ELECTRONIC DESIGN

High Accuracy Servo Element . . . p 24

SEPTEMBER 1, 1957

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

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

◄ CIRCLE 1 ON READER-SERVICE CARD

ELECTRONIC
DESIGN

Contents

Vol. 5, No. 17

September 1, 1957

BPA

ELECTRONIC DESIGN is published semi-monthly by Hayden Publishing Company, Inc., 19 E. 62nd Street, New York 21, N. Y., T. Richard Gascoigne, President; James S. Mulholland Jr., Vice-President & Treasurer and David B. Landis, Secretary. Printed at Hildreth Press, Bristol, Conn. Acceptance under section 34.64 P. L. & R. authorized. Copyrighted 1957 Hayden Publishing Company, Inc. 30,000 Copies this issue.

NBP

Editorial

The Revolutionary Product We Didn't Feature

When the military clamps a lid on performance ratings we're at an impasse in presenting a technical article on a product. That's why we've run no feature on inertial guidance accelerometers, gyroscopes, or stable platforms in Electronic Design.

We're a little remorseful that we haven't had a story on these devices. The production of inertial guidance components, particularly those for long range navigation, is one of today's foremost examples of the genius of American industry. The principles of inertial navigation are simple—a design that is manufacturable is the rub. Fabricating tolerance units on a production basis which are the navigational counterparts of the celestial stars is a milestone for American industry. Only a few companies have accomplished the feat, but it has been done. Here are some of the accomplishments.

To keep the drift rate of a gyro for airborne use not exceeding one minute of arc per hour (one nautical mile per hour), the torque acting on the revolving mass would have to be less than 0.08 dyne-cm. This torque is equivalent to the gravity moment exerted by the weight of the paper *within* this letter (o) cut out and stuck on the gyroscope gimbal at a half-inch radius from the gimbal axis, according to an example provided by J. M. Slater of Autonetics. For an air transport to be guided to within 15 miles of its destination after a five-hour, 3000 nautical mile great circle flight, gyro drift rate can be about 0.6 minutes of arc per hour. Autonetics' C. F. O'Donnell points out that this is but one complete rotation in about four years. Exact military demands are not known, but the above examples give an idea of specifications being met.

Sperry Gyroscope, as we have reported before, does ultraprecision machining to 25 millionths of an inch. Test devices for evaluating precision-machined products measure reaction torques of less than 0.05 dyne-cm. Some of these measurements are made on 3-ton instruments mounted on seismic blocks below the ground. The weight of a gnat is supposed to spin the dial beyond its working scale. There is little possibility of gnats being present, though, as most air is filtered to remove all particles larger than 12 one-millionths of an inch.

New levels of ultraprecision machining, dimensional stability, quality control, cleanliness, and manpower skill have been reached in the manufacture of intertial guidance components. To quote J. M. Slater, "[This] . . . is a tribute to the foresight of the national defense authorities for initiating, subsidizing, and maintaining the requisite intensive development programs. It is also a tribute to the scientific, engineering, and manual skills of the personnel involved in such programs." Such statements have been often made. None other has probably been more sincere or more right.—JAL

Engineering Review

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

Lightweight Traveling-Wave Tube: Reduction in weight and a substantial increase in operating reliability are the result of a new design in traveling-wave tubes developed by Radio Corp. of America. The experimental tube eliminates the need for external electromagnetic focusing equipment amounting to considerable weight in tubes of high-gain, high-sensitivity design. Vibration, and other variations in environment cannot affect the alignment of the focusing field in the experimental tube. As described, the tube substitutes a compact electrostatic focusing element that is built into the tube and is automatically given a permanent proper alignment during assembly.

The result of the design is a plug-in tube which requires no critical alignment during installation, and which operates under severe conditions without requiring realignment. The tube weighs less than a pound, complete with focusing element, which consists of two pairs of helices, or spiral bifilar windings. Only the larger outer pair carries the signal waves, while the inner pair is used with the outer pair for beam focusing.

Ford Gives Missiles a Free Lift

A floating platform for launching missiles is one solution proposed for eliminating the first fuel-consuming miles of a missile's flight. Within the next few months Aeronautics Systems, Inc., Ford Motor Company's West Coast subsidiary, will launch a rocket vehicle which, it is hoped, will travel several thousand miles above the surface of the earth. Designated Operation Far Side, the program is sponsored by the Air Research and Development Command. The initial phase of the Far Side project represents the first step in a research program aimed at obtaining information regarding the environment at great distances from the earth. Present planning calls for further experiments at even higher altitudes, and it is expected that future weapons systems will benefit from the project.

The first Far Side balloon flight experiment was conducted a few months ago at the General Mills Flight Test Center near New Brighton, Minn. During the test a helium-filled balloon designed and produced by General Mills carried 2300 lb to a height in excess of 104,000 ft. The balloon, which measured over 200 ft in diam, proved extremely stable during the test. The missile-launching experiment will occur at about the same altitude.

The rocket, inserted into the lower end of the balloon transport, will blast upward through the balloon on firing with an initial first stage thrust of 160,000 lb. Boosted in four stages by a combination of ten solid propellant rockets, the Far Side instrumentation will go through its maximum acceleration of 200 g during its 26 sec of powered flight. From stage four the 6 x 4 in. instrument package and the burned-out last stage rocket will continue upward into space as a free projectile. During its ascent and descent a miniaturized radio transmitter in the instrument package will transmit measurement of cosmic rays and other data to ground receiving and recording stations. Data will be obtained from these experiments on the nature of cosmic rays, the earth's magnetic field, as well as other phenomena present at high altitudes.

The rocket will be fired from its floating platform and will shoot up through the center of the supporting balloon.

Engineering Review

Computer Testing of Instruments

Fischer and Porter Co., Hatbor Pa., announces the recent purchase an electronic differential analyz from Electronic Associates, Inc. Th analog computer will be used f studying dynamic control system pe formance and for analysis of the ope ating characteristics of the company industrial instruments and instrume components under development. Th unit will provide additional servic for the company's customers by pr viding means of simulating compl processes, such as accurate predicti of transient and steady state pheno ena in closed loop process control.

Enlarging Plant for Teflon Coating

The Sparta Manufacturing Co. Dover, Ohio, is enlarging their faci ties for the specific purpose of incre ing their capacity for coating metal and non-metallic parts with Teflo The new quarters will be equipp with completely air conditioned d rooms so that humidity and temper tures can be accurately controlle Production line techniques will be i stalled enabling Sparta to proce parts in the quantities that are d manded. The company intends work closely with the customer help solve any complex problems th may arise, and it will run certain sa ples at a nominal fee.

VHF Radio-Telephone System

An inexpensive system whi bridges telephone service over terrai where it would be physically or ec nomically impractical to install tel phone lines has been developed Allen B. Du Mont Labs., Inc., N Designated the MCA-474-B Thr Channel Multiplex Station, the equi ment utilizes broadband, point-t point radio in the 450 mc range. B sides its use as a permanent temporary telephone installatio operation in the uhf band makes t equipment advantageously adaptab as a broadband two-way radio syste a multi-channel radio communicatio unit, carrying up to 54 teletype cha nels, or as the transmission faciliti for slow-scan industrial television.

◄ CIRCLE 4 ON READER-SERVICE CARD

Automatic Selective Calling For Two-Way Radios

A unit which converts any standard two-way radio network to a fully automatic selective calling system has been developed. Christened Tonicam (Tone Initiated-Carrier Maintained), the unit eliminates co-channel annoyance in two-way radio communications without the necessity of transmitting bothersome continuous low-frequency tones. Tonicam features both a half-second tone burst to activate a receiver and automatic receiver muting at the termination of a transmission. Selective calling automatically rejects the constant stream of messages on a frequency channel shared by many systems and responds only to messages from its own system. Once the initial contact is made, only the caller and the called unit use the channel and other units within that system hear nothing.

As an illustration of Tonicam operation, a base station wishing to contact a specific mobile unit, Car A, transmits a half-second burst of the system's frequency tone, and unmutes all receivers in his network. All mobile units hear the call to Car A and the operator of Car A lifts his mike from its hangup. This automatically returns his radio to normal two-way operation. All subsequent transmissions between the base and the mobile unit are normal, using no tone burst. Only the base station and Car A use the channel; the other units within the system hear nothing. The base station operator can talk with more than one mobile unit by calling the desired units. Those who lift their mikes from the hangup position on the mobile unit are participants in a conference call. The unit was designed by Allen B. DuMont Labs., Clifton, N.J.

Correction: We hope haste doesn't make waste in this case, but haste did make mistakes in "A Voltage Gain Nomogram For Transistor Circuit Design" by Rudolph Wellsand, p. 56, July 15, 1957. In rushing this nomogram article into our "Transistor Issue" we did not catch inconsistencies in subscripts such as r_e r_c etc. We also confused subscripts by not distinguishing correctly between e's, c's and O's.

1. Following Equation (1), that portion which reads, "Which assumes: $R_E + r_c + r_b \ll r_c$ ", should read: $R_E + r_e + r_b \ll r_c$
2. Equation (2) should read:

$$r_c \quad \frac{V_{CB}}{I_{co}}$$

3. The column headings in Nomogram I which read $(1 = \alpha)$ and r_b $(1 = \alpha)$ should read: $(1 - \alpha)$ and r_b $(1 - \alpha)$ respectively.
4. Midway down on the α scale of Nomogram I, the value marked .890 is obviously .990
5. At the very bottom of the R_R scale on Nomogram II, the correct value should read 10 and not 0.
6. Number 6 of the Sample Problems should read: "$R_E > 46$ by approximately 10 times"—not 100.

DC Testing of AC Insulation

Despite the fact that the electrical industry is expending much effort in testing insulation on ac apparatus by dc voltage, there is no clear and scientific demonstration of the validity of the practice. These findings were announced by two General Electric Co. engineers, C. M. Foust and B. V. Bhimani, of Schenectady, N.Y.

Their conclusion on the widespread practice of direct voltage testing on cables, transformers, capacitors, switchgear and rotating machinery, followed a large number of tests on 12 different kinds of sheet insulation, using especially designed equipment, including a new type of scintillation probe for ionization detection to study the initiation, severity, location and spread of ionization. Based on observations made, several conclusions were reached.

It was noted that composite insulation life or insulation breakdown strength cannot be predicted by test data for three reasons, namely: the voltage-current data cannot be plotted in any systematic manner such that the insulation breakdown voltage can be calculated by its extrapolation; the voltage-current relation involves many variables and uncertainties not incipient to breakdown such as, uncertain correlation between conductivity current and ionization levels and wide variation in current values from one sample to another and from one test to another on the same sample; all factors such as insulation make-up, electrode configuration, temperature, humidity, etc., being the same, the patterns of stress distribution and the location, severity and extent of ionization are different under direct and alternating voltage stresses.

In addition, fissures and defects inside composite insulations cannot be detected by dc test data, nor may damage possibly suffered from the application of high direct-voltage upon insulation designed for operation under ac service be discovered, even from leakage current characteristics. Finally, the mechanism of extending ionization, similar to that existing under direct voltage stresses, is absent under alternating voltage stresses.

In a previous issue of Electronic Design, August 15, 1957, p. 44, the position favoring DC Overpotential Testing for electronic components was discussed by Victor Wouk of Beta Electric Div., New York, N.Y.

Educational Research

The need for research into what is taught and how it is taught was cited by Dr. Eric A. Walker, President of Pennsylvania State Univ. at the American Society for Engineering Education annual meeting at Cornell Univ. Despite brilliant records in research with materials, processes, methods and the like, Walker felt that research involving the shortage of professional skills has been relatively neglected. "In the next 15 years," he stated, "engineering education in the United States is going to be revolutionized. If the sweeping changes that are going to take place in the next few years are to produce a sounder, better system of engineering education, we must frankly recognize the problems that we are going to face; work out sane, logical solutions to them; and then proceed systematically and courageously to carry them out."

The Penn State president suggested a nine-point program calling for: Identification of potential college material, encourage superior students with the desire to go to college, provide financial assistance for each student to attend college, utilize engineers efficiently, revise the Selective Service System, eliminate costly and wasteful cost-plus-fixed fee government contracts, seek means of financing basic research in engineering, and evaluate the curricula and methods used to teach it.

Bouncing Microwaves

The first commercial microwave system to achieve reliable communications over a 40-mile distance by using mirror-like reflectors instead of regular repeater stations has been installed for the El Paso Electric Co. in Texas. The system is designed to improve communications efficiency between the utility company's facilities at El Paso and Las Cruces. It is capable of handling private conversations, printed material and remote control signals, and will be used to give information on the flow of power between El Paso Electric Co. and interconnected companies.

Difficult terrain problems existed for the General Electric Co. communications engineers who designed the system. The point of origin was 150 ft lower than the surrounding terrain and the electrical utility wanted to avoid the expense of high towers and the problem of acquiring real estate for guying areas. El Paso also desired to eliminate repeater points in the system.

Microwave specialists worked out a system which enabled El Paso to achieve maximum system reliability without the expense and maintenance of a repeater station continuously powered by dc. The resulting system included a 14-ft steel mesh dish placed at a 55-ft elevation at the Rio Grande plant. A 20-ft square aluminum reflector was carried piecemeal by jeep to a location on Mount Cristo Rey 4400 ft above sea level, and a 14-ft dish was placed at a point 80 ft high at the main Las Cruces substation. Under the arrangement, microwaves from El Paso's Rio Grande plant are bounced off the mountain reflector on Mount Cristo Rey, and sent to Las Cruces. The system also operates equally well in reverse, from Las Cruces to Rio Grande.

Pulse Transformer Facility: A pulse testing modulator has been installed by the specialty transformer department of Westinghouse Electric Corp., Pittsburg, Pa. The modulator can be used to simulate the input to the pulse transformer under test as well as its output load conditions during operation. For load tests, a water-load rheostat, shown, is used to load the secondary of a pulse transformer. The main advantage of the water load is its smaller physical size with resulting reduced capacitance to ground. The water load can be varied from 500 to 2000 ohms by changing salt concentrations in the solution.

Heat's Image

Answering a long-time need in steel mills, a new type of camera, the evaporograph has been put into use by the steel industry for making maintenance checks and detecting hot spots. Heat from the surface of blast furnaces, and other steel-making facilities appears as a colored image through the lenses of the camera, which was developed by Baird-Atomic, Inc., Cambridge, Mass. Differences in temperature of 1 C can be detected, and objects as distant as three miles will register accurately. The instrument will function as long as the measured temperature is above absolute zero and there is a temperature difference existent in the camera's field of view.

The evaporograph consists basically of a membrane which changes in temperature in relation to the infrared radiations focused on it by a lens. An oil vapor condenses preferentially upon the cooler portions of the membrane, causing an oil film of variable thickness to form. Thus, a heat image focused on the membrane becomes visible and distinguishable through the different interference colors formed by the film, much as oil slick on water exhibits varying colors. By employing a reference temperature in the field of view, the evaporograph can be used to calculate unknown temperatures. By comparison of colors on the membrane, differences of temperature in the target area are readily seen.

Tribulations of a Telescope

The great size of Britain's Jodrell Bank Telescope will make it the most sensitive short wave radio receiver yet constructed, and also the most far reaching transmitter. The justification for producing this fully steerable telescope arose from the important results obtained from an earlier fixed reflector. The fixed reflector was 218 ft in diam in the form of a paraboloid facing upwards constructed of thin wires stretched on tubular scaffolding. However, the construction of the 2000-ton fully-steerable instrument posed problems not encountered with the fixed version.

One school of thought proposed building the structure out of aluminum alloy. This idea was soon discarded in favor of steel, for steel had the advantage of a relatively high modulus of elasticity —an important factor since the reflector bowl would suffer great stress-changes during its revolution. Coupled with this, the weight of steel was necessary to combat the effect of sudden gusts of wind. In a structure this large, the coefficient of expansion was also an important factor, and again steel seemed the best solution.

A design had to be evolved which would allow construction firms, who had no previous experience with such structures, to mount the system with a sufficiently powerful driving unit. The power needed to rotate the reflector would be relatively small on a calm day, but the presence of a wind necessitated a tremendous force to keep it revolving. For this purpose, trunnions and trunnion bearings were developed by Cooper Roller Bearings Co., Ltd., of Kings Lynn, Norfolk, Eng., which could each stand a combined dead load and wind load of 1000 tons with minimum resistance.

In order to amplify minute celestial radiations before they were dissipated, it was desirable that the receiving amplifier be located as close as possible to the aerial. For some purposes the first amplifier will be immediately adjacent to the aerial at the summit of the 66 ft tower in the center of the bowl; but the main amplifiers are suspended in a steel laboratory hung immediately below the center of the bowl itself. The suspended laboratory can be reached by gangways from the top of each bearing tower, where further high level laboratories travel round with the azimuth motion of the telescope. Much of this high-level mechanical and electronic equipment was installed under difficult conditions of access by the Brush Electrical Engineering Co. Ltd. of Birmingham, Eng.

Correction: The model 401A Audio Oscillator, made by Waveforms, Inc., 333 Sixth Ave., N.Y. 14, N.Y., is in truth a highly portable instrument weighing 12 lbs, and not 121 lbs as it appeared in the June 15th Issue.

Engineering Review

Acoustic Test Lab

To check sound pressure levels high enough to affect the reliability of mechanical and electrical components, Bell Aircraft Corp. has developed laboratory test equipment to check sound-sensitive components of its own, and that of other companies on a sub-contract basis. Facilities can also simulate a combination of environments such as temperature and vibration, in conjunction with high intensity noise.

Different types of equipment, such as plane wave tubes and resonant and reverberant chambers, make possible a variety of definitive tests. Sound pressure levels up to 160 db for discrete frequency and up to 145 db for random noise are provided over test areas up to 250 sq in.

Hottest Summer Yet: The appearance of this 25 a silicon diode isn't exactly due to the weather but is the result of a fire at an oil refinery. Still functioning, the diode was originally installed in an oil-immersed cathodic protection rectifier, used to prevent galvanic action corrosion of oil pipelines. The rectifier was burned out in a forest fire, the 11-gage steel case badly warped and the oil burned, but three of these diodes were found to still have their original operating characteristics. The units were manufactured by Westinghouse Electric Corp.

◄ CIRCLE 8 ON READER-SERVICE CARD

Smooth Nose for Missiles

One of the smoothest surfaces ever eated by man exists on the nose nes designed for intercontinental llistic missiles. The Air Force disosed recently that several of these nes have been successfully brought rough the blazing inferno of atmosheric re-entry, using the Lockheed -17 research rocket as the test missle. A 40-ft tall projectile, the cket's first stage is a single rge solid propellant, the second age is a cluster of three Recruit ckets, the third is a single Recruit, l built by Thoikol Chemical Corp. The first stage blasts the rocket into e thin air of the ionosphere. Without sufficient air to provide aerodymic control, the rocket drops tailst to an altitude where denser air gins to turn its nose down. At this oint, the first stage is ejected and the cond stage is ignited, starting the celerated, headlong plunge through e atmosphere. The third stage, with e nose cone, finally comes into acon and drives the X-17 downward at n even greater speed, subjecting ese nose cones to the high temperures used to test their design.

lding 28-Ft Parabolic Antenna

A 28-ft all-aluminum mesh paralic antenna assembly has been degned to be easily dismantled into 12 parate self-nesting reflector pie ctions and 12 backup supports arnged about a center hub. Providing w rate bulk transportation, the ene assembly can be shipped in two x 8 x 4 ft packages. One package ntains 12 reflector sections nested thin each other, and the other box ntains 12 K-frame assemblies with nter hub plate mounting brackets d other hardware.

When erected, the antenna withnds 65 lb per sq ft of wind loading hen completely iced. It can be supled with a supporting structure for sembly on remote locations by a ur man crew using conventional ols. Gains of 29.1 db at 430 mc to .1 db at 2700 mc over normal isoopic antenna performance are ofred by the tropospheric antenna. is made by Prodelin, Inc., 307 Bern Ave., Kearny, N.J.

Washington Report

Herbert H. Rosen

DOD's Reliability Program Grows Teeth

This month the Government Printing Office is selling an 800-page report that reviews all conceivable aspects of reliability. It is the culmination of a 15-month study by nine task groups of DOD's Advisory Group on Reliability of Electronic Equipment–AGREE. It looks at the way reliability is "controlled" by the Department and makes a large number of recommendations as to how the technique may more realistically become a standard operating procedure for both industry and the military. These recommendations may very well become the basis for establishing all future reliability requirements for military electronic equipment.

For more than a month, top technical people from the military departments and DOD have been studying the report in an effort to implement it as soon as possible. A fair proportion of the recommendations are implied in a good number of DOD directives already in force. The problem is that there is probably no one who knows exactly where or if a directive exists covering all aspects of the reliability problem he is interested in. This study should make inroads into this anomolous situation.

Meanwhile, there are reports that another task group may be formed to look at reliability from the management viewpoint. The genesis for the group will be the membership of AGREE's Task Group 5. It will be augmented by top level members of the military departments.

The fact that the recommendations in the report seem to cross over each other indicates a strong need for consolidation of some sort. One plan seems to be gaining acceptance the more it is talked about in the Defense Department and in industry. The first step would be to consolidate the functions of such groups as AGREE and AGECP (Advisory Group in Electronic Component Parts). To this would be added the operations of the Armed Services Electro-Standards Agency–ASESA. Teeth and authority would be put into the directives that established these and similar groups. Then with reliability, parts and performance as the basis of operations, the DOD would have a small bureau of standards to guide its electronic pursuits.

The new group would have the responsibility for establishing specifications, for example, before a component part gets into use. The military would cite a need, and someone would have to come up with an answer. The resulting specification would be the standard for the industry vendor and the military buyer.

In essence, the group would be a judiciary board having the prestige and authority to enforce the standards and specifications it develops.

In very general terms, the nine task groups looked at reliability from a number of vantage points: Practicality of reliability figures, statistical testing and collection of data, packaging effects on equipment, storage effects, procurement practices impeding or aiding the attainment of reliability objectives, definitions of terms so that all con- concerned are speaking the same language, and controls over testing, specifying, and compliance.

TV Translators or Boosters?

In response to petitions from the Governors of a number of Western states, the Federal Communications Commission has instituted a rule-making proceeding on the subject of TV translator stations vs. TV booster or repeater stations. The Commission is inviting all interested parties to submit engineering data or other pertinent comment as "to the feasibility of operating low powered apparatus for the purpose of 'repeating' or retranslating the signals of television broadcast stations into remote and sparsely settled areas without adequate TV service." The repeater stations would be permitted to operate on both vhf and uhf TV broadcast channels.

The FCC has licensed a number of translator stations, largely in the mountainous east and in the midwest. These stations pick up either by wire or by sensitive receivers TV broadcasts from large urban stations. The signals are then retransmitted on channels for short-range or local consumption.

Obviously, the same technique will not work in areas in which TV stations are separated by very long distances.

The rules the FCC is proposing would limit the power input to the final rf amplifier to 1 watt. They would establish certain minimum performance standards considered to be necessary to prevent interference to established services. Also, they would require the inclusion of certain automatic devices to prevent malfunctioning if the apparatus were to be operated without a technically qualified radio operator in constant attendance. TV repeater stations would be required to protect other classes of stations from interference but would receive no protection from interference. They would be permitted to operate as simple co-channel linear amplifiers, i.e. "boosters," or could convert to other vhf or uhf channels which could be used without causing interference to other classes of stations.

Comments from interested parties are expected to be based on sound engineering considerations. Data should be supplied which will enable the Commission to determine whether or not such devices are technically feasible and should be authorized. Manufacturers are invited to submit data as to the probable cost of suitable equipment.

Meetings

Sept. 8-13: Second Annual Course on Investmen Castings

MIT, Cambridge, Mass. Sponsored by the Invest ment Casting Institute. Lectures, laborator exercises and demonstrations will be offered o investment materials; melting; gating, risering solidification and heat transfer; metal and allo systems; defects in castings; and consideration o new investment and allied processes. For furthe information, write Harry P. Dolan, Investmen Casting Institute, 27 E. Monroe St., Chicago 3, Il

Sept. 9-13: Twelfth Annual Instrument-Automatio Conference and Exhibit

Cleveland Auditorium, Cleveland, Ohio. Sponsore by the ISA. Organized under the unifying them "Instrumentation for Systems Control," the confe ence will open with formal sessions devoted to da handling and instrument terminology. Followin these there will be individual workshop sessions limited discussion groups covering such topics a aircraft and missiles (excluding propulsion), win tunnels, flight propulsion systems, process indu tries, power generation and distribution, meteor logical, nuclear, medical, geophysical exploratio and general industrial laboratories. Some 100 pape will be presented at the technical sessions. The will be about 500 exhibits. For details of the tec nical program write to Herbert S. Kindler, Direct of Technical Programs, ISA, 313 Sixth Ave., Pit burgh, Pa.

Sept. 17-18: RETMA Symposium on Numerical Co trol Systems for Machine Tools

Ambassador Hotel, Los Angeles, Calif. For deta write to RETMA, Room 650, 11W. 42nd St., Ne York 36, N.Y.

Sept. 17-21: Institute of High Fidelity Manufacture Show

Morrison Hotel, Chicago, Ill. For further inform tion, contact Bernie Merems, 509 Madison Av New York, N.Y., or Howard Alexander, 75 Wacker Drive, Chicago, Ill.

Sept. 24-25: Sixth PGIE Symposium on Industr Electronics

Morrison Hotel, Chicago, Ill. Sponsored by the I Professional Group on Industrial Electronics a AIEE. The main theme for the conference will the characteristics, use and integration of tr ers into complete systems to measure and con- complete processes. For further details, write J. N. Banky, 628 West 18th Street, Chicago, Ill.

t. 27-28: Seventh Annual IRE Professional Group Broadcast Transmission Systems Fall Symposium

llard Hotel, Washington, D.C. Papers will be d on a variety of subjects ranging from transistor ulated power supplies for video circuits to the lication of automation to TV master control ms and film rooms. More information may be ained from Clure H. Owen, American Broadcast- Co., 7 W. 66th St., New York 33, N.Y.

. 7-11: Fall General Meeting of the American itute of Electrical Engineers

el Morrison, Chicago, Ill. The technical program consist of more than 50 sessions devoted to the st advances in electrical engineering and allied . Nuclear reactors, telegraph systems, research, cs, television and aural broadcasting, basic sci- e, safety, computing devices, land transporta- , power generation, transmission and distribu- , system engineering, computers, mining and al industry, radio, and the chemical industry are e of the subjects being covered. For details e to the AIEE, 33 W. 39th St., New York, N.Y.

9-11: Fourth National Symposium on Vacuum nology

el Somerset, Boston, Mass. Sponsored by the mittee on Vacuum Techniques. Approximately papers will be presented covering fundamental nces in vacuum technique, means of producing, suring and conducting low pressures, and ad- es in applications of vacuum to processing. For her information, write the Committee on uum Techniques, Box 1282, Boston 9, Mass.

9-12: 1957 Convention of the Audio Engineer- Society

York Trade Show Bldg., New York, N.Y. Be- n 50 and 60 papers will be presented. Covered be topics in such fields as disc and tape record- reception, components and systems, noise con- and acoustics. The New York High Fidelity , sponsored by the Institute of High Fidelity, accompany the Convention. More information be obtained from G. K. Dahl, 230 West 41st New York 36, N.Y.

14-15: Third Annual Douglas Aircraft Co. Inc. Bell Helicopter Corp. Integrated Instrument De- pment Program Conference

l Statler, Los Angeles, Calif. Sponsored by the and Navy. For more information send to the s Bureau, Bell Helicopter Corp., P.O. Box 482, Vorth, Tex.

Oct. 16-18: AIEE Conference on Computers in Control

Chalfonte and Haddon Hall Hotels, Atlantic City, N.J. Sponsored by the AIEE Committee on Feedback Control Systems. The conference will stress the role of analog and digital computers in automatic control, both as design tools and as components of systems. For more information, write Prof. J. G. Truxal, Dept. of Electrical Engineering, Polytechnic Institute of Brooklyn, 99 Livingston St., Brooklyn 1, N.Y.

Oct. 16-18: 1957 IRE Canadian Convention and Exposition

Automotive Building, Exhibition Park, Toronto, Canada. Sponsored by the Canadian Sections of the IRE. For information write to Grant Smedmor, IRE Canadian Convention, 745 Mt. Pleasant Rd., Toronto 7, Canada.

Oct. 17: SPE Regional Technical Conference

Hotel Carter, Cleveland, Ohio. Sponsored by the Cleveland-Akron Section of the Society of Plastics Engineers. The theme for the sessions will be "Polyethylene—Properties and Uses." For details write E. J. Haskins, Zenith Plastics Co., 1009 Rockwell Ave., Cleveland 14, Ohio.

