin casting compounds are described in a 12-page booklet. Casting compounds of this type cure at room temperature and are suitable for electrical and electronic potting, plastic tooling, and many other casting applications. Thickol Chemical Corp., 780 N. Clinton Ave., Trenton, N. J.

Cable Catalog 353

This 6-page, 2-color brochure describes and illustrates this company's line of wires and cables. Among the types included are appliance, hook-up, apparatus, annunciator, telephone, antenna loop, and high-frequency lead wires and coaxial, rotor, phonograph, and audio cable. Chester Cable Corp., Chester, N. Y.

Silicone Rubber Gum 354

A 32-page technical data manual, presents many data on fillers, vulcanizing agents and additives, and methods of compounding with "400" gum. The gum is a stable, uniform polymer which permits compounding silicone rubbers to meet particular requirements. Dow Corning Corp., Midland, Mich.

Precision Tools 355

This 20-page catalog presents an extended line of extreme-tolerance gage block sets, sine bars, tri-squares, and accessory sets. Each set is illustrated and described, with its various parts listed. A section is devoted to discussion of materials used, uses of the sets, effects of temperature, and other pertinent subjects. Jansson Gage Co., 13550 Auburn Ave., Detroit 39, Mich.

Rectifiers and Diodes 356

Catalog data bulletin No. SR-1A is an 8-page, 2-color publication on selenium rectifiers and selenium diodes. Comprehensive data on construction, applications, types, and ratings are provided, as well as reference curves, specifications, d-c characteristics, and dimensional diagrams. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

Research Facilities 357

An 8-page, 2-color brochure illustrates, describes, and lists the facilities of this firm's three divisions for research, electronics, and machinery, respectively. The services available from the divisions are detailed, and numerous illustrations of products that have stemmed from the firm are included. Kell-Strom Tool Co., Inc., Wethersfield, Conn.

Tungsten 358

This 20-page brochure is devoted to the manufacturing properties and uses of tungsten. Of special interest is a colorful flow chart which makes up the center spread. The chart follows the manufacture of tungsten from ore to finished product. Also included is a resistance-temperature chart. Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y.

Relays 359

Detailed descriptions on a complete line of industrial relays, plug-mounted for advantages in assembly, inspection, servicing, and maintenance, are provided in five 2-page, 2-color data sheets (Circulars No. 1801-1805). Dimensional drawings, wiring diagrams, and specifications are provided for plug-mounted Classes A, B, F, S, and Z relays. Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago 7, Ill.

Catalog Additions 360

Data sheets on type 4-125A radial beam power tetrodes and heat dissipating connectors are additions to this firm's catalog. Complete operating data and requirements are provided through charts and graphs. Eitel-McCullough, Inc., San Bruno, Calif.

Buyer's Guide 362

The 1955 edition of the Instrument Transformer Buyer's Guide contains basic, up-to-date information on this company's line. The fully illustrated, 100-page publication contains ratings, ASA accuracy classifications, and prices of all standard indoor and outdoor potential and current transformers. Listings of ratio and phase-angle tests, tables of replacement types, and mechanical and thermal data are included. General Electric Co., Schenectady 5, N. Y.

Electron Microscope 363

This 6-page folder describes this company's 75kv electron microscope. It explains the electron-optical system, filament replacement, lens system and viewing screen, specimen holder and airlock, 35mm roll-film carrier, vacuum system, power supply and operation. The bulletin is illustrated with photographs and diagrams. Research & Control Instruments Div., North American Phillips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y.

Synchronous Motors 364

An 8-page illustrated brochure describes this firm's type 112 synchronous motor. The motor runs only at synchronous speed and stops instantly upon removal of power. Dimensional drawings, operating requirements and characteristics, speed ranges, and motor shaft sizes and styles are included. R. W. Cramer Co., Box 22, Centerbrook, Conn.

Chains and Sprockets 365

An 8-page, 2-color catalog on "Miniature Mechanical Chain and Sprockets" provides complete engineering data and accessory information on a wide range of items. The products permit accurate positive control and precise motion transfer through several planes without complicated gearing. Sierra Engineering Co., 123 E. Montecito Ave., Sierra Madre, Calif.

Regulated Power Supplies 366

An 8-page catalog describes "A Sensible Approach to Regulated Power Supply Design." By standardization most conventional power supply applications into single and multiple variations of 8 basic ranges, arising ut of 2 basic circuit designs, selection of the most flexible and least expensive supply to suit a given requirement is easily done. Sixty-four variations of single and dual supplies are described. A full technical description is given for each supply including electrical, mechanical, and constructional specifications. New Jersey Electronics Corp., 345 Carnegie Ave., Kenilworth, N. J.

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electronics engineer
kept worrying
'bout gains non-linear.

Unmeasurable
phase angles
kept him in tangles
And threatened to
wreck his career . . .

Tsk, tsk—too bad he didn't know about

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CIRCLE ED-367 ON READER-SERVICE CARD FOR MORE INFORMATION

Hook-Up Wire 370

Complete information on a line of hook-up wires and electronic cables is furnished in bulletin No. TR-5. Commercial type hook-up wires, high temperature, "Synthinol", "Synthinol 901", and multiple conductor cables are described and illustrated. Rome Cable Corp., 332-400 Ridge St., Rome, N. Y.

Rolling Mills 371

A complete line of laboratory and production rolling mills, rotary gang slitters, levelers, and secondary equipment is shown in this 4-page, 2-color brochure. This precision equipment has all of the rugged features of much larger machinery and is suited to both research and regular production. Stanat Mfg. Co., 47-28 37th St., Long Island City 1, N. Y.

Line-Voltage Regulator 372

Type 1570-A automatic line-voltage regulator is useful wherever it is desirable to keep the line voltage constant. The 4-page bulletin contains oscillograms, functional diagrams, and specifications chart. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Delay Lines 373

New Helidel delay lines are covered in data sheet No. 54-81. This literature describes and illustrates construction, specifications, and applications of these variable, distributed-constant delay lines. Helipot Corp., 916 Meridian Ave., S. Pasadena, Calif.

Small Motors 374

Condensed catalog No. F4271-5 announces this firm's line of high-power, unidirectional type YAF motors available in nine power ratings from 1/200 to 1/40hp. The brochure also describes other types of unidirectional, synchronous, reversible, and geared-head shaded-pole motors with ratings up to 1/20hp. Small Motors Div., Barber-Colman Co., 1200 Rock St., Rockford, Ill.

