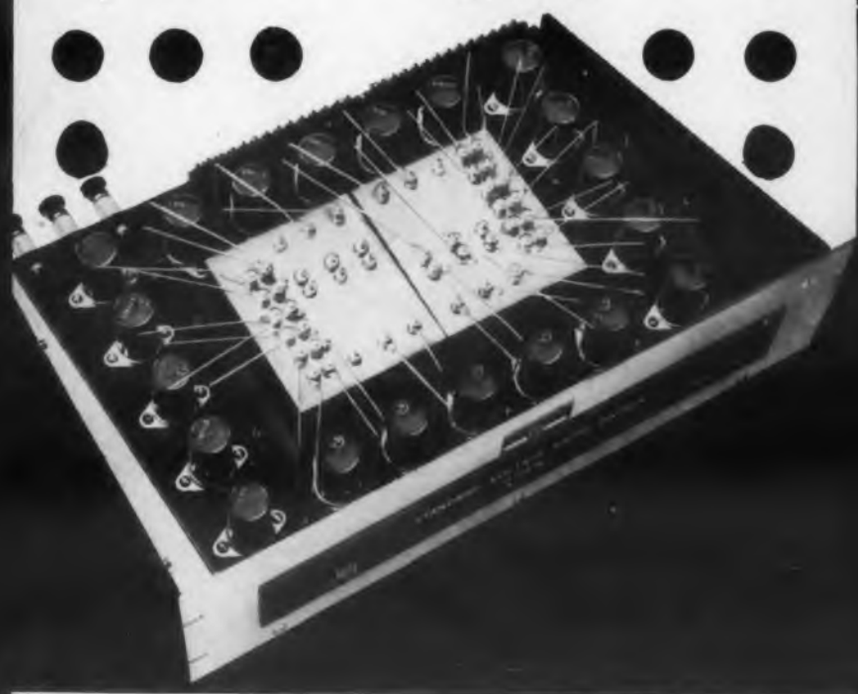
ELECTRONIC DESIGN



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ELECTRONIC DESIGN

Contents

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Editorial

Tavern Talk on the Engineering Shortage

(Scene: Engineers at a bar before a P.G. meet.)

"There wouldn't be any shortage of engineers if the government wouldn't reward companies who failed on a contract."

"What are you saying, Harold?" asked Steve incredulously. Harold had spoken earnestly. As a director of research, his words carried weight.

"Simply this," Harold snorted, "you can fail to produce on a contract, and not only do you get paid, but you get another contract the next day because you have the available manpower."

Steve challenged, "Come on, it's not that bad."

"Maybe not," Harold agreed, "but take the WYZ Company. They made only eggbeaters until they bought up that tiny development outfit that made radio-controlled model airplane kits. They beat the bushes till they got 75 engineers. Then they put that retired admiral on their payroll and now they're designing guided missiles.

"But my main point is this, there is no reward for good work. You can build hardware that's no good, or come up with research reports which say nothing, yet, if you tell the government you tried and it's the nature of the beast that there's no solution, your word is accepted. They can't tell the difference. What's tragic is that your hardware may go into production if you assert it's good. Some kids right out of college can build a fire control system for jets that works, yet it could have been better if older experienced brains had checked the design. What's even worse, research in some promising direction gets stopped because of a negative report. If top scientists had done the research in the first place, results would have been different."

"But, Harold, all you're saying is that there is a shortage."

"No. If the Government knew enough to cancel a few contracts and not to give the contractor another chance, if he doesn't have any proven ability in that field, the demand for engineers would be less. Responsible companies could absorb responsible engineers from these subsidized companies, which should not be in the field anyway, and some responsible work could be done."

"I guess you're right," Steve mused, "Right now we can job hop, picking up a grand or so doing it whenever somebody else wants some missile or systems engineers. Say, how about this idea for controlling job hoppers? They should pay a 90 per cent income tax on their salary gain if they change jobs before a year is out. This would prevent unscrupulous companies from pirating and taking on more government contracts than they can reasonably do."

"Have we got time for another round? Guess not."

Engineering Review

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

Rapid Data Transmission

High-speed data transmission for the business world will be made possible by an experimental device, tentatively called a Data Subset. Capable of transmitting 1000 words per minute, the device meets the increasing demand for communication between information processing machines. The experimental data transmission set, recently built by Bell Telephone Labs., N.Y., is suited to any data-generating or data-processing device that can place its output on a magnetic tape. In a properly encoded form, the transmission set will accept this tape and transmit the data at great speed over telephone lines to another tape at the receiving end.

The tape contains a series of magnetized spots arranged according to an add-parity check code.

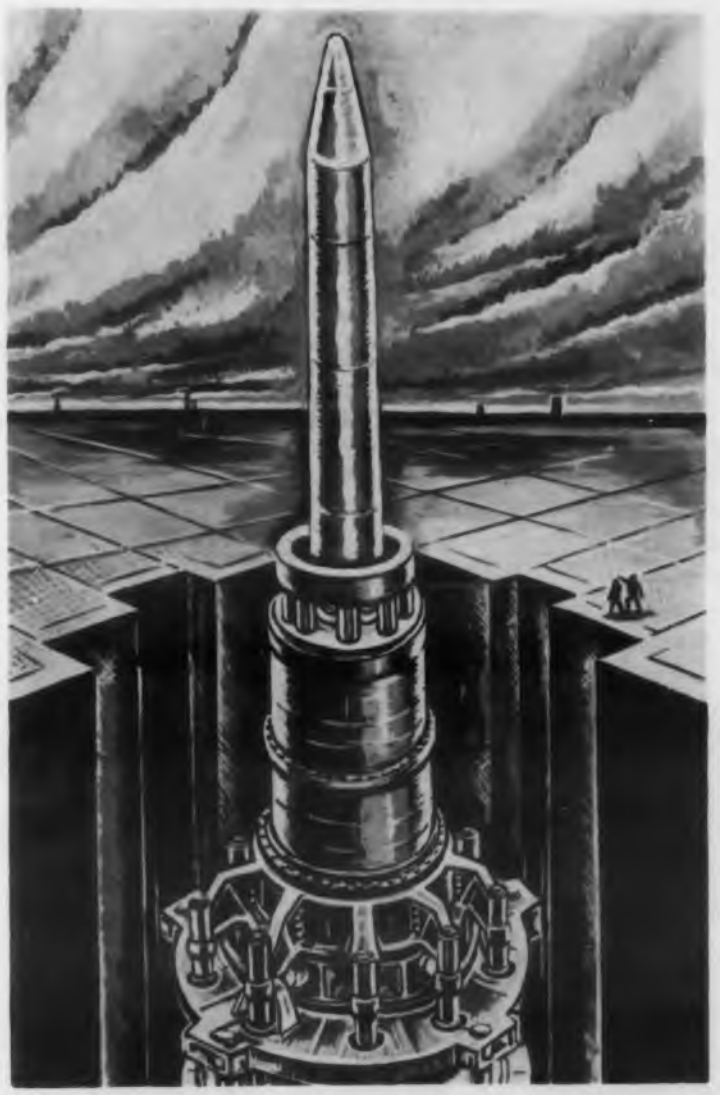
Information in verbal, digital or other form, can be fed on tape into this device for transmission at the rate of 1000 words per min over conventional telephone lines. Called the Data Subset, the system will enable the rapid communication of vast amounts of information between data processing centers. Information from computers, typewriters or other business machines can be coded on the tape previous to transmission.

The code for any unit of data—a digit, a letter of the alphabet, or any arbitrary symbol—will have seven positions. In each of the seven positions there will be either a *zero* or a *one*, but in the entire series of seven there must always be either three or five *one's*. A *one* corresponds to a spot on the tape magnetized in one direction, and a *zero* corresponds to a spot magnetized in the reverse direction. If by error a code group does not have either three or five *one's*, a data subset will detect the error and will take steps so that it can be rectified. The output of the magnetic tape feeds into the amplifier and modulator section. Here, an oscillator generates a 1200-cy carrier which is amplitude modulated by the code signals. If an encoding error is encountered, the set will send out a special symbol that will be recorded on the receiving tape.

At the receiving end, an avc circuit helps insure accuracy by evening out the energy levels of the incoming 1200-cy pulses. A detector circuit converts these to dc pulses that magnetize the appropriate spots on the receiving tape. Another check circuit is meanwhile verifying again the three-or-five-out-of-seven accuracy. This is necessary because an error might have been introduced along the transmission path.

In operation, the tape will be removed from the computer, typewriter or other business machine where it has been prepared. It will be placed directly into the data subset without rewinding. Information, therefore, will actually be transmitted backwards. This has its advantage since the correction symbol will precede the erroneous line and will cause the data subset to skip that line.

One important advantage of the system is that transmission can be accomplished at times when telephone lines are not normally busy. The semi-automatic nature of the machine, which makes this possible, may become particularly helpful to the business world as its communication load increases.



Only Pretending: This is an artist's conception of a device that will simulate the roll and pitch of a ship at sea while simultaneously launching a missile. It will be used by the Navy to determine the limiting conditions of firing a missile off a moving platform. The size of the simulator-launcher, to be built by the Loewy-Hydropress Div. of Baldwin-Lima-Hamilton Corp., Pa., is necessary to maintain this motion during actual firing.

Engineering Review

Standard Saturable Reactors

A standard line of 22 mass-produced saturable reactor assemblies has been announced by "Control," a new division of Magnetics, Inc., of Butler, Pa. Reactors of 240 and 120 v 60 cy are available, with 11 standard sizes in each range. Power output ranges from 50 to 2000 w, with three amp-turns being required for control of the smallest unit. The establishment of this new division has resulted from the demand for mass-produced saturable reactors as opposed to custom-ordered devices.

Gadget for Tired Drivers

A novel rear-vision mirror that is automatically adjusted to prevent a motorist from being blinded by following headlights is the latest contribution to the road-weary. The Mirrotron, as the new mirror is called by its developer, the Instrument Research Co. of 22 Anselm Terrace, Brighton 35, Mass., is activated by a miniature photocell which measures the light being reflected from the mirror into the driver's eyes.

Light striking the photocell is converted to an electrical impulse which, when amplified, operates the mirror when the glare would be blinding. The driver can adjust the point at which the mirror switches from the normal to dim position by a small dashboard control similar to a radio volume control.

Highway Engineering Productivity

Electronic computers are finding new uses in highway location and design. In addition to traffic analyses including origin and destination surveys and route analyses, the computers can be used for traverse calculations, earthwork computation, determination of excavation and embankment volumes.

In California, where some engineers are still reluctant to make use of the computation facilities, 50,000 traverse courses and 200 to 400 miles of earthwork computations are made per month.

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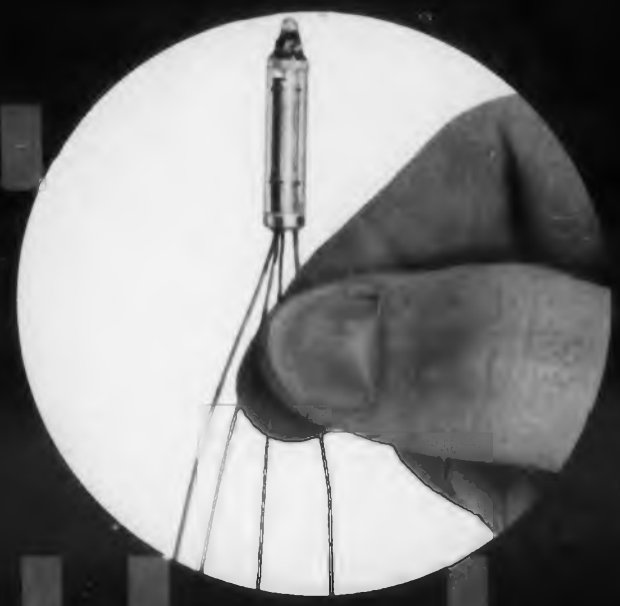
CIRCLE 5 ON READER-SERVICE CARD ▶



The tube that makes present computer indicator system designs obsolete . . .

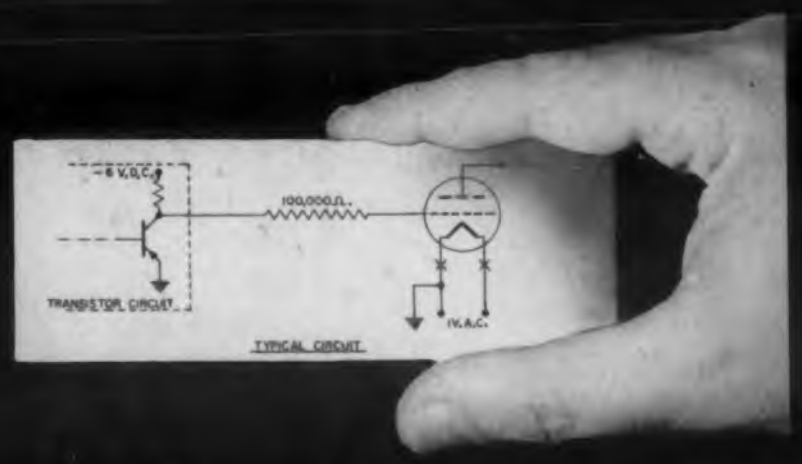
Amperex 6977

subminiature indicator tube

Monitors Transistorized Circuits

- with higher information density
- with simpler associated circuitry
- without ionization- and deionization-time problems
- with increased circuit protection
- with lower power requirements
- with lower cost per unit
- with ultra-compact assembly on printed circuit boards

The AMPEREX 6977 is a high-vacuum filamentary subminiature indicator triode which gives a bright blue-green indication when the control grid is at zero potential. It has been developed specifically for transistorized computers, where its high input impedance and small signal requirements enable it to monitor the transistor circuits without loading them and affecting their operation. It replaces the conventional and much more expensive high-voltage transistor and neon lamp combination so far used in transistor computers for the same purpose. Since its high input impedance permits the use of a series grid resistor, it will not short out the transistor circuit if it should ever fail. Manufactured with special computer tube techniques, the 6977 is designed for 20,000 hours life.



Heater voltage is only 1 volt, 30 ma. AC or DC. The anode will draw only 0.5 ma from a 50 volt DC supply during the zero-bias "on" condition. A 3.0 volt DC voltage is sufficient to cut off plate current and light. Write for data sheet to Semiconductor and Special Purpose Tube Division, Amperex Electronic Corp., 230 Duffy Avenue, Hicksville, L.I., N.Y.

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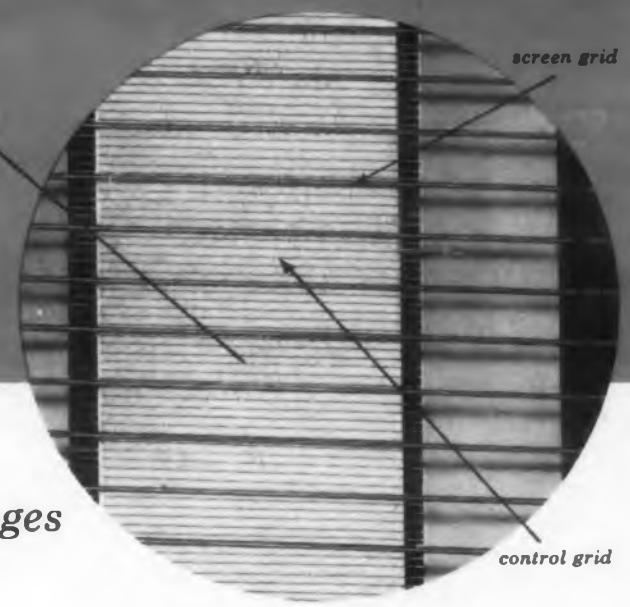

unsurpassed for low-power UHF transmitter applications . . . saves entire stages in original equipment design

AMPLIFIER, CLASS C, FM	*Operating Conditions*	
	C.C.S.	I.C.A.S.
Frequency	500 Mc/s	500 Mc/s
Plate Voltage	180 V	200 V
Screen Grid Voltage	180 V	200 V
Control Grid Bias	−20 V	−20 V
Plate Current	2x27.5 mA	2x30 mA
Screen Grid Current	11 mA	13 mA
Control Grid Current	2x1 mA	2x1 mA
Driving Power	1.0 W	1.0 W
Plate Input Power	2x5 W	2x6 W
Plate Dissipation	2x2.1 W	2x2.25 W
Screen Grid Dissipation	2 W	2.6 W
Output Power	5.8 W	7.5 W
Useful Power in Load	4.5 W	5.5 W

The Amperex 'FRAME-GRID' CONSTRUCTION insures extreme accuracy of interelectrode spacing, the secret of the 6939's brilliant performance. The relatively massive metal frame acts as a heat-sink, safely limiting control-grid temperature.

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. . . for applications engineering assistance on your communications tube problems

Engineering Review

Strain Gage Problems Studied

A new organization has been formed, called the Western Regional Strain Gage Committee, which is composed of aircraft manufacturers and governmental agencies located within the western region of the United States. Some 30 divisions of 14 industrial units are represented at the semiannual committee meetings. The purpose of the committee is to advance the art of measurements utilizing strain gages and strain gage devices through the interchange of ideas and experiences.

The group, which was founded early in 1956, operates as an independent unit and is not affiliated with other societies or organizations. Round-table discussions center around such items as fundamental properties of strain gage materials, strain gage aplications under high and low temperature problems, new requirements in strain gage properties or construction which users need in their applications, and general problems associated with strain gage measurements.

Tubes, Even Transistors, Obsolete

At the International Symposium on the Theory of Switching, Harvard University, several predictions were made concerning the future of tubes and transistors in large scale computers.

Dr. Theodore H. Bonn of the Remington Rand Div. of Sperry Rand saw the vacuum tube as obsolete for computers now being designed by the newer transistors and magnetic amplifiers. A second speaker, Dr. Herbert Callen, looked even further into the future and foresaw the eventual decline of the transistor in favor of new ferromagnetic films, which will carry the speed of switching to as little as one-billionth of a second.

Dr. Callen predicted a time when the upper limit of computing speed would be limited only by the time necessary for a pulse to travel from one point in a computer to another. The thin ferromagnetic film switch is theoretically capable of this speed equal to the speed of light.

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➤ CIRCLE 5 ON READER-SERVICE CARD

DU PONT

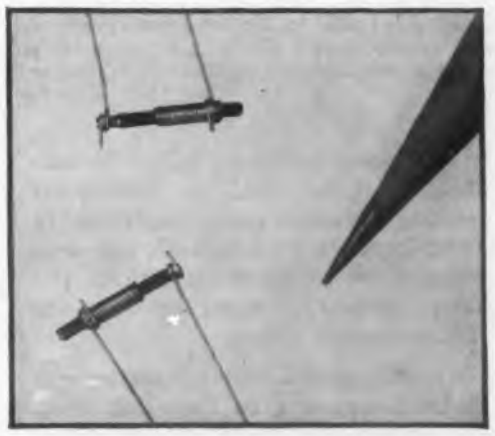
ELECTRONIC DESIGN NEWS

TEFLON®

Remarkable properties of Du Pont TEFLON® resins provide rugged, low-loss insulation for wiring

Use of TEFLON® promotes miniaturization of electronic parts

Owing to the high dielectric strength of Du Pont TEFLON—ratings are 500 to 4,000 volts per mil—insulation on wires can be exceedingly thin. Hence the heating due to current overload, which is always a critical factor with thin conductors, has less of an effect on TEFLON than on any other wiring insulation. Because TEFLON can operate hotter, it permits many miniaturization projects which would not be feasible without it. Miniaturization of coils, capacitors, brushes and other components is frequently possible because of the remarkable properties of wire insulated with TEFLON. TEFLON has opened up new fields of use for magnet wire, hookup wire, lead wire, coaxial cable and resistance wire. Tubing of TEFLON is available down to hairlike diameters. The coupon will bring more information.



These small capacitors use TEFLON as the dielectric. Their degree of miniaturization is shown by comparison with end of lead pencil.

Socony Mobil photo

"Datatron" solves the complex numerical problems of modern industry and commerce. Intricate wiring of the electronic computer is protected by slip-on insulation of Du Pont TEFLON 6 tetrafluoroethylene resin. (Computer by ElectroData Corporation, Pasadena, Calif.; "spaghetti" tubing supplied by Pennsylvania Fluorocarbon Co., Inc., Philadelphia, Pa.)

Designers of the Datatron high-speed digital computer took no chances with ordinary wiring insulation. Heat generation in this equipment cannot damage or age the sleevings of Du Pont TEFLON used to protect the conductors. TEFLON retains its toughness, flexibility and electrical characteristics to a rated 500°F. Soldering-iron temperatures will not burn or melt insulation of TEFLON. In assembly operation, TEFLON does not undergo shrinkage during soldering.

Other properties of this remarkable engineering material are often equally valuable in electronic devices. The arc resistance of TEFLON tetrafluoroethylene resin is outstanding. Its power factor of less than 0.0003 from 60 cycles to 3,000 megacycles guarantees low dielectric losses in high-frequency equipment. The volume resistivity of TEFLON is greater than 10^{18} ohm-cm, even after prolonged soaking in water. Surface resistivity is greater than 10^{17} ohms at 100% relative humidity. Applications are often based on the exceptionally low coefficient of friction of TEFLON. For example, "spaghetti" tubing is easily slipped over long conductors. Parts made of TEFLON will pass any salt-spray test. In fact, TEFLON is one of the most chemically inert materials known. Many electronic products depend on TEFLON to meet stringent MIL specifications.

The components you specify or design may well be improved by the use of protective, durable TEFLON. Further information can be obtained by mailing the coupon.

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TEFLON is the registered trademark for Du Pont tetrafluoroethylene resins, and should not be used as an adjective to describe any other product or any component part; nor may this registered trademark be used in whole, or in part, as a trade name for any product.

SEND FOR INFORMATION

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Engineering Review

200-Mile Microwave Links

A microwave system for the Air Force employing the principles of tropospheric scatter will permit single communication links up to 200 miles in distance. Operating at frequencies in the 7125 to 8500 mc band, development of the system has resulted in the design of a four-cavity klystron amplifier rated at 2000 w continuous power.

Developed by Philco Corp., Pa., the microwave system consists of two 28-ft parabolic antennas each of which has a gain of 54 db and projects a narrow beam-width of three tenths of a degree. The resulting high directivity is effective in reducing interference from aircraft in or near the scattering volume. Receivers have been improved because of the demand for lower receiver noise levels. As there is little correlation between signals received at points more than 100 wavelengths apart, the use of two receivers for diversity reception greatly increases the probability of finding a useful signal at one of the receivers. The outputs of the two receivers are combined in a diversity combiner which has eliminated the switching transient problem. For military use, the narrow beam-widths are expected to reduce the chance of signal interception, and the smaller number of stations necessary for the 200-mile jumps should lessen the chance of damage by enemy action.

Ionized Food for the Army

Preservation of fresh food by radiation instead of cooking or freezing will be studied by the Army in a $7.5 million ionizing radiation center at Stockton, Calif. Heart of the new center will be a giant electron linear accelerator built by Varian Associates. The machine, highest average power electron accelerator ever to be built, is slated for delivery in October, 1958.

Fresh foods for front line troops without need of refrigeration may become routine if the studies prove successful. The new accelerator will handle food packages up to six inches thick. These packages, containing such perishable foods as uncooked pork, chicken and vegetables, will be passed through the accelerator beams on a conveyor belt. They then may be stored many months without refrigeration because the accelerator's ionizing radiation destroys bacteria in the food.

Implemented by the Secretary of the Army and the Quartermaster General, the pilot production plant construction follows a recent program of feeding irradiated food to human volunteers. Frequent medical examinations of the volunteers have revealed no harmful effects from their irradiated diet.

Fluid Drop Acts as Switch

A switching device so tiny that a hundred million of them would fit on a surface one inch square are to be used in the memory circuits of large computers.

A paper given at the International Symposium on the Theory of Switching at Harvard University described the switch as a tiny droplet of light-sensitive fluid. The switch is similar to other two-state switching devices, except that the process here is chemical rather than electrical or mechanical. The fluid is photochromatic; that is, the drop may be changed from one state to another by exposure to different colors of light. The time necessary for this action is about one one-thousandth of a second.

The analogy between the chemical nature of this switch and the chemical nature of the brain was mentioned. Usually the physical or circuitry-network aspects of the brain are stressed rather than the chemical aspects. It was pointed out that the new fluid switch in some ways resembled these latter aspects.

The "Century Lamp" is Lit: An electric light bulb, a replica of Thomas Edison's first practical lamp, is expected to keep burning for more than 100 years on top of a desk once used by Edison. The bulb will glow night and day in the GE Research Lab during its long term of duty. Ralph J. Cordiner, president of GE, is switching on the lamp with a key which will be entrusted for safekeeping to the company's top research scientists. To housewives who may wonder why they cannot purchase bulbs like this and thus save many unnecessary trips to the neighborhood store, Mr. Cordiner remarked that the bulb is actually inefficient compared to ones commonly used, due to the materials used in its construction.

Engineering Review

Engineers as Managers

Fundamental intelligence, emotional stability, an understanding of people combined with ability to cope with their problems, integrity, health and enthusiasm were recently outlined as the fundamental requisites of the manager. A. J. Morgan, of the University of Dayton Research Center, went on to say before an AIEE meeting early this month, that the engineer has most of these qualities as well as some of the following executive abilities. He enumerated these as logical thinking, creative thinking, sense of money, organization of time and social sensitivity. The engineer, by reason of his training, possesses at least three of these fundamentals; fundamental intelligence, logical thinking and creative thinking, and he should thus maintain a distinct advantage over other candidates for a managerial position.

The vital interest in continuing the technological advances in modern civilization was mentioned. This interest stems not only from the comfort that these advances have given civilization, but from preserving what has been gained and what might be gained. If such an interest in technological advances continues to exist, it was concluded that this endeavor will require well trained and qualified management personnel with a greater technical background than was required in the past.

"Milk Bowl" Effect, Problem for Pilots

When an aircraft reaches a certain altitude, it no longer has the benefit of scatter lighting from the sun's rays. Instead sunlight becomes entirely direct and of very high intensity, with little of the light reflected into the pilot's cockpit. The resulting effect is that of looking from within a dark tunnel over a bright white sea of light, thus the name of the "milk bowl" effect.

The intensity of light to which the pilot is subject at this altitude often approaches 8000 ft-L, which, when compared to the usual illumination inside the cockpit, creates a blinding contrast. This contrast, coupled with the fact that the light source is from below—a particularly vulnerable region for the eye —results in extreme difficulty for the pilot in reading his instruments.

This problem, along with the general subject of lighting the modern commercial aircraft, was discussed in a paper given by Philip E. Massie of Day-Ray Products, Inc., Calif., at an Air Transportation Conference of the AIEE. According to the paper, attempt has been made to bring up aircraft meter panel illumination to 125 ft-c. This will still give a maximum brightness ratio of 65 to 1 between outside glare and cockpit lighting, but the normal ratio is not expected to reach this maximum.

Navy X-Rays Weapons

The installation of a new two million-v X-ray unit will make possible the nondestructive testing of defense materials and structures for the Navy. Casting will be evaluated with the X-ray unit before being sent to shipyards that build missiles or nuclear-powered vessels. Since disassembly for inspection will not be necessary, operation of the installation is expected to effect major savings in the over-all costs of quality control.

The unit, built by General Electric's X-Ray Dept. in Milwaukee, is housed in a newly erected concrete building that is large enough to permit entry of an entire railroad car or large truck. Construction requied 1200 cu yd of concrete. A well, extending the length of the building, contains paving and trackage to allow railroad cars and trucks to enter carrying items of major size or weight. Safety is emphasized throughout—the wall separating the control and exposure rooms is concrete 4 ft thick, with radiation traps and lead-lined doors added for fullest protection. Other walls are a full 2 ft in thickness. A 66-ton door which closes the main entry whenever the unit is in operation measures 2 ft in thickness, stands 18 ft high, and is 21 ft wide.

Material handling is facilitated by a separate 10-ton crane capable of handling almost any item likely to require the service of this installation. The Navy's Bureau of Ordnance already has initiated several programs that involve the new two million-v unit. In most cases these programs provide for nondestructive testing of assembled items, as opposed to previous requirements for destructive testing or the dismantling of test items, which necessitated reassembly before returning them to stock.

The massive concrete walls of this building house a two million-v X-ray machine for inspecting large weapons. To be used by the Navy, the unit is expected to save time and expense by making it unnecessary to disassemble articles for inspection.

Engineering Review

Glowing Phosphors provide Flat Light Source

A coating of phosphors suspended in oil between a metal and glass plate provide a two-dimensional source of light. The method, called "Rayescent" lighting, which is made possible by the phenomenon of electroluminescence, is currently being developed by the Westinghouse Lamp Division who have created a subsidiary organization to investigate the possibilities of the field.

Although electroluminescence is by no means a newly discovered phenomenon, it did not reach the level of feasible application until recently. The advantage of deriving light from glowing phosphors is that the metal-and-glass panels can be built directly into the walls, ceilings, or even floors, of a building. The "Rayescent" panels produce a cool, shadowless light which can be easily varied in respect to the brightness or color by turning a dial.

Research in electroluminescence has revealed other sources of light. One potentially important discovery is the possibility of deriving light from silicon carbide. In certain crystals of this material, there are locations which mark boundaries between areas having different concentrations of impurity. Electrons traveling across these boundaries lose energy in the form of light. This requires only a small potential of dc current as compared to the high frequency ac at high voltages necessary in a "Rayescent" panel.

Dr. John W. Coltman, manager of the electronics and nuclear physics department of the Westinghouse Research Laboratories, demonstrates how a weak source of light can control the much greater brightness of a "Rayescent" panel.

The panel, about one-eighth of an inch thick, consists of a coating of phosphors suspended between a metal and glass plate.

Nuclear Reactor Exhibited: The world's first mass-produced nuclear reactor, the AGN 201, has been demonstrated by Aerojet-General Nucleonics of San Ramon, Calif. Over 12,000 people saw the reactor at the Nuclear Congress in Philadelphia this March.

Some 200 scientists and engineers, including visitors from 20 "Atoms for Peace" countries were given the opportunity to sit at the control console and have complete and safe control over a nuclear chain reaction of fissioning and splitting uranium atoms.

Aid for Landing Aircraft

A device, called the Instrument Display Projector, provides at a glance essential information to pilots for completing an instrument landing, while at the same time allowing visual contact outside the airplane. Components of the system are a 1½-in. diam cathode ray tube; a mirror system; collimating optics, or optics that make light rays parallel, and a trichroic combining glass that uses a color contrast principle to enhance definition of the reflected image. With the color separation principle and conventional cathode ray tube, the instrument is capable of obtaining suitable image definition against a bright sky background.

An example of actual application of the instrument, developed by Autonetics Div. of North American Aviation Inc., would be the presentation of instrument landing system data for transport aircraft. In this case, the cathode ray tube image would reproduce the cross-pointer indication, artificial horizon, and a moving pip denoting deviation from desired approach speed. With this information appearing on the windshield display, the pilot could simultaneously assimilate such data and maintain visual contact with the runway. In operation, the cathode ray tube's image is reflected by the mirror system to the collimating optics and then to the color-separating combining glass. The combining glass is interposed in the pilot's line of vision immediately in front of the cockpit windshield.

Since the display is focused to infinity, flight data reproduced on the cathode ray tube appear to the pilot as a bright image suspended in space. As a result, the pilot has no eye accommodation problem, or one that would require him to transfer his visual attention from the tube image to objects outside the airplane.

Engineering Review

Wire's Frequency Measures Air Speed

A new technique for measuring vital flight test data is being utilized in the testing of Convair F102A all-weather supersonic jet interceptors at Edwards Air Force Base, Calif. Called a Vibratron Absolute Pressure Transducer, it is capable of measuring altitude and airspeed through changes in the tension exerted upon a 2-1/2 in. wire about the thickness of a human hair. Tension variations on the fine wire are sensed as extremely precise frequency changes which are readable as numerical indications at ground level.

The Transducer, developed by Borg-Warner Corp., Calif., consists of a fine wire stretched between a diaphragm and an anchor point within a magnetic field. The length of the wire and the tension exerted upon it determine the frequency at which it vibrates. When pressure changes resulting from variations in altitude or airspeed expand the diaphragm, the latter in turn reduced the tension on the wire and this tension change is then detected as a frequency change.

In actual operation during flight testing, two Vibrotron Transducers are utilized, one which senses total pressure and a second which senses static or barometric pressure. When these pressure signals are amplified and transmitted to ground level stations, the static pressure signal indicates altitude. Then by mechanical methods, the static pressure indication is subtracted from the total pressure indication to establish a plane's airspeed.

Trade Shows Challenged

A questionnaire was recently prepared by the RETMA Trade Show Survey Committee to determine the cost of exhibits to manufacturers and their opinion as to the value of trade shows. The survey is the result of the committee's alarm at the rising number of industry exhibits and shows throughout the nation. The value of such shows is questionable and it is the committee's intent to ascertain their actual effectiveness and utility.

Electronic Metal Detector

RCA has placed on the market a new type of metal detector specially developed for continuous electronic inspection of textile fabrics in production. The first production model of the textile inspector has been installed by Klopman Mills, Inc. of High Point, N. C. It can spot dot-size stray metal in strip material traveling at 10 to 1000 ft per min and can trigger alarm systems, stop production lines, activate warning signals or mark contaminated areas on the fabric.

The metal detector uses special coils to produce a high-frequency electromagnetic field which is distorted by stray metal. Field distortion creates an electrical signal which is fed to a control unit, amplified and used to trigger the alarm system.

The unit, which should protect product and production equipment, also is expected to have important applications in continuous inspection of plastics processed in sheet form.

Launch It-Yourself Rockets

Small, high-altitude rockets may shortly become commonplace university research tools for investigating the stratosphere. The great demand for trained scientists in the fields of rocket technology, telemetering techniques and upper atmosphere research has turned a number of universities toward high-altitude rocket research. This would make possible teaching advanced work which will gain in importance as means are developed for projecting vehicles into the space around the earth.

Maryland University, in collaboration with Republic Aviation Corp., has designed the Terrapin high-altitude sounding rocket, a 200-lb midget consisting of a modified ABL Deacon first stage and a Thiokol T-55 second stage which, in line with university requirements, is a low-cost vehicle that has the great advantage of being easily launched. This is the beginning stage of a small-rocket upper atmosphere program which will investigate many important high-altitude phenomena, such as cosmic rays, solar radiation, micrometeors, the earth's magnetic field, the day airglow and night airglow, the aurora, magnetic storms and others.

CIRCLE 14 ON READER-SERVICE CARD ➤

Washington Report

Herbert H. Rosen

Airways Control Board Proposed

President Eisenhower has sent to Congress a bill in which is recommended the establishment of the Airways Modernization Board. As an independent agency, it would be "responsible for developing and consolidating the requirements for future systems which are needed to accommodate the future air traffic in the U.S. Other responsibilities include systems engineering, and the evaluation and selection of such aids as will best serve the needs of aviation."

The plan was proposed, and presented virtually word for word, by the President's Special Assistant for Aviation Facilities Planning, Edward P. Curtis. He and his staff have made exhaustive studies for the past year. They found that our air traffic system is antiquated and under strength, but not for lack of scientific ideas. "In fact, an over-abundance of electronic systems have been developed in the laboratories to improve our terminal and enroute operations. Most of these have been shelved and never used," Mr. Curtis said. He cited the principal cause as the setting up such bodies as the Air Navigation Development Board with broad responsibilities but no authority to implement its recommendations.

The Airways Modernization Board will have such authority. It will specify new systems which will best serve all air navigation and traffic control. However, the Board will not have the authority to develop or procure the final ground or airborne equipments to be used in operations. Nor will it usurp the powers and authority of the Civil Aeronautics Administration, especially in light of its current expanded program aimed at equipping the airlanes for the jet transport age. There are indications, as well, that a final report from Mr. Curtis will make some sweeping recommendations for changes in the Federal Government organization of aviation matters.

Frank D. Newbury Resigns

Apparently bending to the attacks of the research community, Frank D. Newbury, Assistant Secretary of Defense (Research and Engineering), has resigned from his job. His office was established only last Feb. 25 when the research and engineering functions of the Department of Defense were

merged into one secretariate. Newbury has been a defense assistant secretary since 1953, when he left Westinghouse (and semi-retirement as a consultant) to help Charles Wilson set up a new secretariate for applications engineering. At the same time, Donald Quarles came in from Sandia Corp. to organize a similar secretariate for research and development. Quarles has more recently assumed the position of Deputy Secretary of Defense, the number-two job in the department.

Newbury's appointment to the research and engineering post precipitated an avalanche of derision from that portion of the scientific community believing he would relegate research to a secondary position. Although no final organization had been disclosed, feelings ran high that research programs in the Department of Defense would be largely curtailed or eliminated in favor of engineering programs leading to a weapon or system.

With the statement that he had originally agreed to stay for only six months (it stretched into four years), Newbury said it was past the time for him to bow out. Sources close to the Secretary say that the 76 year old engineer felt that the battle between research and engineering was just too much. A successor will be named some time in May.

Signal Corps and Industry Sponsor Reserves

A new twist in the military reserve program has been revived by the U.S. Army Signal Corps with the help of private industry. Last month Chief Signal Officer Maj. Gen. J. D. O'Connell and B. M. Grimes, Superintendent of the American Cable and Radio System in Washington, signed an agreement that established the 262nd Signal Company. By the agreement, ACR employees may become members of the Signal Company and hold their meetings in a training center supplied and maintained by the ACR. This idea of industry-service cooperation goes back to the Civil War. More than 400 units were in operation after World War II. But apparently the whole concept collapsed after that and has only recently been revived. This latest agreement with ACR marks the ninth in the Signal Corps. Most of the others are in the New York City area.

Members of the Signal Company have all of the benefits, rights, and responsibilities of any other reserve soldier. They will be "asked" to participate in the two-week summer drills common to such organizations. Eventually, they will be briefed on all of the new techniques and equipment being used in the Signal Corps. According to Brig. Gen. K. F. Zitzman, Chief of Personnel Training, "the (concept) offers a new kind of challenge to the tested relationship betwen the Communications-Electronics industry and the Army Signal Corps—for the first time in history we have a requirement for a large and truly ready reserve force."

Government Needs Engineers

Dear Sir:

There are many challenging job opportunities in engineering and physical sciences at the Diamond Ordnance Fuze Laboratories (DOFL), Washington, D.C. These research and development laboratories are a part of the Ordnance Corps, Department of the Army, and paid advertising for the purpose of recruiting personnel is not allowed. Your magazine reaches many engineers, physicists, chemists, mathematicians, and others in the field of physical science and engineering. As an additional informational service to such people, we believe you may wish to publish this letter in your Editors Column, as an announcement of employment opportunities.

The program at Diamond Ordnance Fuze Laboratories concerns interesting and vital defense work and practically every field of the physical sciences and engineering are utilized. Such typical fields are, electronics, physics, mechanics, applied mathematics, chemistry and optics. Research is carried on in such relatively new fields as microwaves, ferrites, transistors, printed circuits, and plastics. The programs include system analysis; invention and investigation of new approaches to fuzing, circuits, and mechanisms. There is work involving the design, development, laboratory and field testing of a new fuze or other related devices.

A qualified scientist or engineer coming to the Diamond Ordnance Fuze Laboratories can often choose the type of work preferred. There are good opportunities for advancement for those who demonstrate their professional growth, and there are college level courses both at the Laboratories and in nearby universities to help one advance in his field. The Diamond Ordnance Fuze Laboratories will pay the major part of such tuition costs, and allow time for attendance at such courses.

Employment applications (Standard Form 57) are available from any of the Civil Service Commission offices or post offices, or directly from Civilian Per-

Letters to the Editor

sonnel Office, Diamond Ordnance Fuze Laboratories, Washington 25, D.C.

Lawrence P. Conners, Chief
Civilian Personnel Office
Washington, D.C.

Dear Sir:

I am writing to ask if there is any possibility of your magazine helping government laboratories. I am an engineer at the Rome Air Development Center which has a significant role in the development of Air Force electronic equipment and techniques. It is important that RADC engineers contract to have industry's engineers work on the "right" jobs. To recognize what these "right" jobs are and formulate the best approach to their solutions requires a caliber of engineer at least as high as that of industry—and requires engineers in sufficient numbers.

Our government laboratories cannot spend funds for advertising to attract the quality and numbers of engineers they need.

In my opinion, RADC has a critical shortage of engineers—and the consequences of this shortage are more costly to the nation than the equivalent shortage of engineers in industry. . . . I am not representing RADC in this letter, but am writing as a private citizen.

Incidentally, I believe your magazine provides a valuable service to the industry.

William J. Blinn
Rome Air Development Center
Rome, New York

Correction

On page 50 of the April 1 issue, the "Improved Noise Blanker" produced by Hoover Electronics Co. appears with the photo of another product from the same company. Illustrated is the Subcarrier Oscillator designed for use in telemetering systems.

Meetings

May 16-18: Eighth Annual Conference and Convention, American Institute of Industrial Engineers

New York City, Hotel Statler. For information write to AIIE, P.O. Box 8, Substation 135, The Bronx 53, New York.

June 6-7: First National Symposium on Production Techniques

Hotel Willard, Washington, D. C. Sponsored by the IRE Professional Group on Production Techniques. Discussions will be held on "How to Prepare For and Implement Automation "and "Military Problems in Electronic Automation." Papers will be presented on "Designs for Production." For information, write to IRE, 1 E. 79th St., New York 21, N.Y.

June 8-12: Technical Career Conference

Sherman Hotel, Chicago. Sponsored by the Technical Career Council. For more information write Marcus W. Hinson, Technical Career Council, 19 S. LaSalle St., Chicago 3, Ill.

June 10-11: Second RETMA Symposium on Applied Reliability

Syracuse, N.Y., Hotel Syracuse. Symposium emphasizes the practical aspects of achieving reliability. Sessions will be held on mechanical design, selection and use of components, proof of mature design and case histories of reliable and unreliable designs. A panel discussion is planned on industry vs. military responsibility on contract and specification control for reliability. Advance registrations will be handled by the RETMA Engineering Office, Rm. 650, 11 W. 42nd St., New York 36, N.Y.

June 10-14: Fifth Annual Technical Writers' Institute

Rensselaer Polytechnic Institute, Troy, N.Y. Designed for those who supervise technical writing in business, industry and the professions. Sessions on manuals and instruction books, reports, technical promotion, training programs, industrial films and graphic and illustrative aids. For additional information, write Jay R. Gould, Director, Technical Writers' Institute, Rensselaer Polytechnic Institute, Troy, N.Y.

June 27-29: Thirteenth Annual Meeting of the Institute of Navigation

Washington, D.C. For more information, write to Peter C. Sandretto, Federal Telecommunication Laboratories, Nutley, N.J.

Aug. 20-23: Wescon (Western Electronic Show and Convention)

Cow Palace, San Francisco, Calif. Sponsored by the San Francisco and Los Angeles Sections representing the Seventh Region IRE and West Coast Electronic Manufacturers Association. For more information write to Don Larson, Business Manager, 342 N. LaBrea Ave., Los Angeles 36, Calif. For those interested in submitting papers, check the paper deadlines at the end of this section.

Sept. 4-6: Special Technical Conference on Magnetic Amplifiers

Penn Sheraton Hotel, Pittsburgh, Pa.

Oct. 31-Nov. 1: Third Annual Technical Conference of the Professional Group on Electron Devices, IRE.

Shoreham Hotel, Washington, D.C. Those interested in submitting papers should check the paper deadlines at the end of this section. For more information, write W. M. Webster, RCA Semiconductor Div., Somerville, N.J.

Paper deadlines

Aug. 1: Deadline for papers proposed for the Oct. 31-Nov. 1 conference of the **Professional Group on Electronic Devices, IRE,** in Washington, D.C. Abstracts should be submitted to the program chairman, W. M. Webster, RCA Semiconductor Div., Somerville, N.J. Subject matter should concern developmental techniques and devices, such as electron tubes and transistors, rather than basic research or circuit applications.

Correction

Appendix I of "Production Design of Compensated Attenuators," January 15, page 41, should be corrected as follows:

Equation (3) of appendix 1 should read

$$K = (R_1 + R_2)/R_2$$

The tolerances assigned to C_1 and C_2 should be $(n_1 \times 100)$ percent and $(n_2 \times 100)$ percent, respectively.

Near the bottom of page 41 of appendix 1, the limit should be $K \geqq 100$. At the bottom of the same page the extreme right hand term should be epsilon to the power $(-1 + m + n_2 + mn_2)$ rather than the product.

This is Part I of a two-part article on electronic equipment cooling. The subject of cooling is taking on increased importance as efforts are made to miniaturize and "force" more equipment into smaller and smaller packages. In this first part of the article, the author presents basic design principles of cooling and describes methods of natural air convection and metallic conduction. In the second part, to follow in the next issue of *Electronic Design*, other methods of cooling, including forced air cooling, will be described in detail to offer the designer means of making a selection for his particular application.

Cooling Packaged Electronic Equipment

I—Basic Design Principles

A. Donald Hay, Chief Engineer
McLean Engineering Laboratories
Princeton, N. J.

MOST electronic systems produce an appreciable amount of heat. If this heat is not purposefully removed, the temperature of the electronic components may well rise to the point where accuracy of calibration is impaired, the life of components is materially reduced, or the equipment fails. Thus the thermal design is as important as the circuit design, and both must be well executed.

The electronic engineer or physicist is normally much more familiar with circuit design than thermal design. An attempt will be made to survey the methods of cooling electronic components. Recommendations will be made indicating which type of cooling should be used, as a function of heat dissipation and other factors. Emphasis will be placed on forced-air cooling, as this requires engineering and covers the greatest proportion of the systems. The design methods will be explained so that a large proportion of the cooling problems may be solved by the electronics engineer. Sufficient background material will be given so that, if the cooling problem is to be turned over to another engineer or group, the electronics designer will know basically how the cooling design should be made and the terms used. A detailed explanation of heat transfer calculations cannot be made, but references to texts and manuals which elaborate on many of the methods described will be given.

Design Parameters

The designer must know at what temperature the components should operate and the maximum temperature, and often humidity, allowed. A series of electronic components is being developed which can, and indeed often must, operate at several hundred degrees centigrade. The upper limit for tubes is found in tube manuals, often about 100 C, and for common electronic parts other than tubes, 85 C. One common specification is that the air temperature surrounding the electronic equipment shall not exceed 10 C above the room ambient temperature, for normal room temperatures.

Thermal Design Principles

Several physical principles will be mentioned, since a knowledge of the processes depends upon their understanding. The rate of heat transfer in any given configuration is controlled by a difference in temperature. The heat flows from the hot substance to the cooler substance. If the transmitted heat is not removed from the cooler substance (of finite size), it will increase in temperature, thus decreasing the heat transmitted unless the temperature of the hot substance is also increased. This indicates that the thermal design should not be considered safe unless the designer can trace the flow of heat from the source through paths of adequate carrying capacity to an adequate "sink" to absorb the heat. The sink is normally a large body of air or water. If the temperature of the air in a room is controlled it may be considered a sink, while an uncooled electronic chassis may not.

Heat may be transferred from one substance to another by means of conduction, convection, radiation, or a combination of two or more of these methods.[1] Evaporation and condensation are characterized by a change of state. The basic equation is the same as for convection. For conduction and convection, the heat transfer is proportional to the difference in temperature between the two points under consideration. For radiation, it is proportional to the difference of the fourth power of the absolute temperatures. Because radiation often occurs simultaneously with conduction and convection, acceptable methods[2] have been developed to approximate the total heat flow by using only the first power of the temperature in order to simplify the solution.

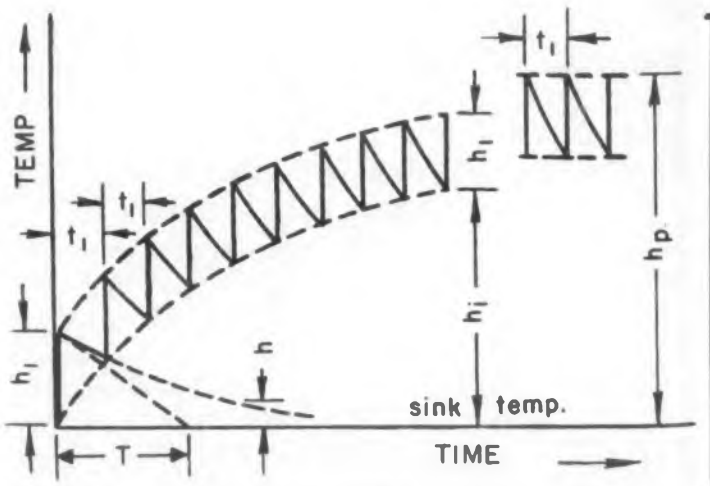


Fig. 1. Periodic Heat Pulses

Most heat flow calculations are based on one of the following rates of heat flow with respect to time. The most common is steady flow. Here the rate of heat flow is constant and the temperature at each point under consideration remains constant. Many of the equations found in literature apply only to a steady-flow analysis. Some electronic circuits involve short pulses of energy which dissipate heat, such as repeated condenser discharge. This condition is shown in Fig. 1.

The temperature after the pulse will drop exponentially. The convenient measure of this transient decay is the time constant, T, after which time the initial temperature ($h_i + h_1$) has dropped to (1/e) of its original value. Mathematically,

$$h = (h_i + h_1)\, e^{-(t/T)}. \qquad (1)$$

From this the initial slope of the curve is $-(h_i + h_1)/T$, as may be seen in Fig. 1. T is dependent upon the mass and specific heat of the hot body and upon the impedance of the thermal path in removing the heat. It may be computed from physical properties or found by measuring the transient by testing the equipment while recording the decay or by using equation (4).

The initial heat pulse raises the temperature of the equipment an amount h_1 above the sink temperature. At the end of n pulses the equipment temperature will be

$$h_1 \sum_{i-0}^{n-1} e^{-(i\ t_i/T)} = h_1 \frac{[e^{-(n\ t_i/T)} - 1]}{[e^{-(t_i/T)} - 1]}.$$

The maximum temperature, when n goes to infinity is

$$\frac{h_p = h_1}{[1 - e^{-(t_1/T)}]}. \qquad (2)$$

The expansion of the exponential

$$e^{-(t_1/T)} = 1 - \frac{t_1}{T} + \frac{t_1^2}{2!\,T^2} - \frac{t_1^3}{3!\,T^3} + \ldots$$

The substitution of the first two terms of the expansion for $e^{-(t_1/T)}$ in equation (2) gives

$$h_p = h_1\,(T/t_1), \qquad (3)$$

but this is accurate only for $t_1/T < 0.3$ as may be seen in Table 1.

Table I. Functions Of The Critical Ratio, t_1/T

t_1/T	$e^{-(t_1/T)}$	$1-(t_1/T)$	$1-e^{-(t_1/T)}$	R*
0	1	1	0	1.00
0.1	0.905	0.9	0.095	1.05
0.3	0.742	0.7	0.258	1.16
0.5	0.607	0.5	0.393	1.27
1.0	0.366	0	0.634	1.58
1.5	0.223	−0.5	0.777	1.93
2.0	0.135	−1.0	0.865	2.31
3.0	0.050	−2.0	0.950	3.16
∞	0	−∞	1.000	∞

* $R = (t_1/T)/1 - e^{-(t_1/T)}$

Table II. Comparison of Methods of Cooling

Method of Removing Heat within Unit	Maximum Heat Dissipation	
	Watts/in.² (for 40 C rise)	Watts/in.³ (sealed units)
Free air (nat. convection)	0.25	0.15
Plastic embedment	—	0.25
Metallic conduction	—	2–5
Forced air cooling	2	7
Direct liquid cooling	4	10
Vaporization cooling	7	20

Table III. Useful Dimensionless Ratios

Symbol	Name	Formulae
Pr.	Prandtl No.	$\frac{c\mu}{k}$
Nu.	Nusselt No.	$\frac{h_c L}{k}$
Gr.	Grashof No.	$\frac{g B \triangle t L^3 \varrho^2}{\mu^2}$
Re.	Reynolds No.	$\frac{L V \varrho}{\mu}$

Table IV. Engineering System of Units Free and Forced Convection Equations

Symbol	Nomenclature	Units
h_c	Convection coefficient of heat transfer	Btu/(hr—ft²—F°)
L	Characteristic length	ft
k	Thermal conductivity	Btu/(hr—ft²—F°/ft)
g	Acceleration due to gravity	4.17 x 10⁸ ft/hr²
B	Coefficient of thermal expansion	cu ft/(cu ft—°F)
ϱ	Density	lb/cu ft
μ	Viscosity	lb/(ft—hr)
c	Specific heat at constant pressure	Btu/(lb—F°)
V	Velocity	ft/hr

The above pulsed heating may be compared with the same equipment under steady state operation where the same average heat is dissipated. For equilibrium the heat emission or dissipation must equal the heat removed from the equipment. The pulsed input heat in watt-seconds equals KMC_ph_1, where K = heat conversion factor; M = weight; C_p = specific heat; and h_1 = temperature rise. The average rate of input heat equals KMC_ph_1/t_1 with no heat removal. At equilibrium the rate of heat removal must equal this. From equation (1) the rate of temperature drop is the slope of the curve with no heat supplied or h_s/T where h_s is the new steady state temperature above the sink temperature. The rate of heat removal equals KMC_p (h_s/T). Therefore for heat balance KMC_p (h_1/t_1) = KMC_p (h_s/T), giving the equation

$$h_s = h_1 \, (T/t_1). \tag{4}$$

A comparison of equations (3) and (4) shows that for values of $t_1/T < 0.3$ the maximum temperatures of pulsed and steady heating are about equal, and heating calculations based upon average heating would be safe. For pulsed circuits with values of $t_1/T \geqq 0.3$ equation (2) should be used, or equation (4) used and the right side multiplied by R of Table 1.

A variation of heat pulses is called transient heat flow. It consists of a single cycle approximated by an exponential curve on time-temperature coordinates, as for the heat pulse. The normal application is in determining the warm-up time or cooling time for a piece of equipment, and the same equations apply. Periodic heat flow is often treated in a similar manner to transient heat flow. If the heat is caused to flow through a non-homogeneous conductor, the analysis becomes difficult and the graphical methods[3] or analog computers[4] are very often used.

Some electronic components are sealed so that dust and moisture cannot enter to harm the parts, while other components are open to the convection of air for economy, ease of maintenance, and often better cooling. There are several ways to cool either kind of packaging. The basic methods are shown[5] in Table II and commented upon below. The numbers apply to packages approximately ten inches on a side and should not be applied to components which vary greatly from these dimensions as do transistors. If the external surface area of the device limits the thermal resistance to heat flow, the recommendations of dissipation in watts per square inch should not be exceeded. The tabulated values are only guides. The heat flow should still be analyzed by calculation.

Natural Air Convection

Consider first the cooling provided by the natural convection of free air. If the unit is sealed and has little vertical height, the natural convection currents within the unit will be small and the heat transfer will depend mainly on air conduction, radiation, and metallic conduction. Whenever a unit is sealed hermetically, it is important that dry air is enclosed (instrument air) in order to avoid moisture condensation within the unit when the temperature drops below normal. If the seal is not perfect, it is well to pressurize the unit slightly with instrument air admitted through a regulating valve. The transfer of heat through the gaseous conduction may be increased by employing a gas with a high thermal conductivity such as helium or hydrogen. The radiation is normally quite small, but on aluminum base the heat transfer by radiation may be approximately doubled in going from an etched or light anodized surface to a dark anodized surface or black crackle lacquer. The heat removal by metallic conduction is especially important for sealed units using natural convection, and use should be made of the available opportunities.

Usually the first thermal resistance that impedes the release of heat is the film coefficient which surrounds the normally small heating surface. Subsequent resistances, or impedances, are usually smaller. The basic equation for the free convection film coefficient for any fluid is:

$$Nu. = c(Gr.)^m \, (Pr.)^n.$$

The constant c is from 0.35 to 0.71; the values of m and n are about 0.25 and are tabulated in heat

transfer texts.[5,6] The equation relates the pertinent dimensionless ratios so useful in fluid mechanics and thermodynamics. Those mentioned here are shown in Table III. Inspection will show the inclusion of the gas properties needed to create natural convection currents and carry heat.

Open units usually create a more effective "chimney effect" to cause the circulation of gas caused by different densities and temperatures of gas. Graphical solutions have been developed to determine the heat transferred by natural convection and radiation.[5,6] These save much time in executing the thermal design.

Plastic Embedment

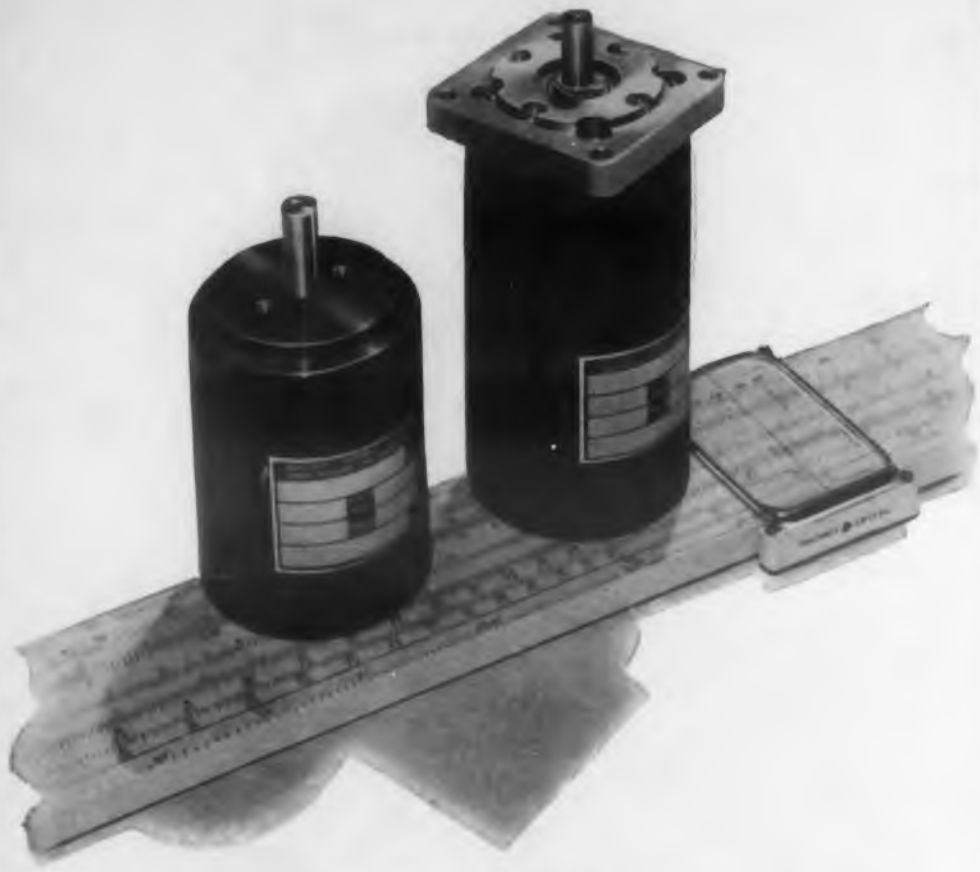
Table II shows that sub-assemblies may be potted or embedded in plastic with only a slight increase in heat dissipation. The potting is usually done for protective purposes, but the embedment materials currently available cannot withstand temperatures over 185 C. The heat transfer may be improved by incorporating metal heat conductors in the plastic.