Oct. 24-25: Fourth Annual Computer Applications Symposium

Hotel Sherman, Chicago, Ill. Sponsored by the Armour Research Foundation of Illinois Institute of Technology. Advances in automatic coding and new computers and applications will be stressed. Both management and engineering applications will be considered. More information may be obtained by writing the Secretary, Computer Applications Symposium, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

Oct. 28-30: Fourth Annual East Coast Conference on Aeronautical and Navigational Electronics

Fifth Regiment Armory and the Lord Baltimore Hotel, Baltimore, Md. Sponsored by the Baltimore Section of the IRE and the Professional Group on Aeronautical and Navigational Electronics. Exhibits will be offered along with the technical sessions. For details write Clayton Knight, 3603 Howard Park Ave., Baltimore, Md.

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

Shoreham Hotel, Washington, D.C. For more information, write W. M. Webster, RCA Semiconductor Div., Somerville, N.J.

Nov. 6-8: Tenth Annual Conference on Electronic Techniques in Medicine and Biology

Boston, Mass. Sponsored by ISA and AIEE. Furth etails and advance programs may be obtained from H. S. Kindler, Director of Technical Programs, Instrument Society of America, 313 Sixth Ave., Pittsburgh 22, Pa.

ov. 6-8: Third Aero-Com Symposium

otel Utica, Utica, N.Y. Sponsored by the IRE rofessional Group on Communications Systems. he conference will deal with systems, equipment esign, techniques, antennas, spectrum conservaon, air traffic control, management and other opics. For the presentation of confidential mateal, there will be a classified session on Nov. 8. For ore information, write to R. C. Benoit, 138 Riverew Pkwy., Rome, N.Y.

ov. 11-13: Third Annual Instrumentation onference

ltmore Hotel, Atlanta, Ga. The theme of this conrence will be "Instrumentation for Data Handling" ith special symposiums on electronic instrumentaon as applied to medicine and the sales and purhasing aspects of electronic instrumentation. Paers should be submitted to Lamar Whittle, Federal Telecommunications Lab., 1389 Peachtree St., .E., Atlanta, Ga. For more information write B. J. asher, School of Electrical Engineering, Georgia stitute of Technology, Atlanta, Ga.

v. 13-14: Mid-America Electronics Convention

unicipal Auditorium and Hotel Muehlebach, Kans City, Mo. Sponsored by the Kansas City Section the IRE. There will be exhibits and twelve techcal sessions. Approximately thirty papers will al with medical electronics, airborne electronics strumentation, engineering management, electnics in nucleonics and a diversity of other subts. Persons who want to submit papers should ntact the Technical Papers Chairman, MAECON, 09 Cherry St., Kansas City 10, Mo. The deadline r submissions is Aug. 15. For more information ite Richard L. Clarke, 425 Volker Blvd., Kansas ty 10, Mo.

per Deadlines

v. 1: Deadline for papers to be presented at the 58 IRE National Convention. The convention ll be held March 24-27 at the Waldorf-Astoria d the New York Coliseum, New York, N.Y. Prosctive authors should submit a 100-word abstract d a 500-word summary. Both must be in triplicate th the title of the paper and the name and ads of the author. The technical field in which paper falls must also be indicated. Only papers published or presented prior to the convention ll be considered. Military or company clearance st be obtained before submittal. Address all terial to Dr. George L. Haller, Chairman, 1958 chnical Program Committee, IRE, 1 E. 79th St., w York 21, N.Y.

The electronic design engineer has a basic responsibility for ensuring that the system he is designing has adequate reliability in the ultimate application. This article presents a technique for predicting the reliability of a system while it is in the design stages. In addition, the technique shows readily those factors of design which can be changed to realize the best reliability and economy.

Before a reliability prediction can be made one or more proposed system delineations as well as part-reliability figures must be available, of course. The part reliability figures can occasionally be obtained from experience. Often, however, these figures must be extrapolated roughly from available data or estimated on the basis of part performance description. But the lack of accurate figures need not delay the reliability analysis. The resulting predictions can be modified easily as new data become available.

A further prerequisite to a design reliability analysis is a detailed statement of what minimum performance levels result in "successful" operation of the system. Although it is possible to evaluate "success" in terms of the system operator's satisfaction after the system is working, during the design stages it must be related to criteria that can be stated mathematically. Success-definition, the construction of reliability diagrams, and reliability formulas are presented in this article.

Reliability—Design Technique for Complex Systems

H. Elmore Blanton

Cambridge, Mass.
Hycon Eastern, Inc.

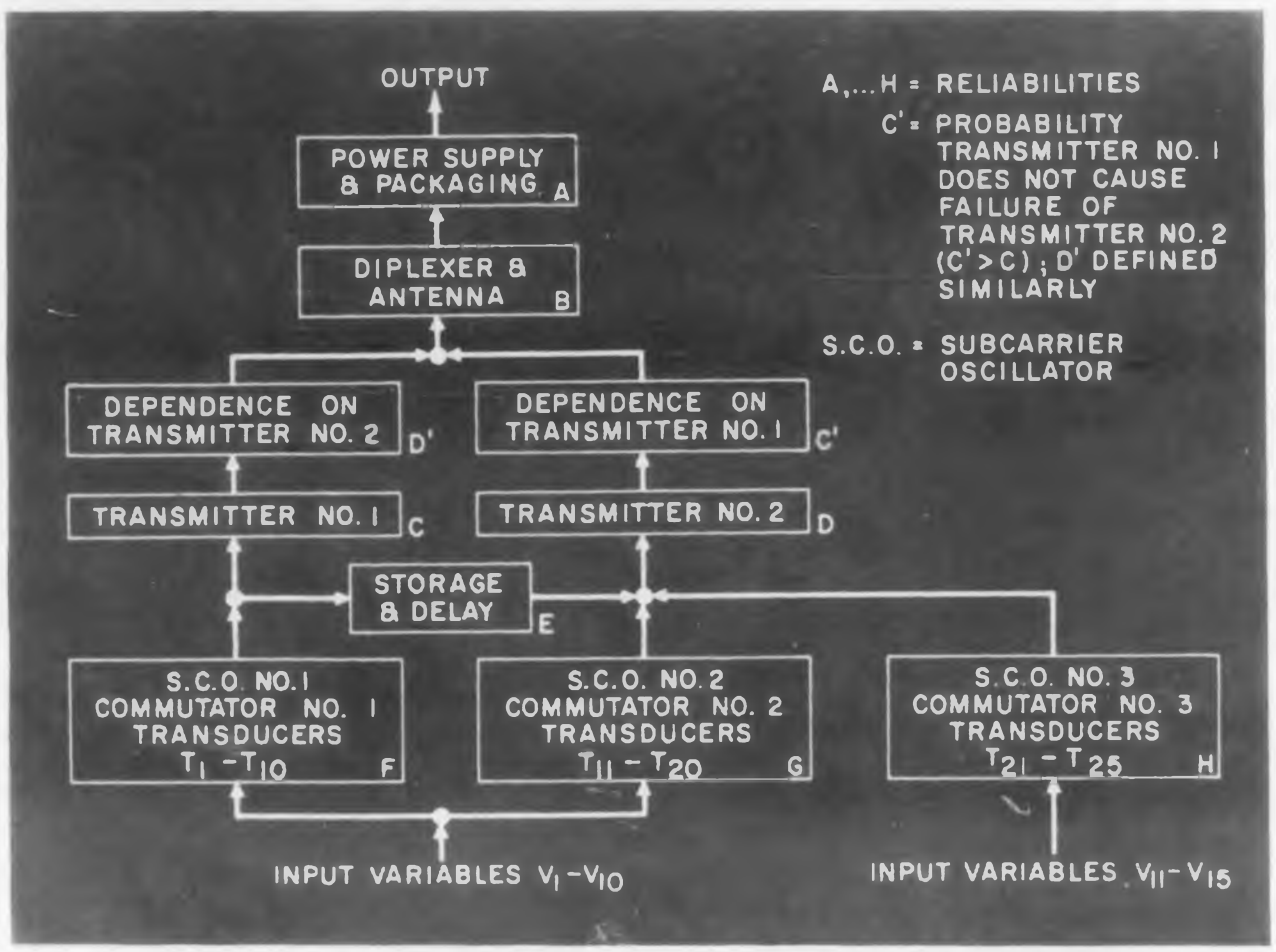

Fig. 1. Reliability diagram of proposed hypothetical airborne telemetering system. Note that this illustration closely resembles an electronic block diagram showing paths of signal flow. These paths can also represent information flow.

A REASONABLY simple reliability-prediction technique has been developed which can be used in the early stages of the design of complex systems. Conventional statistical methods are adapted to a familiar engineering format in order to make an analysis of system reliability easy and straightforward. This technique facilitates comparison of proposed system designs and leads to estimations of the degree of redundancy or component improvement required to realize the target figure for system-performance reliability.

In using this technique, *reliability diagrams* are prepared by making appropriate changes in the engineering block diagrams for the system. After one or more possible definitions of successful performance are stated, basic rules from probability theory lead to the derivation of *reliability formulas* for the system. Effects of failures due to one part depending on another and engineering considerations such as the relative importance of various modes of performance can be included readily. Numerical reliability predictions are achieved by evaluating these formulas using the best available component-reliability data. An example based on an airborne telemetering system illustrates the application and usefulness of this technique.

A simplified block diagram of such a telemetering system is given in Fig. 1. For the present, disregard boxes C′ and D′. Fifteen variables, V_1, V_2, etc. are measured by the system. The engineering design proposes the use of two transducers each to measure 10 important variables in order to provide redundancy and consequently possible reliability improvement—relative to that obtainable when using single transducers. The two groups of 10 transducers use separate commutators, subcarrier oscillators, and transmitters. To increase the probability that the signals representing these ten variables will be received successfully in the event of a temporary loss of transmitted signal, the output of Subcarrier Oscillator No. 1 is continuously recorded and re-

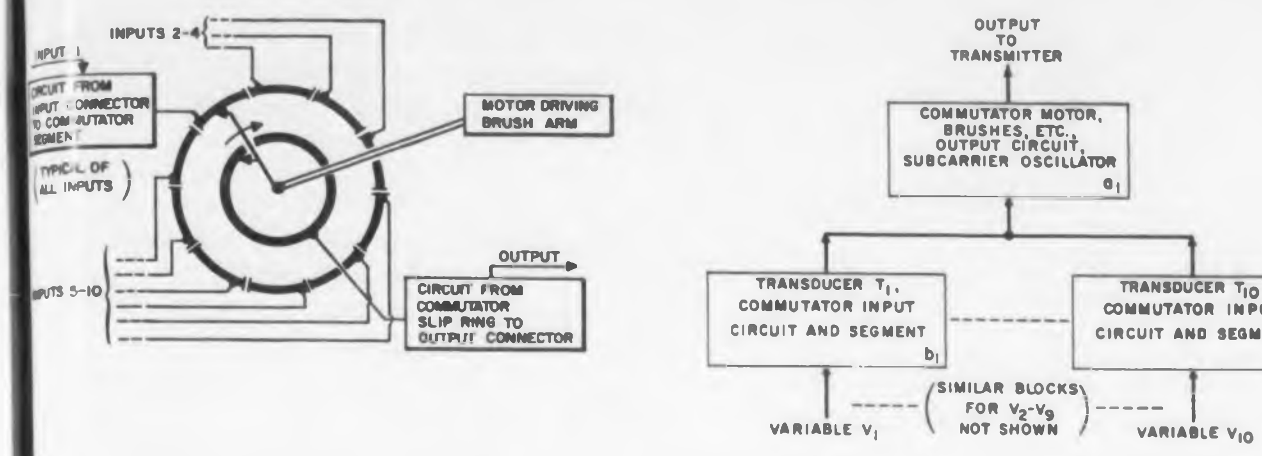

Fig. 2. Reliability analysis of electromechanical commutator. A sketch of this unit is represented in (a), showing that each segment controls one input. If a segment should be inoperant the variable associated with it would not be transmitted. The reliability diagram for this situation is shown in (b).

broadcasted over Transmitter No. 2 after a delay of τ minutes. A common antenna and power supply are used. In this hypothetical system, the simplifying assumption is used that the only part interaction occurs in the transmitters where, if either fails in a particular manner, so will the other.

This telemetering system is used in a missile which is tested during flights of specified duration. Data giving the reliability of the parts under the flight environment are assumed to be available. The problem to be investigated is:

What is the probability that the telemetering system transmits successfully, throughout the test flight, the desired information about the variables which are measured?

Reliability Diagrams

The first step in deriving a formula for system reliability, of course, is to determine the manner in which the reliability of each part affects the reliability of the whole. This information can be displayed effectively by means of *reliability diagrams.* In these diagrams, the series or parallel grouping of parts, the effects of packaging, power supplies and other associated equipment, and the consequences of interdependence between the performance of parts is clearly evident.

A reliability diagram, as defined in this paper, resembles a conventional signal-flow block diagram. The two types of diagram must not be confused however. Basic considerations in constructing and using reliability diagrams are:

- A line represents a unidirectional path of information flow. For electrical systems, *information flow* may be interpreted as *signal flow.*
- A block represents a part or a group of parts which must function successfully if the information is to pass from the input to the output of the block. The information does not necessarily pass through the parts included within the block.
- The group of parts which are denoted by a particular block preferably should be describable by a probability of successful performance which is independent of the performance of any other part. Dependence between parts in different blocks is admissible if the dependence exists between a specified part shown by one block and the entire group of parts denoted by another block.
- A distinctive symbol represents the probability of success of the parts denoted by each separate block. The probability of success of the parts within a block is defined on the basis of the part specifications and the definition of success in the given application, which will be discussed later.
- A path of information transfer consists of a single series connection of successive lines and blocks from the system input to the system output. Successful transmission occurs along a particular path if the parts represented by each of the blocks operate successfully. Redundant parts that are excluded from one path are included as elements in other parts. A part may serve as a series element in several paths.

The construction of the reliability diagram, Fig. 1, for the telemetering system is initiated by drawing a conventional block diagram. Next, blocks are added as series elements to show the effects of transmitter dependence, power supply, and packaging. Each of these blocks is located on the basis of the manner in which the reliability of the parts influences the system reliability.

A set of transducers, the related commutator, and the subcarrier oscillator are grouped conveniently in a single block in Fig. 1 since these parts function together, independent of other parts, to perform a particular task. The sketch of an electromechanical commutator in Fig. 2(a) reveals that portions of the assembly are associated with individual input signals, whereas other portions are common to all signals. As a result, this single part must be represented by several blocks in a reliability diagram, as is shown in Fig. 2(b). This figure includes the transducers and subcarrier oscillators in the appropriate blocks to give the complete diagram for the commutated subcarrier channel.

Cables and connectors between parts effectively introduce additional series blocks in a reliability diagram. To eliminate this complication, the reliability symbol assigned to a particular block may be taken as denoting the probability of success of the parts represented by that block *and* of the cables and connectors leading to and from those parts.

Definition of Successful Performance

The reliability of a system in performing its assigned function obviously should be computed with respect to a precise definition of what constitutes success. It may simply be that the operator is satisfied with the system performance, or at the other extreme, it may be that the output of system fails within certain well-defined, measurable bounds. For our purpose, a definition which can be stated mathematically is necessary.

Ideally, the output of the telemetering system is composed of four signals which are members of groups of successive samples originating from the three commutators and transmitted either immediately or after the delay of τ minutes. A definition of successful performance can be stated in terms of the minimum number of samples which must be present in the output during a specified interval.

An engineer, on the basis of his knowledge of the ultimate use of the data, often assigns weights indicative of the relative importance of the record of each telemetered variable. Several procedures may be suggested for incorporating these engineering considerations in reliability calculations.

One procedure is based on exponent weighting factors. These are determined by the relative importance of the various telemetered variables. Exponents in the range of zero to one are affixed to the reliabilities of parts that are associated with the transmission of particular variables. If the variable is of primary importance, the exponent is 1 and the related parts must perform exactly in accordance with specifications. However, if the variable is of secondary importance, an exponent less than one, roughly proportional to the relative importance of that variable is used. A mathematical method to derive the weighting factor appears in reference (6). With exponent weighting factors, the definition of successful performance must state that certain variables must be telemetered satisfactorily with a weight w_1, others with weight w_2, and so forth, where $1 \geq w_1 > w_2 > w_3 \ldots \geq 0$.

Let us say that our system performs successfully if the signal received by the ground-based receivers during a test flight contains the theoretically maximum number of samples representing:

(a) At least and four of the five variables V_1-V_5.

(b) Variable V_6.

(c) Variables V_7, V_8, V_9, and V_{10} subject to exponent weighting w_1 ($1 > w_1 > 0$), and

(d) Variables V_{11} to V_{15}, subject to exponent weighting factor w_2 ($1 > w_2 > 0$).

To fulfill this definition, variables V_1-V_{10} may be received either simultaneously with measurement or after the delay of τ minutes which is inherent in the record-rebroadcast arrangement.

Reliability Formulas

When a reliability diagram is drawn and the definition of success stated, a reliability formula can be obtained as follows:

1. Refer to the reliability diagram and write the probability of success for transmission along each separate path of information transfer from an input to the output. Note if the success of a particular path is required for system success or if alternative paths are available. Indicate applicability of weighting factors.

2. Compute the individual probability of success for each separate combination of paths which can result in system success. Each of these probabilities is obtained as the product of the reliabilities associated with all blocks which are required for the simultaneous success of the several necessary paths. Effects of exponent weighting factors are included.

3. Compute the probability that each pair of combinations of paths, as in Step 2 are successful simultaneously.

4. If more than two combinations of paths which can yield system success exist, compute the probabilities that each group of three, four, etc., of these combinations are simultaneously successful.

5. Compute the probability of success for the system by summing the probabilities obtained in Step *2* subtracting those obtained in Step *3*, and alternately adding and subtracting those for the groups computed in Step *4*.

An example based on the reliability diagram of Fig. 1 and the definition of successful telemetering given in the preceding section is shown in Table 1. In this table, Lines 1-4 correspond to Step *1*, 5-7 to *2*, 8-10 to *3*, 11 to *4*, and Line 12 to Step *5*. As may be noted, the reliabilities given on Line 1 for Path 1 and on Line 4 for Path 4 include the factors D, D', E, and E'; however, the reliability of Paths 1 and 4, Line 5, includes only D and E because these factors are more restrictive than D' and E', respectively, for the same parts. With this exception, the probability on Line 5 includes each symbol which appears in the probabilities on Lines 1 and 4. The exponent weighting factor w_2 is included in the derivation. The effect of the delay of τ minutes in the storage and delay device is neglected in making a first approximation to the actual problem.

The reliability formulas for F, G, and H in Table 1 and Fig. 1 are derived by reference to a reliability diagram similar to Fig. 2(b). On the basis of the definition for success, the formulas for the channels associated with Subcarrier Oscillator Nos. 1 and 2 are

$$F = a_1\left[\prod_{i=1}^{5} b_i + \sum_{i=1}^{5}(1-b_i)\prod_{\substack{j=1\\ j\pm i}}^{5} b_j\right] b_6\,(b_7b_8b_9b_{10})^{w_1}, \quad (1)$$

$$G = a_2\left[\prod_{i=11}^{15} b_i + \sum_{i=11}^{15}(1-b_i)\prod_{\substack{j=11\\ j\pm i}}^{15} b_j\right] b_{16}\,(b_{17}b_{18}b_{19}b_{20})^{w_1}. \quad (2)$$

In each of these formulas, the two terms in the bracketed expression represent the probability that V_1 through V_5 are all measured successfully and that any four of these variables are measured successfully when any one measurement is unsuccessful. The formula for the channels associated with Subcarrier Oscillator No. 3 is

$$H = a_3b_{21}b_{22}b_{23}b_{24}b_{25}. \quad (3)$$

The exponent weighting factor w_1 is applied to the last group of factors in each of eqs (1) and (2) because only these part reliabilities are affected thereby; however, the weighting factor w_2 is not included in eq (3) because, for convenience, it is applied directly to H in Table 1.

Table 1. Derivation of Reliability Formula

Line	Item		Probability of Success	Remarks
1	V_1-V_{10} ,	Path 1	ABCD'F	One path required for success
2		Path 2	ABC'DEF	
3		Path 3	ABC'DG	
4	V_{11}-V_{15} ,	Path 4	ABC'DH	Required, weight $= w_2$
5	Paths 1 & 4		$ABCDFH^{w_2}$	Any one combination yields success
6	Paths 2 & 4		$ABC'DEFH^{w_2}$	
7	Paths 3 & 4		$ABC'DGH^{w_2}$	
9	Paths 1, 2, & 4		$ABCDEFH^{w_2}$	Success of various combinations of paths
10	Paths 1, 3, & 4		$ABCDFGH^{w_2}$	
11	Paths 2, 3, & 4		$ABC'DEFGH^{w_2}$	
12	Paths 1, 2, 3, & 4		$ABCDEFGH^{w_2}$	
8	Reliability Formula		$ABDH^{w_2}$ (CF + C'EF + C'G — CEF — CFG — C'EFG + CEFG)	

Table 2. Reliability Predictions

	Situation	Formulas	Reliability
1	System-reliability prediction using proposed technique	Line 12, Table 1, and Eqs (1)-(3)	0.819
2	Same as 1 except Subcarrier Oscillator No. 2 and associated transducers eliminated	Same as 1 except G = 0	0.740
3	Same as 1 except Transmitter No. 1 eliminated	Same as 1 except C = 0, C' = 1.0	0.823
4	System-reliability prediction using product rule	Eq (4)	0.444
5	Same as 4 except part unreliability reduced by factor of 4 (e. g., A is changed from 0.95 to 0.9875, etc.)	Eq (4) with variables redefined	0.818
6	System reliability prediction considering redundancy shown in Fig. 1 and all data required for success	Eq (5)	0.749

Overall reliability is based on the following part-reliability estimates:
$A = C = D = E = 0.95$ $\quad w_1 = 0.8$ $\quad a_i = a = 0.97$ $\quad (i = 1, 2, 3)$
$B = C' = D' = 0.99$ $\quad w_2 = 0.5$ $\quad b_i = b = 0.98$ $\quad (i = 1 \ldots, 25)$

The importance of assigning a distinctive symbol represent the reliability of each separate block of he reliability diagram is emphasized by the process f deriving the reliability formula. During this erivation, these symbols mean that the success of e respective parts is required for the success of e associated paths of information transfer. The ymbols, as factors in the formula, may be manipu-ated in accordance with the associative, commuta-ve, and distributive laws of algebra and the special ules previously stated. But after the complete re-ability formula is written, the symbols again repre-ent merely the reliability of the parts. At that time, e rules of ordinary arithmetic apply; equalities be-ween the numerical values of factors can be recog-ized and appropriate substitutions made if desir-ble.

Reliability Predictions and Analyses

When reliability formulas are evaluated using the est available estimates for part reliabilities, nu-erical reliability predictions are obtained. Another portant use of the technique, however, is in the esign analyses which are directed towards achiev-g the highest possible reliability under stated strictions. Several sample computations for the tele-etering system and a comparison between the pre-ictions obtained using the technique described in is article and other methods is given in Table 2. he arbitrary set of point estimates for the part re-abilities, as used in the computations, is given be-w the table.

Situation 1, Table 2, indicates that the predicted liability for the system is 0.819 when the reli-ility formulas derived in the preceding section are ed. If this reliability is assumed to be acceptable, e question arises if the engineer's choice of re-undancy in the system is wise. Situation 2 shows at the elimination of Subcarrier Oscillator No. 2 d associated transducers for V_1 through V_{10} re-ces the reliability by roughly 10 per cent. This ange probably is undesirable. The opposite effect obtained when Transmitter No. 1 is eliminated, shown by Situation 3. An *increase* in system re-ability is realized because the interaction that duces the reliability for transmission through ansmitter No. 2 is eliminated. Other situations n be investigated in a similar manner.

If the conventional product rule for system reli-ility is used without consideration either of the anner in which the parts are interconnected or of e actual definition of successful performance, the liability formula for the telemetering system is

$$P_s = ABCDE\, a^3 b^{26}. \qquad (4)$$

his formula, which includes the assumption that all s and *b's* are equal to *a* and *b*, respectively, is aluated as Situation 4. As can be noted, the result-g prediction of 0.444 is lower by nearly a factor of o when compared with the prediction for Situation 1. Situation 5 shows that when the product rule is used the unreliabilities of the various parts must be decreased by factors of the various parts must be decreased by factors of four in order to set a system reliability roughly equivalent to Situation 1. When the effect of the system redundancy is included in the reliability prediction, and successful performance is defined as the transmission of signals representing *all* variables (Situation 6), the reliability formula is

$$P_s = ABD\, a^2 b^{15} [1 + (1 - ab^{10})\,(C + E - CE)]. \qquad (5)$$

As anticipated, the predicted reliability of 0.749 obtained using this formula is higher than for Situation 4, but it is again less than for Situation 1.

The principal significance of the comparison between the predictions for Situations 1, 4, and 6 is that the more nearly the reliability formula approximates the characteristics of the actual system and the engineering requirements for success, the more valid and useful is the reliability prediction. If the specified reliability for this particular system is indeed 0.8, the prediction obtained using the technique proposed in this paper indicates that the present design is adequate. The erroneously low prediction obtained using either eq (4) or eq (5) would result in substantial additional work on system design and part improvement. If the designer wisely wishes to include a safety factor in the predicted reliability, the reliability diagrams and formulas for Situation 1 enable him to determine quickly the places in the system where design changes—for example, Situation 3—or increases in part reliability are most beneficial. In fact, the greatest advantage of this technique is not that the reliability predictions are usually higher than those obtained by other methods, but rather that it leads to effective and economical plans for improving system reliability.

For further information on this reliability-prediction technique, and for derivations of exponent weighting factors and representation of statistical dependency see 1. the IRE Convention Record, Vol. 5, Part 10, 1957 and 2. reference (6).

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6. Reliability-Prediction Technique For Use in Design Of Complex Systems, by H. Elmore Blanton, Publication No. AV7M, Hycon Eastern, Inc., Jan. 21, 1957. (Copies of this report are available from the author.)

High Accuracy Servo El

ACCURACY to one second of arc is achieve by this unusual position indicating devic In addition to its applications in fire contr telemetering, missile guidance and automati control, the 12 in. "Rotary Inductosyn" may b used, in appropriate systems, as an analog digital converter, a position servo, an electroni back-lash-free gear ratio, and a high spee electromechanical phase shifter.

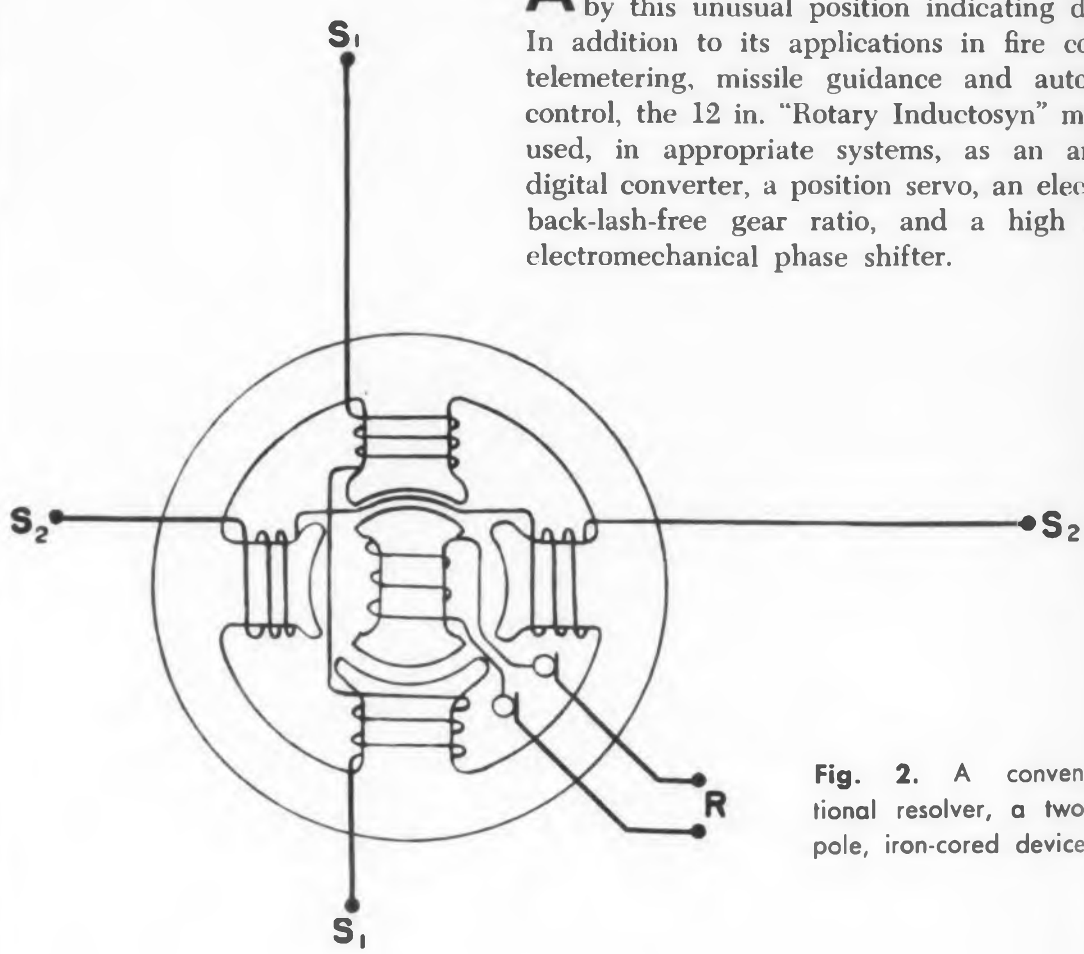

Fig. 2. A conventional resolver, a two-pole, iron-cored device.