Wire and Cable 375

This "Turbo Product Index" includes 44 pages of specific information concerning wires and cables, plastic tubing, coated tubing and sleeving, and identification markers. It includes much general information, product performance data, specifications, ordering information, and data on applications. William Brand & Co., Inc., Willimantic, Conn.

Waveguide System 380

A new catalog series covers the entire range of components in the double ridge waveguide system used in commercial air-borne weather penetration radar. The series provides detailed technical descriptions of each of the components comprising the system. Airtron, Inc., 1103 W. Elizabeth Ave., Dept. A, Linden, N. J.

Silicone Grease 381

A 6-page brochure describes Dow Corning 41 grease, a silicone fluid-carbon black mixture designed for high temperature, slow speed bearings. Performance data is shown by illustrated case histories detailing savings in relubrication schedules, replacement, and maintenanace costs. Specifications and typical properties are also given. Dow Corning Corp., Midland, Mich.

Knobs and Handles 382

Standard thermosetting plastic knobs and handles are described and illustrated in this catalog. Types included are instrument knobs, utensil handles and knobs, dual control knobs and dials, pointer and bar knobs, radio and general usage knobs. Kurz-Kasch, Inc., 1422 S. Broadway, Dayton 1, Ohio.

Bonding Wires 383

Bulletin No. 54-102 contains information on bonding stranded conductors by induction heating. Newly developed plastic-insulated bonding wires can be consistently and satisfactorily bonded during the cutting and stripping process by induction heating. William Brand & Co., Inc., North & Valley Sts., Willimantic, Conn.

Transformer Amplifier 384

The Model 400 differential transformer amplifier features a 0-1000cy flat response, 20kc carrier oscillator, better than 1% linearity, and high level scope output. This 2-color data sheet provides specifications, a block diagram, and operating principles. Daytronic Corp., 216 S. Main St., Dayton, Ohio.

Booster Transmitter 385

This 30-page illustrated report, "Report No. 1—Experimental UHF Satellite (Booster) Transmitter", describes an experimental installation of a u-h-f TV satellite near Waterbury, Conn. Complete technical details of the operation are given, as well as charts, graphs, and maps. Adler Communications Laboratories, 1 LeFevre Lane, New Rochelle, N. Y.

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Power Supplies 388

Bulletin No. 55 is a 2-color 10-page publication containing illustrations and specifications of a variety of regulated power supplies. Features of these units include continuously variable output power, excellent regulation, no affect as the result of line or load variation, and low output impedance. Oregon Electronics, 2232 E. Burnside St., Portland 15, Oregon.

Control Unit 389

The Brown Electr-O-Vane Control Unit is an electronic control switch. Data sheet No. 10.20-6 describes the unit in detail and explains how it can be applied as a sensitive limit switch in weighing, positioning, counting, and other motion-measuring devices. Industrial Div., Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Pa.

Thermistors, Bolometers 390

A variety of waveguide items are illustrated and described in this 2-page brochure, including two types of thermistors, two bolometers, three types of frequency meters, and directional couplers, and terminations. Specifications, prices, application data, and similar information are provided. Narda, 66 Main St., Mineola, N.Y.

Test Instruments 391

A 4-page brochure describes this firm's new line of electronic test instrumentation, including vacuum tube voltmeters, oscillators, square wave generators, resistance bridges, power supplies, wide band amplifiers, and various accessories. Ranges, characteristics, and other data are provided. Shasta Div., Beckman Instruments, Inc., 1432 Nevin Ave., Richmond, Calif.

Cycling Timers 392

Bulletin No. PB-510 describes in 8 pages this company's line of cycling timers. Program timers, percentage timers, and pulse timers are illustrated and described in detail complete with time ranges and ratings available, wiring diagrams, and dimension drawings, special housings, etc. R. W. Cramer Co., Centerbrook, Conn.

Connector Catalog 393

This firm's line of Blue Ribbon connectors are described and illustrated in Catalog No. R 1. These rack and panel connectors use a ribbon type contact and are available in pin polarization and barrier polarization. The catalog gives complete electrical data. American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.

Packaging Method 394

A new catalog highlights the applications of all purpose cushioned pads and blankets where shock, abrasion, marring, freezing, or dust presents a shipping or warehouse problem. Jet-Pak, Inc., 859-879 Summer Ave., Newark, N. J.

Adjustable Speed Drives 395

Fractional hp adjustable speed drives are illustrated and described in these technical data sheets. Dimensional drawings, interconnection diagrams, and operating requirements are given. Machinery Electrification, Inc., Northboro, Mass.

Steel Shelving 396

A new catalog features steel shelving, lockers, and other storage and maintenance equipment for industrial use. Precision Equipment Co., 3636 N. Milwaukee Ave., Chicago 41, Ill.

Synchronous Motors 397

This 24-page brochure describes over 125 hysteresis and salient-pole induction synchronous motors. Performance curves and characteristics are given for single-, dual-, 3-, and 5-speed hysteresis models for operation at frequencies from 30 to 400cy. Electric Indicator Co., Inc., Springdale, Conn.

Motors 398

Catalog No. 41 lists servo motors, motor tachometers, synchros, etc., as well as a new line of special transformers for use with grid-controlled rectifiers. Servo-Tek Products Co., Inc., 1086 Goffle Rd., Hawthorne, N. J.

Service Routines 399

"Univac Service Routines", for use by programmers and designed to assist in the actual operation of the computer, are briefly described in a "Techniques-Methods-Applications" brochure. The brochure covers various service routines and can serve as a training aid for programmers and operators. Electronic Computer Dept., Remington Rand, Inc., 315 Fourth Ave., New York 10, N. Y.

Atomic Models 400

The Courtald atomic models, described in a 12-page leaflet, are designed for use in research and education. Characteristics of the various models are detailed and illustrations show applications. Griffin & Tatlock, Div. of Griffin & George Ltd., Nivoc House, Ealing Rd., Alperton, Wembley, Middlesex, England.

High Vacuum Pumps 401

A 4-page, 2-color bulletin provides a comprehensive view of this company's line of high vacuum pumps. Bulletin No. V-54 describes the constructions and operating characteristics of the single-stage, compound, and two-stage booster types. Kinney Mfg. Div., New York Air Brake Co., 3529 Washington St., Boston, Mass.