Metallic Conduction

All electronic components must be held by some means, and, through the use of good heat conductors to support the components, much heat can be effectively drawn toward a cool sink. Several principles should be kept in mind. Miniature tubes dissipate much heat, and this may be conducted away through a proper heat shield-support and through short leads. The shield should conform to the tube shape and touch as much of the cylindrical shape as possible to avoid air films with associated thermal resistance.[5] For best results the shield should be screwed into or soldered to the chassis to provide a good heat path. The chassis should be metal, preferably aluminum or copper, to conduct the heat toward the sink. The same principles apply to resistors, but they dissipate less heat than tubes. For best results provide short, sturdy, tight-fitting, metallic paths for the heat to follow. If convenient, attach the assembly to the hull of a ship or its equivalent to acquire a good heat sink.

References

1. *Heat Transmission*, W. H. McAdams, McGraw-Hill Book Co. Inc., 1954.
2. *Industrial Heat Transfer*, F. W. Hutchinson, The Industrial Press, 1952.
3. *Refrigeration and Air Conditioning*, B. F. Raber and F. W. Hutchinson, John Wiley and Sons, Inc., 1945.
4. Application of Difference Techniques to Heat Flow Problems Using the Electronic Differential Analyzer," R. M. Howe, AIR-10, Dept. of Aeronautical Engineering, University of Michigan, 1954.
5. "Guide Manual of Cooling Methods for Electronic Equipment," Navships 900, 190, No. 27X, Supt. of Documents, U. S. Govt. Printing Office, $2.00, 1955.
6. "Heat Transfer in Miniaturized Electronic Equipment," Navships 900, 189, No. 26X, Supt. of Documents, U. S. Govt. Printing Office, $1.25, 1955.



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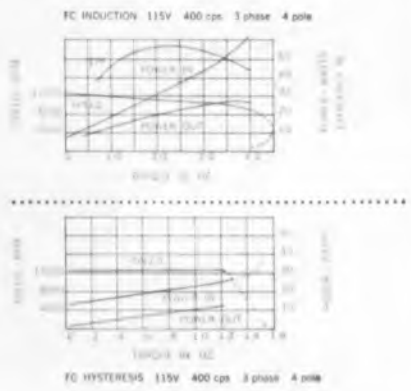
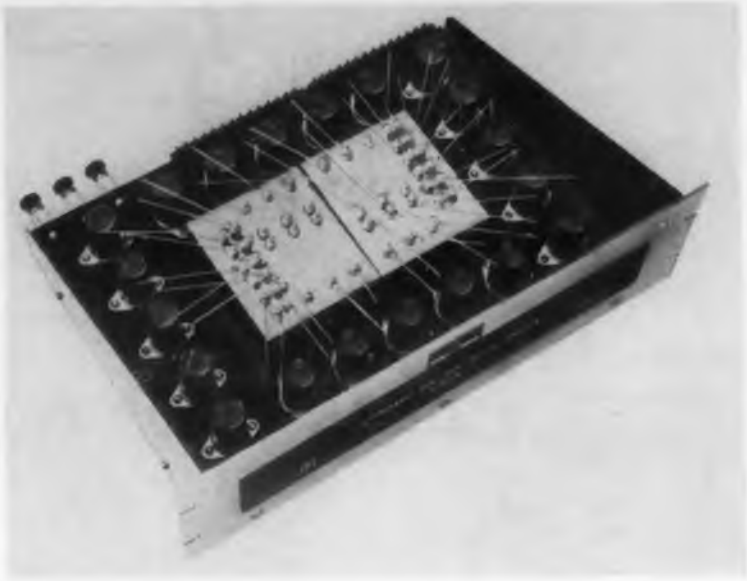


CIRCLE 23 ON READER-SERVICE CARD FOR MORE INFORMATION



High Accuracy

Relay

Accuracy ten times greater than hitherto available is provided by a new relay operated voltage divider. This highly stable reference standard with a resistance and ratio accuracy of 0.001 per cent is particularly suited to experimental applications. It is useful as a programmable standard in automatic measurement or readout. In combination with suitable circuitry it is the heart of an automatic reading digital voltmeter, current meter, ratiometer or bridge.

The unit, developed by Julie Research Labs., 556 W. 168 Street, New York 32, N.Y., may be set up manually from a switch bank, or it may be programmed automatically from punched cards or tape.

Highly accurate and stable resistors, hermetically sealed in a metal case which provides electrostatic shielding and isolation from environmental effects, are connected to twenty relays by aerial bus wiring to maintain high leakage resistance. Overall resistance available as a voltage divider or rheostat is 100 K with a resolution of one ohm. The temperature coefficient is 5 ppm per deg C.

The relays in the instrument will operate in 10 msec, making the instrument suitable for automatic control. Using auxiliary equipment, the voltage divider may be time shared to perform several functions as the occasion demands. The instrument is available with the relays coded in a five-decade binary or binary-coded decimal form.

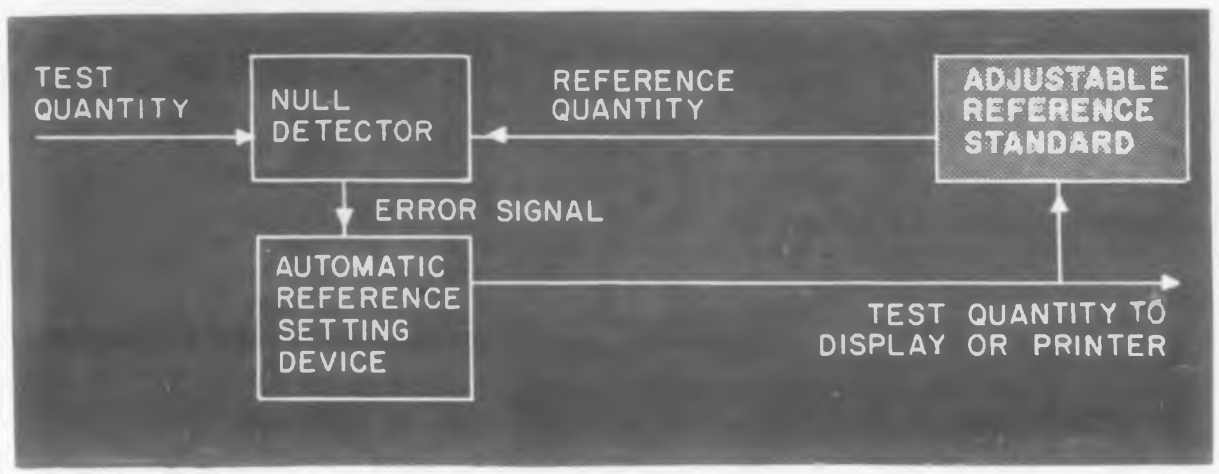


Fig. 1 For automatic test quantity measurement, the null detector generates a signal representing the difference between the unknown and the voltage divider output. A reference setting device re-adjusts the divider till the error vanishes.

Operated Voltage Divider

In experimental applications, where test quantity magnitude is important, the divider is used with a null method as in Fig. 1. Here, in a closed loop system, an error signal is fed to the automatic reference setting device whose coded output is sent to the relay operated voltage divider which is used as an adjustable reference standard. This generates a quantity equal in magnitude to the test quantity. The coded output of the reference setting device is a representation of the test quantity and may be read out or printed.

Fig. 2 shows the use of the divider in a calibrated error detector. The divider is used here, also, as an adjustable reference standard. The theoretically desired test quantity is programmed into the reference setting device by card, by tape reader, or manually from a keyboard. The reference standard generates the reference quantity which is compared with the test quantity by an error detector. This generates the error quantity which is read out or printed. This method is desirable in automatic testing since the error is presented directly, obviating the need for additional computation to obtain error plots.

The instrument, called the RVD-105A comes in a fully shielded chassis which mounts in a standard 19 in. relay rack, is 5¼ in. high and 12 in. deep. For more information on relay operated voltage divider, circle 24 on the Reader's Service Card.

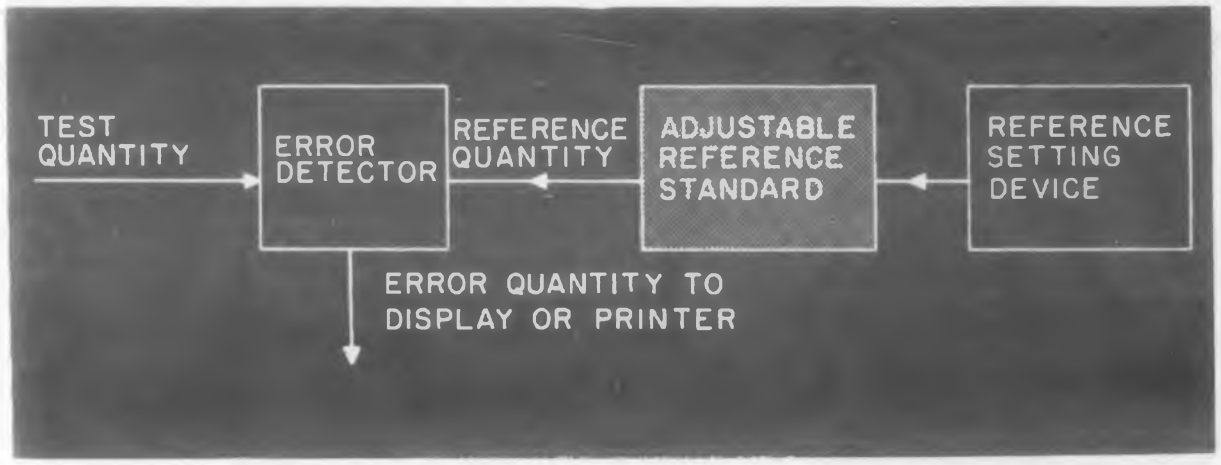


Fig. 2 Automatic measurement of error or deviation is facilitated when the voltage divider is used in this calibrated error detector arrangement.

The Cryotron—A New Computer Device

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Dept. of E.E.
The City College
New York, N. Y.

The Cryotron is a new type of computer element which has recently been developed by Dudley A. Buck at M.I.T. It is small, light, and dissipates little power. It is estimated that a large-scale digital computer could be packed in about one cubic foot, exclusive of cooling and terminal equipment, and dissipate about one-half watt. This bit packing density and power requirement is far better than could be expected with any other present-day computer element. Because of this the Cryotron holds promise of becoming one of the major components of future digital computers, and Cryotron research is now being conducted in many industrial laboratories throughout the country.

CRYOTRON operation is based upon the phenomenon of superconductivity and the fact that this conductivity can be destroyed by the application of a magnetic field. Superconductivity was discovered by H. K. Onnes at Leiden in 1911 who noticed that the electrical resistance of metals disappears (zero ohms) at temperatures close to absolute zero. The fact that the resistance becomes truly zero can be demonstrated by Professor S. C. Collins of M.I.T., who has a lead ring in which an electric current of several hundred amperes has been flowing without any change in magnitude, from the time it was induced three years ago. It was also noted by Onnes and his coworkers that the transition temperature at which superconductivity takes place is a function of the magnetic field which may be present. The transition temperature approaches absolute zero as the magnetic field is increased. This effect is independent of the orientation of the magnetic field with respect to the superconductor. Figure 1 shows how the superconductive transition temperature of Tantalum varies with the magnetic field. It can be seen from this curve that if the temperature

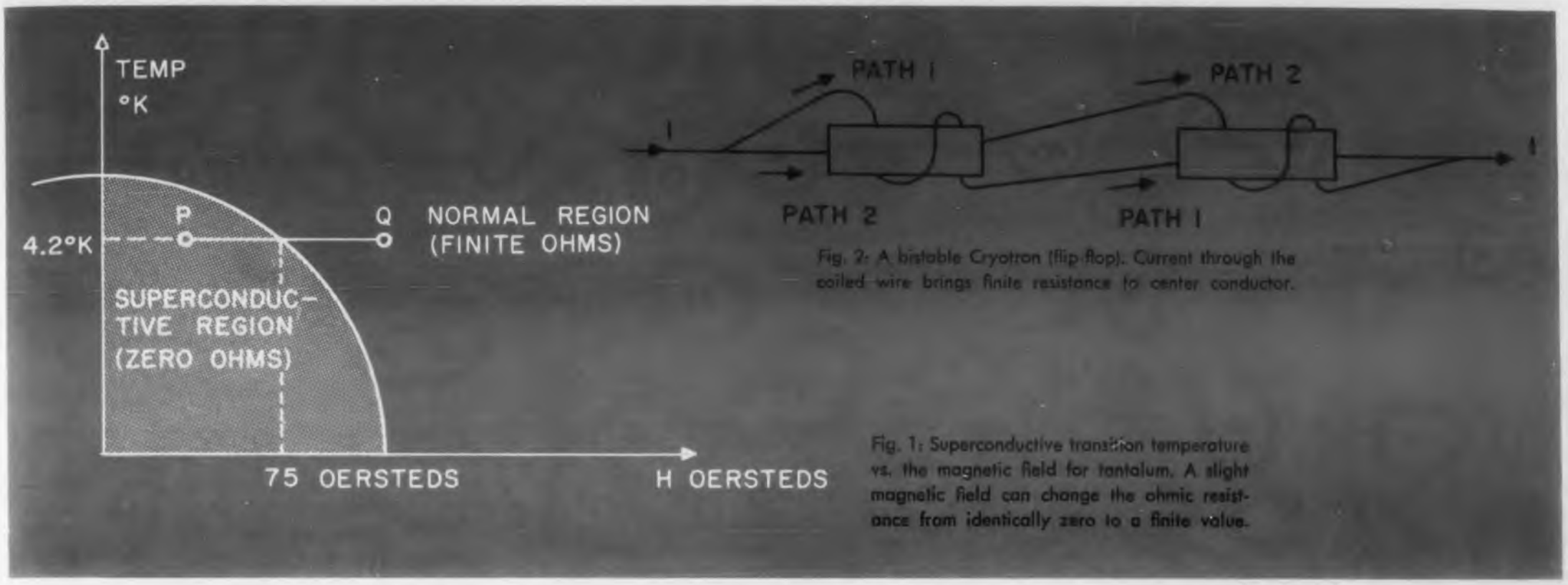

Fig. 1: Superconductive transition temperature vs. the magnetic field for tantalum. A slight magnetic field can change the ohmic resistance from identically zero to a finite value.

Fig. 2: A bistable Cryotron (flip-flop). Current through the coiled wire brings finite resistance to center conductor.

is held constant and the magnetic field varied, the ohmic resistance of the Tantalum can be changed from identically zero to a finite value. This is equivalent to traversing the horizontal line PQ in the figure. The zero and finite resistance represented by points P and Q are used as the two stable states for a binary digital computer element.

In a typical Cryotron, the resistance being controlled is a one inch 9 mil. diameter Tantalum wire. Tantalum has been used because its superconductivity can be controlled by small magnetic fields (50 to 100 oersteds) at a temperature of 4.2 K which is conveniently the boiling point of liquid Helium at atmospheric pressure. Thus, the Cryotron can operate in an open bath of liquid Helium. The other wires used in the Cryotron are made of Niobium which has a high transition temperature compared with Tantalum, and remains superconductive over the entire range of magnetic field variations. A single Cryotron gate unit consists of approximately 250 turns of insulated Niobium wire (3 mil. diameter) wound around the 1 inch Tantalum wire. The Niobium winding functions as a control winding. When the current through it gets greater than about 100 to 200 ma, there is enough of a magnetic field present to cause the resistance of the 1 inch Tantalum wire to switch from zero ohms to approximately 8 milliohms. The Tantalum wire functions as a switch or gate controlled by the control winding; the ratio of open to closed circuit resistance being infinite.

Figure 2 shows two Cryotron gate units wired as a bistable (flip-flop) element. The control winding

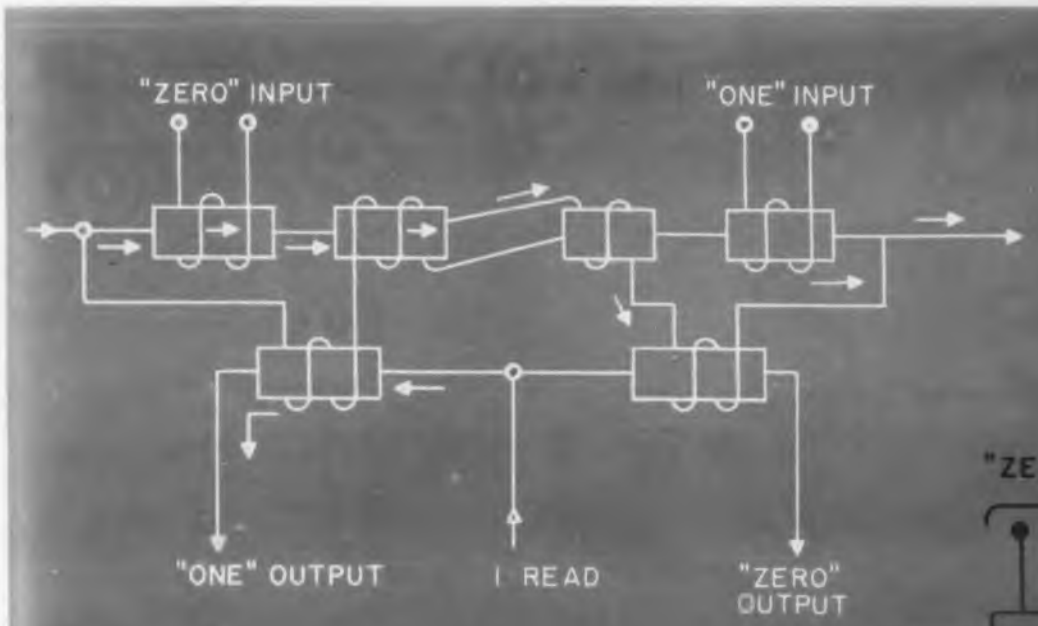

Fig. 3: A Cryotron flip-flop with read-in and read-out gates. The arrows indicate the current path when storing a "one".

Fig. 4: A Cryotron flip-flop with "OR" inputs.

of one unit is connected in series with the center Tantalum wire or gate of the other unit and vice versa. If the combination is connected to a constant current source, the current can flow continuously only in one or the other of two possible paths as shown in the figure. Once a current path is chosen it creates a resistance in the alternate path thereby blocking current flow in the alternate path. This in turn assures zero resistance in the chosen path and the current flow is firmly established. The flip-flop can be placed in any desired state by adding a Cryotron gate in series with each side of the flip-flop. Pulsing one or the other of these input gates places finite resistance in one side of the flip-flop and causes the current path to switch accordingly.

The status of a Cryotron flip-flop can be sensed by the addition of two more Cryotrons, placed with their control windings in series with the control winding of the flip-flop elements. One or the other of the sensing Cryotron gates will always be in the superconductive state depending upon which one has its control winding in the conducting half of the flip-flop.

Figure 3 shows a Cryotron flip-flop arrangement with read-in and read-out Cryotron gates. The arrows indicate the current path when storing a "one."

Various other types of computer elements can be made from Cryotrons. An "or" operation for setting the flip-flop can be obtained by adding any number of Cryotron input gates in series. In this way, any one of the input gates can be used to set or reset the flip-flop (Figure 4). Similarly, an "and" operation may be obtained by shunting the control windings of the input gates with other Cryotrons as shown in Figure 5. It can be seen that current will flow through the input gate control winding and set or reset the flip-flop only if all of the shunt gates are resistive. If any one of the inputs is absent its gate will act to bypass the input gate control current. In this connection it should be noted that in the case of two parallel superconductors the current divides inversely as their inductances. Figure 6 illustrates a Cryotron decoding switch to convert a 3 bit binary input into an octal output. It can be seen that, depending upon the 3 bit binary input, one and only one of the Tantalum gate elements will have zero magnetic field and be superconductive. The output current will then flow through this element.

The Cryotron operates at the temperature of liquid Helium; however, this operating temperature can be achieved relatively easily today and Helium liquifier units are commercially available. The bath of liquid Helium is held in a thermos type container with liquid Nitrogen in the jacket. The cooling unit recirculates the Helium and the Nitrogen.

The average power dissipation of a Cryotron unit is of the order of one-tenth milliwatts. Batteries are used as the power supply for most Cryotron work today. The current drain is usually large (the voltage requirement is small) and eventually special

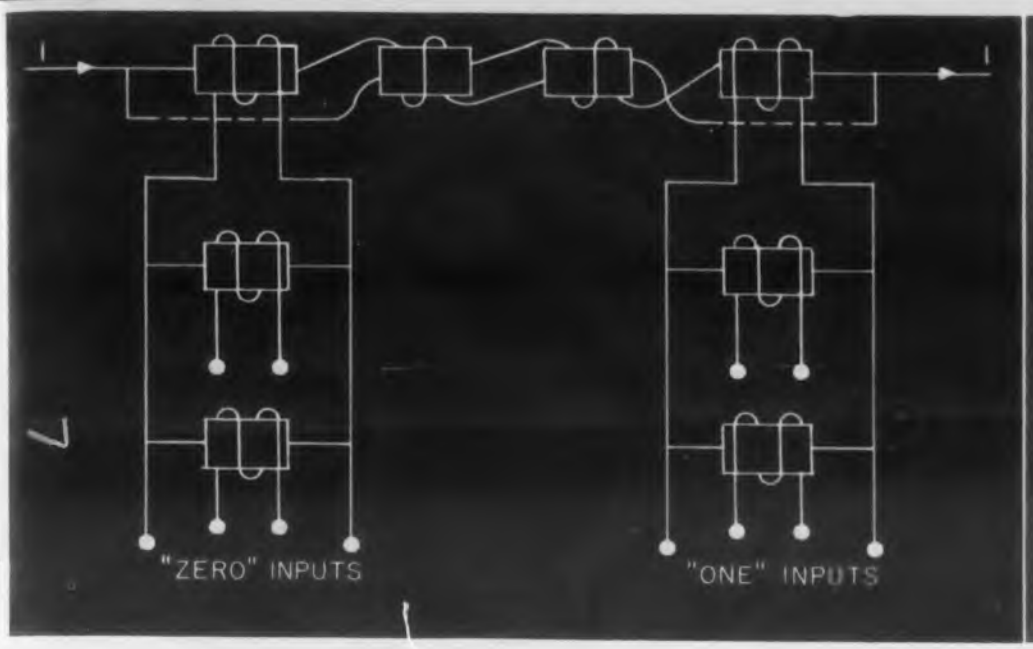

Fig. 5. A Cryotron flip-flop with "AND" inputs.

power supplies will be necessary.

One of the major disadvantages of the Cryotron is that switching time is but slightly faster than relay speeds, a far cry from the megacycle requirements of modern day computers. However, this problem is being studied and it appears to be only a matter of time before higher speeds will be achieved. Reports from the laboratories indicate that switching speeds up to 10 kc have been obtained and that millimicrosecond switching time is held within the realm of possibility.

Note: Many of the theoretical ideas and applications discussed here are based on the work of Dudley A. Buck and his paper which is listed among the references.

Bibliography

D. A. Buck, "The Cryotron—A Superconductive Computer Element," IRE; April 1956

D. Schoenberg, "Superconductivity," Cambridge University Press, Cambridge, England; 1952

F. London, "Superfluids," John Wiley & Sons, Inc., New York, N.Y., vol. 1; 1950

B. Serin, "The Magnetic Threshold Curve of Superconductors," ch. VII, "Progress in Low-Temperature Physics," edited by C. J. Gorter, Interscience Publishers, New York, N.Y.; 1955

T. E. Faber, "The phase transition in superconductors II. Phase propagation above the critical field," Proc. Roy. Soc. A, vol. 219, pp. 75-88; 1953.

A. B. Pippard, "Kinetics of the phase transition in superconductors," Phil. Mag., vol. 41, p. 243; 1950.

T. E. Faber, "The phase transition in superconductors III. Phase propagation below the critical field," Proc. Roy. Soc. A, vol. 223, pp. 174-194; 1954.

C. A. Swenson and A. G. Emslie, "Low-temperature electronics," Proc. IRE, vol. 42, pp. 408-413; Feb., 1954.

W. H. Keeson, "Helium," The Elsevier Press, Inc., New York, N.Y.; 1942.

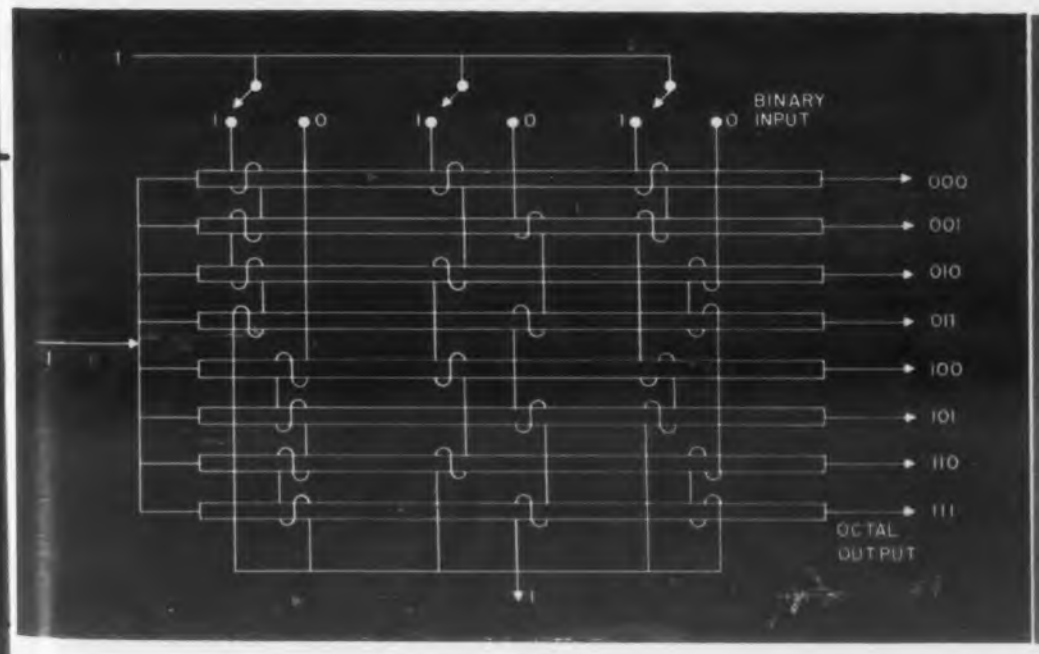

Fig. 6. A Cryotron decoding switch to convert a three-bit binary input into an octal output.

Fig. 1. Direct-printed circuits on cylindrical and conical surfaces. Circuits can be printed inside or on both sides of tube. The truncated cone is a depolarizing element of a discone-type antenna.

Direct-Printed Ci

FOR THE design engineer with difficult space requirements to cope with, these direct-printed circuits may be of particular value. They can be made to conform to almost any degree of flexibility or geometric.

These circuits are not etched; they are printed directly on a base material, using silver inks. The inks will bond well to cellophane, cellulose acetate and butyrate, vinyl chloride and acetate, acrylics, styrenes, polyesters, Mylar, CR-39 resin, phenolics, epoxies, silicones, melamines, Kel-F, Teflon, mica, ceramics, glass, paper and wood (in case you have any wooden circuits). Manufactured by the J. Frank Motson Co., Flourtown, Pa., the circuits have a wide variety of applications from printed antennas to rotors, commutators and wave guides, can be used in ambients up to 500 F.

Three basic silver inks are used. The K59 and C93 type inks (see Table) require heat to harden, while the C37 ink hardens at room temperature. Circuits printed with K59 may be dip- or iron-soldered. Each type of ink can be modified without changing its essential properties to meet flexibility, resistivity and bond requirements. By substitution of carbon for silver, square resistivities of 20 ohms to 100 meg may be obtained.

A comparison of copper-clad stock with Motson printed circuits shows that 0.0013 in. clad stock has about 50 times the conductivity of 0.001 in. K59 ink, the thickness usually applied. Solder-dipping of the silver ink reduces this difference to a 10 to 1 ratio, while electro-plating can provide conductivity

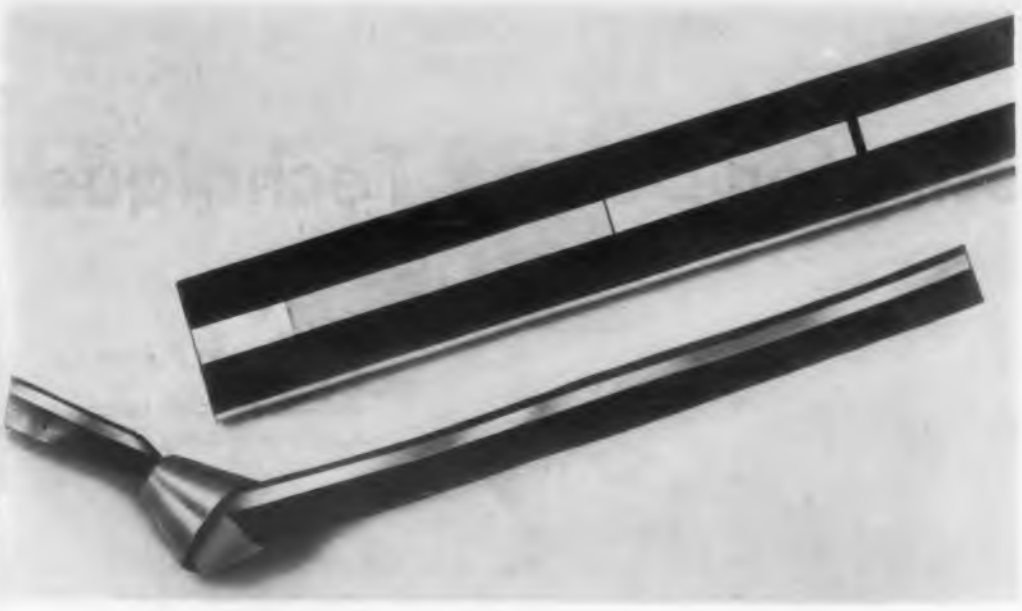

Fig. 2. Microwave strip line filter (top of photo) consists of solderable silver printed on both sides of Teflon material. The spaces between strips are accurate to 2 mils and the front-to-back register is held to within 5 mils. In the bottom of the photograph the flexibility of a circuit printed on 5 mil Teflon and plated with ductile copper is shown.

Circuits

equal to that of clad stock. The peel strength of soldered K59 ink is approximately 12 lb per in.

In general, the thickness range of the ink deposit is between 0.0002 and 0.0018 in. and can be held within ±10 per cent in critical applications. Pattern tolerance can be held to ±0.001 in. in special cases.

Note that the inks themselves are not for sale. They were developed by the Motson Co. for use in the manufacturer of direct-printed circuits.

For further information on these circuits, turn to the Reader's Service card and circle 30.

Properties of Basic Conductive Inks

Square and volume resistivities depend somewhat on cure temperature, with higher temperatures giving lower resistivities.

Ink Types	K59	C93	C37
Heat stability, F	500	300	180
Minimum curing temp, F	350	200	70
Organic solvent resistance	Good	Good	Poor
Water resistance	Very Good	Very Good	Fair
Aliphatic hydrocarbon solvent resistance	Very Good	Very Good	Good
Resistance—50 per cent H_2SO_4	Very Good	Very Good	Fair
Resistance—ethanol	Very Good	Good	Poor
Square resistivity, 0.001 in. thick, ohms per square at 70 F	0.016	0.03-0.05	0.05-0.30
Per cent rise in resistivity with 100 F rise in temperature	11-14	10-12	10-14
Volume resistivity, ohm-cm x 10^{-5}	4.1	7.0-11.7	11.7-70
Load carrying capacity at 110 v. Amps per 0.060 in. line 0.001 in. thickness, on glass	Over 8.0	Over 8.0	Over 8.0
Scratch resistance (on glass)	Very Good	Very Good	Fair to Poor

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No wonder the new Silic-O-Netic Time Delay Relay has aroused such interest. It offers basic advantages as a delay device unequalled in its low price range.

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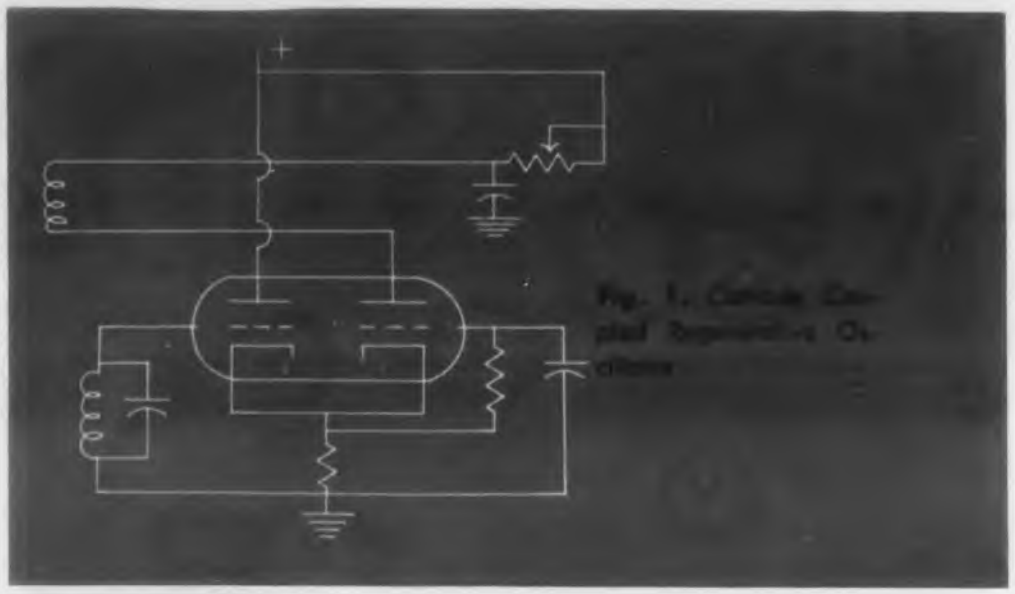


Oscillator Design Techniques

Keats A. Pullen, Jr.

Ballistic Research Laboratories
Aberdeen Proving Ground, Md.

THE DESIGN of oscillators requires the design of two elements, first an amplifier, and second a frequency selector circuit. The amplifier must be able to provide enough amplification to offset the loss in the frequency selector circuit. The frequency selector circuit, on the other hand, must provide maximum feedback with the proper phase angle at the desired oscillation frequency. A corollary requirement is that the effective Q of the frequency selector circuit should be as high as possible in order to provide the best possible frequency stability. This requirement means that the effect of rectification and conductance loading on the frequency selector circuit should be reduced to the lowest possible value in all oscillators.

Notes on Oscillator Theory

The development and maintenance of oscillation in oscillators have been shown to result from amplification of noise by the oscillator circuit.[1] Theoretical non-linear mechanics analyses[2] show that two types of conditions can produce oscillations in a non-linear circuit. In the first of these, a phase plane plot of resonant circuit current against the derivative of the current will show two things: that a limit cycle will be formed and that establishment of a set of conditions corresponding to any point in the phase plane within the limit cycle will degenerate in time to a point cycling around the limit cycle (oscillation). In the type two oscillatory condition, establishment of conditions corresponding to part of the area within the limit cycle does not lead to operation on the limit cycle, whereas establishment of conditions in the other parts of the area within the limit cycle does produce operation around the limit cycle.

Electronically, most oscillators are of the type one, or completely unstable, variety. Motorboating amplifiers frequently are of the type two, or semi-stable, variety. Such an amplifier does not motorboat until it has been shocked into vibration. Physically, the difference between the two conditions may be described as follows. If the overall loop amplification of the amplifier is greater than unity at the nominal starting condition and all other positions within the limit cycle, and gradually reduces to unity due to some cause —such as rectification biasing—as the oscillation amplitude builds up, the type one condition may be said to exist. If, on the other hand, the loop gain is somewhat less than unity and stays less than unity for small changes in operating conditions, in a given area, but builds up to greater than unity for a reasonably large change of operating condition, the type two condition exists. If the amplification is only slightly greater than unity at its highest point on the limit cycle (the average value is unity over the entire cycle), the cycle is

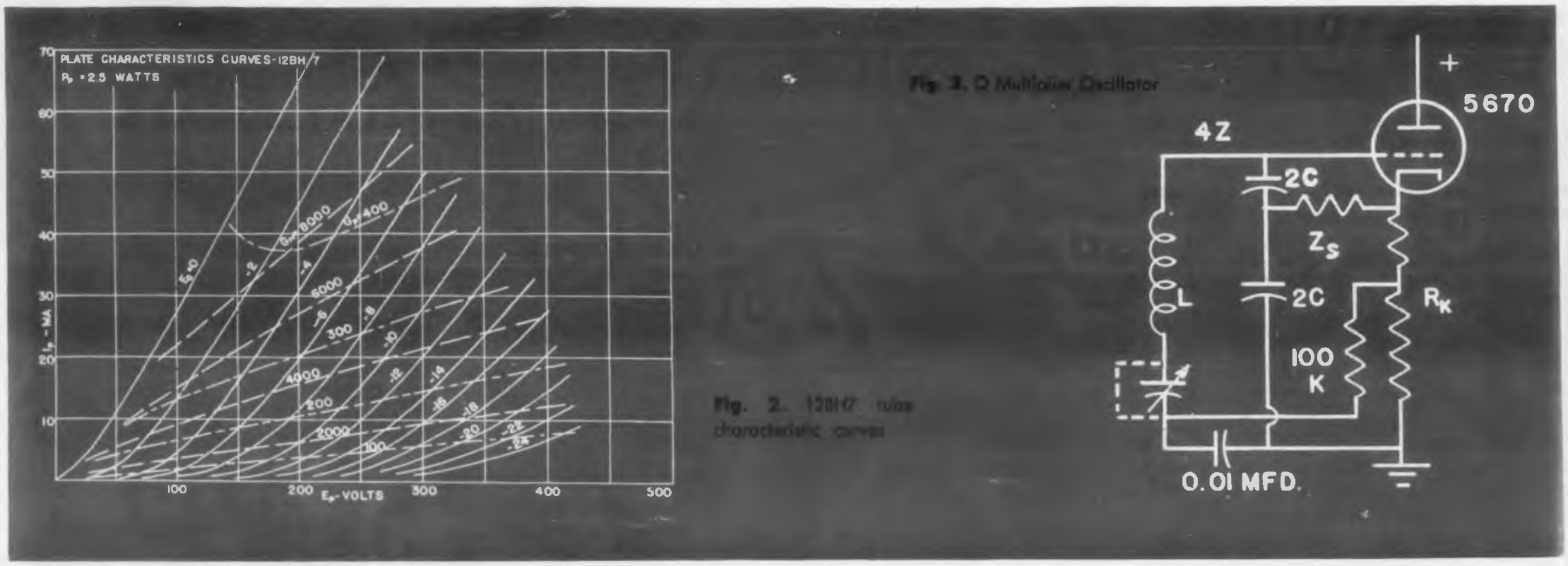


Fig. 2. 12BH7 tube characteristic curves

Fig. 3. Q Multiplier Oscillator

Using Conductance Curves

approximately circular and sinusoidal waveforms can be obtained at the preferred frequency. The smaller the variation of loop gain from unity at different points along the limit cycle, the smaller is the distortion and the better the frequency selecting network Q.

A Special Regenerative Detector and Oscillator[3]

The following design may be used as a regenerative detector with a *5670/2C51W* dual triode, or as a power oscillator with a *12BH7* dual triode (Fig. 1). This circuit is a modification of the tuned grid oscillator or regenerative detector. Tickler to tuned circuit feedback is made as loose as possible to minimize loading. The tuned circuit feeds a cathode follower to minimize direct loading. Limiting of amplitude is obtained by rectification biasing the grounded grid amplifier. The rectification loading then does not affect the tuned circuit Q.

The voltage amplification of this cathode coupled amplifier is approximately

$$VA = \frac{g_{m_1}\, g_{m_2}\, Z_K\, Z_L}{1 + (g_{m_1} + g_{m_2})\, Z_K} \tag{1}$$

or the forward admittance is

$$Y_f = \frac{i_e}{e_{gc}} = \frac{g_{m_1}\, g_{m_2}\, Z_K}{1 + (g_{m_1} + g_{m_2})\, Z_K} \tag{2}$$

For the feedback circuit,

$$e_c = Q_c\, K_{cp}\, \frac{n_c}{n_p}\, X_p\, i_p \tag{3}$$

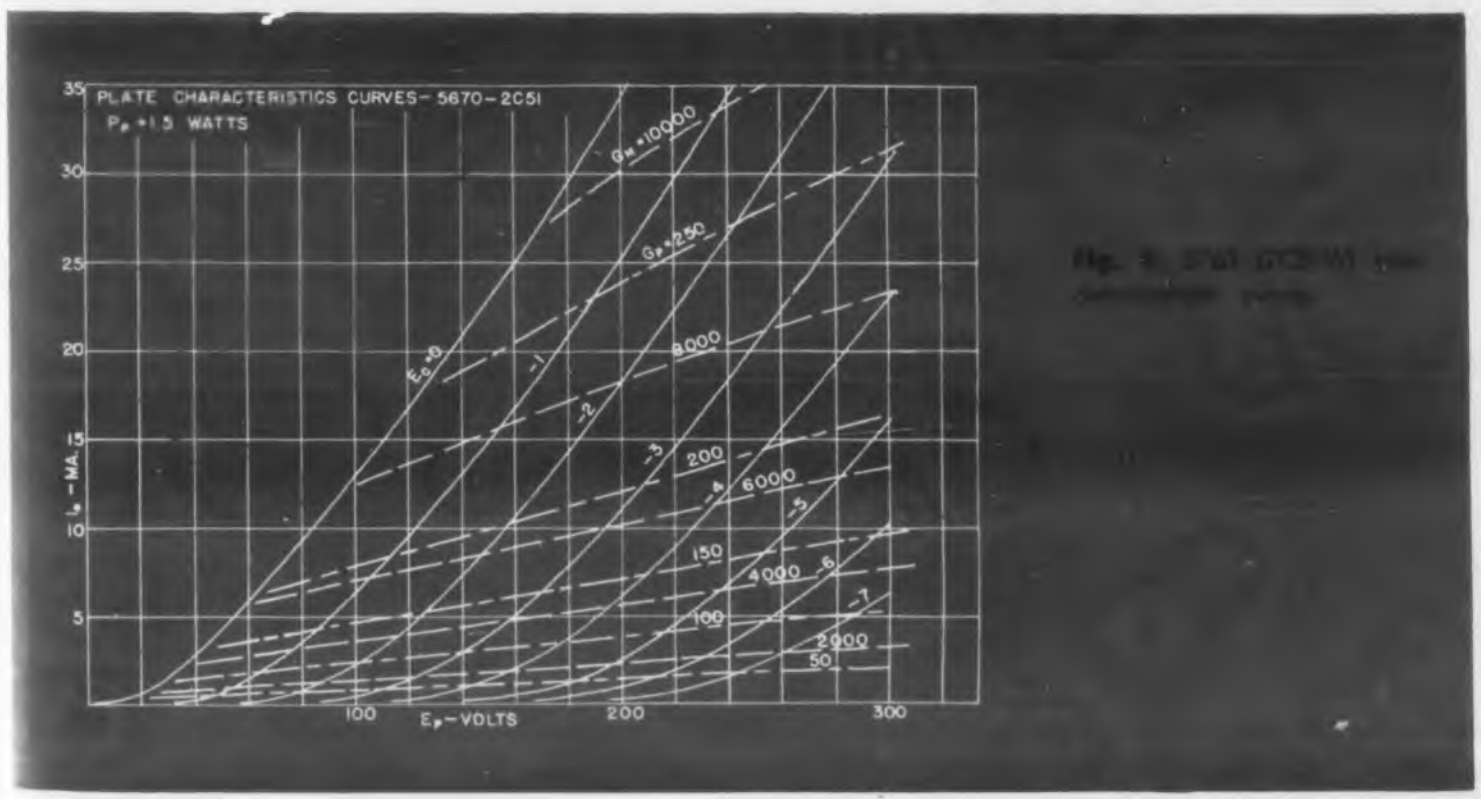
If, now

$$Q_c\, K_{cp}\, \frac{n_c}{n_p}\, X_p \cdot \frac{g_{m_1}\, g_{m_2}\, Z_K}{1 + (g_{m_1} + g_{m_2})\, Z_K} > 1 \tag{4}$$

then oscillation will start. If the build-up of oscillation causes more loss of g_{m2} than g_{m1} increases, then the overall loop gain will drop as the amplitude of oscillation increases. Adjustment of either K_{cp} or X_p, the plate coil reactance, will permit adjustment of the loop amplification to approximately unity. Then, adjustment of the plate supply voltage for the grounded grid stage permits adjustment of regeneration as a regenerative detector.

Assume that a *12BH7* tube (Fig. 2) is to be used in a power oscillator at 30 mc. A 100 v plate supply is being used. Assume further that the grid tuned circuit Q is 200, the coupling from plate to grid 0.01, the plate circuit reactance 400 ohms. The cathode follower grid is returned to a point 80 ohms down from the cathode. The plate to grid turns ratio is unity. The value of e_c/i_p from eq 3 is then 800 ohms. Since the value of eq 2 at initiation is 0.00191, the overall initial amplification is 1.5. (Grid to cathode bias on the grounded stage is zero at initiation. Based on the resulting plate current for the grounded grid stage, the bias and transconductance for the cathode follower may be found.) Oscillation develops immediately. If, now, 2 v rectification bias were developed at one instant as the oscillation builds up, the cathode follower bias would then be about −2.1 v. The overall loop amplification is 1.37.

Repeating the process for a grounded grid amplifier bias of −3 v, the cathode follower bias would be −1.8 v. The loop gain is now 1.26. At −4 v bias on the grounded grid amplifier, the cathode follower bias is −1.7 v, and the loop gain 0.89. Consequently, oscillation will limit at a bias of about −3.7 v on the grid of the amplifier triode. The output of the oscillator in the cathode circuit will be about 6 to 7 v peak to peak.



The Q Multiplier Oscillator[4]

The Q multiplier oscillator, one version of which is called the Clapp Oscillator, is another high Q and high stability oscillator. The equation for oscillation in this oscillator (Fig. 3) is

$$\frac{g_m\, R_k}{[1 + (g_m + g_p)\, R_k]} \geq \frac{1}{2} + \frac{Z_s}{2Z} \tag{5}$$

Since the value of $g_m R_k / [1 + (g_m + g_p)\, R_k]$ required for oscillation slightly exceeds one half, tapping the cathode resistor for the grid return is indicated.

Amplitude limitation in the Q multiplier is not by rectification loading. It is obtained in this oscillator by effective reduction of tube transconductance. The left hand side of Eq. 5 becomes, on the average, smaller as the amplitude rises. The amplification follows one of the equations,

Effective transconductance

$$\approx \frac{1}{4}\,(g_{m_{min.}} + 2\, g_{m_{mean}} + g_{m_{max.}}) \tag{6}$$

or Average Amplification

$$\approx \frac{1}{4}\,(VA_{min.} + 2VA_{mean} + VA_{max.}).$$

For sake of an example, assume that one section of a *5670* dual triode be used for the oscillator (Fig. 4). Take the total R_k as 1000 ohms, the net bias as −1 v, and the supply voltage as 100 v. The left hand side of eq 5 has the value of 0.84, since $g_m = 6000$ μmhos and $g_p = 170$ μmhos at the chosen operating point. At a bias of −2 v the amplification is 0.67, and at zero bias 0.86. Average amplification for a swing from 0 to −2 v then is 0.80. The value of the ration $Z_s/2Z$ then has the value 0.3 for a 2 v peak to peak oscillation amplitude. Assuming a Q of 300, a grid-to-ground capacitance of 500 μμf, and a frequency of about 30 mc, the tuned circuit impedance is 1500 ohms. The value of Z_s then is 900 ohms. The grid dc return lead should be returned to a point 140 ohms below the cathode. Oscillation would just start with a Z_s of 1020 ohms. If the oscillator were adjusted near this point and the signal were then detected, a regenerative type detector would result.

An RC Oscillator

The design of RC oscillators requires the acceptance of a series of compromises. The first of these compromises involves the oscillator loop amplification without degeneration. Stability requires a large amplification; frequency response requires a relatively smaller loop amplification. Whereas operation to very high video frequencies requires small capacitance in the frequency selection variable capacitor, low frequency operation requires a large capacitance in the variable capacitor. In either case, the loading of the frequency selector circuit must be small compared to the loading of the other impedances in the circuit if frequency stability is to be obtained. Where small magnitude of oscillator distortion is a paramount consideration, one must hold the oscillator frequency selector circuit loading to a very small level.

An oscillator, offering a good combination of impedance levels with reasonable gain and a low source impedance for the frequency selective circuit, is shown in Fig. 5. A suggested tube for use with this oscillator is the *12BY7* (Fig. 6). If the oscillator is to operate from 10 cps to 1 mc, R_L may be 10,000 ohms, and R_{k2} may be 200 ohms. R_{k1} would be a thermistor having a positive coefficient and a resistance under full tube cathode and signal current of about 65 ohms. Using a dual 40 to 400 μμf tuning capacitor, a 100 kc to 1 mc oscillator decade would require 4000 ohm tuning resistors. The total resulting load on the cathode follower is approximately 8000 ohms.

Using *12BY7* tubes with 120 v from screen to cathode and a bias of −0.5 v, a nominal transconductance of 15,000 μmhos is developed. The approximate equation governing operation of this oscillator is

$$R_1 = \frac{R_2\,(1-2R_2/R_L) - 3/g_{m_1}\,(X_{p_1}+X_{c_{21}})\,g_{m_2}\,X_{p_2}\,R_L - 3R_2/g_{m_2}\,X_b\,R_L - R_2/g_{m_1}\,(X_p+X_{c_{21}})\,R_L}{2+3R_2/R_L+3/g_{m_2}\,X_{p_2}\,R_L} \quad (7)$$

Substituting gives $R_t = 65$ ohms for a ratio of $E_p/E_{c2} = 1$.

The frequency range of this oscillator may be extended somewhat. In order to extend the range, it is necessary to redesign the cathode follower to have a lower output impedance. Paralleling two *12BY7* tubes for the cathode follower and using the usual grid series damping resistors of 50 ohms resistance will permit R_2 to have a value of 100 ohms, and R_1 about 32 ohms. With a load resistance R_L equal to 3900 ohms, an oscillator capable of operating up to about 3 mc will result. The tuning resistance for the highest frequency decade then is 1300 ohms. The 2800 ohm parallel load, on the 132 ohm cathode follower output, will not upset oscillator operation.

Since the approximate plate current in all tubes is 34 ma, the load resistance voltage drop is 130 v. Including a plate to cathode voltage of 120 v and a cathode to ground voltage of about 12 v, the total required supply voltage is 262 v. The screen resistors for each tube have a resistance of 18,000 ohms. The parallel screens of the cathode follower may have a 9100 ohm resistor and two 50 ohm decoupling resistors to provide the current supply to the screens. The screen to cathode bypasses may consist of ceramic discap capacitors backed up by large paper or electrolytic capacitors. The bias voltages for the two (or three) control grids should be obtained by use of high resistance voltage dividers across the respective cathodes. The dividers should be adjusted to provide the required 0.5 v bias on the respective tubes.

A Three Phase RC Oscillator

The phase shift oscillator is frequently used as a means of generating audio or video frequency voltages. Establishment of a 3φ phase shift oscillator requires arrangement of a symmetrical closed circuit amplifier having RC frequency selection circuits. A possible oscillator configuration is shown in Fig. 7.

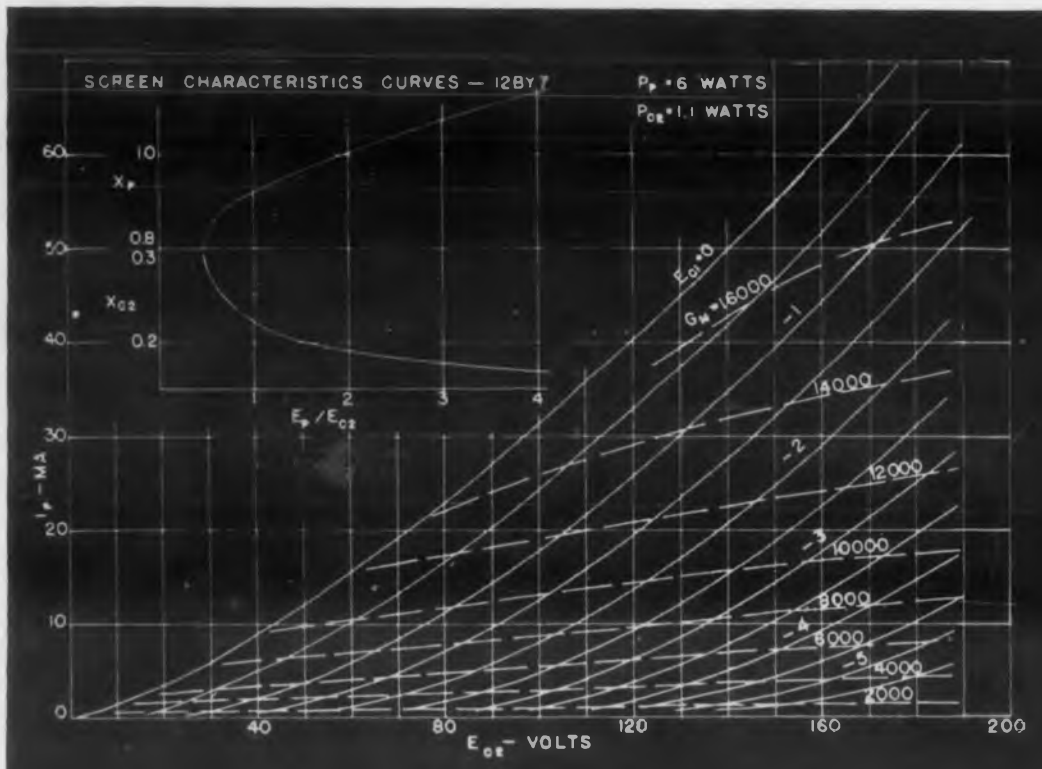


Fig. 6. 12BY7 tube characteristic curves

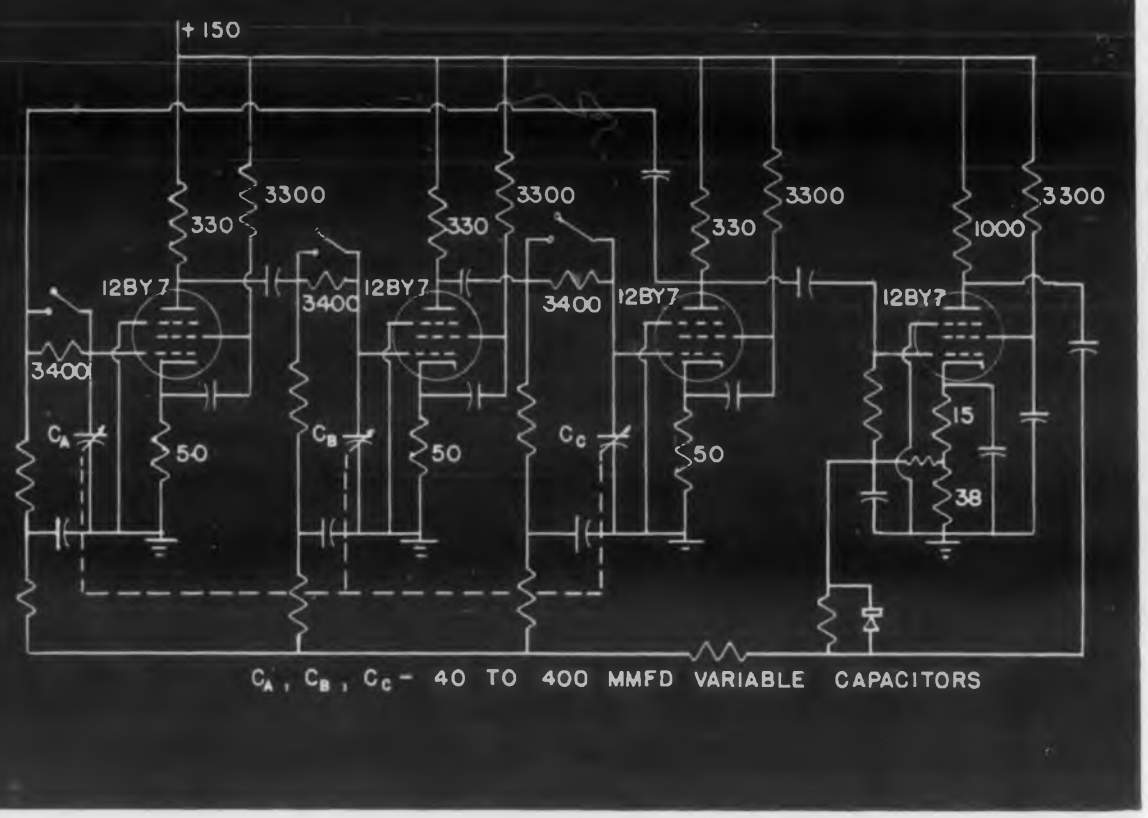


Fig. 7. A phase shift R-C oscillator

This oscillator will produce a 3φ output with approximately equal voltages on the phases. In addition, it has an amplitude control circuit to stabilize its output amplitude.

The tube used in this oscillator, as in the last, is the *12BY7*. The screen to cathode voltage is chosen as 120 v, the cathode to control grid voltage as −0.5 v. Typical part values are shown. The amplifier aids in regulating the output voltage to constant amplitude.

A modification of Fig. 7 can be used to produce an oscillator capable of operating to a considerably higher frequency. This oscillator has its frequency selective circuit include the plate load resistor of each tube in parallel with the tuning capacitance. The only change required to provide this modified circuit is to short the tuning resistance position directly to the plate.

A 3φ output may be obtained at any frequency in the frequency range of the oscillator by use of three low impedance low gain amplifiers, one coupled to each oscillator tube plate.

An estimate of the oscillation amplitude may be obtained for the three phase oscillator. The nominal amplification of the avc amplifier in accordance with the parts values listed is thirteen. The overall gain per stage of the oscillator with no avc is

$$VA = \frac{-g_m X_p R_L}{2\,[1 + g_m (X_p + X_{c2})\, R_k]} = -1.16 \qquad (8)$$

To reduce the *VA* to unity per stage, a reduction of transconductance to approximately 10,760 μmhos is required. A total bias of −1.8 v is required to produce this reduction of transconductance. An oscillator signal voltage output of approximately 0.14 v will generate the required bias.