Fig. 1. The "printed" silver conductors of the rotor (top) and stator are etched on a glass disc.

vo Element

The "Inductosyn," a two-phase device manu-lactured by Farrand Controls, Inc., 4401 Bronx Blvd., New York 70, N. Y., utilizes the inductive coupling between a pair of silver patterns on parallel glass discs, about 12 in. in diameter. A .01 in. air gap separates the stator disc from the rotor which is directly coupled to the rotat-ing shaft. The stator (Fig. 1), is divided into uccessive sectors, out of phase with each other by one-quarter cycle. Leads are brought hrough the glass to prevent interference with otor and stator magnetic fields. Due to the low oefficient of coupling, a high-frequency oscil-lator (10 kc) is used for excitation.

Functionally, the 12 in. "Inductosyn" is like a esolver that has been geared up 180 to 1, with-out the errors inherent in a geared system. Conventional electrical resolvers are iron-cored devices, constructed generally, as shown in Fig. 2. A two-pole machine is indicated in the igure, each pole being bifurcated and having indings displaced by 90 electrical degrees. The output voltages of the "Inductosyn" are xactly similar to those from a resolver except hat there are many pairs of poles. A complete oltage cycle is produced for a rotation equal o the spacing between pole pairs. The 12 in. nit has 360 poles. This corresponds to a 180 peed resolver (180 electrical cycles per rev.)

For further information about this high pre-ision device, turn to the Reader's Service ard and circle 17.

New polyclad insulation eliminates core taping

(Left) New Polyclad resin provides complete insulation, eliminates taping required for former uncoated core (shown above).

This excellent insulation, added to the unique properties of Hipersil® cores—highest permeability with lowest loss, 100% flux carrying activity, lowest volume and weight—means a better foundation for better transformers . . . smaller, lighter, more efficient, and at a lower unit cost.

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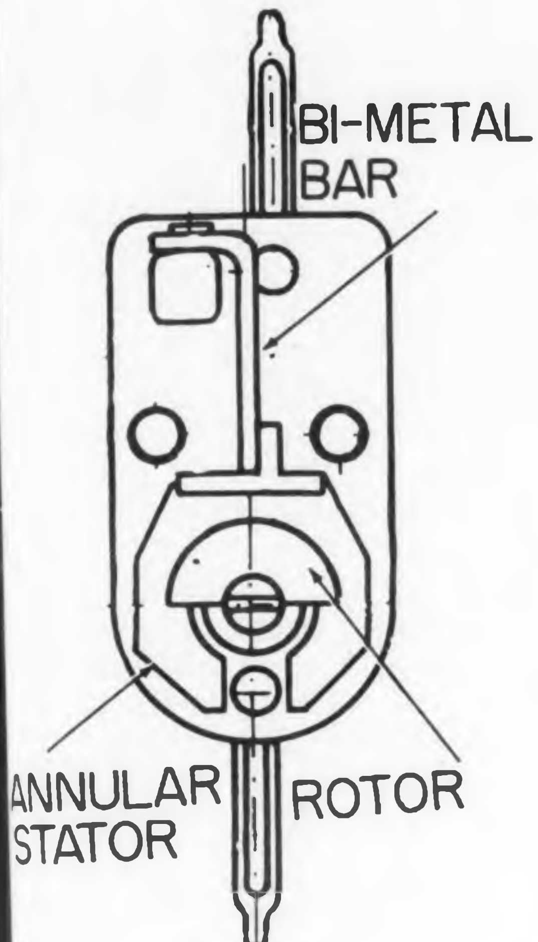
The operating principle of the Tempa-trimmer, available from British Radio Electronics Ltd., 1833 Jefferson Place, N. W., Washington 6, D. C., is that at room temperature, adjustment of the rotor does not appreciably affect interelectrode capacity. With a change of temperature, however, the annular electrode moves laterally, thereby increasing or decreasing the capacity between electrodes to an extent depending on the rotor setting.

The fact that the capacity remains substantially constant whatever the compensating angle of the rotor electrode, finds application in the following process of adjusting an oscillator for temperature variations: The oscillator is adjusted immediately after switching on, with the Tempatrimmer set approximately for the required amount of correction (if this is known); when a stable operating temperature is reached, the circuit is retuned by the Tempatrimmer only, in the knowledge that its capacitance will be restored to its initial value when the equipment cools.

Nominal capacity at room temperature is 6.5 $\mu\mu f$; Test voltage is 750 v dc at 760 mmHg; torque is 3.8 oz.-ins. The vanes and lugs are made of silver plated brass, the base is high frequency ground ceramic. The bimetal is heat treated.

For further information turn to the Reader's Service Card and Circle **20**.



ucture of variable temperature efficient trimmer. The semi-circu- electrode moves on a bimetal . The amount of temperature pensation is determined by the r setting. Nominal capacity room temperature is 6.5 $\mu\mu f$.

Editor's Note: Part I, which appeared in the Aug. 15 issue, investigated meters intended for laboratory measurements. Part III will investigate meters which could have been included in either the Laboratory or Service Groups, but because of their unusual features they are given the catch-all designation—Special Group. It will appear in the Sept. 15 issue.

VTVM Survey – II

Sol Prensky

VACUUM-TUBE voltmeters intended for general-purpose maintenance meas urements are analyzed in Part II of the sur vey. A representative cross-section of the meters has been investigated and pertinent information listed in tabular form. The survey is offered to aid the engineer in choosing a VTVM best suited to his needs. Meters included in Part II are priced at less than $150.

Circuit Type

The last column of the tabulation lis circuit design features and places eac meter in one of four general circuit type Circuit Types 1 and 2 employ dc ampli catio nand circuit Types 3 and 4 ac ampl fication. A detailed discussion of the circu types is given in Part - I of the survey.

Circuit Type 1: This circuit is a straig dc amplifier and is generally used in symmetrically balanced form. Amplifi gain stability is greatly improved by fee back, especially when more than one stag of amplification is used. Grid curren which is an inherent characteristic of th input tube, is not changed essentially by feedback, as is sometimes believed. I spite of grid-current limitations of arou 10^{-11} amp, many special applications usi electrometer type tubes are in commerci use. When the single-stage balance bridge is preceded by a rectifier, it becom a Type 2 circuit.

Circuit Type 2: A rectifier plus a sing

SERVICE METERS

Manufacturer	Model & Price	DC Scales: Voltage Range	DC Scales: Impedance Megohms	DC Scales: Accuracy Per Cent	Resistance Ranges—Ohms (CS) Center of Scale	AC Scales: Voltage Range	AC Scales: Impedance Megohms	AC Scales: Accuracy Per Cent	Freq. Range	Power Tube Compliment	Accessories	Circuit Design Features
Allied Radio 00 N. Western Ave. Chicago 80, Ill.	83Y125 Knight-Kit $24.95	1.5—1500 (7 ranges)	11	±3	Rx1—Rx1 Meg. (7 ranges) 10 (CS)	1.5—1500 (7 ranges)	.2—2 Meg. 75—50 μμf	±5	30 cps to 3 mc	AC (1) 6AL5 (1) 12AU7 (1) Sel. Rect.	Available: HV probe to 50 kv; HF probe extends ac to 250 mc. Provided: DCV, ACV, Ohms probe.	Type 2. Circuit: Rectifier and balanced bridge; printed circuitry. Peak to Peak voltage range from 4-4000.
American Chronoscope Corp. 16 W. First St. Vernon, N.Y.	601 $79.50	3—1200 (6 ranges)	13	—	1—100 Meg. (6 ranges)	3—300 (5 ranges)	6 (approx.)	—	—	BATT (2) 3V4 (1) 1A3	Batteries and dc probe included.	Type 2. Circuit: Feedback in battery-powered circuit. DC milliammeter with 6 ranges from 0-3 ma. to 0-1200 ma. at 300 mv drop.
Cornell-Dubilier Electric Corp. Hamilton Blvd. Plainfield, N.J.	BF 100 $59.50	1.5—1500 (7 ranges)	11	±3	Rx1—Rx1 Meg. (7 ranges) 10 (CS)	1.5—1500 (7 ranges)	—	±5	—	AC (1) 12AU7 (1) 6AL5	Available: HV, DC probe to 30 kv; RF probe to 30 v at 250 mc. Provided: DCV, ACV probe.	Type 2. Circuit: Peak to Peak voltage ranges from 4-4000.
Electronic Design School St. Yonkers, N.Y.	100 $52.50	3—100 (6 ranges)	11	±3	1—1000 Meg. (6 ranges)	10—1000 (5 ranges)	1000 ohms/v	±5	—	AC	Provided: Test Leads, DC probe and batteries. Available: Ediprobe, HF and HV probes.	Type 2. Circuit: Null detector position for FM TV alignment.
co-Electronic Inst. Co. Inc. Withers St. Brooklyn, N.Y.	232 KIT $29.95 (Wired $49.95)	1.5—1500 (7 ranges)	11	—	0.2—1000 Meg. (7 ranges)	1.5—1500 (7 ranges)	—	—	—	AC (1) 12AU7 (1) 6AL5	Provided: Probe with internal switch for all functions. Available: HV probe to 30 kv and RF probe to 250 mc.	Type 2. Circuit: Zero-center position provided. Peak to Peak voltage ranges from 4-4200.
Electronic Measurement Co. Lewis St. & Maple Ave. Eatontown, N.J.	106 KIT $23.90 (Wired $35.90)	1.5—1000 (5 ranges)	16.5	±3	Rx1—Rx1 Meg. (5 ranges) 10 (CS)	1.5—1000 (5 ranges)	2	±5	25 cps to 200 kc	AC (1) 12AU7	Available: HF probe to 250 mc; HV probe to 30 kv. Provided: DCV, ACV, Ohms probes.	Type 1. Circuit:
	107 KIT $34.50 (Wired $48.90)	1.5—1000 (6 ranges)	16.5	±3	Rx1—Rx1 Meg. (6 ranges) 10 (CS)	1.5—1000 (6 ranges)	1.5	±5	25 cps to 200 kc	AC (2) 12AU7	Available: HV probe to 30 kv and HF probe to 250 mc. Provided: DCV, ACV, ohms probe.	Type 2. Circuit: Measures capacity (6 ranges). Peak to Peak voltage ranges from 4-2800.
M. Harrison Labs. Winchester St. Newton Highlands 61, Mass.	735 $159.95	0—1000 (4 ranges) 3000 with multiplier	13.3 with multiplier 38.3	±4	Rx1—Rx1 Meg. (4 ranges) 20 (CS)	0—1000 (4 ranges)	—	±6 100 v ±7 over 100 v	5 cps to 50 kc	AC (1) 5751 (1) 5814 (1) 5726	Available: HF probe 1kc—100 mc.	Type 2. Circuit: Log. Scale Meter DC current 0-1000 ma ±5. Peak to Peak voltage ranges from 0-3000.
Heath Co. Territorial Rd. Benton Harbor 4, Mich.	V-78 KIT $24.50	1.5—1500 (7 ranges)	11	±3	Rx1—Rx1 Meg. (7 ranges) 10 (CS)	1.5—1500 (7 ranges) 4—4000 V P to P	750 k 25 μμf	±5	60 cps to 7 mc	AC (1) 12AU7 (1) 6AL5	Available: HV probe to 30 kv and RF probe to 250 mc.	Type 2. Circuit: Printed circuit etched copper foil. .00135 on 3/32 in. xxp laminated phenolic. Peak to Peak voltage ranges from 0-1400.
Hickok Electrical Inst. Co. 514 Dupont Ave. Cleveland 8, Ohio	209A $140.25	3—1200 (6 ranges) zero center	12	±3	Rx1—Rx1 Meg. (8 ranges) 100 (CS)	3—1200 (6 ranges)	12 7 μμf	±5	50 cps to 150 mc	AC (1) 6AL5 (2) 6X5GT (1) 6SJ7 (1) 6SN7	Provided: Inductance conversion chart and AC and DC probes.	Type 2. Circuit: Rectifier and balanced bridge circuit. Peak to peak voltage ranges from 3-300.
	225 KIT $59.50	1.5—1200 (7 ranges) zero center	10.5	±3	Rx1—Rx1 Meg. (7 ranges) 10 (CS,	1.5—1200 (7 ranges)	10 150 μμf	±5	40 cps to 3 mc	AC (1) 12AU7 (1) 6AL5	Provided: Single unit AC-DC probe.	Type 2. Circuit: Continuity test provided by audio tone. Peak to peak voltage ranges from 4-3200.
	415 $82.50	1.5—1500 (7 ranges)	13.3	±3	Rx1—Rx1 Meg. (7 ranges) 10 (CS)	1.5—1500 (7 ranges)	15 150 μμf	±5	40 cps to 3 mc	AC (1) 12AU7 (1) 6AL5	Provided: AC - DC probe ohm leads.	Type 2. Circuit: Rectifier (6AL5) and balanced bridge (12AU7) circuit.
con Mfg. Co. E. Colorado St. Pasadena 8, Calif.	614	1.5—1500 (7 ranges)	11	±3	0—1K— 0—1000 Meg. (6 ranges)	1.5—1500 (7 ranges)	1 60 μμf	±5	30 cps to 3 mc	AC 6w (2) 6AL5 (1) 12AU7	Provided: Auxiliary probe jack for rf crystal probe.	Type 2. Circuit: One-half of second 6AL5 bucks out contact potential, and second-half acts as power-supply rectifier.
kson Elec. Inst. Co. Inc. S. Patterson Bl. Dayton 2, Ohio	709 $95.00	1.0—1000 (7 ranges)	11	—	0—1000— 0—1000 Meg. (7 ranges)	1—1000 (7 ranges)	0.2 150 μμf	—	4.5 mc	AC (1) 12AU7 (2) 6AL5	Provided: Single probe with switch for DC, AC, ohms. Available: HV probe to 30 kv and HF probe to 200 mc.	Type 2. Circuit: One-half of second 6AL5 bucks out contact potential, and second-half acts as power supply rectifier. Identilite windows illuminate the selected function and large scale in use. Peak to Peak voltages range from 2.8-2800.

SERVICE METERS

Manufacturer	Model & Price	DC Scales: Voltage Range	DC Scales: Impedance Megohms	DC Scales: Accuracy Per Cent	DC Scales: Resistance Ranges—Ohms (CS) Center of Scale	AC Scales: Voltage Range	AC Scales: Impedance Megohms	AC Scales: Accuracy Per Cent	AC Scales: Freq. Range	Power Tube Compliment	Accessories	Circuit Design Features
Measurements Corp. Boonton, N.J.	62 $135.00	1—100 (5 ranges)	—	±2	—	1—100 (5 ranges)	—	±2	30 c to 150 mc	(1) 6H6 (1) 5W4 (2) 6C5		Type Circuit: Designed with stabilized, balanced degener ative amp. to make possible the changing of dc voltage ranges without read ustment of zero for each range.
Phaostron So. Pasadena, California	777 $74.95	1.5—1500 (7 ranges)	11	±3	Rx1—Rx1 Meg. (7 ranges) 9.1 (CS)	1.5—1500 (7 ranges)	—	±5	30 cps to 1 mc	(1) 6AL5 (1) 12AU7	Available: HV probe to 50 kv. DC, RF probe to 400 mc 10 per cent.	Type 2. Circuit: Rectifie (12AL5) and Balanced Bridg (12AU7) Circuit. Peak to pea voltage ranges from 0-4000.
Precise Development Corp. 2 Neil Court Oceanside, N.Y.	9071 KIT $35.95	5—1000 (5 ranges)	25	±2	Rx1—Rx1 Meg. 10 (CS)	5—1000 (5 ranges)	3	±3	30 cps to 1 mc	AC (1) 6AL5 (1) 6X5 (1) 6SN7 (1) 0A2	Available: RF probe to 250 mc; HV probe to 50 kv. Provided: DC, AC, ohms lead.	Type 2. Circuit: Voltag regulated.
	909 KIT $25.95 (Wired $37.50)	5—1000 (5 ranges)	25	±2	Rx1—Rx1 Meg. 10 (CS)	5—1000 (5 ranges)	3	±3	30 cps to 1 mc	AC (1) 6AL5 (1) 6X5 (1) 6SN7	Available: RF probe to 250 mc; HV probe to 50 kv. Provided: DC, AC, ohms lead.	Type 2. Circuit:
Precision Apparatus Inc. 70-31 84 Street Glendale 27, L.I.	68 $54.50	3—1200 (5 ranges)	13	—	— (5 ranges)	3—1200 (5 ranges)	.5	—	—	AC (1) 12AU7 (2) 6AL5	Provided: Single probe with switch for all ranges.	Peak to peak voltage range from 3-1200.
Radio City Products Co. Inc. Centre & Glendale Sts. Easton, Pa.	655 $59.50	1.5—1500 (7 ranges)	11	±3	Rx1—Rx1 Meg. (7 ranges) 10 (CS)	1.5—1500 (7 ranges)	1 40 μμf	±5	3 mc	AC (1) 6AL5 (1) 12AU7	Available: HV probe.	Type 2. Circuit: Peak fullwav rectifier and balanced bridg (12AU7) Circuit. Peak to pea voltage ranges from 4.2-4200
	65 $99.85	1.5—1500 (7 ranges)	11	±3	Rx1—Rx10 Meg. (8 ranges) 10 (CS)	1.5—1500 (7 ranges)	1 95 μμf	±5	3 mc	AC (1) 6AL5 (1) 12AU7	Provided: Jack for 6 kv DC or AC. Available: HV probe to 30 kv.	Type 2. Circuit. Six ranges c capacity 1 μμf to 1000 μ Peak to peak voltage range from 4.2-4200.
Radio Corporation of America Camden, N.J.	WV77C $59.50	0.05—1200 (5 ranges)	11	±3	Rx1—Rx1 Meg. (5 ranges) 10 (CS)	0.1—1200 (5 ranges)	1 50 μμf	±5	30 cps to 3 mc	AC (1) 12AL5 (1) 12AU7	Available: HF probe to 250 mc; HV probe to 50 kv.	Type 2. Circuit. Rectif (12AL5) and balanced brid (12AU7).
	WV87B $137.50	0.1—1500 (7 ranges)	11	±3	Rx1—Rx1 Meg (7 ranges) 10 (CS)	0.05—1500 (7 ranges)	1.3 80 μμf	±3	30 cps to 3 mc	5W (1) 12AU7 (2) 6AL5	Available: HF probe to 250 mc; HV probe to 50 kv.	Type 2. Circuit: Rectif (6AL5) and balanced brid (12AU7). Peak to peak vol age ranges from 0.2-4200.
	WV98A $79.50	0.02—1500 (7 ranges)	11	±3	Rx1—Rx1 Meg. (7 ranges) 10 (CS)	0.05—1500 (7 ranges)	1.3 60 μμf	±3	30 cps to 3 mc	AC (1) 6AL5 (1) 12AU7	Available: HF probe to 250 mc; HV probe to 50 kv.	Type 2. Circuit. Rectif (6AL5) and balanced brid (12AU7). Peak to peak vol age ranges from 0.2-4200.
Radio Kits Inc. 120 Cedar St. New York, N.Y.	O-12	3—1000 (5 ranges)	11	—	0—1000— 0—1000 Meg. (5 ranges)	3—1000 (5 ranges)	6.5	—	—	AC (1) 6SN7 (1) 6H6 (1) 6X4		Type 2. Circuit:
Simpson Electrical Co. 5200 W. Kenzie St. Chicago, Ill.	303 $68.00	1.2—1200 (5 ranges)	10	±3	Rx1—Rx1 Meg. (5 ranges) 10 (CS)	1.2—1200 (5 ranges)	275 k 200 μμf	±5	25 cps to 100 kc	AC (1) 6AL5 (1) 12AU7	Available: HF probe 20 kc to 100 mc (20 v max.); HV probe 30 kv. Provided: AC-DCV, ohms probe.	Type 2. Circuit: Rectifier and balanced bridge.
Teletronics Lab. 54 Kintel St. Westbury, L.I.	VM236 $125.00	—	—	—	—	.01—300 (10 ranges)	1	±5	10 cps to 200 kc	AC (2) 12AT7 (1) 6C4		Type 3. Circuit: Cascade am plifier.
	VM237 $95.00	1.5—1500 (7 ranges)	10	±3	Rx1—Rx1 Meg. (7 ranges) 10 (CS)	1.5—1500 (7 ranges)	10	±5	50 cps to 5 kc	AC (1) 12AU7 (1) 6AL5		Type 2. Circuit: Recti (6AL5) and balanced brid (12AU7). Peak to peak vo age ranges from 4-4000.
Triplett Elec. Inst. Co. Bluffton, Ohio	650 $89.50	1—1000 (7 ranges)	11	±3	Rx1—Rx1 Meg. (6 ranges) 10 (CS)	1—500 (6 ranges)	1.4 13 μμf	±3	15 cps to 110 mc	AC 6.5W (1) 12AU7 (2) 6AL5	Available: HV probe to 50 kv. Provided: DCV, ohms lead, ac-rf shielded tube probe.	Type 2. Circuit: Rectifier and balanced bridge circuit; meter shorted in off position for damping when carrying. Peak to peak voltage ranges from 2.8-700. Thirty per cent accuracy at 110 mc.
Weston Electrical Instrument Corp. 614 Frelinghuysen Ave. Newark, N.J.	982 $76.50	1.6—1600 (7 ranges)	10	±3	Rx1—Rx10 K (7 ranges) 25—250 K (CS)	1.6—1600 1.6—1200 (7 ranges)	2.8 1.0	±5	20 cps to 1.5 kc	DC OP. (1) CK 548 DX	Available: RF probe to 250 mc; HV probe to 20 kv. Provided: Low cap probe, isolation probe, shielded cable leads.	Type 2. Circuit: Rectifier and balanced bridge with 2 go bonded germanium diod CK 740. Peak to peak voltag ranges from 1.6-1600.

stage balanced-bridge dc amplifier make up this circuit. It is widely used for providing a combination of ac and dc volt ranges. It can be readily adopted to resistance and peak-to-peak ranges, especially for service work. When used for laboratory ac measurements, this circuit is capable of covering a frequency range up to 300 mc, if maximum voltage sensitivity is not a prime consideration. The nonlinearity of the rectifier limits accuracy in low-voltage measurements. Lowest full scale range is usually 0 to 1 v, if the wide-frequency capability is retained.

Circuit Type 3: Particularly suitable for measuring small ac voltages. This type employs an ac amplifier-plus-rectifier circuit. It has wide use in audio and low frequency applications where it is often provided with logarithmic meter indications. For laboratory use, it appears most often in an arrangement having a frequency-compensated, constant-impedance input for a multi-stage ac amplifier, with large amounts of feedback to stabilize gain and expand bandwidth. Shunt capacitance in the input circuit is fairly high, but generally acceptable for applications up to 10 mc. Lowest full-scale ranges are usually around 0 to 10 mv. Overload protection is obtained from the buffer action of the amplifier.

Circuit Type 4: This type uses a modulator for conversion of dc to ac, plus a rectifier circuit. It is capable of very high dc voltage sensitivity at a high input impedance. With chopper dc to ac conversion, only a narrow frequency response of the ac amplifier is required, since it need cover only the driver frequency as expanded by the rate of the dc input variation. Use of large amounts of feedback in the multi-stage ac amplifier allows improvement of stabilized gain and higher input impedance. In a pH application, input impedance can be made to exceed 100 megohms.

When a modulator of the capacity type is used for dc to ac conversion, an input impedance as high as 10^{15} ohms is achieved and measurement of very small voltages from a high-resistance source can be made. Current measurements in the micromicroampere range are attainable. At measurement levels or around 100 mv, zero stability of this circuit becomes better than that of the chopper type.

The less common galvanometer-type modulator allows full-scale measurements as low as 0 to 10 μamp at a 50 ohms input resistance, with long-term stability ±0.2 ...

250 Mc Coaxia

Radio frequencies up to 250 mc can be switched by this coaxial switch making possible the use of one detector for signal comparisons.

A COAXIAL switch which can handle rf sig-nals up to 250 mc makes it possible to use one detector for both the reference circuit and the unit being tested. Consequently, the possibility of error caused by non-identical detectors is avoided.

The switch manufactured by Jerrolds Elec-tronic Corp., 23rd and Chestnut Sts., Philadel-phia 3, Pa., utilizes two Clare Mercury Wette switch elements mounted in a coaxial circuit. Th unit has a maximum current rating of 5 a at 50 v and can be supplied for either 50- or 75-ohm lines with a vswr of less than 1.08 from 0 to 25 mc. The insertion loss of the unit is approxi-mately 1/2 db.

Telemeter Decommutatio

A 27-channel, completely self-contained de-commutation system has been develope for use in airborne or trailer-installed telemete receiving stations and in portable ground check-out equipment. The system, consisting of a ga ing unit, a pulse selector, and a regulated pow supply, occupies 19-1/2 in. of panel height wi an overall depth of 13 in. Two spare modul gating units are maintained on standby for in stant use.

This twenty-seven chan decommutation system cons of a gating unit (top), a pu generator (middle) and a reg lated power supply (botto The system measures 19-1/2 high and 13 in. deep.

Switch

The switching functions are controllable by a blocking oscillator synchronized to some submultiple of the 60 cps of the line. Synchronization is obtained by varying a potentiometer through a screwdriver control. A phase reverse switch and a phasing control are provided for adjusting the phase with respect to the line. Gain adjustment is obtainable with the use of an rf attenuator which must be connected externally to the switch.

When used in conjunction with an oscilloscope, the switch displays two voltages simultaneously for qualitative measurements, making point-by-point analysis unnecessary.

For additional information concerning this coaxial switch, fill out the enclosed Reader's Service Card and Circle 25.

System

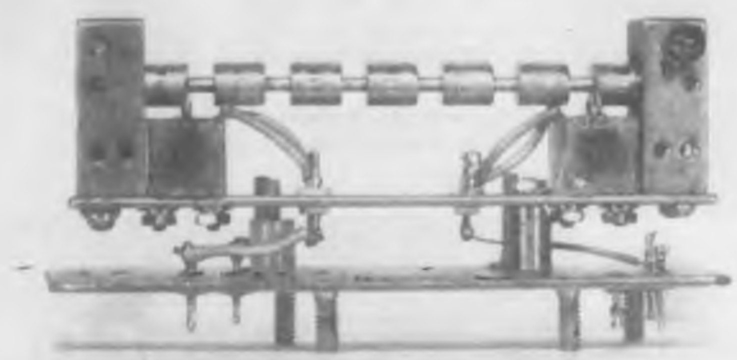
All standard RDB inputs, either PAM or PDM, at any repetition rate from 2-1/2 to 40 rps, and either single-ended or push-pull signals are accepted. Outputs may be operated single or double ended. The overall linearity is within 1/2 per cent at maximum signal level. Circuitry design does not reflect errors produced by center frequency drift of subcarrier oscillators, drift of discriminator dc output level, or playback speed errors. Long term level drift is within 1/2 per cent and gain drift is negligible.

The system, manufactured by Arnoux Corp., 11924 West Washington Blvd., Los Angeles 66, Calif., includes a built-in test selector which permits visual inspection of waveforms throughout for rapid malfunction detection. Neon indicators on each gating unit give continuous visual indication of correct sequence operation.

Miniaturization is accomplished through the use of seventy-six tubes in the design as compared to a hundred in similar systems. Modular construction permits the expansion of the system to any desired capacity.

The power required by the unit is 115 v, 60 cps single phase. An optional 115 v, 400 cps power supply is available for airborne use.

Further information on the decommutation system may be obtained by filling out the enclosed Reader's Service Card and circling 26.



Ferrite Transducers for Electromechanical Filters

Glyndon S. Hipskind
Radio Corporation of America

An interesting application for the magnetostrictive property of ferrites is in an electromechanical filter. Such a filter, which can be an extremely selective band-pass device, consists of an input transducer, a section of mechanically coupled resonant elements tuned to a specific frequency, and an output transducer. Ferrite rods or cores are used as the input and output transducers. Assume that a small ferrite rod having relatively high magnetostrictive characteristics is placed in a coil in such a manner that the rod is free to vibrate. Then a small permanent magnet is placed near the coil assembly to supply a biasing effect on the core. If the coil assembly is excited with an ac signal, the circuit can be tuned by means of capacitor so that the coil energy is absorbed by the core. The core is mechanically resonant and the energy of the coil is used to provide mechanical motion to the core.