Machinery Mounts 402

How mounting machinery can provide higher production output and lower production costs is shown in this 8-page bulletin. The bulletin also gives a summary of the types of mounts which have been engineered for applications on various machines. Barry Control Inc., 1000 Pleasant St., Watertown, Mass.

Liquid Level Measurement 403

Bulletin No. 1161 includes a discussion of the basic principles of liquid level measurement, control, and transmission. Systems are described in detail along with the applications, principles of operation, limitations, and advantages of each. Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne & Windrim Aves., Philadelphia 44, Pa.

Interval Timers 404

Interval timers are the subject of this 8-page bulletin, No. PB-210. The 2-color booklet features exploded views, complete descriptive and technical data, with wiring, dimension, and housing information. R. W. Cramer Co., Centerbrook, Conn.

TV Picture Tubes 405

The 2nd edition of the "CBS-Hytron Reference Guide for Television Picture Tubes" lists all magnetically deflected picture tubes to date, monochrome or color, of all manufacturers. Basing diagrams and pertinent data for 242 tubes are presented. CBS-Hytron, Danvers, Mass.

Ceramic Coating 406

Bulletin No. 155 contains complete data on Nicote, a metal-to-ceramic coating for use with both hard and soft solder. Application data and a complete property chart are given. Frenchtown Porcelain Co., 100 Muirhead Ave., Trenton 9, N. J.

Dynamotors 407

A condensed catalog of commercial, military, and mobile dynamotors contains information on d-c to d-c power conversion as provided by these units. Sangamo Generators, Inc., 2110 Clear Lake Ave., Springfield, Ill.

Design Facilities 408

A 20-page illustrated booklet describes modern facilities for the design and production of precise electromechanical and electronic products. Facilities illustrated include electronic production, electromechanical, and electronic testing. Transitron, Inc., 154 Spring St., New York 12, N. Y.

Nickel Powder 409

Technical data sheets Nos. PMS-72 and 73 list chemical and physical properties of two grades of electrolytic nickel powder, Plast-Nickel. Physical property and hydrogen loss tests are by Metal Powder Association Standard Methods. Plastic Metals Div., National Radiator Co., Johnstown, Pa.

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Cable Catalog 413

Catalog No. W1 contains 34 pages of cable illustrations and descriptions and includes the following information: jackets, conductors and dielectric data, attenuation, and power ratings, a complete listing of military RG/U nomenclature, cable/connector selector chart. American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.

Furnace Pressure Controller 415

Bulletin No. 7404 describes the Honeywell indicating furnace pressure controller and its uses. Exploded views and connection diagrams illustrate principles and applications. Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne & Windrim Aves., Philadelphia 44, Pa.

Colloidal Graphite 414

Bulletin No. 433 contains information, photographs, and charts pertaining to colloidal graphite applications in electronics. Acheson Colloids Co., Div. of Acheson Industries, Inc., Port Huron, Mich.

Automatic Ratio Relay 416

Bulletin No. 8410 describes an automatic ratio relay which received pneumatic input signals from two sources and transmits an output signal which is proportional to one of the inputs. This relay is useful in ratio control, cascade control, pneumatic computing systems, etc. Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne & Windrim Aves., Philadelphia 44, Pa.

Dynamotors 417

This company's line of dynamotor power supplies is described in catalog No. 155. Performance charts, brush life characteristics, and other engineering data are provided. Carter Motor Co., 2644 N. Maplewood Ave., Chicago 47, Ill.

Vibration Control 418

Revised 12-page Bulletin No. 616 contains basic information on vibration, charts, and data on standard and special performance vibration isolators. MB Mfg. Co., Inc., 1060 State St., New Haven 11, Conn.

Punched-Card Methods 420

How to get more from punched-card methods is described in a 6-page illustrated folder. In chart form, this firm's line of punched card machines is listed showing their use. An illustration and description is given for each of the 25 machines. Remington Rand Inc., 315 Fourth Ave., New York 10, N. Y.

Construction Method 421

The new "universal slotted angle system" for simplified construction of anything from workbenches to warehouses is explained and illustrated in this bulletin. Photographs of sample installations are given. Flowstrut Corp., 141 E. 44th St., New York 13, N. Y.

Test Chambers 422

Two data sheets describe this firm's humidity chamber and low temperature chamber. Specifications and features are given. Environmental Equipment Corp., 369 Linden St., Brooklyn 27, N. Y.

Miniature Components 423

Two sizes of small adjustable inductors and a series of i-f transformers of similar design are cataloged in leaflet No. VI-1154. The units are described with complete application design data including dimensioned drawings and performance curves. Levinthal Electronic Products, Inc., 2758 Fair Oaks Ave., Redwood City, Calif.

Precision Ceramics 424

Precision ceramics is the subject of a 4-page bulletin. Production methods and techniques for manufacturing ceramic parts and metallized ceramic assemblies are illustrated. Drawings of typical parts show the high degree of precision attained. Stupakoff Ceramic & Mfg. Co., Latrobe, Pa.

Soldering Fluxes 425

This 4-page bulletin describes and illustrates soldering pastes, fluid fluxes, and soldering salts and paints. Characteristics of each type are outlined. M. W. Dunton Co., 7 Goff St., Providence 3, R.I.

Research Facilities 430

Brochure No. R-14 explains this firm's organization and facilities for basic, applied, and development research in servomechanisms, radar, sonar, guided missiles, and electronic instrumentation. Examples of research and development work are described and illustrated. Cook Research Laboratories, Div. of Cook Electric Co., 2700 Southport Ave., Chicago 14, Ill.

Industrial TV Equipment 431

Catalog No. E.51 describes the ITV-6 industrial TV equipment made by this company. Features, applications, and construction details are given. Specifications are listed. Radio Corp. of America, Engineering Products Div., Bldg. 15-1, Camden 2, N. J.

Technical Ceramics 432

Bulletin No. 551 supplies the latest information on the mechanical and electrical properties of AlSiMag technical ceramics. Graphs show thermal expansion and dielectric strength. American Lava Corp., Chattanooga 5, Tenn.

Programmer Thermometers 433

Specification sheet No. 602 describes internal cam programmer thermometers which are designed to maintain a definite relationship between temperature and time. Minneapolis - Honeywell Regulator Co., Industrial Div., Wayne & Windrim Aves., Philadelphia 44, Pa.