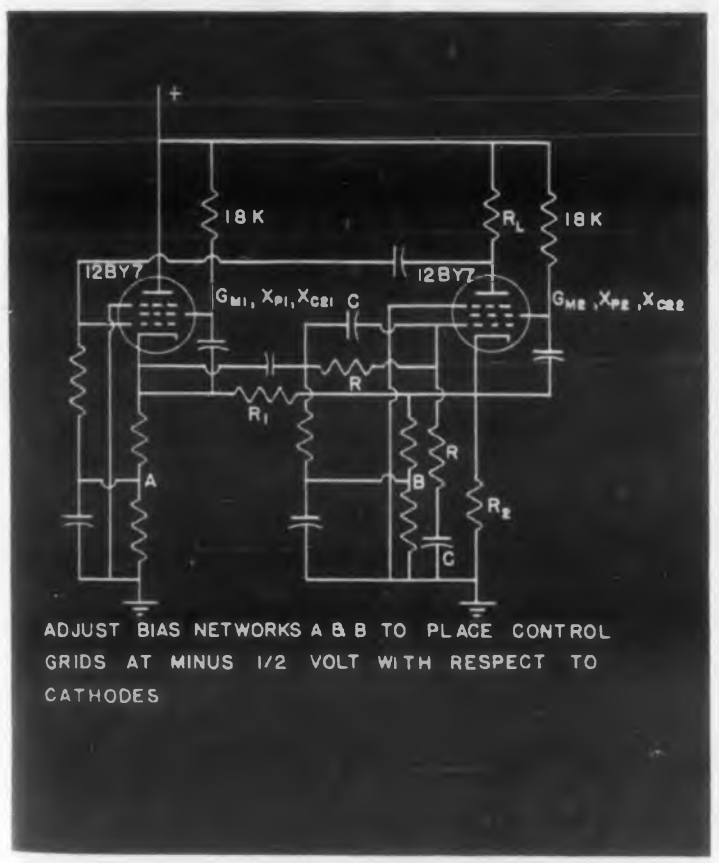


Fig. 5. An R-C oscillator

Basic Requirements for Oscillator Stability

Some of the requirements for construction of a stable oscillator have already been noted in the sample designs. In view of the importance of oscillator stability, however, a review of some of the requirements for stability appears to be in order.

No circuit can be any more stable than its basic components and design permit. Coils must be rugged and must be temperature compensated. Capacitors must be mechanically and electrically stable and compensated as required to match other components in the circuit. Wiring should be rigid, well supported and securely soldered. Leads carrying signal voltage should be as short as possible. Tubes should be held securely in place.

The second requirement is a high effective Q for the frequency determining element. The effective Q is a function of both the basic Q of the frequency determining element and the loading effects of the circuit. The effective Q of the frequency selective circuit may be adversely affected by tube plate or screen conductance, by grid rectification or transit time loading, or by the effect of externally reflected loads. Since the cancellation of loss in the frequency control circuit and initiation by noise is based on the effective Q including all these loading factors as broad-banding elements, minimizing coupled losses from all sources is evidently of considerable importance in both amplitude and frequency stability.

The loop gain of the stabilized oscillator should be self adjusting to a value of unity. In addition, the variation of amplification over the signal excursion range should be as small as possible. Oscillators having a large gain variation as a function of rf signal voltage become much more sensitive to the effects of noise synchronization and external signal synchronization. This is because the avalanche effect increases very rapidly as the loop amplification increases from unity instantaneously.

Conclusion

Only a few typical sample oscillators could be considered in the space available. An effort has been made to select oscillator circuits possessing properties of interest designwise, and to develop the application of conductance curve techniques to show the simplicity of design by this method.

References

1. Oscillator Frequency Indeterminancy, Leon Riebman, IRE National Convention 1951, Paper 180.
2. Non-Linear Mechanics, Minorsky, Edwards Brothers, 1944.
3. An Advanced Regenerative Circuit, Irving Gottlieb, *Radio and Television News*, Vol. 49, No. 5, May 1953, p. 48.
4. An Inductance-Capacitance Oscillator of Unusual Frequency Stability, J. K. Clapp, *Proceedings of the IRE*, Volume 36, Number 3, p. 356. See also A Simplified Negative Resistance-Type Q Multiplier, H. E. Harris, IRE National Convention 1948, Paper 10.
5. Notes on UHF Oscillator Design, K. A. Pullen, *Tele-Tech*, February, 1953.

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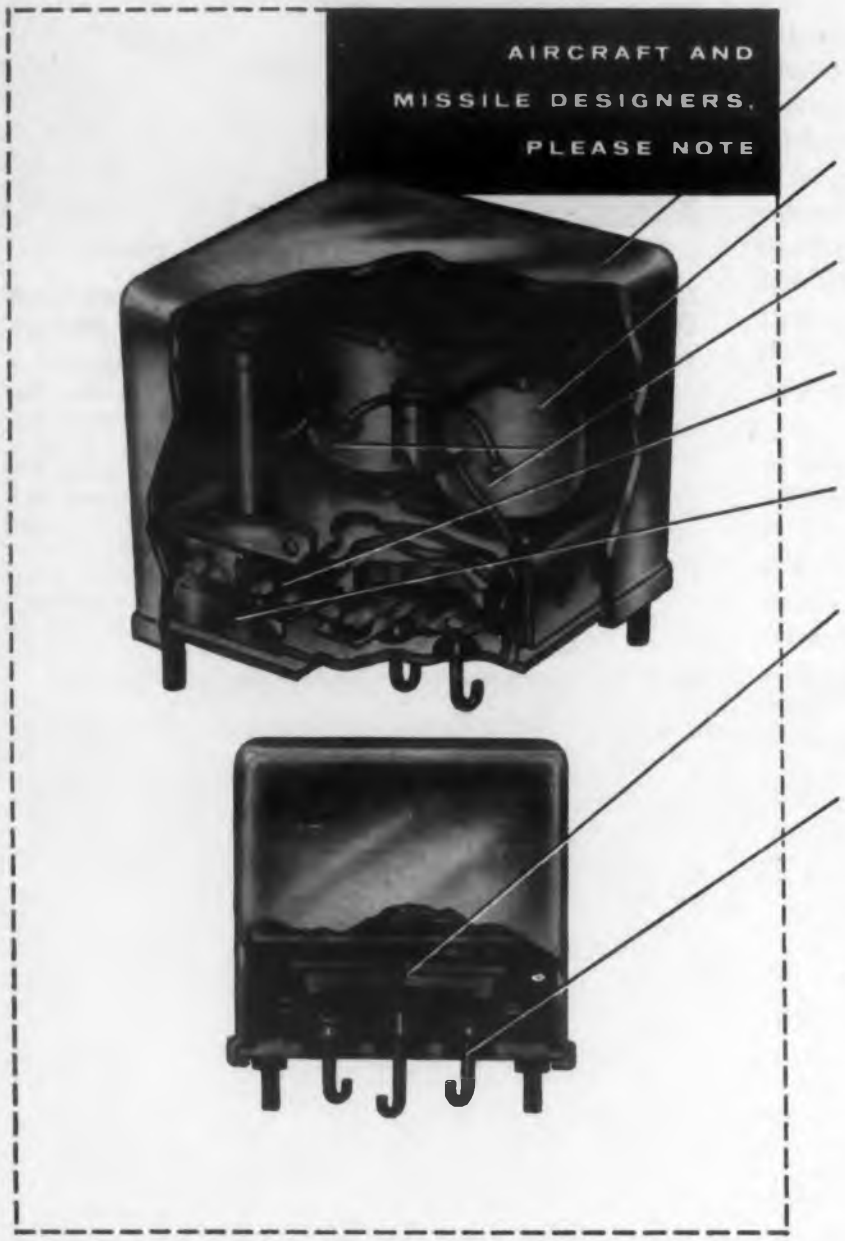

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CIRCLE 34 ON READER-SERVICE CARD FOR MORE INFORMATION

Transformer

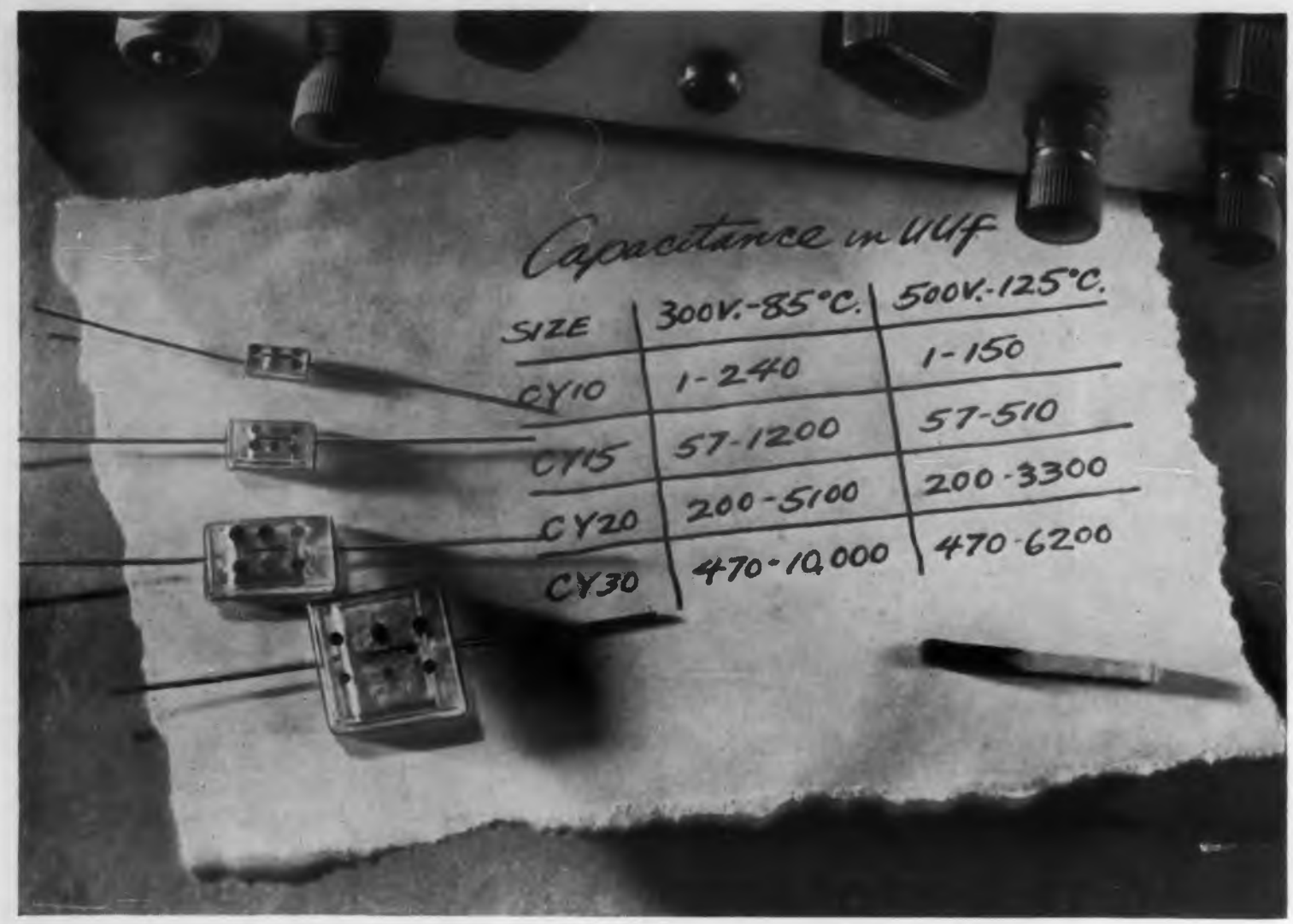
Design Nomograph – II

Martin Berger
Minitran Corp.
5 Oliver Street
Newark, New Jersey

SECOND in the series of five transformer design nomographs is this 60 and 400 cps capacitance and inductance reactance chart. Not only does it give reactance of known component values readily, but is provides a handy means for determining the capacitance needed to tune a given inductance to resonance or vice versa.

Direct readings can be made from the nomograph without need for a straight-edge. For capacitances or inductances in other units than given on the charts, apply the *K* factor as indicated. For example: What is the reactance of a capacitor of 10 μμf? This capacitance is not on the chart but can be expressed as 10 μf divided by 10^6. Thus, *K* is 10^6. The reactance for 10 μf is read off the chart as 267 ohms. Applying the *K* factor as indicated, the reactance for 10 μμf is $KX = 10^6 \times 267$ or 267 megohms.

REACTANCE NOMOGRAPHS



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These are *glass* capacitors—probably as much as one-third smaller than those you're used to; certainly much lighter.

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This unusual construction, developed at Corning offers you these advantages:

Small size, light weight. If you're at work on guided missiles, fire controls, computors, and similar devices, you can cut valuable ounces and inches from your assemblies with these capacitors. See table above for some indications.

Exceptional stability. After a load life test at 50% more than rated voltage at 85° C., the average change in capacitance of these units is less than 0.4% after 1,000 hours, less than 0.6% after 10,000 hours.

Very low drift. This drift is so slight that it's generally within the normal error of measurement. Taking MIL-C-11272A as a standard, capacitance drift is less than 0.1% or 0.1 *uuf* (whichever is greater).

Predictable, retraceable TC. The difference in TC between any units at any given temperature is less than 15 ppm/° C. It is well within the limits of 140 ± 25 ppm/° C. from −55° C. to +85° C. and referred to 25° C.

Low loss. Even at elevated temperatures, the dielectric loss is relatively low. Dissipation factor at 1 kc. and 25° C. is about 0.055% and independent of capacitance.

Bulletin shows performance charts. Bulletin CD-1.00 contains charts and other data on these capacitors. Circle this magazine's service card for a copy or write us direct at Corning.

Capacitance in uuf

Size	300 V. —85° C.	500 V. —125° C.
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CY15	57-1200	57-510
CY20	200-5100	200-3300
CY30	470-10,000	470-6200

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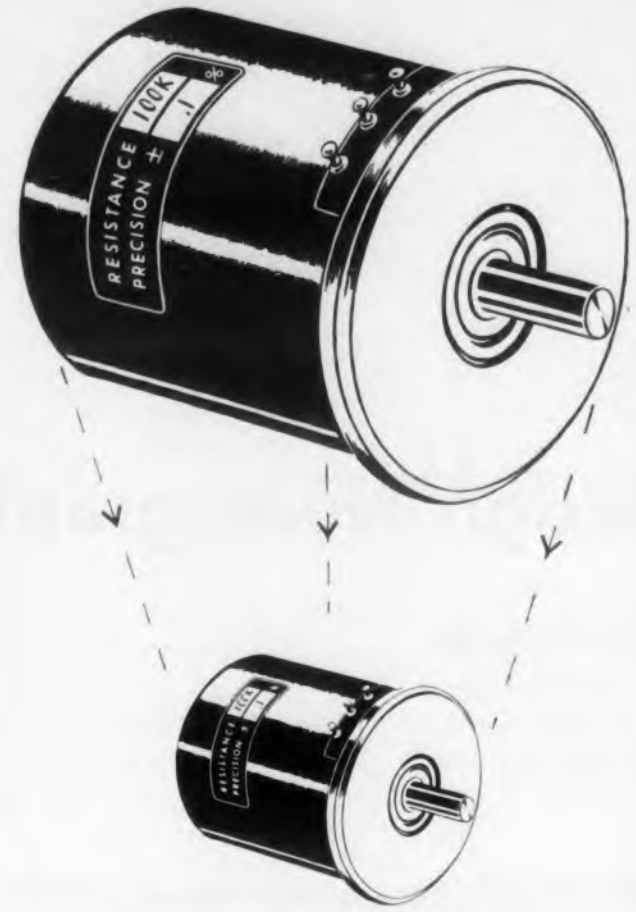
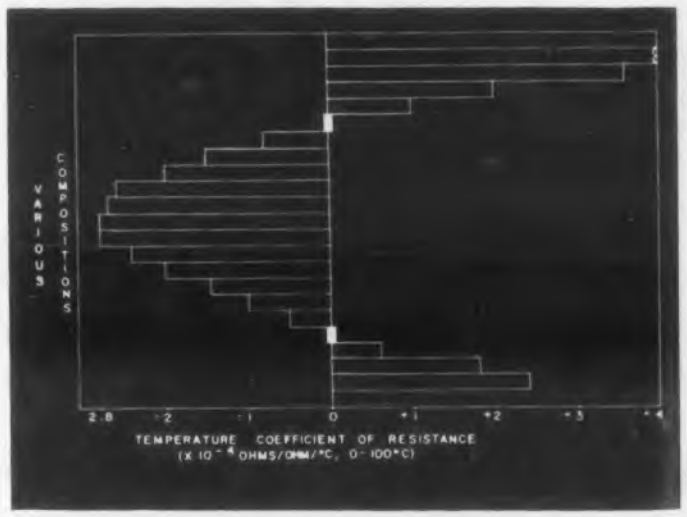
Electronic Components Department

CIRCLE 35 ON READER-SERVICE CARD FOR MORE INFORMATION



Precision potentiometer is miniaturized with High Resistance Wire.

Extra-High Potentiometer



Twenty-one different temperature coefficients of resistance are available. Coefficient of the potentiometer wire may be set to compensate for temperature variations of other circuit components.

POTENTIOMETER wire resistances up to 1100 ohms per circular mil foot—more than twice that previously obtainable—are possible using a new precious-metal alloy. This increased resistance will enable designers to substantially decrease the size of potentiometers and other wire wound components. Composition of the alloy can be varied to give both positive and negative temperature coefficients.

Developed by Baker and Company, Inc., 113 Astor St., Newark 2, N.J. the palladium-gold-iron alloys contain approximately 90 per cent precious metal. Twenty-one different temperature coefficients of resistance ranging from 4 x 10^{-4} ohms/ohm/deg C, 0-100 C, through zero to -2.8×10^{-4} are available to the designer (see chart). By specifying the proper temperature coefficient, resistance fluctuation of other circuit components caused by changes in temperature can often be offset by the potentiometer.

Resistivity Wire

Good Linearity

All constituents of the alloys are in solid solution, resulting in good linearity. After suitable heat treatment, the resistivity is so stable that prolonged heating at 200-250 C will not affect it. As would be expected from precious-metal alloys, the new compositions have good corrosion resistance up to temperatures of 1100 F—a major consideration in precision instruments.

In some potentiometers, the higher resistivities will enable designers to avoid the use of very fine wire—which often adds to production costs—without describing coil resistance. Wear tests with a 20 gram load on the contact have produced only negligible wear after 2,000,000 cycles. The highest resistance commercially available in precious-metal alloys heretofore was 550 ohms per circular mil foot, the highest in base-metal about 800 ohms per circular mil foot.

For further information on this potentiometer wire, turn to Reader's Service Card and circle 36.

Rack Stack & Carry

Modular Instruments

Fig. 1 Modular instruments 1/6, 1/3, 2/3 and full rack width mount conveniently in 19 in. standard rack.

SPECIFICALLY designed to be mounted or stacked without sacrifice of space, efficiency or performance, these instruments are the latest addition to the modular concept. The policy of rack mounting developmental circuitry has been generally accepted. These modular instruments can add the necessary equipment to the rack to make the installation complete.

How to mount the small, less-than-width, unit has been an awkward problem. In attempting to rack-adapt instruments, most companies have mounted them on a 19 in. panel leaving part of the panel blank. This space is not wasted in the modular system since the instruments are made in either 1/6, 1/3, 2/3 or full rack width. By combining these fractional modules the user can assemble the desired combination of test instruments for his specific needs and yet utilize the full rack width.

To meet the basic requirements of a standard test facility, Teletronics Laboratory, Inc., 54 Kinkel St., Westbury, L.I., N.Y., provides the following modular instruments:

Audio VTVM	10 cps to 200 kc, 10 mv to 300 v
AC-DC VTVM	1.5 to 1500 v
Multimeter	1.5 to 5000 v
Audio Oscillator	10 cps to 100 kc, .5 percent distortion
Regulated DC Power Supply	150 to 350 v, 100 ma
AC Power Supply	0 to 135 v, 3 amp
Frequency Meter	10 cps to 100 kc
Step Attenuator	42 db, 6 Steps 2010-6-3-2-1

It was recognized that many users would have equipment of their own design special to their needs which they would like to mount in the system. Modular cases, panels, and chassis identical to those used for the modular instruments are available thus preserving the functional benefits of the system and insuring a neat, uniform, completely organized appearance.

How The Rack Works

A rack adapter 19 in. wide by 8-3/4 in. high is used to mount the instruments. Made to fit the

Typical bench assembly using test instruments (top) and modular instruments (bottom). Both assemblies contain the same equipment.

Fig. 2 Instruments can be simply stacked upon one another. For semi-permanent installations, a locking strip and stand are available.

standard 19 in. relay rack, it comes in a single frame or with a supporting shelf for the longer, heavier instruments. Since the smallest module is 1/6 of the rack adapter width, the 1/6 width is used as spacing increments for mounting screw pairs. A 1/6 unit is held by one screw top and bottom (Fig. 1); a 1/3 size by two screws top and bottom. Panels, regardless of size, fit side by side and flush with one another to form a neat, compact assembly.

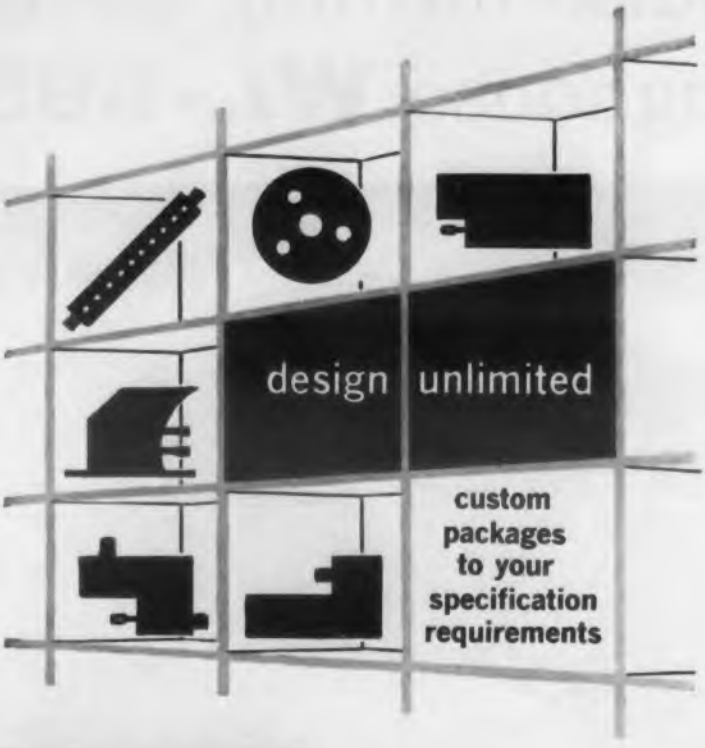
How the Stack Works

The bench rack is used in many cases because it is the only way of stacking equipment. Since all units have the same form, height and modules of width, the instruments can be simply stacked upon one another (Fig. 2). For semi-permanent installations a strip is available which locks two layers of instruments together using the same screws used for rack mounting. Also for convenience a stack pedestal is available which raises and tilts the assembly. The instrument is fastened to this mount by the usual mounting screws. Power strip, switch, and pilot light are incorporated to provide convenient power for the whole assembly.

Carry

The smaller units have a strap handle which may be removed for permanent rack or stack installation. The heavier, larger units have permanent handles which are conveniently recessed to prevent interference with the rack or stack installation.

Other items are planned to expand the utility of the system. A complementary low and a high frequency oscillator will soon be announced, and it is expected that at least six more instruments will be added to the system this year. For information on these instruments, turn to Readers Service Card and circle 38.



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CIRCLE 39 ON READER-SERVICE CARD FOR MORE INFORMATION

A REFLEX klystron with ceramic insulation, the ZV1009 has a continuously variable output frequency from 1,500 to 6,000 mc. The external cavity, pulseable, broadband tube is intended as an improvement and replacement for klystron tubes 6BL6 and 5836. It can be used in any appropriate cavity such as the one designed for a 5836 tube.

Designed for operation at high temperatures by the Polarad Electronics Corp., 43-20 34th St., Long Island City 1, N.Y., the ceramic envelope permits elevated cavity temperatures much higher than equivalent glass tubes, eliminating the need for blower cooling. The heater operates at 6.3 v, the control grid at 10 v (relative to cathode), the accelerating potential at 325 v (relative to cathode), and the repeller at −45 to −320 v for n=2 repeller mode. The repeller voltage can be tracked over the entire band in the 2-3/4 repeller mode.

Due to its rugged internal construction, the tube is virtually non-microphonic. It is completely hard-soldered and is equipped with standard four-pin connections. For more information about this product, turn to Reader's Service Card and circle 40.

Miniature One-Shot Power Supply

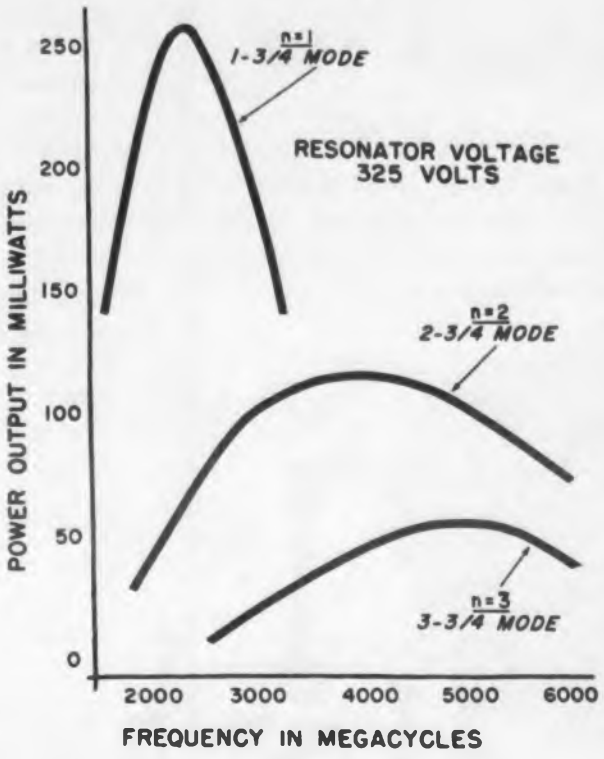
AN OUTPUT of 28 v at 700 w is produced by this miniature silver zinc battery for a period of 2 min. When current is required, a signal actuates a simple fluid transfer system which, in as little as 100 msec, fills the battery cells with electrolyte and thus initiates battery output. The power available is sufficient to supply all the electronic equipment on guided missiles, and rockets.

Electrolyte for the battery, manufactured by Frank R. Cook, 36 So. Santa Fe Drive, Denver 23, Colo., is carried in a separate tank within the hermetically sealed main case. A highly simplified design is used in the fluid transfer system which increases reliability and eliminates the need for maintaining a vacuum. A double set of electrically-ignited gas generators produces all of the pressure required.

The battery is connected directly to the load at the time of installation in the missile. Activation is thus accomplished under full load. In a typical application the battery performs as follows: (1) voltage is applied to the activation circuit. (2) 0.5 sec later the voltage is within 4 per cent of its steady-state value, where it remains within ±2 per cent during the next 2 min. (3) at 3 min, the battery is exhausted but the "flight" is over.

Uses for this battery are primarily found in missile auxiliary power supplies, piloted aircraft emergency power units, torpedoes and many classified applications. Several models are in production, in-

Broadband Ceramic Klystron

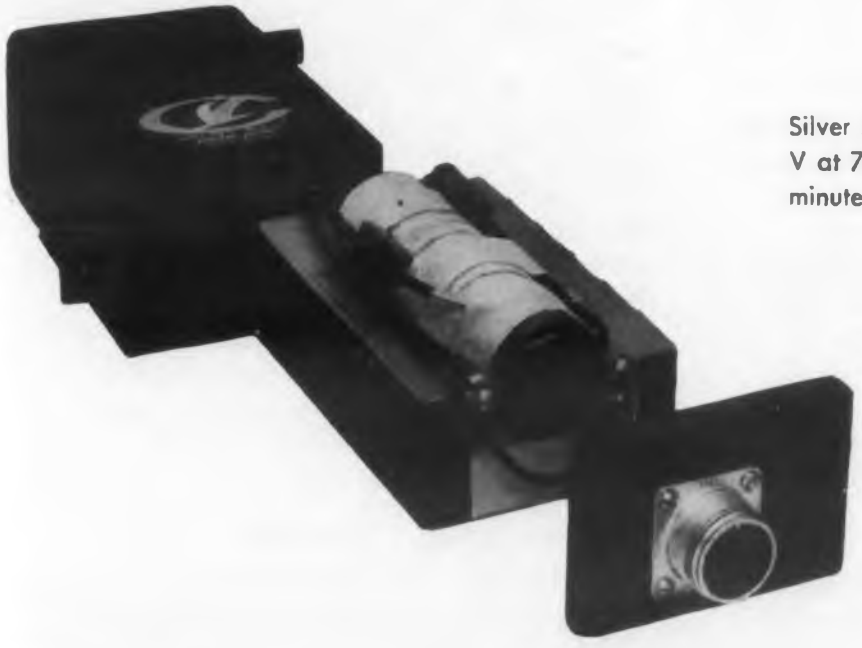


Average power characteristics of ZV1009 klystron.

cluding a combination 7 V "A" supply and 495 V "B" supply in which 362 cells are filled uniformly in 150 msec. Shelf-life is conservatively estimated at 5 yrs. Operating ambient temperature is between —65 and 240 F.

Peculiar to the silver-zinc cell, exhaustion times of 0.5 min to many weeks can be provided at high efficiency. The long shelf life, flat voltage characteristic, and the ability of the silver-zinc cell to yield all of its energy over a very brief period makes this an ideal portable power source in many one-shot applications.

For further information on this miniature power supply turn to Reader's Service Card and circle **41.**



Silver zinc battery provides 28 V at 700 W for a period of 2 minutes.

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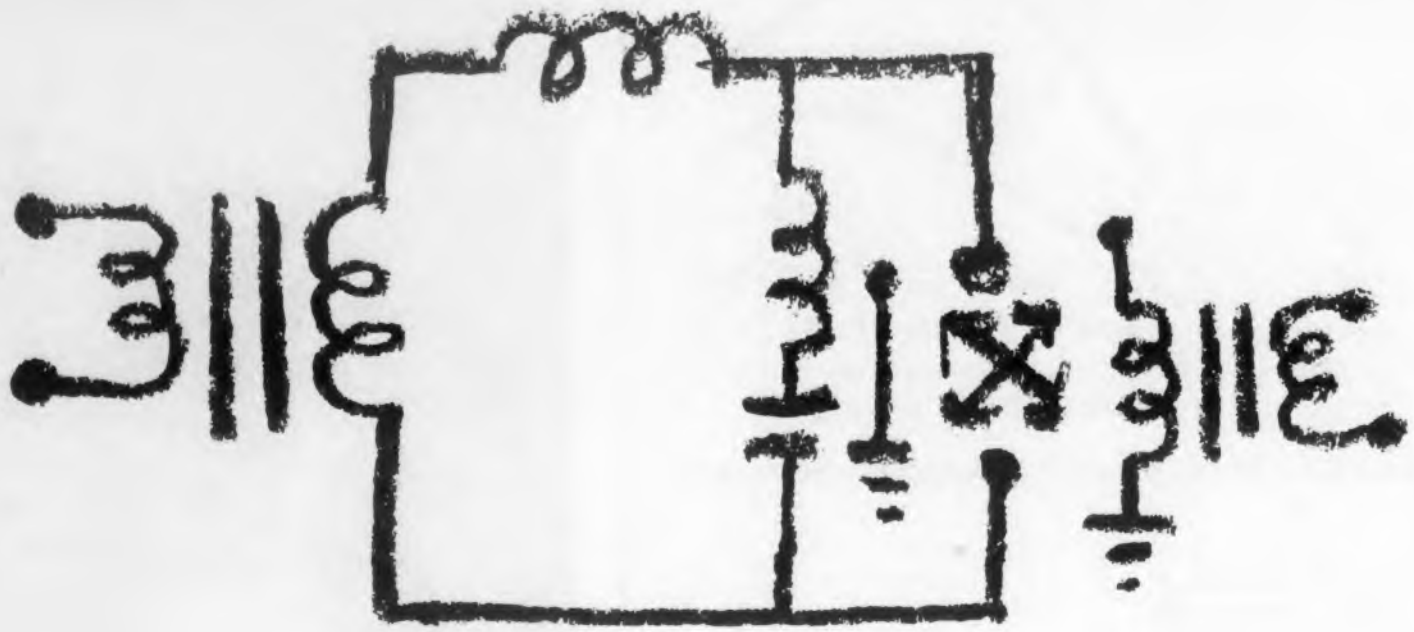
CIRCLE 42 ON READER-SERVICE CARD FOR MORE INFORMATION

This is the second of a series of two articles reviewing radar modulators and their requirements. The first, appearing in the April 15 ELECTRONIC DESIGN, discussed the circuit requirements and operational factors the design engineer must consider in order to solve his particular problem. Modulator devices fall into three basic classes: hard-tube, line-type, and passive modulators. Operational factors may limit the free choice of any of these three classes. Further limitations may be imposed by performance and packaging factors, since in the first case one must live with these requirements, having no other choice, while in the second case these factors may in themselves force a decision on the type of modulator device.



Performance and Packaging of Modulators

M. H. Zinn
Signal Corps Engineering Laboratories

EVERY radar system must be capable of performing one or more functions within certain tolerance limits dependent upon the end use of the equipment. A number of these factors (the list is not necessarily all-inclusive) that will affect the ability of the modulator device to meet system performance requirements are:

- Time jitter and time drift in the modulator device
- Warm-up time
- Versatility, or the ability to operate at different pulse and repetition rates
- Ability to switch information in addition to single pulse
- Ability to meet ambient conditions

These performance requirements may dictate the particular type of device that can be chosen, even though all types are freely available. On the other hand, the choice of suitable operating and packaging factors may permit a device, which is apparently limited in any one of the characteristics, to operate satisfactorily within system tolerance limits.

Time Jitter

The hard-tube modulator clearly provides no basic problem with respect to time jitter, although jitter can be introduced by poor wiring techniques, particularly in the driver stages. A gas tube operating in a line-type modulator, on the other hand, can introduce jitter into the circuit. In the hydrogen thyratron this time jitter is maintained within usable limits and can be minimized by proper attention to grid drive and plate supply ripple. Furthermore, the nature of the time jitter is known. It appears essentially as a line-frequency modulation of the time position of the pulse. We can, therefore, calculate the effect of jitter on a pulse-to-pulse basis and predict the performance of the thyratron in a system where this characteristic is critical.

In the ignitron or pool cathode device, jitter is a definite problem, since it occurs in this type of tube as a random phenomenon. It can be alleviated to some extent by using multiple grids in the tube to form a plasma, which can then be used as the ion source for the next step in the discharge and thereby minimize some of the statistical fluctuations. In the magnetic modulator, when it is self-triggering, there is no problem in jitter. The pulse duration may vary in position over wide ranges, but since the output pulse is used as the reference point for all the time bases there is effectively no jitter in the system. This type of operation limits the equipment engineer in what he can do with his system and may severely cut down the tactical versatility of the equipment with respect to such items as the minimum range possibilities and other features. Many modulator engineers consider the use of a self-triggered system (also possible with any other type of modulator) as a return to the prehistoric days of radar.

Time Drift

Time drift is an important characteristic since it affects range accuracy of the equipment. The hydro-

gen thyratrons and gas-discharge devices, in general, present a problem with respect to time drift. It can be minimized to some extent by proper circuitry, but this will add to the total size, weight, and complexity of the equipment. Good stability can be achieved by the use of compensating circuits to maintain a constant time delay of the output pulse, either with respect to the input or between two successive pulses where sequential firing is used. The two remaining classes of modulator devices should have little or no trouble due to this characteristic.

Warm-up Time

The ability to get on the air quickly when one needs to is an important characteristic of many equipments, but the problems are not necessarily restricted to the switching device. The limitations may be as great in the final rf tube as in the switch tube. All that is necessary is to make the two units compatible with respect to both the time required to heat the cathodes to operating temperature and the time required to raise the voltage to its full operating level. Thus, although the passive modulator and cold cathode gas discharge device may appear to have a basic advantage, the hot cathode gas tube and hard-tube modulator may adequately meet requirements.

Versatility

Versatility is an important factor as far as performance is concerned. Many of the systems in the field today operate at two, three, four, and possibly more combinations of pulse duration and repetition rate, each of these operating conditions perhaps serving a different function with respect to range, definition, resolution, and use with moving target indicators. Where available in the equipment, these conditions are usually chosen by the operator as desired. This can be done very easily with the hard-tube modulator where such switching can be accomplished at low power levels. In the line modulator it is a little more troublesome. Individual networks operating at the desired output level are required and possibly individual charging inductors as well, but this has been accomplished and is standard practice in the field today. With the passive-element modulator one is, however, generally limited in repetition rate to the supply frequency of the complete system. Possible exceptions to this can be obtained by using two-phase, three-phase, and six-phase circuits. These require a generator capable of operating at the greatest number of phases desired, permitting operating at specific multiples of the basic applied frequency. As far as the writer knows, present plans incorporating passive-element modulators and at least one equipment where this device is presently used, involve operation that is restricted to a single repetition rate.

Codability

Another performance characteristic that is becoming more and more important today is the ability to transmit a group of pulses to provide coded information. The hard-tube modulator is extremely well suited for this type of application, since all that is necessary is to feed the modulator a train of pulses at a low power level. Line modulators may be used to provide coded pulse operation, within certain limitations. First, one must generally use individual tubes and individual modulator circuits to provide each pulse. Second, there is a limit on how closely the pulses can be formed. When the second tube fires, the output voltage across the load appears as inverse voltage on the first tube, which has already completed its firing. If the second pulse is too close to the point at which the previous pulse stopped, additional inverse power of considerable magnitude can be dissipated in the first tube, and this process will be repeated in succeeding tubes. The passive-element modulator would also require multiple circuits for coded operation, with phase delays of some type provided in the supply side of equipment. The writer is not certain of the effect an inverse voltage pulse across the load would have on the circuit that fired previously. Certainly it will have some effect and might tend to precipitate ringing. The trouble is that this inverse voltage obviously cannot be clipped since it is the useful output of the modulator.

Ambient Conditions

Any device that dissipates power will have some limitations with respect to ambient temperature. The real question involved is how much auxiliary equipment must be utilized to maintain the device within rated temperature over the desired range of ambient temperature. It is not possible to make a complete comparison because of the wide range of power levels possible with these devices. In general, considering an ambient temperature range of —55 C to 90 C, hydrogen thyratrons require no auxiliary equipment (reservoir types do require an ac voltage supply to maintain the desired pressure); ignitron devices require air or water cooling or heating to maintain a portion of the envelope within a temperature range considerably narrower than the ambient; hard tubes, as a function of the power level, require no cooling, air cooling, or water and air cooling; the passive modulator should be susceptible to being designed for no external cooling although it may be necessary to use oil immersion and/or air cooling at higher power levels in order to minimize size. With respect to shock and vibration ambient, again a comparison is difficult, although the passive-element device should be superior while a liquid pool device such as the ignitron should be the poorest.

Packaging Factors

Every radar system used in the field must meet, within limits determined by the particular end use, specific size, weight, and, in many cases, shape requirements. The factors that determine the final package requirements are:

- Size and weight of the modulator device itself
- Drive requirements of the modulator
- Over-all efficiency of the modulator
- Impedance level of the modulator supply
- Need to include features to take care of deficiencies in the switch with respect to performance factors

Again, assuming that a free choice of modulator device is still possible, the effect of the packaging factors is dependent on the type of application. Thus, in a fixed land-based system, the packaging requirements may exercise little or no influence on the choice, while in an airborne or extremely portable equipment it may be the sole determining factor.

Size and Weight of the Modulator Device

A gas tube designed for use in a line-type modulator generally is considerably smaller than a hard tube designed to switch an equivalent power. This factor has been improved further in the newer designs of hydrogen thyratrons using ceramic-metal construction. The passive-element modulator cannot be compared by itself against other modulator devices, since the inductive elements that perform the switching cannot be separated easily from the capacitive elements that store energy. The over-all modulator, however, is comparable with a line-type modulator at power levels where passive-element devices have been used to date.

Drive Requirements

The drive requirements of the gas-tube switches, in general, are very much lower than those of a hard-tube modulator, although some of the margin may have to be sacrificed in order to buy improvements in performance factors. Although the drive requirements for a hard-tube modulator may be reduced by driving it with a gas tube, this can be done only by sacrificing some of the performance factor advantages of this type of device. A self-triggering passive-element modulator will obviously require no drive. As indicated in the previous discussion, this may not be an over-all advantage. In addition, the requirements for biasing elements with dc power to control triggering or for shaping, may result in a device with poor total efficiency.

Over-all Efficiency

Considering the switch itself for the moment, it can be stated as a general fact that, for comparable power levels, the power lost in a gas tube switch will be less than that lost in a hard-tube switch. The efficiency of a passive-element modulator, con-

sidering the switching section only, will be a function of the number of stages. Based on data indicating that a stage efficiency of 85% is a reasonable design figure, the efficiency of a two-, three-, or four-stage switch would be comparatively low compared with the other switches alone. In order to determine over-all efficiency, the remaining components of the modulator—such as the power supply, charging choke, network or storage capacitor (included in switch for the case of the passive-element modulator), and pulse transformer when used—must be considered. Using extremely rough assumptions on the efficiency of each of these components, the over-all efficiency of a hard-tube modulator not requiring a pulse transformer is comparable to that of either the line-type or single-stage passive modulator with pulse transformer. A two- or three-stage passive-element modulator would be considerably less efficient than either of the others, and if it were possible to use a line-type modulator without a pulse transformer this would be the most efficient. If drive or biasing requirements are considered in the over-all efficiency calculations, the line-type modulator with a gas-tube switch must be considered superior with respect to efficiency, even with a pulse transformer output. The estimate of power supply efficiencies used for the passive-element modulator did not include electronically generating the supply frequency. This would cut the over-all efficiency even further.

Impedance Level of Power Supply

The size and weight of the power supply for the modulator often represents a large fraction of the total size and weight of the modulator. The ability of a line-type modulator or a passive-element modulator to operate at half the stored voltage plus operation at a higher ratio of current to voltage, generally leads to a smaller and possibly lighter power supply design. In the case of the passive-element modulator or ac charging line-type modulator, this advantage is further increased by the elimination of the dc rectification. The importance of this power supply size factor in the choice of modulator device can be minimized by the use of oil immersion of the rectifier components.

Performance Deficiencies

This factor is listed only to emphasize the point that, while it is possible to overcome many apparent operational deficiencies of a switch, the process will usually result in an increase in size of the modulator. A complete evaluation of the individual problem is required before one can arrive at a final choice of modulator device.

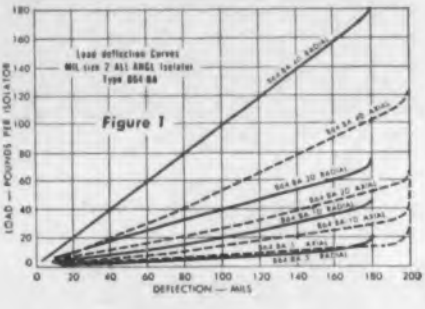
This article appeared originally in the A.G.E.T. News Bulletin, Dept. of Defense, Vol. 1, No. 2, Apr. 1957.

How to Meet Tougher Specifications for Shock and Vibration Protection in Jets and Missiles

You've got to design to tougher specifications for combined shock and vibration isolation if you're going to protect the reliability of electronic controls in today's high-performance jets and missiles. Faster accelerations, zero-length launching, and extreme maneuverability combine to impose shock and vibration loads far beyond current MIL specs. *These severe operating conditions must be reduced to a predictable environment suitable for electronic equipment.*

Isolator Requirements

Higher shock inputs require more stiffness in the isolator, to store more energy for a given deflection, so there will be less energy to dissipate if the isolator bottoms. *Higher vibration amplitudes* call for greater clearances and minimum transmissibility at resonance. And vibration protection *under high-g sustained acceleration* demands a combination of these characteristics.



Use of Performance Curves

The characteristics of an isolator having the stiffness necessary for handling the shock and sustained accelerations of jet and missile take-offs is shown by the curves of Figure 1. These curves can be used in choosing the proper isolator for operation under the expected service conditions, since they show both the deflection of isolators under a wide range of loadings and the maximum allowable deflection due to the combination of static load, sustained acceleration, and vibration amplitude.

A transmissibility at resonance well below three — considered exceptionally low — is shown by the curves of Figure 2. The measurements for these curves were made with a 27-pound load supported on four 10-pound isolators, with double-amplitude vibration input of 80 mils. These curves, showing performance for both base and bulkhead mounting, also indicate that the isolator satisfies the need for *consistent operation in every attitude* of flight, launching, and maneuvering.

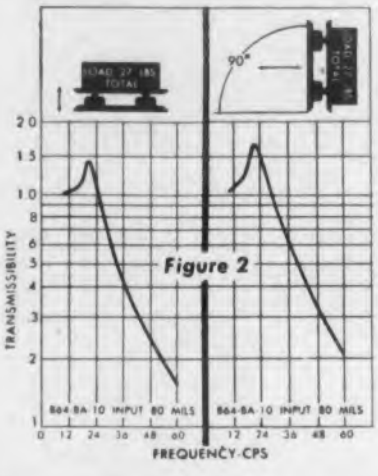


Figure 3 illustrates the construction of the B64 isolator that provides the performance characteristics shown by the curves, yet is dimensionally interchangeable with MIL-size mounts of comparable load ratings.

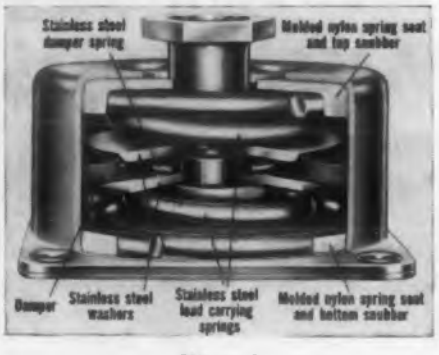


Figure 3

Additional Design Data

Other curves of isolator characteristics, and data on their use in designing *for predictable environment in jets and missiles,* are contained in Barry Bulletin 57-2. This bulletin fully describes the complete line of ALL-ANGL Barrymount isolators in standard MIL sizes. Write today for your free copy.

Uncoated flexible guide (top). Coated guide in its rigidized position (bottom).

Smoothing the rigidizing compound using a light flow of air from an air dryer to make it run.

Rigidized Flexible

FLEXIBLE waveguide can be rigidized by applying a paste-like compound which hardens into a strong, lightweight jacket. Complicated assemblies, difficult or impossible to make in one piece of rigid waveguide, can be readily fabricated, using this technique. Besides saving tooling costs, it eliminates superfluous flanges and reflections from joints.

The compound, developed by Technicraft Laboratories Inc., Thomaston, Conn., is particularly advantageous for small quantities which would not justify bending tools. It is tough and has relatively

Rigidizing compound is brushed on flexible waveguide. Complicated assemblies can be easily fabricated using this technique.

Waveguide

high tensile strength. Rigidized assemblies will withstand impact tests which seriously dent RG-67/U aluminum waveguide. Pressure-tight, they will withstand as much internal gas pressure as their equivalent rigid guides. The coating can be painted, if desired.

Useable over a temperature range of from —67 F to +300 F, coated assemblies subjected to 20 hours exposure at —55 C, showed no ill effects. As far as has been ascertained, the compound is practically impervious to acids, alkalis, oils and common solvents. U-shaped rigidized X-band flexible waveguide assemblies both 180 deg E-plane bends and 180 deg H-plane bends, when subjected to vibration and shock per Spec Mil-5422 C (ASG) showed no evidence of damage.

Transmission Characteristics

For a complex, small X, rigidized flexible waveguide assembly, of 12 in. overall length, typical characteristics are: VSWR, 1.06 max over the frequency range 8500 to 9600 mc; over the range; 8200 to 12,400 mc, VSWR 1.08 max, attenuation 0.12 db max; pressure 60 psi. In small X size, the average weight of the rigidized flexible waveguide is 5-1/4 oz per ft. compared with 8-1/2 oz per ft. for RG-67/U, aluminum. The weight differential in favor of rigidized flexible waveguide is more favorable when flanges are added. Assemblies are available in K_u and X bands. Small X rigidized seamless-corrugated assemblies may be made with a multiplicity of bends with centerline radii as sharp as 5/8 in. for E-plane bends, and 1-1/8 in. for H-plane bends.

For further information on this rigidized waveguide, turn to Reader's Service Card and circle 47.

Editor's Note: This article compares the results of operating and non-operating life tests in an effort to reduce the problem of component over-specification. The authors consider this an interim report on the subject, and it is intended to stimulate the presentation of more information and data by other investigators. Transistor engineers can do a great deal by writing realistic specifications before too many precedents are established.

Determining Transistor Reliability

IN DESIGNING military systems, the reliability of a component has to be designed and built into it, but the customer has little direct control over designs and processes except through specification on the completed item. Because of this lack of control, specifications are redundant and excessive, and the cost of an item can increase as much as 300 percent in an attempt to guarantee reliability through over-specification. Since one of the most costly tests are operating life tests, these were studied to determine if simplification could be achieved in military specifications.

Experimental Results

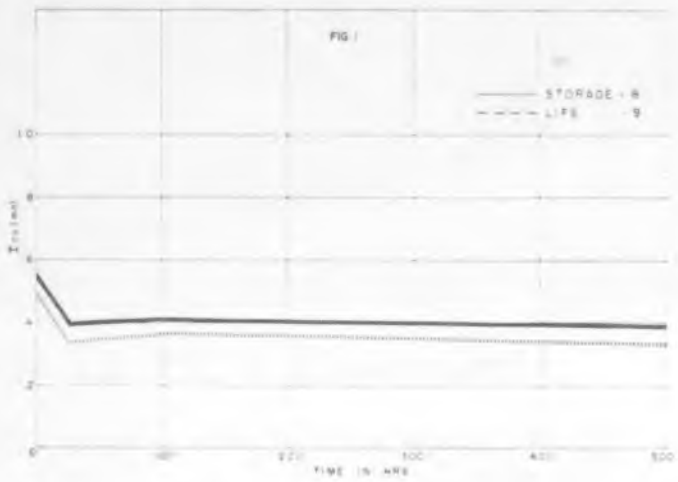
Three different types of PNP alloy junction power transistors were evaluated under operating and non-operating conditions to indicate a measure of reliability. The data taken indicates that the beta degradation under both conditions is quite similar. The I_{co} parameter variation seems in general more difficult to explain. In one instance close correlation between operating life and storage life was noted. In another case the storage effects appear to impose more severe degradation with respect to this parameter. In still another case mechanical failures were noted under the operating condition.

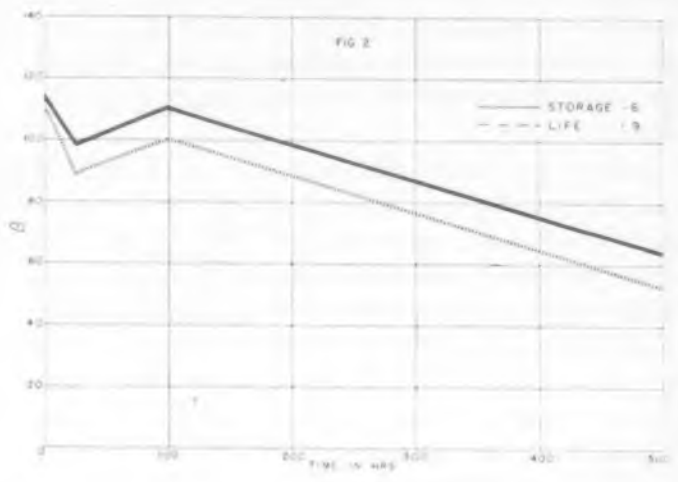
The samples chosen for these tests were selected from a screened lot of transistors by removing non-hermetically sealed units. Operating junction temperatures were set to approximately coincide with the shelf life storage temperature.

The first type of unit evaluated contained a nitrogen back fill. Storage and operating junction temperature were held at 85 C. Figs. 1 and 2 are graphs showing the variations of the collector cut-off current, (I_{co}) and current gain, (β) as a function of time under both the operating and non-operating conditions. It is noted that both parameters seem to vary in a parallel manner under both conditions. The curves represent an average of all the data taken at various time check points.

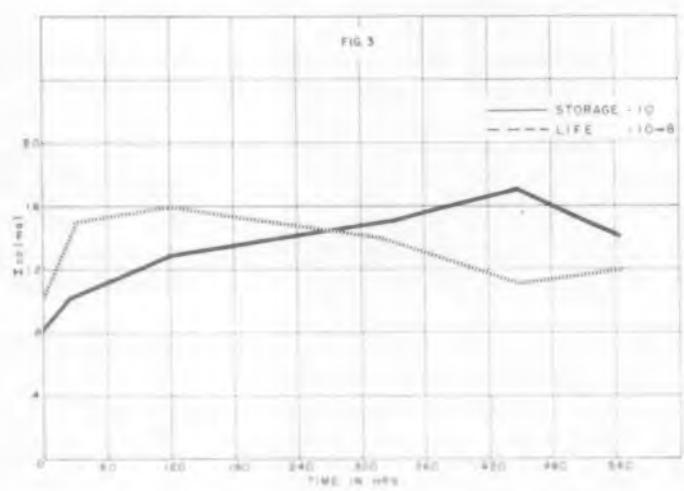
The second type of unit evaluated was one which contained a dry air back fill. During the course of the investigation two mechanical failures were noted under the operating life tests. The failures, occurring after 320 hours, consisted of units which developed open emitters apparently due to improper soldering of the emitter lead to the emitter electrode. Figs. 3 and 4 indicate average curves on the variations of collector cut-off current and current gain against the time of study. It is noted that the current gain variations are similar under both conditions. In the case of the collector cut-off current, comment on variation beyond the 320 hour point is deferred because of the failures noted.

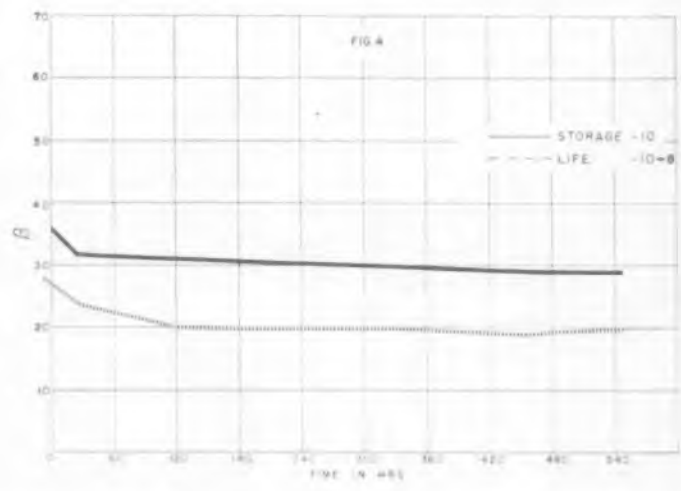
The final series of tests were run on units containing a nitrogen back fill but do not represent the same units





Figs. 1 and 2: Graphs showing the variations of collector cut-off current (I_{co}) and current gain (β) as a function of time under both operating and non-operating conditions. These units have a nitrogen back fill.





Figs. 3 and 4: Average curves on the variations of collector cut-off current and current gain against time for units with a dry air back fill.

Operating vs Non-Operating Methods

Bernard Reich and Harry V. Wood
Signal Corps Engineering Labs.
Fort Monmouth, N. J.

previously discussed. Fig. 5 and 6 exhibit the variations of parameters as a function of time. It appears from Fig. 5 that the storage condition imposes a greater degrading effect on the device than does the operating test. With respect to the current gain characteristic, a parallel degradation appears to exist.

Life Test Considerations

Consideration must be given to determine a reasonable operating life test. Little is known on exactly how any particular device will be used, so that the basic specification does not spell out the life test except in general terms. If the device is to be used as an amplifier, switch, or oscillator, then possibly the type of test should follow the application. When a device is tested on the basis of usage, however, the test circuitry involved may become cumbersome.

In the past transistor life tests have been carried out as a continuous d-c operating life test for a specified period, or a similar test with an "on-off" cycle. Under a recent reliability program conducted at the Signal Corps Laboratories different types of life tests were performed including high temperature shelf storage tests, d-c operating tests, switching tests, and voltage pulsing tests. It was found that in all the studies performed, temperature seemed to be the common degrading environment. It was also noted that voltage would enhance radical failure on those units which did not have a good hermetic seal or permitted moisture to enter through the leads.*

In comparing operating and non-operating reliability studies, it was decided to compare d-c operating life tests and high temperature storage life tests. These tests were chosen because of the common practice of the military in using them for reliability information. This particular discussion is centered about power transistors, although the information is applied to other types of transistors.

*See "Report on Power Transistors for Converters", B. Reich, ELECTRONIC DESIGN, March 15, 1957.

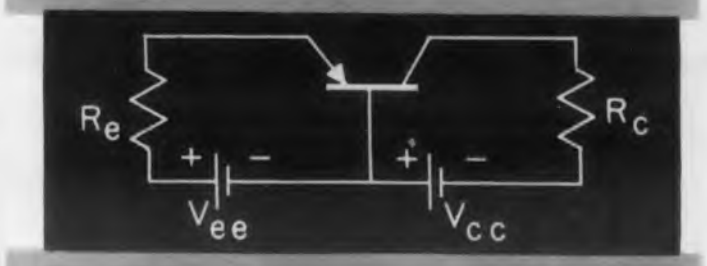
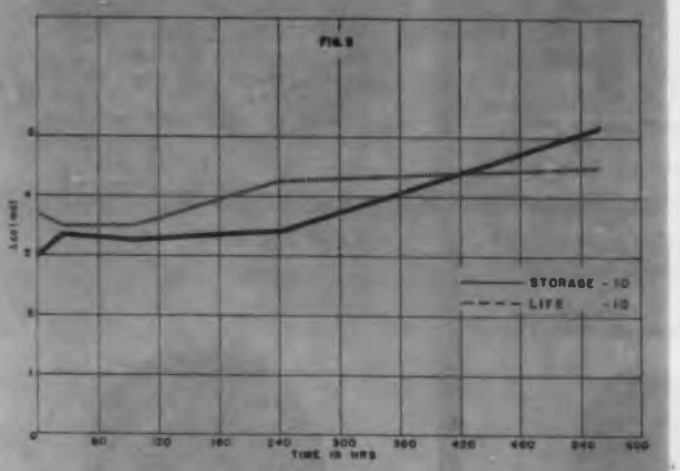
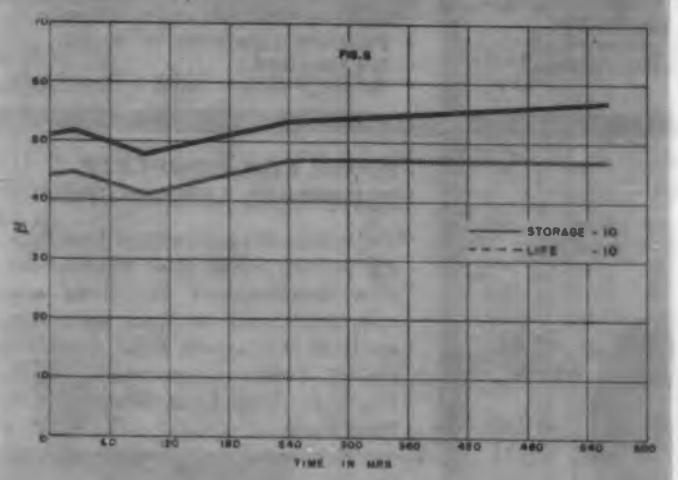


Fig. 7: Diagram of life test circuits used to gather data.