Such a device is a transducer converting electrical energy to mechanical energy. A reversal of energy conversion can also take place. If the core is provided with mechanical motion, it will induce a current in the coil at the same frequency as the mechanical motion of the core. The important parameters for the evaluation of a ferrite rod for transducer applications and methods for the measurement of these parameters are described in this article. Empirically obtained values for these parameters are given for rods having differences in size, composition, and firing conditions. In conclusion, performance data including frequency-response and temperature stability characteristics are given for a developmental electromechanical 200 kc filter utilizing ferrite-rod transducers.

In any magnetostrictive transducer the efficiency of operation depends upon the magnetostrictive activity of the core or resonator material. One useful way to express this efficiency is by the coefficient of coupling between a given coil and the associated core. The coil with core in place may be represented by the equivalent circuit shown in Fig. 1. In this figure, L is the inductance of the coil with resonator in place, K is the coefficient of coupling, and C is the distributed capacitance of the coil plus any external capacitance necessary to resonate the coil. The antiresonant frequency of the parallel branch of the circuit is the same as the natural frequency of the resonator; the Q of the parallel branch is the same as the mechanical Q of the resonator. The impedance of the parallel branch may be expressed as

$$Z_\rho = \frac{j\omega K^2 L}{1 - \omega^2 K^2 LC}. \qquad (1)$$

For the frequency where the circuit is series resonant, the total impedance Z will be equal to zero, neglecting the resistance of the coil.

Let ω_2 be the series resonant frequency; then,

$$Z = j\omega_2 L + \frac{j\omega_2 K^2 L}{1 - \omega_2^2 K^2 LC} = 0 \qquad (2)$$

and

$$K^2 = \frac{1}{\omega_2^2 LC - 1}. \qquad (3)$$

Let ω_1 be the frequency at which the parallel branch of the circuit is at resonance (antiresonance condition); therefore:

$$LC = \frac{1}{\omega_1^2 K^2} \qquad (4)$$

Substituting the value of LC from eq (4) in eq (3),

$$K = \frac{(\omega_2 + \omega_1)(\omega_2 - \omega_1)}{\omega_1^2}. \qquad (5)$$

If it is assumed that $\omega_2 \approx \omega_1$ then

$$K = \frac{1}{\sqrt{\frac{\omega_1}{2(\omega_2 - \omega_1)}}} = \frac{1}{\sqrt{\frac{f_1}{2(f_2 - f_1)}}} \qquad (6)$$

The coefficient of coupling K, therefore, can be determined with eq (6) from f_2, the seeries resonant frequency of the circuit, and f_1, the natural resonant frequency of the core.

Natural Resonance and Propagation Velocity

The resonant frequency of the ferrite core is a function of the velocity of propagation of sound through the body, Young's modulus, the length of the core, and the density of the core material. For rods vibrating in the longitudinal mode, this frequency is expressed by

$$f_1 = \frac{M}{2l}\left(\frac{E}{\rho}\right)^{\frac{1}{2}} \qquad (7)$$

Where f_1 is the frequency in cycles per second, n is a small integer (for the fundamental frequency, $n = 1$; for the second harmonic, $n = 2$; etc.), l is the length of the rod in meters, ϱ is the density of the rod in kilograms per meter³ and E is Young's modulus in newtons per meter². The expression $(E/\rho)^{\frac{1}{2}}$ is equal to the velocity of propagation in meters per second.

Because the rod is not affixed at either end, it is free to vibrate as a half-wave resonator. The velocity of propagation of sound through the ferrite medium, therefore, is given by:

$$V = f_1 \lambda \qquad (8)$$

where v is the velocity of propagation, f_1 is the resonant frequency, and λ is the full-wave length, all in meters.

Testing Procedures

The coefficient of coupling may be measured by means of the circuit arrangement shown in Fig. 2. The frequency of the signal generator is adjusted until the voltmeter reading is a minimum. This reading indicates the antiresonant condition: the impedance of the coil is a maximum and the current is a minimum. This frequency is recorded as f_1. The frequency of the signal generator is then increased until the voltmeter reading is a maximum. This reading indicates the series-resonant condition. The frequency at this point is recorded as f_2. The coupling coefficient may now be calculated from eq (6).

The coefficient of coupling depends to some extent upon the coil design. Such factors as how close the winding is to the core, how long the coil is with respect to the core, and how the cores fit into the coil form affect the coefficient values.

Initial Permeability

Another characteristic of importance is the initial permeability of the core material. Because of its relationship to the termination impedance of a filter using ferrite transducers, the permeability of the ferrite must be controlled within very close limits. Since the ferrite is in the form of a rod instead of a ring, this property can be controlled by measuring the effective permeability in place of the actual ring permeability. The effective permeability is defined as the ratio of the inductance of the coil with core inserted to the inductance of the coil with an air core. This effective permeability — μ_{eff} — is measured with a Q-meter and may be expressed

$$\mu_{eff} = \frac{C\ (\text{coil only})}{C\ (\text{coil with core})} \cdot \tag{9}$$

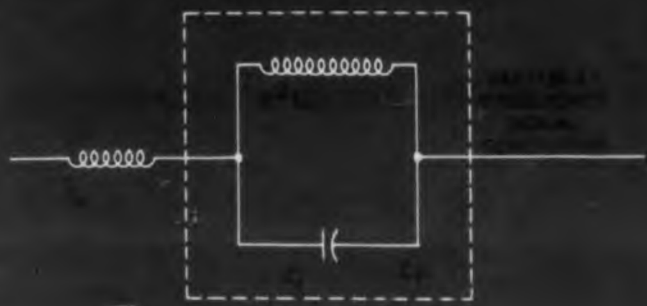
The capacitance C indicated on the meter for both conditions is measured at the same frequency.

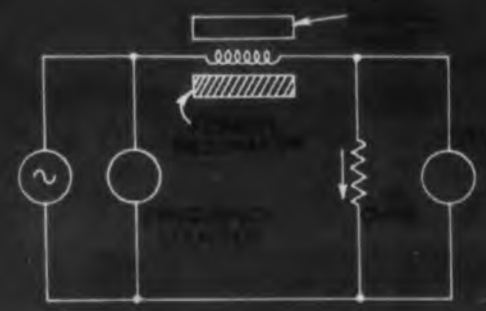
Frequency Stability

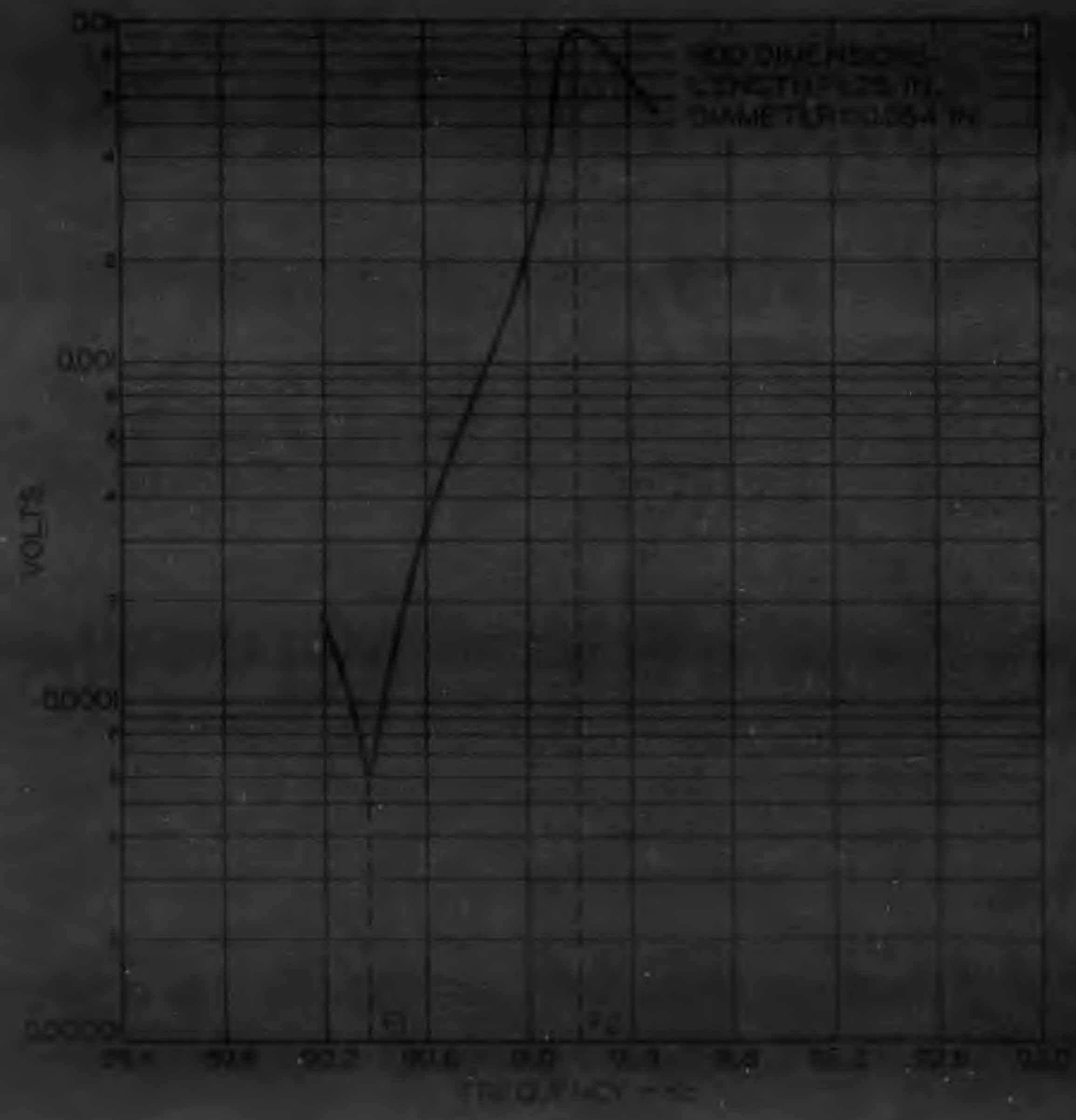
The frequency stability of the core depends on the change of permeability of the ferrite resonator with temperature as well as the magnetostrictive quality. The exact extent of this change, expressed as a temperature coefficient, depends upon the composition and processing conditions. This temperature coefficient is most easily determined by measurement of the resonant frequency of the ferrite resonator at different temperatures. The coefficient is expressed as follows:

$$a = \frac{f_{t_2} - f_{t_1}}{(t_2 - t_1)\, f_{t_1}} \times 10^6 \tag{10}$$

where a is the temperature coefficient in cycles per mc, f_{t_1} is the resonant frequency at room tem-







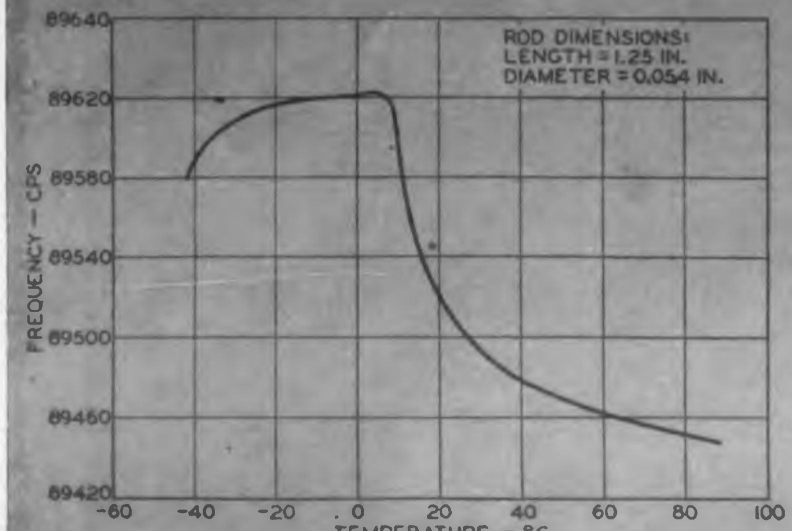


Fig. 4. Temperature stability characteristic of a 100 kc ferrite resonator.

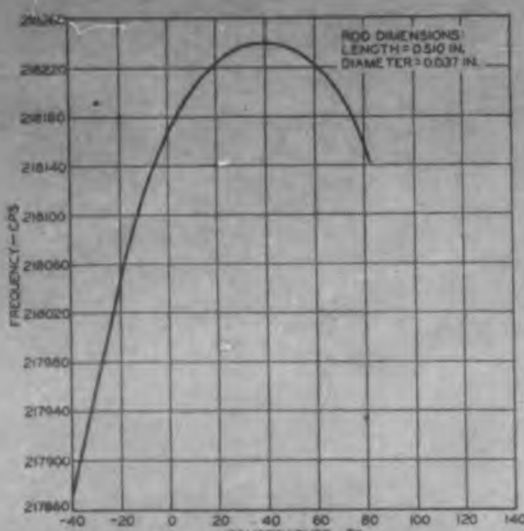


Fig. 5. Temperature stability characteristic of a 200 kc ferrite resonator.

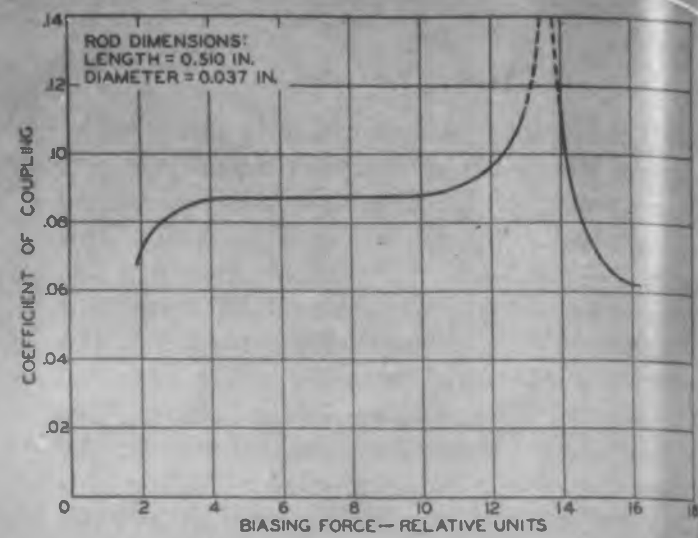


Fig. 6. Effect of change in biasing force on coefficient of coupling.

perature t_1, in deg C and f_{t2} is the frequency at any other temperature, elevated or reduced, t_2. The resonant frequency for determining the temperature coefficient is measured in the same way as the resonant frequencies for the coupling coefficient.

Experimental Results

Fig. 3 shows a typical frequency-response curve of a ferrite resonator core. The ratio of the peak voltage to minimum voltage is about 150 or 200 to one. As previously stated, the anti-resonant frequency, f_1, of the parallel branch is the natural resonant frequency of the core. The series resonant frequency f_2 is about 1000 cycles above frequency f_1. The greater the difference between f_1 and f_2, the greater the coefficient of coupling.

Five ferrite rods having different compositions or firing conditions, each 0.510 in. long and 0.37 in. diam and designed for operation in the vicinity of 200 kc were tested for coupling coefficient, resonant frequency, Young's modulus, velocity of propagation, effective permeability, and density. The results are given in Table 1. With the addition of small amounts of impurities, the coefficient of coupling increases. This increase continues until somewhat over the 1 per cent impurity point is reached. It then decreases. The value of Young's modulus increases with addition of impurities. The velocity of propagation decreases slightly with small additions of impurities, but further impurity additions cause an increase in velocity. Effective permeability increases with the addition of impurities regardless of the change in firing conditions. The densities show a slight decrease with the addition of impurities.

Table 2 lists the various parameters for two 100 kc ferrite rods produced under different conditions. There is a considerable difference in almost every parameter, but the two that stand out most are the values for the effective permeability and density.

The frequency vs temperature characteristics of a 100 kc transducer rod are given in Fig. 4. The temperature range studied was —40 to 85 C. It will be noted that the frequency increases with increase in temperature until 4 C is reached. At this tem-

Table 1. Parameters for different ferrite rods 0.510 in. long and 0.037 in. diam designed for operation at approximately 200 kc.

Composition	Coeff. of Coupling K (per cent)	Resonant Frequency f_1 (cps)	Young's Modulus E (newtons/m²)	Velocity of Propagation v (m/sec)	Eff. Perm. μ_{eff}	Density ρ (kg/m³)
Ni Ferrite	.1253	219899	1.65 x 10	5,740	2.45	5.30×10^3
Ni Ferrite with 1/3 per cent impurity added	.1450	217903	1.681 x 10	5,680	2.74	5.21×10^3
Ni Ferrite with 1/3 per cent impurity added. Fired under different conditions than above.	.1495	218052	1.692 x 10	5,690	2.66	5.23×10^3
Ni Ferrite with 1 per cent impurity added	.1593	220358	1.718 x 10	5,750	2.82	5.19×10^3
Ni Ferrite with 2 per cent impurity added.	.1389	222941	1.765 x 10	5,820	3.02	5.21×10^3

Table 2. Parameters for two 100 kc ferrite rods 1.25 in. long and 0.054 in. diam produced under different conditions.

Composition	Coeff. of Coupling K (per cent)	Resonant Frequency f_1 (cps)	Young's Modulus E (newtons/m²)	Velocity of Propagation v (m/sec)	Eff. Perm. μ_{eff}	Density ρ (kg/m³)
Ni Ferrite	.1445	90406	1.700 x 10	5,760	7.66	5.12×10^3
Ni Ferrite	.1288	91381	1.815 x 10	5,800	4.60	5.39×10^3

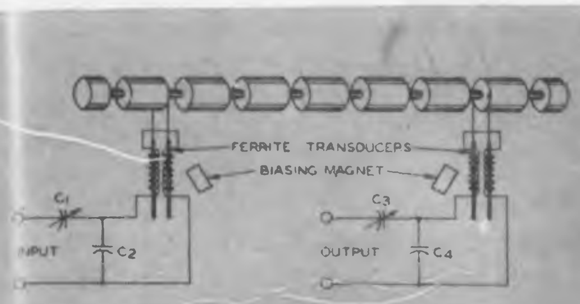


Fig. 7. Schematic diagram of electromechanical filter using Ni-span filter elements and ferrite transducers.

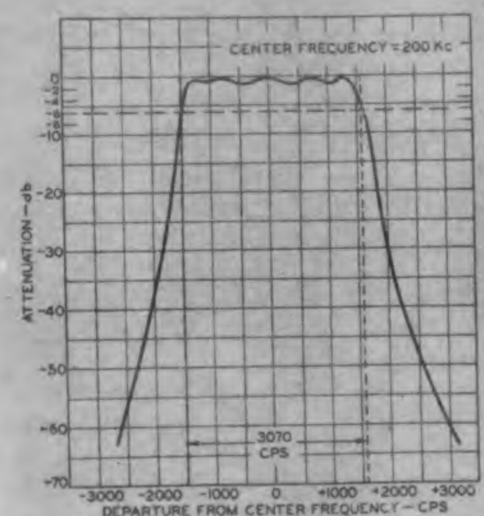


Fig. 8. Frequency response characteristic of 200 kc electromechanical filter.

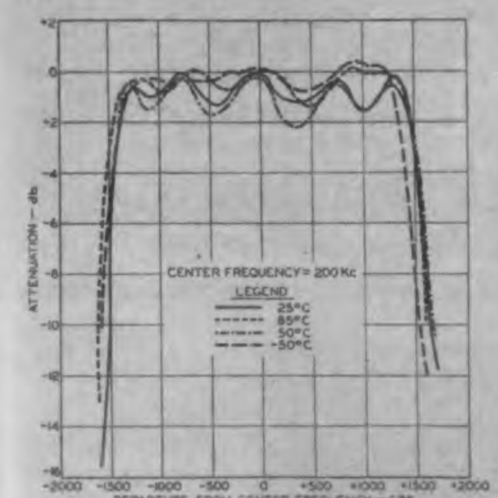


Fig. 9. Temperature stability characteristic of 200 kc electromechanical filter.

...erature, the frequency decreases quite rapidly and ...en shows a tendency to level off. The coefficient is ...sitive between -40 and 4 C and negative for ...mperatures above 4 C.

A similar frequency-temperature study, made for ...0 kc rods, is given in Fig. 5. The same general trends exist except that the curve rises faster and peaks at a higher temperature than does the curve for the 100 kc rods. There is no indication of a tendency for frequency response to level off as it does for the 100 kc rod.

Although the 100 and 200 kc rods were made of the same compounded material extruded in the same manner, they have different characteristics due, undoubtedly, to differences in extrusion pressures for each size.

Another interesting feature of this magnetostrictive material is the effect of the biasing force on the coefficient of coupling. Fig. 6 shows the results of a typical core subjected to different biasing forces produced by changes in the position of a permanent magnet. With a very weak field, the coefficient of coupling is low. As the field is increased, the coefficient increases and then levels off. A further increase in bias causes the coefficient to increase at a very rapid rate. The maximum value is limited only by the effective resistance of the circuit. With still further increase in the biasing force, the coefficient of coupling again drops off. Obviously there are bias limits within which the rod vibrates most efficiently; the extent of this range depends on the composition and processing conditions of the rod.

Use as Transducer in Mechanical Filter

The best proof as to the effectiveness of these ferrites as transducers is how they perform in an actual filter. A complete filter was built using transducer elements having a coupling coefficient of 0.14 to 0.17, an effective permeability of 2.46 ± 3 per cent and a temperature coefficient of $\pm$ 35 cycles/C/mc. Fig. 7 is a schematic diagram of the filter. The filter was tuned by means of capacitors C_1 and C_3 for a 200 kc center frequency. After the tuning, the capacitor received no further adjustment for the remainder of the tests. Several response curves were taken at various temperatures. The filter was placed in an oven for elevated temperature tests and in a ventilated box with dry ice for the tests below room temperature. The frequency response of the filter is given in Fig. 8. The bandwidth, measured at the -6 db point, is a little over 3,000 cycles. The peak-to-valley variation is not more than 2 db over the passing range. The sides of the curve are quite steep as far down as -50 to -60 db.

Fig. 9 shows the temperature characteristics of this filter for temperatures ranging from -50 to $+85$ C. The greatest peak-to-valley variation occurs at a temperature of 50 C; however, the value is not more than 2 db. The bandwidth is approximately the same for all temperatures.

The author wishes to express his appreciation to Messrs. George Katz and R. E. Hurley who made the magnetostrictive ferrites; to R. D. Hunter who conducted the tests on the rods and filter; and to L. Dimmick who built and supplied the filter.

New Products

Miniature Inertia Switch

Weighs 3/4 Oz, Has One Moving Part

This miniature inertia switch is designed to eliminate friction and sticking causing unreliable function, costly, complicated mechanisms, and waste space. A single moving part held in a magnetic field momentarily closes electrical contacts, following impact or acceleration above a preset value. Switch setting easily adjustable from 1.5 g up, tolerance ± 0.15. Volume, 1/2 cu. in. Weight, 3/4 oz.

Safe Lighting, Inc., Dept. ED, 527 Lexington Ave., New York 17, N.Y.

CIRCLE 29 ON READER-SERVICE CARD FOR MORE INFORMATION

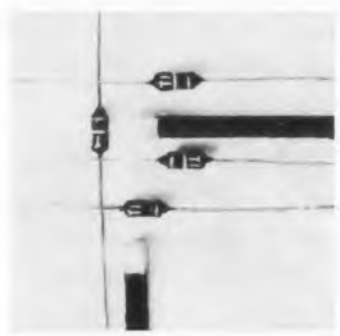
Telemetering Switch

Operates Up to 200,000 Ft

This multichannel sampling switch is designed for use in missile telemetering applications. The cylindrical pressure sealed container allows the switch to operate at altitudes up to 200,000 ft and in temperatures from 125 down to -65 C. This switch is available with from one to five poles with up to 60 contacts per pole, at sampling speeds ranging from 0.5 to 30 rps. The various motor drives offered include 6, 12, and 27.5 v dc governed or ungoverned, 60 cps single phase, or 400 cps single or three phase. The governed dc units have a speed regulation of ± 3 per cent. The construction will withstand 150 g shocks and 100 g continuous acceleration bi-directional in each of 3 planes, and a vibration of from 20 to 2000 cps at 20 g for 1/2 hr. This switch will provide continuous operation for 100 to 1000 hr depending upon the sampling speed, the severity of environmental conditions, and the quality of switching required.

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

CIRCLE 30 ON READER-SERVICE CARD FOR MORE INFORMATION



Diffused Silicon Diode

400 Ma, 600 V Peak Inverse

The diffused silicon diode/rectifier features 400 ma average rectified forward current plus 600 v peak inverse voltage ratings. The IN649 highlights a guaranteed minimum 2-million-to-1 forward to reverse current ratio. Other significant parameters on the unit include 1.25 a recurrent peak forward current rating, a 3 a surge current (one sec), 600 mw power dissipation, and a 720 v breakdown voltage.

Four other silicon diode/rectifiers, the IN645, IN646, IN647, and IN648, all diffused silicon glass devices, differing from the IN649 only in peak inverse voltage (225 to 500 v), breakdown voltage (275 to 600 v), and reverse current ratings at elevated temperatures, have also been introduced.

Texas Instruments Inc., Dept. ED, Semiconductor Components Div., 2929 Cedar Springs Rd., Dallas 21, Tex.

CIRCLE 31 ON READER-SERVICE CARD FOR MORE INFORMATION

Plug-in Transformer

For Printed Circuits

High precision plug-in transformers for printed circuit application are epoxy encapsulated units designed for maximum moisture resistance and insulated for high operating temperatures. Plug-in terminals are spaced on multiples of 0.1 in. for standard grids.

Celco Constantine Engineering Labs. Co., Dept. ED, Island Ave., Mahwah 1, N.J.

CIRCLE 32 ON READER-SERVICE FOR MORE INFORMATION

Miniature Molded Composition Resistor

0.14 In. Long

Molded composition resistors in a 1/10 w si[ze] are 0.067 in. in diam and 0.14 in. long. Lead wir[es] are hot-solder-coated for rapid soldering. The units are available in RETMA values from 1[illegible] ohms to 1 megohm, ± 10 per cent tolerance.

Ohmite Manufacturing Co., Dept. ED, 36[illegible] Howard St., Skokie, Ill.

CIRCLE 33 ON READER-SERVICE CARD FOR MORE INFORMATION

High-Speed Counter

Electrical Reset

The Model MCRP-700 is a high-speed, precision ounter developed to add or subtract electrical pulses with optional microswitch control at zero evel and featuring electrical reset to any predeter-mined number. The lightweight armature, which ctuates the counting mechanism, is dynamically balanced to provide accurate counting under severe vibrations. The unit can be furnished as a three, four, or five digit counter with any combination of add, subtract, and microswitch control at zero evel.

Photocon Research Products, Dept. ED, 421 N. ltadena Dr., Pasadena, Calif.

CIRCLE 35 ON READER-SERVICE CARD FOR MORE INFORMATION

Right-Angle Gear Motor

75 RPM

This right-angle gear head motor is 2 in. in diam, 0 cps, 115 v, single phase. With an output speed 75 rpm, the motor is designed especially for tape ecording, aircraft, and numerous other applica-ons requiring moderate torque at low speeds.

Air-Marine Motors, Inc., Dept. ED, 369 Bayview ve., Amityville, N.Y.

CIRCLE 36 ON READER-SERVICE CARD FOR MORE INFORMATION

3 In. Cathode Ray Tube

26 to 35 V/In. Vertical Sensitivity

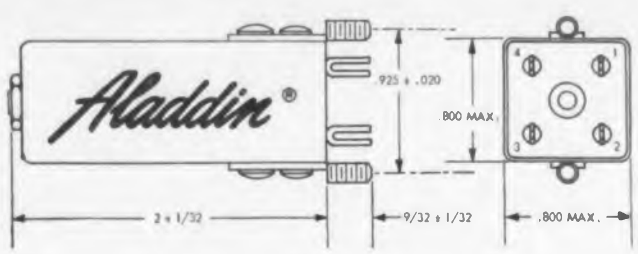
The rectangular 3-in. cathode ray tube has a rtical sensitivity of 26 to 35 v dc per in., which achieved with a second anode voltage of 1000 v. hen an extremely well defined spot is required for h resolution and optimum brightness, the tube n be operated with 2000 v at the second anode. der these conditions the vertical sensitivity is to 70 v per in. The tube is available in P1, P2, P7, d P11 phosphors.

Waterman Products Co., Inc., Dept. ED, 2445 merald St., Philadelphia 25, Pa.