Potentiometers 434

Bulletins No. D54-1 and D54-A describe this company's types 2134-35 and 2234-35 potentiometers. Specifications, design features, and applications are explained. Markite Corp., 155 Waverly Pl., New York 14, N. Y.

Magnetic Amplifiers 435

Magnetic amplifiers for positioning servos, motor and speed controls, and other precision control applications are described and illustrated in a 2-color brochure. Graphs of typical transfer characteristics are included. Keystone Products Co., 904 23rd St., Union City 2, N. J.

Micro Socket Screws 437

Set and head cap screws of alloy steel and stainless steel are described in a 4-page brochure. Charts show dimensions, threads, per inch, diameter, and weight per 100. Dimension drawings and illustrations are given. Unbrako Socket Screw Div., Standard Pressed Steel Co., Jenkintown, Pa.

Meters 438

A 4-page, 2-color bulletin gives features, technical specifications, and schematic drawings on a new meter series available in sealed or ruggedized models. Electronic Sales Div., De-Jur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Rotary Limit Switch 439

A new technical brochure details applications and construction features of rotary limit switches. Specifications, prices, and installation dimensions are also given. Gemco Electric Co., 25681 W. 8 Mile Rd., Detroit 19, Mich.

Radar Components 440

An 8-page bulletin shows radar antennas, mounts, components, and accessories for use with land and ship-based radar systems. Photographs of complete antennas and mounts and accessories and components are included. General Electric Co., Apparatus Sales Div., Schenectady 5, N. Y.

Stack Switches 441

Three typical stack switch assemblies are illustrated in Catalog Supplement No. S-520. The bulletin contains detailed drawings with complete information for designers' drawings and for requesting prices. Switchcraft, Inc., 1328 N. Halstead St., Chicago 22, Ill.

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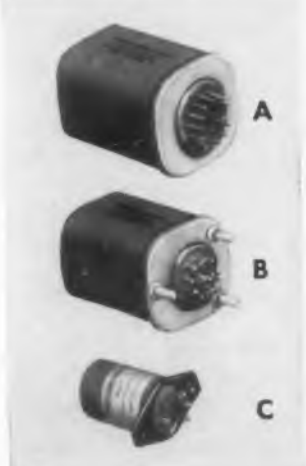

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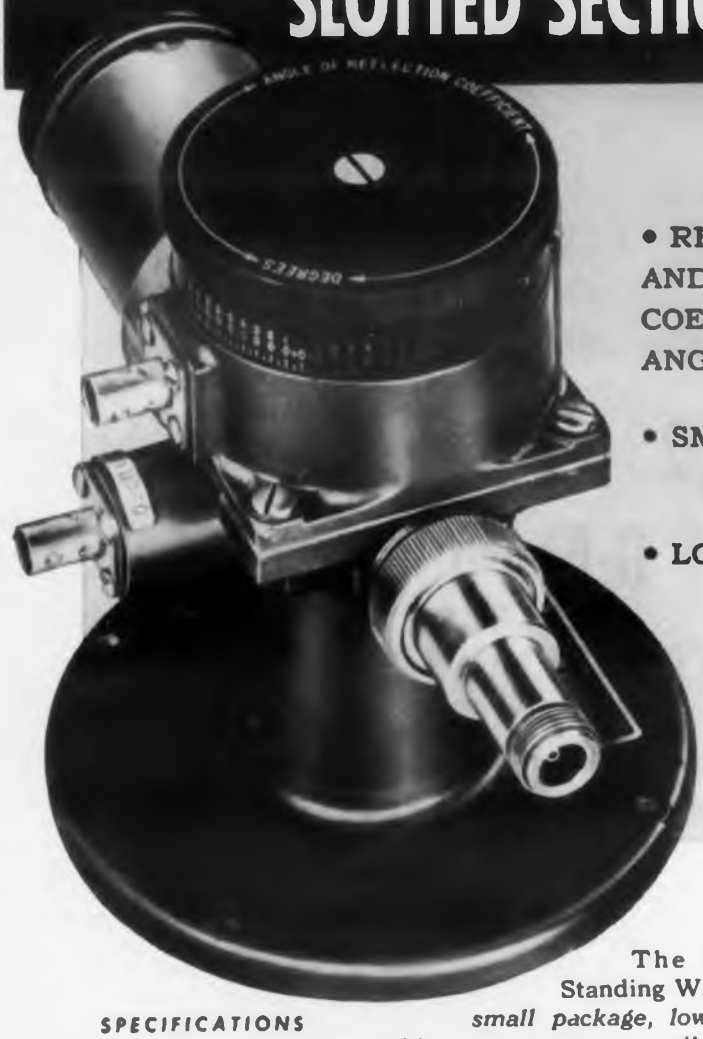

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Patents . . .

By John Montstream

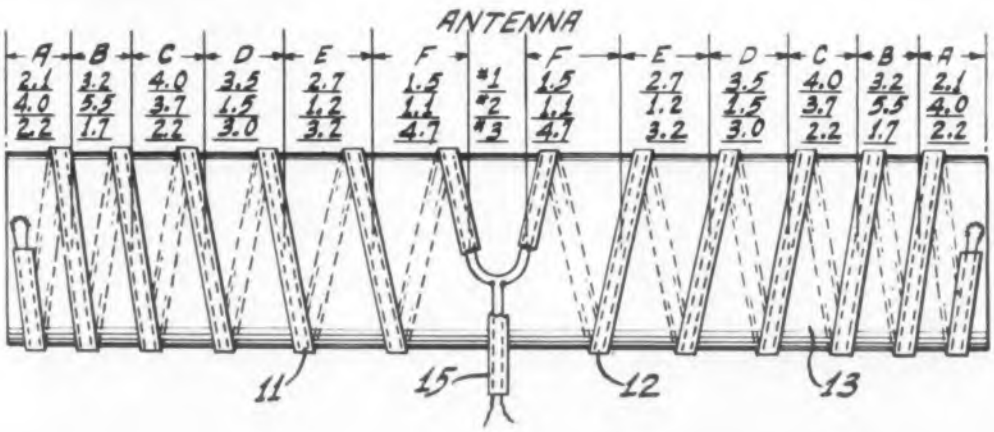
Indoor Television Antenna . . . *Patent No. 2,682,608. E. O'E. Johnson. (Assigned to Radio Corp. of America, New York, N. Y.)*

An indoor antenna for television receivers has many advantages if it can be made efficient and provide satisfactory reception over the channels available. An indoor antenna adjacent to the receiver is not troubled by the many antennas erected on the roofs of multiple dwellings. Also a television antenna above the roof does not improve the esthetic appearance of a single dwelling. The indoor antenna of the patent furthermore does not have an installation cost since it can be placed upon the receiver cabinet or at any other convenient adjacent location or be mounted within the cabinet. It is shown below in Fig. 1.