Figs. 5 and 6: Variation of parameters as a function of time. These units have a nitrogen back-fill but are different from those of figs. 1 and 2.

Based on previous experience, it was decided that the junction temperature was the most important parameter of the transistor for reliability considerations. The operation junction temperature can be related to the dissipated power by the following expression:

$$T_j = T_c + \Theta P_t \qquad (1)$$

where T_j is the junction temperature in degrees C, T_c is the case temperature in degrees C, P_t is the total power dissipated in watts, and Θ is the thermal resistance in degrees C/watt between the junction and the case.

In order to conduct a satisfactory life test and minimize the variability of thermal resistance which may vary by as much as three to one in a lot of devices, it is necessary to conduct life tests in the following manner. Examination of Eq. 1 indicates two methods of obtaining an operating junction temperature. For the sake of discussion, it is assumed that an operation junction temperature of 90 C is satisfactory. If the case temperature is maintained at 25 C the ΘP_t component must add an additional 65 C. If the design value of thermal resistance, Θ, of a power transistor is 3 C/W, then it would be necessary to supply approximately 22 w per device. If any number of transistors are set up on a life test the amount of power that would have to be supplied would be considerable. If on the other hand the case temperature were maintained at 75 C then 5 w of power would have to be supplied per device to achieve the desired junction temperature. As stated previously the value of Θ can be quite variable in presently available devices. To operate at a specified junction temperature with a minimum of error, introduced by Θ, the ΘP_t component of T_j (Eq. 1) should be smaller than the T_c component.

In addition to this type of test where the case is held at a constant temperature it is also possible to conduct tests where the transistor is mounted in a position where natural convection occurs. The desired value of T_j is then obtained by successive thermal measurements on the case. This type of arrangement is not as useful as the one previously discussed since variations in mounting may result in varying operating junction temperatures.

The previous discussion indicates some of the considerations involved in setting up an operating life test. In contrast to this it is a simple matter to set up a storage oven to a desired temperature level and subject devices to this environment for a specified period of time. In addition the amount of equipment necessary to set up a life test rack is considerable in comparison to the requirements of a high temperature shelf life type of test. The question to be resolved is whether the tests conducted yield information which is identical or serves the same ultimate purpose.

COMMUNICATIONS ENGINEERS

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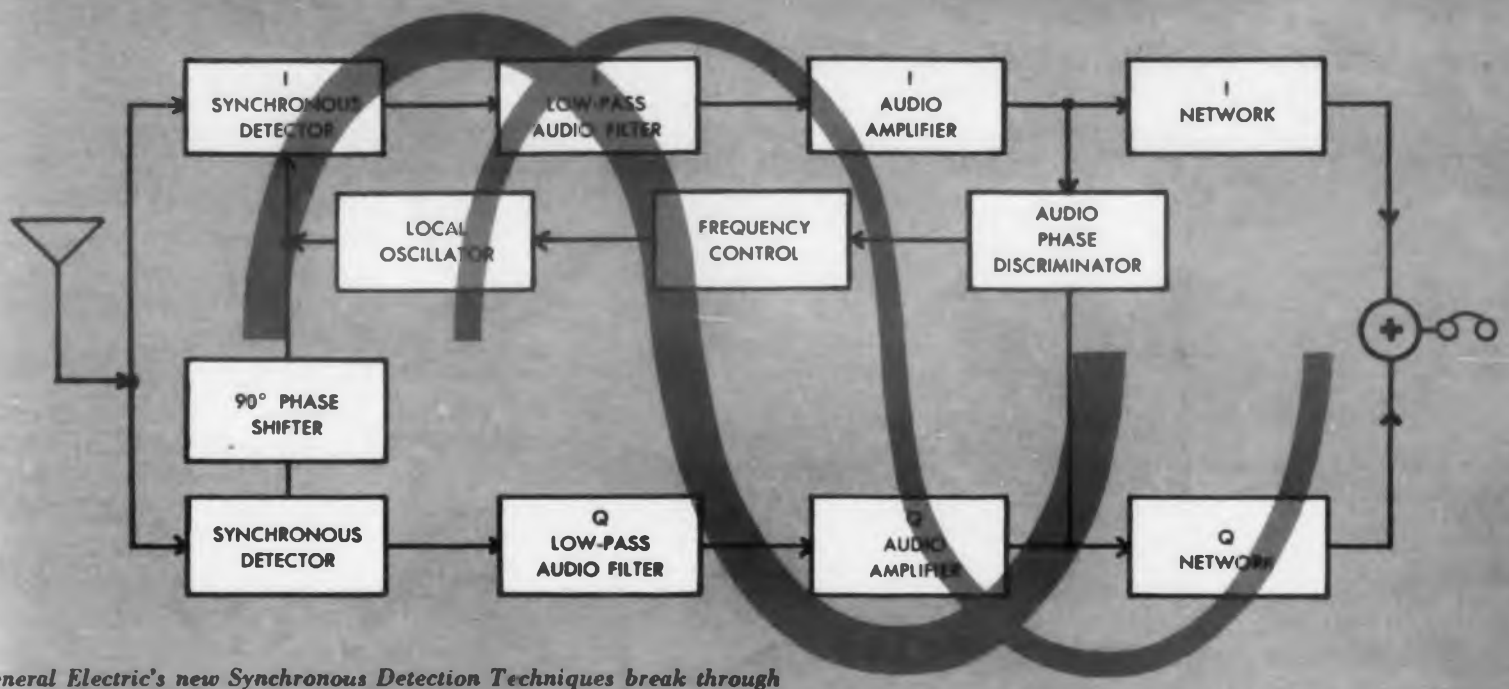

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In comparing an operating life test to a storage test it is often stated that units which are operating under bias conditions may show a tendency toward run away. It has also been pointed out that storage life is not comparable to operating life. No comment is made on this hypothesis, however some mention should be made on the matter of transistor stability which may obviate a conclusion of this sort. In order for a transistor to be stable under operating conditions in a life test circuit certain stability requirements have to be met. It has been shown that stability is maintained if

$$SI_s < \frac{13}{V_c\Theta} \qquad (2)$$

where I_s is the reverse saturation current, S is the circuit stability factor as outlined by Shea, Θ is the thermal resistance in degrees C/watt, and V_c is the collector voltage.

The stability of the transistor can be determined by knowing the applicable transistor parameters, I_s and Θ, and circuit parameters S and V_c. Failures which occur due to instability cannot be used as an argument against storage tests if the above circuit conditions are not met.

The life test circuit used for the tests is shown in Fig. 7. Under these conditions the S factor of the circuit is approximately equal to unity. The value of V_c used is 28 v. A typical power transistor has a reverse saturation component of 0.050 ma at 25 C. If it is desired to operate the junction at 85 C, I_s can be calculated to be approximately 3.2 ma at 85 C. In addition, if the thermal resistance value given by the manufacturer is in the range of 5 degrees C/w, the calculations turns out to be from Eq. 2:

$$1 \times 0.003 < \frac{13}{28 \times 5} = 0.093$$

Under these conditions, thermal run away would not be exhibited.

Overall conclusions on transistor reliability testing cannot be reached form the data presented in this report, since the samples were small and are not representative of all different transistor types. It appears however from the data presented that operating life tests may be quite useful as a design check, and for routine reliability evaluation storage life tests will be sufficient. More experimentation would seem to be in order to verify this preliminary data.

References

1. Reliability of Power Transistors in d.c. to d.c. Converters, B. Reich, presented at the Transistor Reliability Symposium on 17 September 1956.
2. H_5, H_6, H_7 Power Transistor Specification, Transistor Division, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

New Products

Blocking Oscillator

3/4 In. Cube

A complete blocking oscillator circuit for generating trigger pulses, including a subminiature pulse transformer, transistor, capacitor, resistor, and crystal diode, has been packaged in a three-quarter inch molded cube. The DuMont Pulse-Cube produces a pulse of 3 μsec duration with a rise time of 0.06 μsec. Amplitude is from +6 v to −3 v peak. Variations of the unit offer fixed repetition rates of 25 kc, 1 kc, or a variable repetition rate from 400 cps to 24 kc. When operating at a 25 kc repetition rate and a 3 μsec pulse width, the unit can run for approximately 1,000 hrs on a miniature 6 v mercury cell.

Available either as a free-running blocking oscillator or as an externally triggered type, the pulse-cube can be furnished as a plug-in or as a solder lug type. The operating temperature range is from 55 to 60 deg C.

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

CIRCLE 52 ON READER-SERVICE CARD FOR MORE INFORMATION

Sweep Operated Relay

To Observe Transients

In the study of single transient phenomena with an oscilloscope, the Sweep Operated Relay will be found useful by initiating the transient at a convenient pre-set portion of the trace on the face of the cathode-ray-tube. Visual observation is achieved by setting the scope to repetitive sweep. The unit will then initiate the transient at a pre-set portion of the sweep cycle.

The unit consists of a dc amplifier which compares the sawtooth voltage from the scope against an adjustable reference voltage. When the instantaneous value of the sawtooth voltage exceeds the reference voltage the amplifier actuates a relay which in turn initiates the transient to be studied. Input impedance is 10 meg shunted by 50 μμf. Frequency range is 0 to 20 cy—up to 35 cy at reduced accuracy for relay output, or pulsed output through audio frequency range. Unit will initiate the transient on the same point of the cathode ray tube within the thickness of the trace.

Engelhardt Eng. Co., Dept. ED, 38 Burritt Ave., So. Norwalk, Ct.

CIRCLE 53 ON READER-SERVICE CARD FOR MORE INFORMATION

Vibration Meter

For Quick Inspection

The Model 305 Portable Vibration Amplitude Meter is a self-powered instrument for seeking out vibration and establishing acceptable tolerances in production, inspection and maintenance. The 24 oz weight of the instrument makes it convenient for use in usually inaccessible places. It is operated on either "A" or "B" Mallory or Ever Ready batteries. The meter is calibrated directly in three ranges of 0.1, 1, and 10 mils full scale reading.

International Research & Development Corp., Dept. ED, 797 Thomas Lane, Columbus, Ohio.

CIRCLE 54 ON READER-SERVICE CARD FOR MORE INFORMATION

1 F Amplifier

High G Type

Developed to withstand 20 G vibration at 2000 cps, these units utilize ruggedized subminiature tube in a specially cast chassis designed for high heat conduction and minimum chassis resonance. Specifications of the 1F64D are 60 mc center frequency, gain 65 db, bandwidth 10 mc. 1F64 amplifiers with other gain or bandwidth specifications can be supplied.

Lel Inc., Dept. ED, 380 Oak St., Copiague, L.I., N.Y.

CIRCLE 55 ON READER-SERVICE CARD FOR MORE INFORMATION

AC to DC Converter

Directly Proportional

Used for conversion of ac to dc for measurement, recording and telemetering, the converter provides a dc output of 0 to 12.5 v, directly proportional to the peak alternating input. Range of input is from 10 cps to 200 kc at 0 to 25 v peak to peak. Linearity is better than one per cent, with an accuracy range of 0.1 per cent of calibration. Initially developed for guided missile application, it weighs 8 oz.

Nacimco Products, Inc., Dept. ED, 2300 National Ave., National City, Calif.

CIRCLE 56 ON READER-SERVICE CARD FOR MORE INFORMATION

Silicon Power Rectifiers

From 100 Ma to 3 Amp.

A series of silicon diodes and medium power rectifiers covering the current range from 100 ma to 3 amp, these components are stud mounted and hermetically sealed.

United States Dynamics Corp., Dept. ED, 1250 Columbus Ave., Boston, Mass.

CIRCLE 57 ON READER-SERVICE CARD

Medium-Temperature Solder

428-435 F Eutectic

Adapted to applications that require high creep strength without high temperature application, a recently developed solder melts in the range 428-435 F. While its creep strength is less than that of silver solders, the material withstands creep indefinitely under usual stress loads, and its use eliminates the risk of distortion resulting from excessive heat in application. Low conductivity resulting from oxide films also is eliminated where this solder is used. Designated #38 alloy, the solder is self-annealing, has a tin base, ready flow and good wetting properties. Its manufacturer's Alpha 200L flux is recommended for use with it. Melting may be accomplished by iron, resistance tools, flame or induction heating. The solder comes in solid wires, in diameters from 0.032 to 0.125 in.

Alpha Metals, Inc., Dept. ED, 56 Water Street, Jersey City 4, N.J.

CIRCLE 58 ON READER-SERVICE CARD

Identification Name Plates

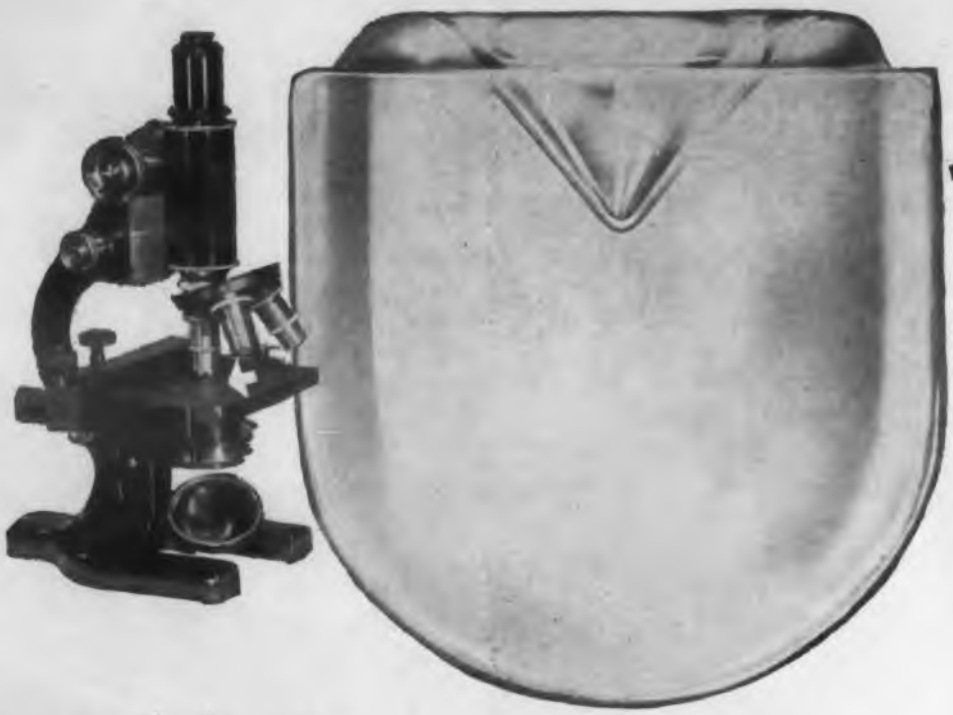
Adhere Without Screws

Name plates which identify panel components, motors, terminal boxes or other equipment are fastened in place by a special adhesive on the back of each plate, which forms a strong, permanent bond. It is a heat-resisting bond, and may be applied to any surface. The plates are available in either fibre or aluminum. A line of standard markings, and a standard plate size (3/8 x 1 in.) make lower prices possible.

E. C. P. Corp., Dept. ED, 6808 Wade Park Ave., Cleveland 3, Ohio.

CIRCLE 59 ON READER-SERVICE CARD

CIRCLE 60 ON READER-SERVICE CARD ➤



Typical of the scientific technology that is behind Triplett's world wide reputation for reliability—these jewel pivot bearings are so minute that 1000 do not even half-fill this one-half inch bottle and every jewel is perfectly balanced with more painstaking care than the watchmakers' art.

Triplett current catalog offers more than 15,000 available types and ranges of clear plastic front and conventional design black plastic panel meters.

The identical careful accuracy and high reliability is available in the complete Triplett line of VOMs, VTVMs, scopes and other test equipment.

TRIPLETT

TRIPLETT ELECTRICAL INSTRUMENT COMPANY
Bluffton, Ohio

Over half a century of experience

New Products

I-F Amplifier Tube

For 12 V Operation

Designed to operate with plate and screen voltages supplied directly from a 12-v battery, an automotive service-type miniature pentode, designated 12CN5, has the characteristics for i-f amplifier service. It is equipped with a 7-pin miniature button. Heater, plate and screen grid are designed to operate satisfactorily at the varied voltages obtainable from a nominally 12.6 v storage battery. Heater current is 0.450 amp, plate resistance 40,000 ohms, transconductance 3800 μmhos and typical plate current 4.5 ma.

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

CIRCLE 62 ON READER-SERVICE CARD

Mass Production Delay Lines

1.0 Microsecond or Less

Distributed parameter delay lines designed for mass production in a continuous process have been put on the market. Not only does the continuous process mass production technique reduce the cost of these delay lines, but it also insures stability and uniformity. They are designed for time delays of 1.0 microsecond or less.

International Resistance Corp., Dept. ED, 401 North Broad Street, Philadelphia, Pa.

CIRCLE 63 ON READER-SERVICE CARD

Frequency Calibrator

For Telemetering

Either manual or automatic channel and frequency point switching can be had with this 7-point frequency calibrator, designated Model TMC-307. The instrument is accurate within 0.02 per cent. It furnishes seven equally spaced frequencies per channel. End limits of the lower two are ±7.5 per cent; of the upper five ±15 per cent. Other limits and spacings can be supplied to order. The calibrator takes 10-1/2 in. panel space and is suggested for miniaturized ground station equipment.

Panoramic Radio Products, Inc., Dept. ED, 10 S. Second Ave., Mount Vernon, N.Y.

CIRCLE 64 ON READER-SERVICE CARD

◀ CIRCLE 61 ON READER-SERVICE CARD

Metal Film Resistors

Low L and C

Characterized by low inductance and low capacitance, a new line of metal film resistors designated Types MEC and MEF has been made available. These units feature high accuracy and stability, low and controllable temperature coefficients. They are suited to high frequency applications.

International Resistance Co., Dept. ED, 401 North Broad St., Philadelphia, Pa.

CIRCLE 65 ON READER-SERVICE CARD

Frequency Analyzer

Tracks Frequency Components

Frequency components are tracked and a visual plot of component frequency vs component amplitude is provided by a test instrument designated Synchronous Frequency Analyzer Model SF-1. It is particularly intended to track components derived from rotating or oscillating sources, and is expected to prove very helpful in dynamic balance analysis.

Panoramic Radio Products, Inc., Dept. ED, 10 S. Second Ave., Mount Vernon, N.Y.

CIRCLE 66 ON READER-SERVICE CARD

Motor-Driven Time Switches

With Nylon Gear Trains

Nylon gears, pinions and shafts are featured in three new off-peak control time switches, for longer life and reduced maintenance. These new models, designated Types TGW 5, 6 and 7, replace the maker's former models T-43, TGW-1 and TGW-2. No lubrication is needed. Aluminum studs and shafts replace brass parts formerly used, and the on-off triggers and arms are of single-unit construction. Contact block assemblies are molded. Contacts have been made larger. A marker arrow permits checking motor synchronism. The current rating of the TGW 5, formerly the T-43, has been raised from 20 to 35 amp.

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

CIRCLE 67 ON READER-SERVICE CARD

CIRCLE 68 ON READER-SERVICE CARD ➤

Allied's New MHJ Relay

Built for Shock and Vibration

10-55 cps at 0.122 inch double-amplitude • 55-2000 cps at 20g

Here are the facts!

Contact Ratings:
Low level up to 3 amperes non-inductive or 1 ampere inductive at 28 volts d-c or 115 volts a-c

Contact Arrangements:
MHJ-12D: 4 PDT
MHJ-18D: 6 PDT

Temperature:
Minus 65°C to plus 125°C

Vibration:
10-55 cps at 0.122 inch double-amplitude
55-2000 cps at 20g

Operating Shock: 100g

Altitude:
Sea level to 80,000 feet

Weight:
MHJ-12D: 3.0 ounces
MHJ-18D: 4.2 ounces

Insulation:
1000 megohms minimum

Dielectric Strength:
1000 volts rms at sea level;
450 volts rms at 70,000 feet

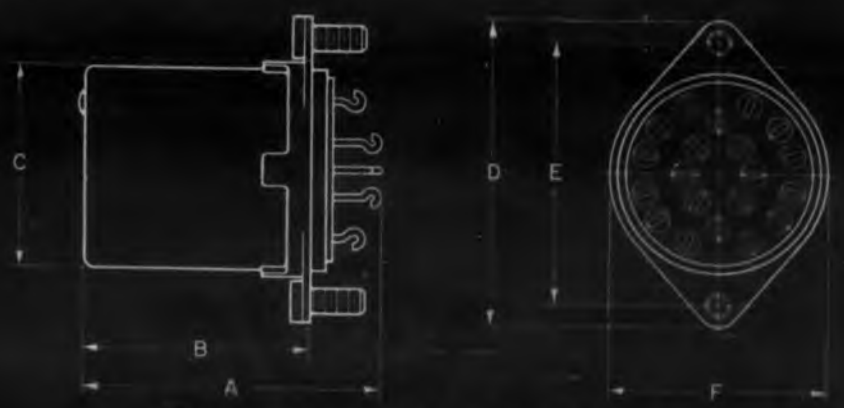
Initial Contact Resistance:
20 ohms maximum at 28 to 2 amps

Operate Time:
15 milliseconds or less
at rated voltage at 25°C

Release Time:
5 milliseconds or less
at rated voltage at 25°C

ACTUAL SIZE

Type MHJ



MOUNTING — 6-32 NC-2A THD. (2) STUDS

	A	B	C	D	E	F
MHJ-12D (4 Pole)	1¾ max.	1 5/16	1 3/64	1 21/32	1.406	1⅛
MHJ-18D (6 Pole)	1¾ max.	1 5/16	1 3/16	1 13/16	1.562	1 3/64

ALLIED CONTROL

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

New Products

Wirewound Resistors
Non-Inductive

Completely non-inductive, the NS type resistors are wirewound, power resistors of miniature size. Silicone sealed, they offer protection from salt laden air and humidity and have high dielectric strength. Available in five wattages, 2, 3, 5, 7, and 10 w and six physical sizes, the NS resistors have a maximum continuous operating temperature of 275 C. Resistance range is 1 ohm to 37 K, depending on size and tolerance. Temperature coefficient is 0.00002 per deg C. They are available in tolerances of .05 per cent, .1 per cent, .25 per cent, .5 per cent, 1 per cent and 3 per cent.

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

CIRCLE 70 ON READER-SERVICE CARD FOR MORE INFORMATION

Constant-Output Amplifier
For Synchronous Motors

This constant voltage power amplifier is designed to supply a constant output voltage at frequencies ranging from 40 to 1000 cy within 1 db for the operation of power equipment requiring up to 150 va at 115 v ac. Its main function is to furnish power to induction and synchronous motors by the amplification of a specific frequency for operation of these motors or equivalent loads. The amplifier automatically compensates for varying input line voltages, variable loads, and varying power factors ranging from 0.7 to unity, leading or lagging.

The amplifier is capable of delivering a maximum of 220 w at less than 5 per cent distortion. Its output load regulation is better than 10 per cent and its a-c line stabilization is better than 5 per cent. With a gain of 56 db, a signal-to-noise ratio of 54 db and an input impedance of 10,000 ohms, it may be coupled to any signal generator, tuning-fork or crystal-controlled oscillator. A screw-driver slotted control is provided on the front panel to adjust the output voltage and to accommodate input signal levels ranging from 0.8 to 20 v. Hum and noise level is less than 1.0 v. A O to 150 rectifier type a-c voltmeter, mounted on the front panel, indicates the output voltage.

Amplifier Corp. of America, Dept. ED, 398 Broadway, New York 13, N.Y.

CIRCLE 71 ON READER-SERVICE CARD FOR MORE INFORMATION

Rectangular Panel Meters

Efficient Design

Modern design for more efficient reading, is featured in a line of rectangular panel instruments. Designated Wide-Vue, these instruments have open-faced covers for wide-angle readability, and longer scale lengths than conventional instruments. Scale length of the new 2-1/2 in. size is as long as the scale of a conventionally designed 3-1/2 in. meter. The durable plastic cover is formed in one piece. Two movements are available, the standard magnet type and the self-shielded core magnet type. Three sizes are available—2-1/2 in., 3-1/2 in. and 4-1/2 in.

Simpson Electric Co., Dept. ED, 5200 W. Kinzie Street, Chicago 44, Ill.

CIRCLE 72 ON READER-SERVICE CARD

Resin Process Equipment

Fiberglass Plastic

A range of standard and special tanks, fume ducts, hoods, towers, trays and other process equipment has been made available in a new plastic resin. Price range is comparable to that of polyester process equipment, but the new resin offers greater fire resistance, resistance to chemical corrosion and strength than polyester resins; is equally light in weight, and will not support combustion. It is reinforced with fiberglass. Designation is Haveg 6610.

Haveg Industries, Inc., Dept. ED, Wilmington, Del.

CIRCLE 73 ON READER-SERVICE CARD

Thermoplastic Spray Unit

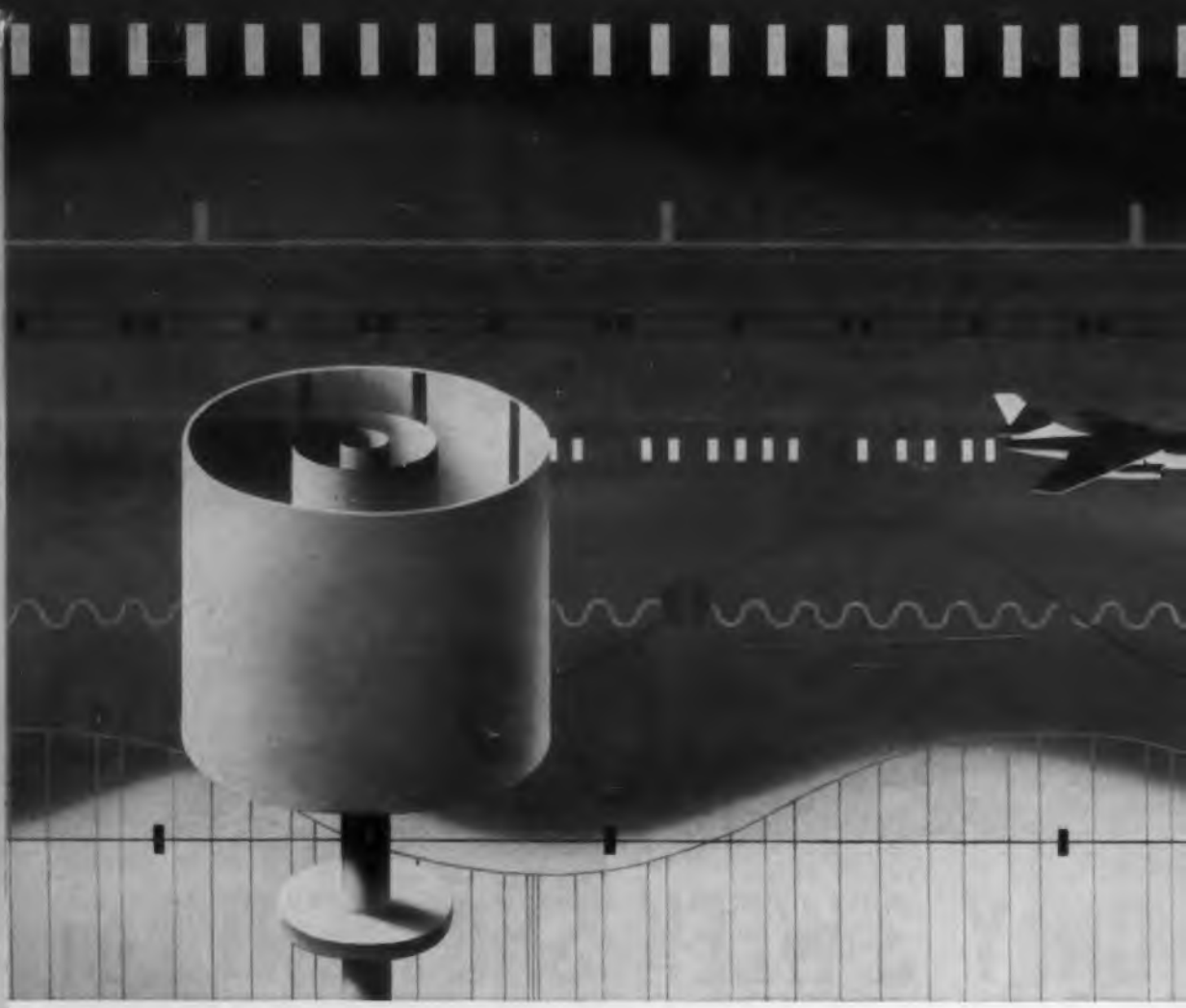
For Metals

For spray coating of metallic targets, the Mark III utilizes a modified polyethylene powder to provide a coating up to 3/16 in. thick. For fluidizing, other finely divided thermoplastic resins may be used in addition to polyethylene.

American Agile Corp., Dept. ED, 5461 Dunham Rd., Maple Heights, Ohio.

CIRCLE 74 ON READER-SERVICE CARD

CIRCLE 75 ON READER-SERVICE ➤



Eimac X676 Modulating Anode Klystron

Shaped RF Pulse, 30 KW Peak Power Output for 955-1220 mc Air Navigation Systems

Designed for air navigation systems, the Eimac X676 three cavity, air cooled klystron will deliver 30 KW peak power output in the 955 to 1220 mc range. With a power gain of 35 db, this tube has an efficiency of 40 per cent.

A typical air navigation systems requirement is a shaped RF pulse output to eliminate spectrum interference in adjacent channels. The Eimac X676 conservatively meets the 60db requirement of the CAA's air navigational system without using critically tuned, expensive filters in the RF output transmission line. The modulating anode permits pulsing the beam current while keeping the accelerating voltage constant. Also, the modulator circuit for this application is quite simple.

The RF cavities are external to the vacuum system and detachable from the klystron. The user may purchase spare tubes without buying additional tuning and focusing assemblies.

For the design engineer, the features of the X676 simplify circuitry — for the equipment operators the X676 provides reliable, long-lived performance at moderate cost.

For further information about the Eimac X676 Modulating Anode Klystron, consult our Application Engineering Department. Also available are two highly informative booklets; "The Care and Feeding of Klystrons" and "Klystron Facts . . . Case Four".

EITEL-McCULLOUGH, INC.
SAN BRUNO CALIFORNIA

***Eimac First** in high power amplifier klystrons*

Typical Pulse Operation X676

DC Beam Voltage	24 KV	Power Output	32 KW	Power Gain	
DC Beam Current	3.3 Amps	Driving Power	10 watts	Average Power	
Power Input	80 KW	Efficiency	40%		

imac

. . . . . 35 db
. . . . . 1 KW

New Products

Crystal and Oven Package

4 kc to 125 mc

Combined into a single hermetically sealed plug-in unit is an all-glass vacuum mounted crystal, plus integral temperature stabilizers for high precision frequency control at 75 or 85 C. High reliability over the frequency range of 4 kc to 125 mc is provided.

Bliley Electric Co., Dept. ED, Union Station Bldg., Erie, Penna.

CIRCLE 77 ON READER-SERVICE CARD

Power Supply Filter

Ripple 8 Mv

Designed for use in conjunction with its manufacturer's Model MR532-15A d-c power supply, a filter section designated Model M-709 reduces the power unit's output ripple to 8 mv or less. Addition of the filter section to the power supply increases its use in precision testing. The filter section is built for standard 19-in. rack mounting; its overall dimensions being 8-3/4 x 10 x 19 in.

Perkin Engineering Corp., Dept. ED, 345 Kansas St., El Segundo, Calif.

CIRCLE 78 ON READER-SERVICE CARD

Non-Linear Function Generator

Relates Function to Rotation

With applications in the non-linear servo field, in computers and in the correction of non-linear transducers, an adjustable non-linear function generator has been put on the market in four production models. The instrument consists of a function adjusting assembly, and an interpolating potentiometer. A total of 100 taps is connected to a 31-pole, 100-position, printed circuit switch. Any of the 31 poles can be switched to any of the 100 taps, and the potential of each of the 31 poles can be adjusted to within one-half of one per cent of the input voltage. These generators have been miniaturized to about one-half the size of the prototype displayed by their maker a year ago.

Perkin-Elmer Corp., Dept. ED, Main Ave., Norwalk, Conn.

CIRCLE 79 ON READER-SERVICE CARD

◀ CIRCLE 76 ON READER-SERVICE CARD

High Power Transistor

PNP Alloy Junction

Capable of handling 2 w in Class A, 9 w in Class B push-pull—a recently announced germanium transistor is serviceable not only as an output stage, but also can be used for switching. In the latter application its switch power is 26 w max. Power gain in switching or as a push-pull stage is 25 db; as a Class A amplifier it is 33 db. Collector supply voltage in all applications is —14 v dc. The collector current in Class A operation is —360 ma, dc, the zero signal dissipation 4.4 w. In Class B operation zero signal collector current is —50 ma, dc; max signal collector current —500 ma, dc, and peak collector current —1.5 a, dc. Because of the very narrow spread between upper and lower limits of characteristics these transistors can be used without preselection. Designation is 2NI55.

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

CIRCLE 80 ON READER-SERVICE CARD

Tension-Free Wound Resistors

Give Added Reliability

Low-tension winding techniques give these resistors exceptional stability and high accuracy over longer periods of time. All windings are heat-cycled and aged to further insure stability. Designated the Series CB, the units are available in standard resistance ranges of 150 K to 8.0 megohms. They perform reliably over an ambient temperature range of —55 to +85 C. Windings are coated and filled with a resin-base varnish to permit normal operation under conditions of high humidity. Most types are rated for full wattage up to 85 C, and can be made to dissipate four times their rated wattage, over a lower resistance range, through the use of glass-insulated wire. Low inductive effects of the reverse-pi wound resistance wire maintains tolerance up to a frequency of 30 kc. Standard tolerances are 1, 0.5, 0.25 and 0.1 per cent.

Kelvin Electric Co., Dept. ED, 5907 Noble Ave., Van Nuys, Calif.

CIRCLE 81 ON READER-SERVICE CARD

CIRCLE 82 ON READER-SERVICE CARD

New Products

Lattice Network
For Digital Storage

This lumped constant electromagnetic network is specifically developed and designed for digital storage and uses only 1.2 elements per bit, providing stable characteristics without extreme tolerances on the individual elements. Hermetically sealed units can be supplied for any capacity up to 30 bits at digit rates up to 5 mc, for satisfactory operation over a temperature range of —20 to +70 C.

Ferranti Electric, Inc., Dept. ED, 30 Rockefeller Plaza, New York 20, N.Y.

CIRCLE 84 ON READER-SERVICE CARD FOR MORE INFORMATION

Varitron Camera
For Computer Readout

This camera provides a permanent film record of the summation to computations performed by computing devices. It is designed to pick up computer readout directly from the cathode ray tube presentation, thereby eliminating any time lag. Summations recorded on film by the Varitron require a minimum amount of storage space, provide an immediate record for present or future use, and may be enlarged for detailed study at any time.

Special field-flattening optics correct distortion. The precision micrometer lens focusing mount permits precise focusing, which is necessary to maintain accurate image dimension and configuration. The Beattie Varitron camera holds 100 ft of 35 mm film which is automatically advanced by an electrical drive mechanism. Exposures may be made at regular, predetermined intervals or at random intervals, if so desired.

Photographic Products Inc., Dept. ED, 1000 N. Olive St., Anaheim, Calif.

CIRCLE 85 ON READER-SERVICE CARD FOR MORE INFORMATION

Telemetering Filters

Miniature

A line of subminiature, lightweight telemetering filters have a size of 2 cu in. or less per unit. Telemetering filters for channels 1 through 6 are 1.562 x 0.75 x 1.187 in.; weight is 71 grams (±1 gram). Channels 7 through 18 are 1.375 x 0.75 x 0.75 in.; weight is 36 grams (±1 gram).

Completely cast in an epoxy-filled resin, all units are hermetically sealed and will meet all applicable MIL Specifications for immersion, shock and environmental tests. All channels will pass 20 g at 2000 cy for 2 hr. Temperature range is —55 to +85 C. Channel points have standard Johns Hopkins band-pass telemetering call-outs. All units are made to plug into standard 4-pin Winchester sockets. Standard input impedance is 20 K and output impedance is 100 K. This can be varied to meet customers' specific application requirements.

Aerovox Corp., Dept. ED, Pacific Coast Div., 2724 Peck Rd., Monrovia, Calif.

CIRCLE 86 ON READER-SERVICE CARD FOR MORE INFORMATION

AC Motor

102 Ratios

A line of standard motors for 115 or 200 v ac, 60 or 400 cps, measures 1.675 in. diam, and up to 4.5 in. long. The motors are wound for single phase (with a capacitor) or two phase operation, two, four, or six pole, and three phase, two and four pole. Motors can be furnished with integral planetary gear reducers, offering 102 ratios between 4 to 1 and 3 million to 1. By varying the speed of the basic motor, up to 306 standard output speeds are available.

Type FC gear reduced motors are supplied with induction or hysteresis rotors: the former produces up to 3.5 in.-oz of torque, the latter, operating at synchronous speed, produces up to 1.2 in.-oz of torque.

Globe Industries, Inc., Dept. ED, 1784 Stanley Ave., Dayton, Ohio.

CIRCLE 87 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Wire Clamp
Quick Installation

Designed to secure wire bundles, installation of wire in this U-shaped clamp involves only two quick operations--placing the wire inside the clamp, and manually pushing a keeper over the notched edges where it locks with high holding power. To release for adding or removing wires, the technician merely presses the horns together and lifts off the keeper.

Units are available in sizes starting at 3/16 in., weighing 0.001 lb, and extending to a 2-1/2 in. size weighing 0.052 lb. Sizes are reckoned across the horns. The smaller size will secure 58,000 cir mils of wire, and the larger size 8,570,000 cir mils. Clamps have mounting holes on the bottom, and may be fastened permanently.

Dakota Engineering, Inc., Dept. ED, 6641 Crenshaw Blvd., Los Angeles 43, Calif.

CIRCLE 91 ON READER-SERVICE CARD FOR MORE INFORMATION

Bathtub Capacitor
High Temperature

Base size in this new Type SBXM series is 1-1/8 x 1 in. with heights of 1/2 in. and 11/16 in. Ratings are 0.1 to 2.0 μf at 200, 400 and 600 v dc working. The Type SBXM capacitors are designed for operation over the temperature range for −55 to +130 C and are provided with high-temperature glass-to-metal seals, with solder lug terminals. They are hermetically sealed after Polykane impregnation and fill, and conform to MIL-C-25A humidity, inversion, vibration and shock environmental test requirements for paper capacitors.

The Type SBXM capacitor is for use in equipment where capacitors with short current path and low rf impedance characteristics are needed. Power factor does not exceed 1.5 per cent at 25 C.

Cornell-Dubilier Electric Corp., Dept. ED, South Plainfield, N.J.

CIRCLE 92 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Supply

Strain Gage Type

Model 7PO1 single or multiple channel power supplies have these specifications: 115 v, 60 cy input; 10 v dc output, adjustable from 9 to 11 v dc with a 10-turn potentiometer; output voltage changes less than ±0.05 per cent due to temperature change from 0 to 0.45 C; output voltage changes less than 0.1 per cent due to 2 per cent change in load current; output ripple is less than 300 μv rms, isolated from ground as follows: insulation resistance to ground—10,000 meg, ac pickup voltage to ground—5 μv peak.

Western Gear Corp., Dept. ED, Electro Prods. Div., 132 W. Colorado St., Pasadena 1, Calif.

CIRCLE 93 ON READER-SERVICE CARD FOR MORE INFORMATION

Meter Relay

High Sensitivity

The Model 126 very high sensitivity meter-relay measures 1 x 1-1/4 x 2-1/4 over-all and fits a 9-pin miniature socket. The meter-relay has a moving coil armature which rotates in the flux gap of an Alnico magnet. The moving element rotates on polished pivots in vee cup jewels. The pointer is a contact of solid iridium-platinum alloy. A locking coil in the moving element develops additional torque to drive the contacts together with considerable pressure.

Range and accuracy are 50 μa to 10 amp and 10 mv to 500 v at 2 per cent. It ranges down to 0.2 μa (12,000 ohms) and 0.1 mv (5 ohms) at reduced accuracy. Millivolt ranges may be internally compensated to operate directly from thermocouples. Ac ranges will monitor line voltage or work on the output of a tachometer generator to check rpm. Microampere meter-relays are null detectors for checking voltages in regulated power supplies. The instrument is supplied for both ac and dc.

Assembly Products, Inc., Dept. ED, P.O. Box XX, Palm Springs, Calif.

CIRCLE 94 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Dry Circuit Tester
Checks Relays

These relay test sets pass low-current, low voltage signals thru the contacts of relays to be used for grid switching applications while the relays are energized. Individual contacts can be monitored for research into the dry circuit phenomena or all contacts can be connected in series for production lots. The Model R-3C passes 30 μa thru the contacts with an open circuit voltage of 30 mv. The Model R-4C passes 1 μa through the contacts with an open circuit voltage of 5 μa. The test relay is energized once per second, and a counter records the number of times a failure is encountered. Test sets of various sizes are available to test from one to twenty-four relays simultaneously.

Fleetwood Labs. Inc., Dept. ED, 300 Victory Blvd., New Rochelle, N.Y.

CIRCLE 97 ON READER-SERVICE CARD FOR MORE INFORMATION

Soldering Pencil
Long Life, 50 w

A soldering pencil equipped with a long-life 1/4 in. tip, rated at 50 w, is capable of doing the work of 100 w soldering irons, yet weighs but 2 oz. A stainless steel alloy for element housing plus a unique design in ventilation insures a comfortable handle and maximum soldering efficiency. Tip and element are separate parts and are both replaceable independently, without returning to the factory. Designed and recommended for constant-duty, it operates on ac or dc, any cycle. Available for 110 or 220 v.

Hexacon Electric Co., Dept. ED, 299 W. Clay Ave., Roselle Park, N.J.

CIRCLE 98 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Absorber
13,500 W

The power absorber operates at 13,500 w continuous duty, and has a weight of 1 lb per kw absorbed. Air is drawn in through circumferential slots in the casing, and flows over V-section resistors. The motor and fan can be operated either as part of the load, or from an independent power source. The power absorber is fully protected against overloading.

Sun Electric Corp., Aeronautical Div., Dept. ED, 6701 S. Sepulveda Blvd., Los Angeles, Calif.

CIRCLE 99 ON READER-SERVICE CARD FOR MORE INFORMATION

Counting Circuits
Plug-In

Plug-in P Series, and C Series comprise a line of transistorized counting circuits for telemetering frequency determination, time internal origination, sequencing, counting and scaling, and similar operations. The former, a plug-in package fits standard 7 pin miniature socket and can be conveniently retained with a standard tube shield. The latter, C Series cartridge, a rectangular flat configuration for permanent installations, features high space density stacking and miniature styling.

The lines are comprised of a binary counter, types PM 6003 and CM 6003, which has use as a binary or as a flip-flop; type PM 6023 and CM 6023 trigger which will convert a sine wave or other wave shape into a fast rising pulse suitable for driving the binary counter and other circuits; a delay multivibrator, types PM 6013 and CM 6013, which is a nominal 3 us delay circuit; specifically designed to provide delayed feedback or reset pulses to the binary counter; and a dual emitter follower amplifier, types PM 6033 and CM 6033, which is a circuit that can be coupled directly to transistor counter output.

Walkirt Co., Dept. ED, 141 W. Hazel St., Inglewood, Calif.

CIRCLE 100 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

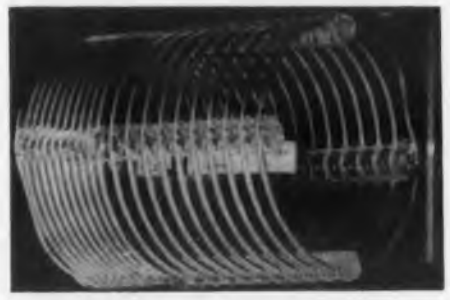
Pyrometers
Easily Read

These medium resistance pyrometers (4 ohms per mv) are available in 21 standard ranges. Meters are 3-3/4 and 4-1/2 in. wide, and may be read accurately from all angles because they have been redesigned with mirror scales to cut down parallax effect. Maximum sensitivity for a pyrometer connected to one thermocouple is 300 F for full scale deflection. Standard ranges begin with −400 to +100 F and go up to 0/3000 F. Full scale accuracy of 2 per cent is standard, although 1 per cent may be obtained at extra cost. These pyrometers may be thermistor-compensated to maintain accuracy in spite of ambient changes. They are furnished with compensation for changes in cold junction.

Assembly Products, Inc., Dept ED, Chesterland, Ohio.

CIRCLE 103 ON READER-SERVICE CARD FOR MORE INFORMATION

Air Dux Coils
For Pi Output



A series of air dux coils designed primarily for modern pi output circuits may also be used in conventional LC output circuits, interstage and oscillator circuits. Available in two series: indented and variable pitch. Indented coils make connecting of taps by clips or soldering easy, and variable pitch coils offer complete ease in obtaining the proper inductances at high frequencies. Pi air dux coils are adaptable to a wide range of tube and load impedances in either high or low power transmitters. Each coil is made with bright tinned copper wire and low loss polystyrene coil supports, and comes complete with plastic mounting strip.

Illumitronic Engineering, Dept. ED, 680 E. Taylor St., Sunnyvale, Calif.

CIRCLE 104 ON READER-SERVICE CARD FOR MORE INFORMATION

Test Load

High Amperage

The Hi-Amp unit is said to deliver a heavy test load with a minimum of wattage and a continuously adjustable secondary current, from zero to a maximum of 240 amp. The high ampere capacity permits the simulating of starting currents for large and small motors to check relays under these conditions. A wide range of voltages on each tap permits dropping the current from starting value to normal by simply adjusting the vernier control. The momentary overload rating is 200 per cent of normal. Total weight of the unit is 111 lbs.

Sittler Corp., Dept. ED, 16 North Ada St., Chicago 7, Ill.

CIRCLE 105 ON READER-SERVICE CARD FOR MORE INFORMATION

Wires and Cables

Teflon Insulation

The Series T line of wires and cables for high temperature applications encompasses hook-up wires, miniature coaxial and coaxial cables and multiconductor cables. Extruded as well as spirally wound and fused Teflon insulations are offered in a range of 14 colors and/or spiral striping, on solid, standard and special strandings of silver plated copper wire conductors of from AWG 32 through AWG 10. Hook-up wires with extruded Teflon insulation comply with MIL-W-16878B specifications and have a rating of from −90 to +250 C. Hook-up wires with spirally wound and fused Teflon insulation are manufactured to the MIL-W-16878B specifications for temperatures to 250 C, and feature a free-stripping and extra flexible construction. All hook-up wires can be shielded and jacketed to individual specifications. Miniature coaxial cables with either extruded or spirally wrapped and fused Teflon jacketings are offered in wide ranges for high impedance as well as low capacitance applications.

Times Wire and Cable Co., Dept. ED, Wallingford, Ct.

CIRCLE 106 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Accelerometer
For 450 F Use

The Glennite AD series are designed for continuous operation at temperatures up to 450 F with no temperature compensation and no external cooling required. Each amplifier and cathode follower is individually potted with a plastic compound to insure performance under extreme conditions. The filament in the amplifier may be set for operation at either 6.3 or 26 v. Four systems are available, the AD-1, AD-5, AD-10 and AD-14 with the AD-5 and AD-14 systems having a wider acceleration range and higher frequency response. Glennite connectors and cables are supplied.

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

CIRCLE 109 ON READER-SERVICE CARD FOR MORE INFORMATION

Analog Field Plotter
Dry Paper Type

This dry paper type field plotter is for use in solving complex two-dimensional field problems. It has been used to solve mathematical functions, including orthogonal plotting, electrostatic and electromagnetic fields, gas and liquid flow and heat transfer problems. Excellent results may be obtained in establishing design criteria involving electrostatic patterns around wires, insulators and shields, and also in determining flow patterns in wing and propellor design, wind tunnels, turbine blades, pump and valve body, piping design and model work. The plotter provides a visual and permanent record of such problems.

Sunshine Scientific Instrument, Dept. ED, 1810 Grant Ave., Philadelphia 15, Pa.

CIRCLE 110 ON READER-SERVICE CARD FOR MORE INFORMATION

Sampling Switch

Miniature

A miniaturized version of the Type A Sampling switch weighs only 7 oz and measures 2-11/16 x 1-13/16 x 1-11/16 in. The two-pole 30 contacts per pole switch will provide 60 channels in make-before-break operation. A filtered 27.5 v dc motor rotates the switch at 2.5 rps providing a sampling rate of 150 samples per second.

Applied Science Corp. of Princeton, Dept. ED, Princeton, N.J.

CIRCLE 111 ON READER-SERVICE CARD FOR MORE INFORMATION

Time Acceleration Switch

For Missiles

An acceleration-time integrating switch for missile and rocket applications actuates when sustained acceleration in excess of the internal bias is applied. It is hermetically sealed and conforms to Air Force environmental specifications. An observation window and reset feature facilitate laboratory testing. The switch can be adapted to a wide range of acceleration and time parameters to satisfy specific requirements. Contact closure occurs in the presently available unit when the missile or rocket has reached a velocity of approximately 460 ft per sec under conditions of sustained accelerations between 4 and 15 g. The pictured unit is approximately 3 cu in., and weighs approximately 9 oz.

The Magnavox Co., Dept. ED, 2131 Bueter Rd., Fort Wayne, Ind.

CIRCLE 112 ON READER-SERVICE CARD FOR MORE INFORMATION

CTC coil forms with Perma-Torq* Tensioning Device are designated PLST, PLS-6, PLS-5, PLS-7, PLS-8 and are factory assembled to mounting studs. The units are completely interchangeable with CTC's LST, LS-5, LS-6, LS-7 and LS-8.

Reliability is their family resemblance

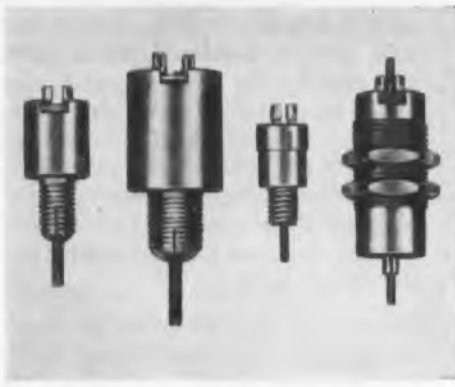
Here's a reliable family of coil forms ready to meet your specifications. These Perma-Torq Tensioning Devices on CTC coil forms allow locking of tuning cores while still tunable — and you can depend upon them to do their job well.

This built-in dependability is a result of CTC's unique design plus quality control — that meets or betters government specifications.

Perma-Torq is a compression spring of heat treated beryllium copper, that has a very high resistance to fatigue and keeps coils tuned as set — even under extreme vibration and shock. The device also allows for immediate readjustment — without removal or loosening of any mounting nut or locking spring.

Quality control and features like the above are just two of the reasons why CTC can offer you guaranteed standard or custom electronic components — whose performance you can rely upon.

CTC researchers and practical experts are always available to help you solve your component problems. For all specifications and prices, write Cambridge Thermionic Corporation, 457 Concord Ave., Cambridge 38, Mass. West Coast stocks maintained by E. V. Roberts and Associates, Inc., 5068 West Washington Blvd., Los Angeles 16, and 61 Renato Court, Redwood City, California.



CTC miniature shielded coil forms are rugged and perfect for "tight spots." The LS-9 is 7/16" diameter ½" high. LS-10 is ⅝" diameter x 1 1/16" high. The LS-11 is 5/16" x 17/22. The LS-14 is double ended and is ½" OD, 1 and 5/64" overall in length. All are highly shock resistant with mechanically enclosed protected coil windings. The units are ideal for use with IF strips or as RF coils, oscillator coils, etc. Available as coil form assemblies or wound to your specifications.

*Patent pending.

CTC

CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components custom or standard

CIRCLE 115 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Filtration Unit

3 to 10 Gal Per Min

The MIK filtration unit is designed to remove physical impurities from electronic wash waters and demineralized waters. The unit makes possible the production of physically pure water on a large scale. Capacities range from 3 to 10 gallons per min and the filter removes all physical impurities larger than the rated density of the cartridge. MIK permanent cartridges are available in the following densities: 25, 10, 1 and 0.1 microns.

Heico Inc., Dept. ED, 25 North Sixth St., Stroudsburg, Pa.

CIRCLE 116 ON READER-SERVICE CARD FOR MORE INFORMATION

Spectrum Analyzer

10 CPS Resolution

Designed for applications requiring high resolution, such as investigations of side bands caused by low modulating frequencies, single side band transmissions, teletype etc., the SB-12 Panalyzor can be used to observe signals anywhere in the spectrum up to 1,000 mc by means of an external signal generator and an internal aperiodic mixer which translate the spectrum segment to be analyzed down to the 450-550 kc input band of the Panalyzor. The SB-12 also permits examination of signals closely adjacent in frequency. Maximum sweepwidth is 100 kc continuously reducible to 0 kc. Scan rate is adjustable in steps of 30, 5, 1, and 0.1 cps. Resolution ranges from 3.2 kc to 10 cps. AFC is provided for narrow sweepwidths.

Panoramic Radio Products Inc., Dept. ED, 10 So. Second St., Mt. Vernon, N.Y.

CIRCLE 117 ON READER-SERVICE CARD FOR MORE INFORMATION

Servomotor Dampers
For Diehl FPE-25

Need for tachometers, networks, or other bench-engineered means of stabilization is eliminated by a new line of viscous-coupled-inertia dampers. They are primarily intended for use with Diehl FPE-25, 5-w servomotors. High velocity and torque constants, with good stability, are provided by these dampers. They need only the simplest form of servo amplifiers. Each is factory adjusted to specified time constants within the range 0.02 seconds to 1.20 seconds. Mountings are available for tapered or straight shafts, with or without integral pinion.

Feedback Controls, Inc., Dept. ED, 899 Main Street, Waltham 54, Mass.

CIRCLE 118 ON READER-SERVICE CARD FOR MORE INFORMATION

DC to DC Converter
Lightweight

A series of dc to dc power converters for portable, aircraft, and vehicular electronic equipment is transistorized for lightweight, efficient operation. Standard units are available for 12 and 28 v inputs, in a number of nominal output voltages from 120 to 2100 v, and in power outputs up to 500 w. Custom engineered combinations of input and output voltages and higher power ratings are available on special order as high as 12 amp or 100,000 v. Typical of this series is Model UAC 500/28/400 ma, which delivers 200 w (500 v at 400 ma) from 28 v dc input, weighs only 2 lb, and comes in a compact 6 x 3 x 3 in. package.

Regulation is available to 0.25 per cent, and efficiency under special conditions to 98 per cent. Standard operating temperature range is —40 to +71 C, but higher temperatures are available.

UAC Electronics, Dept. ED, Div. of Universal Transistor Products Corp., 143 E. 49th St., New York 17, N.Y.

CIRCLE 119 ON READER-SERVICE CARD FOR MORE INFORMATION

EPOXY COATED

Good-All CERAMIC DISC CAPACITORS

A BETTER DISC CAPACITOR BECAUSE IT'S PROTECTED FOR LIFE with Good-All's tough, durable Epoxy coating.

HIGH VOLTAGE BREAKDOWN STRENGTH

Epoxy bonds securely to the ceramic edge and blocks leakage or actual breakdown.

MOISTURE RESISTANT

Complete encapsulation in Epoxy keeps moisture out. Lead entries are tightly sealed.

DURABLE AND ATTRACTIVE

This tough, durable coating is a glossy red color. No wax is needed to add further protection.

COMPETITIVE COST

Good-All Epoxy coated discs are available at no premium cost over types with conventional coating.

Condensed Table of Widely-Used Stock Types

DISC TYPES	CAPACITY RANGE	MAXIMUM DIAMETER	STANDARD TOLERANCES	APPLICATION NOTES
TRANSISTOR TYPE "H"	.00047-.001 MFD .0015 -.005 .006 -.01 .015 -.02 .022 -.05	.250" .375" .437" .500" .660"	G M V +80% −20%	FOR MAXIMUM SPACE SAVING. RATINGS UP TO 200 VDC
BY-PASS TYPE "B"	.00047-.001 MFD .0015-.002 .0022 -.0047 .005 -.02 .022	.290" .400" .570" .660" .790"	G M V +80% −20% ±20%, ±10%	MEET ALL REQUIREMENTS OF RETMA CLASS 2, Z5Z
STABLE TYPES "E" & "EE"	100- 330 MFD 331-1000 1001-1500 1501-2000 2001-3300 3301-5000	"E" .290 .400 .570 .660 .790 .890 "EE" .400 .570 .660	±20% ±10% ± 5%	Temperature Stability* in the Range From −25°C to +85°C is: Type "E" +5% to −15% Type "EE" 0% to −10% *Compared to 25°C reading

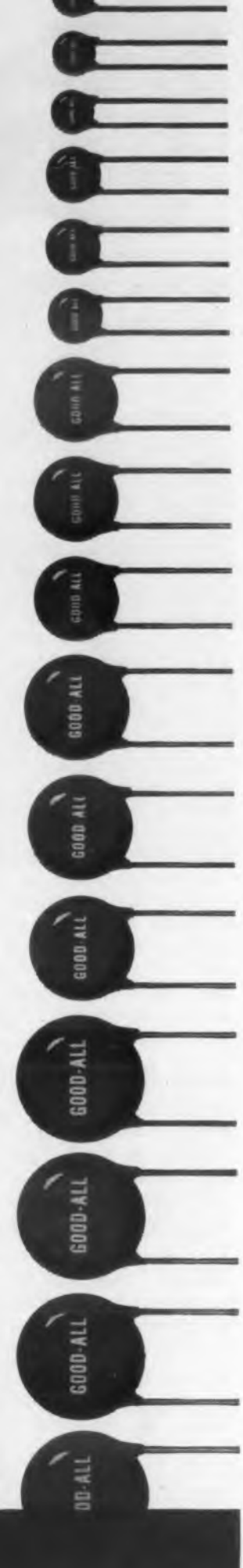
TEMPERATURE COMPENSATING TYPE "A"	MAXIMUM DIAMETER FOR CAPACITY SHOWN				
Temperature Coefficient	1/4"	5/16"	1/2"	5/8"	3/4"
NPO	2-12 MMF	13-22 MMF	28-60 MMF	61-75 MMF	76-110 MMF
N150	2-15	16-30	31-60	61-75	76-110
N220	3-15	16-30	31-75	75-100	101-140
N330	3-15	16-30	31-75	76-100	101-140
N470	3-20	21-40	41-80	80-120	121-170
N750	5-25	26-50	51-150	151-200	201-290
N1400	15-50	51-100	101-200	200-250	251-470

Write for a complete brochure. Samples for tests against your specifications will be supplied upon request.