CIRCLE 37 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW ENGINEERING BULLETIN LISTS 120 DIFFERENT COMBINATIONS OF FREQUENCY RANGE AND CONSTRUCTION STYLE . . . LIKE THIS:

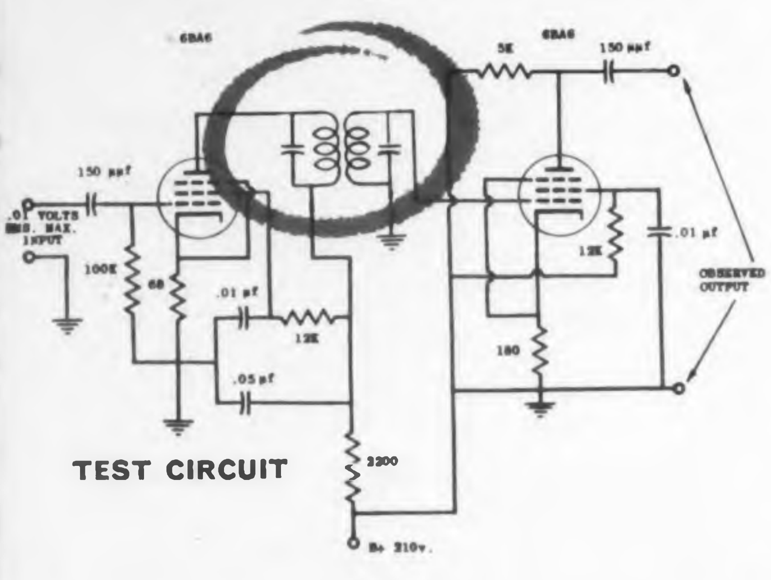
esign your IF strips with Aladdin standard transformers



I. F. SPECIFICATIONS

ALADDIN PART NO.	FREQ. KC	BANDWIDTH KC ±10% 3DB	6DB	20DB	40DB	LOADED Q
*—250	50	3.5	5	12.5	39	19
*—285	85	4	5	12.4	40	31
*—313	132	5.2	6.9	17.4	56	35
*—326	262	7	9.2	22.6	13	52
*—337	370	9.9	12.2	30.1	96.5	54
*—346	455	10.3	14	33.6	108	61
*—350	500	11.9	15.5	37.8	122	57
*—380	800	23	30.1	72.9	236	49
*—410	1000	27.6	36.1	87.9	286	50
*—415	1500	32.8	43.2	106	346	63
*—417	1700	35.7	46.5	113	369	67
*—418	1800	39.5	50.9	123	396	65
*—420	2000	36.4	47.6	117	375	76
*—422	2200	43.7	55.8	137	441	71
*—425	2500	46.2	59.1	144	466	77
*—427	2700	52.4	68.1	165	504	74
*—429	2900	52.4	68.3	167	541	77
*—440	4000	76.5	98.8	241	790	74
*—511	10700	203	258	643	2130	74
*—525	25000	296	390	970	3010	117

*Supply proper prefix. See text for available styles.



TEST CIRCUIT

20 standard frequencies, from 50 kc to 25 mc. Military and commercial quality units. Four pages of text on IF transformer theory. Performance data and test circuits. Tables of engineering data on performance characteristics of *available* IF transformers.

***WRITE** on Company letterhead for this new Aladdin bulletin*

Aladdin® ELECTRONICS

A Division of Aladdin Industries, Inc.
719 Murfreesboro Road
Nashville, Tennessee
Tarrytown, N.Y.; Pasadena, Calif.

New Products

Waveguide Pressure Window

Low VSWR From 12.4 to 18 Kmc

A broadband waveguide pressure window, designated MA-1342, provides low vswr operation across the 12.4 to 18 kmc freq range. The window provides a vacuum-tight seal when mounted between choke flanges in RG-91/U waveguide, but is transparent to rf energy over the specified freq range. Vswr at the band extremes is less than 1.2. The window will withstand 125 kw of applied power without arc-over at atmospheric pressure. Maximum pressure ratings are 45 psi on the glassed-in side and 30 psi on the reverse side of the window. The window cover flange thickness is 0.06 in. Materials used are low-loss glass which is sealed into a kovar metal flange of appropriate dimensions.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

CIRCLE 40 ON READER-SERVICE CARD

Ferrite Isolators

X and K_E Bands

Model IXL1, an X-band type, has frequency range of 8.5 to 9.6 kmc provides greater than 18 db isolation weighs 6 oz, and is 1-1/8 in. long. Model IK_EL1, another standard type covers a range of 13.2 to 13.7 kmc in the K_E band with greater than 20 db isolation; it weighs 7.5 oz and is less than 1-1/2 in. long. Modified standard units with flanges rotated to any desired twist angle are available on order, thus providing versatility for system packaging with negligible increase in insertion length.

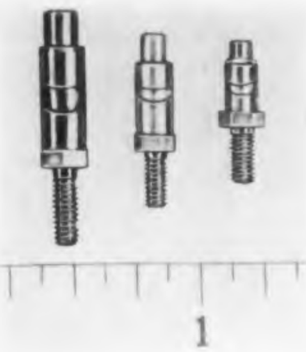
Raytheon Mfg. Co., Dept. ED, Special Microwave Dveice Group, Seyon Bldg., Waltham 54, Mass.

CIRCLE 41 ON READER-SERVICE CARD

◄ CIRCLE 39 ON READER-SERVICE CARD

Diode Clips

Spring Loaded



Two spring-loaded diode clips have been designed to hold securely diode pigtail leads. The two, plus one other previously offered, can handle pigtail leads in sizes from 0.005 to 0.085 in. diam.

The smallest size clip has been designated as X2146 when furnished with a screw stud and X2147 when furnished with a rivet mounting. The middle size clip has been designated as 2329 with a screw stud and 2330 with a rivet mount; the large diode clip is 2339 with a screw stud and 2340 with a rivet mount. Each of the three rivet mounted clips is available with five different shank lengths.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge, Mass.

CIRCLE 43 ON READER-SERVICE CARD

AC Motors

Induction, Torque and Hysteresis

The 3800 Frame series of ac motors, designed for induction, torque or hysteresis synchronous applications, is available with input voltages of from 6 to 230 v, 1, 2, and 3 phase with an input frequency from 25 to 400 cps. For induction applications, units in this series are offered in outputs to 1 hp; torque motors 10 to 200 oz in. stall torque; hysteresis synchronous 1/200 to 1/4 hp. Motors can be wound for single, dual, or three speed, and can be supplied as self cooled with integral fan. Units in this frame series vary in weight from 8 to 11 lb. All can be used as fan and blower motors and as permanent magnet generators.

Induction Motors Corp., Dept. ED, Main St., Westbury, N.Y.

CIRCLE 44 ON READER-SERVICE CARD

CIRCLE 45 ON READER-SERVICE CARD ➤

New Products

AC Accelerometer

High Response

An ac output linear accelerometer for high response systems, this unit has an accurate, large output signal obtained while maintaining high natural frequency and low cross talk. Temperature-compensated fluid damping maintains constant damping over the operating temperature range without a heater, and according to the company, provides exceptionally good dynamic characteristics.

Available in a wide selection of g ranges, the accelerometer meets MIL-E-5272A for all conditions with the following variations: temperature range from —40 to 185 F; shock to 60 g; and vibration of 30 g, 10 to 2000 cps.

Pacific Scientific Co., Dept. ED, P.O. Box 22019, Los Angeles, Calif.

CIRCLE 48 ON READER-SERVICE CARD FOR MORE INFORMATION

Two Phase Power Supply

Total Output of 550 VA

This supply is designed for the development and testing of 400 cps servo systems, two phase gyro motors and similar components. Three continuously variable outputs—two at zero degrees and one at ±90 deg provide flexibility. No. 1 output provides 0 to 225 v, 1 a, zero phase; No. 2 provides 0 to 225 v, 1 a, zero phase; and No. 3 provides 0 to 130 v, 1 a, ±90 phase. Phase switch allows output no. 3 to be switched to either lead or lag outputs no. 1 and no. 2 by 90 deg. Input is 115 or 200 v line to line, 400 cps, 3 phase. The unit measures 22 x 15 x 11 in., and weighs 51 lbs.

Pacific Technical Co., Dept. ED, 2047 Sawtelle Blvd., Los Angeles 25, Calif.

CIRCLE 49 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnetic Voltage Regulator
400 Cps Applications

Type TMH7101 is designed for 400 ∼ single phase applications where requirements demand lightweight equipment. It has no tubes, transistors or moving parts. The unit can be ordered cradled on a shock mount. Input is 95 to 130 v for nominal output voltage; output is 115 v nominal, adjustable from 110 to 120 v; load is 1.0 kva; stabilization and regulation is 1.0 % bandwidth for line voltage variation. It measures 7-3/4 x 5 x 14-3/8 in. to fit military standard case MS91403-1B.

The Superior Electric Co., Dept. ED, 83 Laurel St., Bristol, Conn.

CIRCLE 52 ON READER-SERVICE CARD

Temperature Probes
For Low Measurements

For precise measurements at very low temperatures. Model S-101 is a wafer type thermistor used for liquid oxygen at temperature range of —185 to —170 C. Model S-102 is designed for measurement of air with a range of -20 C to 100. The S-105 probe is designed to determine temperature ranges of electronic components, and operates from 0 C to 60 C with an accuracy ±2 per cent of resistance. A three-point temperature vs. resistance calibration is available for all probes except Model S-101.

Gulton Industries, Inc., Dept. ED, Metuchen, N.J.

CIRCLE 53 ON READER-SERVICE CARD

CIRCLE 54 ON READER-SERVICE CARD ➤

CIRCLE 56 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Recording Potentiometer

Two Continuous Record

This recording potentiometer features 2 pens both writing margin to margin on a single 5-in strip chart, producing two continuous records. Th recorder is available with one front set limit switc and 3 back set limit switches on each pen. The am plifiers are completely transistorized. The instru ment offers 0.5 per cent accuracy on each pen, 0.1 per cent of scale span sensitivity, and maximum source impedance of 1000 ohm per mv of span. Th case extends 13 in. behind the panel face. Option features include transmitting slidewires, quic change or manual change gears for 3 speed cha drive, selsyn motor, or synchronous motor cha drive, automatic reference junction compensatio table or panel mounting and margin marker pens.

Westronics, Inc., Dept. ED, 3605 McCart S Fort Worth, Tex.

CIRCLE 57 ON READER-SERVICE CARD FOR MORE INFORMATI

Load Sentry

Controls Overload

Load Sentry, a fail-safe electro-mechanical ove load control, is intended for use wherever overlo of any kind may be registered on an electric mot It is built around the positive action of a conta meter-relay. It is readily hooked into start-st switches. The maximum load to be permitted the motor being monitored is set by an adjusta pointer anywhere on the dial of the meter-rel The dial has 30 divisions, ranging from zero to 1 per cent of normal load. Another pointer indica the actual running load on the motor. When t pointers meet at an overload position, contacts lo and the circuit is broken. The Load Sentry will th sound an alarm and/or shut down the system.

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

CIRCLE 58 ON READER-SERVICE CARD FOR MORE INFORMA

Coaxial Switch

Remotely Controlled

This remotely controlled coaxial switch, Type 10, provides 4-sec switching of 3-1/8 in. coaxial ...smission line to standby equipment at frequen... up to 1000 mc. It can be used in high power ...mmunication systems, as well as uhf and vhf ...levision stations. Use of these switches eliminates ...e-consuming manual changes of coaxial trans...ssion line connections. Standby equipment may ... quickly checked under actual operating condi...ns. In the event of main equipment failure, the ...re equipment is switched in with negligible off-...e-air time. The switch is operated from 115 v, ... cps. Other motors are available on special order. ...ntrol circuitry includes a wafer switch for use ... remote position indication circuits. The micro...itch is mechanically linked to the switching ...chanism so that transmitter power is removed ...fore switching and is reapplied only after new ...ntact is made.

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

...CLE 60 ON READER-SERVICE CARD FOR MORE INFORMATION

DC Power Supply

Dual Range

The EFB dc power supply is designed for tran...or circuitry. Designed to operate under almost ... voltage input condition, the unit supplied a ...tinuous variable power source from 0 to 16 v ... current loads to 8 a, and 0 to 32 v for current ...ds to 4 a. Current and voltages are indicated on ...Arsenval-type meters. At greatest load it has less ...n 10 mv ripple. The unit is built into a 12 x 7 x ...2 in. blue hammerloid heavy steel cabinet.

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

...LE 61 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 62 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Temperature Indicator
Direct Reading

This small direct-reading temperature indicator, a self-balancing potentiometer, is designated the NI-10. Used for flight testing, readings on the potentiometer are recorded by photograph, which includes other instrument readings at the same time. Superior legibility of the NI-10 is the featured improvement over the familiar clock-face temperature gage. One model covers the —100 +600 F range and the other covers the 300 to 900 C range.

Handley Electronics Co., Dept. ED, Van Nuys, Calif.

CIRCLE 64 ON READER-SERVICE CARD FOR MORE INFORMATION

Shaft Angle Converter
1000 Hour Life

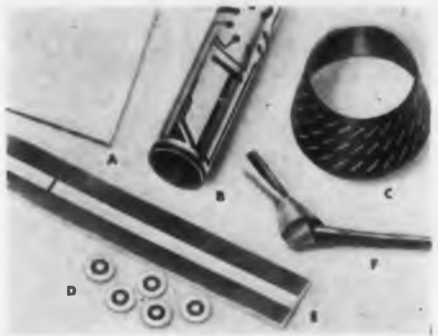
The shaft angle converter converts rotary motion into an accurate coded system of numbers. It provides a binary decimal read-out of 1 in 360 counts at 40 codes per revolution of the input shaft. Special intermittent gearing and precision bearings provide extremely low driving torque. The input shaft can rotate at speeds up to 300 rpm in either direction and will provide digital output coding on-the-fly. The code drum cylinder has a 0.65 in. diameter and is approximately 1-1/8 in. long. The cylinder is composed of an epoxy fiber glass tube with 0.005 in. thick copper tubing bonded to its outer surface. The fiber glass tubing provides a mechanical method for supporting the code drum and rigid member for translating motion to the first stage of gearing. The brushes are rated at 4 v dc at 20 ma current and can operate directly into most associated circuit. They operate at low noise and negligible bounce. The drive system translates each code read-out within the least significant figure. The entire converter is 1.87 in. in diam and 2.37 in. long. It weighs slightly more than 3 oz. Its total expected life is in excess of 1000 hrs.

Instrumental Development Labs. Inc., Dept. ED, 67 Mechanic St., Attleboro, Mass.

CIRCLE 65 ON READER-SERVICE CARD FOR MORE INFORMATION

Printed Circuits

For Many Shapes or Materials



In applications for which they are suitable, these rcuits remove many of the limitations imposed by pper-clad printing methods. Conductive silver ks are applied only where required by circuitry, us etching is eliminated. The silver inks though, e not for sale.

Circuits may be applied to a base of most any ometrical shape including the inside or outside of bes, the surfaces of flats, cylinders, spheres, cones, c. The choice of base material also covers a wide nge including cellophane, cellulose acetate and tyrate, vinyl chloride and acetate, acrylics, sty-nes, polyesters (including Mylar), Nylon, CR39 sin, phenolics, epoxies, silicones, melamines, el-F, Teflon, mica, paper, wood, ceramics and ass.

Examples listed in photo are: (A) Condenser ter-inals printed on Teflon before die-cutting. (B) ubes may be printed on outside or inside. (C) De-larizing element of discone-type antenna, printed Teflon. (D) Condenser terminals after die-cut-g. (E) Microwave strip line filter. Solderable sil-r printed on both sides within 0.005" limits. Ends n-soldered. (F) Flexibility illustrated by copper-ated silver circuit printed on 0.005 in. Teflon.

J. Frank Motson Co., Dept. ED, Flourtown, ansylvania.

CLE 67 ON READER-SERVICE CARD FOR MORE INFORMATION

Single Pole Voltage Tester

6 to 250 v

The tip tester tests ac or dc voltage from 6 to 250 s a single pole tester, indicating polarity on dc. e tester clips into a pocket like a pen with no ngling wires. For voltage above 250 and up to 0 v, an extension is supplied and converts the trument to a bi-polar tester. Contact point can ground to a needle point for puncture testing ds with negligible damage to insulation.

ick Inc., Dept. ED, 2210 Hampton Rd., Erie,

CLE 68 ON READER-SERVICE CARD FOR MORE INFORMATION

DC Microvolt-ammeter and Amplifier

Fifteen Voltage Ranges

The Model 203AR is a 19-in. rack-mountable combination dc microvoltmeter, microammeter, and low-level dc amplifier. Partially transistorized, the unit uses chopper circuitry to provide high sensitivity with previously unobtainable drift-free stability and high input impedance. Fifteen voltage ranges cover from 100 μv full scale to 1000 v full scale and nineteen current ranges cover from 0.001 μa full scale to 1 a full scale. The uncluttered zero-center meter face instantly indicates polarity on two mirrored scales which cover all ranges. The instrument can measure 10 μv to 100μμa. Input impedance is 10 megohms on the 30 mv range or below and 100 megohms on the 100 mv to 1000 v ranges. Impedance accuracy is ±1.5 per cent. Output terminals on the front panel are provided for its use as a low-drift dc amplifier with high gain, high input impedance, and low output impedance. Maximum gain as an amplifier is 80 db, and maximum output is ±1 v across 500 ohms or greater. Output impedance is less than 2 ohms, and drift less than 10μv equivalent input.

KIN TEL, Dept. ED, 5725 Kearney Villa Rd., San Diego 11, Calif.

CIRCLE 71 ON READER-SERVICE CARD FOR MORE INFORMATION

Potentiometer

–65 to 400 F Temperature Range

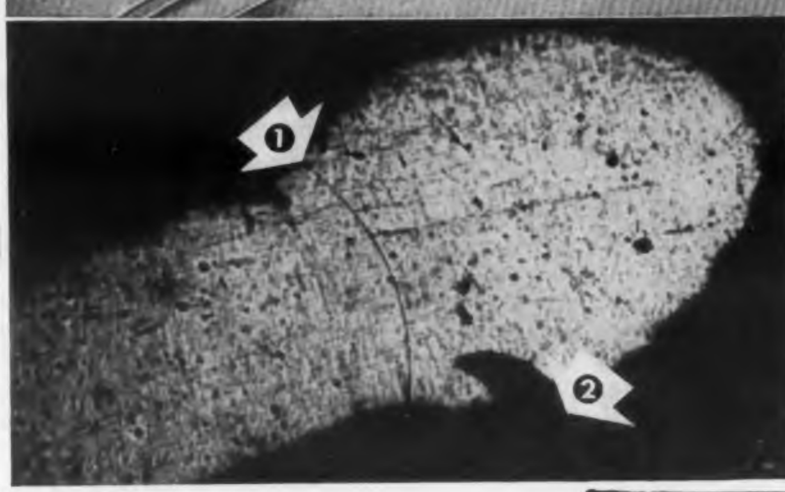
Designed for missile systems, this circular potentiometer, Type CPO5-0101-1, is moisture-proof and will meet explosion-proof requirements. It has 1-3/4 in. square base and 1/4 in. diam stainless steel shaft with Graphitar bearings. The temperature range is –65 to 400 F; vibration 10 g to 2000 cps. The 10,000 ohm winding is constructed so that it can be furnished with taps.

Humphrey Inc., Dept. ED, 2805 Canon St., San Diego 6, Calif.

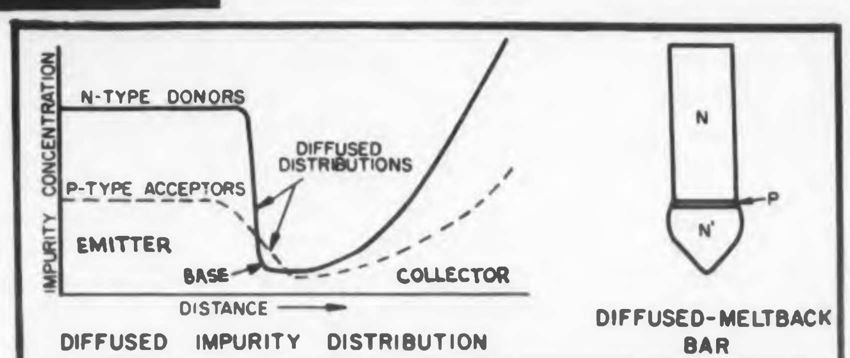
CIRCLE 72 ON READER-SERVICE CARD FOR MORE INFORMATION

Using the diffused-meltback process

G.E. gets the most from silicon...



Before going through the diffused-meltback operation, a crystal of silicon is sawed into wafer-form: wafers are then diced to produce 4000 to 5000 individual silicon bars. Photomicrograph at left shows size-comparison of a silicon NPN bar, or pellet, with human hair (Arrow 2). "Tear drop" at end of bar is formed during meltback process. Micro-thin base, or "P", region (Arrow 1) is created through G-E diffusion technique. Base regions of 2-micron size are made with relative ease.



Curves illustrating impurity distribution after diffusion. P-type impurities in the high concentration side of the meltback junction diffuse, within solid semiconductor, into "plateau" region of low impurity concentration. High resistivity "plateau" contributes to elimination of punch-thru effects.

Set Screws

For Miniaturized Equipment

Mini-Mite No. 0, 1, 2 and 3 set screws are available in socket, socket cap and slotted styles, and in a variety of points. The advantages of Mini-Mite set screws include elimination of need for special design set screws. They have precision, fully formed threads, uniformity for maximum contact with driving tools and special heat-treating to give high tensile strength without brittleness or decarburization. The set screws give maximum reduction in weight and bulk, without sacrificing holding power in sub or final assemblies. They are available in specified lengths, threaded lengths and special materials.

Set Screw & Mfg. Co., Dept. ED, Bartlett, Ill.

CIRCLE 76 ON READER-SERVICE CARD FOR MORE INFORMATION

Potentiometer

Multiturn

The type 909 potentiometer, a 7/8 in. diam multiturn, uses a stainless steel for the case as well as for major structural components, completely eliminating structural parts of phenolic, plastic or other non-metallic materials. Cylinders of stainless steel tubing form the case, which is insulated from the mandrel by a dielectric film. The design utilizes a helical slip bar, which serves also as a guide for the wiper. The wiper assembly straddles the slip bar and the wiper rides on the resistance winding in the middle. Therefore, dual slip bar contact and, due to the different resonant frequencies of the two contacts, excellent vibration characteristics are provided. By riding the helical bar, wear on the resistance element is eliminated and life characteristics are improved. Metal to glass type terminals are used which are welded to the case.

Typical resistance range is 100 ohms to 200,000 ohms for a 10 turn version of the type 909. Standard linearity is 0.5 per cent with 0.05 per cent available on special order. Rated at 2.5 w at 40 C the standard 909 derates to 0 at 90 C and the high temperature version, available on special order derates at 150 C.

Fairchild Controls Corp., Dept. ED, 225 Park Ave., Hicksville, N.Y.

CIRCLE 77 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Wave and Power Meter Set

500 to 1500 Mc, 0.5 Mw to 2 W

This portable wave and power meter set measures power and frequency from 500 to 1500 mc at power levels of 0.5 mw to 2 w average (−3 dbm to −33 dbm). Model 107 consists essentially of a transmission line comprising a coaxial step attenuator and a coaxial direct reading frequency meter; the line is terminated in a power measuring thermistor mount and bridge. These three principal components are connected in series by coaxial cables and are mounted on the front panel of the set. A fixed 10 db attenuator (CN-388/UP) is provided to extend the power range of the step attenuator. The frequency meter has a direct reading dial and power measurements are obtained directly in db by adding the meter reading and attenuator setting. The set is housed in a combination type carrying case with a separate lid. The carrying case is watertight with the cover on. The power input connector is a coaxial series N connector on the front panel. A video pulse envelope detector, series BNC, is also provided.

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

CIRCLE 80 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Monitor

Radio Frequency

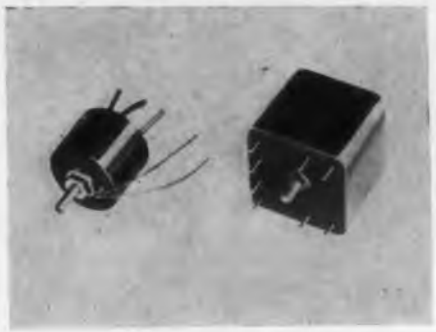
This feed-thru rf power monitor measures incident power between 2 and 500 mc and reflected power and vswr between 10 and 500 mc. The instrument can be calibrated and the calibration can be checked frequently at 60 cps with aid of a 60 cps wattmeter. The power measuring range is 0-15 w and 0-60 w.

Electro Impulse Lab., Dept. ED, 208 River Rd., Red Bank, N.J.

CIRCLE 81 ON READER-SERVICE CARD FOR MORE INFORMATION

Pulse Transformers

Encapsulated



Hermetically sealed pulse transformers are being anufactured to meet military specifications such s MIL-T-27. They will operate at ambient temeratures up to 85 C. Special designs for high acleration applications are available for specific ustomer requirements. Also available are subiniature pulse transformers for printing wiring oard, transistorized circuit and miniaturized cirit applications. All of the units meet the standard ltage, life, pull, temperature, immersion and oisture resistance tests.

Telex, Dept. ED, Telex Park, St. Paul 1, Minn.

CLE 83 ON READER-SERVICE CARD FOR MORE INFORMATION

Signal Generator and Scope Unit

Displays Gain vs Frequency Response

Called the Wobbulator Model 7200, this integral it combines a swept frequency signal generator th a built-in oscilloscope. The latest model perits the visual display of the gain or loss vs freency response of amplifiers and networks in the nge from 2 to 1000 mc. A swept frequency range 2 to over 55 mc centered anywhere in the 2 to 0 mc region allows rapid play. The effect of comnent or adjustment changes or gain and freency response are instantly pictured on the crt as ain, or loss, vs frequency characteristics.

The scope has a display sensitivity of 50 μv. Since maximum output voltage of the generator is re than 0.03 v, the Wobbulator has much greater p sensitivity than older equipment offered. The plitude variation of the swept output voltage is stant within +1 db over 40 mc and constant thin fractions of 1 db over 30 mc. High impede and low impedance probes are furnished.

Canoga Corp., Dept. ED, Van Nuys, Calif.

LE 84 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Vernier Potentiometer

3 Terminal Construction

Featuring 3 terminal construction, for use in circuits having a common ground, a vernier potentiometer provides single knob control of two resistance decades. Standard resistance ranges are, 1000 ohms, 10,000 ohms and 100,000 ohms; accuracy is ±5 per cent of full scale resistance; linearity is ±0.5 per cent; resolution is 0.1 per cent; power rating is 4 w when used as a potentiometer and 20 ma when used as a rheostat. Elimination of helical elements allows accurate operation over an unusually wide frequency range from dc to 10 kc. No disassembly is required for mounting.

Research Instrument Co., Dept. ED, P.O. Box 9168, Portland 16, Ore.

CIRCLE 87 ON READER-SERVICE CARD

Teflon Hook-Up Wire

300 V, 32 to 22 AWG

Extruded Teflon insulated, 300 v hook-up wire with a wall thickness of extruded insulation of 0.003 in. to 0.006 in. is available. Sizes available are 32 AWG to 22 AWG inclusive.

Hitemp Wires, Inc., Dept. ED, 1200 Shames Drive, Westbury, L.I., N.Y.

CIRCLE 88 ON READER-SERVICE CARD

Teflon Film Capacitors

−65 to +165 C Range

An operating temperature range of −65 to +165 C without derating is normal for a new line of hermetically sealed Teflon film capacitors. Special models are available up to 200 C. Multiple layer Teflon dielectric construction, together with glass-to-metal compression-type end seals, provides exceptionally high insulation resistance, low dissipation factor, and minimum effect from dielectric absorption. The capacitors' service life is unusually long, as shown by tests.

Electronics Development Corp., Dept. ED, 1323 Airway, Glendale 1, Calif.

CIRCLE 89 ON READER-SERVICE CARD

CIRCLE 90 ON READER-SERVICE CARD ➤

Unity-Gain RF Probe
Employs Transistors

A new departure from passive type probes, the Transiprobe has unity gain—which is held constant by a transistorized feedback amplifier, ensuring complete stability. The unit is powered by mercury cell batteries. Standard BNC connectors are provided to the scope and battery-box power supply. Low input capacity makes it ideal for use with broad-band oscilloscopes and as an oscilloscope isolation amplifier. Features included in the Transiprobe are low power dissipation, no hum and open design for easy manipulation.

Frequency response is 20 cps to 15 mc, 1 db down at 50 cps and 12 mc, and 3 db down at 20 cps and 15 mc. Nominal output impedance is 50 ohms. Input impedance: capacitive, 4 μμf; resistive, 100,000 ohms. Maximum input voltage: 0.3 v peak-to-peak. Power supply: mercury cells, 800 hr life; constant supply over life of cells. Separate power supply and connecting cables provided with probe.