The antenna uses an insulating tube (*13*) about 2-3/4" in diameter and 33" long upon which is wound a length of flat ribbon transmission line (*11* and *12*). The line is insulated with a polyethylene coating. This is a well known commercial transmission line. It must be about 100" long to provide about 300 ohms. From the midpoint the line is wound helically and in opposite directions around the tube. The extreme ends of the line are connected together in the manner of a folded dipole. At the midpoint one of the conductors is severed and each severed end is connected with one of the wires of a transmission line (15) leading to a transducer. The antenna so constructed is a dipole.

The helical windings of lines *11* and *12* are wound with varying spacing between adjacent turns in order to tune the antenna. With the spacing increasing toward the center of the antenna, a larger signal is received in the lower frequencies. With the windings concentrated at the ends of the antenna, a larger signal of the higher frequencies is received. Usually for each installation there is one spacing arrangement which gives good reception for all channels being broadcast in the area. Once the windings have been adjusted they may remain in such adjusted position and are secured in place by tape or other means. The spacing between turns does not improve appreciably the signal response since the length of the antenna is the factor which affects the strength of the received signal. The spacing, however, does change the impedance characteristic. The table ad-

Fig. 1. The turns on this indoor antenna can be moved to change response.



jacent to the figure gives some satisfactory spacing for the winding. The spacing of $\lambda/2$ gives a generally wider frequency response.

The antenna has a directive reception characteristic of a figure 8 pattern, so that by turning it by hand, maximum response may be secured from any one station. The patent also describes some variations that may be made in the construction, but its essential features are as have been described.

Deflection System . . . *Patent No. 2,681,426. Kurt Schlesinger. (Assigned to Motorola, Inc., Chicago, Ill.)*

In earlier patents Nos. 2,617,076 and 2,617,077 granted to the patentee, cathode-ray tube beam-deflection systems are described that provide simultaneously two electrostatic fields at right angles to each other for deflection of the beam. The electrodes surrounding the beam producing these fields are interleaved with each other in such fashion that interaction between the electrodes is reduced to a minimum. The new cathode-ray tube, illustrated in Fig. 2, shows an improved form of electrode arrangement for this type of beam deflection which has better beam deflection sensitivity and less distortion than the forms described in the earlier patents.

The cathode-ray tube (*10*) is of usual construction with an electron gun (*12*) and a beam deflection system of tubular form in front of the gun through which the beam passes and is deflected by the existing field. The anodes preferably provided are a second anode (*14*) on the inner wall of the tube that carries a potential at or lower than the maximum voltage on the deflecting electrodes of the deflection system and an ultor anode (*15*) also on the inner wall of the tube and spaced from the second anode.

The electrodes of the deflection system are of herringbone form, that is a continuous ribbon extending longitudinally with circumferentially extending points. There are four such electrodes disposed around the beam and spaced 90° apart with the points of one electrode interleaved with but spaced from the electrodes on each side. The electrode form may vary considerably from that illustrated. One alternate form being generally a series of connected and alternately directed cone-shaped figures with rounded cone sides and another form being interlaced helices. The deflection system may be cylindrical, square, rectangular, conical, or rhomboid in form.

An electron beam moving through the deflection system adjacent to the electrodes is alternately deflected and attracted as it passes from the field of an interleaved portion of one electrode to the field of the interleaved portion of the adjacent electrode. The amplitude of the deflection is dependent upon the distance of the electron beam from the electrode so that when the beam passes through the deflection system spaced from the electrode it passes through fields that tend to merge into a relatively uniform field. With electrodes as described, a deflection system of greater sensitivity is secured with less distortion.

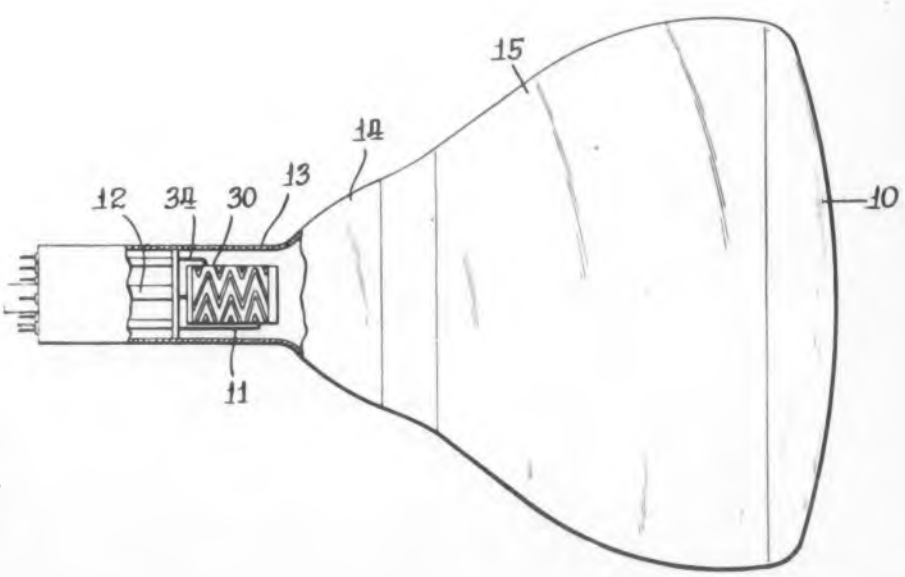


Fig. 2. This cathode-ray tube has electrostatic deflection fields at right angles to each other.

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Electric Timer . . . *Patent No. 2,679,021. E. C. Hartwig and R. F. Barrell. (Assigned to Westinghouse Electric Corp., E. Pittsburgh, Pa.)*

Timing circuits for precision control of the magnitude of current impulses in welding machines are known. Such circuits are complex and require the use of expensive components. They are, therefore, unsuited as a practical consideration for a bench welder, which is an inexpensive form of welding device. A timing circuit that is simple enough for bench welders yet effective and precise in its operation is set forth in the patent.