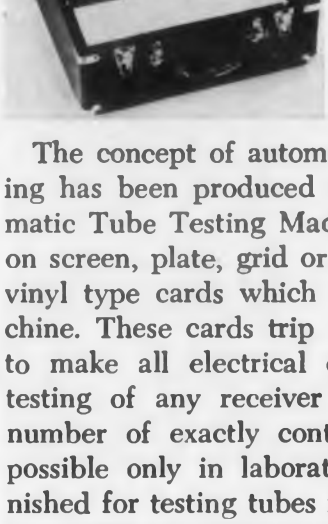
GOOD-ALL ELECTRIC MFG. CO. OGALLALA, NEB.

A leading manufacturer of tubular and ceramic disc capacitors

CIRCLE 121 ON READER-SERVICE CARD FOR MORE INFORMATION



New Products



Tube Tester
Automatic

The concept of automatic, high-speed tube testing has been produced in the Model 123A Cardmatic Tube Testing Machine. Preselected voltages on screen, plate, grid or filament are tabulated on vinyl type cards which are inserted into the machine. These cards trip an automation mechanism to make all electrical connections necessary for testing of any receiver tube. An infinitely large number of exactly controlled voltages (formerly possible only in laboratory type testers) are furnished for testing tubes in special purpose circuits. Unusually low 0.22 rms signal used on the grid permits testing of the newer sensitive tube types without distortion. Tubes are checked within seconds and the simplified operation permits even unskilled personnel to run laboratory-accuracy tests on a production line basis.

Hickok Electrical Instrument Co., Dept. ED, 10581 Dupont Ave., Cleveland 8, Ohio.

CIRCLE 122 ON READER-SERVICE CARD FOR MORE INFORMATION

Frequency Meter
3 to 100,000 Cps

This transistorized unit provides accurate direct frequency measurements from 3 to 100,000 cps in nine separate ranges. Accuracy is independent of input voltage waveform and amplitude. The instrument's sensitivity to short pulses minimizes lost counts when measuring the average frequency of random events. For tachometry and vibration indications, an output connector on the Model 503 provides all operating voltages for the Model A-503-1 and A-503-2 phototransistor pickups. These pickups allow the speed of rotating machinery or the frequency of vibrating parts to be sensed by means of interrupted light.

Cubic Corp., Dept. ED, 2841 Canon St., San Diego 6, Calif.

CIRCLE 123 ON READER-SERVICE CARD FOR MORE INFORMATION

Servo Amplifier

Plug-In

The Model 1800-0500 is a high temperature, miniaturized, hermetically sealed, plug-in transistor servo amplifier. It is primarily intended to receive signals from a syncho control transformer and to operate a size 15, 400 cy, 6.1 w servo motor (Kearfott Type R110-2) or equivalent. The amplifier is designed to exceed the environmental requirements of Specification MIL-E-5400A. Input-power requirements are 100 v dc at 100 ma and 28 v dc at 12 ma.

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

CIRCLE 124 ON READER-SERVICE CARD FOR MORE INFORMATION

Mass Spectrometer

For Low PPM Range

Problems of analyzing extremely small amounts of gaseous mixtures, or liquids capable of being vaporized, can be solved with a mass spectrometer designed for both laboratory and industrial use. Known as the Type 21-611 Mass Spectrometer, it has a mass range from 2 to 80 with resolving power adequate for separation of adjacent peaks up to about mass 35. Mass numbers appear linearly with time on a large, motor-driven dial, making mass marking unnecessary. A manual override on the motor drive permits the operator to turn quickly to any mass number of interest, or to start and stop the automatic scan at any desired point. High sensitivity makes possible the detection of gas impurities in the low ppm range. Modular design permits the control unit to be separated from the analyzer unit and grouped with other essential elements necessary for observing related phenomena. This new mass spectrometer weighs 115 lb, and is suitable for bench, rack, or trailer mounting, with the analyzer and control modules either stacked or separated.

Consolidated Electrodynamics Corp., Dept. ED, 300 N. Sierra Madre Villa, Pasadena, Calif.

CIRCLE 125 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Magnet Wire Kit
For Experimental Use

A wide variety of gage sizes in Class HT Teflon coated Magnet Wire is now being offered in a single kit. This teflon magnet wire kit was designed specifically for use in research and development projects where small quantities of different gage sizes are needed for prototype and experimentation.

The kit contains an assortment of 12 miniature spools of teflon coated magnet wire in gage sizes 20 through 42 awg. This wire conforms to Type III, MIL-W-19583 (Navy) Specifications.

Tensolite Specialties, Inc., Dept. ED, 198 Main St., Tarrytown, N.Y.

CIRCLE 128 ON READER-SERVICE CARD FOR MORE INFORMATION

IF Band-Pass Filters
For Single Conversion

A standard line of i-f band-pass crystal filters for improved design of single conversion receivers in the hf and vhf bands are stated as retaining all the advantages of multiple conversion performance at a lower cost.

Model 2215 KA is designed for voice utilizing a 2800 cy 6 db bandwidth. Model 2215 KB has a band of 250 cy and is of primary interest in cw reception. These units are electrically and mechanically interchangeable and may be cascaded in any combination to achieve selectivity. Both models may be incorporated between the mixes and i-f amplifier of a single conversion receiver. No padding or transformation networks are required between the two filters since they are designed to operate at the same impedance level. Some of the features of these filters are: smooth pass band, no spurious responses, reduced birdies and cross modulation, cw and phone filters interchangeable, single conversion and SSB reception. Both of these filters are currently being delivered from stock at a price of $44.50 each.

Hycon Eastern, Inc., Dept. ED, 75 Cambridge Parkway, Cambridge 42, Mass.

CIRCLE 129 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 131 FOR G.E. SPREAD AD >

THE MARK OF QUALITY

BARBER COLMAN

introducing the new

Microverter

a-c d-c chopper

Here's the new Barber-Colman Type NYZA Microverter specifically engineered to meet the more exacting chopper requirements of today's applications.

It can be used to convert a low level d-c signal (such as 10 microvolts produced by thermocouples and photocells) into a low level a-c signal, which can be further amplified to operate various kinds of control apparatus in null balance servo systems, industrial instruments, and other automatic controls.

The Microverter may also be used as a synchronous rectifier to convert low level a-c signals to d-c without loss. An important new field of application is chopper-stabilized operational amplifiers where minimum amplifier drift is important.

Low noise level of the Microverter is due to: (1) Extremely low driving power required — 2-volt coil will operate at 4 milliamperes (approximately 4 milliwatts); (2) load circuit members isolated from the magnetic field of driving coil; (3) contacts thermodynamically symmetrical to eliminate stray thermal emfs.

This new hermetically sealed chopper features excellent stability under shock and vibration, long operating life, rugged construction. *10,000 hours' service life has been achieved* at contact load of 1 ma at 1 volt d-c, resistive.

SPECIFICATIONS OF A TYPICAL MICROVERTER

MODEL NYZA 6192	
d-c coil resistance	215 ohms
Drive voltage	2 volts
Drive frequency	60 cycles per second
Dwell time	45 plus or minus 3 percent
Balance	Within 2 percent average; 6 percent maximum
Phase angle (nominal)	74 degrees at 60 cps
Contact rating	2 volts at 2 milliamperes resistive load
Contact noise	10 microvolts maximum when operated into 1000 ohm resistive load
Ambient temperature range	30° F. to 130° F.

HELPFUL NEW DATA SHEET

Includes Barber-Colman Microverter description, specifications, and schematic diagrams for typical applications. Write today for your free copy or contact the nearest Barber-Colman engineering sales office: Baltimore, Boston, Chicago, Cleveland, Dayton, Fort Worth, Los Angeles, Montreal, New York, Philadelphia, St. Louis, Seattle.

BARBER-COLMAN COMPANY

Dept. Q, 1883 Rock Street, Rockford, Illinois, U. S. A.

Electrical Components • Aircraft Controls • Small Motors • Automatic Controls • Air Distribution Products • Industrial Instruments • Overdoors and Operators • Molded Products • Metal Cutting Tools • Textile Machinery

CIRCLE 381 ON READER-SERVICE CARD FOR MORE INFORMATION

a new line of...

vitreous enameled resistors

General Electric presents a new line of enameled resistors designed for dependable, long-lasting service. These new resistors—rated from 5 to 218 watts—are ideal for both industrial and electronic applications.

RELIABLE PERFORMANCE THROUGH PRECISION MANUFACTURING

Maximum equipment-performance and long resistor life are assured with G.E.'s new line of resistors because:

- Low-temperature-coefficient wire means stable operation.
- Elimination of "hot-spots" reduces resistor burnouts.
- Special enamel coating is moisture and acid resistant.
- Wire junctions are silver brazed for positive connection.

NEW CATALOG SIMPLIFIES SELECTION AND ORDERING

To aid you in selecting the right resistors for your specific applications, General Electric's new easy-to-use resistor catalog puts complete information on performance, ratings, dimensions, mounting arrangements, and ordering instructions right at your fingertips.

For complete information on General Electric's new enameled resistors, contact your nearest General Electric Apparatus Sales Office. For your copy of the new G-E resistor catalog, GEA-6592, write Section 784-5, General Electric Company, Schenectady, N.Y.

Industry Control Department, Roanoke, Virginia

Progress Is Our Most Important Product

GENERAL ELECTRIC

New Products

Limit Switch
Heavy Duty

The heavy duty limit switch No. 1230 is a ruggedized mechanism normally closed (single-pole, single throw), double break action actuated by a 35-lb force. Featured in the switch design is the instantaneous snap-action of the contacts regardless of the speed of the actuating mechanism. The superfast acting contacts open within 1/8 in. depression travel from the fully extended position. Tests and operation of over 20,000 cy while interrupting 50 amp of current at 28 v dc and an L/R ratio of 0.005 (ambient conditions) gave no evidence of malfunction nor critical wear. Additional tests with 500 cy of operation interrupting 300 amp (six times normal rate) of current at 28 v dc with similar L/R ration of 0.005 providing the same reliable results.

Dynamic testing of 2000 cy with both electrical studs under 50 lb load in six major axes, the nuts under a torque load of 65 lb and a 150 lb static load to the plunger with switch on normal mountings, provided the same reliable operating characteristics.

Janco Corp., Dept. ED, Burbank, Calif.

CIRCLE 134 ON READER-SERVICE CARD FOR MORE INFORMATION

Solenoids
Custom-Designed

This line consists of 17 models to provide 34 widely differing specifications. Pull and/or push capacities range up to 45 lbs., sizes from 1-3/8 by 1-3/8 in. to 3 x 3 in., stroke lengths fractional to 2 in. Double shading coils provide high sealed pull without hammer or excessive ac hum. Electrical characteristics are thoroughly uniform. Units are compactly engineered to extremely close tolerances. Rugged construction provides long service-life.

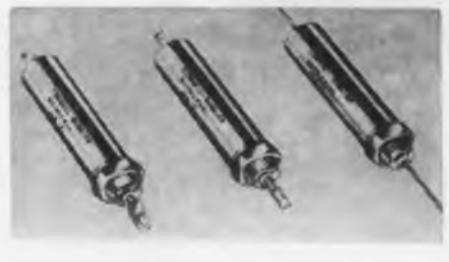
Dormeyer Inc., Dept. ED, 3418 N. Milwaukee Ave., Chicago 41, Ill.

CIRCLE 135 ON READER-SERVICE CARD FOR MORE INFORMATION

◀ CIRCLE 131 FOR G.E. SPREAD AD

New Products

Suppression Capacitors
5, 15 and 25 amp



A 25-amp rating has been added to this line of miniature three-terminal NFT feed-through capacitors for rf noise suppression. The capacitors are intended for easy installation in a chassis, bulkhead, or other partition. The units afford minimum contact resistance to ground and minimum mutual coupling between input and output terminals, with attenuation characteristics similar to those obtained in applications using low-pass rf noise filters. Reactance closely follows the reactance curve of an ideal capacitor through all frequencies up to 1000 mc.

Cornell-Dubilier Electric Corp., Dept. ED, South Plainfield, N.J.

CIRCLE 138 ON READER-SERVICE CARD FOR MORE INFORMATION

Level Switches
Off-on and Proportional

These arc-shaped gravity sensor devices, unlike mercury-filled levelers, are made for both off-on and proportional control in both vertical and lateral directions. When filled with a special electrolyte, the switches indicate level and deviation from level within tenths of degrees. Made to conform to military temperature specifications, the switches can withstand temperatures up to 200 C. They have operated perfectly at —60 C and lower.

The switch is made of glass tubing, ground to an exacting spherical, radius of curvature. One hollow and two solid platinum leads are sealed with precise spacing into its surface. Electrolyte is inserted through the hollow lead, which is then arc-welded closed. Calibration is made during the filling operation.

Corning Glass Works, Dept. ED, Corning, N.Y.

CIRCLE 139 ON READER-SERVICE CARD FOR MORE INFORMATION

Modular Oscilloscope

Interchangeable Units

Four modules comprise this complete oscilloscope, which is available in portable case or standard relay rack-mount. A series of interchangeable amplifiers and sweep generators can be combined with basic CRT and power supply modules to provide general purpose low frequency oscillography, high frequency pulse observation, phase-shift measurement or other desired applications. Designated the Model 200, the unit incorporates direct reading amplitude and time calibrations, sweep expansion and driven and recurrent sweeps. Modules may be purchased individually or preassembled into standard high or low frequency units.

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

CIRCLE 140 ON READER-SERVICE CARD FOR MORE INFORMATION

Stop Clock

Electrical Reset

This electrical stop clock features instantaneous electrical reset (1/10 sec) and accuracy of 0.02 of 1 per cent. Designated Type 691 Time Totalizer, a dust-tight commercial model and a military version are offered. The military unit is hermetically sealed and designed to meet stringent vibration, shock and environmental specs. Type 691 is available for either local or remote reset.

Load switches rated 5 amp to 250 v ac resistive, operated from cams on either fast or slow pointer shafts, can be supplied. Number of pulses per second or minute, and duration of pulses are factory set. With switches on both fast and slow pointer shafts (wired in series) it is possible to use the 691 as a highly precise time delay or interval timer. Available ranges are 60 sec in 1/100 sec, 60 min in 1/1000 min and 60 min in seconds. Ratings include all standard voltages at 50 and 60 cy, 115 v 400 cy (with d-c clutch) and various d-c voltages.

Cramer Controls Corp., Dept. ED, Centerbrook, Conn.

CIRCLE 141 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

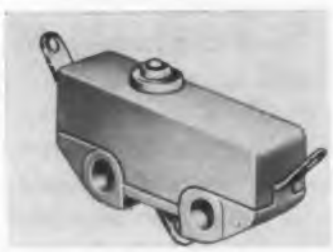
Vacuum Tube Voltmeter

Stable

Long-time stability and accuracy are achieved in this vacuum tube voltmeter through the use of balanced circuits, liberal inverse feedback and precision components. The instrument measures dc (plus or minus) from 1 to 1000 v in seven ranges, ac from 1 to 300 v rms in seven ranges, and resistance up to 500 megohms by means of seven multipliers. Accuracy of d-c voltage measurement is ±2 per cent full scale; a-c voltage measurement, ±3 per cent full scale. Frequency response is ±1 db from 10 cps to 700 mc. Input impedance for d-c measurement is 100 megohms to minimize loading of the measured circuit. Input capacitance of the a-c probe is kept extremely low (1.2 μμf) to maintain high input impedance up to 700 mc. The instrument operates on 110 to 120 v 60 cps 20 w power.

Acton Labs., Inc., Dept. ED, Acton, Mass.

CIRCLE 144 ON READER-SERVICE CARD FOR MORE INFORMATION



Precision Switches

Miniature

The No. 5300 series switches measure only 25/32 x 17/32 x 1/4. Two No. 5302 switches can be mounted, activator to activator and operated in a 1 in. diam tube. The important feature of these subminiature precision switches is that they can be ganged together in infinite numbers to perform multiple switching functions in confined areas.

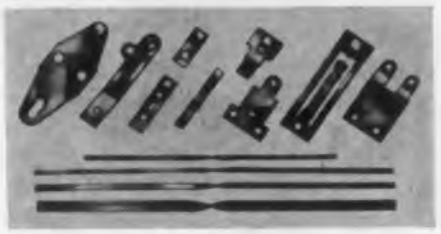
Each switch in the 5000 series is available according to specifications as SPNO, SPNC or SPDT. The characteristics are 5 amp resistive at 28 v dc; 5 amp resistive at 115 v ac. They will operate satisfactorily at −65 deg as well as +250 deg.

Haydon Switch, Inc., Dept. ED, Waterbury, Conn.

CIRCLE 145 ON READER-SERVICE CARD FOR MORE INFORMATION

Contact Tape

Simplifies Production



Contacts formed from electrical contact tape facilitate the assembly of component parts into one integral unit. Tape introduces automation to the manufacture of contact assemblies by machine feeding contacts through the welding process. Tape is preformed to finished shapes with close tolerance limits. This shape is maintained during the assembly process, resulting in precision subassemblies. Contact material facings need not be any thicker than actually required for the expected life, thus saving precious metal. Clad electrical contact tape assemblies require less contact volume for required electrical and thermal values, and approximately 70 per cent of the face area of rivets for equivalent electrical capacity. They are rolled to finished form and normally supplied with a serrated base metal backing to facilitate welding.

Metals & Controls Corp., Dept. ED, General Plate Div., Attleboro, Mass.

CIRCLE 146 ON READER-SERVICE CARD FOR MORE INFORMATION

Phase Standard

Measures Shift

Designed for calibrating phase meters and other phase measuring instruments, this phase standard can also be used with an oscillograph to measure the phase shift in electronic circuits or to calibrate precision phase shifters. It converts an externally supplied signal (20 cps to 20 kc) into two sinusoidal signals whose phase relationship can be varied from 0 to 360 deg in four revolutions of a single control. Phase angle accuracy is ±1 deg from 20 cps to 10 kc; ±3 deg from 10 to 20 kc. Inherent distortion is less than 1 per cent; over-all distortion is dependent upon the externally supplied signal. The 0.5- to 5-v output of the instrument varies less than ±2 per cent with phase shift. A self-contained electronic-regulated power supply can accept 105 to 125 v, 50 to 60 cy.

Acton Labs., Inc., Dept. ED, Acton, Mass.

CIRCLE 147 ON READER-SERVICE CARD FOR MORE INFORMATION

From Dearborn come two new glass tubular capacitors: Type GML operates up to 85°C. without derating over the range .002 mfd-1000 VDC to .03 mfd-12,500 VDC. Type GTL operates up to 125°C. without derating over the range .001 mfd-2000 VDC to .03 mfd-10,000 VDC.

These complex-dielectric, oil-filled capacitors introduce a new high in reliability, a new high in insulation resistance, and a new concept in miniaturization in these voltage ranges. The endseals are tiny metal rings permanently bonded to the glass, and metal discs soldered to the rings. This rugged, leak-resistant seal offers maximum creepage distance between terminals.

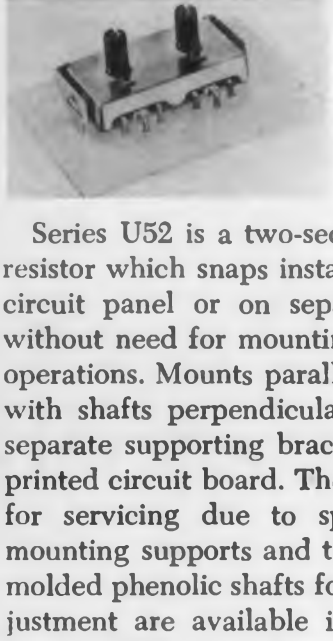
WRITE FOR BULLETIN RL-4

Dearborn

electronic laboratories

1421 NORTH WELLS ST., CHICAGO 10, ILL.
CIRCLE 149 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products



Variable Resistor
For Printed Circuits

Series U52 is a two-section side-by-side variable resistor which snaps instantly into place on printed circuit panel or on separate supporting bracket, without need for mounting hardware or additional operations. Mounts parallel to printed circuit panel with shafts perpendicular or can be mounted on separate supporting bracket with shafts parallel to printed circuit board. The control is easily removed for servicing due to specially designed clip-off mounting supports and terminals. Quarter-in. diam molded phenolic shafts for finger or screwdriver adjustment are available in three styles. Resistance range is 250 ohms through 10 megohms and rotation angle 300 ±5 deg.

Chicago Telephone Supply Corp., Dept. ED, Elkhart, Ind.

Wave Analyzer
Measures Harmonics

Model CF-83 is a precision harmonic wave analyzer capable of measuring the amplitude of signals and harmonics from 10 to 500 kc. It is essentially a highly tuned frequency selective detector designed for voltage measurements on carrier telephone systems as well as precise measurement of the harmonic content of various types of waveforms. The linearity of response is sufficient to permit measurements of harmonics at least 60 db below the fundamental. Its lightweight rugged construction makes possible precise measurements for field as well as laboratory use. This instrument features a precision rf attenuator to insure accurate measurements down to the microvolt region. A rugged 12 to 1 antibacklash gear reduction system allows for ease of tuning with no sacrifice in resetability.

Mack Electronics Division, Inc., Dept. ED, 1120 S. 2nd St., Plainfield, N.J.

CIRCLE 151 ON READER-SERVICE CARD FOR MORE INFORMATION

Stepping Motor

Bi-Directional

This stepping motor is completely balanced and meets all standard shock and vibration requirements. The output shaft is positively locked into position after each actuation and cannot be rotated by external forces. Angular accuracy is within $\pm 1/2$ deg. Although it is ordinarily manufactured to move bi-directionally in 36 deg steps (10 steps per revolution), it may be supplied in various other configurations. Maximum pulse rate is up to 60 per sec. The torque is approximately 5 in. oz in the 1-1/2 in. diam x 2-1/2 in. length motor.

Nemeth Inc., Dept. ED, 2223 So. Carmelina Ave., Los Angeles 64, Calif.

CIRCLE 154 ON READER-SERVICE CARD FOR MORE INFORMATION

Impedance Angle Meter

For Lower Values

This low impedance angle meter Type 314 measures low values of complex impedances in polar form. Impedance and phase angle of the unknown are determined by equating its voltage drop to that across a standard impedance of adjustable value, with the same current applied to both. A four-terminal arrangement, wherein current and voltage terminals are provided for the unknown impedance, nullifies the effect of lead impedance and insures accurate measurement. The instrument has two dials from which results are read. One dial is calibrated in absolute magnitude of impedance in ohms; the other dial is calibrated in phase angle and dissipation factors. Operating over a frequency range of 30 to 1000 cps, the Type 314 has an impedance magnitude range of 0.001 to 1000 ohms in six steps with an accuracy of ± 1 per cent, a phase-angle range of 0 to 90 deg (lead or lag) with an accuracy of ± 1 deg, and a dissipation-factor range of 0 to infinity. External oscillator input voltage can be 0 to 10 v; input impedance is 0.5 megohm.

Acton Labs., Inc., Dept. ED, Acton, Mass.

CIRCLE 155 ON READER-SERVICE CARD FOR MORE INFORMATION

YOU GET *Lighter Operating Pressure* WITH THESE NEW ACRO PRECISION SWITCHES

NEW MODEL CM *Snap Action*

The big features of this new, small Acro precision switch are long life and light operating pressure—lighter than any other switch of its type. Having snap action parts of beryllium copper and contacts of fine silver, the CM offers extremely good repeatability and will deliver millions of actuations *without failure.* It can be ganged for multi-pole applications, will operate in a temperature range of 160°F., and is designed for use where positive control is required and slow actuation inherent.

NEW MODEL CS *Non-Snap Action*

Operation of the Acro CS switch is through rotary motion (either clockwise or counter-clockwise), with a spring bias provided for quick return. Available in normally open and normally closed models, this new switch also operates by very light pressure and will give extra long mechanical and electrical life. It's designed for use where rapid actuation is inherent and contacts are protected against vibration or shock in the "at rest" position.

Both the Acro CM and CS Switches are furnished with a choice of integral actuators to suit individual applications!

Literature and engineering data furnished without obligation!

MR. CONTROLS

Robertshaw-Fulton CONTROLS COMPANY

ACRO DIVISION

Columbus 16, Ohio

In Canada: Robertshaw-Fulton Controls (Canada) Ltd., Toronto

CIRCLE 157 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

DPST Switch
No Current in Spring

This switch is a lever-actuated, double-pole, single-throw, normally closed switch. Over-all size is 1-7/8 x 1-1/2 x 3/4 in. Its principal feature is that the parts necessary to the mechanical operation of the switch, including the spring, do not carry electric current. The mechanical or upper part of the switch is separated from the electrical or lower part by a division inside the switch case which is made of nonconducting, nonabsorbent plastic material.

Because mechanical and electrical parts are completely separate, the dangers resulting from loss of tension and failure in the spring due to overheating and metal fatigue have been eliminated. Since these parts in the Tait switch do not conduct electricity, better, high-quality materials can be used. Contact points are heavy silver and are self-cleaning; steel parts are cadmium plated to resist moisture.

The Tait Mfg. Co., Dept. ED, 500 Webster St., Dayton 1, Ohio.

CIRCLE 158 ON READER-SERVICE CARD FOR MORE INFORMATION

Low Cost Reducer
Offers 19 Ratios

This speed reducer for fractional horsepower motors offers an inexpensive solution to the problem of obtaining any of the following speed reduction ratios: 15:1, 20:1, 30:1, 48:1, 60:1, 225:1, 300:1, 400:1, 450:1, 600:1, 720:1, 900:1, 960:1, 1200:1, 1440:1, 1800:1, 2304:1, 2880:1 and 3600:1. Available from stock in the first five ratios, these reducers may be paired in 14 different combinations to produce the additional ratios indicated. The unit combines a precision molded nylon gear with a precision machined steel worm. Bearings are of sintered bronze. Size of unit: 2-5/8 in. wide, 1-3/8 in. deep, 3-3/8 in. high.

Rampe Mfg. Co., Dept. ED, 14915 Woodworth Ave., Cleveland 10, Ohio.

CIRCLE 159 ON READER-SERVICE CARD FOR MORE INFORMATION

Threaded Inserts

Self-Locking

The self-locking principle used in these inserts provides a locking action on both internal and external threads. They will withstand temperatures ranging from —70 to above 250 F, and can be reused many times without appreciable reduction in torque.

A tough resilient nylon pellet is permanently imbedded in the body of each insert. The pellet projects beyond the external threads, and, when engaged, is compressed into the internal threads. The torque on the outside thread is always greater than that on the inside. Thus, the insert won't turn when a screw is installed or removed. Because the nylon pellet attempts to regain its original shape when deformed, it actually "grows" into the threads. Thus, the longer it is installed the greater the torque.

Nylok Corp., Dept. ED, 611 Industrial Ave., Paramus, N.J.

CIRCLE 161 ON READER-SERVICE CARD FOR MORE INFORMATION

Shock Mounts

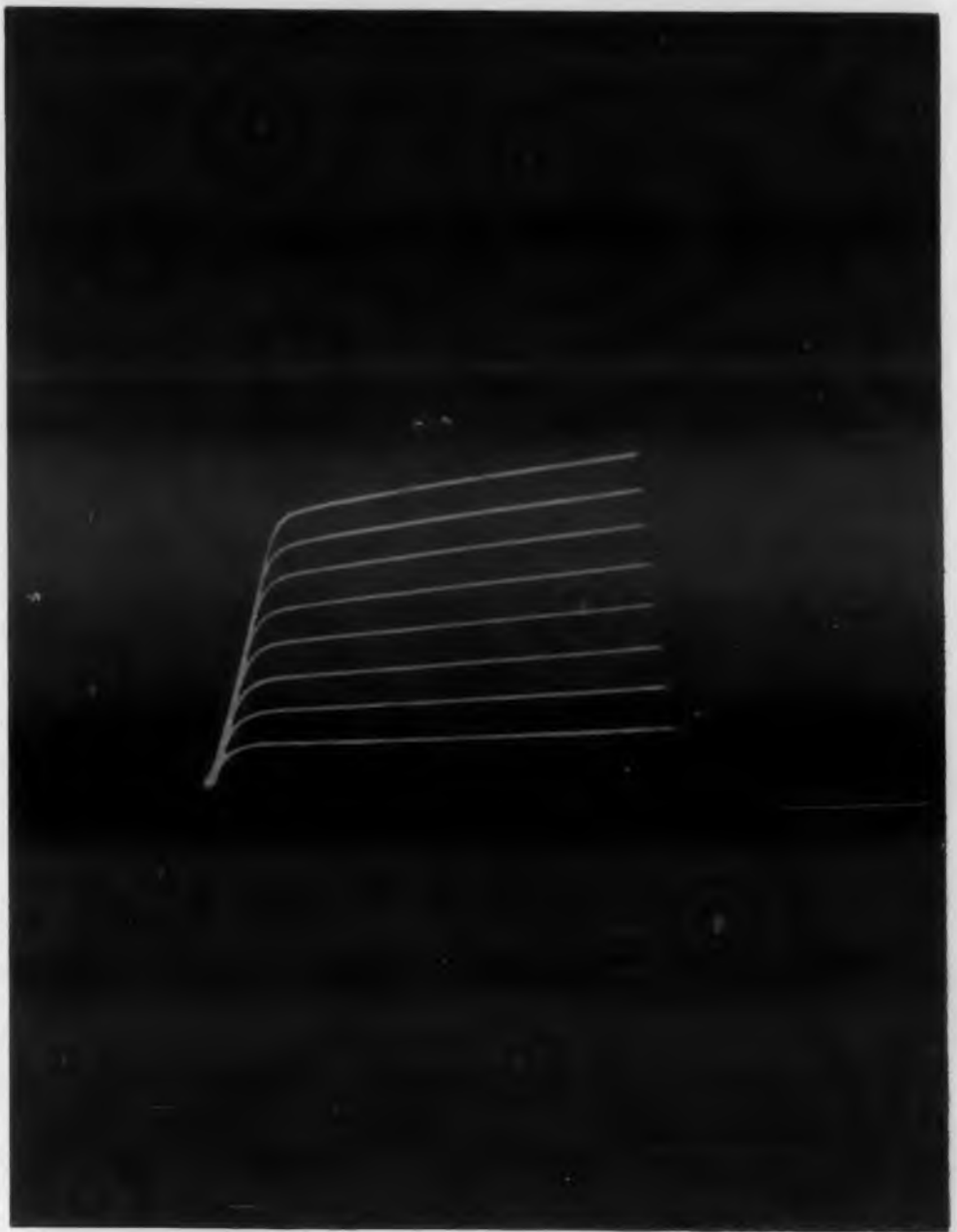
Center of Gravity

All the models within this series are basically a radial cushion center-of-gravity mounting system incorporating Met-L-Flex resilient elements. All-metal construction in accordance with such applicable military specifications as MIL-E-5400, MIL-T-5882 and MIL-T-5796, assures durable and dependable service of the vibration and shock mounting system within this series. Vibration and shock requirements are tested in accordance with military specifications MIL-E-5272, MIL-C-172B and MIL-E-5272A.

Dimensions and load ratings vary from 1.8 to 8.5 in. diameter and 5 to 50 lb respectively. To mount the equipment either clamp fasteners or four prespaced mounting holes are used to simplify replacements of the mounted equipment for maintenance and to accommodate many of the instruments and equipment currently used in military and commercial aircraft.

Robinson Aviation, Inc., Dept. ED, Teterboro, N.J.

CIRCLE 162 ON READER-SERVICE CARD FOR MORE INFORMATION



Actual unretouched photo

Transistor evaluation your problem? The CUBIC Curve Tracer, Model 504 eliminates time-consuming set-up. The 504 is a 5¼-pound precision laboratory instrument that gives you instantaneous evaluation of the dynamic qualitative characteristics of low power PNP/NPN transistors. Used with any oscilloscope, it presents an 8-curve family of collector voltage vs. collector current, determined by electronically stepped values of base drive. Manual step control provides precise quantitative analysis of operating characteristics.

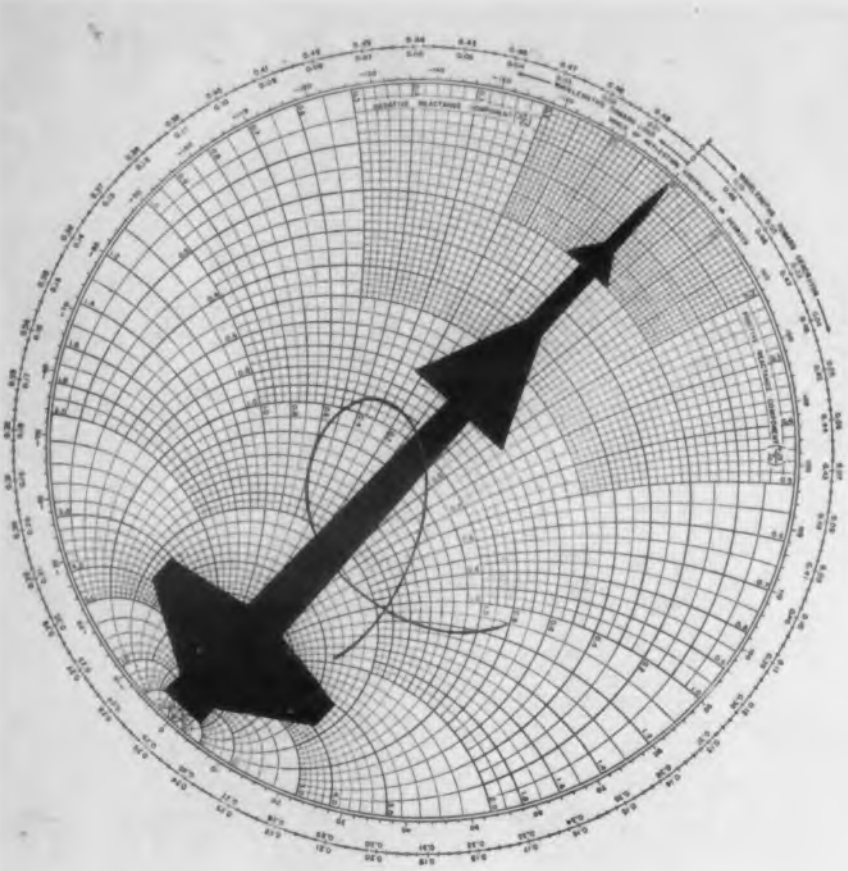
Conceived to meet the military trend towards transistorization

Available immediately from stock **$325.00**

CUBIC CORPORATION

5575 KEARNY VILLA ROAD, SAN DIEGO 11, CALIFORNIA

CIRCLE 163 ON READER-SERVICE CARD FOR MORE INFORMATION



WRAP IT UP WITH TRANSCO ANTENNAS

TRANSCO offers a single, competent source for all—or any part of your antenna program

Here is a technical staff *and* producing facilities. Here, too, are 10 years' experience in supplying a wide variety of approved antennas. We can serve you in Design, Development, Production Engineering and Manufacturing—all, or any combination.

STUDY AND DESIGN. We have experienced engineers who draw on broad knowledge. Their designs reflect a firm grasp of practical applications.

DEVELOPMENT. Once a satisfactory approach has been chosen, a test sample is "wrung out" in TRANSCO'S radiation lab, RF lab and environmental lab.

PRODUCTION ENGINEERING— often the missing link—eliminates production delays. We're after design producibility, with a staff of liaison people that keeps design and production on the same track.

PRODUCTION. TRANSCO has the capability to support your own requirements. We maintain the highest standards of quality.

Transco is an active contributor to the ICBM and IRBM programs.

TRANSCO PRODUCTS, INC.

the finest in RF system components

12210 NEBRASKA AVENUE, LOS ANGELES 25, CALIFORNIA

REPRESENTATIVES IN MAJOR AREAS

CIRCLE 165 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Accelerometer
Gold-Plated

The Model GLH accelerometer is a precision, potentiometer-type instrument, relatively inexpensive, and particularly suited for aircraft and guided missile flight and fire control systems. Balanced range Model GLH instruments are available in ranges between ± 1 and ± 8 g, or up to ± 30 g with reduced damping. Frequency response is characterized by a very close approximation to a second-order first-degree system (single degree of freedom spring mass system with near-pure viscous damping), usually desired in guided missile and aircraft applications. Unbalanced range instruments and special ultra-sensitive units with ranges as low as ± 0.1 g can also be supplied.

Ratio of resistance unbalance varies directly with the magnitude of acceleration applied. Travel of the mass in all directions other than the sensitive axis is substantially restrained. Gold plating provides a good, long-lasting exterior surface protection and permits a superior hermetic seal.

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

CIRCLE 166 ON READER-SERVICE CARD FOR MORE INFORMATION

Switches
27/32 in. Deep

This switch line, series SH, has much shallower depth than heretofore available. The series SH units may be adapted to any of the standard single pole per deck and two pole per deck, up to 15 positions shorting per pole. Additional decks may be added with an increase of only 3/4 in. in depth per deck. The switch panel can be made with either XXXP phenolic or silicone fiberglass (GSG). All parts are plated to withstand 200 hour salt spray. Rotors, contacts and slip rings are solid silver alloy. Shaft material in stainless steel.

Daven Co., Dept. ED, 530 W. Mt. Pleasant Ave., Livingston, N.J.

CIRCLE 167 ON READER-SERVICE CARD FOR MORE INFORMATION

Ultrasonic Transducers

For High Temp

These transducers are designed for use in high temperatures environment, i.e. irradiating high temperature solutions, degassing molten metals; and for developing high amplitude ultrasonic motion, i.e. drilling, grinding, particle disintegration. Featuring internally biased, water-cooled, 400 w average to 1600 w peak power magnetostrictive driving elements operating at 25 kc per sec, these transducers can be driven singly or in groups by appropriately rated standard ultrasonic generators from 400 w to 10 kw and above.

Acoustica Assoc., Inc., Dept. ED, Glenwood Landing, N.Y.

CIRCLE 170 ON READER-SERVICE CARD FOR MORE INFORMATION

Digital Voltmeter

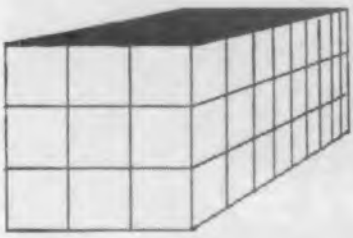
Low Level

This instrument makes possible measurement of low level d-c voltages from thermocouples, strain gages, and transducers and displays this information in digital form. Identified as the Model 460 series digital voltmeter, the unit will be available in either a rack mount or portable bench type package. Range is ± 0.001 to ± 9.999 mv; sensitivity of 3 to 5 μv and accuracy of ± 0.1 per cent of full scale. Principal applications for this equipment include reading and recording outputs of strain gages, thermocouples and other low-level transducers—automatic data logging systems—industrial process monitoring—automatic testing systems and the calibration of other voltage measuring, recording or plotting devices,

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

CIRCLE 171 ON READER-SERVICE CARD FOR MORE INFORMATION

cores + engineering + $ economy + volume = the leader



ENGINEERED ECONOMY* IRON CORES of course!

*trademark

We are proud as the originators of ENGINEERED ECONOMY* IRON CORES that we have been able to reduce the prices of our products so tremendously in the past few years. This has been achieved through constantly increasing volume production, reduction of costs through improved manufacturing techniques and the use of automation. We now have better and more uniform quality than ever before.

Now, you can select from over 19 types of ENGINEERED ECONOMY* IRON CORES where previously we had to produce over a hundred. Fewer varieties enables us to stock more and sell at lower prices. We invite your inquiry.

Also, custom iron cores to your specifications.

Radio Cores, Inc.

MEMBER mpa METAL POWDER ASSOCIATION

9540 Tulley Avenue Oak Lawn, Illinois

CIRCLE 172 ON READER-SERVICE CARD FOR MORE INFORMATION

It's just part of the Victoreen story...

an entirely **new**
concept in
power supply regulation with

CORONA TYPE VOLTAGE REGULATORS

Victoreen Corona Type Voltage Regulators are approved by the military.

Superior voltage regulation and greatly extended current ranges—that's *part* of the Victoreen story. But it doesn't stop there. Use of these new glass or metal corona regulators means you can eliminate complex circuitry regulators. Fail-safe feature gives protection not afforded by other forms of regulators.

Improved Regulation results from new electrode structures and improved processing for greater dynamic resistance, greater protection, simplified circuits.

Improved Current Rating increases scope of applications.

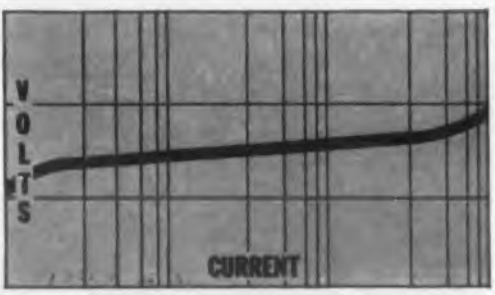
Improved Life Expectancy results from even better processing, even more rigid selection of materials.

Improved Ruggedization means these regulators withstand more rigorous adverse environments longer.

AA-5421

Get the full story on the new Victoreen voltage regulators.

Write for your free copy of Form 3003-7 today.



The Victoreen Instrument Company
Components Division
5806 Hough Avenue, Cleveland 3, Ohio

CIRCLE 173 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Test Point Jack
Strong Grip

This test point jack combines resilient Teflon insulation with resilient beryllium-copper contacts. Although designed for standard 0.080-in. test probes, it takes an oversized 0.083-in. without deforming, or holds a 0.077-in. pin with minimum of 2-oz retention. Regardless of chassis thickness, the insertion and extraction ease remains unimpaired with the floating contacts.

Beryllium-copper rod is machined for the one-piece metal insert in the Teflon insulator body. The four-leaf floating contact provides maximum and lasting spring temper. The beryllium-copper is heat treated after machining, and no pretempered stock is used. The metal insert is gold-over-silver plated.

Sealectro Corp., Dept. ED, 610 Fayette Ave., Mararoneck, N.Y.

CIRCLE 174 ON READER-SERVICE CARD FOR MORE INFORMATION

Crystal Oven
For New CR Types

This BHC-18 crystal oven series is specifically designed for the new military CR types utilizing the sub-miniature HC-18/U holder. The BHC-18 units will conform to the military warm-up requirement of 3 minutes. The 10 and 15 crystal oven will stabilize within ± 2 C. over an ambient of -55 C to below reference temperature. This series is available in units capable of housing a single crystal, 2 crystals, 10 crystals and 15 crystals. The operating voltage for the 10 and 15 crystals units is 6 v to 115 v ac or dc. The single unit oven is available from 6 to 24 v ac or dc.

Bulova Watch Co., Electronic Div., Dept. ED, Woodside 77, N.Y.

CIRCLE 175 ON READER-SERVICE CARD FOR MORE INFORMATION

D-C Amplifier

Transistorized

Maximum drift of the Model 71 differential d-c amplifier after warm-up is only 3 mv. Response is from dc to 50 kc. Input impedance is 0.5 megohm and output is either differential or single-ended at low impedance without superimposed d-c level. Gain is adjustable in four steps up to 500 times and linearity is better than ±2 per cent. Transient response is ideal because of essentially gaussian fall-out permitting reproduction of square waves without overshoot or ringing.

The unit, only 3-1/2 in. wide, 6 in. high and 12 in. deep, weighs 10 lb. The Model 71 may be operated from 105 to 125 v ac or from mercury batteries. The units are also available for rack mounting and can be arranged for mounting five amplifiers in 7 in. of rack space.

Video Instruments Co., Inc., Dept. ED, 2340 Sawtelle Blvd., Los Angeles 64, Calif.

CIRCLE 178 ON READER-SERVICE CARD FOR MORE INFORMATION

Pulse Height Analyzer

Dekatron-Tube Storage

This instrument utilizes dekatron, glow-transfer tubes and four-digit registers to store pulse height information in any of 20 channels. Counting rates up to 10^6 cpm can be accepted with no data distortion. Total instrument dead-time is 500 μsec. Base line drift is less than 1 per cent per day.

Components include: a preamplifier for photomultiplier-crystal detector, a nonoverloading amplifier, an amplitude digitizer, a dekatron storage unit, a decade scaler (1000) with 500 to 1500 v HV supply, and 42-in. high cabinet. Also available are 40, 80 or 100 channel instruments.

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

CIRCLE 179 ON READER-SERVICE CARD FOR MORE INFORMATION

Electronic Designers:

OVER 240 MODELS OF JOY FANS...

...Designed especially for your applications

LIGHTWEIGHT because they are made of aluminum or magnesium castings produced in Joy's own foundries.

COMPACT design—with motor mounted inside the fan—permits installation anywhere . . . even inside a duct.

EFFICIENT vaneaxial design provides more air per given size than any other type fan.

Joy's vaneaxial design is rugged and simple. The outer casing, the vanes, and motor mounts are cast in one piece . . . vibration free. Experience as the world's largest manufacturer and supplier of vaneaxial fans to G. E., Hallicrafters, Lear, Motorola, R.C.A., Raytheon, Sylvania, means Joy has the background to help you with your problems.

Joy has a complete line of fans . . . over 240 standard models with custom designs available to your specifications . . . fans from 1/500th hp up. Let us help . . . Write ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

Consult a Joy Engineer

Write for FREE Bulletin 135-57

WSW 16348-135

JOY

WORLD'S LARGEST MANUFACTURER OF VANEAXIAL-TYPE FANS

CIRCLE 180 ON READER-SERVICE CARD FOR MORE INFORMATION

this man knows what's **INSIDE** *his* **BLACK BOX FILTER**

He's taking advantage of a new trend spearheaded by Sprague toward unitized filter assemblies. Sprague's individual cylindrical filter elements can be taken from the shelves, wired in any configuration which available space dictates, and used! Black boxes, when used at all, serve only as "wrappers".

Now many of your most complex r-f interference problems can be solved in this way. It reduces inventory problems and cuts your manufacturing costs. Order the elements and package them yourself in your system, or else Sprague can do the packaging for you.

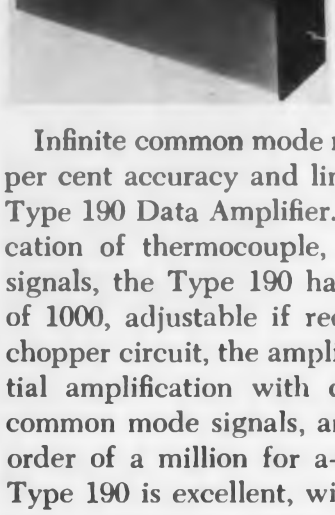
Even if unitized filter assemblies do not add up to the answer to your problem, you're sure to benefit from Sprague's library of more than four thousand proved filter designs . . . three laboratories for filter research and development . . . complete facilities for interference measurement and control . . . field consulting service . . . and mass production facilities on the East and West Coasts.

If you, too, have an interference problem, pick up your phone and call your nearest Sprague Electric Field Engineering Laboratory. They are located at 12870 Panama Street, Los Angeles 66, Calif. (TExas 0-7531); 224 Leo Street, Dayton 4, O. (ADams 9188); 347 Marshall Street, North Adams, Mass. (MOhawk 3-5311).

see SPRAGUE® for filters

CIRCLE 181 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products



Data Amplifier

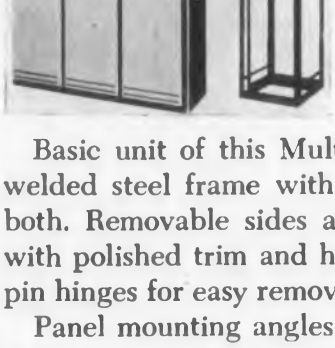
Zero Drift

Infinite common mode rejection, zero drift and 0.1 per cent accuracy and linearity are features of the Type 190 Data Amplifier. Designed for d-c amplification of thermocouple, strain gauge and similar signals, the Type 190 has a standard voltage gain of 1000, adjustable if required. Employing a new chopper circuit, the amplifier provides true differential amplification with complete rejection of d-c common mode signals, and a rejection ratio of the order of a million for a-c signals. Stability of the Type 190 is excellent, with no zero-point drift and gain remaining constant within 0.1 per cent over 1000 hours of operation, even with voltage variations of ± 10 per cent.

For strain gauge use, the differential input of the Type 190 allows a single battery to be used to excite a number of bridges, thus simplifying installation. With thermocouples, differential input eliminates errors due to multiple grounds, particularly where the same thermocouple is used simultaneously in several circuits.

Offner Electronics Inc., Dept. ED, 5320 N. Kedzie Ave., Chicago, Ill.

CIRCLE 182 ON READER-SERVICE CARD FOR MORE INFORMATION



Electronic Rack

Removable Sides

Basic unit of this Multi-Rack is a heavy gauge, welded steel frame with rear door, front door or both. Removable sides are sold separately. Doors with polished trim and handles are hung on loose-pin hinges for easy removal.

Panel mounting angles are adjustable from front to back. Louvres on any side, door or top, and rectangular or round opening in top can be provided at no extra cost. Bottom of the rack has a rectangular cut-out for cables. Made in 18 or 24 in. deep models, Multi-Rack is available in primer coat, two-tone grey enamel, black or grey wrinkle finish.

Wyco Metal Products, Dept. ED, 6918 Beck Ave., No. Hollywood, Calif.

CIRCLE 183 ON READER-SERVICE CARD FOR MORE INFORMATION

Modulated RF Sources

from 50 to 90 omc

The output of these rf sources is at least 200 mw peak power into 50 ohms with 100 per cent square wave modulated internally at 1000 cps. Stability is ±0.2 db per hour for constant load, and ±0.02 db per hour using an internal feedback circuit with external probe or coupler. This equipment achieves the amplitude stability required for precise rf measurements. By means of an external directional coupler and internal feedback, the incident power is held constant over a wide range of load impedances, thereby simulating a constant impedance source equal to the coupler impedance. If a voltage probe is used instead, the voltage is kept constant simulating a zero impedance source.

Weinschel Engineering, Dept. ED, Kensington, Md.

CIRCLE 186 ON READER-SERVICE CARD FOR MORE INFORMATION

Servo Rate Generator

Custom-Wound Motor

This 20-oz servo-mounted unit consists of a servomotor and rate generator contained in one housing and rotating on the same shaft. Designated Model 18 MG 490/460, it is a size 18, 115-v, 400 cps instrument which meets the specifications of Navy Bureau of Ordnance MK 16 MOD 1, and the first of a new family of similar units. The housing is stainless steel, 3.680 in. long and 1.750 in. in diam. Motor and generator fixed windings can be provided for any standard carrier voltage supply, and motor control windings may be custom built for input from various amplifiers. Power requirements of a standard unit are: motor fixed phase 9.2 watts; motor control phase 9.6 watts; generator excitation, 5.4 watts. Rotor inertia is 5.73 gm/cm^2; minimum torque at stall 2.35 oz-in., and acceleration at stall 29,000 rad./sec^2. Duty is continuous at stall for ambient temperatures between —55 C and +125 C; maximum operating temperature, 200 C.

Beckman Helipot Corp., Dept. ED, Newport Beach, Calif.

CIRCLE 187 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW! ½-inch wire-wound

ACTUAL SIZE

UP TO 250 K

PRECISION POTENTIOMETERS

NOW YOU CAN specify a Waters pot for miniaturized designs that require potentiometers up to 250K. In the reliability-proved construction of the AP-½, these new, higher values give you:

- ***Resistances — 10 ohms to 250 kilohms***
- ***Ganging — up to four units***
- ***Three mounting styles — plain-bushing, split-bushing, or servo***
- ***Three terminal styles — radial, axial, or wire-lead***
- ***Automation models — for printed circuits***

General specifications: Centerless-ground, stainless-steel shaft can be sealed with 0-ring; gold-plated, fork-type terminals standard; 2% standard linearity for 50K and above — 5% for lower values; temperature range −55 to +105C, to 125C on order; 2 watts at 80C; anodized aluminum body ½" diameter × ½" long — ⅝" long for 100K and 250K; corrosion-resistant-alloy bushing; all electrical connections spot-welded or soldered; furnished with stops or for continuous rotation. *Write for data sheet on these dependable ½" potentiometers.*

COMING SOON!

Complete new family of
Waters precision potentiometers

WATERS MANUFACTURING, inc.
Wayland, Massachusetts
Mail address P.O. Box 368 So. Sudbury, Mass.
APPLICATION ENGINEERING OFFICES IN PRINCIPAL CITIES

MFG. INC.

CIRCLE 188 ON READER-SERVICE CARD FOR MORE INFORMATION

CAMLOC *low cost/light weight*

5F series

Camloc's new small, lightweight 5F Series features high strength-weight ratio plus the quick-operating advantages of a ¼-turn fastener...in a size and weight that offers new design possibilities to original equipment manufacturers! Particularly adaptable to thin materials and miniaturized equipment like airborne electronics, small electro-mechanical and computing devices and communications components. Ideal for attaching lightweight components in "packaged" equipment or for holding access panels on everything from washing machines to radar units.

Offered in many different head styles. Complete specifications will be sent to you on request.

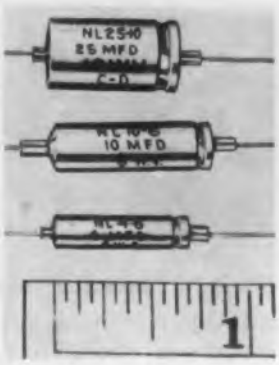
CAMLOC®

FASTENER CORPORATION
61 Spring Valley Road, Paramus, N. J.

WEST COAST OFFICE: 5410 WILSHIRE BLVD., LOS ANGELES, CAL.
FORT WORTH OFFICE: 2509 W. BERRY ST., FORT WORTH, TEXAS

CIRCLE 189 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products



Aluminum Foil Capacitors

For Printed Circuits

Designed expressly for transistorized and printed circuits and other compact or miniaturized low-voltage d-c equipment, the Type NL electrolytics meet the demand for compactness in bypass, filter and coupling applications. Available in d-c working voltages of 1, 3, 6, 10, 15, 25 and 50 v, in capacitances from 1.0 to 200 μf, and in sizes from 3/16 x 1/2 in. to 3/8 to 1 in., these units can be operated within the temperature range of −20 to +85 C.

Capacitors are compression-sealed and resistant to moisture and humidity. Terminal leads are tinned copper wire. The positive lead is connected to the anode through the rubber bushing of the compression seal, and the negative lead is grounded to the aluminum can. Also available with outer plastic insulating sleeve where physical contact with adjacent components is a design requirement.

Cornell-Dubilier Electric Corp., Dept. ED, South Plainfield, N.J.

CIRCLE 190 ON READER-SERVICE CARD FOR MORE INFORMATION

Field Power Supply

High Reliability

For use with mobile computers and amplifiers, this unit is built with all Mil Spec components for high reliability. Designated Model 3-150XHS, it mounts at any angle, withstands high humidity, and is fungus-proofed. Output voltage is nominally set at 300 v dc, but may be varied from 275-325 v dc by means of screw-driver-adjusted potentiometer. Current is 0-150 ma max. For 325 v d-c/150 ma output regulation is 100 mv change NL to FL. For line voltage change of 105-125 v ac, with same output, regulation is 100 mv change max. Ripple is below 3.5 mv rms for 325 v d-c/150 ma outputs. Unit measures only 12-1/2 in. in length and 5 in. in width. Height above chassis is 5-1/2 in. below chassis: 2 in.

Dressen-Barnes Corp., Dept. ED, 250 N. Vinedo Ave., Pasadena, Calif.

CIRCLE 191 ON READER-SERVICE CARD FOR MORE INFORMATION

X-Y Recorder

Sensitivity 10 mv/in

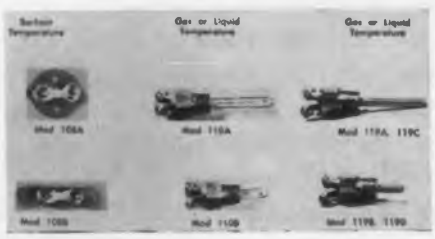
This x-y recorder draws curves in Cartesian coordinates. The unit has a sensitivity of 10 mv per in.; input resistance is 10,000 ohms; power requirements—115 v, 60 cps, 100 w. Standard 8-1/2 x 11 graph paper is used. Full chart visibility at all times. Writing speed 7.5 in. per sec.

Mandrel Industries, Dept. ED, Instrument Div., 5134 Glenmount Drive, Houston, Tex.

CIRCLE 194 ON READER-SERVICE CARD FOR MORE INFORMATION

Temperature Probes

Thermistor Type



The Model 108, 110 and 119 temperature probes use thermistors as a temperature sensing element. They are specially designed for environments where small size and dependable operation is of importance. They are available with nominal resistance at 25 C from 1000 ohms to 1/2 megohm or more. The resistance tolerance is ±20 per cent, as supplied by thermistor manufacturers. Maximum operating temperature is 500 F, and the thermistors have been aged for two weeks at this temperature. All electrical connections are coated against water entry except for the terminals themselves. The sensing element is insulated from ground and is calibrated at 0 and 100 C. Power dissipation for typical operating conditions for 0.5 C temperature rise is 0.6, 1.3, and 0.8 milliwatts for models 108, 110 and 119 respectively. The time constant for the Model 108 is 7 sec when quickly applied to a plate of aluminum. The time constants for Model 110 and 119 probes are 0.5 and 4.0 sec, respectively, when immersed in slowly agitated water. The Model 108 probe is particularly intended for measurement of surface temperature and the others are for gas or liquid temperature, and may be used with highly corrosive fluids. The probes are fungus resistant and will survive the vibration tests of MIL-E-5272, procedure 1, extended to 2000 cps.

Rosemount Engineering Co., Dept. ED, Rosemount, Minn.

CIRCLE 195 ON READER-SERVICE CARD FOR MORE INFORMATION

TOROIDAL COMPONENTS

Whether it's a complex 10 winding magnetic amplifier or a simple choke . . . at Celco each toroid is precision-made. New core materials are used in Toroidal magnetic amplifiers, reactors and transformers to achieve maximum performance.

At Celco, the proper matching of cores, winding, handling, impregnation, encapsulation and electrical history of the final assembly is carefully controlled to maintain the original design characteristics.

Our years of design, development, and production know-how are available for application to your specific **TOROIDAL** problems.