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

CIRCLE 92 ON READER-SERVICE CARD FOR MORE INFORMATION

Ballistic Computer
Seven Parameter Display

The Type K-1 Ballistic Computer contains all necessary amplifiers, programming circuitry and balance equipment for direct hookup to thrust and pressure transducers, and automatically displays such parameters as ignition delay, action time, integrals of thrust and pressure, as well as peak values. The K-1 can be supplied either for print-out on paper tape by a clary printer or on cards by IBM summary card punch. It is also available as the Type K-2 which contains special tape recording equipment and a play-back analyzer section for detailed examination of isolated portions of a record.

Allegany Instrument Co., Inc., Dept. ED, 1091 Wills Mt., Cumberland, Md.

CIRCLE 93 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Voltage Monitor
for Power Supplies

The series 2303 Compacts are voltage sensitive meter-relay controls for monitoring voltages. A Compact contains a VHS meter-relay, load relay and other components for continuous monitoring or control of voltage supplies. Relay action may be manual reset or automatic reset. Several variations are available for detecting either over-voltage, under-voltage, or both over- and under-voltage, either ac or dc. Specifications include: Input—10 mv dc to 500 v dc, accuracy 2 per cent at 75 F, 4 per cent from −40 to +150 F; 250 mv ac to 500 v ac, accuracy 3 per cent at 75 F, 6 per cent from −40 to +150 F. Other inputs down to 0.1 mv ac or dc are available at reduced accuracy. The input of low range voltmeters and millivoltmeters is protected against overload with Stabistors. Load switch is spdt, 5 a, 125 v ac, non-inductive. Connections and mounting are 9 pin plug-in, octal type with AN connectors and 4 hold down screws optional. Case measures 1-3/4 x 4-1/4 x 4-3/4 in., and is steel and dustproof with hermetic sealing optional.

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

CIRCLE 96 ON READER-SERVICE CARD FOR MORE INFORMATION

Servo Digitizer
Binary-Decimal Output

The servo driven digitizer, SL-1004, designed to digitize an ac input signal, operates directly from the 400 cps line, and is packaged for inclusion in larger equipment. It includes a miniaturized, high gain transistor-magnetic servo amplifier and power supply. The output is binary-decimal, and the encoder shaft is driven ±170 deg from null. Full scale corresponds to 10 v rms 400 cps, in phase with the line. The static error is 0.15 per cent of full scale, and fast rates can be followed with a velocity error constant of 500 sec^{-1}.

Industrial Control Co., Dept. ED, 805 Albin Ave., Lindenhurst, L.I., N.Y.

CIRCLE 97 ON READER-SERVICE CARD FOR MORE INFORMATION

Variable Speed Drive

1/8 and 1/15 Hp

These Magne-Speed Junior drives incorporate dynamic braking and reversing. These features may be disconnected by the user if not required. Motors may be mounted in any position and may smoothly adjusted from zero rpm to full rated speed. Base speed is 8000 rpm. They will operate in ambient temperature of 32 to 110 F. Motor is a dc shunt, open construction (closed on special order), with die cast housing. The 1/8 model has ball bearings, and the 1/15 hp has sleeve bearings with thrust washers. Available with or without gear reduction. All motors equipped with 5 ft cable.

Magnetic Amplifiers, Inc., Dept. ED, 632 Tinton Ave., N. Y. 55, N.Y .

CIRCLE 99 ON READER-SERVICE CARD FOR MORE INFORMATION

Pressure Transducer

High Output

The Model R-3 is similar to the standard S-3 dual coil transducer, except that it contains four active elements so that a four-arm bridge can be completed within the transducer. The magnetic circuit within the transducer is designed for applications that require very high output sensitivity. This unit has adequate output to drive typical ruggedized ac meter movements without application and may be used in most servo applications.

Specifications include: pressure range, 5 to 1000 psi; acceleration sensitivity 0.01 to 0.03 per cent per g or less, referred to full range pressure in most sensitive plane; rise time, 150 to 250 μsec, depending on pressure range; output sensitivity, dependent on carrier frequency and pressure range and will vary from 600 mv/v at 400 cps to approximately 50 mv/v at 20 kc; zero drift with temperature, 0.06 per cent per deg F or less referred to full range, and the change in sensitivity temperature is 0.09 per cent per deg F. or less referred to full range. It measures 7/8 in. diam x 1 in. long.

Ultradyne Engineering Labs., Inc., Dept. ED, P.O. Box 3308, Albuquerque, N.M.

CIRCLE 100 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Molded Composition Potentiometer

Diameter of 0.5 In.

Type AS potentiometer is rated at 0.5 continuous duty and measures 1/2 in. diam. The relatively thick molded resistance elements offer a large factor of safety. The brush is also molded for long wear and lower noise level. Type AS units are furnished in linear taper with locking type, screw-driver-slotted shafts. The units are dust-tight, splashproof and fungus-resistant. Terminals are gold plated to speed soldering. They are available in 15 resistance values from 100 ohms to 5 meg.

Ohmite Manufacturing Co., Dept. ED, 3630 Howard St., Skokie, Ill.

CIRCLE 104 ON READER-SERVICE CARD FOR MORE INFORMATION

Shaft Position Encoder

Accuracy within 3 Min of Arc

The type RD-13 Digisyn is a high precision photoelectric shaft position encoder which provides angular position data in cyclic binary code to an accuracy of 13 digits, or better than three minutes of arc. The unit consists of a glass disc coded by an array of opaque and transparent segments, a flash lamp to illuminate a radius of the code disc, a multi-element photosensitive detector to detect presence or absence of illumination, and a 13 channel transistor preamplifier. Each channel is encapsulated separately and is readily replaceable. The flash lamp assembly also is encapsulated and can be replaced readily. Type 23x6a synchro mounting has been provided. Maximum rotation rate is 1200 rpm for full accuracy readout: operating temperature ranges from −55 to +85 C. Diameter measures 3-1/2 in. od.

Adcon Inc., Dept. ED, 1117 Commonwealth Ave., Boston 15, Mass.

CIRCLE 105 ON READER-SERVICE CARD FOR MORE INFORMATION

Using Thermistors

Edited by
FENWAL ELECTRONICS

Thermistors, with their almost incredible ...itivity to temperature change, now get ...ews column all their own.

The cases in point for the first column: ...perature measurement and tempera... control.

Three basic circuits for temperature ...surement with thermistors:

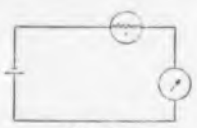


FIG. 1

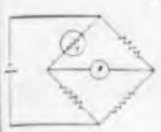


FIG. 2

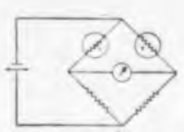


FIG. 3

The first is a battery, a thermistor, and ...ro-ammeter. The second, more sensi... has a thermistor as one leg of a bridge ...uit. The third incorporates two ther...ors in a bridge, making possible even ...e precise temperature differential meas...ents.

Two basic circuits for temperature con... with thermistors:

FIG. 4

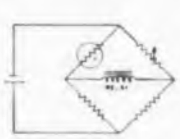


FIG. 5

The first has a thermistor in series with a ..., a battery, and a variable resistor. ...adjusting the resistor, it is possible to ...e the relay operate at any desired tem...ture of the thermistor.

The second is more sensitive, and has a ...istor as one leg of a bridge circuit, a ...ble resistor in another leg, and a ...ized relay across the output. Even ...sensitive control can be had by apply... AC to the bridge and placing a high... amplifier between the bridge and the ...

...igners: if you are not already familiar ...he tremendous possibilities of ther..., write for details to FENWAL ELEC...ICS, INC., 310 Mellen St., Framing... Massachusetts.

Makers of Precision Thermistors

...RCLE 108 ON READER-SERVICE CARD

200 Channel Analyzer

Simplified Circuitry

The Model 3302, 200 channel analyzer offers all the advantages of a 256 current analyzer but retains the simplicity of the 100 channel analyzer. Burroughs tubes greatly simplify the address circuits and a simple computer logic is used to program computer and other non-storage functions. The memory may be divided and separate data stored in each half. On special order, the analyzer may be had with the ability to store in one half the memory while simultaneously printing out of the other half. A deadtime correction factor correlates data regardless of energy distribution or counting rate. The analyzer presents data on a cathode-ray tube during and after measurements. It automatically subtracts background and may be operated in coincidence with external pulses, either prompt or delayed. Provision is made for precision recording or decimal printed readout which totals every 10 or 100 channels with channel numbers printed directly.

Radiation Instrument Development Laboratory, Dept. ED, 5737 S. Halsted St., Chicago 21, Ill.

CIRCLE 109 ON READER-SERVICE CARD FOR MORE INFORMATION

Waveguide Pressure Window

9.5 to 10.1 KMC

This flange-mounted waveguide pressure window for use in half-X waveguide applications covers the frequency range from 9.5 to 10.1 kmc with maximum vswr of 1.10 at the band edges. Resonant freqency is 9800 mc. Designated the MA-1339 it is used in 0.2 x 0.9 ID waveguide applications. Window flange thickness is 0.060 in. Maximum power rating is 20 kw. Maximum pressure handling capability is 45 lbs on the glassed side of the window. Pressure-handling capability in the reverse direction is 30 psi. The windows are constructed of kovar and glass. All metal surfaces are silver plated.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

CIRCLE 110 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Microwave Oscillator
9000 to 10,500 Mc

The Model 815 makes a stabilized signal source available for the X-band microwave region from 9000 to 10,500 mc. It delivers a nominal 40 mw of power from a 40/U choke flange. It offers short term stability of five parts in 10^8 and long term stability of one part in 10^6. Stability is obtained by means of an invar reference cavity and a high gain, low noise feedback amplifiers. The direct reading dial and the automatic stabilization indicator make this instrument easy to operate. The size is 19-1/2 x 13 x 18 in., and it can be rack mounted. This instrument is similar to the Model 814 ultrastable microwave oscillator covering the X-band region from 8500 to 10,000 mc, and the Model 803 covering the S-band region from 2680 to 3405 mc.

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

CIRCLE 114 ON READER-SERVICE CARD FOR MORE INFORMATION

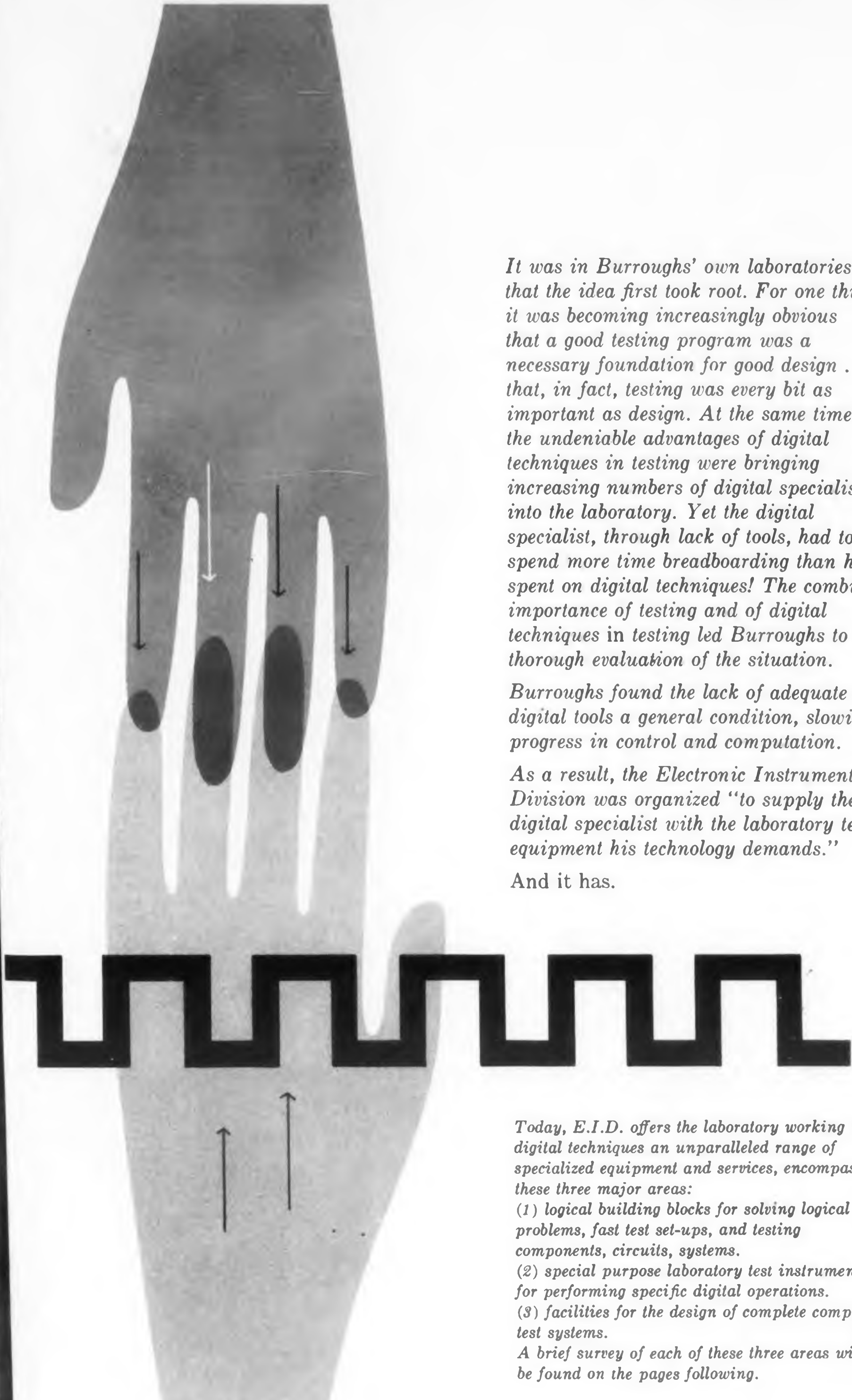
Travel Rate Meter
Measures Linear Speed and RPM

The MF-2 speed-feed meter measures and indicates linear rates of travel and rpm by converting linear motion of any length of travel into an electrical signal. An illuminated meter gives the reading directly, with push-button selection of four scale ranges from 0-1 to 0-125 in. per min. Models are available with four speed ranges or with combinations of linear rate and rpm scales. The small fixed tachometer pickup has no moving parts and is mounted near a gear on the shaft being measured. Neither pickup or indicator can be harmed by overspeeding or sudden starts and stops.

Maico Co., Inc., Dept. ED, Industrial Div., 21 North 3rd St., Minneapolis 1, Minn.

CIRCLE 115 ON READER-SERVICE CARD FOR MORE INFORMATION

digital techniques in the laboratory



It was in Burroughs' own laboratories that the idea first took root. For one thing, it was becoming increasingly obvious that a good testing program was a necessary foundation for good design . . . that, in fact, testing was every bit as important as design. At the same time, the undeniable advantages of digital techniques in testing were bringing increasing numbers of digital specialists into the laboratory. Yet the digital specialist, through lack of tools, had to spend more time breadboarding than he spent on digital techniques! The combined importance of testing and of digital techniques in *testing led Burroughs to a thorough evaluation of the situation.*

Burroughs found the lack of adequate digital tools a general condition, slowing progress in control and computation.

As a result, the Electronic Instruments Division was organized "to supply the digital specialist with the laboratory test equipment his technology demands."

And it has.

Today, E.I.D. offers the laboratory working in digital techniques an unparalleled range of specialized equipment and services, encompassing these three major areas:

(1) logical building blocks for solving logical problems, fast test set-ups, and testing components, circuits, systems.

(2) special purpose laboratory test instruments for performing specific digital operations.

(3) facilities for the design of complete complex test systems.

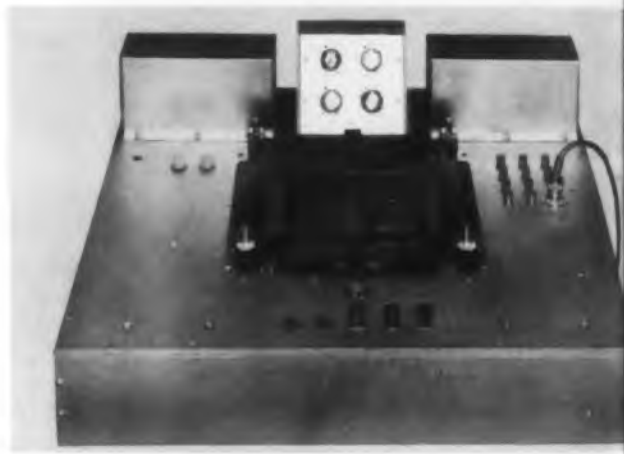
A brief survey of each of these three areas will be found on the pages following.

3

Installing Magnetic Memory For Large Computer

complete systems design

While Burroughs pulse control units are ideal laboratory tools for solving logical problems in computer design . . . testing individual components for pulse circuitry . . . performing specific digital operations . . . there are design and test requirements so complex as to require an entirely different approach. Designing and testing a complete core memory, for example . . . or building and testing complete digital computer subsections. Actually, both these jobs *have been done* by Electronic Instruments Division with Burroughs equipment. But chances are, they could not have been done successfully without the full-time efforts of Burroughs logical circuit and logical hardware designers . . . the men who developed the equipment. Should your needs be of this order of complexity, their experience and knowledge are available to you. Electronic Instruments Division can either serve you in a consulting capacity . . . or design, develop, and install the entire system from start to finish.



Memory Plane Tester

Burroughs Corporation Electronic Instruments Division

1209 VINE STREET PHILADELPHIA PENNSYLVANIA

tools for engineers

FOR FURTHER INFORMATION

Complete the reply card on the other side of this sheet . . . insert in an envelope, or attach to a postcard . . . and mail to Burroughs Corporation, Electronics Instruments Division, 1209 Vine Street, Philadelphia 7, Penna. Your request will be given prompt attention.

Optical Circular Table

Projects Readings

The Matrix 18-in. optical circular table is equipped with a 2-in. diam illuminated screen, protected by armour plate glass, on which direct readings to 3 sec of arc are clearly visible. The projection is accomplished by system of lenses from a large diameter glass circle graduated in 10 min intervals. This glass circle built within the table is supported in mounting that prevents movement arising from temperature change or shock.

The entire optical system is sealed against dust or oil and insulated from heat radiated by the projection lamp. Smooth and uniform rotation of the table and minimum back-lash are obtained through a precision worm wheel drive. The table is clamped by two diametrically opposed clamps operated by a single lever.

Engis Equipment Co., Dept. ED, 431 S. Dearborn St., Chicago 5, Ill.

CIRCLE 119 ON READER-SERVICE CARD FOR MORE INFORMATION

Regulated Power Supply

For Traveling Wave Tubes

The multiple-voltage regulated power supply is used to operate traveling wave tubes. The supply contains eight output voltages:

Helix output	0-1500 v,	0-20 ma
Collector output	0-150 v,	0-20 ma
Grid no. 4 output	0-850 v,	0-5 ma
Grid no. 3 output	0-300 v,	0-5 ma
Grid no. 2 output	0-150 v,	0-5 ma
Grid no. 1 output	—150-0 v,	0-5 ma
Filament supply	0-13 v,	0-2 a
Solenoid output	20-150 v,	0-2.5 a

All voltages are continuously variable and the supply is designed for continuous duty operation. The unit features undercurrent protection on the solenoid voltage and provides for the application of external helix voltages.

Kepco Labs., Inc., Dept. ED, 131-38 Sanford Ave., Flushing 55, N.Y.

CIRCLE 120 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

High Voltage Rectifiers

Diameter of 0.22 In.

The HDMP Series of high voltage medium power silicon diffused junction rectifiers are designed for applications requiring up to 1000 peak inverse working volts. Rated for operation in free air with no external heat sink, there is a choice of axial or single ended body construction. Maximum dimensions are 0.22 in. diam x 0.36 in. long. The line of HDMP rectifiers includes ten different models.

Hoffman Electronics Corp., Dept. ED, Hoffman Semiconductor Div., 930 Pitner Ave., Evanston, Ill.

CIRCLE 123 ON READER-SERVICE CARD FOR MORE INFORMATION

Waveguide Window Seals

Ranges from 0.2 - 90 KMC

This hermetic waveguide window seal, passes microwave energy with minimum reflection loss, and is thermally stable. The D-B seal maintains a constant pressure and constant dielectric inside when soldered directly to the waveguide flange, and seals out moisture, dust, oil and salt spray. The unit will hold hard vacuum, and withstand shock and vibration. Temperature range is from −55 to +100 C, and the seal will withstand degassing by baking. Pressure differential is 30 psi, and vswr averages 1.19 over the entire range. The seal is designed with optically clear metal-glass-mica windows, and is available in seven standard sizes covering the microwave and ultra-microwave range from 8.2 to 90 kmc.

DeMornay-Bonardi, Dept. ED, Pasadena, Calif.

CIRCLE 124 ON READER-SERVICE CARD FOR MORE INFORMATION

AL PURPOSE

RANSISTORIZED LECTROMETER

bined preamplifier and dc vtvm has ohms input, 1 mv sensitivity

GH input impedance is only part of the y with the new Keithley Model 220. sensitive dc vtvm, it's especially convenient en measuring voltages of transistors, amplifiers and computers, as l as many electrochemical and biological s. In its alternate role as a dc pre- plifier, the 220 has gains of 0.05 to 167 h suitable outputs. Uses include ording the variations in piezo-electric l pH voltages; currents in photocells, uum tube grids and ion chambers; and er long-term monitoring functions.

NE-OPERATED, the 220 has 8 voltage ges from 30 millivolts to 100 volts l scale. With added accessories, the ument measures voltages from 1 mv 20 kv, currents from 10^{-3} to 5×10^{-14} pere, resistances from 10^4 to 10^{16} ohms.

EFUL FEATURES include a 5-volt alanced output for amplifiers and cilloscopes, and a one-milliampere output sensitive recorders; a polarity reversing tch; and zero drift below 3 mv/hr.

TAILS about the Model 220 are given Keithley Engineering Notes, Vol. 5 . 2. A request on your company erhead will bring a copy promptly.

KEITHLEY INSTRUMENTS, INC.
12415 Euclid Ave., Cleveland 6, Ohio

CIRCLE 127 ON READER-SERVICE CARD

Intermittent Condition Analyzer

For Radio and TV Troubleshooting

This Model 828 Intermittent Condition Analyzer provides for faster troubleshooting of intermittent circuits using a new principle which makes TV or radio receivers supersensitive to intermittent and pre-intermittent noises caused by capacitors, resistors, tubes, coils, chokes and other components. A sensitive amplifier and an intermittent tracer probe pick up and localize the noises produced by borderline components without waiting for actual breakdown to occur. Phantom probe attachments provide signal pickup from tubes and wiring without making actual circuit connections. A built-in line voltage step-up transformer provides a high line voltage supply to make intermittents easier to locate.

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

CIRCLE 128 ON READER-SERVICE CARD FOR MORE INFORMATION

Balance Bridge

For Large Systems

Ten 4-arm gage bridge or resistive type pickups may be calibrated individually or simultaneously with a rack-mounted balance unit designed for large-scale instrumentation systems. The Model 228 Bridge Balance employs individual plug-in calibration resistors which are inserted from the front through a hinged door on the panel. Precision 10-turn balance and sensitivity potentiometers are provided with knurled finger locks for maintaining desired settings. Toggle switches permit individual transducer calibration, or all transducers may be calibrated by a remote contact closure. Individual or common voltage supplies of 0 to 30 v may be used. The system is designed for 4-arm resistive transducers of 120 ohms or more.

Consolidated Avionics Corp., Dept. ED, 66 Brooklyn Ave., Westbury, N.Y.

CIRCLE 129 ON READER-SERVICE CARD FOR MORE INFORMATION

According to Mrs. L. B. Q. (who is pictured in the above candid photograph of the advertising department's mail department and is in charge of Sigma premiums, box tops, blown tops and the like) Sigma's July offer of free Slidecharts has turned into a polymorphous hydra.

Now it becomes necessary, due to the laws of Kirchoff and diminishing returns, to terminate the *free* offer.

Hereafter we'll be glad to oblige, but at 25¢* (C. I. A.) per. (It's either this, fellows, or raising the price of Sigma relays.)

Don't think we do not appreciate the interest displayed — it's just . . . . .

Still free is the EBG reprint which resumés SIGMA products and is big enough so you can read it.

*Cash, stamps or rare fiduciary objects.

SIGMA INSTRUMENTS, INC.
91 Pearl Street, So. Braintree 85, Mass.

CIRCLE 130 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Silicon Transistors

High Frequency

Eleven types are included which provide a range of current gains up to 60, and collector voltage ratings to 45 v. Rated for operation to 175 C, these units feature low collector cut-off currents. All types are specified for a maximum of 0.5 μa at their maximum collector voltage rating. Types ST13 and ST33 have a typical cut-off frequency of 17 mc. Manufactured by the diffusion process, close control is maintained on all characteristics to achieve uniformity and interchangeability. All units are subjected to temperature cycling and storage, and other environmental tests.

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

CIRCLE 133 ON READER-SERVICE CARD FOR MORE INFORMATION

VHF Amplifier

Broadband

This automatic level controlled, broadband trunk line vhf amplifier is equalized to compensate for cable slope between 53 and 89 mc with a flatness of ±0.25 db. It can deliver up to 0.2 v output into a 75 ohm load and has a maximum gain of 45 db on channel 6. Automatic level control uses stable, drift free circuits to hold the output level within 1 db for 10 db increases of input level. The input stage of the amplifier uses the newly developed 6922 long life, low noise, dual triode to achieve an 8.5 db noise figure. A constant voltage transformer and silicon diodes provide a power supply that requires only 45 w and maintains an output stability of ±0.2 db for ±20 per cent line voltage variations.

Entron, Inc., Dept. ED, P. O. Box 287, Bladensburg, Md.

CIRCLE 134 ON READER-SERVICE CARD FOR MORE INFORMATION

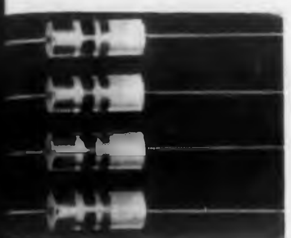
Transistor Heat Sinks

Beryllium Copper

Beryllium copper heat sinks enable the transistor operate at higher levels of dissipation and pro- le a mounting clamp for the transistor in those es where the transistor is suspended by its leads d not used with a socket. Model HS-10 is de- ned for the GT soldered case and Model HS-20 the GT version of the JETEC 30 case.

General Transistor Corp., Dept. ED, 91-27 138th , Jamaica 35, N.Y.

CLE 138 ON READER-SERVICE CARD FOR MORE INFORMATION



Epoxy Chokes

1.1 to 120 μh

Thirteen epoxy encapsulated chokes ranging in lues from 1.1 through 120 μh following preferred lues are available. All are 5/16 in. in diam and l in. long with axial pigtail leads. They are lor-coded for value identification. The chokes e constructed so as to have maximum ruggedness d resistance to moisture, temperature and other vironmental extremes.

James Thomas Chirurg Co., Dept. ED, 414 Park Bldg., Boston 12, Mass.

CLE 139 ON READER-SERVICE CARD FOR MORE INFORMATION

Vacuum Tube Electrometer

Measures 10^{-11} A

The Model VTE-1 Vacuum Tube Electrometer asures direct currents of either polarity from 10^{-3} 10^{-11} a. The unit features a built-in bucking cur- t source, with range from 10^{-3} to 10^{-9} a for scale pansion. Time constants of 0.1 to 30 sec are avail- e on a single rotary selector switch. Zero drift 0.1 per cent per day after initial warm-up period. e meter is available with high and low level ay trips for process or nuclear control uses.

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

CLE 140 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Gearhead Motor
AC, Oil-filled

This oil-filled gearhead motor meets requirements of MIL-M-17059 and MIL-S-901, Class AI shock. It is a 2 speed motor, 2 pole and 6 pole, designed for 220 v ac, 60 cps 3 phase rated at 1/10 hp output at 250 rpm and 84 rpm, intermittent duty at high speed, continuous duty at low speed. It is equipped with an electrically energized brake which will stop motor within 0.2 sec and within 25 deg of output shaft of gear box. The motor is totally enclosed to provide protection against moisture, dust, fungus and salt spray. It is filled with Verselube F-50 silicone fluid for cooling. Ambient temperature: —65 to 200 C, 100 per cent humidity.

Western Gear Corp., Dept. ED, P.O. Box 182, Lynwood, Calif.

CIRCLE 143 ON READER-SERVICE CARD FOR MORE INFORMATION

Isolation Amplifier
Selectable Bandwidths

The Model 102B serves as either a general purpose preamplifier or as an isolation amplifier covering both audio and ultrasonic frequencies. It has a 5-v, 50-ohm output to drive oscilloscopes, sound level meters and pen recorder power amplifiers. Frequency response is from 2 cps to 150 kc or to 1.7 mc with selectable bandwidths and accurate decade gains of 0.1 to 1000. Impedence input is 400 megohms, and noise is below 10μv with 150 kc response. Two accessory probes for low-capacitance connection to the circuit being measured are included. Typical uses include work with accelerometers and hearing aids, pulse amplification, and vibration and noise studies.