The welding device includes the electrodes (*11*) that receive current from the secondary winding (*13*) of transformer *3*. The primary winding of the transformer is connected with power terminals through parallel-connected power thyratrons *5* and *7* which are controlled by the timer circuit to fire at a precise time in relation to the supply voltage. Normally the power thyratrons are rendered non-conducting by the biasing voltage on their respective control grids *61* and *65* which is supplied through secondary windings *59* and *69*, respectively, of transformer *21*. When the control circuit renders power thyratron *7* conductive, condenser *67* becomes positively charged through potentiometer *73* and rectifier *75* to swing the control grid (*65*) of power thyratron *5* positive. This tube fires and continues to conduct on negative half waves of the power supply so long as thyratron *7* is conducting. In other words, conduction of the second thyratron is controlled by conduction through the first.

The control circuit for firing the power thyratrons comprises a normally non-conducting starting tube (*15*) and a normally conducting control tube (*17*). A time constant circuit (*76*) connects the plate (*23*) of the starting tube with the control grid (*31*) of control tube *17* so that as long as tube *15* is non-conducting, a positive potential exists on the control grid of tube *17* and it conducts on positive half waves of the anode potential. With tube *17* con-

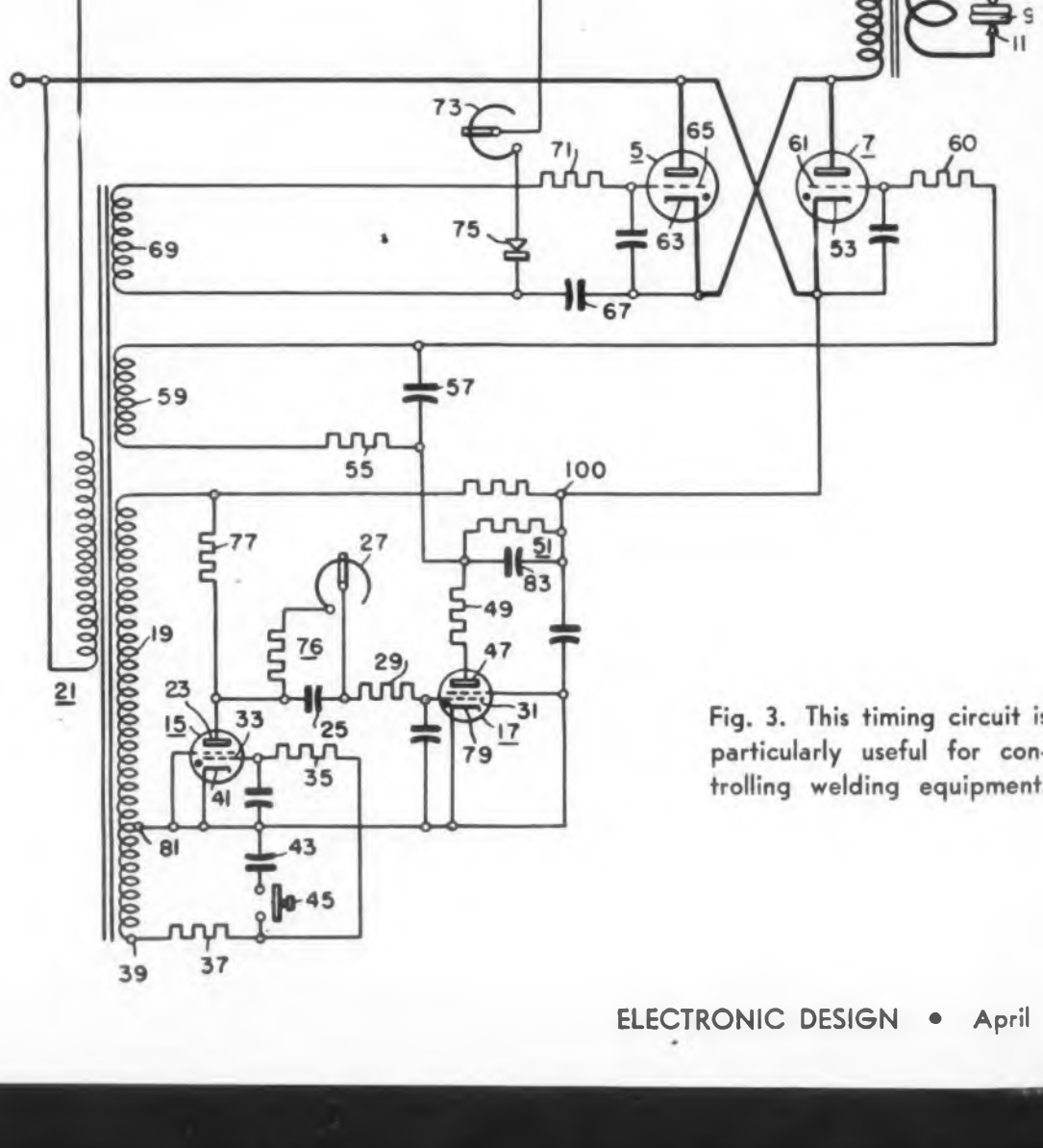

Fig. 3. This timing circuit is particularly useful for controlling welding equipment.

ducting, condenser *83* of a time constant circuit (*51*) is charged, which maintains a biasing voltage on control grid *61* of power thyratron *7*. So long as thyratron *7* is non-conducting, it maintains a bias on control grid *65* of power thyratron *5*.

The thyratrons are fired by closing switch *45*, which connects a phase-shift circuit including capacitor *43* and resistor *37* into the control grid circuit of starting tube *15*. This tube becomes conducting during a part of the positive wave. As explained, control tube *17* then becomes non-conducting and this action initiates conduction through the power thyratrons. A welding current is then supplied between the welding electrodes (*11*). With the starting tube non-conductive, condenser *25* of time constant circuit *76* begins to discharge and after a predetermined time it reestablishes a biasing potential on the control grid of control tube *17*. This tube then begins to conduct, which biases the control grid of power thyratron *7* to non-conduction. This action in turn renders power thyratron *5* non-conducting. The starting switch then may be released for a repeat cycle of operation.

The control circuit described gives precise timing of the welding operation. In addition the control circuit uses but two tubes (*15* and *17*) and other inexpensive components which makes the circuit suitable for the bench type of welders.