* *For immediate attention, call* **DAvis 7-1123** *— or write today.*

Celco

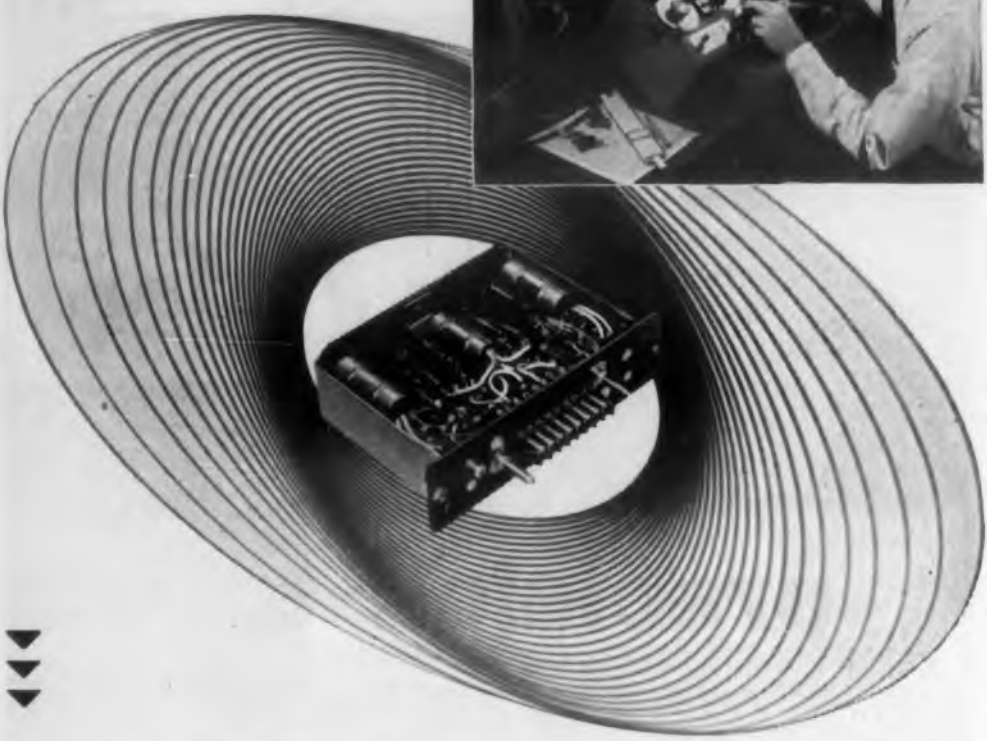
Constantine Engineering Laboratories Co.

MAHWAH, NEW JERSEY

CIRCLE 196 ON READER-SERVICE CARD FOR MORE INFORMATION

To the engineer capable of original thinking...

Highly accurate AiResearch electronic amplifier used in precision analogue computer networks. Built to withstand 50 G's vibration, has over 20 megohm input impedance and less than 1 ohm output impedance.



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If you're the sort of engineer to whom an obstacle is only a challenge, you'll be interested in working with us. You'll have the finest research and laboratory facilities at your disposal . . . have your choice of location among the Los Angeles, Phoenix and New York areas.

All modern U.S. and many foreign aircraft are Garrett equipped. We have pioneered such fields as refrigeration systems, pneumatic valves and controls, temperature controls, cabin air compressors, turbine motors, gas turbine engines, cabin pressure controls, heat transfer equipment, electromechanical equipment, electronic computers and controls.

We are seeking engineers in all categories to help us advance our knowledge in these and other fields. Send resume of education and experience today to: Mr. G. D. Bradley

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AIRSUPPLY • AIR CRUISERS • AIRESEARCH AVIATION SERVICE

CIRCLE 553 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Video Dummy Load

Non-Inductive

Available with fixed resistances from 5 to 200 ohms, the Model G6A dummy load can also be supplied with tapped resistances as shown. A 0.1 ohm non-inductive monitoring resistor is included for measuring pulse current. Time constant of the unit is less than 0.05 μsec.

Using ordinary tap water as a coolant, the load can dissipate up to 50 kv average power with 9 gpm of water flow and a 21 C water-temperature rise. Peak power capability is 100 mw and maximum energy per pulse 500 w-sec.

Weighing approximately 30 lbs. (exclusive of cabinet), the unit has dimensions as follows: 49 in. overall length, 3 in. outside diam glass tube with 5 in. diam flanges.

Levinthal Electronic Products, Inc., Dept. ED, 885 Stanford Ind. Pk., Palo Alto, Calif.

CIRCLE 197 ON READER-SERVICE CARD FOR MORE INFORMATION

Flush Latch

Leak-proof

A flush latch that eliminates the need for contoured shims features a leak-proof seal of fuel-resistant rubber. Silicone rubber gaskets are provided for high temperature conditions. The over center toggle allows for positive locking with minimum deflection. Available for all door types, the latch is designed for door and access panels on both aircraft and ground handling equipment. The latch is constructed of stainless steel, with the exception of the buttons which are an aluminum alloy. Weight of the latch is 1 oz. Simplified installation is inexpensive, requiring no specially shaped cut-outs.

Missile-Air, Dept. ED, 1108 W. 135 St., Gardena, Calif.

CIRCLE 198 ON READER-SERVICE CARD FOR MORE INFORMATION

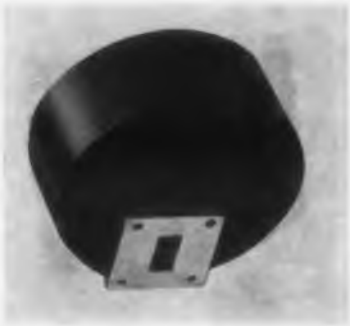
Oscilloscope

20 mv/cm Sensitivity

The Model 411A oscilloscope is a general-purpose, precision laboratory-type instrument. It has a bandwidth of d-c to 10 mc. It has a sweep speed range of 0.1 μsec to 0.1 sec per cm. Six plug-in units provide versatility in application. Useful in the laboratory are the sweep delay, the gated marker generator and the dual trace plug-in units. Sensitivity is 20 mv/cm, and rise time is 0.035 μsec.

Laboratory for Electronics, Inc., Dept. ED, 75 Pitts St., Boston 14, Mass.

CIRCLE 201 ON READER-SERVICE CARD FOR MORE INFORMATION



Ferrite Isolator

Resonant Absorption

Long line effects are minimized, AFC performance improved, system reliability increased and mechanically adjusted phase shifters eliminated by a new 100 kw resonant absorption miniature Ku band ferrite isolator. By furnishing isolation between magnetron and rf energy reflected from line mismatches, the isolator insures optimum magnetron spectrum and power output. Its action is based on the principle of resonant absorption of rf energy. The ferrite material is mounted directly on the wave-guide wall, which, in conjunction with the full waveguide opening, permits the rapid conduction of heat away from the waveguide. This miniature oscillator thus operates at high power levels in a small space, without forced air cooling. Frequency range is 16,000 to 17,000 mcs with a minimum isolation of 15 db and a maximum insertion loss of 0.4 db. Peak power is 100 kw; average power 100 watts into a 2 to 1 mismatch load. When terminated by a matched load, the isolator presents an inherent VSWR to the magnetron of the order of 1:10. Operating range is guaranteed at −55 C to +100 C; and vibration characteristics conform to MIL-E-5272A.

Airtron, Inc., Dept. ED, 1103 West Elizabeth Ave., Linden, N.J.

CIRCLE 202 ON READER-SERVICE CARD FOR MORE INFORMATION

Acetrim* sub-miniature precision TRIMMERS for PRINTED CIRCUITS

Here is another new development from Ace . . . sub-miniature precision wire-wound trimmers especially for printed circuits. Designed and produced to meet your tightest specifications, the new Acetrim has flat or round tabs to facilitate production assembly. Just plug into printed circuit board, secure, and dip solder.

Featuring

- ½" size
- 10 ohms to 150 K
- weight ¼ ounce
- power 2 w. @ 60° C. max.
- temperature to 125° C.
- sealed, moistureproofed, anti-fungus treated
- withstands severe shock, vibration, acceleration
- meets applicable Military specs

Ace delivers reliability

Modern mass production techniques assure delivery to meet your schedules . . . rigid quality controls assure highest standards of performance-reliability.

Acetrim — *write for Technical Data Unit #563.*

Acepot — ½" sub-miniature precision wire-wound linear potentiometers from 10 ohms to 250K. ±.3% standard. *Write for Technical Data Unit #564.*

Nonlinear Acepot — precision wire-wound nonlinear potentiometers for sine-cosine and square-law functions and other applications. High resolution, close conformity. *Write for Technical Data Unit #572.*

X-500 Acepot — ½" sub-miniature precision potentiometers for extreme temperatures of —55° C. to 150° C. 10 ohms to 250K. *Write for Technical Data Unit #571.*

*trademarks applied for

ACEPOT*
ACETRIM*

ACE ELECTRONICS ASSOCIATES, INC.

Dept. ED, 101 Dover St. • Somerville 44, Massachusetts

Telephone: SOmerset 6-5130 • *Engineering Representatives in Principal Cities*

CIRCLE 203 ON READER-SERVICE CARD FOR MORE INFORMATION

Polycarbonate Resin

Toughness, impact strength, heat resistance and dimensional stability are properties of a new molding compound called Lexan. The discovery and initial development of the polycarbonate resin was announced recently by General Electric Co. According to the announcement, Lexan resin is being made in small lots at the company's applied research laboratory at Pittsfield, Mass., and is being evaluated in the form of molding compound, extrusion compound, film, varnish and coatings. Early studies indicate that Lexan resin can be made in a variety of transparent or opaque colors, with parts showing good surface hardness and gloss. Properties of the polymer suggest its use in such applications as electronic components in general, coforms, decorative and functional appliance partgears, housings, structural parts, handles, drawerollers, and telephone accessories.

The excellent electrical characteristics, high thermal stability, low water absorption, and high tensil strength of Lexan make it suitable for use as a electrical insulating material. The chemical propert ties are characterized by stability to water and t dilute mineral and organic acids. The resin is in soluble in aliphatic hydrocarbons, partially solubl in aromatic hydrocarbons, and soluble in chlor nated hydrocarbons. It is slowly decomposed b alkaline substances.

Nails molded from the new polycarbonate resin can actually be driven into a piece of lumber. The thermoplastic compound, called Lexan, has exceptional impact strength and rigidity, and may be expected to take the place of cast metals, ceramics and other plastics in some applications.

Performance of New Resin

Impact Strength, notched Izod	12-16 ft-lb/in.
unnotched Izod	>50 ft-lb/in.
Tensile Impact	600-900 ft-lb/cu in
Tensile Yield Strength	8000-9000 psi
Tensile Ultimate Strength	9000-10,500 psi
Flexural Strength	11,000-13,000 psi
Water Absorption, 24 hr immersion	0.3%
Indentation Hardness, Rockwell	M70
Specific Gravity	1.20
Arc Resistance	100-140 sec
Dielectric Strength, short time, ⅛ in. thickness	400 v/mil
Dielectric Constant, 60 cy	2.80
10^6 cy	2.85
Power Factor, 60 cy	0.009
10^6 cy	0.0095
Volume Resistivity	>6 x 10^{15} ohm-cm
Heat Distortion Temperature, 264 psi	280-290 F
66 psi	283-293 F
Mold Shrinkage	0.005-0.007 in./in.
Melting Point (crystalline)	514 F

Properties of Lexan Polycarbonate: These values were determined at room temperature on injection molded samples unless otherwise indicated. Each test was made using the appropriate standard method for testing materials. Ultimate properties of the new polymer may vary from those listed, since the compound is not yet available for field applications.

The molding compound is not presently available for field evaluation. The present limited quantities of the resin are being used in a controlled testing program designed to provide information needed to arrive at a decision on large scale commercialization. One commercial form which the compound will take will be that of cylindrical pellets suitable for molding.

Significantly, the original polycarbonate chemistry on which Lexan polymer is based grew out of research efforts directed at a new, improved insulating material. The affinity between electrical and chemical research has been demonstrated in many previous discoveries in the chemical field. Among these are mica mat, silicone elastomers, resins, and fluids, and irradiated polyethylene. Like polycarbonate resins, these products have traced a pattern of discovery leading to development and application in a wide variety of products not always related to their originally intended use as electrical insulating materials.

Phosphor Bronze Strip

Greater Fatigue Strength

A fine grain phosphor bronze strip has been designed for fatigue strength and forming properties by the Riverside-Alloy Metal Div., H. K. Porter Co., Inc., Riverside, N.J. Called Flexograin, the strip has better surface condition after forming in situations of severe bending. It never exhibits the orange-peel effect common to coarse grained phosphor bronze and other copper alloys. The improvement in fatigue resistance is of particular value in parts subject to alternating stresses or vibration, such as relay springs, bellows, electrical contact springs, and diaphragms. Formability permits use of a harder, stronger strip for a part that requires severe forming in its production.

Soldering Flux

Low Temperature

Although soldering is usually done in the range of 360 to 500 F, it is frequently necessary in certain types of work to use alloys with melting points ranging down to 150 F. For such applications, this new type of noncorrosive soldering paste has been developed. The flux, called Amco No. 261, is entirely free of chlorides and rosin compounds. It is active at low temperatures and has a long life. Thus, when used with conventional solders, the cleaning action will begin about 150 F and continue right up to the melting point of the regular solder. Because it is active over a longer period, Amco No. 261 is as effective at the higher temperatures as a more corrosive flux would be.

American Solder & Flux Co., 19th and Willard Sts., Philadelphia 40, Penna.

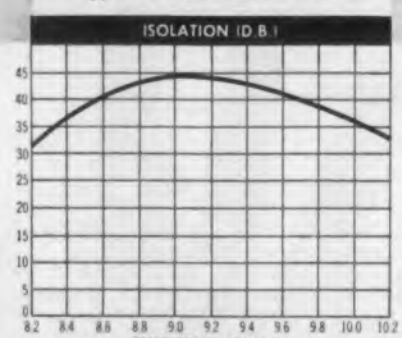
CIRCLE 206 ON READER-SERVICE CARD FOR MORE INFORMATION

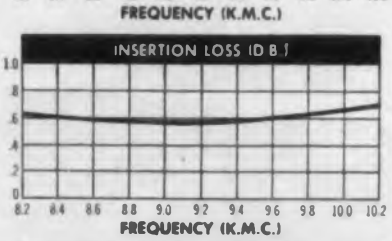
A New Broad Band Kearfott FERRITE ISOLATOR for Laboratory Test Bench Use

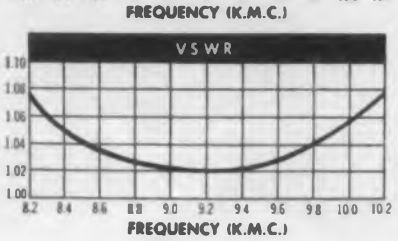
Model
W177-2C-1

Use this Ferrite Isolator in your microwave setup for maximum frequency stability.

Typical Performance Curves







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Broad Band—Usable from 8.2 to 10.2 KMC

High Isolation—A minimum of 25 db over the band

Insertion Loss—Less than 1 db

Small & Compact—Only 2½ inches long—weighs only 1½ lbs.

Flanges—Cover type. Mates with UG39/U flanges. Will absorb up to 10 watts reflected power

Price—$135.00 each f.o.b., Van Nuys, Calif.

Delivery—From stock

Order—Model W177-2C-1

For custom-made isolators for specific radar & microwave application, you can depend on the skill of the Kearfott organization.

Kearfott, Western Division, has complete facilities for waveguide production, with qualified experts to assist in solving your problems. Let us help you.

For detailed information, ask for bulletins on new Ferrite Isolators and Radar Test sets.

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South Central Office: 6115 Denton Drive Dallas, Texas

Western Area Office: 253 Vinedo Ave. Pasadena, Calif.

CIRCLE 209 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Retaining Rings 210

The 1957 catalog and application idea manual of two-turn, coil action retaining rings is now available. It gives application and specification data covering standard catalog sizes and special designs for specific applications. Illustrations and data, showing coil spring action is included. Thompson Products Inc., Piston Ring Div., (Ramsey Corp.,) St. Louis 8, Mo.

Semi-Conductor Aids 211

Aids for engineers in the electronic and allied industries involved in design, development, production or application of semiconductors have been printed.

They include a periodic chart of the elements, with chart of physical properties of pure elements used in semi-conductor production. A complete list of all metals and alloys used plus equilibrium phase diagrams for ten or more popular doped alloys are included. Anchor Metal Co. Inc., 966 Meeker Ave., Brooklyn 22, N.Y.

Electric Brake 212

An electric brake for ac motors is described in a pamphlet just released. Typical applications, performances, performance curves, specifications and the advantages of this type of brake are given in full detail. American Rectifier Corp., 95 Lafayette St., New York 13, N.Y.

Portable Beta Tester 213

Portable Beta tester for transistor measurements is described in Bulletin TP 106-1 now available. It notes the tester, Model KT-1, can be used for rapid measurement of basic transistor characteristics in quality control testing, circuit design, incoming inspection and trouble shooting, and is self-contained, utilizing a 1 kc oscillator and mercury cell power supply. Battery life of the mercury cell is approximately 750 hrs. Also included in the bulletin is complete electrical and mechanical data. Baird-Atomic, Inc., 33 University Rd., Cambridge 38, Mass.

Vinyl Laminates 21

Vinyl-to-board and vinyl-to-metal lam nates and the process for securing them featured in a recent bulletin. Illustrati and six colorful samples enhance the fo page folder. North East Laminates, Inc., Osgood St., Methuen, Mass.

Precision Wire-Bound Resistors 21

Series CB precision wire-wound resist which feature tension-free windings presented in Bulletin CB-2. The two pa contain complete specifications, pho graphs, dimensional drawings and descr tive information. Kelvin Electric Co., 5 Noble Ave., Van Nuys, Calif.

NBS Radio Stations 21

An eight-page brochure describes function, applications and recent impro ments of National Bureau of Standa radio stations WWV and WWVH. T brochure also describes the model WWV Receiver recently introduced. Be man Instruments, Inc., Shasta Div., P. Box 296, Sta. A, Richmond, Calif.

Wire Wound Resistors 21

Tubular and flat power wire wound sistors are depicted and described in Ca log Data Bulletin C-lb. The comprehens 12-page treatment covers constructi characteristics, coating, winding, insulati identification, mechanical strength, ter nals and brackets. Photographs and detai charts and graphs illustrate the booklet. ternational Resistance Co., 401 N. Bro St., Philadelphia 8, Pa.

Sequential Weather Transmission 21

Sequential transmission of weather m with the D-658-G/B 18-in. Chart Transm ter and the D-789-A Switching Unit is plained in Provisional Publication 874 The illustrated two-page text presents tailed descriptions and specifications both instruments along with a discussion their functions in the system. Muirhead Co., Ltd., Beckenham, Kent, England.

search Facilities 219

Bulletin S-1053, "An Approach to Interative Research," describes laboratory facities for contract research. It outlines investigations directed toward the creation, velopment and application of precise t and fluid processing techniques and terials to improve both the rate of protion and the quality of the products of ustry. Replete with photographs, the 24-e booklet illustrates research methods resultant production processes and ipment. Selas Corp. of America, sher, Pa.

ne-Temperature Recorder 220

An overheat-time recorder for aircraft jet ines is described in an eight-page bro-re. Block schematics and diagrams show the recorder automatically logs any gle, multiple group or range of engine peratures. The publication analyzes the d for monitoring engine temperature explains the operation of a time-temature recorder system. Each of the sys-'s three basic components are illustrated described. Avien, Inc., 58-15 Northern d., Woodside 77, N.Y.

Oscillogram Reader 221

Bulletin CR-187 provides information on the use and operation of an oscillogram reader. Also described in the two-page illustrated sheet is a variety of accessory and output equipment. Coleman Engineering Co., Inc., 6040 W. Jefferson Blvd., Los Angeles 16, Calif.

Binder for Relay Bulletins 222

A durable three-ring loose-leaf binder is offered along with a series of product engineering bulletins. The bulletins provide detailed descriptions, tables and dimensional drawings on standard, enclosed and hermetically sealed relays. Phillips Control Corp., 59 W. Washington St., Joliet, Ill.

Extrusion Presses 298

Aluminum extrusion presses are described in a six-page bulletin 340C now available. The illustrated bulletin gives detailed description of the presses with design features and services offered to the extrusion industry. Watson-Stillman Press Div., Farrel-Birmingham Co., Inc., Roselle, N.J.

This is your answer where quality and size are prime factors

Centralab's Model 3 Radiohm®

The Centralab Model 3 Radiohm, with its exclusive Interfused Composition Element, provides unbelievable wattage dissipation, yet is smaller than a dime.

This miniature rotary potentiometer, with its rugged element, is ideally suited for high-temperature operations in both commercial and military applications.

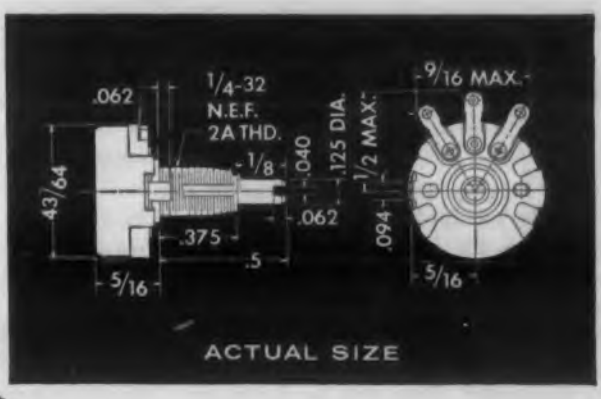
Advanced design features offer you both standard and locking-type bushings. Each is available with sealed construction to meet today's demand for a unit that can be potted.

For immediate delivery in ratings from 1,000 ohms to 2.5 megohms, ask your local Centralab distributor for the JP and JL Series.

typical watt-hour rating

Only 10% maximum resistance change, when used at . . .

1 watt for 1-1/2 hours
3/4 watt for 35 hours
1/2 watt for 80 hours
1/3 watt for 300 hours
1/4 watt, continuous rating



Write today for Technical Bulletin EP-63, for complete engineering data.

Centralab

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CIRCLE 300 ON READER-SERVICE CARD FOR MORE INFORMATION

GROOV-PIN FASTENERS

for Products Improvement

GROOV-PINS
Press Fit Fasteners

TAP-LOK® INSERTS
For Strong Threaded Connections

Defy Vibration — Shock

Reduce Assembly Time and Cost

No Reaming — No Tapping

GROOV-PINS The pioneer of all fasteners of this type, Groov-Pins are locking press fit fasteners which have proven their practical usefulness in a multitude of applications throughout more than 25 years. They hold well under conditions of shock and vibration, and eliminate the need for special hole preparation . . . reaming, peening, tapping, milling. Only a straight drilled hole is needed. Pins may be driven by hand, air cylinder or hydraulic press. They are usually cut from cold rolled steel (or other metals where conditions require) into which longitudinal grooves are rolled or pressed to deform the pin stock within controlled limits. When the pin is forced into a hole, the constraining action of the hole wall causes displaced material to flow back and effect a locking fit within its elastic range.

TAP-LOK INSERTS These internally and externally threaded bushings of steel or brass were designed as permanent fasteners to increase thread holding strength in comparatively weak materials . . . aluminum, magnesium, plastics, wood, etc. Their unique self-tapping feature substantially reduces assembly time and cost, by eliminating separate tapping operations, hole preparation, secondary staking. They withstand vibration without loosening and permit application of standard threaded fasteners without danger of stripping threads. The increased shear area obtained allows full utilization of the tensile strength of threaded fasteners. Used widely as original equipment, they are also excellent for salvage, and repair of stripped threads.

GROOV-PIN CORPORATION

1125 Hendricks Causeway — Ridgefield, New Jersey

Representatives in principal cities throughout the U. S. A.

IN CANADA: Metal and Wood Fastening Devices Co., Valois, Montreal

CIRCLE 223 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Coaxial Connectors and Cables 224

Illustrated listings of all available coaxial connectors and cables are presented in Catalog 7. Mechanical and electrical characteristics are given, and a brief comprehensive description prefaces tables listing each type. The 42-page booklet also contains cross reference numbers of government designations and other leading manufacturers. Progress Electronics Co., 296 Broadway, New York 7, N.Y.

Permanent Magnets 225

Catalog PM-121, superseding PM-100, covers a variety of cast Alnico 5 and sintered Alnico 2 permanent magnets. It offers information on magnetic and mechanical properties, approximate tolerances, and magnet assemblies. Also presented in the illustrated booklet are ordering information and sales and service offices. General Electric Co., Metallurgical Prods. Div., Detroit 32, Mich.

Hi-Fi Catalog Service 226

This catalog service provides subscribers with descriptions, specifications and illustrations of the products of more than 228 manufacturers of high fidelity and sound equipment. Prices for all products cataloged are listed alphabetically by manufacturer. The accompanying index pinpoints the location of more than 5000 products. The cost of this subscription service is $15 per month. United File-O-Matic, Inc., Audiofile Div., 60 Madison Ave., Hempstead, N.Y.

Solenoids and Coils 227

With graphs, diagrams and photographs to illustrate, a recent catalog offers 8 pages of detailed information on solenoids, coils and electrical components. Bobbin and layer wound coils, resin molded coils, metal enclosed coils and wiring harnesses are some of the products covered. Anderson Controls, Inc., 2777 Mannheim Rd., Des Plaines, Ill.

Seamless Tubing 228

Tabbed and of file-folder size is a recent booklet describing seamless tubing and production processing and facilities. Separate sections on mechanical seamless carbon or alloy tubing, aircraft seamless tubing and electric resistance welded tubing contain lists of industrial applications together with minimum-maximum size range tables. A standard table of gauges and decimals is included for reference purposes. Copperweld Steel Co., Ohio Seamless Tube Div., Shelby, Ohio.

Radiation Protection Services 231

Bulletin 407 is a 4-page description of services for health and safety precautions against the hazards of radioactivity. The services outlined are accountability (for SS nuclear materials management); criticality precautions (for fuel element fabrication); and complete health physics services. Additional services are also described, among them research and development, equipment procurement and consulting. Drawings illustrate the text. Nuclear Science and Engineering Corp., P.O. Box 10901, Pittsburg 36, Pa.

Heaters and Heating Devices 232

Heaters and heating devices for 1957 are cataloged in Bulletin GEC-1005H. The publication contains information on such products as redesigned cartridge heaters, miniature soldering irons, aluminized steel sheath strip heaters, and new ratings and configurations of finned tubular heaters. Also described are ceramic-to-metal and plastic resin hermetic seals. In the 16-page power requirements section, each heating process is described. Typical application problems are solved to give heating requirements in both a long and a short form method. Long form calculations give answers more precisely, for applications where the exact amount of heat required is critical. Short form calculations give adequate accuracy for ordinary heating requirements. The booklet also contains data, specifications, operating information, and list prices. Listed are immersion, strip, cartridge, tubular, finned tubular, and railroad switch heaters; also unit heaters, soldering irons, soft metal melting pots, oven equipment, and control. Graphs, photographs, and dimensional diagrams illustrate the catalog. General Electric Co., Schenectady 5, N.Y.

Analytical Lab Instruments 233

"Instrumentation for Analysis" is the title of a 16-page catalog of laboratory analytical instruments. The text describes a line of infrared and ultraviolet spectrophotometers, monochromators, flame photometers and vapor fractometers. It also covers accessories and instrument components available for use with these units. Brief treatment is given to process control instruments. Perkin-Elmer Corp., Norwalk, Conn.

Manufacturing and Research Facilities 234

Manufacturing facilities for electronic test equipment component parts and for complex custom electronic devices are outlined in a brochure of 12 pages. Also described are facilities for electronic research and development. A generous number of photographs illustrate the text. Laboratory for Electronics, Inc., 75 Pitts St., Boston 14, Mass.

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POTENTIOMETER

2 watts at 150°c

+ 200°c rating

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SHOWN ACTUAL SIZE

Now—the little pot with a big power rating

. . . is available for high temperature applications. Rated to operate in ambient temperatures as high as 200°C, this ⅜" diameter precision wirewound potentiometer will dissipate 2 watts at 150°C—and even more at room temperature!

Providing linearity and resolution usually found only in much larger units, the 875T represents the finest achievement in subminiature design as well as high temperature operation. It is truly representative of the engineering skill and creative ability of Giannini engineers . . . craftsmen in the art of precision instrument manufacture.

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Resistance: 500Ω to 100,000Ω per section
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Torque: 0.1 oz-in per section
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Dimensions: 0.875" diameter by 0.75" long

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CIRCLE 236 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Metal Stampings 237

With photographs and concise text, Bulletin No. 80 describes precision metal stampings and deep-drawn parts. The 4-page folder lists materials and finishes used for the parts along with a range of sizes. Johnson & Hoffman Mfg. Corp., 31 E. 2nd St., Mineola, N.Y.

Strain Gage Apparatus 238

The Model BL-1516 strain gage apparatus for measuring both static and dynamic strain is described in a catalog sheet of 4 pages. The illustrated literature covers operational and design features of the instrument along with its specifications. It also contains information on standard and optional accessories which may be used with the basic instrument. Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.

Potentiometers 239

Life expectancy figures and noise ratings for 1 13/16 in. diam series A (ten-turn), C (three-turn) and T (single-turn) precision potentiometers and additions to Data Sheets 54-03 and 54-52 just released.

Extensive tests have resulted in the establishment of a life expectancy of 2,000,000 shaft revolutions for each series. The maximum noise ratings for Series A and C has been set for 250 mv while Series T has a 7/8 in. diam potentiometer set at 100 mv. Each series is rated at 100 rpm with 1 milliamp of slider current. Helipot Div., Beckman Instru. Corp., Newport Beach, Calif.

Silicone Rubber 240

A 48-page booklet entitled "1957—Silicone Rubber, a basic-up-to-date report on a highly versatile elastomer" is now available.

The booklet, including 38 graphs and figures, reprints three papers given by chemists at the recent Silicone Rubber Symposium held in six aircraft centers across the country. The papers discuss basic chemistry, properties due to this chemistry, and considerations and compromises involved in compounding silicone rubber for fabrication. The booklet will serve as a basic reference on material and will supply design engineers with background necessary when considering the material for extreme temperature applications. (Available for $1.00) The Connecticut Hard Rubber Co., 407 E. St., New Haven 9, Conn.

Welding Movie 243

"Modern Methods for Joining Metals" is a 20-min. sound and color movie of welding processes and applications. Treated in a generally nontechnical manner and filmed at leading metal fabricating companies, the picture illustrates the importance of the welding engineer in industry. It shows the many factors involved in electric welding, and how research, development and engineering serve to provide increasingly better methods and equipment. Arrangements to see this film can be made by contacting the nearest Linde office, or by writing to Linde Air Products Co., Div. of Union Carbide and Carbon Corp., 30 E. 42nd St., New York 17, N.Y.

Conversion Chart 244

Conversions common and uncommon are tabulated on an 8 x 12 in. wall chart. The reference table, intended mostly for electro-mechanical engineers converts, among many others, inches to centimeters, watts to horsepower, cubic feet to liters, microns to meters, and quintal to pounds. Precision Equipment Co., 3714 N. Milwaukee Ave., Chicago 41, Ill.

Subminiature Tubes 245

To the 4th edition of "Reliable Subminiature Tubes" six cathode types have been added. Also new to this edition are specification and microscopic inspection improvements. An introductory section of the 117-page catalog contains a detailed discussion of tube reliability and quality control with a variety of quality tests described.

In the listings, each tube type is minutely analyzed with descriptive text and extensive mechanical and electrical data. Graphs and diagrams show characteristics and dimensions. Listed are pentodes, triodes, double triodes and gas diodes for various applications.

In the "Application Notes" maximum ratings are discussed and notes on individual types are presented. Here also is a chapter on temperature ratings. The price for this book is $1.00. Raytheon Mfg. Co., Special Tube Div., 55 Chapel St., Newton 58, Mass.

Transformer Catalog 246

Over 700 transformers, 117 of them new, are described and illustrated in a 1957 General Catalog, TR-57. Toroids, pulse, transistor, hermetically sealed, geophysical, power, filament and audio transformers, chokes and television components are some of the items listed. Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif.

APPLICATIONS

Electrical and Acoustical Measurements
Electrical Communication Systems (Selective Calling)
Remote Operation and Supervisory Control of Machinery and Apparatus
Electrical Computers and Telemetering Systems
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They can be made with any one nominal control frequency between 20 and 1100 cps. They will control the output frequency of circuits, under specified conditions, constant within ±0.15% of the nominal control frequency.

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B-706

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CIRCLE 247 ON READER-SERVICE CARD FOR MORE INFORMATION

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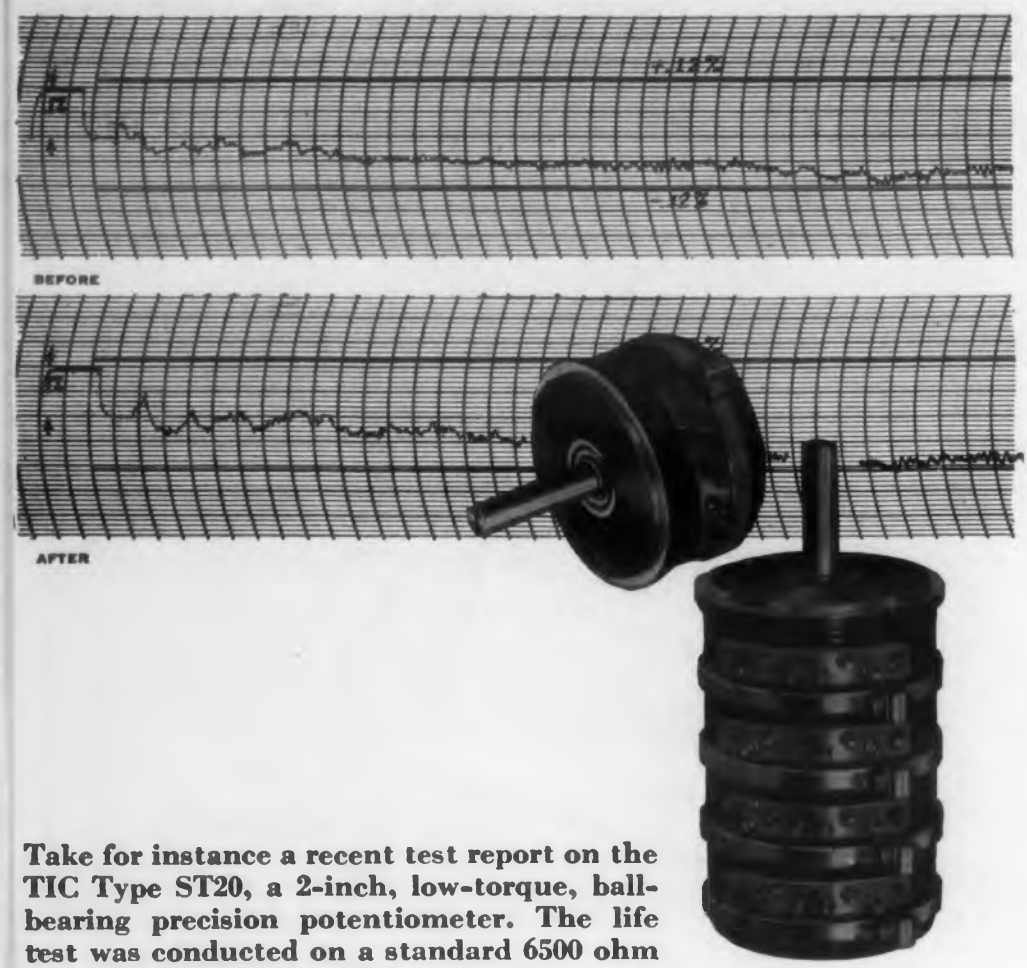

Take for instance a recent test report on the TIC Type ST20, a 2-inch, low-torque, ball-bearing precision potentiometer. The life test was conducted on a standard 6500 ohm unit. At 30RPM the ST20 was subjected to 700,000 cycles, reversing direction every 30 minutes. The linearity graphs shown above show the before and after of the ST20's independent linearity. *As can be seen, the linearity change is imperceptible.*

Some of the change in linearity after the life cycling can be attributed to change in effective resolution due to contact wear. Other results from the life test indicate less than 100 ohm equivalent noise resistance except for one spot, where it was less than 1000 ohms. The 1000 ohm spot was of such short duration that the linearity recording did not pick it up. Test Summary: The ST20 will perform with only infinitesimal degradation for over 700,000 cycles. If it's long life *at full precision performance*, that you want, specify precision potentiometers by TIC.

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CIRCLE 249 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Magnet Wire Trade Name Directory 250

Directory (16 pages) of current magnet wire trade names as used throughout the electrical industry is now released. Included in this comprehensive directory are various trade name designations as used and submitted by twenty magnet wire manufacturers, and a brief general description of the physical, chemical and electrical characteristics and application common to the ten general classifications of magnet wire. An easy-to-read chart is also included giving a complete resume of trade names by magnet wire types, and manufacturer. Magnet Wire Div., Essex Wire Corp., Ft. Wayne, Ind.

Water Bath Unit 251

A 2-page data sheet describes a self-contained unit for laboratory water baths that combines a heater, stirrer, and circulator with a built-in pneumatic control system and temperature indicator. Illustrations show the unit and some accessory equipment. Arthur S. LaPine & Co., 6001 S. Knox Ave., Chicago 29, Ill.

Portable Water Bath Cooler 252

A page of data has been issued to describe a portable cooler for laboratory water baths. Illustrations and performance data are included. Arthur S. LaPine & Co., 6001 S. Knox Ave., Chicago 29, Ill.

Hook-Up Wires 380

Series 100 and 110 hook-up wires made of silver plated copper conductors for continuous operation at 600 v in a —60 to +200 C temperature range are covered in two single-page data sheets. Both sheets contain a description, an illustration, a specification table and a list of performance requirements. Philadelphia Insulated Wire Co., 200 N. 3rd St., Philadelphia 6, Pa.

Precision-Drawn Cases 253

Services for supplying standard and special precision-drawn cases and covers are announced in a 4-page folder. Photographs illustrate a number of available items. Hudson Tool & Die Co., Inc., 18 Malvern St., Newark 5, N.J.

Screw Machine Products 254

Facilities for making beryllium copper screw machine parts are outlined in Bulletin A-57. The 1-page treatment includes photographs showing a variety of manufactured parts. Instrument Specialties. Co., Inc., 232 Bergen Blvd., Little Falls, N.J.

Insulated Wires and Cables 257

Insulated wires and cables are the subject of a 6-page folder. For each type listed, there is an illustration and a short description. Military hook-up wire, multiple conductor cable, coaxial cable, microphone, photoelectric cell cable, miniature wire and cable, flame retardant high voltage wire and high frequency lead wire are among those mentioned. Chester Cable Corp., Chester, N.Y.

High Temperature Insulation 258

"High Temperature Insulation" is a 12-page guide which describes the requirements established for Class H and Class C insulation and materials that meet these specifications. Micanite, Samica, Isomica, and laminated plastic and empire coated glass cloth are fully discussed with suggestions for application. Complete data on essential electrical, physical and mechanical characteristics are tabulated at the end of the booklet. Mica Insulator Co., Schenectady 1, N.Y.

Disc Type Thermostats 259

Punched for insertion in standard 3-ring binders, Bulletin 3000 describes a line of bimetal disc type thermostats for electronic, appliance and industrial applications. With a schematic diagram to illustrate, the 2-page text explains the operating principle of the units. It also provides performance data, ratings, dimensions, and construction details. Both hermetically sealed and semi-enclosed styles are covered. Photographs illustrate mounting arrangements. Stevens Mfg. Co., Inc., Lexington, Ohio.

Teflon Spaghetti Tubing 260

Bulletin BR-4A is a 2-page story on engineering thin wall Teflon tubing as an insulation sleeving for electric and electronic components. The dielectric, handling and performance advantages of the tubing are listed along with applications and electrical and physical property data. Illustrations and a specification table of 26 different sizes are also presented. The Polymer Corp. of Pennsylvania, 2140 Fairmont Ave., Reading, Pa.

Electrical Resistance Heating Material 261

Complete data on an ultra high-temperature electrical resistance heating material for continuous use at temperatures to 1600 C are contained in an illustrated booklet of 16 pages. In addition to a description of the electrical, chemical and physical characteristics of this cermet material, the brochure suggests designs and specifications for the construction of laboratory high-temperature furnaces. The Kanthal Corp., Amelia Place, Stamford, Conn.

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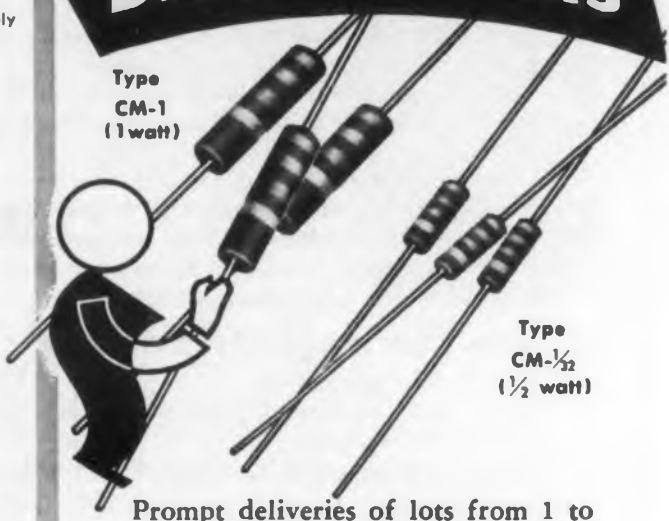

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CIRCLE 262 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Machined Components 264

Components precision-machined from industrial plastics are shown in a four-page brochure just issued. Important properties of plastic, such as Teflon, Kel-F, Nylon, and styrenes are given. Applications are indicated and some typical machined plastics applications in the electronic, aircraft, instrument, mechanical and other fields are illustrated. Tri-Point Plastics, Inc., 175-177 I. U. Willets Rd., Albertson, L.I., N.Y.

Aperture Mask for Color TV 265

Aperture masks for color television picture tubes are illustrated and described in Data Memorandum No. 5, just published.

Data Memorandum No. 5 illustrates the principal steps in the manufacture of aperture masks, which is essentially a photoetching process which produces tapered holes measuring .010 in. on one face of the mask and .015 in. on the opposite. Most tolerances are held to plus or minus .0006 in., but closer tolerances are possible. Superior Tube Co., Norristown, Pa.

Electronic Relays 266

Electronic relays, open and hermetically sealed, are described in an eight-page engineering Bulletin No. 1050 now available. Complete information on applications, construction and engineering specifications of these electronic relays is presented in concise outline form. Details include coil voltage, resistance and wattage, contact forms available and approximate weight. Dimensional drawings and circuit diagrams are shown for the eight groups of relays featured. Essex Wire Corp., Ft. Wayne, Ind.

Teflon and Glass Yarns 267

Fluorglas, a material combining Teflon and glass, and the yarns, threads and fibers made from it are illustrated and described in a folder of 8 pages. The electrical, chemical and physical properties of the material are listed along with specifications and uses for yarn, continuously coated fabric, woven fabric and lacing tape. Tables show available yarn sizes and weights. Dodge Fibers Corp., Hoosick Falls, N.Y.

Fine Pitch Gears 268

An illustrated brochure entitled "Precision Fine Pitch Gears" has been released. The brochure discusses precision gears as compared to commercial gears and methods and equipment employed. Quality control measures required for accuracy and close tolerances are also stated. Still another section is devoted to recommended gear data formats used in requesting quotations and cost estimates. Precision Gear Dept., Fairchild Camera and Instrument Corp., Robbins Lane, Syosset, L.I.

Die-Cast and Molded Products 269

Assembled in the "Services and Products Bulletin" are nine catalog sheets with complete listings of all 67 available types of zinc alloy die-cast and thermoplastic molded products. Section I of the bulletin deals with small parts made to customer specifications. Section II covers standard stock products, among them bobbins, insulators, bushings and a diversity of fasteners. All product types are illustrated. Gries Reproducer Corp., 125 Beechwood Ave., New Rochelle, N.Y.

Strain Gage Balance 270

Series D six-component internal strain gage balance is described in detail in an illustrated four-page brochure now available.

The balance is of the floating-frame type, and primary frames consist of an inner rod which fastens to the model support, and a cylindrical outer case which is inserted into and attached to the model. The brochure contains a chart of sizes and ranges, and a cutaway drawing of the balance. Performance evaluation is discussed in detail. E. F. Ward, Task Corp., 1009 E. Vermont Ave., Anaheim, Calif.

Fotoform Glass 271

The four types of Fotoform glass—how they are made, how they differ, their specific and potential uses—are described in an illustrated folder of four pages. Form EPFF-1 presents design and production data for these glasses and cites their latest mechanical and electrical applications in the electronic and allied industries. Corning Glass Works, Electrical Prods. Div., Corning, N.Y.

New Literature

Radiography on Subminiature Tubes 277

In "Radiography in Production Control and Inspection of Subminiature Tubes," Eric A. Kolm describes techniques used at Raytheon Mfg. Co. Reprinted from a technical magazine, the six-page article deals with the basic requirements for precision radiography. Smallness of X-ray source, stability of X-ray tube voltage and adequacy of target cooling are some of the factors covered. The author also discusses ability to mass-radiograph and properly treat geometrical accuracy between X-rays and electron tubes. Illustrations show radiographs made of subminiature electron tubes with the method described. Drawings give details for the film holder, the electron tube holder and the production inspection installation. Another drawing illustrates the geometric relationship between film, X-ray source and specimens. Philips Electronics, Inc., Instruments Div., 750 S. Fulton Ave., Mount Vernon, N.Y.

Differential Transformer 278

"Notes on Linear Variable Differential Transformers," copyrighted in 1955, is available as Bulletin AA-1A. The 18-page text explains techniques involved in the use of an LVDT for accurate determination and control of mechanical quantities in scientific and industrial operations. With graphs, diagrams and line drawings to illustrate, it discusses at length the characteristics, environmental factors, installation, operation and application of the unit. The comprehensive study, with more than 40 subject headings, covers mechanical and electrical features, mechanical frequency response, velocity measurement, linearity and linear range, sensitivity and output, impedance, resolution, phase characteristics, forces and tolerances. Schaevitz Engineering, P.O. Box 505, Camden 1, N.J.

A-C and D-C Relays 279

Comprehensive construction and application details for a-c and d-c general purpose relays are given in Bulletin 1060. Complete contact construction, arrangement and ratings are charted along with maximum dimensions for front and rear mounting positions. Featuring the 98000 Type a-c and d-c general purpose relays, the eight-page brochure also contains information on special construction and the 97000 Type designed for application requiring additional coil power and increased relay contact actuating force. The booklet is generously illustrated with photographs and extensive engineering drawings which give all dimensions for the many contact forms available. Essex Wire Corp., Logansport, Ind.

Polyethylene Insulation 284

Originally presented at the 1957 AIEE Winter Meeting, "Polyethylene for Higher Voltage Cables" is available in booklet form. In the article, author Robert C. Graham presents detailed information on the development and use of polyethylene as an insulation and jacket material for power cables used on a-c circuit voltages from 2300 through 33,000. Sections are devoted to polyethylene insulation and sheath characteristics; cable design, manufacture, and specifications; installation; price comparison; the use of polyethylene on cables rated higher than 15 kv; and the future of polyethylene as an insulation material. Coded RCT 700, the eight-page bulletin contains four photographs and three cutaway cable sketches and graphs and tables. It is punched for notebook insertion. Rome Corp., Rome, N.Y.

Pulse Calibrator 285

The Type 1810 pulse calibrator, an instrument designed for accurately measuring current and voltage pulse amplitudes, pulse durations and rise time, is fully described in a technical brochure. The 4-page pamphlet shows how the calibrator operates, illustrating and explaining actual waveforms obtained from different applications of the unit. Complete operation theory for the chopper and calibrator sections is given along with specifications. Burroughs Corp., Electronic Instruments Div., 1209 Vine St., Philadelphia 7, Pa.

Aircraft Thermocouples 286

A recently expanded catalog, Bulletin A, presents a line of aircraft thermocouples and aircraft thermocouple assemblies. It contains illustrations, specifications and ordering charts and points out applications. Three basic types of reciprocating aircraft engine thermocouples — engine - cylinder - bayonet, gasket, and blind rivet—are discussed in full. The 10-page booklet also offers information on MIL-Spec thermocouples, AN firewall quick disconnects, AN resistors and AN extension lead assemblies. Thermo Electric Co., Inc., Saddle Brook, N.J.

Grinding Cemented Carbides 287

Graphic test results of grinding cemented carbide cutting tools are presented in Engineering Bulletin No. 104. Comparative removal rates and wheel costs in grinding carbides with the electrolytic method and conventional grinding methods are given. Two charts are reproduced. One shows stock removal rates in cubic inches per minute for seven examples of grinding. The other indicates wheel costs in dollars per cubic inch of carbide removal for four grinding methods. Anocut Engineering Co., 661 W. Washington Blvd., Chicago 6, Ill.

Transistorized Sa

The Problem

In developing a horizontal output amplifier for a general purpose oscilloscope, using transistors, it was desired to pass sawtooth wave-forms at frequencies up to 40 kc. In order to obtain sufficient voltage output from the transistor to drive the deflection plates, it was necessary to use a step-up transformer. The requirement was for a transformer with at least a 5:1 step-up ratio and reasonably flat response from 20 cycles out to at least 250 kc. No such unit was available commercially, and it sounded like a difficult and possibly expensive design project, to build up such a transformer.

Solution

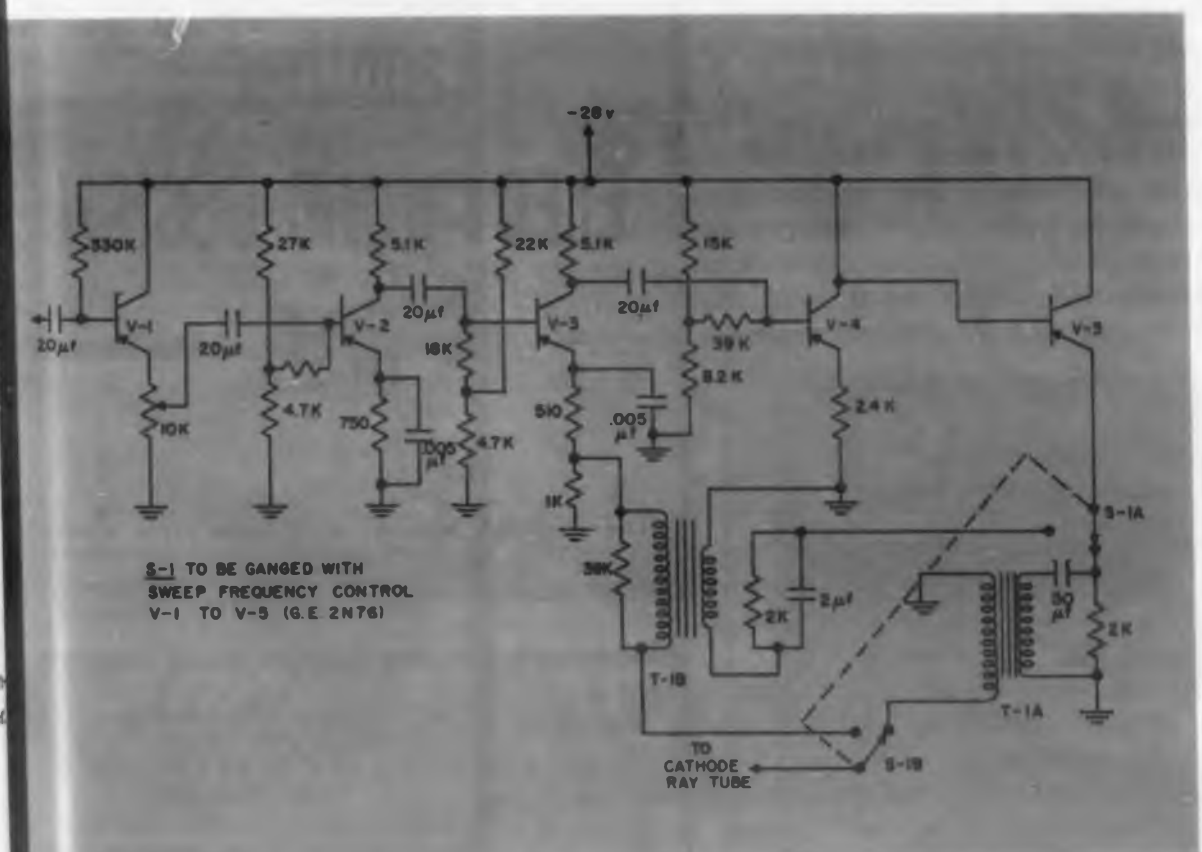
As an alternate solution to the problem, two horizontal output transformers were used, a UTC A-24 for the low and middle frequencies, and an Argonne AR-104 for the high frequencies. Once a switch-over frequency had been determined, switching one or the other transformer into the output circuit is accomplished by extra contacts on the usual sweep frequency range switch. Thus, two comparatively inexpensive transformers are used to perform the

Transistorized horizontal deflection amplifier

Get $10.00 plus a by-line for the time it takes you to jot down your clever design idea. Payment is made when the idea is accepted for publication. Full information and an "entry blank" can be obtained by circling 548 on the Reader's Service Card.

Sawtooth Amplifier

function of one expensive, and unavailable, unit. A second advantage of this arrangement is that it permits great flexibility in the choice of the means used to drive and terminate each transformer, as well as in the choice of feedback arrangements. These quantities can then be optimized for a particular frequency range. The horizontal output transistor, a GE 2N76, is shown as V-5 in the accompanying schematic diagram and S-1A, and S-B are ganged with the sweep frequency control. The switch-over frequency was 4 kc. *Joseph Chernof, Sr., Electronic Engineer, Bell Aircraft Corp., Buffalo, N.Y.*



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Output	115 VAC, adj. 110-120V
Regulation accuracy (RMS, average, or peak, switch selected)	±0.1% against line ±0.1% against load
Distortion	3% max.
Load	0-1000VA
P.F. range	Unity to 0.7 lagging
Recovery time	0.1 sec.

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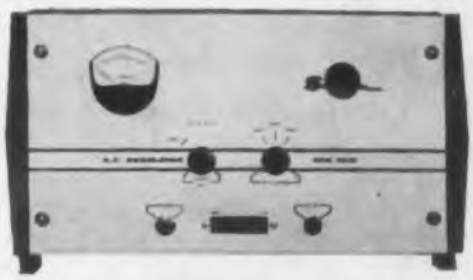

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CIRCLE 297 ON READER-SERVICE CARD FOR MORE INFORMATION

Ideas for Design

Surge Limiting Device

The Surgistor, a combination of a resistor and a thermal relay, is claimed to triple the life of all TV tubes. This simple device, inserted in series with the power line, reduces the current drawn by electronic equipment for about 10 sec before applying full voltage.

The cold resistance of vacuum tube filaments is about one-seventh of the hot resistance. Hence, when electronic equipment is first turned on, there is a rush of current which greatly exceeds the current drawn in normal operation. Though most modern vacuum tubes are designed to withstand this "inrush current," with no deleterious effects, the Wuerth Tube-Saver Corporation, 9125 Livernois Ave., Detroit, Mich., manufacturers of the Surgistor, maintains that at least 50% of all damage to tubes is caused by the instantaneous surge of current when the power is initially switched on. The Surgistor is claimed to increase tube life 65 to 360%, as well as lengthening the life of selenium and silicon rectifiers, electrolytic capacitors and other components.

The device is designed for use with 117 v equipment drawing 100 to 300 w. Its theory of operation is simplicity itself. The resistive element is a wire, tightly wound on a glass fiber core. The element is sealed in a ceramic case. On one end there is a bracket which positions the relay's stationary contact. On the opposite end, another bracket anchors the bi-metal blade and moving contact. When the equipment is first turned on the fixed resistance heats up, reducing the voltage across the equipment and heating the bi-metal blade. As the internal resistance of the circuit rises due to filament warm-up, the voltage drop across the equipment increases.

In about 10 sec the contacts of the bi-metal strip close, shorting out the fixed resistor and allowing full voltage across the equipment. Line current through the 0.2 ohm resistance of the strip generates enough heat to keep the contacts closed.

Simplified Potting

A simplified way for potting electrical connectors on missile and aircraft wiring harnesses has been developed at Chance Vought Aircraft. A mold of aluminum formerly was used to form the polysulphide plastic resin base around the connectors. The resin either stuck to the metal and had to be scraped off; or, if a petroleum coating was smeared inside the mold, this had to be wiped off after each operation.

By making the mold of chrome-plated steel, the resin does not stick. To keep the molten resin from leaking through the mold and fouling up the electrical points on the open face of the connector, the mold with the connector in it is dipped in cellulose acetate butyrate plastic. This forms a cap which seals off the exposed portion and can easily be peeled off and remelted after each operation.

This new method of potting the connectors saves an estimated 10 minutes work on each dipping and eliminates messy molds.

Three Bolts Do the Work of Four

Three bolts, positioned 120 degrees apart around a common center, can provide as stable a joint as the conventional pattern of four bolts arranged symmetrically. Savings in assembly, made possible by fewer holes to drill and fill, often make the three-bolt joint more desirable. Savings in cost of fasteners are also significant.

Holding capacity lost in using fewer bolts is made up by using stronger ones. This alternative still permits savings in the cost of fasteners. For example, either four 3/4-in. bright cap screws or three 3/4-in. high tensile bolts may be used to carry an 80,000 pound load safely. But three of the high strength bolts cost less than four of the cap screws.

In terms of holding power, the stronger the bolt, the less it costs. Engineers at Russell, Burdsall, & Ward Bolt and Nut Co. calculate that a dollar's worth of holding power in high tensile bolts cost $1.50 when bright cap screws are used and $1.65 with machine bolts.

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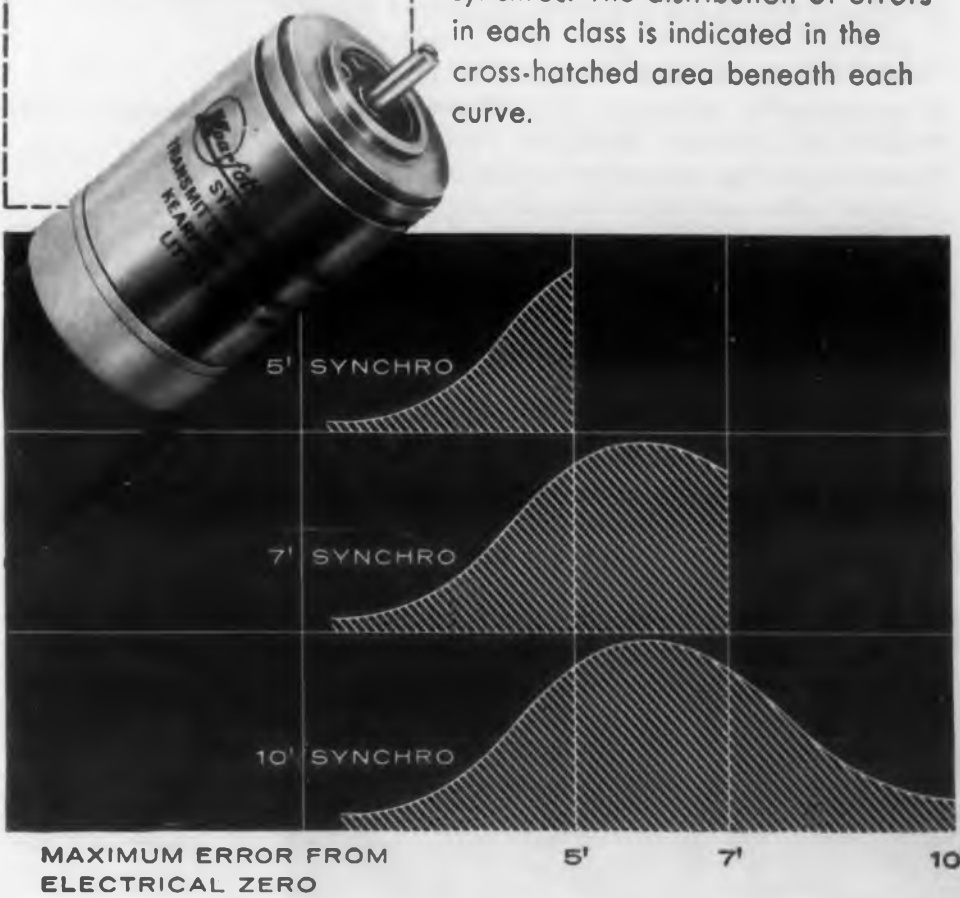
. . . are not selected, but are built to the specific degree of accuracy required. The accuracy of each class and the distribution of errors within each class, is a function of rigid quality control. The curves below indicate the degree of accuracy of three classes of synchros. The distribution of errors in each class is indicated in the cross-hatched area beneath each curve.