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

CIRCLE 144 ON READER-SERVICE CARD FOR MORE INFORMATION

Differential Amplifier

Rejects Noise & Hum Pickup

Providing high gain and stability necessary for strain-gage and thermocouple applications, the Model DA-101 wide-band differential amplifier handles low-level signals, including pulse signals, without noise or hum pickup. Noise is 6 mv referred to the input with a bandwidth of 50 kc at the 3 db point and at 20,000 ohms differential input impedance. Static common-mode rejection is greater than 100,000 to 1. Gain is adjustable in steps from 100 to 2000 with a gain accuracy of 0.1 per cent. Linearity is ± 0.05 per cent.

The amplifier is built so that six units can be mounted on a 7-in. relay-rack panel.

Epsco, Inc., 588 Commonwealth Ave., Boston 15, Mass.

CIRCLE 150 ON READER-SERVICE CARD FOR MORE INFORMATION

Double Pulse Generator

Variable Delay and Width

This double pulse generator, Model B-3-2, is capable of generating two pulses both having reoccurrence rates of 1 mc. The internal oscillator controls both pulses and has repetition rates from 10 cps to 1 mc, or the instrument may be triggered externally at rates up to 1 mc. Each of the two pulses may be independently and continuously delayed from 0 to 10,000 μsec with respect to the common synchronizing pulse. Each of the two pulses may be continuously varied in width from 0.08 to 10,000 μsec. The two pulses are available on separate output jacks or may be mixed via a resistance mixing network so that they are both available at a common output. Due to the modular construction of the instrument it may be expanded to furnish greater numbers of pulses.

Rutherford Electronics Co., Dept. ED, 8944 Lindblade St., Culver City, Calif.

New Products

Silicon Rectifier Units Supply 1500 Amp

A line of silicon regulated power rectifiers supply up to 1500 a continuous capacity. The unit proves particularly useful as the dc source for ground support equipment and missile testing. Reliable performance is provided by hermetically sealed silicon diodes which are impervious to humidity, fungus, salt spray, sand and dust as well as ambient temperatures from —55 to +65 C. Standard models are available for 1000 a continuous capacity with dc voltage ranges from 6 to 40 v, with dc regulation of ±0.5 per cent, response of 0.1 sec and ripple of 1 per cent rms. All models are built to meet the requirements of military specifications.

Christie Electric Corp., Dept. ED, 3410 W 67 St., Los Angeles 43, Calif.

CIRCLE 156 ON READER-SERVICE CARD FOR MORE INFORMATION

Fixed Pad Attenuators 10, 20, 30 db

A series of precision fixed pad attenuators have been designed to partically absorb rf power in the 8.2 to 75 kmc frequency spectrum. The pads are useful between klystrons and other elements of a typical waveguide test bench to counteract frequency pulling effects or to reduce by a known amount of rf power flowing in a system. Ratings and general characteristics include a maximum power dissipation of 2 w and nominal attenuation values of 10, 20, and 30 db. The accuracy of attenuation measurement and limits is 1/4 db. The attenuation value and calibration frequency are stamped on each unit. The fixed pads are fabricated from short sections of waveguide in which a lossy element is mounted. Standard cover flanges are used at each end. All surfaces are silver plated throughout. Excepting flanges, external surfaces are finished with blue-gray lacquer.

Microwave Associates Inc., Dept. ED, Burlington, Mass.

CIRCLE 157 ON READER-SERVICE CARD FOR MORE INFORMATION

X-Band Magnetron

40 Watt

A 40 w, MA 215, X-band pulsed magnetron has been developed for operation in the frequency range from 8800-9600 mc. The tube is rated at 40 w peak pulsed power output at a 25 per cent duty cycle for maximum pulse lengths of 5 μsec. Substantially higher peak powers may be achieved with shorter pulse durations and reduced duty cycle requirements. Frequency and amplitude modulation of the magnetron output pulse has been measured at less than ±30 kc modulation deviation in experimental models. Operating efficiency of the MA-215 is 20 to 30 per cent. A ceramic cathode bushing structure is used for increased reliability. The magnetron weighs approximately 20 oz.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

CIRCLE 163 ON READER-SERVICE CARD FOR MORE INFORMATION

Antenna Matching Transformer

Minimum Loss from 1 to 50 Mc

The antenna coupling or matching transformer is designed to match a 700 or 200 ohm receiving antenna balanced transmission line to a 72 or 52 ohm coaxial line with a minimum transmission loss over the range of 1 to 50 mc. This transformer employs the use of a core material which extends its frequency response considerably beyond that of former units. The insertion loss has also been kept quite low, less than 1 db at mid-band. A spark gap arrangement has been provided for protection against the effects of lightning. The transformer and circuitry has been arranged to provide dc continuity through the antenna for checking purposes. The transformer has been designed with an octal plug to allow easy replacement. Printed circuitry is used to assure uniformly high performance. The overall dimensions making a compact unit are 5-1/4 x 7-7/7 x 4-1/2 in. It is encased in a completely watertight housing and provided with desiccant.

Nems-Clarke, Inc., Dept. ED, 919 Jesup-Blair Dr., Silver Spring, Md.

CIRCLE 164 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Battery Charger
50 to 200 Ma

A battery trickle charger with continuous adjustment range of 50 to 200 ma is available. The battery charger includes a meter to indicate charging current; output is fused to protect charger components. Output voltages are 12 and 24 v dc with input voltages of 110 to 120 v, 60 cps. A full wave selenium rectifier circuit is provided.

Automatic Switch Co., Dept. ED, Florham Pk., N.J.

CIRCLE 168 ON READER-SERVICE CARD

Series Summation Amplifier
Summation and Isolation

A transistorized summation and isolation amplifier has been designed for eliminating resolver non-linearities. The single channel Model 807 can be used with any standard 400 cps resolver, Mach 4 Mod 0 or equivalent. With an operating life of over 8000 hrs and an accuracy of ±0.1 per cent the 807 holds phase shift errors to less than 0.15 deg. Operating efficiency is over 90 per cent; temperature range is −55 to +85 C.

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

CIRCLE 169 ON READER-SERVICE CARD

Transmission Coupling
Flexibility with Positive Action

The Posiflex Coupling for transmis-n components permits flexibility of deg shaft to shaft angular misalign-nt and 1/8 in. shaft to shaft parallel alignment with positive action. e unit measures 1 1/8 in. long by in. diam wtih a wide range of e sizes. Space saving is made pos-le by housing the gimbal joints in-ally in the coupling shell. All parts of Type 303 stainless steel. Gimbal nts are heat treated for maximum ength and precision ground assur-tight backlash requirements at h speeds and torque.

Fourdee, Inc., Dept. ED, P. O. Box 6, Orlando, Fla.

CIRCLE 173 ON READER-SERVICE CARD

Magnetic Tape Reel
Easily Threaded

Called the C-Slot Reel, the design features a curved groove in the hub for threading. Tape is simply slipped into this groove in the opposite direction of reel rotation and the recorder is ready for operation. No kinks or twists are made in the tape and no tape-ends are left sticking up. Since the C-Slot is self-locking, there is no need to turn the reel by hand. Sharp edges have been eliminated, including those on the inner surface where considerable tape wear takes place on ordinary reels. Hub construction provides strong and well-balanced characteristics.

Audio Devices, Inc., Dept. ED, 444 Madison Ave., New York 22, N.Y.

CIRCLE 174 ON READER-SERVICE CARD

New Products

Accelerometers
Range of 0.03 to 40,000 G

Series 400 Accelerometers employ barium titanate in compression and have a natural frequency of 75 kc. They operate over an acceleration range from 0.03 g to 40,000 g and over a frequency range from 0.05 cps to 20,000 cps, with a sensitivity of 30 mv/g ±5 per cent throughout the usable range. Pickups are available in various sizes, weights and mounting configurations.

Columbia Research Laboratories, Dept. ED, Woodlyn, Pa.

CIRCLE 181 ON READER-SERVICE CARD

Linear Displacement Transducer
1000 Ft Remote Operation

This linear displacement transducer, Model LD-20, features an all stainless housing and waterproof connector. The unit measures displacement remotely at distances up to 1000 ft or more, employing the variable reluctance principle. It is designed to operate over a linear range of 2 in. With the use of a simple bridge, the transducer may be used at frequencies of 60-100 cps and the output fed to a galvanometer or recorder. Models operating over a linear range of 5 in. are also available.

Jones-Porter Instruments Co., Inc., Dept. ED, Box 666, Riverdale, N.J.

CIRCLE 182 ON READER-SERVICE CARD

Balancing Potentiometer
2 W Rating

Model 220 measures 3/16 x 5/16 x 1 . Mounting is accomplished by ans of 2-56 screws through stainless el eyelets on 3/4 in. centers. Tinned per leads 1-1/2 in. long by 0.016 diam. permit the use of either ated circuit or standard wiring hniques. A 15-turn screwdriver ad-ment features a self-locking shaft d an idling wiper assembly to pre-t damage from forcing adjust-nts. Power rating is 2 w. The unit designed for a maximum operating nperature of 175 C. Model 220 is ilable in standard resistance values from 100 to 20K ohms.

Bourns Laboratories, Inc., Dept. D. 6135 Magnolia Ave., Riverside, lif.

CIRCLE 186 ON READER-SERVICE CARD

Neutron Detector Tubes
For Reactor Control

Two new neutron detector tubes for use in reactor control and reactor monitoring systems are anounced. Model VXN-1 is an enriched boron trifluoride proportional tube for counting thermal neutrons. It is available in 1, 2, and 2-1/16 in. diam of various active lengths. Nominal operating voltage is 1700 v with a 250 v Minimum plateau having a typical slope of 2 per cent per 100 v. The second type, Model VXN-2, is of the recoil type. It has a polyethylene inner wall and an ethylene filling and is used to count fast neutrons. Nominal operating voltage is 1575 v. It is supplied only with a diameter with length corresponding to standard three-chamber ORNL design.

The Victoreen Instrument Co., Dept. ED, 5806 Hough Ave., Cleveland 3, Ohio.

CIRCLE 187 ON READER-SERVICE CARD

New Products

Snap-Action Switch
Handles 2 Hp

A heavy duty, snap-action switch has been designed to handle up to 2 hp. Called the Duo-Snap, the device comes in four terminal and circuit arrangements, permitting at least six circuit variations. Its snap-action is achieved through the rolling spring principle. The unit is 2 in. in length and has an electrical rating of 2 hp, 230 v ac; 1 hp, 150 v ac; and for pilot duty, 20 a, 250 v ac.

Robertshaw-Fulton Controls Co., Dept. ED, Acro Div., Columbus, Ohio.

CIRCLE 193 ON READER-SERVICE CARD

Miniature Timer
Weighs 6 Oz

A timer measuring 1-1/2 in. sq and weighing 6 oz is hermetically sealed and designed for 115 v 400 cps, 115 v 60 cps and 28 v dc operation. Its mounting mechanism is internally shock-mounted to meet applicable military specifications on shock and vibration. It operates in a temperature range of –55 to +125 C and to altitudes of 60,000 ft.

The Advanced Products Co., Dept. ED, North Haven, Conn.

CIRCLE 194 ON READER-SERVICE CARD

RF Duplexer
450 to 900 Mc

The Type 149 radio frequency duplexer is a tuned cavity network designed to couple a transmitter and receiver operating in the 450 or 900 mc bands to the same antenna and transmission line without interaction and with negligible loss in efficiency. With the duplexer, one antenna and transmission line are eliminated. High Q reduces the spurious radiation of the transmitter by at least 20 db and the spurious responses of the receiver by at least 40 db. The duplexer is assembled on a 3-1/2 x 19 in. panel to fit standard relay rack and is normally mounted on the same rack as the radio equipment. All tuning adjustments are made at the factory in accordance with specified frequencies and locked to prevent movement in shipment or under vibration.

Budelman Radio Corp., Dept. ED, 375 Fairfield Ave., Stamford, Conn.

CIRCLE 195 ON READER-SERVICE CARD

◄ **CIRCLE 196 ON READER-SERVICE CARD**

Magnetic Cores
Provide Greater Stability

Magnetic cores for transistorized ...tronic computers are available ...ich reportedly offer the greatest ...bility yet achieved for a transistor-...rated core over a wide range of ...peratures, currents and other dis-...bing influences. The result is ...ater computer accuracy and less ...wntime for trouble-shooting. The ...es can maintain ratios of 3 to 1 or ...ter between a Read 1 and a Read 0. ...e drive current used with one of ...new cores can vary plus or minus ...2 per cent in the 300 to 400 ma ...nge, over a range of 50 to 100 F. The National Cash Register Co., ...pt. ED, Dayton 9, Ohio.

CIRCLE 197 ON READER-SERVICE CARD

Wire Wound Resistor
Up to 250,000 Ohms

...wire wound resistor, completely ...apsulated, measuring 3/16 in. in ...meter by 3/8 in. in length and ...d at .25 w is available. The max-...m resistance on this unit is 250,-...0 ohms. All requirements of mili-...y specifications, except physical ...e, can be met by this resistor. The Daven Co., Dept. ED, Living-...n, N.J.

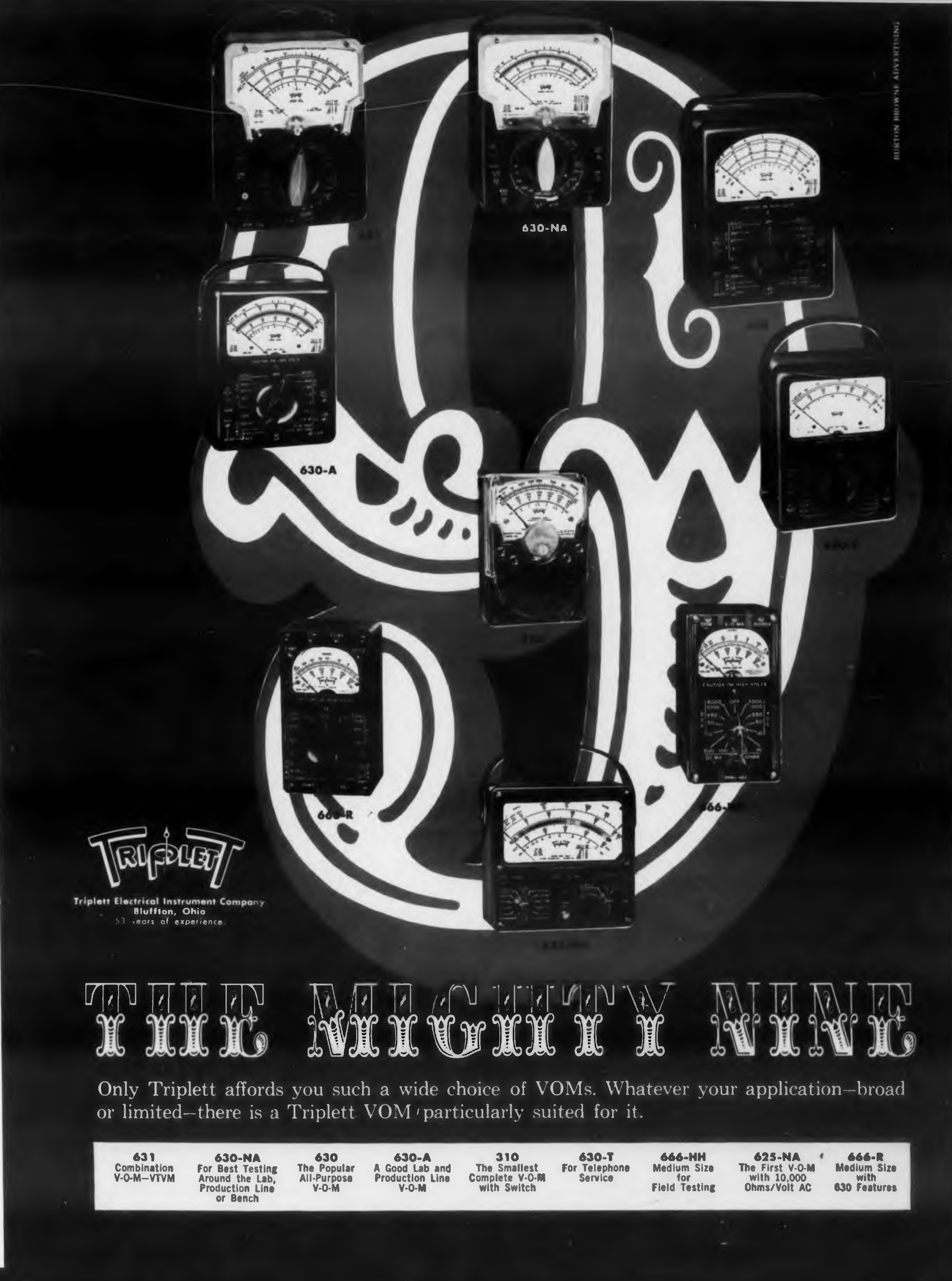
CIRCLE 198 ON READER-SERVICE CARD

Missile Tracking Camera
70 Millimeter

...70 mm data recording camera, ...LTIDATA MOD V, specifically ...gned for missile tracking provides ...more detailed record of missile ...t than 16 or 35 mm cameras can ...d and a larger field of view. With ...same focal length lenses, it mini-...es the effect of tracking error and ...s keep the missile within the ...era's 2-1/4 x 2-1/4 in. frame. ...istration pins insure precise ...e-to-frame alignment. A sturdy ...transport eliminates vibration ...permits high resolution at speeds ...0 fps and at shutter openings of ...deg. Two neon lights provide visi-...coding on both edges of film for ...ect correlation with time base. ...ight Research, Inc., Dept. ED, ...mond, Va.

CIRCLE 199 ON READER-SERVICE CARD

CIRCLE 200 ON READER-SERVICE CARD >



Wire-Wrap Machine

Solderless Technique

In this solderless wire-wrap unit, two latera[l] adjustable wrapping tools are mounted side [by] side, spaced to accommodate the component use[d]. This new technique designed for the automat[ic] assembly of axial-lead components. Tape-mount[ed] components are fed from a reel to a set of gripp[er] jaws which pluck a single component from t[he] tape into the wrapping position. The compone[nt] leads are simultaneously placed in a set of "sid[e] loading" wrapping bits, the gripper maintaini[ng] contact with the leads at either end of the comp[o]nent body. The "side-loading" bits fold the lea[ds] from the tangential position to an axial positi[on] in the bits. The assembly (component, gripper ja[ws] and wrapping tools) moves forward to a positi[on] each wrapping bit over a terminal. The wrappi[ng] bits then rotate in opposite directions, forming solderless wrapped connection with each lead [of] the component. The total cycle time for this ope[ra]tion is two seconds.

The process is designed to use commercia[lly] available components. Permanent connections wi[th] the lowest known resistance and high reliability a[re] made. The elimination of heat and protection pr[o]vided by the gripper jaws during the operati[on] gives maximum care to the component. The si[m]plicity of this type of connection results in increas[ed] reliability of commercial electrical equipment.

Gardner-Denver Co., Dept. ED, Keller Tool Di[v.], Grand Haven, Mich.

CIRCLE 202 ON READER-SERVICE CARD FOR MORE INFORMATI[ON]

Toroidal Coil Winder

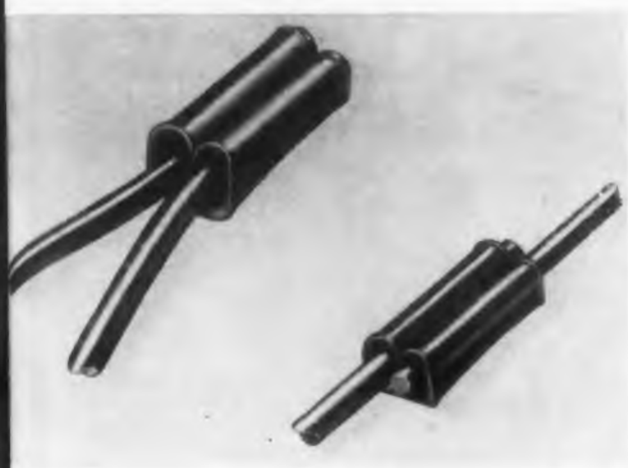
2 to 8 In. OD Coils

This heavy duty toroidal coil winding machine designed to wind medium to large size toroidal ils such as are used in magnetic amplifier and ntrol systems. The unit specifications include: l size, 2 to 8 in. OD; residual hole, 3/4 in.; eed, maximum of 500 turns per min; winding g, 24 in. diam, 1/2 in. cross section; wire load, aximum 1-1/2 lb per loading. Turns are counted a system incorporating thyratron pulsing circuit. Donald C. Harder Co., Dept. ED, 3710 Midway , San Diego 10, Calif.

CLE 205 ON READER-SERVICE CARD FOR MORE INFORMATION

Horizontal Splicing Machine

Joins Coated Wires



The AMPli-var splice with its automatic "Horintal" splicing machine, is designed to produce up 1200 per hr identical, mass produced splices on amel, polyvinyl acetal and similarly coated wire. e splices, with multiple ring stripping action, minate scraping, dissolving in solvents, burning other methods of removing insulation. There is heat damage. The splice, scarcely larger than wires themselves, is design-engineered to lock es and connector into a high tensile strength ice. The joint is hermetically sealed during splic-, thus rendering it corrosion resistant. Soldering terial and equipment are unnecessary, less wire l time are required, thereby lowering installed ts. They can be used on solid or stranded conctors or combinations thereof.

AMP Inc., Dept. ED, Harrisburg 13, Pa.

CLE 206 ON READER-SERVICE CARD FOR MORE INFORMATION

Transistor Washer

Uses Distilled Water

A special apparatus for washing and rinsing transistors and other small electronic parts in hot distilled-demineralized water has been developed. It has been found that rinsing in hot, highly-purified, particle-free water improves quality and reduces rejects. This equipment incorporates continuous repurification of the rinse water by ion-exchange plus activated carbon filtration followed by ultra-fine filtration of submicroscopic particles to 0.45 micron. Washing and rinsing is accomplished in a five stage cascade type rinse tank. Rinse chambers are individually electrically heated and a regenerative heat-exchanger is employed in the circulating system to conserve electricity. Demineralizer and carbon filter are disposable cartridge type. Submicron filter employs replaceable membranes.

The final rinse water is of high electrical resistance, 5,000,000 (18 C) or more ohms, and is also free of organic impurities and submicroscopic particles which often contribute to sub-standard results. Complete unit is mounted on a mobile frame with circulating pump, etc, as illustrated.

Barnstead Still & Demineralizer Co., Dept. ED, 2 Lanesville Terrace, Boston 31, Mass.

CIRCLE 210 ON READER-SERVICE CARD FOR MORE INFORMATION

Automatic Soldering System

For Printed Circuits

This Flowsolder unit is designed to eliminate the difficulties involved in the conventional flat dip-soldering of printed circuits. This unit lifts the molten solder up to the circuit instead of lowering the circuit panels down to the molten solder. The solder wave, 8 in. wide and free from oxide, is produced by pumping molten solder through an elongated spout by a motor driven impeller pump. The circuit panel is passed through the crest of this wave and the joints between the component leads and the copper conductors on the underside of the panel are soldered. Fresh solder is fed to the bath by feeder ingots; as the solder is consumed the ingot is gradually lowered into the bath. The unit is electrically heated and the solder temperature is thermo-statically controlled with normal operating temperature at 250 C.

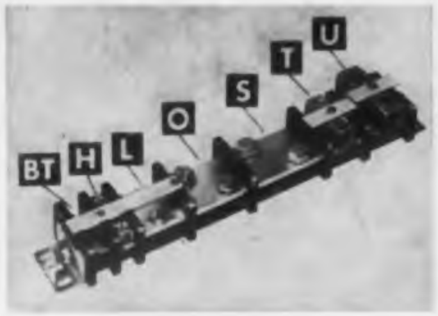
Advantages over the conventional dip-soldering method for soldering printed circuits include: (1) provision for angled entry and exit by the shape of the solder wave, which together with the washing action of the moving solder, prevents trapping of flux or air and assures sound joints; (2) accommodation for panels of any length up to 7-1/2 in. wide; (3) automatic conveying system preventing hesitation or break in the production flow; (4) constant flow of solder which provides a more rapid heat transfer from solder to panel, reducing dipping time and eliminating surface chilling; (5) short panel exposure to heat, diminishing warping of the panel and heat damage to components; (6) continuous flow of clean solder since the molten solder welling up through the nozzle is drawn from below the bath surface; (7) controlled wave level maintained by adjusting the speed of the metal pump which forces the molten solder upwards through the nozzle.

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

CIRCLE 213 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Combination Terminal Block
30 to 250 Amp.



This terminal block allows the grouping of any combination of seven different types of terminals in a single block, as required. Terminals with capacities from 30 amp to 250 amp may be factory assembled in the particular combination required by the user. Since the various components of this combination block are all standard, it can be assembled at the factory with a minimum delay and free of special tooling costs.

Curtis Development & Mfg. Co., Dept. ED, 3250 N. 33rd St., Milwaukee, Wis.

CIRCLE 217 ON READER-SERVICE CARD

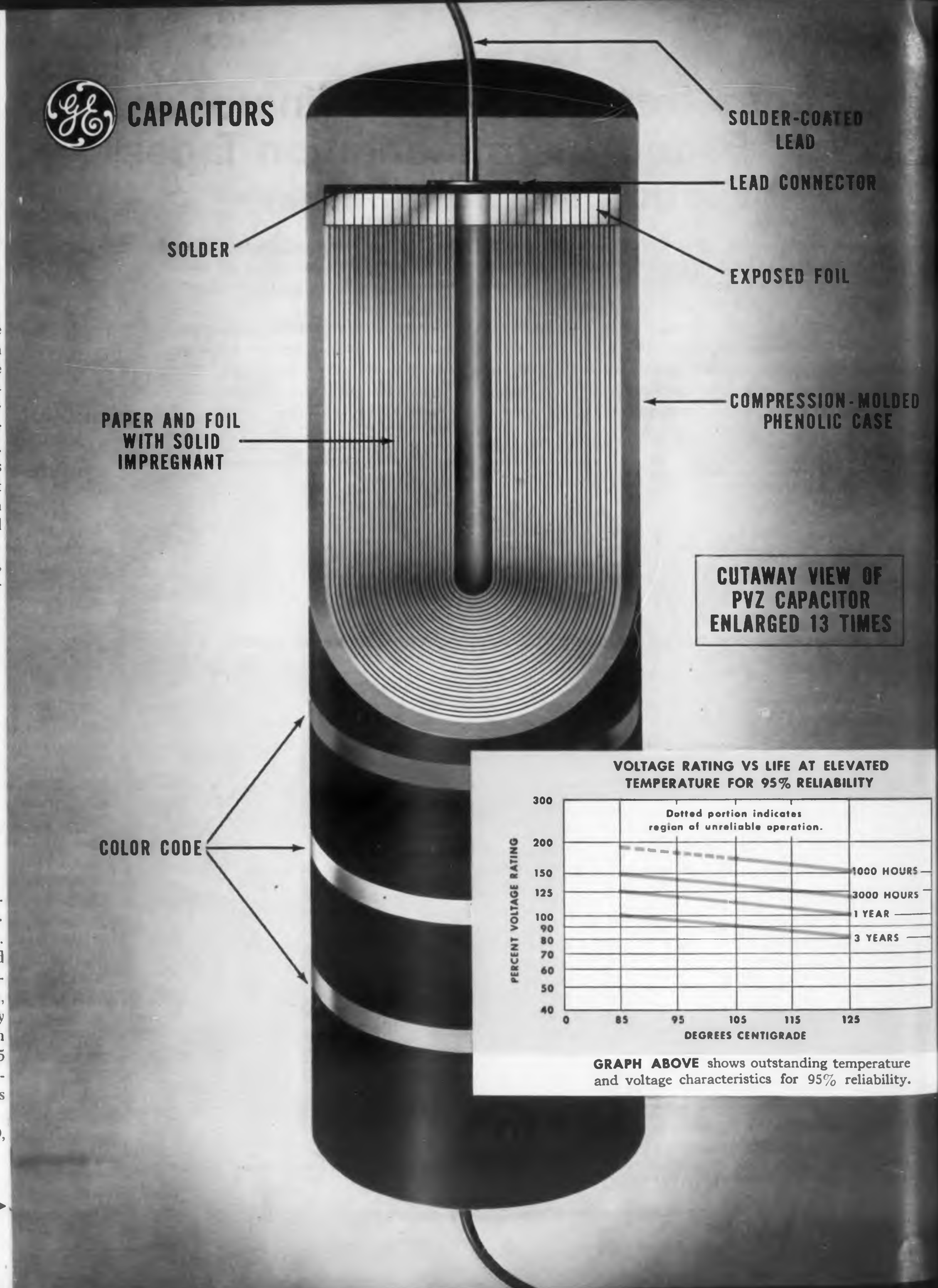
Miniature Oscilloscope
DC to 150 Kc

Designated Mini-Scope, these oscilloscopes feature high deflection sensitivity and minimum pattern distortion. Series 300 Mini-Scopes are supplied in three models with frequency response from DC to 150 kc, 3 db down, usable to 200 kc. Horizontal sensitivity is standardized at 0.5 v per in., with vertical sensitivities ranging from 0.5 v to 1 mv per in. Dimensions are approximately 5 in. cube, and weigh less than 4 lb.