Series Resonant High Voltage Supply

. . . *Patent No. 2,680,830. Peter G. Sulzer. (Assigned to the United States, as represented by the Secretary of Commerce, Washington, D. C.)*

An oscillator-type, direct-current high voltage supply source is used in oscilloscopes and television receivers because it does not require large and heavy components. The oscillator-type voltage supply source as presently used includes a transformer that usually require special design, and hence is not readily available in commercial channels in sizes suitable for such service. The oscillator-type high-voltage supply shown in Fig. 4 does not require a high-frequency transformer and has a further advantage in that it uses circuit components which are readily available. It provides both a high negative voltage source and a high positive voltage source.

This circuit, essentially a Colpitts oscillator, except that the value of capacity for condenser *18* is comparable to the reactance of inductor *17*. More precisely, in order for the circuit to oscillate, the value of the capacitive reactance of condensers *19* and *21* in series must equal the value of the inductive reactance of condenser *18* and inductance *17* in series. A diode (*22*) has its filament connected in series between

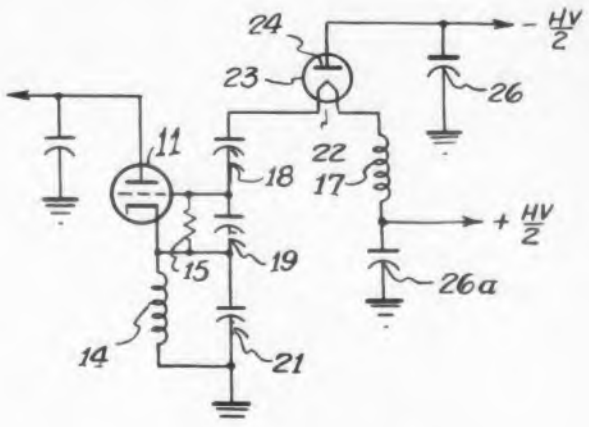

Fig. 4. This high-voltage supply does not require a high-frequency transformer.

condenser *18* and the inductor *17* so that the oscillatory voltage in the series resonant circuit provides the diode heater current. When the filament is negative on a negative swing of the resonant circuit, current flows to the plate and charges capacitor *26* negatively to provide a negative potential at the output terminal indicated by the arrow head. Condenser *26a*, which is connected between one end of inductor *17* and ground, is charged positively on positive swings and provides a positive voltage at the $+HV/2$ terminal. If the two condensers *26* and *26a* are of the same value, the voltage divides equally between them to provide equal voltages in the output of the circuit.

A circuit for negative voltage solely may be provided by removing condenser *26a* and grounding that end of inductor *17*. A circuit for positive voltage only will be secured by directly grounding the anode of the diode. In each of these circuits, the voltage would be twice the value or equal to *HV* of that secured at either of the output terminals of the circuit of Fig. 4.

The patent illustrates other circuits which are modifications of that illustrated by means of which the voltage output may be doubled.

AEC Patents For Industry

Additional patents owned by the Government and held by the Atomic Energy Commission have been made available for licensing on a non-exclusive, royalty free basis. Applicants should apply to the Chief, Patent Branch, Office of the General Counsel, U. S. Atomic Energy Commission, Washington 25, D. C. Of the 21 patents released, the following ones are particularly interesting to electronic design and development engineers.

Vacuum Pumping Apparatus (Patent No. 2,691,481); K. M. Simpson, inventor. The patent describes pumping apparatus for the production of high vacuum of the vapor-stream type. Size limitations of the prior art devices are overcome, enabling the production of higher vacuum with fewer pumping systems. One or more rectangular openings of the chamber to be evacuated communicate in tapered configuration to a substantially rectangular discharge opening maintained under reduced pressure by mechanical pumps. The higher vacuum is obtained by a fast-moving, continuously recycled, vapor-stream introduced from boilers through elongated tubular vapor jets.

High-Voltage Bushing (Patent No. 2,692,297); H. M. Owren, inventor. An improved high-voltage bushing for use in connection with the isolation of either large a-c or d-c voltages is described. Its advantages, including decreased size, are obtained by a combination of insulations particularly adapted for a-c and d-c voltages, by the elongation of the voltage creep path and by expansion of the areas having potential differences between them.

Pulse Analyzer (Patent No. 2,694,146); E. Fairstein, inventor. This patent relates to differential-integral pulse-height analyzers for fast operation having dead times as low as 1microsec or less. This is accomplished in part by providing a differential-integral pulse height analyzer which responds to various forms of driving pulses. The

pulse shape is not critical by providing an impedance transformer for coupling the integrating circuit to the pulse-shaping circuit, and by providing an anti-coincident circuit where the pulse height of the driving signal is independent of and not affected by the aging of the tubes.

Radioactive Electric Generator (Patent No. 2,696,564); P. F. Ohmart, inventor. The patent relates to methods of and apparatus for converting the energy of radioactive radiations directly to electrical energy. A radiation detector is provided, which itself serves to generate an electrical current from the energy of the ionizing radiations and accordingly requires no external source of electrical energy. The current generated being proportional to the amount of radiation.

Load Torque Responsive Follow-Up System (Patent No. 2,689,318); R. C. Goertz and F. Bevilacqua, inventors. This patent describes a remote positioning mechanism so designed that in operation the restraining force at the load end is transmitted to the operator's hand at the control end, thus providing a sensitive response.

Electrostatic Amplifier (Patent No. 2,696,530); Q. A. Kerns, inventor. This patent describes a variable capacitance amplifier. It embodies the desirable control characteristics of electromagnetic amplifiers without the attendant disadvantages. This is accomplished by employing electrically responsive capacitors whose capacitance is varied by a d-c signal voltage impressed thereon. This provides a power amplifier employing high-frequency electrical energy to produce d-c power proportional to a d-c control bias.

Dual Circuit Electrical Safety Device (Patent No. (2,696,539); E. W. Peterson, inventor. The patent covers means for simultaneously interrupting many electric circuits. This is accomplished by mounting two opposing sets of contacts on resilient conducting members which are spaced apart by insulating material at one end and joined together by a fuse element at their other end in such a manner as to hold the opposing sets of contacts in a closed position. Malfunction of the circuit through the resilient conductors will blow the fuse connecting them. This action permits the contacts mounted on the members to spring apart, thus breaking their circuits.

Pyrometer (Patent No. 2,695,364); R. A. Wolfe, inventor. The patent pertains to pyrometry, and more especially to a method and apparatus for measuring elevated temperatures over a wide range. This is accomplished by exposing a pair of apertured Geiger-Muller counters characterized by the different work functions of their cathodes to the radiations emitted from the source of heat, counting the rate of occurrence of discharges of the counters, and deriving an electrical signal proportional to the ratio of these counting rates. The magnitude of this signal is directly proportional to the temperature of the source.