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CIRCLE 307 ON READER-SERVICE CARD FOR MORE INFORMATION

Report Briefs

Lovotron Gap Switch

The construction of a triggered gap switch which operates at voltages as low as 1 kv and handles currents up to 5 x 10^5 amperes is described. The switch is designed to operate on single pulses. Time jitter is of the order of 0.1 μsec between successive pulses. *PB 121061 Lovotron: A Low Voltage Triggered Gap Switch, E. H. Cullington, W. C. Chace, R. L. Morgan, US Air Force. Air Research & Development Command, Cambridge Research Center. Geophysics Research Directorate, Cambridge, Mass. Sep 1955. 19 pp, $0.50.*

Damping Devices

A bibliography of the literature on damping devices for mechanical vibrations published between 1924 and August 1956. The references cover studies of vibration damping by increasing the mechanical impedance of the system, by energy dissipation, or by tuned attachments, and of vibration isolation by vibration dampers, connection damping, and material damping. *PB 121299 Devices For Damping Mechanical Vibrations, A Bibliography, M. Benton, Naval Research Lab., Dec. 1956, 101 pp. $2.75.*

Spiraled Waveguides

The discussion is based on some simplifying assumptions about the field distribution in the neighborhood of the solenoid. A simple boundary condition is used that represents an idealized case and enables a rigorous solution of Maxwells' equation in terms of a superposition of TE and TM guided waves. In this idealized case the field inside the solenoid is completely isolated from the field inside the window. Separate solutions are found independently for both fields and there is no coupling between them. For an actual spiral these ideal conditions could not be met. *PB 123148 Spiraled Coils As Waveguides, L. Brillouin. Harvard University. Cruft Lab, Cambridge, Mass. Mar 1947, 23 pp, Microfilm $2.70, photostat $4.80.*

Radiological Health Handbook

This radiological health handbook contains a glossary of radiological terms and sections on physical, chemical and mathematical data, radioisotopes, decay, radioassay, and radiation protection. A table of isotopes also is included. *PB 121784, Radiological Health Handbook, S. Kinsman, R. A. Taft Sanitary Eng. Center, Public Health Service, OTS, U.S. Dept. Commerce, Washington 25, DC, January 1957, 356 pp, $3.75.*

Control System Nulls

The major result of this report is a formula for null voltage of a synchro control system, consisting of a transmitter and transformer, in terms of its impedances. It is found that the error and null voltage (more precisely, the null voltage ratio) are conjugate parts of the same complex function of the impendances. *PB 120852, Part II, Null Voltages in Control of Systems, by G. H. Weiss and J. H. Rosenbloom, January 1953, 46 pp Mi $3.30, ph $7.80, LC, Washington 25, D.C.*

Analysis of Synchros

In a linear lumped parameter analysis, the action of synchros is completely defined in terms of their impendances and a single-frequency voltage source. The impedances are Fourier series in terms of the angular position of the rotor. Necessary and sufficient conditions for an errorless synchro control system and formula for the error of an individual synchro are derived in terms of the impedances. An elementary introduction to matrix and tensor analysis to the extent required to develop these results is also included. *PB 120921, Part 1, Linear lumped parameter analysis of syschros, J. H. Rosenbloom, U.S. Naval Ordnance Lab., White Oak, Md. LC, Washington 25, D.C., Feb. 1951, 51 pp, $3.60 Mi, $9.30, ph.*

Variance Analysis Equations

Computational formula are presented for a statistical method for distribution-free, or non-parametric, tests of hypotheses concerning both main effects and interactions in multi-factor experimental designs. The formulae reduce computational errors by resulting in an integer numerator and an integer denominator for each component at the last step in the computational process. The statistical method and formulae may be especially useful in cases of multi-factor analysis-of-variance designs in which the assumptions are not met by data. *PB 121698, Computational Formulae for a Distribution-Free Test of Analysis-of-Variance, Hypotheses, E. A. Alluisi, Ohio State University and OSU Research Foundation for Wright Air Development Center, OTS, Dept. Commerce, Washington 25, DC, July 1956, 17 pp. $.50.*

Report Briefs

Near-Zone Paraboloid Fields

The field structure produced when the feed is displaced from the focus with the feed horn axis remaining parallel to the reflector axis is described. Experimental results have been compared with theoretical geometrical optic principles and with theoretical intensity patterns resulting from the theory of aberrations as developed by Nijboer. In discussing the effects of geometrical aberrations upon the intensity pattern it is shown that various types of phase variation over the aperture have the same effect upon the intensity patterns. *PB 123426 Near-Zone Fields of Paraboloid Reflectors, D. G. Dalley, California, Div. Electrical Eng. Electronics Research Laboratory, Antenna Group, Berkeley, Calif. Oct. 1955. 80 pp, Microfilm $4.50, photostat $12.30.*

Thermistor Circuits

Methods are developed for the accurate determination of the linear parameters of this circuit in this report. In order to obtain the complete data of the thermistor it is only necessary to determine its thermal time constant and three points on a static U-1 characteristic. A simple method for measuring the thermal time constant is described. Measured data for a number of thermistor types are presented. The paper gives a convenient method for the investigation of static and dynamic small amplitude problems in thermistor circuits. Applications to the analysis and synthesis of such circuits are given. *PB 122885 Small Signal Behavior of Directly Heated Thermistors: A Study of Thermistor Circuits, Part 2, N. Bjork and R. Davidson. Chalmers University of Technology, Gothenburg, Sweden. 1955 44 pp, Microfilm $3.30, photostat $7.80.*

Transistor Amplifier Design

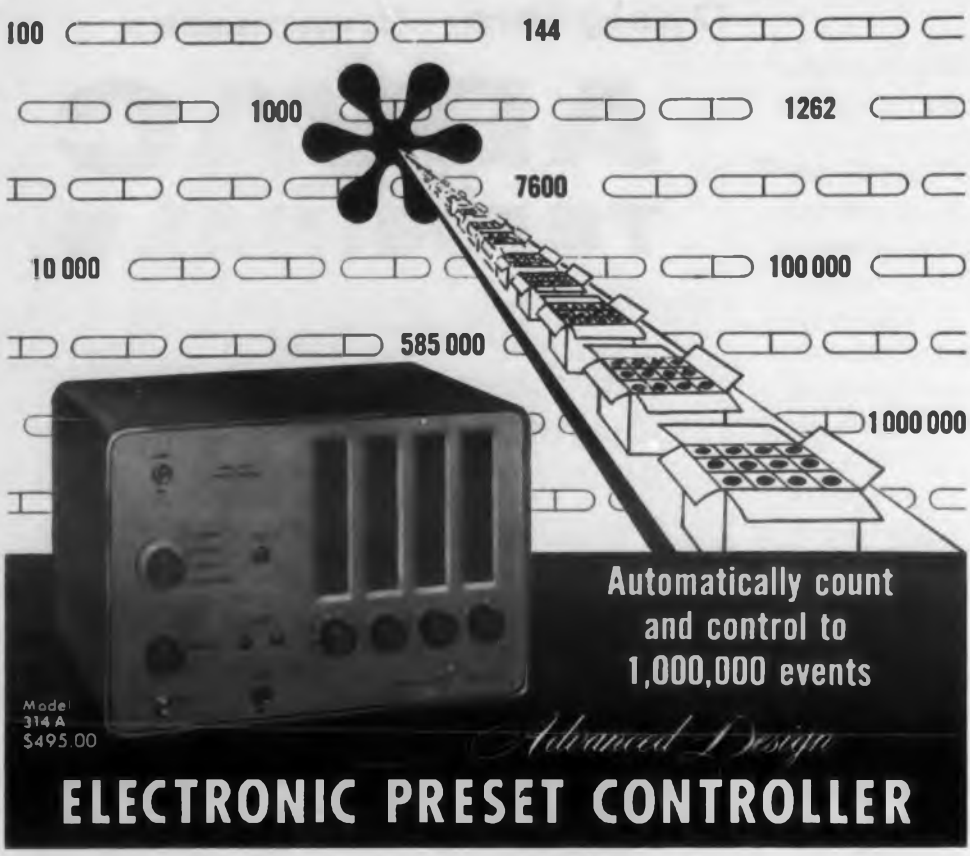
This report describes a method of multistage wideband transistor amplifier design incorporating constant resistance ladder networks in the external feedback path. The method described allows one to synthesize the feedback amplifier without the use of equivalent circuits for the transistors. This is done by approximating the measured amplifier gain function without feedback with a rational function of frequency and then applying unilateral feedback theory in the design of the feedback path. By use of constant resistance ladder networks in the feedback path interaction effects are eliminated. The results of some design experiments are discussed. *PB 121556 Transistor Feedback Amplifier Design, George L. Benning. California University. Division of Electrical Engineering. Electronics Research Lab., Berkeley, Calif. Oct. 1955. 29 pp, $0.75.*

X-forms in Variance Analysis

Usual analyses of variance procedures depend on assumptions which may not be fully met by experimental conditions. This difficulty often may be decreased by transforming the collected data before making the tests or estimates. This study investigates the theory of various transformations, including square-root, reciprocal, logarithmic, and square-root of the log. Objective tests for use as criteria for determination of the proper type of transformation are also examined. *PB 121716, Notes on the Use of Transformations in the Analysis of Variance, E. G. Olds, T. B. Mattson, and R. E. Odeh, Carnegie Institute of Technology for Wright Air Development Center OTS, U.S. Dept. of Commerce, Washington 25, DC, July 1956, 34 pp, $1.00.*

Acoustic Wattmeter

The author has constructed a device which gives pointer indications of acoustic intensity over a 50 db range at any frequency between 90 and 10,000 cps. The theory of operation of the apparatus is discussed; the design, construction and testing of the various components is described; and the report concludes with a brief account of the operation of the acoustic wattmeter as a whole. *PB 124311 Acoustic Wattmeter, Theodore J. Schultz. Harvard University. Acoustics Research Lab. Nov. 1954 107 pp, Microfilm $5.70, photostat $15.80.*



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SPECIFICATIONS					
	312A	313A	314A	315A	316A
Decades	2	3	4	5	6
Count Capacity	100	1000	10,000	100,000	1,000,000
Counts per Second	0 to 100,000 (as totalizing counter)				
Recycling Rate	50,000 counts per second (as preset counter)				
Input Sensitivity	0.05 volts rms: 10-100,000 cps 0.07 volts rms: 1-10 cps Positive Pulse Rise Time: ½ volt or more per sec.				
Input Impedance	0.5 megohm, 50 mmf				
Accuracy	Absolute				
Output	60 volt positive pulse, 10 microseconds duration (negative pulse optional)				
Output Relay Contacts	5 amps, 117 volts, non-inductive load Normally open or normally closed (with indicator lamps) Can be switched out				
Relay Hold Time	Automatic: Continuously variable from 0.1 to 1 second Manual: Lock until release				
Auxiliary Power	6.3 volts ac @ 3 amps; +225 volts dc regulated @ 50 ma; −150 volts dc regulated @ 5 ma.				
Power Requirements	117 volts ± 10% 50-60 cycles 100-150 watts depending on model				
Dimensions	13" W x 8¾" H x 13" D				16¼" x 8¾" x 13"
Net Weight	20 to 28 lbs. depending on model				
Finish	Panel: Light grey baked enamel Case: Dark grey baked enamel				
Data Subject to Change Without Notice					

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Model 101A $75.00

Write for complete catalog and prices.

Computer-Measurements Corporation

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CC-14

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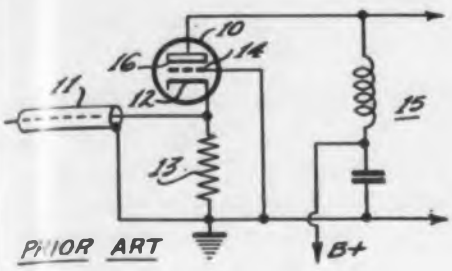
Patents

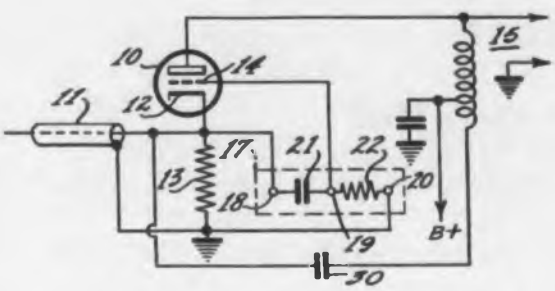
Cathode Input Amplifiers

Patent No. 2,756,283. H. M. Bach. (Assigned to Radio Corporation of America)

Cathode input amplifiers are commonly used in high frequency receivers and usually as a part of the antenna connection which feeds into the cathode of a three element amplifier. Where such a tube has its grid connected to ground, undesired cross modulation is encountered particularly from strong signals which are substantially higher or lower in frequency than the signal which is to be received. The amplifier illustrated amplifies the desired input signal but not the undesired frequencies and thereby eliminates cross modulation.

The usual cathode input amplifier includes a triode *10* having a cathode resistor *13* with the input being applied across this resistor. The control grid is grounded and the plate impedance is an inductor *15*. To this well known circuit the patentee adds a filter or frequency selective unit *17* in parallel with the cathode resistor. The control grid is connected with a center tap *19* of this filter. The illustrated filter is a low pass unit with the impedance between the control grid and cathode being a capacitor *21* and the impedance between the control grid and ground being a resistor *22*. These impedances are selected to provide a low impedance for the undesired frequencies and a high impedance for the frequency which is to be received and amplified. With this circuit the tube functions as an amplifier for the desired frequency and for undesired frequencies the control grid is connected with the cathode and functions as a diode and hence without gain.





The impedance represented by the capacitor *21* and resistor *22* may be substituted by other impedances depending upon the frequencies which are to be attenuated. The patent illustrates a circuit in which the capacitor *21* is substitued by a conductance and the resistor *22* is substituted by a capacitor to form a high pass filter so that lower frequencies are amplified. In another circuit the capacitor *21* is substituted by a parallel tuned circuit and the resistor *22* is substituted by a series tuned circuit. This is a band pass filter so that only those frequencies in the desired frequency range are amplified. In another form of the circuit the impedance network *17* may be connected between the anode and ground with the control grid being connected to the center terminal between the impedances of the network. These circuits overcome the cross modulation difficulties, which have been experienced with the cathode input amplifiers heretofore used.

Signal Phase-Correcting System

Patent No. 2,776,428. N. A. Hassler, H. R. Jurman and C. F. Fragola. (Assigned to Sperry Rand Corporation)

There are many signal sources, the output of which is a signal of a noisy character. The purpose of the circuit described is to provide an output signal which is a smooth version of the noisy input signal and is both proportional to the input signal and substantially in phase therewith. The circuit necessarily effects a predeterminable phase lag so that the circuit includes means for advancing the phase of the signal by an amount sufficient to compensate at least to some extent for the phase lag.

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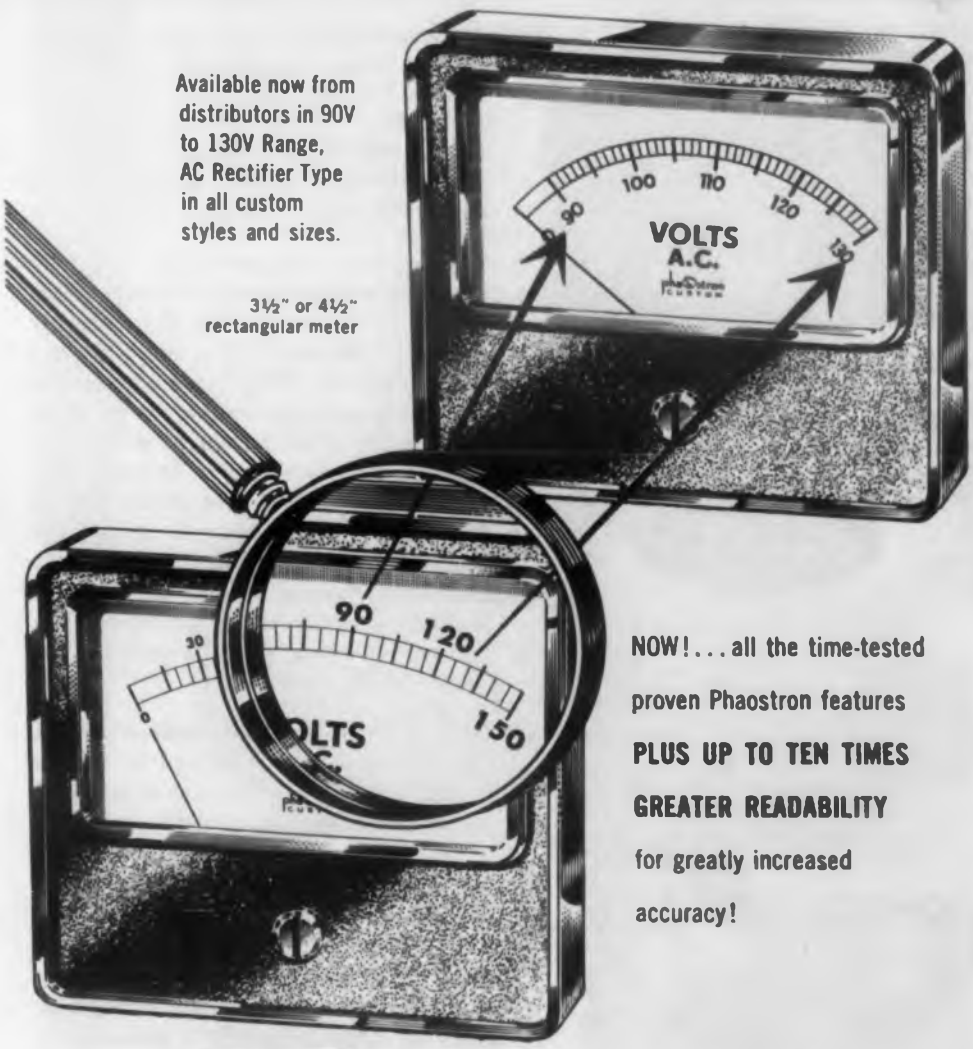

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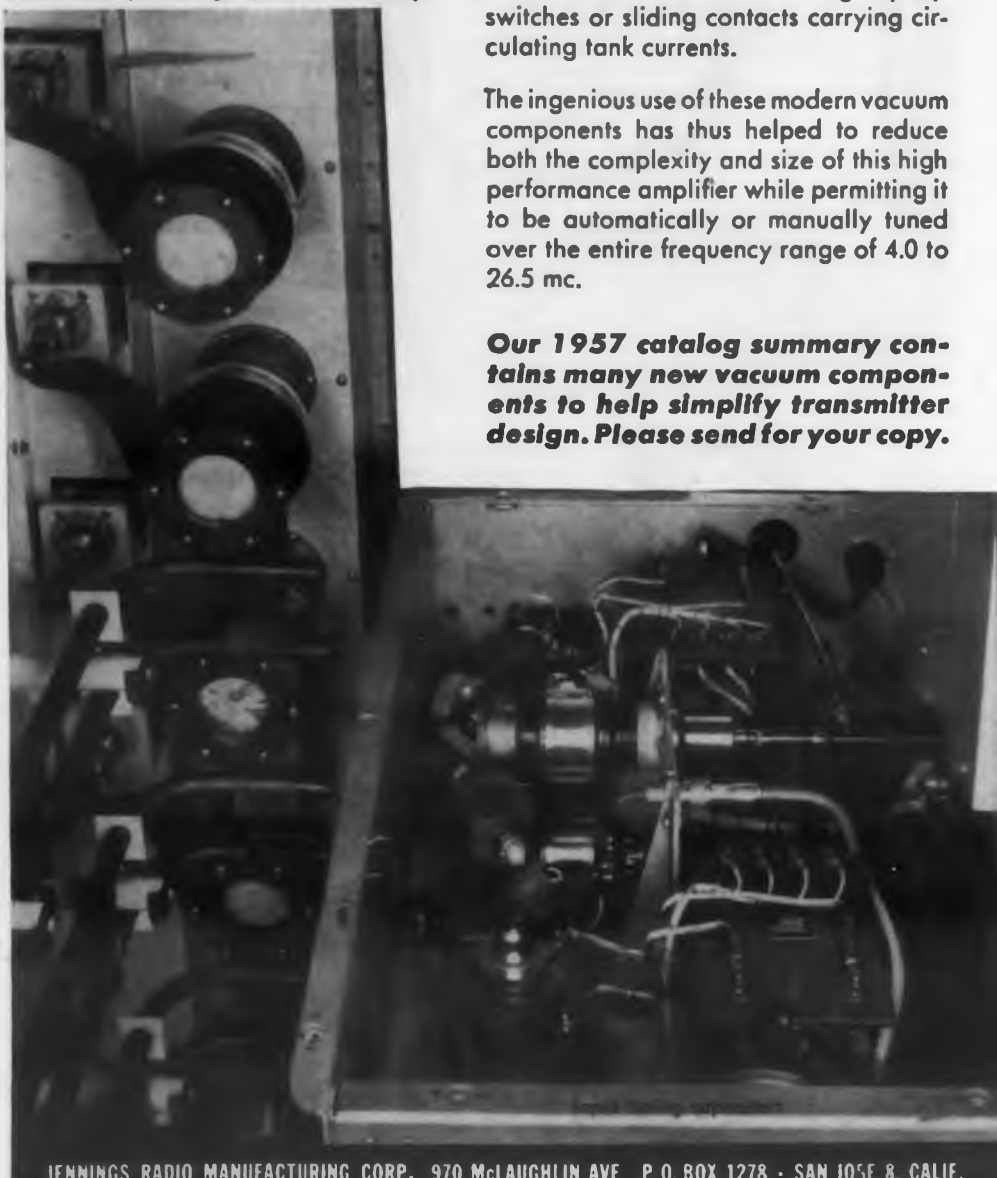
Our 1957 catalog summary contains many new vacuum components to help simplify transmitter design. Please send for your copy.



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CIRCLE 329 ON READER-SERVICE CARD FOR MORE INFORMATION

Patents

Synchronizing Circuit

Patent No. 2,761,895. R. M. Snyder. (Assigned to International Telephone and Telegraph Corp.)

In a synchronizing circuit such as the one used for interlace scanning in television, it is necessary that the sweep frequency ratio between the horizontal and the vertical sweep circuits be accurately controlled. The patent discloses a circuit in which it is not necessary to maintain a precise ratio in frequencies. The circuit is shown diagrammatically in the figure. The circuit which achieves this result is relatively simple.

A sine wave oscillator *1* is used, of any known type, but it is desirable that it be crystal controlled. The output of the oscillator is coupled to a full wave rectifier of two triodes through a transformer. The grids of the two triodes are connected to the secondary winding of the transformer with the center turn grounded so that a wave of

the same frequency but 180 deg out of phase is applied to the control grids.

The potential on the plates of the rectifier tubes are controlled by a 30 cps multivibrator of any known type having two triodes which generate two square waves 180 deg out of phase. The output of one multivibrator tube is applied to the plate of one of the rectifier tubes and the plate of the other multivibrator tube is connected with the plate of the other rectifier tube so that the output of each rectifier tube is alternately gated to pass a sweep control signal. The output of each rectifier tube controls a signal shot multivibrator 5 which generates the signal for control of the sweep of the cathode ray tube. Since one sine wave is 180 deg out of phase with the other, the control of the sweep generator signal will give a signal for interlace scanning.

Pulse Amplitude Selector

Patent No. 2,775,693. T. W. Berwin. (Assigned to Collins Radio Company)

A selector circuit which determines which one of a plurality of incoming signals has the largest amplitude has varied applications. The circuit uses a one-shot multivibrator which receives a triggering pulse each time that a determination is to be made. The multivibrator tube has a cathode circuit of a cathode resistor and parallel condenser. The circuit also makes use of a plurality of trigger circuits, each consisting of a pair of tubes. One of each pair of tubes of the trigger circuits is coupled to the cathode of the multivibrator tube. The plate of the other tube of each trigger circuit is provided with an output terminal and one of these output terminals receives an output indicative of which of the input signals has the largest amplitude.

Cathode Ray Sweep Correction System

Patent No. 2,774,910. Emil Sanford. (Assigned to Allen B. Du Mont Laboratories, Inc.)

Geometrical distortion in a cathode ray tube deflection system exists because of differences in the center of curvature of the tube screen and of the sweep of the beam. The circuit corrects for this distortion by generating a first sawtooth deflecting signal and a second sawtooth deflecting signal. An integrating circuit integrates the first sawtooth signal to provide a parabolic waveform as a correcting signal. The parabolic waveform is then used to modulate the amplitude of the second sawtooth signal which is applied to the cathode ray tube.

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Output (hp)	⅓
Speed (rpm)	3400
Duty	continuous
Field Voltage	70
Field current (amps)	0.470
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Armature inertia (lb. in.^{2})	1.10
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The above values are valid for DC operation.

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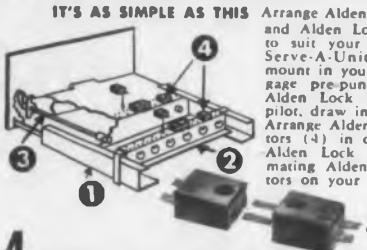

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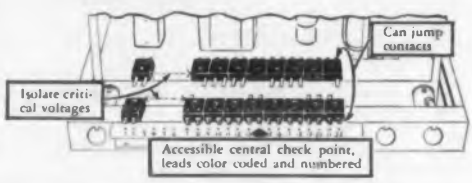

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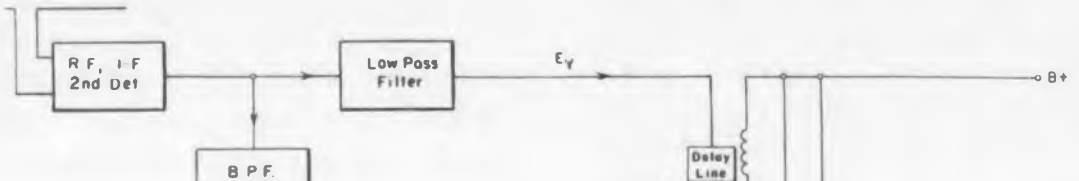
Patents

Color Television Receiver Apparatus

Patent No. 2,763,716. K. E. Farr. (Assigned to Westinghouse Electric Corporation)

A color television signal is made up of a monochrome signal component (Ey) and two color difference signal components (Er–Ey) and (Eb–Ey). The green color information is transmitted by these two latter signals and no separate signal is required for this color. A color television signal is transmitted in this form so that when the program is not in color the receiver will reproduce the picture in monochrome. By adding the monochrome signal to the color



difference signal, the color signal is obtained. In the prior receiver circuits the monochrome signal (Ey) was applied to the control grid of each of the three electron guns of the picture tube and the color difference signal was applied to the cathode of its respective gun. The green color information was derived from the red and blue signals through a mixer and inverter which signal was then applied to the cathode of its gun. This method of reproduction is called an internal matrixing system.

The circuit devised by the patentee differs from the prior circuits in that each of the two color difference signals is applied to the control grid of its respective triode *38* and *40*. The green signal is derived from the output of these two triodes by applying them to the control grid of a triode *42*. The monochrome signal is applied to the control grids of each of three triodes whose plates are connected to the plates of the color triodes and the resultant signal is fed to the respective guns of the picture tube. A delay line *70* and *72* are required in the monochrome circuit connections. This circuit provides external matrixing which enables more effective control of the picture to be secured.

Electrical Translator and Methods

Patent No. 2,773,925. Bernard J. Rothlein and Frieda A. Stahl. (Assigned to Sylvania Electric Products Inc.)

In the operation of transistors it is beneficial to have a localized inhomogeneity in the germanium crystal. The patentee secures this characteristic by exposing the surface of the germanium to the action of a particle of zinc at a relatively high temperature of 600 to 800 degrees centigrade. The germanium is then gradually cooled and etched so as to remove any reaction products of the zinc and the germanium.

Automatic Frequency Control

Patent No. 2,774,877. Lowell E. Norton. (Assigned to Radio Corporation of America)

A simple frequency stabilization system is described having two or more radio-frequency oscillators. The oscillators are coupled to a gas cell having therein a molecularly resonant gas at a low pressure. A circuit component is coupled to the gas cell from which a separate frequency control signal is derived for each of the oscillators. The separate control signals are then applied through coupling means to the oscillators to stabilize their frequencies.

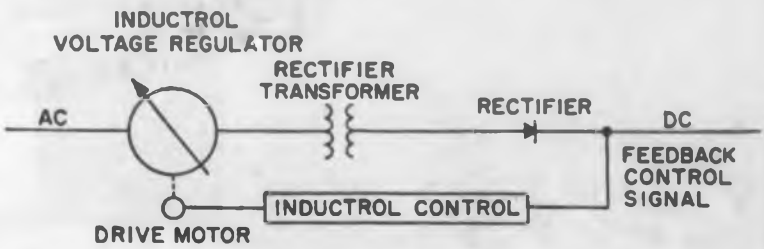
GENERAL ELECTRIC

VOLTAGE REGULATION IDEA FILE

by C. A. Neumann

ENGINEERING DESIGN IDEA: A.C. Controls D.C.

General Electric Inductrols*, a-c induction voltage regulators, can control d-c voltage or current. Here's how:



Inductrols compensate for a-c line variations, rectifier aging effects, regulation as d-c load current varies, hold voltage (or current) to ±1%.

DESIGN BENEFITS: Inductrol's drift-free controls always keep voltage settings at desired level. Cost is low.

RADAR APPLICATION IDEA:

New England radar manufacturer uses three single-phase Inductrols to give precise phase-angle control, hold voltage to ±1%. A three-phase, motor-operated, manually-controlled Inductrol is used for tube warm-up. Power can be increased by raising voltage from 0 to 600 in either two seconds or 30 seconds.

DESIGN BENEFITS: Easy-to-install Inductrol introduces no waveform distortion into electronic systems.

COMPUTER APPLICATION IDEA:

Massachusetts computer manufacturer got line stability and proper tube warm-up by using both voltage stabilizer and voltage regulator. One Inductrol now does both jobs.

DESIGN BENEFITS: Inductrol voltage regulators have an excellent space factor, require little maintenance. They neither affect, nor are affected by, system power factor.

HEAT TEST IDEA:

Boston electronics firm uses battery of infrared quartz lamps to simulate missile in-flight heat conditions. Lamps, energized suddenly on this 208-volt circuit produced rapid heat, but lack of warm-up time caused expensive lamp mortality. A complicated and expensive wiring-switching arrangement was considered, discarded in favor of 3-phase automatic Inductrol voltage regulator.

DESIGN BENEFITS: Inductrol voltage regulators have no brushes to maintain or replace; are rugged, designed for long life; are extremely accurate and reliable.

FOR MORE INFORMATION write Section 425-8, General Electric Company, Schenectady 5, N. Y.

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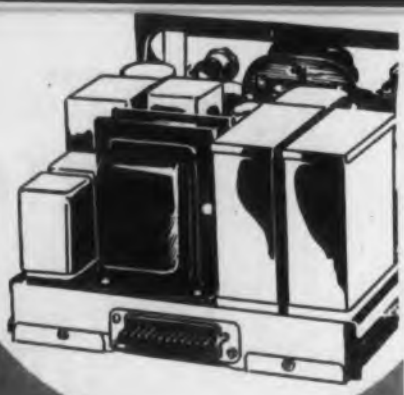
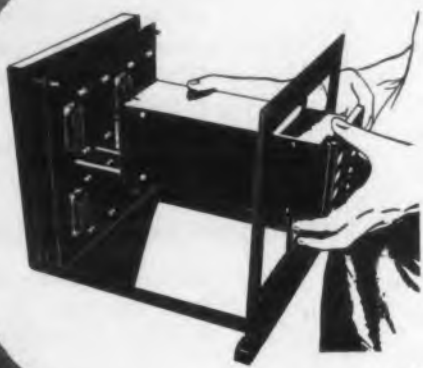
PLUG IN

with BLUE *Ribbon* CONNECTORS





AMPHENOL's Blue Ribbon connectors have gold-plated "ribbon"-like contacts and diallyl phthalate dielectrics. They are available with guide pin or contact barrier polarization and as inserts with mounting plates or in keyed shells. Up to 32 contacts are provided in standard size connectors and as many as 50 in new Micro-Ribbon versions.

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Books

Electrical Measurements and Their Applications

Walter C. Michels. D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N.J., 331 pages, $6.75.

Reviewed by E. A. McGinnis

Professor Michels has tackled the almost impossible task of covering the very broad field of Electrical Measurements together with applications in a single text book. He includes a description of most electrical measuring devices along with applications. In the case of basic measuring instruments his description is complete and is accompanied by the necessary theory.

Even though this text would apear to be written specifically for use in the classroom; it will be a valuable edition to the library of the average test or design engineer. The complete choice of experiments and the thorough description of how to perform these experiments, will serve as a good reminder of the uses and limitations of the basic electrical instruments. The explicit development of the theory underlying the basic instruments makes available in one book the types of instruments, how they are applied, and why they work. Engineers in

the field will find it invaluable as a reference text and will in many cases find enclosed in its covers the answers to their measurement problems or at least an approach to the solution of a difficult measuring problem.

Teachers will of course welcome this text. Of particular interest to the teacher of Electrical Measurements or any related laboratory course will be the first chapter on laboratory practice and precision of measurements. The author goes into some detail on how data should be handled and explains how the reliability of data can be ascertained. It is hard to find any fault with the choice of experiments or with the presentation of the related theory and applications.

This book should also prove to be a very valuable book to the student whether or not it is selected as the text for the course he is taking. It is complete and it is very clearly written. Sufficient theory is given for most of the experiments so that the reader can get more than just a superficial knowledge of the instruments covered. The experiments contained in the text are valuable not only when performed but also if only a description of the experiment is read.

The volume contains many illustrations of late model electrical instruments. The use of late model illustrations instills confidence in a book within a field that is continually and rapidly changing.

The title of the book is misleading although essentially correct. The author covers not only what we consider to be strictly electrical measurements but also goes into some detail on electronic instruments. His applications include use of electrical and electronic measuring instruments in acoustics. He gives a complete description of many of the basic measurements in microwaves with sufficient explanation of the underlying theory that the average engineer regardless of his specialty will understand the measurements. As evidence of the "up-to-dateness" of the book, one section is devoted to the discussion and description of measurements in nuclear physics.

To cover so many topics so well in a book of only 320 pages is a tribute to the organizational ability of the author. This book is one of the better bargains in either the text book or reference book field and would be a welcome addition to the library of any technical man.

E. A. McGinnis is Assistant Professor of Physics at the University of Scranton, Pennsylvania.

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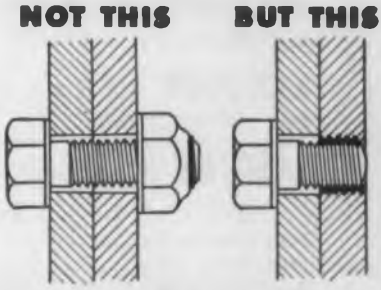

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Books

Differential Equations Applied in Science and Engineering

Harold Wayland. D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N.J., 353 pages, $7.50.

Prepared primarily for advanced students, it has been the author's purpose to analyze the mathematical solution of physical problems so that the processes may be viewed in their entirety. Commencing with the translation of physical concepts into mathematical language, the work proceeds through formal solutions to consideration of the physical reasonableness of results.

To the central theme of partial differential equations many topics from advanced calculus have been added. Particular atteniton is given to vector analysis. The techniques of formulating the most important vector expressions in orthogonal curvilinear coordinates are presented in some detail. Separation of variables is stressed as a method of solving differential equations under given boundary conditions. Other topics are power series expansions, special functions, expansion in series of orthogonal functions, and integral transforms.

Quality Control for Plastics Engineers

Edited by Lawrence M. Debing. Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y., 142 pages, $4.95.

Assuming the reader has no prior knowledge, this book introduces the subject of statistical quality control in plastics. Referring specifically to examples of application currently used in the plastics industry, the text explains basic statistical procedures as a means of achieving the highest possible standards of performance. There are chapters dealing with control charts, process capability studies and specifications, sampling methods to assure adequate inspection, correlation, and experimental design. Written by a team of experts, the volume is the first in a series of technical works to be sponsored by the Society of Plastics Engineers.

Frequency Modulation

L. B. Arguimbau and R. D. Stuart. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. 96 pages. $2.00.

This monograph is largely based on experience gained by the writers in the Research Laboratory of Electronics of the Massachusetts Institute of Technology. It is a high level treatment on frequency modulation with special emphasis on its noise-eliminating ability. For the most part, circuits are considered from a steady state alternating current point of view. The book treats fm from its most fundamental definition to its application in television.

Frequency-Modulated Radio

K. R. Sturley, The Macmillan Co., 60 Fifth Ave., New York 11, N.Y. 120 page $3.00.

Principles of frequency modulation are explained in terms that can be readily understood by the technician and repairman. General principles, theory, design, construction and servicing of vhf/fm receivers are discussed. Each stage of a vhf/fm receiver is analysed in detail and a chapter is devoted to the special features of combined am/fm receivers. A section on alignment problems, and the location of faults with a minimum of test equipment should prove of particular interest to the repair technician. The author is affiliated with the British Broadcasting Company and information given on transmitters is taken from those used in the BBC vhf broadcasting service.

Foundations of Radio

M. G. Scroggie, Philosophical Library, Inc., 15 East 40 St., New York 16, N.Y. 349 pages, $10.00.

Starting with the most elementary principles, this sixth edition of M. G. Scroggie's book, remains an excellent introduction to radio. Except where it is absolutely necessary, the treatment is essentially non-mathematical. Fundamental laws of electricity and radio, the theory of valves, transmitters and all types of modern receivers are described. An introduction to the techniques of television and radar is also given. Mr. Scroggie's frequently humorous and painstakingly lucid treatment of his subject should appeal to the beginner. It could very well appear redundant to the experienced technician or engineer.

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What the Russians are Writing

J. George Adashko

Contents of Radiotekhnika i Elektronika No. 8, 1956

THIS issue is devoted in its entirety to semiconductors and its applications in engineering. It contains several papers delivered at the 8th All-Union Conference on semiconductors, held by the USSR Academy of Sciences in Leningrad on November 14-20 in 1955. Participating in this conference were more than 1,000 people, including scientists from China, Poland, Rumania, Hungary, Czechoslovakia, and East Germany.

This issue contains several papers read in the sessions on semiconductor electronics and semiconductor intruments, photoelectric phenomena, magnetic phenomena in semiconductors. Other papers read in these sessions will be published in future issues of "Radiotekhnika i Elektronika."

Status of our Knowledge of Semiconductors and Problems Remaining to be Solved (Opening Remarks), A. F. Ioffe, (4 pgs).

Historical review, emphasizing that more than 10,000 articles on semiconductors were published during the last 30 years, and that their number increases at very high rate. He also points out that the volume of production of equipment containing semiconductors has reached dimensions commensurate with other important branches of electronic engineering. This is a good reason for analyzing in detail the strong and weak points of the modern status of semiconductors and for indicating paths that further progress in this field is to follow. He mentions contributions of many Soviet scientists to the art and concludes that the existing theoretical and experimental foundations are insufficient for exhaustive development of semiconductor technology. Shows, for example, that a tremendous quantity of heat that presently can not be converted into useful work in furnaces and in heat engines could be converted, using semiconductor thermocouples, into useful work. Mentions also the possibility of using semiconductors to tap solar energy.

Behavior of Semiconductors in Strong Electric Fields, Iu. K. Pozhela, (7 pgs, 8 figs).

In strong electric fields, near the break-down threshold of the semiconductor, the voltage-current characteristic of a metal-semiconductor junction can assume two forms (Figure 1). Curve II is obtained when the increased conductivity is local and restricted to the region where the additional carriers, produced by the increased field, are located. Curve I occurs when the strong electric field produces mobile pairs of carriers, and if the potential applied to

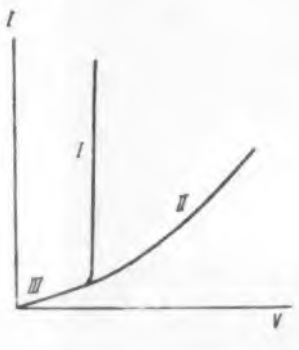


Fig. 1: Proposed current-voltage characteristics of metal probe to semiconductor contact.

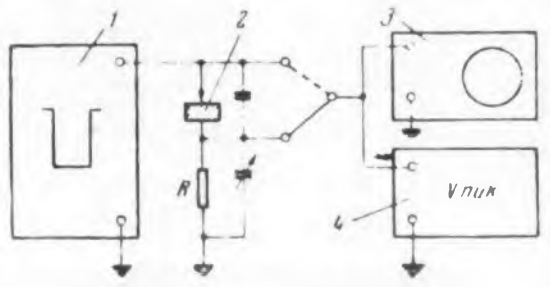


Fig. 2: Set up used to measure current-voltage characteristics: 1—source of rectangular voltage pulses; 2—specimen; 3—oscillograph; 4—peak voltmeter.

the metal is such that the electron-hole pairs move into the semiconductor, the region of increased concentration will move into the semiconductor, modulating the conductivity of the entire region near the contact, and increasing sharply the current flowing through the contact. Thus curve I depends on the polarity of the applied potential, while curve II does not.

Figure 2 shows the experimental set-up used for the investigation. Reference is made to work by E. J. Ryder, *Physical Review*, 1953, *90*, 5, 766, Navon, Bray, and Fan, *Prog. IRE*, 1952, *40*, 11, 1342, and Dunlop, *Physical Review*, 1955, *97*, 3, 615.

Principal Theories and Several Results of Investigation of Germanium Diodes and Triodes. B. M. Vul, (12 pgs, 9 figs).

Gives the fundamental theory and some particular results of investigations on Germanium diodes and triodes performed in the P. N. Lebedev Physics Institute of the USSR Academy of Sciences. Covers some fundamental equations, the capacitance of the p-n junction and the field intensity in it, the current through a p-n junction, elementary theory of transistors and certain measurement results. Makes numerous references to American papers.

Parameters and Constructions of Certain Russian Transistors, A. V. Krasilov, (8 pp, 9 figs, 3 tables).

An abstract of this article will appear in a coming issue of Electronic Design.

Industrial Types of Thermistors and Fields of their Application, B. T. Kolomiets, I. T. Sheftel, E. V. Kurlina, and G. I. Pavlova, (9 pp, 12 figs, 2 tables).

An abstract of this article will appear in a coming issue of ED.

Transients in Transistors, E. I. Adirovich, V. G. Kolotilova, B. V. Malin, (6 pp, 4 figs).

Contains a straightforward theory, leaning heavily on work by Schaffner and Suran (Journal of Applied Physics, 1953, 24, 11, 1355) and Shea (Principles of transistor circuits, New York, 1953). Of interest is the experimental results on several Russian transistors, uing a rectangular pulse of 1 ma amplitude and 10 microsecond duration at a repetition rate of 10 kc.

Frequency Characteristics of Germanium Junction Type Diode at Low A-C Voltages, S. G. Kalashnikov, N. A. Penin, K. V. Iakunina, (13 pgs, 11 figs, 3 tables).

Semiconductor diodes are presently used to rectify currents in many frequency ranges. The limiting frequencies at which a noticeable reduction in the rectification coefficient occurs vary from 10^2—10^3 to 10^{10}—10^{11} cycles, depending on the type of the diode, on the properties of the semiconductor, and on the operating conditions (silicon and germanium crystal detectors). An investigation of the causes of the frequency dependence of the rectified

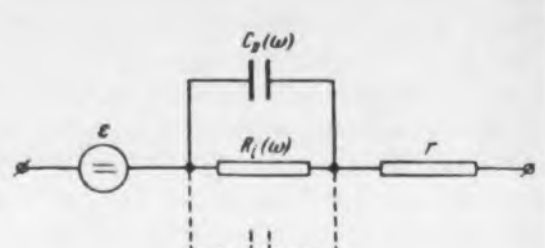


Fig. 3: Equivalent circuit of semiconductor diode, where the frequency-dependent component is much greater than the fixed component.

current in semiconductor diodes is therefore of great interest.

Figure 3 shows the equivalent circuit of the semiconductor diode where the frequency-dependent component $C_D(\omega)$ is much greater than the fixed component C. The frequency dependence is due first of all to the frequency dependence of the total impedance of the p-n junctions, owing first of all to the injection of carriers, and leading to the so-called diffusion junction capacitance C_D, and also due to displacement currents (intrinsic or charged capacitance C of the junction).

Figure 4 shows the circuit used to measure the rectified voltage at no load, while Figure 5 shows the bridge for measuring the total impedance of the diode.

The experiments have confirmed that the above equivalent circuit is valid for frequencies at least from 1 kc to 10 mc, and that the theoretical assumptions made on the basis of this circuit have been fairly well corroborated in practice.

Properties of Germanium Detectors with Fused Contact at Very High Frequencies, N. A. Penin, N. E. Skvortsova, (9 pgs, 10 figs).

Report on an experimental investigation of the capacity and resistance of the blocking layer of Germanium detectors with point contacts in the frequency range from 1,000 to 6,000 megacycles at various positive bias currents. It is found that the capacitance and resistance of the blocking layer vary in inverse proportion to the square root of the frequency. It has been established that the capacitance and conductivity of the blocking layer at very high frequencies varies linearly with the positive-bias current.

The data obtained are in good agreement with the diffusion theory of p-n junctions, taking the injection of unbalanced charged carries into account.

Investigation of Break-Down of Junction-Type Germanium Diodes, B. M. Vul, A. P. Shotov, (6 pgs, 6 figs).

Study of break-down of p-n junctions, prepared by the method of fusing Indium in n-Germanium and by the method of diffusing antimony in p-Germanium. It is established that in all the p-n junctions the break-down is of the electric type, due to

the shock ionization, provided the voltage is applied in the form of short pulses. If d-c voltage is applied, the break-down character is different, and may be electric, thermal, or thermoelectric, depending on the structure of the p-n junction and on the conditions under which the heat is carried away. In some transistors, the electric break-down data can be used to determine the coefficient of shock ionization. Reference is made to an article by S. L. Miller in *Physical Review* 1955, 99, 1234 and by McKay and McAfee, *Physical Review*, 91, 1079, 1953.

Surface Recombination and its Effect on the Characteristics of Semiconductor Devices, A. V. Rzhanov, (7 pgs, 3 figs, 1 table).

The speed of volume recombination of excess carries is one of the most important criteria of the quality of the material and of the degree of its suitability for the preparation of semiconductor devices for radio and other purposes. Surface recombination, unlike volume recombination, depends not only on the properties of the material, but also on the geometric parameters of the device and on the technological methods used in its manufacture. This article reports on investigations made in 1953–1954 in the Electrophysica Laboratory of the Physics Institute of the Academy of Sciences which show a very close relationship between the speed of surface recombination and the size of the surface potential barrier, and which emphasize the great importance of future research on methods of processing the semiconductor surfaces so as to insure sufficiently stable surface potential barriers of the desired height.

Investigation of Rectifying Properties of Point-Contact Germanium Diodes, K. B. Tolpygo, V. A. Fomenko, (13 pgs, 8 figs, 2 tables).

Derives the theory of the p-n junctions for hemispherical contacts and compares the results with those obtained for junction-type diodes. The experimental procedure is described and it is established that diodes with high values of inverse current and resistance are obtained using high-resistivity Germanium ($\rho = 25$–20 ohm-centimeter) by using strong electric forming. However, the transfer characteristic of such diodes are poor, and diodes with higher detection efficiency at low voltage and with good transfer characteristics are obtained using low-resistivity germanium (2–4 ohm cm) and weak forming (forming current of 0.2 amp).

Good agreement with theory was obtained for saturation currents at room temperature, and also for the temperature dependence of the parameters of diodes made of high-resistivity germanium. The theory does not explain, however, the noticeable reduction in temperature coefficients of the parameter at temperatures of 0–100 C in the case of diodes made of low-resistivity Germanium. A good qualitative and quantitative agreement was obtained for the current-voltage characteristic above 100 mv (up to 1–2 volts) as predicted by the theory.

Other articles of interest in this Issue:

Electrochemical Method of Improving the Quality of the p-n Junction in a Selenium Rectifier Cell, L. Iu. Belenkova, I. Kh. Geller, D. N. Nasledov, F. M. Tartakovskaia, (6 pgs, 4 figs).

Photo-Electronics of Organic Compounds, A. N. Terenin, (8 pgs, 2 figs);

New Views on the Mechanism of Photo Conductivity and Phosphorescence, N. A. Tolstoi, (9 pgs, 5 figs);

Volume Photoelectric EMF in Semiconductors, V. E. Lashkarev and V. A. Romanov, (3 pgs, 1 fig, 1 table);

Magnetic Viscosity of Nickel-Zinc Ferrites, I. A. Lednev, R. V. Telesnin, (7 pgs, 9 figs);

Effectiveness and Characteristics of p-n Junction Photocell, V. S. Vavilov, L. S. Smirnov, (8 pgs, 9 figs);

Spectral Distribution of the Internal Photoeffect in Several Systems of Sulfides, Selenides, and Tellurides, N. A. Goriunova, B. T. Kolomiets, (7 pgs, 16 figs);

Internal Photoelectric Effect in Semicrystalline Cadmium Sulfide, B. T. Kolomiets, A. O. Olesk, S. G. Pratusevich, (5 pgs, 6 figs);

Features of the Long-Time Components of Photoconductivity of Cuprous Oxide, Iu. I. Gritsenko, V. E. Lashkarev, (7 pgs, 4 figs);

Photoresistors of Cadmium Selenide, B. T. Kolomiets, S. G. Pratusevich, (3 pgs, 3 figs).

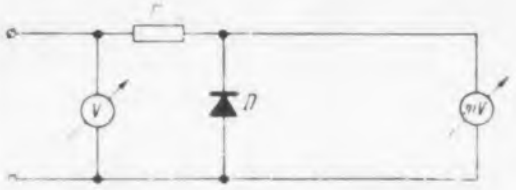


Fig. 4: Circuit used to measure the rectified diode voltage at no load.

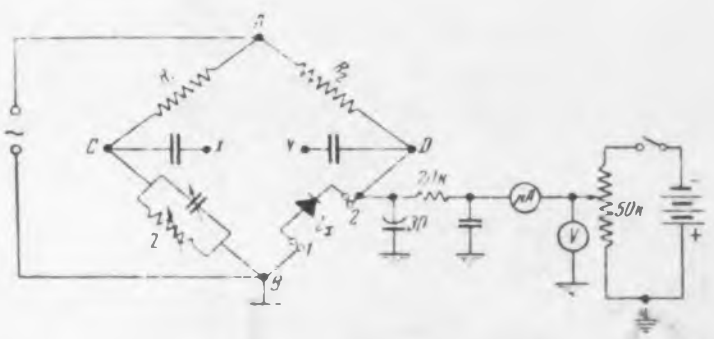


Fig. 5: Bridge for measuring the total impedance of the diode.

Abstract—German

A New Photocell For Infra-Red

E. Brenner

THE conventional photocell for the red region of the visible spectrum uses a Caesium cathode. Above wavelengths of about 1.2 microns (μ) the spectral sensitivity of such cathodes virtually vanishes. A lead-sulphide photoconductor has been developed for use in the infrared region of the spectrum. The type *61SV* photocell (Valve Corp., Hamburg) uses a lead sulphide semiconductor whose resistance, in the presence of infrared radiation is proportional to the intensity of the radiation. Comparative spectral sensitivity for lead-sulphide and Caesium-Silver-Oxide are shown in Fig. 1.

For applications (measurements, relay activation, etc.) a dc potential is applied to the tube through a load resistor (R_L in Fig. 2). When the intensity of the incident radiation varies, then the resistance variation produces proportional voltage variations across the load resistor; these signals can then be amplified as with conventional phototubes.

A material difference between vacuum phototubes and the photoconductor cell lies in the fact that in the latter the output signal is linearly related to the supply voltage at constant illumination. Within the operating range, the photoconductor acts as a linear resistance.

Exactly as for phototubes, the sensitivity of photoconductors is specified in μa per lumen. With 200 v applied to the cell and an incident radiation of 0.05 lumen on the effective area, the rating is $N = 3.5$ ma/lumen at a source color temperature of 2700 K. This rating corresponds to about 150 times the rating of a vacuum phototube with emitting cathode at the same wavelength.

In Fig. 2 the linear characteristics with the radiated power are shown up to 0.05 lumen. For supply voltages of 100 v and 250 v several typical load lines are shown. The effective area illuminated was 6 x 6 mm.

An important characteristic of the infrared sensitive device is temperature dependence. Fig. 3 shows a curve which describes this property. The graph shows relative rms output voltage (normalized with respect to output at 200 C as a function of source temperature. For the test the cell is illuminated through a rotating disk which has holes punched in it.

The sensitivity is also a function of the ambient temperature. With a black source at 200 C sensitivity, N between −10 and +50 C, is approximated by the formula

$$N = N_r\,(1.4 - t/50)$$

where N_r is the sensitivity at room temperature (20 C) and t is the ambient temperature in degrees C. High ambient temperatures result in greatly reduced sensitivity, hence artificial cooling is often required. *Abstracted from an article by E. Suchel,* Electronische Rundschau, *Nov. 1956, pg. 296.*

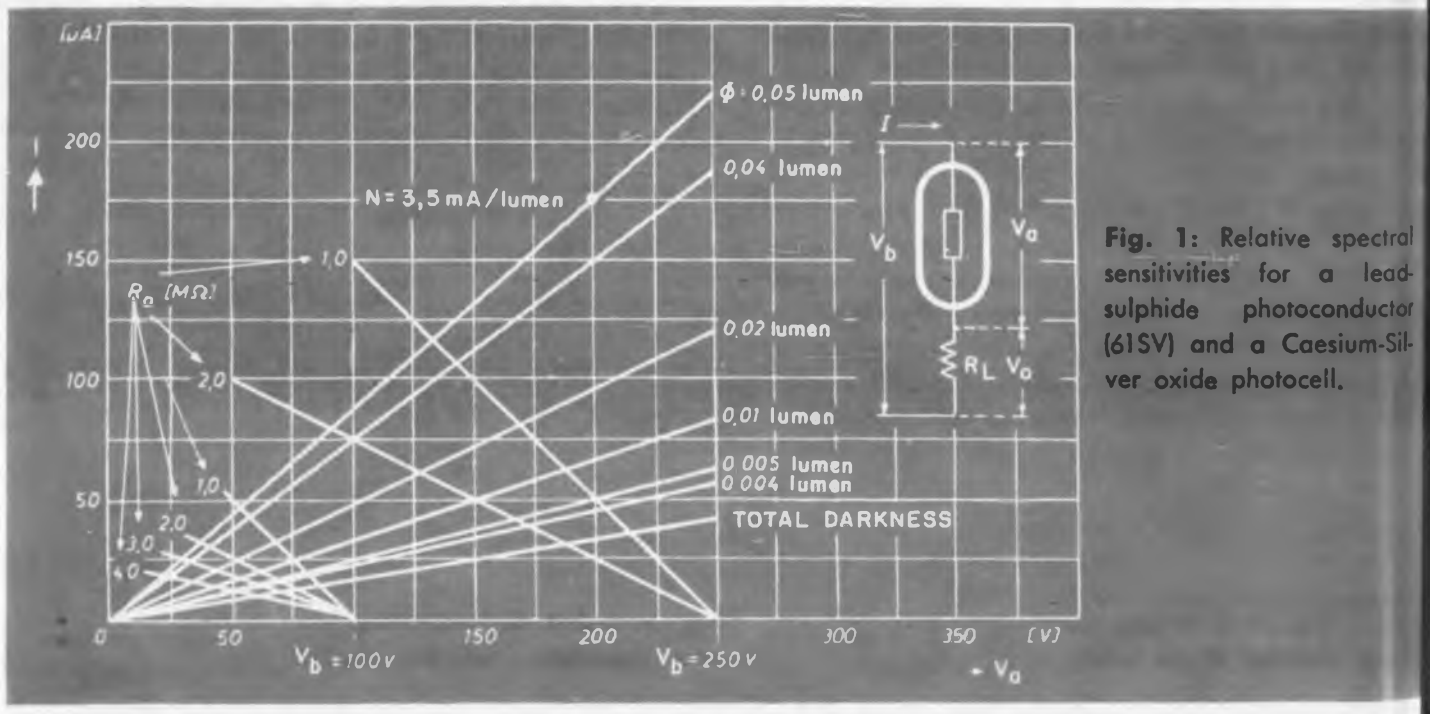


Fig. 1: Relative spectral sensitivities for a lead-sulphide photoconductor (61SV) and a Caesium-Silver oxide photocell.

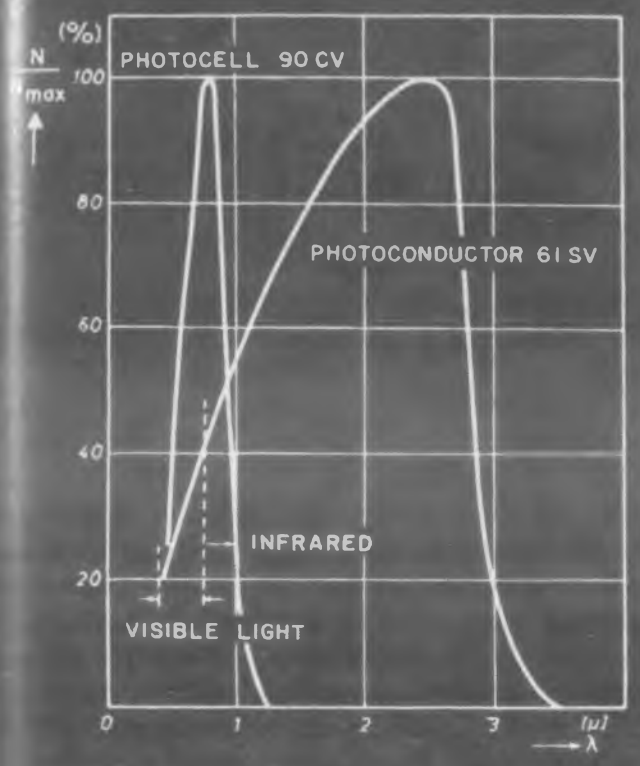


Fig. 2: Characteristics of the 61SV with constant incident power.

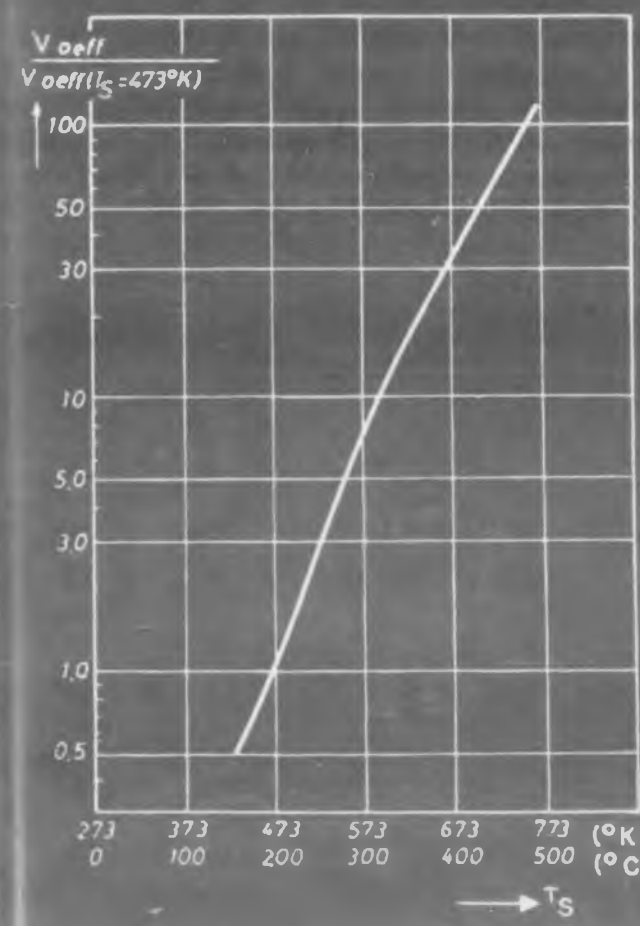


Fig. 3: Relative sensitivity as a function of temperature.

Abstract—German

Ionization Chamber

TO OBTAIN time delays of more than about three minutes, the ordinary R-C circuit is not suitable. Precision potentiometers above about 10 megohms and reasonably large capacitors above 20 μf with dielectrics for the required voltages are not available. The conventional time delay relay circuit which employs a cold cathode triode as shown in Fig. 1, is restricted to delays ranging from fractions of seconds to about three minutes, if the box marked R is an ordinary resistance.

If the resistance R in Fig. 1 is replaced by an appropriately designed ionization chamber then time delays up to several hours are possible with a rather small capacitance. Such an ionization chamber usually consists of two parallel plates. On one plate a radiator such as a Radium mixture is mounted. Alpha rays ionize gases with sufficient intensity so that usable currents can be obtained. In the presence of about 10^{-5} gms of radium about 10^{-8} amp can be obtained with a chamber potential of 100 v.

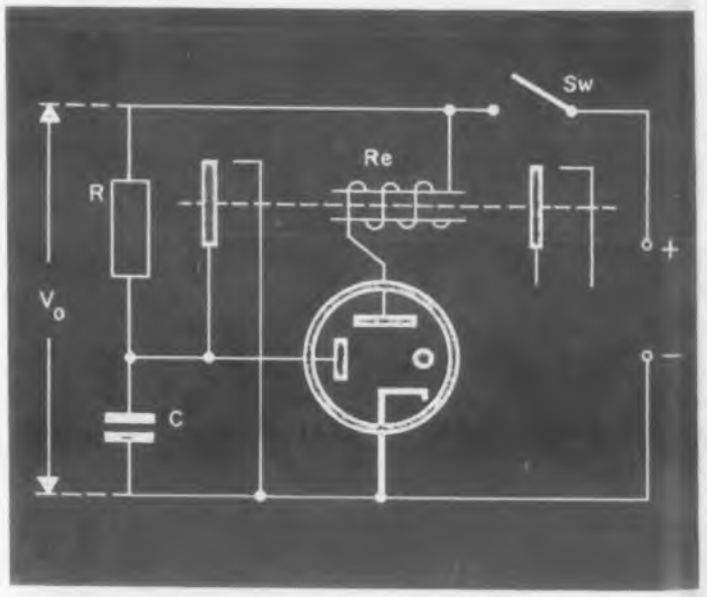


Fig. 1: Basic circuit of time-delay relay with cold-cathode triode. The usual resistance R can be replaced with an ionization chamber.

Time Delay Relay

E. Brenner

The alpha rays ionize the air so that conduction takes place. The current which is collected depends on the applied potential and the spacing of the plates. As spacing is increased a maximum is reached as shown in Fig. 2. Similar behavior is noted if the gas pressure in the chamber is varied. The effect of temperature, which is slight, as well as the effect of humidity can be compensated by pressure adjustment.

The ionization chamber exhibits a saturation phenomenon; beyond a critical voltage the current is independent of potential. This is a distinct advantage since a 10 percent fluctuation of supply voltage produces timing errors of about 15 percent in RC circuits while the corresponding error with the ionization chamber is less than 3 percent. Commercial time delay relays in the 20-30 min. ranges, made by Elesta A. G., Bad Ragaz, are cited as examples of application of the ionization chamber. *Abstracted from an article by H. Jucker,* Electronische Rundschau, *vol. 11, no. 1, Jan. 1957, pg. 13.*

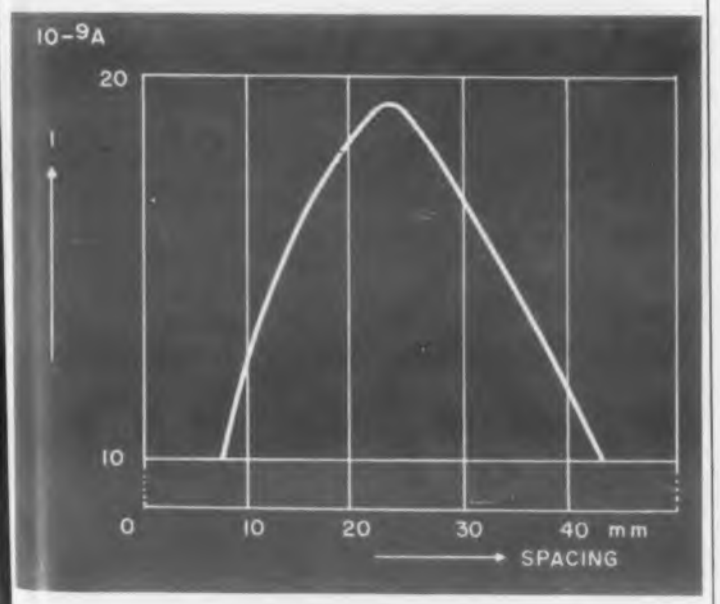


Fig. 2: Ionization current as a function of electrode spacing. A maximum spacing can clearly be reached.

Abstracts

Transistors In A Reactor Field

TRANSISTORIZED electronic equipment designed for use in the presence of the full fission spectrum of a nuclear reactor should take into account the following effects of the field: *1.* transient effects due to flux density—mostly noise—and gamma heating, *2.* semipermanent effects due to integrated flux, and *3.* permanent effects remaining after annealing.

To test these effects during in-pile operation a transistorized crystal video set, consisting of a silicon crystal detector and a 2-stage germanium transistor amplifier, was used. It was found that a noise effect was present while the device was in a flux field above that which was provided by integrated flux. Annealing the transistors after irradiation generally tended to improve the operation. In cases such as gain, however, this was not always true. Tentative limits for flux density and total integrated flux for no appreciable degradation in the operation of the crystal video receiver of 10^8 nv and 10^{13} nvt, respectively, may be chosen. Fig. 1 shows that in the 2-stage receiver amplifier an appreciable increase in noise voltage and reduction in gain appears just one order of magnitude of time-integrated flux higher.

It was noted that I_{co} was higher while transistors were in the flux field and recovered somewhat when removed. The change in temperature due to gamma heating was not sufficient to account for the change in I_{co}, and the latter may be due in part to the production of hole and electron pairs by the gamma flux. *Abstracted from* Dynamic Effects of a Nuclear Reactor Field *Upon Transistors, a paper by R. L. Riddle, presented at the Symposium on Nuclear Radiation Effects on Semiconductor Devices and Materials, sponsored by the Working Group on Semiconductor Devices, Office of the Asst. Secretary of Defense, Research Development, February 1957.*

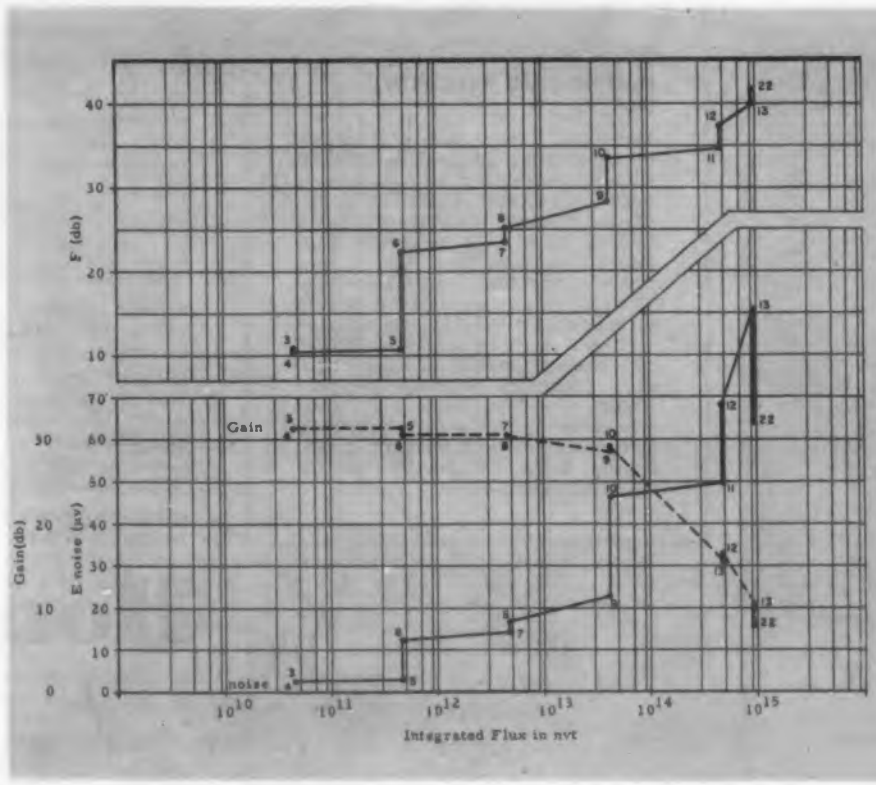


Fig. 1. Transistor amplifier parameters. Upper curve is the noise figure. Lower curves represent gain and noise voltage measured against total time-integrated flux.

Transistorized Phase Discriminator

USING recent, randomly selected silicon junction transistors, a phase discriminator with high sensitivity and temperature stability was designed. Operation between 125 C and —55 C was tested, and a reasonably flat power gain of 25 db over the entire range noted.

Former attempts at phase discriminator design using germanium transistors were unsuccessful due to the adverse sensitivity of the transistors to temperature variation. Subsequent developments in silicon transistors led to the design of this unit, which was proved to be stable with respect to temperature. The transistors used were npn silicon junction; the diodes, shown in Fig. 1, were also silicon junction types.

This full-wave discriminator uses a phase reversible signal source coupled by a transformer with a voltage stepdown ratio of about 12 to 1 on each side of the center-tapped secondary. For most efficient operation with the 3 terminal or split-load shown in Fig. 1, it is essential that the input signal be in phase or 180 deg out of phase with the power supply, and at the same frequency. If this is not the case current will flow in both arms of the load simultaneously, reducing the current differential. Conversion of the full wave discriminator with a 3 terminal load to a 2 terminal load results in a considerable loss of useful power due to bleeder resistors which dissipate five-sixths of the total power output. A respectable useful power, however, can be obtained depending upon the maximum ratings of the transistors. The way the transistors operate in the full wave circuitry permits power outputs much greater than the maximum effective power dissipated in each.

This discriminator will produce a phase sensitive dc output capable of driving a magnetic amplifier or energizing relays, heating coils and hydraulic valves, for aircraft applications. *Abstracted by Sol Prensky from* Transistorized Phase Discriminators *by A. N. DeSautels, a paper presented at the AIEE Winter General Meeting, January 1957.*

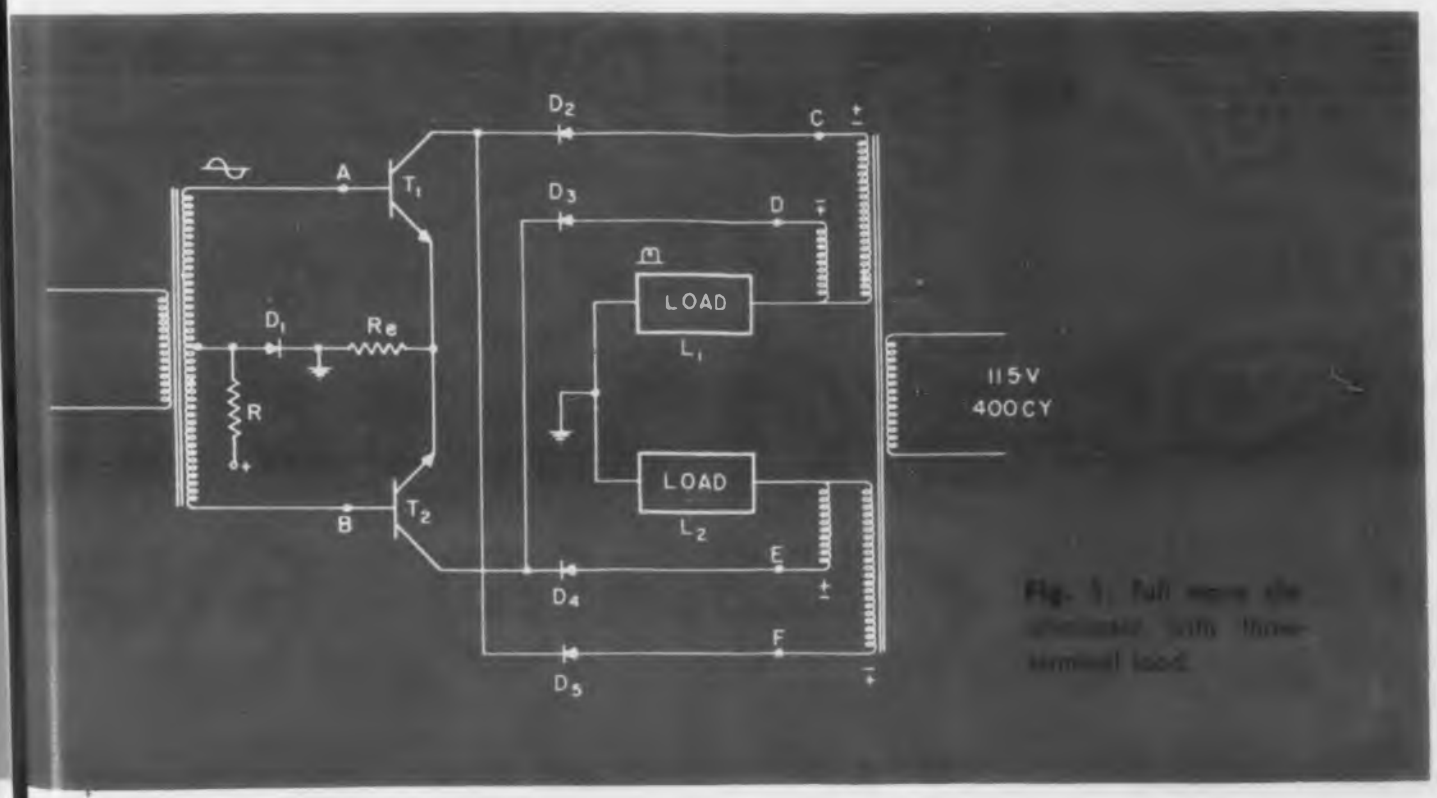


Fig. 1. Full wave discriminator with three-terminal load

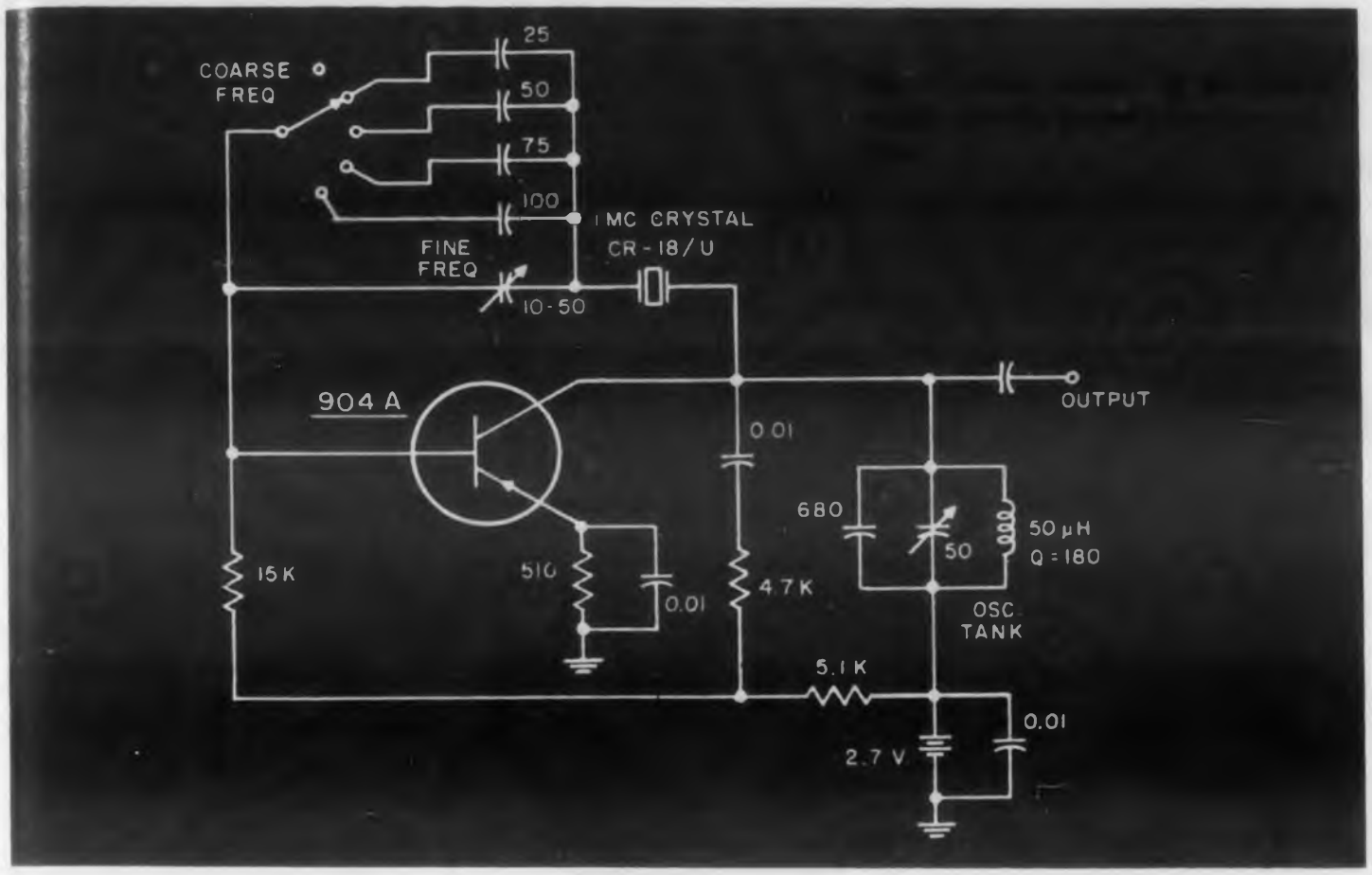
Abstract

REQUIRING only periodic connection to a commercial power line, this compact frequency standard may prove valuable for airborne use and in other cases where a stable but portable frequency source is required.

The principle of the latent-heat stabilization method for controlling enclosed-space temperature is applied in this unit. Using diphenyl at its 70 C double-point—the temperature where it exists as a mixture of solid and liquid—a temperature stability of a few hundredths of a deg C is obtained. The oscillator stability is ± 1 part in 10^7 over a period of several hours.

The apparatus consists of a transistor crystal-controlled oscillator and a two stage transistor buffer amplifier shown in Fig. 1 and 2, which are operated continuously from four small mercury cells contained in the bottom compartment of the standard. All components of the circuit are enclosed in the diphenyl oven which maintains them at a constant temperature.

Surrounding the diphenyl is an electric heating coil controlled by a microswitch. When the diphenyl is heated it increases in volume and presses against the bottom of bellows located in the inner compartment. This movement of the bellows closes the microswitch and opens the heater circuit. The heat can be adjusted to operate at varying degrees of temperature by a shaft which controls the height of the upper contact point of the microswitch. Heat losses from the oven are reduced by a heat radiation shield and a vacuum insulation space.

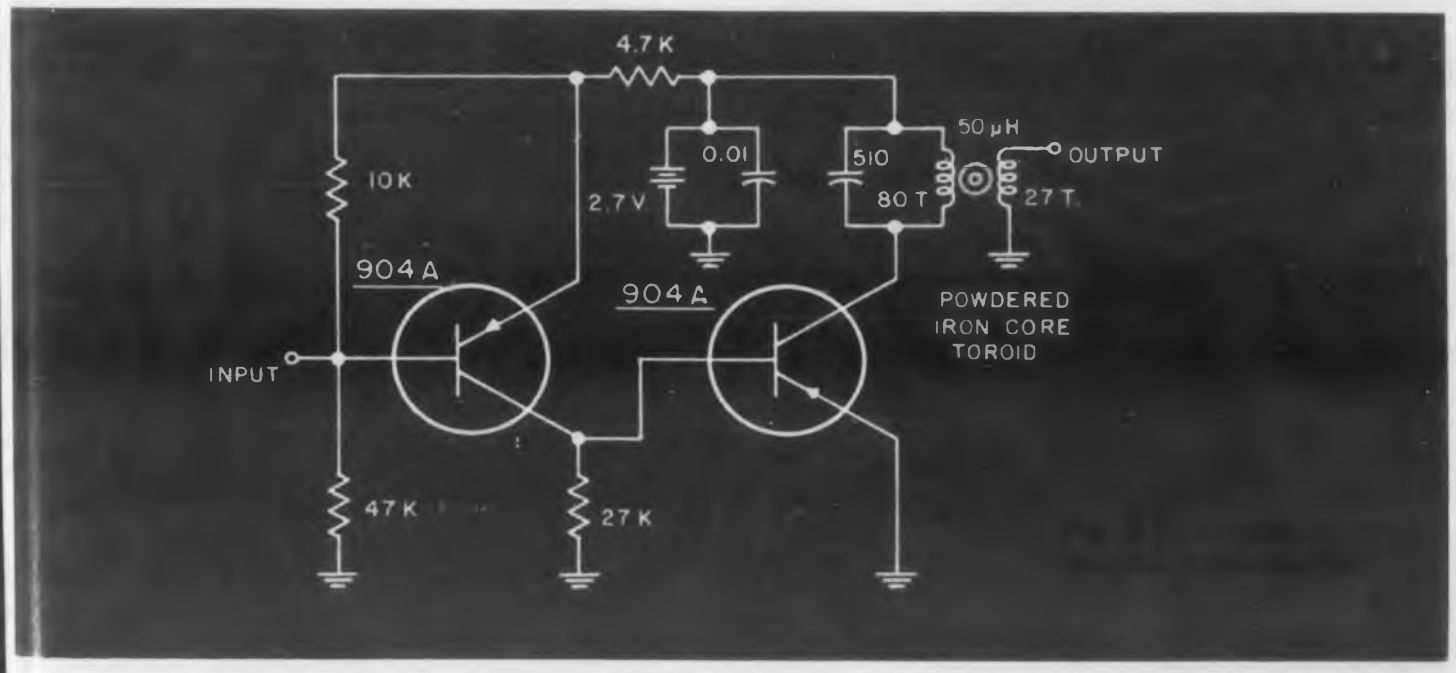


After the oven temperature has been stabilized at the double-point temperature of the diphenyl, the unit may be disconnected from the power source which supplied the initial heat, and operated for several hours on temperature without external power connections.

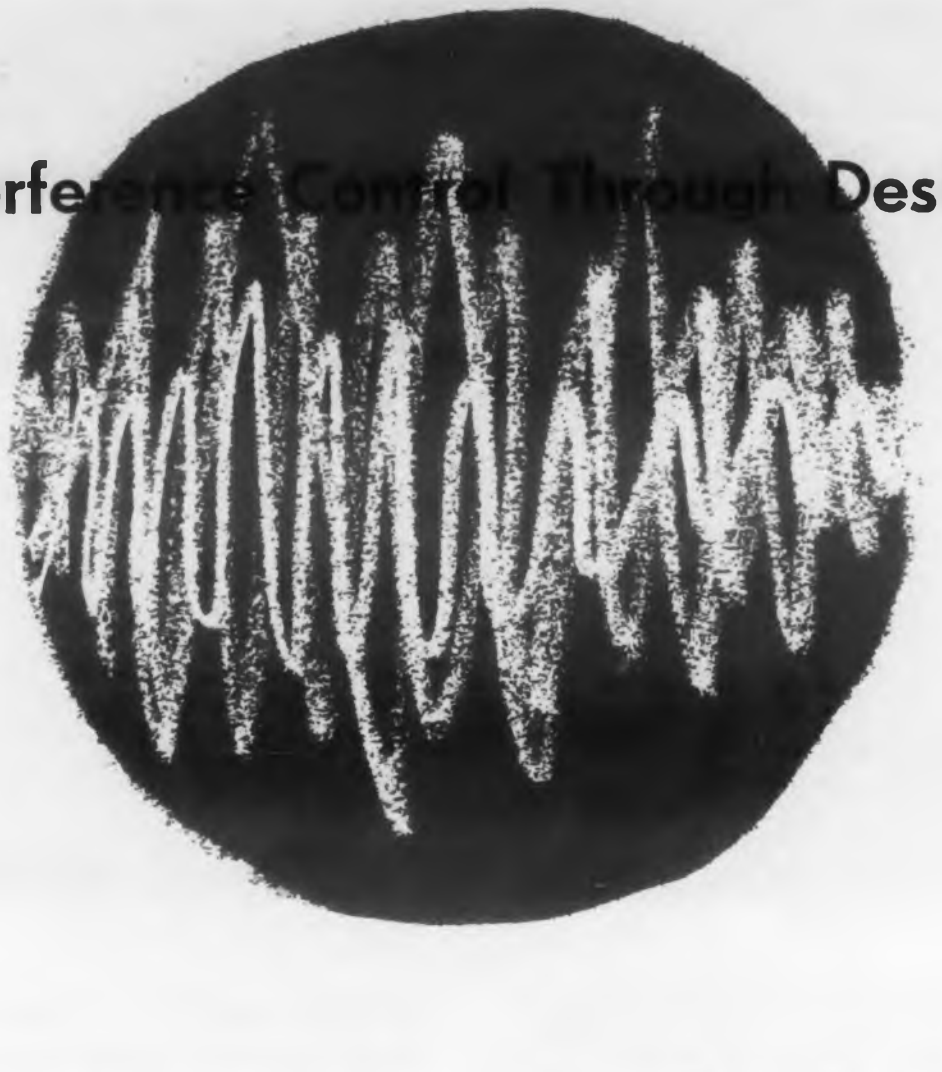
External coarse and fine frequency controls are provided on the developmental model to adjust the oscillator frequency. The oscillator tank capacitor can also be adjusted for best output voltage; and the oven temperature can be varied. An inexpensive, commercial 1 mc quartz crystal is used to control the frequency of the oscillator. The output voltage is about 400 mv into a 600 ohm load.

Silicon junction transistors were chosen for the oscillator and amplifier because of their ability to operate at temperatures up to 150 C, whereas germanium transistors cease operation around 80 C. The overall efficiency of the oscillator and amplifier is around 78 per cent since the input power from mercury cells is 7 mw and matched load output power is 5.4 mw.

Abstracted from an NBS Summary Technical Report Portable Frequency Standard, *March 1957.*



Interference Control Through Design



GREATER reliability, improved performance, longer life and less maintenance for any given piece of equipment will result from interference-free design. From a cost point of view, the price of applying filters, capacitors, compressors, and other interference suppression devices is substantially higher than the cost of the time expended in designing the equipment to be interference-free.

Consider a hypothetical communications transmitter. It is required to cover a specific frequency range and to deliver a specified amount of rf power to an antenna. There are size and weight limitations placed upon the complete unit, and it should not require more than so many of ac input power.

The job of designing this transmitter is given to an engineer who elects to use tubes in the final amplifier that require forced air-cooling. To reduce the number of frequency multiplying stages, he also decides to triple in the final rf stage, and to work all preceding multiplying stages to their maximum power limits. To reduce the size and weight of the power supply unit, he uses tubes all of the same heater voltage—which is a good idea—but he grounds one side of the heater winding of the power transformer and runs a single lead to all tubes in the transmitter. The effective forced air-cooling of the final amplifier tubes requires a minimum of air-flow. The space available in the transmitter for a blower is so small that only a small high-speed blower can be used. The speed of the blower is over 10,000 rpm, and the motor is of necessity of the ac/dc universal type with brushes and a commutator. The design of this transmitter is now frozen.

Attempts are made to suppress the interference. A filter is placed in the input power line adjacent to the terminal board. In an effort to reduce the radiation of crystal harmonics from the antenna, a band reject filter tuned to one-third the transmitter output frequency is placed in the final amplifier tank circuit. The blower motor creates such a high level of interference that the power line filter is ineffective. An attempt is made to insert another filter in the leads of the blower motor, and the only kind that fits in the space available is one that uses metallized capacitors which, in themselves, have been found a source of interference.

Because of keying in the stage following the crystal oscillator, and because of radiation of rf power under key-up conditions, break-in operation of the transmitter is impossible. The frequency multiplying stages generate numerous harmonics, and the filter in the final tank circuit is not fully effective. In short the transmitter is highly unsatisfactory.

This case does not seem to be a serious exaggeration of the difficulties that could be presented in the production of such a transmitter. Designwise the engineer could have done a number of things

to correct these problems before their inception. He could have included more low-level frequency multiplying stages so that tripling in the final would be unnecessary. He could have used twisted-pair filament leads to cancel the inductive fields. Compartmentizing low power stages providing effective shielding isolation between stages in the common filament bias and plate supply leads would have helped appreciably. If forced air-cooled tubes were required, enough space should have been allowed near the tubes for adequate ac induction-motor driven blower to supply cooling air.

In order to further reduce the harmonic and spurious frequency content of the transmitter output, each stage succeeding the oscillator should be tuned. Parallel tuning, or pi-network coupling is preferable from an interference point of view since it minimizes the transfer of off-frequency signals. Over-driving low power stages will cause them to produce undesired harmonics, so it is necessary that the transmitter design include enough low-power stages, operating well within their ratings.

Other factors that are simply good engineering practice but which are often neglected include making the cabinet or case an effective shield, and routing the internal leads within the chassis. Once a transmitter case has been incorrectly designed, usually no amount of patching up will make it an effective shield. Inside, laced cables look fine, but tying low-level and high-level r-f leads together can cause many spurious radiations in a transmitter output. Low-level leads should not be laced into cables, but should be run direct, and in many instances shielded. Both ends of the shielding may be grounded. Leads that do not terminate in a unit should not be routed through it, where they could transmit interference either into or out of the unit.

If undesired, frequencies are eliminated in the low-power stages of a transmitter, the design of the final amplifier stage and antenna coupling units will be greatly simplified, because then their only functions will be to amplify a given frequency and transfer it into the antenna.

A naval laboratory, recently commenting on interference says engineering designs for radars in current use do not fully exploit known techniques for: the reduction of interference from high-power modulators; the limitation of pulsed rf radiation spectrum to minimum bandwidth, including the reduction of harmonic radiation, and the rejection of spurious responses in the radar receivers, which may be traced to lack of adequate rf preselection as well as inadequate rf shielding and decoupling.

Abstracted from a paper, The Control of Interference Through Basic Design, *L. W. Thomas, Bureau of Ships, Department of the Navy, presented at the ARF Third Conference on Radio Interference Reduction, February 1957.*

Abstract

Microwave N

A GOOD quality noise source useful for radar jamming, and producing signal strengths of the order of 1μw per mc over several hundred mc in the 3 to 4 kmc range was designed. There is no repetitive component; the signal is random. The source does not have any severe sputtering limitation on tube life since no electrodes are used.

Using rare gas excitation, this high power cw r-f discharge noise source generally has less efficiency than dc arc discharge sources, squegging oscillators or rotating commutator types, but the advantages gained through randomness of signal and lengthier tube life are believed to make use of the method worthwhile. In the design of this equipment a gaseous discharge was produced in a quartz tube inserted into a wave guide and excited by microwave power at approximately 1850 mc. The gases used for experiment were helium, neon, argon and xenon; pressures ranged from 0.05 to 5 mm Hg. Driving power up to 300 w was applied and a steady state glow discharge resulted.

Measuring equipment was set up to test the equipment as shown in Fig. 1. A fairly bulky set-up, the operational device would of course be smaller, the only sizable component being the r-f driving source. The results of measurements showed that noise output was not significantly dependent on the type of gas used, but that it was dependent on pressure, being maximum at low pressure near the limit of a stable discharge. Such limiting pressure discharges were characterized by two properties–the mean free path for electron-atom collisions became comparable with the mean free path for electron-wall collisions; and the ionization became sufficient to make electron-electron and electron-ion collisions important.

While 1 μw per mc–83 db above room kT—over a 200 mc band in the S-band region was obtained using a well-filtered 1 kw cw magnetron, broadband noise of the same strength and roughly flat over a range from 3 to 4 kmc was obtained when the drive was not filtered in the S-band.

Noise Generation

For testing and measuring purposes the filter was necessary since there is a strong fm component as well as extraneous cw power in the output of the magnetron, and it was desired to measure only the noise originating in the discharge tube.

Effective electron temperatures measured by probes were found to be as high as 35 ev; the highest measured electron densities at the center plane of the tube were about 10^{12} per cm^3 corresponding to 0.03 per cent ionization. Densities were probably higher in the portion of the tube nearest the driving power input. *Abstracted from Noise Generation In High-Power Microwave Gas Discharges. Roger C. Jones and Walter J. Graham, OTS PB 121338 U.S. Dept. of Commerce, Wash. 25, D.C.*

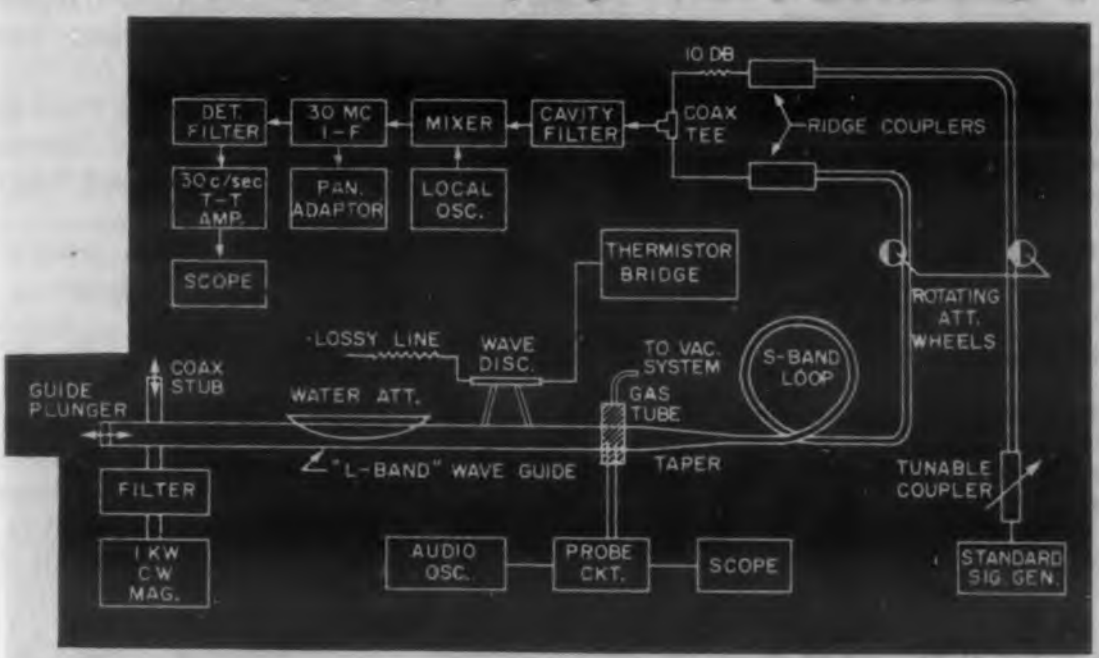


Fig. 1. Block diagram of experimental equipment. The set-up consists of the rf driving source and filters, experimental tubes, microwave radiometer, and the vacuum system and gas supply.

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Standards and Specs

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Connectors

MIL-C-25516(USAF), CONNECTORS, ELECTRICAL, MINIATURE, SHIELDED OR UNSHIELDED, ENVIRONMENTAL RESISTANT TYPE, GENERAL SPECIFICATION FOR, 26 NOVEMBER 1956

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RETMA Standards Proposals

The following RETMA Standards Proposals are being circulated for comment. Although the official comment period may have expired, you are encouraged to contact the Radio-Electronics-Television Manufacturers Association Engineering Department, 11 West 42nd Street, New York 36, N.Y., if you are vitally interested in any proposal.

S.P. 531, RADIATION RATING OF TELEVISION AND F.M. BROADCAST RECEIVERS, RETMA standard REC-129-D (Rescission of)

S.P. 532, POLARIZED DRY ELECTROLYTIC CAPACITORS FOR GENERAL USE, RETMA standards RS-154 (Additions)

S.P. 533, TERMINATING AND SIGNALING EQUIPMENT FOR MICROWAVE COMMUNICATIONS SYSTEM:- PART I, RETMA Standards Proposal S.P. 51[illegible] (Revision)

S.P. 534, ELECTRON TUBE BASES, CAPS AND TERMINALS, RETMA Standard ET-103D, (Revision)

Resistors

MIL-R-11B, RESISTORS, FIXED, COMPOSITION (INSULATED), AMENDMENT 1, 14 DECEMBER 1956 . . . The marking and workmanship test, previously listed in Group B acceptance tests are now included in the Group A tests, where they are spelled out with their defect classifications. The voltage coefficient, dielectric strength, terminal strength and effect of soldering test have been changed from Group B to Group C, and are to be performed monthly. The balance of the Group C tests, previously specified on a quarterly basis are now to be performed semi-annually.

ransformers

ETMA RS-183, Output Transformers for Radio Broadcast Receivers, March 1957

Minimum mechanical and electrical requirements o be included in purchase specs are covered by this tandard. Also included are definitions and various ethods of testing and measuring output trans- ormers. Copies of this standard are available for 5 cents from Radio-Electronics-Television Manu- acturers Association, 11 West 42nd Street, New ork 36, N.Y.

ETMA RS-181, Iron Core Charging Inductors, arch 1957

This standard covers iron core charging reactors r use in radar transmitters and similar equipment here long life, reliability, and continuity of opera- ion is essential. A charging inductor is an inductor laced in the charging circuit of a pulse-forming etwork. This standard, developed from Standards roposal 514, is a revision of TR-127. Copies of this tandard are available from RETMA, 11 West 42nd treet, New York 36, N.Y. for 60 cents per copy.

IL-T-27A, Transformers and Inductors (Audio, ower, and Pulse), Supplement 1C, 17 December 56

This supplement lists 34 Military Standards which e now a part of the spec.

ETMA

ETEC PUBLICATION No. 2A, Basing Diagrams or Electron Tubes

This second addendum lists those tube types gistered during 1956 with the new basing dia- ams. Copies of this publication are available from e RETMA Engineering Office, 11 West 42nd reet, New York 36, N.Y., for $1.00 per copy.

R-135, Electrical Performance Standards onochrome Television Studio Facilities

A new resolution chart is being circulated by ETMA as part of Standards Proposal 536. This art will be incorporated in the revised standard ith the material previously issued and approved Standards proposal 475.

ductors

ETMA RS-175, Audio Inductors, December 1956

Iron-core inductors which are employed for fre- uency discrimination elements or for filters other an power supply applications are covered by this andard. The frequency range of the inductors is t limited to the region of audio frequencies. This andard is a revision of TR-122. Copies of this andard are available from RETMA, 11 W. 42nd , New York 36, N.Y. for 50 cents each.

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ELECTRO-MECHANICAL ENGINEERS are constantly faced with the problems of capturing information from the various input devices and converting this information into a usable form for subsequent use in data-handling equipment.

ELECTRONIC ENGINEERS enjoy an unparalleled freedom in the development of new types of circuitry and components which are necessary to maintain leadership in the competitive field of record-keeping automation.

COMPUTER ENGINEERS backed by the company's computer research since 1938 are developing an economical, flexible digital computer to meet the requirements of all record-keeping applications.

GOING OUR WAY?

ENGINEERS and *PHYSICISTS* are going one direction at MOTOROLA . . . UP!

We, at Motorola, know where we're going—and we're confident about getting there. If you, too, believe there's plenty of room at the very top—why not join us? You'll be teaming up with men of vision in an organization that respects creativeness as well as hard work. We think you'll grow with the challenging assignments at Motorola—missile guidance, radar, microwave, and the many other pioneering projects.

Motorola's continuing expansion program offers excellent opportunity for advancement to match your abilities. But, just as important to an engineer or physicist, the daily challenge to the imagination will bring the strong sense of accomplishment you seek.

If you're an electrical engineer, mechanical engineer, or physicist (senior or junior level), and looking for more important assignments in:

CHICAGO, ILLINOIS

Two-Way Communications
- Receivers and Transmitters
- Power Supply
- Antenna design
- Systems Engineering
- Portable Communications Equipment

Microwave
- Pulse Circuit Design
- Systems Design
- Circuit Design

Field Engineers
- Microwave Maintenance
- Airborne Radar

Transistor Applications

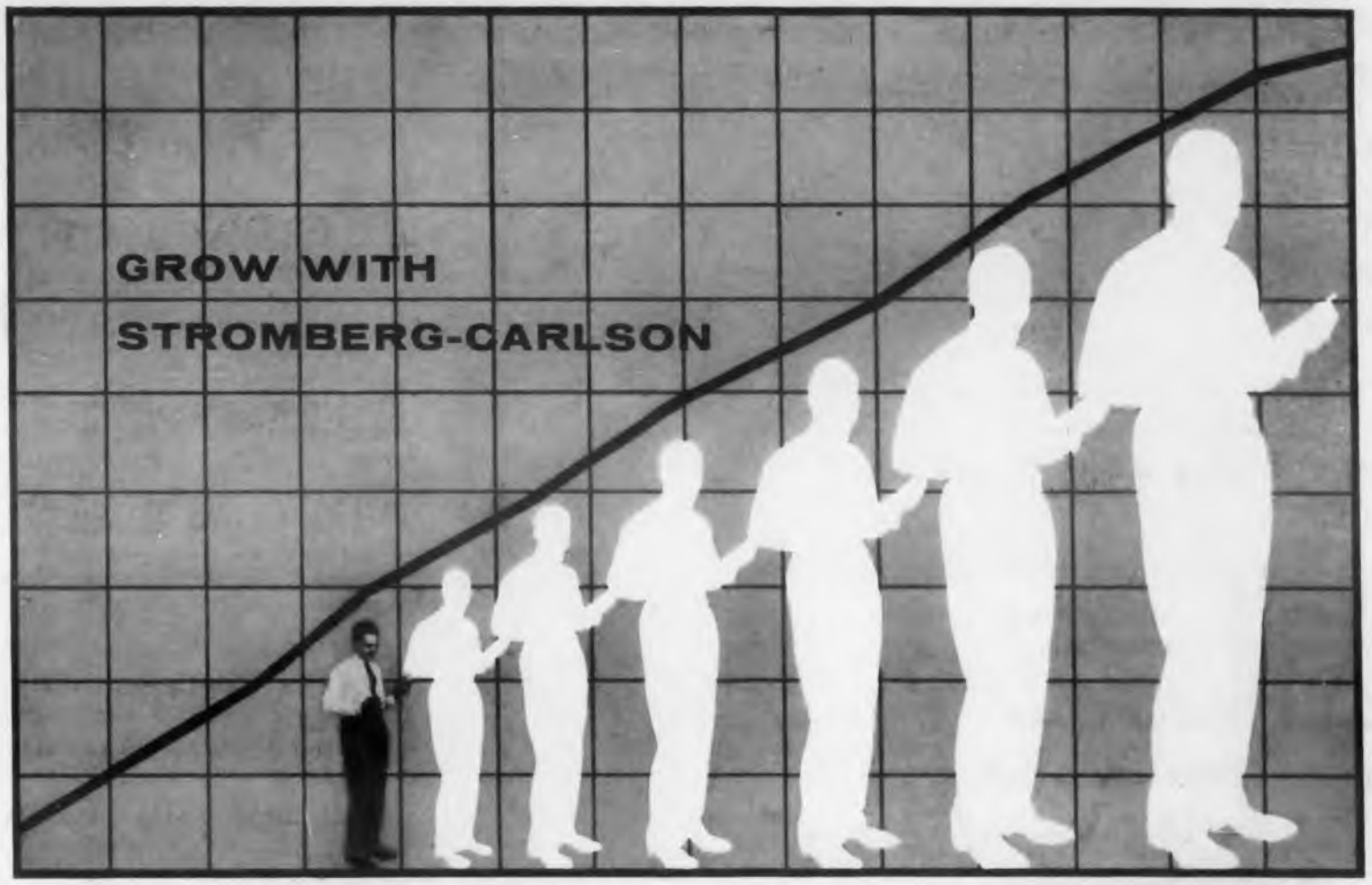
Radio Sales and Field Service Engineers

For Assignments with a FUTURE UNLIMITED write Dept. No.____

MOTOROLA, inc

Engineering Personnel Mgr., 4501 W. Augusta Blvd., Chicago 51, Illinois

CIRCLE 560 ON READER-SERVICE CARD FOR MORE INFORMATION



Electronics Engineers—

Chart your personal and professional growth with STROMBERG-CARLSON

Your growth curve in Stromberg-Carlson's booming Electronics Division goes steadily—and rapidly—upward. Here's why:

1. The company itself is one of the "hottest" in the electronics industry today.
2. Three-times expansion of the Electronics Division means rapid advancement for you right from the start.
3. Liberal management attitudes encourage your own initiative . . . your ideas don't get lost in the shuffle.

In addition to opportunities for personal and professional growth, we offer challenging, interesting work. Check this list of assignments to see where you fit best:

Components and Specifications	Field Engineering	Communication Systems
Countermeasures	Microwave Circuits	Missile Guidance Systems
Data Systems	Navigational Systems	Sales Engineering
Digital Techniques	Radar	Systems Test Equipment
	Transistor Engineering	Writers—Technical

Send your letter or resumé now to
R. W. HOLMES, Electronics Engineering

STROMBERG-CARLSON COMPANY
A DIVISION OF GENERAL DYNAMICS CORPORATION
52 Carlson Road, Rochester 3, N. Y.

ROCHESTER . . .
a great place to live

New Community War Memorial is the scene of major league sports, ice shows and other spectacles.

Nearby lakes provide outstanding facilities for boating, swimming, fishing and other water sports.

University of Rochester is among the country's finest institutions, as are the city's public and private primary secondary schools.

CIRCLE 561 ON READER-SERVICE CARD FOR MORE INFORMATION

ENGINEERS for GUIDANCE and NAVIGATION SYSTEMS

ZEST—

a level of enjoyment reached in the professional life of engineers participating in Sanders' forward-thinking environment.

Please address inquiries to D. H. Johnson

SANDERS ASSOCIATES, INC.
NASHUA NEW HAMPSHIRE

CIRCLE 562 ON READER-SERVICE CARD FOR MORE INFORMATION

Product Engineering
for ICBM and IRBM

ICBM and IRBM operational environments impose unusual product engineering requirements. Particularly, electronic systems must be packaged to withstand extremes of temperature and vibration. Advanced product engineering is required to assure the necessary high reliability levels. As a result, the general field of electronic packaging is an essential aspect of R-W's overall systems engineering and technical direction responsibility for the Air Force Ballistic Missile programs.

Major elements of this activity include structural analysis... shock and vibration... materials application... and mechanical and electronic component design. The responsibilities of the product engineering group include developing design criteria and investigating new packaging techniques.

Inquiries regarding these opportunities in product engineering at R-W are invited, and should be addressed to: Mr. W. J. Coster

The Ramo-Wooldridge Corporation
5730 ARBOR VITAE STREET • LOS ANGELES 45, CALIFORNIA

CIRCLE 564 ON READER-SERVICE CARD FOR MORE INFORMATION

AVIONICS OPPORTUNITIES
In Sunny, Tropical San Diego, California

SYSTEMS ENGINEERS	FOR **NEW** AIRBORNE NAVIGATIONAL SYSTEMS
SYSTEMS ANALYSTS (engineering and mathematics)	
CIRCUITRY DESIGN ENGINEERS	MISSILE GUIDANCE SYSTEMS
SERVO DESIGN ENGINEERS	
COMPONENT PACKAGING ENGINEERS (mechanical and electrical)	HELICOPTER INSTRUMENTATION
ETCHED CIRCUIT DRAFTSMEN	AIRCRAFT CONTROL SYSTEMS
MICROWAVE TECHNICIANS	

Work on these challenging projects at RYAN
Live in beautiful San Diego—a year-round playground

WRITE TO ENGINEERING PROFESSIONAL PLACEMENT

RYAN AERONAUTICAL COMPANY
2704 Harbor Drive, San Diego 12, California

CIRCLE 563 ON READER-SERVICE CARD FOR MORE INFORMATION

KENNETH STEPHANZ-Chief Engineer, Vacuum Tube Department: from B.E.E. at Ohio State in '48, has advanced at Federal from junior to chief engineer, is typical of career-minded Federal engineers.

Recognition, advancement, security and hard work

"In my nine years at Federal I think I have discovered the key to success — the right choice of company and hard work," says Ken Stephanz. "It takes an engineer and a company to make a career. You must know what you want to do, what direction you want to move in. Then you must answer a tough question . . . What company offers me greatest opportunity to develop my talents, to build a career and have a happy personal life? The rest is up to you. The rewards are great — recognition of your efforts and abilities, chance for advancement, and financial and job security.

"True, there are other considerations — location, work of your choice, living conditions, association with capable engineers, company prestige and growth potential. Engineers at Federal find that this company provides all these advantages. In fact, you will find that Federal, a member of the world-wide IT&T System, presents unusual opportunities for the ambitious engineer."

The markets for Federal's many products will keep the Company growing, assuring a bright future for Federal and its engineers. The broad scope of engineering projects opens to you a wide choice of assignment. When you join Federal you join a stable, dynamic organization, a leader in the electronics industry.

Join the IT&T Team

For information of engineering opportunities and assignments write to Mr. J. Connington, Technical Placement Director.

Federal Telephone and Radio Company

A DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

100 Kingsland Road, Nutley, New Jersey

CIRCLE 565 ON READER-SERVICE CARD FOR MORE INFORMATION

ADVERTISING INDEX

May 15, 1957

☐ I do no design work

...and Title

(Print or type all information)

...ny

...ny Address

...nge of Address: Old Company Name

...mpany Address | City | Zone | State

10	20	30	40	50	60	70	80	90	300	310	320	330	340	350	360	370	380	390
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19	229	239	249	259	269	279	289	299	509	519	529	539	549	559	569	579	589	599

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HOME ADDRESS | City | Zone | State

(Use before June 30th, 1957) ☐ I do no design work

Name and Title

(Print or type all information)

Company

Company Address

For Change of Address: Old Company Name

Old Company Address City Zone State

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ELECTRONIC DESIGN

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New York 21, N. Y.

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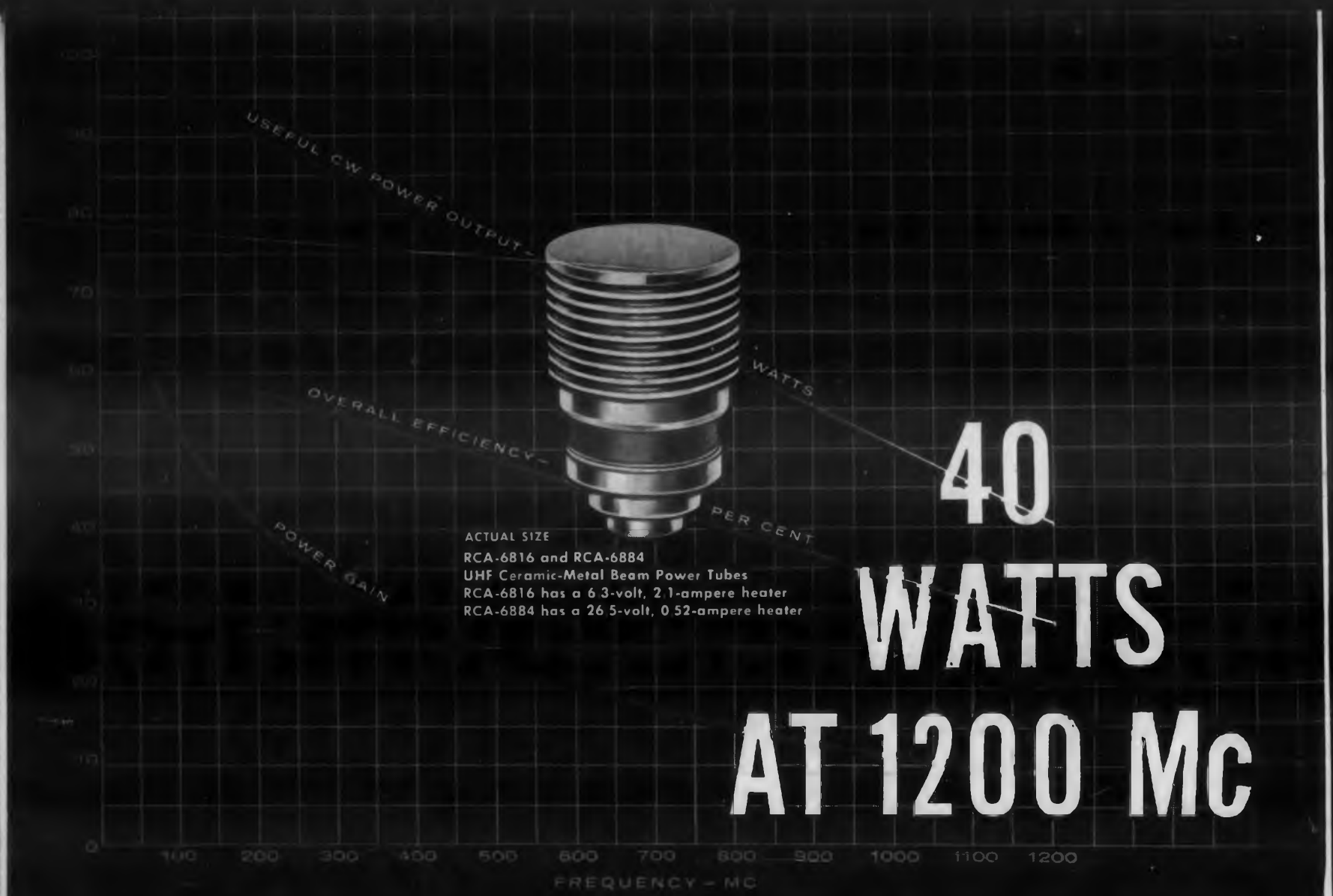


ACTUAL SIZE

RCA-6816 and RCA-6884
UHF Ceramic-Metal Beam Power Tubes
RCA-6816 has a 6.3-volt, 2.1-ampere heater
RCA-6884 has a 26.5-volt, 0.52-ampere heater

40 WATTS AT 1200 Mc

For extremely compact and efficient UHF transmitter designs... RCA-6816 and RCA-6884, small-size, light-weight Ceramic-Metal beam power tubes have high power sensitivity and high efficiency at relatively low plate voltage.

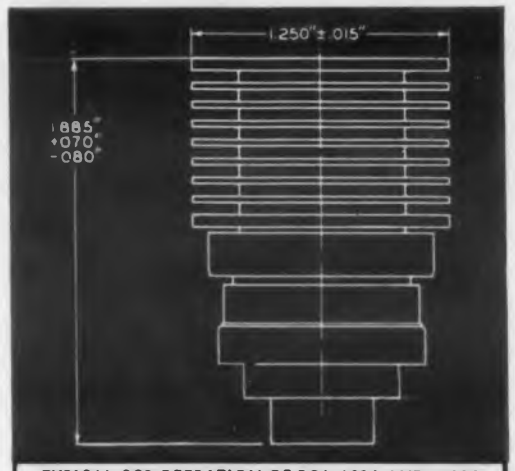
These tubes feature low-inductance rf electrode terminals—*insulated from each other by low-loss, high-strength ceramic bushings*—are particularly well-suited for UHF oscillator, frequency multiplier, and power amplifier applications.

Technical bulletin on the RCA-6816 and RCA-6884 is available from RCA Commercial Engineering, Section E-18 Q2, Harrison, N.J. For sales information contact the RCA Field Representative nearest you.

East: HUmboldt 5-3900
744 Broad Street
Newark 2, N. J.

Midwest: WHitehall 4-2900
Suite 1181
Merchandise Mart Plaza
Chicago 54, Illinois

West: RAymond 3-8361
6355 East Washington Blvd.
Los Angeles 22, Calif.



TYPICAL CCS OPERATION OF RCA-6816 AND -6884
RF Power Amplifier, Oscillator—Class C Telegraphy
and
RF Power Amplifier—Class C FM Telephony

	at 400 Mc		at 1200 Mc
DC Plate Voltage	400	900	900 volts
DC Grid-No. 2 Voltage	200	300	300 volts
DC Grid-No. 1 Voltage	-35	-30	-22 volts
DC Plate Current	150	170	170 ma.
DC Grid-No. 2 Current	5	1	1 ma.
DC Grid-No. 1 Current	3	10	4 ma.
Driver Power Output (approx.)	3	3	5 watts
Useful Power Output (approx.)	23	80	40 watts

RADIO CORPORATION OF AMERICA
Tube Division Harrison, N. J.

CIRCLE 376 ON READER-SERVICE CARD FOR MORE INFORMATION

◀ CIRCLE 376 ON READER-SERVICE CARD

MAY 15, 1957

DESIGN

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