Books . . .

Electronics Test Equipment Descriptive Data Sheets . . . *Three volumes, 2300 pages. Carl L. Frederick & Associates, 4630 Montgomery Ave., Bethesda 14, Md. $100.00.*

The electronic designer who is continually faced with the problem of finding the proper instrument to measure a certain parameter will find this compilation of descriptive data sheets of immense value. Almost 900 different electronic measuring devices used by the Air Force are listed in the three volumes making up the set. The material was collected under an Air Force contract, and has now been released for use by industry. It covers both commercial and military instruments.

Each instrument is covered in one or more loose-leaf pages showing a photograph and giving a functional description, its relationship to other equipment, an electromechanical description, manufacturer's or contractors data, tube complement, reference data and literature, and shipping data. A list of equipment supplied with each instrument is also given. As additional instruments are covered, added data sheets will be made available to owners of the original volumes.

The data sheets are especially useful to engineers who work on military projects or on military contracts. They help to specify which piece of test equipment should be used to test certain designs. The knowledge that certain test equipment is available to a military electronics technician could influence the design of a certain device, especially in regard to the complexity of the control panel.

The instruments are indexed both by military nomenclature and function. Volume I covers: voltage and current measuring equipment; frequency measuring equipment; and wave-form measuring devices. Volume II discusses: signal generating equipment; field intensity measuring equipment; impedance and standing wave ratio measuring equipment; amplifying equipment; and time base measuring and counting equipment. Volume III covers: combination and group test sets; associated devices for electronics test equipment; calibrating equipment for electronics test devices; and power measuring equipment.

These volumes are highly recommended for all design laboratory libraries.

Electroacoustics: The Analysis of Transduction and Its Historical Background . . . *By Frederick V. Hunt. Harvard Monographs in Applied Science Number 5. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. $6.00.*

Electroacoustics and transducers have been a part of electronics since the telephone-type earphone was used with the first radio. Although the greatest use for transducers will always remain in communications, transducers have increasingly important roles in other branches of the electronic industry such as sonar, automatic control equipment, and test and inspection devices. This small book presents a wealth of information and useful approaches to the understanding of electroacoustics.

The most interesting section to designers deals with a method of representing all types of transducers by the same form of equivalent circuit. Three chapters show how to analyse both electrostatic and electromagnetic systems of electromechanical coupling by the new method. The method is then illustrated by examples of application to moving-conductor, electrostatic, and moving-armature transducers, respectively.

The book opens with a 91-page chapter on the historical development of electroacoustics. The purpose of this section is to relate this field to the other basic sciences. Some of the material in this work, based on studies at the Harvard Underwater Sound Laboratory during the war, has not been widely disseminated before.

Modern Physics for the Engineer . . . *Edited by Louis N. Ridenour, 499 pages. McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y. $7.50.*

The frequent references to engineering as "applied science", prevent us from forgetting that all engineering practice rests on the solid foundation of the physical sciences. This compilation is designed to familiarize the working engineer with some of the more interseting developments in the fundamental physical sciences.

The book is composed of 18 chapters divided into three parts: "The Laws of Nature", "Man's Physical Environment", and "Information and Its Communication". In Part 1, electronic engineers will find chapter 3, "Physics of the Solid State", and chapter 5, "Microwave Spectroscopy", of particular interest.

The entire third part is of much interest to the electronic designer, especially those who have been specializing in one field and thereby losing touch with the rest of the art. Part 3 is composed of four chapters: "Electrons and Waves", "Semiconductor Electronics", "Communication Theory and the Transmission of Information", and "Computing Machines and the Processing of Information". The book is well illustrated with charts, photographs, and tables.

Works such as this one help to strengthen the already strong ties between the scientific and technical communities. Even if the engineer can find little direct use for added knowledge of new scientific developments, such knowledge will help him as a human being to live in our time.

A Dictionary of Electronic Terms . . . *72 pages, paper cover, Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill. Available gratis on request.*

This volume of definitions of electronic term, though written mainly for non-engineers, should prove of assistance and interest to electronic engineers—at least as a guide to spelling. Included in the book are terms encountered in general commercial and professional usage and in magazine articles, books, and lectures. Many of the definitions are illustrated. In addition to the definitions of more than 3000 terms, abbreviations and letters, a section of useful radio data is appended.

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Arithmetic Operations in Digital Computers . . . *By R. K. Richards, 397 pages. D. Van Nostrand Co., Inc., 250 Fifth Ave., New York 3, N. Y. $7.50.*

This volume is useful to the electronic design engineer for two reasons: to aid in the designing of digital computers by giving the engineer an understanding of the computer's duties; and to help the engineer learn how to solve his design problems on digital computers.

The first chapter deals with symbolic representation of quantities. The second chapter is entitled "Boolean Algebra Applied to Computer Components". The Boolean algebra notation is then widely used in conjunction with the many block diagrams in the book used to explain the function of digital computers. Separate chapters are devoted to the methods employed in binary and decimal systems. The final chapter discusses programming. To explain programming, a simplified hypothetical machine is used as a model.

The extensive bibliography lists the papers that deal with each of the giant brains now in operation by the name of the computer. The author is a development engineer with the International Business Machines Corp.

Active Networks . . . *By Vincent C. Rideout, 485 pages, Prentice-Hall, Inc., 70 Fifth Ave., New York 11, N. Y. $10.65.*

Based on a course in circuitry that the author teaches at the University of Wisconsin, this volume can act as a valuable reference and refresher work for the practicing circuit designer. Among the subjects treated are: low-pass vacuum-tube amplifiers; transient response of amplifiers; band-pass amplifiers; and some special types of small-signal amplifiers. The volume concludes with a chapter on noise and information theory.

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See Page 96

What Every Engineer Should Know About Rubber . . . *By W. J. S. Naunton, 128 pages, Natural Rubber Bureau, 1631 K St., N. W., Washington 6, D. C. $0.50.*

Based on experience and contact with many engineers, the author has treated the subject from the point of view of the engineer wishing to incorporate rubber in his designs. Over half the book is devoted to specific engineering uses of rubber. In the remainder, the sources, properties, manufacture, and testing of rubber are covered. Many photographs and diagrams illustrate the material.

Advertising Index

April 1955

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