Special Products Corp., Dept. ED, 875 Barbey St., Brooklyn 7, N.Y.

CIRCLE 218 ON READER-SERVICE CARD

CIRCLE 220 ON READER-SERVICE CARD ➤



Potentiometer and Mv Source

For All Thermocouples

Model P-55 can be used with any thermocouple, and measures any potential in the 0 to 55 mv range. In addition, the instrument will accurately supply the same potential for check-out of recorders and other instruments. The P-55's dual input provides two sets of 55-way binding posts for checking two thermocouples, or one thermocouple against a standard, etc. A thermometer is shock-mounted in the lid, and the instrument is available in a weatherproof aluminum case or in mahogany. It measures 4-1/8x4-1/2 x7-1/2 in. and weighs 3-1/2 lb.

Allegany Instrument Co.. Inc., Dept. ED, 1091 Wills Mountain, Cumberland, Md

CIRCLE 221 ON READER-SERVICE CARD

400 Cps or DC Circuit Breaker

Single or Ganged

The AM17 circuit breaker can function on either 400 cps ac or dc without any change in rating or essential time-delay characteristics. Although manufactured in single-pole form only, the breakers can be readily linked with others to make two- or three-pole units. The only operating connection necessary is a tie rod through the breaker handles; electrical tripping of ping of the other connected breakers. The breaker, which operates on the hydraulic-magnetic principle, does not require derating for either temperature or vibration conditions.

Heinemann Electric Co., Dept. ED, 453 Plum St., Trenton 2, N.J.

CIRCLE 222 ON READER-SERVICE CARD

◄ CIRCLE 220 ON READER-SERVICE CARD

New Literature

Silicone 225

Brochure No. 6-206 devoted to the properties and performance of silicone-greases is now released. Developed primarily for high-temperature, slow-speed bearings, it has become an industry standard for uses ranging from worm-and-pinion sets to compressor engine injector valves; from hold-down bolts to plastic extruder nozzles. Dow Corning Corp., Midland, Mich.

Diameter Dilemma 226

Booklet on thread gaging showing that variations in screw thread angle and lead, product misfit fasteners as readily as do deviations in pure diameter dimension itself is now available. The increase can be considerable as shown in charts included in the booklet. Standard Pressed Steel Co., Box 202, Jenkintown, Pa.

Sensitive Relays 227

Sensitive and power type relays are described in 4-page leaflet now available. The illustrated pamphlet gives the specifications and characteristics of each model. Five Star Co. Inc., Plantsville, Conn.

Tubing Prices 228

Prices, properties, and application information are given for a complete line of electrical tubing in a 16-page pricing guide. Included in the guide is a selector chart for plastic tubings. This chart lists application information, maximum recommended operating temperatures, low temperature brittle point, durometer hardness, dielectric strength, dielectric constant, shrinkage, moisture absorption, flammability, fungus resistance, available colors, and applicable military specifications for each available type. A similar chart is provided for various types of coated tubings. The guide also contains data and pricing information on a line of telephone products, among them a wire vibration damper, a filled splice sleeve, and an open splice sleeve. Minnesota Mining and Mfg. Co., Irvington Div., 6 Argyle Terrace, Irvington 11, N.J.

Timers 229

A line of electronic timers is described in 4-page bulletin now available. This bulletin provides specifications, applications and operation of 11 timers of the repeat cycle, interval and delay types. G. C. Wilson & Co., 1915 Eighth Ave., Huntington, W. Va.

Paper Tape Equipment 23

Those involved in tape handling will fi the 4-page brochure now available intere ing. The illustrated pamphlet describes t construction of the winder and unwinder simple terms. Whiteford Lab., 258 Bro St., Lynn, Mass.

Liquid Sealant 23

Technical Report No. 5 gives compl information on how to lock threaded f teners with a liquid sealant. Proper sel tion of grade is outlined in simple termin ogy so that predictable results to m specific locking torque requirements can easily obtained. Specific uses and metho of application are documented for stu screws, nuts, and other threaded produ Covered are techniques for sealing a soldering sleeve joints. Fundamental d is given on the basic principles of thre locking with plastics, as well as formu for torque determination under varyi conditions. Physical properties of the se ant, both in the liquid and solid state given, including cure time, resistance solvents and chemicals, heat aging, strength, resistance to thermal shock, ele trical properties. Drawings and diagra illustrate the 12-page booklet. Americ Sealants Co., 103 Woodbine St., Hartfo 6, Conn.

Electronics Catalog 23

A 220-page catalog has been issu which contains extensive, detailed listi of industrial electronics and public addr equipment as well as other electronic co ponents and equipment. Radio Specialt Co., 456 Charlotte, Detroit 1, Mich.

Plastic Wiring Ducts 23

Low cost plastic wiring ducts for f electrical control panel wiring are featur in 4-page folder just released. The fold shows two types of non-flammable vi plastic ducts, both with covers that snap place directly on the duct. The covers said to provide quick access to the fu width of the duct for quick, install tion, trouble-shooting and revision. Th methods of mounting are also illustrat speed mounting with spring steel stand clip; security mounting with threaded st and standard flush mounting with through base of the duct. Panduit C 10132 S. Washtenaw Ave., Chicago 43,

hat Goes On Here? 235

In basic, non-technical and conversa-nal language, the illustrated 8-page oklet describes connectors, terminals, ices, panels, and components for the ectronic, Appliance, Aircraft and Military rkets. Burndy Corp., Norwalk, Conn.

igital VTVM Booklet 236

Full line of digital voltmeters, ohmme-s, ac-dc converters, and complete data ging systems are described in twenty-ht page booklet just released. The book-is illustrated with charts, diagrams, and otos of instruments. Non-Linear Systems, ., Del Mar, Calif.

pes for Tape Recording 237

"How to Choose the Right Recording pe," is the name of color pamphlet now eased. The illustrated brochure offers neral information on magnetic recording e, recording characteristics and the ele-nts, such as Mylar and cellulose acetate, ich governs the physical characteristics product. The booklet described indi-ual requirements which should be con-red in choosing a tape. Reeves Sound-ft Corp., 10 E. 52nd St., New York, N.Y.

Weld Fasteners 238

Various types of weld fasteners are described in Bulletin No. 58 now released. Among the highlights of the catalog are typical applications . . . methods of improving the products and reducing costs, production economies and others. It is well illustrated and complete information is available on all types of fasteners. Ohio Nut & Bolt Co., 33 First Ave., Berea, Ohio.

Panel-Mounting Units 239

In a 36-page catalog and designers guide an entire line of miniature, panel-mounting electronic instruments are presented. For each instrument photographs, outline drawings, a description, mounting details, complete specifications, and operation theory are given. The catalog, sectioned for ease of reference, includes ac vtvm's, dc vtvm's, power supplies, and special instruments such as multichannel vtvm's, phase meters, and null meters. The designers guide aids in the selection and application of vtvm's to measurement or monitoring problems and discusses the how-to phase of building electronic instruments into system equipment. Trio Labs., Inc., 4025 Merrick Rd., Seaford, N.Y.

New Literature

Hi-Fi, PA, and Ham Products 246

In a complete catalog, electronic products for high fidelity, PA, ham, industrial, and experimental applications are listed. The catalog contains 180 pages, 72 of which are devoted to PA and high fidelity items. Custom Electronics, Inc., 1000 S. Main St., Dayton 9, Ohio.

Design and Production Facilities 247

The facilities of the company's specialized engineering, research and product development facilities, experienced personnel and modern production equipment for the design and manufacture of electronic equipment and components is described in four page bulletin 67-193 now available. Hupp Electronics Co., 743 Circle Ave., Forest Pk., Ill.

5 In. Precision Pot 248

General information and specifications on Series HP1500 5 in. high resolution precision potentiometers are presented in a data sheet of two pages. The literature is illustrated with a photograph and dimensional drawings. De Jur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N.Y.

Tape Noise 249

"Sound Talk," Bulletin 34, discusses the problem of noise in magnetic tape recordings. Illustrated with graphs and line drawings, the 5-page text tells what tape noise is and how it is diagnosed on a tape recorder. Among the topics considered are frequency modulation noise, drop-out noise, modulation noise causes, and erasure problems. Minnesota Mining and Mfg. Co., 900 Bush St., St. Paul 6, Minn.

Conversion Tables 250

A series of tables which simplify conversion from decimal to binary numbers, and vice versa, have been published in a pocket size folder. The tables should prove useful to those working with coding systems of binary numbers. Barnes Engineering Co., 30 Commerce Rd., Stamford, Conn.

Industrial Tachometers 251

A variety of generators and indicating recording instruments are described in Bulletin 1258A now released. The illustrated booklet states that the instruments are available for measuring speed of any industrial rotating equipment, including tachometer generators and hand tachometers. General Electric Co., Schenectady 5, N.Y.

iming Device 255

Additions and replacements are easily ade in a recent loose leaf catalog and ference manual on timing devices. The pages of data, color coded for conven- nce, are divided into six major categories: lays; repeat cycle timers; time delay re- ys; elapsed time indicators and stop ocks; ac, dc and chronometrically gov- ned timing motors; and miscellaneous in- rmation and application data. The scriptive matter is supported by 60 photo- aphs, 30 dimensional drawings, and 50 arts and diagrams. There are approxi- ately 600 catalog item part numbers. The W. Haydon Co., 232 N. Elm St., Water- ry, Conn.

ctronic Data Processing Systems 256

Individual business applications of the tatron electronic data processing system described in a series of brochures now ilable. The pamphlets document specific utions to computational problems in pay- l processing, invoice billing, parts inven- y controlling, accounts payable process- utility billing, and life insurance re- ding. Burroughs Corp., Div. Electro- ta, 460 Sierra Madre Villa, Pasadena, lif.

Servomotor-rate Generator 257

Complete specifications, characteristics, 3-view drawing, and schematic of servomotor-rate generator, Model II is described in Data Sheet 872 now released. The sheet states that the unit provides fast response, low power input, oscillation damping, signal-to-noise ratio of 25:1 and linear torque-speed curve. Beckman/Helipot Corp., Newport Beach, Calif.

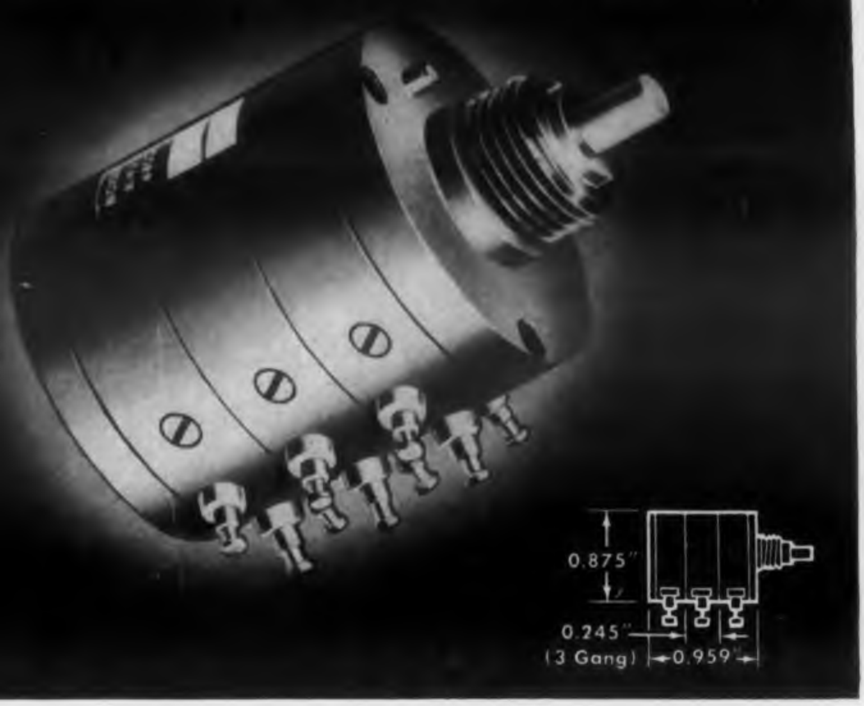
Variable Transformer 258

Double wound powerstat with an isolated secondary on a single core is described in 4-page bulletin L 3578 now available. Connection diagrams and ratings are given as well as illustrations, outline drawings and technical rating data on this variable transformer. Superior Electric Co., 83 Laurel St., Bristol, Conn.

Klystron Facts 259

"Klystron Facts Case No. 4" is a 24-page brochure summarizing recent developments in the field of klystron design. The illustrated booklet contains information on depressed collector operation, use of klystrons in high power uhf SSB service, and shaped pulse applications. Eitel-McCullough, Inc., San Bruno, Calif.

Looking for a Gang-- OF POTS?



If you are in the need of miniature, precision potentiometers with a built-in affinity for each other, you need the MODEL 319 by Daystrom Pacific Corporation, Potentiometer Division.

GANGED IN ALMOST ANY NUMBER, THIS UNIQUE DESIGN OFFERS:

- ★ **Independent phasing**
- ★ **Smallest cup depth, lightest weight on the market**
- ★ **No clamp rings**
- ★ **Excellent performance under extreme conditions**

Each wiper can be independently phased without interfering with the phasing of the other cups in the gang, and without rotating case or terminals, so that pre-assembled wiring harness can be used. Individual cups are one-half the length of any other similar potentiometer, and the high-strength, heat-resistant body reduces weight and eliminates insulation problems.

Available with panel or servo mount, and with ball or sleeve bearings. **WRITE FOR COMPLETE SPECIFICATIONS.**

Challenging openings exist for highly-qualified engineers

DAYSTROM PACIFIC CORPORATION

A Subsidiary of DAYSTROM, INC.

POTENTIOMETER DIVISION

11150 La Grange Avenue, West Los Angeles, California

New Literature

Extruded Acrylic Sheets 266

Complete information on the handling, machining, forming, cementing and annealing of low-cost Cadco extruded acrylic sheets is given in a 12-page bulletin now available.

Table of properties and four pages of light transmittance charts, including comparison with cast sheet are also included. Cadillac Plastic & Chemical Co., 15111 Second, Detroit 3, Michigan.

Ceramic Capacitors 267

Ceramic capacitors are described in a six-page catalog now available. Disk, tubular, and plate types of ceramic capacitors are illustrated with charts and diagrams. Each application for temperature compensating, stable capacitance, high voltage, printed circuitry is discussed, with complete specifications and properties of the ceramics listed. Special customized applications are mentioned. Skottie Electronics Inc., Peckville, Pa.

Brass Fittings 268

Recently issued is a 48-page brass tube fitting catalog. It lists all available sizes and types, and has a section showing a complete line of drain and shut-off cocks. Other subjects covered in the catalog are push-pull controls, complete assembly instructions on all brass fittings, data on right and wrong ways for tubing a system, tube fitting data and tools. The Weatherhead Co., 128 W. Washington Blvd., Fort Wayne, Ind.

Analysis and Test Instruments 269

In an eight-page catalog digest of all standard devices, instruments are grouped by type and application. Depicted and described with specifications are subsonic, sonic and ultrasonic waveform analyzers; rf, vhf and uhf spectrum analyzers; special and accessory instruments; and telemetering test instruments. A summary list of applications and a detailed table of contents help to locate equipment of specific interest. Panoramic Radio Products, Inc., 10 S. 2nd Ave., Mount Vernon, N.Y.

Motors, Fans and Blowers 270

Fourteen-page catalog, No. 83 describing motors, fans and blowers, has been released. This informative catalog offers full details, physical specifications and electrical characteristics on complete line of synchronous, torque, induction and gear motors, centrifugal blowers and axial fans. Both standard and custom models are available to order for commercial or military applications. Ashland Electric Products Inc., 32-02 Queens Blvd., Long Island City 1, N. Y.

Microwave Products Catalog 273

Short form Catalog 57-BG describes all of the products manufactured. Among items included are pulsed and CW magnetrons, TR and ATR duplexing tubes, microwave silicon diodes, silicon power rectifiers, flange-mounted and solderable waveguide pressure windows, waveguide components, and test equipment.

Operating characteristics are tabulated for a majority of the products. Microwave Assoc. Inc., 22 Cummington St., Boston 15, Mass.

Efficiency Poster 274

An unusual training poster has been released recently. It is an attractive, colorful 18 x 24 in. sheet, addressed to assembly line operators, and illustrating dramatically how to do a more effective soldering job, eliminating costly rejects and adding to production efficiency. The poster is designed to be useful in any plant, posted along the assembly line. It is an appeal to the employee's pride of accomplishment. Multicore Sales Corp., 80 Shore Rd., Pt. Washington, N.Y.

Automatic & Semi-Automatic Machines 275

Four specification sheets describing special automatic and semi-automatic machines have been issued. These sheets describe Machine No. 1507, glass tubing cutting machine; Machine No. 2070, automatic bulb blowing machine; Machine No. 1416, high-speed pneumatic base filling machine; and Machine No. 1708, an automatic neck sealing machine. Kahle Engineering Co., 1400 Seventh St., No. Bergen, N.J.

Resistance Elements 276

Three bulletins of interest to industrial companies dealing in electronics are available. One bulletin describes the highly-individualized engineering manufacturing and marketing services offered; second bulletin deals with revolutionary line of resistance elements known as RdF Stikons; and third describes development of miniaturized high-temperature resistance thermometer probe. Arthur C. Ruge Assoc, Inc., 733 Concord Ave., Cambridge 38, Mass.

Instrumentation Tape for Telemetering 277

Type B Instrumentation tape designed specifically for telemetering is described in a booklet recently released.

The multi-colored booklet completely describes operating characteristics of the Type B tape for carrier-type recording, including specifications and magnetic properties. The booklet covers use of the tape for FM/FM or FM/PM, PDM/FM, or PDM/PM. Reeves Soundcraft Corp., 10 E. 52nd St., New York, N.Y.

Sub-Miniature Metallized Paper Capacitors

Peter P. Grad
Aerovox Corp.
New Bedford, Mass.

A major modification of the metallized paper capacitor has resulted in a 50 per cent volume reduction of the smallest available units of this type. The insulation resistance and temperature coefficient characteristics have been improved over the best commercial subminiature paper capacitors. The small size and high precision of this component make it suitable for transistor circuitry. Although the capacitor is not yet available on the market, this preview should be useful to the design engineer.

Aside from constructional details, the impregnant and the method of impregnation employed are most important in the manufacture of metallized paper capacitors.

It was found that a liquid impregnant—polysiloxanes—is the most successful for high reliability subminiaturization, and for heretofore unobtainable electrical characteristics. Although liquid impregnants were generally considered unsuitable for metallized paper capacitors because of the conductive particles resulting from the self clearing burnout, a newly developed impregnation technique coupled with the properties of methyl polysiloxane changed this misconception.

This liquid impregnant has many advantages. Inherent in their chemical structure the silicone oils

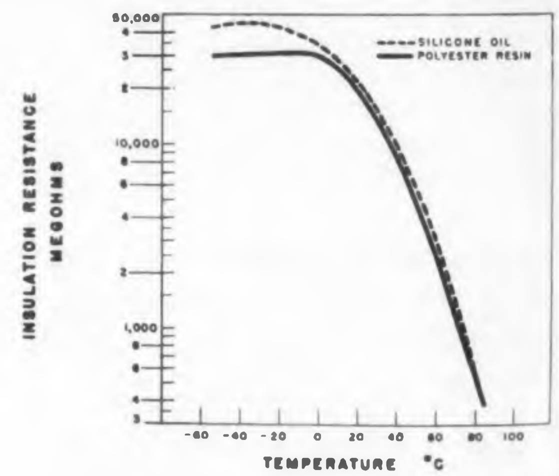


Fig. 1. Graph of insulation resistance vs temperature. 1.0 μf subminiature metallized paper capacitors impregnated with silicone oil and polyester resin.

exhibit a high degree of stability. Their resistance to heat and oxidation is high, and relatively slight changes in viscosity and dielectric properties take place with temperature changes. Added factors are the high degree of water repellency and availability in viscosity ranges.

Experimental evidence indicates that methyl polysiloxanes partially polymerizes under the stress of arcing which occurs when the metallized paper undergoes self-clearing. The resultant small gummy masses occlude any conductive decomposition particles as a consequence of the paper pyrolisis. This is a partial explanation for the puzzling phenomenon that silicone oil does not cause breakdowns whereas mineral oil, for example, is unsuitable as a metallized paper impregnant. The good performance of the silicone oil impregnant is predicated, however, on its complete penetration into the fibrous structure of the paper.

The development of the subminiature metallized paper capacitor has resulted in the following:

- Insulation resistance values attained at 25 C (10,000 meg-μf) and at 85 C (300 meg-μf) are better than the highest values for commercially available metallized paper capacitors. See Fig. 1.
- The volumes are an average of 55 per cent smaller than the volumes of the smallest commercially available metallized paper capacitors. A completely assembled 1 μf unit has a total volume of .1 cu in.
- A low capacitance change with temperature has been obtained: −2, +0.3 per cent. See Fig. 2.
- Power factor values are equivalent to present commercial and military standards for metallized paper: 0.55 per cent at room temperature.
- Tolerance on capacity can be kept within ±10 per cent.
- Life expectancy is 7.5 years at 85 C and 25 v.
- Large scale production is feasible without major retooling or large equipment investment.

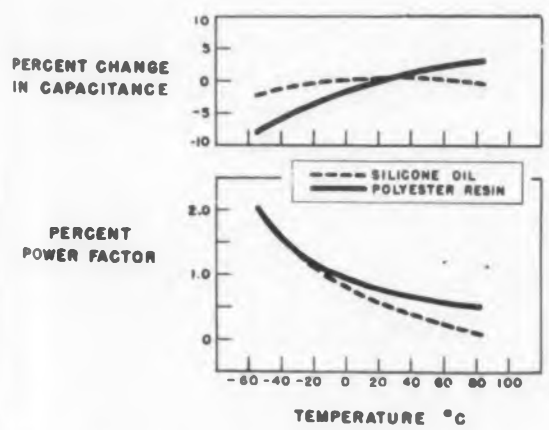


Fig. 2. Graph of capacitance and power factor vs temperature. 1.0 μf subminiature metallized paper capacitors impregnated with silicone oil and polyester resin.

Measuring AC Currents in Transistor Circuits

OWING to the nature of audio vacuum tube circuits, it is possible to make fairly complete analysis of an experimental circuit by measuring stage-by-stage voltage gains using conventional equipment. In transistor circuits, it is also desirable to ascertain current and power gains. Once knowing these additional facts, it becomes possible to calculate actual stage-by-stage impedances.

Since most small laboratories are not equipped with low impedance ac microammeters, it is possible to measure signal currents as low as 0.1 μa by using the circuit shown in conjunction with a vtvm.

Requirements

The requirements for an ac microammeter should include the following: 1. it should not increase the impedance in the circuit being metered; 2. input terminals must be above ground; 3. the frequency response should be flat over the ac frequency spectrum to be applied; 4. it should be convenient and easy to use.

In the circuit, a Triad type HS-52 transformer was used, having the following specifications: frequency response—20 to 20,000 cps; impedance ratio—62.5 ohms to 20,000 ohms (1.320); turns ratio—1:17.9; dc resistance of primary—3.6 ohms; dc resistance of secondary—780 ohms. Because the vtvm is actually measuring the current in the

	SZ Switch Position		
	1	2	3
Secondary Impedance	180 ohms	1.8 K ohms	18 K ohms
Primary Impedance	.563 + 3.6 ohms	5.63 + 3.6 ohms	56.3 + 3.6 ohms
Multiplying Factor	0.1	1.01	0.001
Min. Detectable Current*	10 μa	1 μa	0.1 μa

* Based on Minimum of 0.1 mv on Ballantine Model 310 A vtvm

condary, the dc resistance of the secondary has o effect on the accuracy of the measurement; lthough it does decrease the sensitivity somehat.

The 3.6-ohm dc resistance of the primary does ot affect the accuracy, but in a low-impedance rcuit—such as a 50 ohm common-base input rcuit—it will reduce the input current by apoximately 5 per cent.

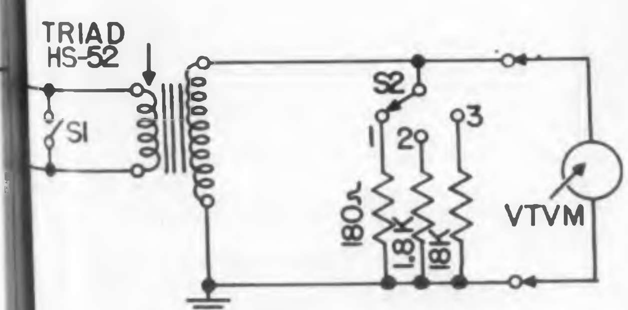
The multiplier resistances in the secondary ere chosen so that the switch positions vary the urrent ranges in powers of 10. The voltmeter us reads directly in current, by mentally multiying the scale reading by the proper power 10.

Switch *S1* is used to check the effect of inserting the device in the circuit to be measured. This done by noting any change in the output of the st circuit when *S1* is alternately opened and osed. With *S1* opened, *S2* is stepped until a ading effect is noticed by a slight decrease in e output voltage of the test circuit. The voltage ading is then noted and by means of the mulying factor is converted directly to current. If a fourth step were added to *S2*, its resistance ould be 180 K ohms. Because the maximum ecified secondary impedance is 20 K ohms, the 0-ohm resistor would seriously degenerate the equency response. Frequency response is as ated by the transformer manufacturer, proled the 20 K ohm impedance rating is not ceeded.

Accuracy

The circuit shown is adequate to measure dio current to at least 3 per cent, which is the it of the Ballantine vtvm. Further improvent can be obtained using a transformer of wer dc resistance and higher inductance.

Due to temperature effects and transistor rameter variations, most high quality transis- circuits make use of multiple ac and dc feed ck loops to improve stability and linearity. is circuit has been especially useful in measng currents and impedances in these closed p circuits. *John W. Sullivan, Northrop Airft, Experimental Flight Test, Development b.*



Ideas for Design

Low Cost Speaker Horn

A plant loudspeaker paging system was needed. A low-cost solution was found by improvising for loudspeaker enclosures as follows:

Surplus metal spheres were purchased which had been used to hold gyros in transit. These were cut as shown; then the speakers were mounted in the half spheres, resulting in very efficient radiating horns.

These horns were then mounted from the ceiling with a resultant saving in amplifier cost because of the increased efficiency brought about by the horn effect.

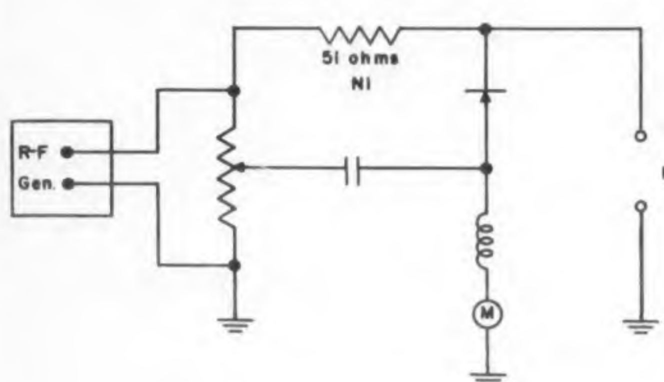
Herbert Piller, National Electronics, 451 Thieriot Ave., N.Y. 72, N.Y.

Antenna Impedance Measurements

The solution shown here increases the utility of existing antenna impedance measuring equipment (Heathkit, etc.). It results in *1.* greater frequency range; *2.* avoids scale compression at low R readings and extend range to ∞, and *3.* gives more uniform loading of the generator.

The variable series resistor has been replaced by one of fixed composition having superior frequency characteristics. The variable resistor is now used as a slide wire voltage divider across the source, as shown.

The bridge now balances at mid scale with a 51 ohm R_x and gives a range of 0 to ∞ ohms. The generator load varies from approximately 33 to 100 ohms. *A. H. Nichols, Sr. Staff Eng., Hughes Aircraft Co., Culver City, Calif.*



Modified impedance measuring circuit

Improved Harness Layout

A simple method for the layout of wiring harness assemblies, that lends itself to the accurate duplication of two or more harness boards for higher production rates, has been developed at the Columbus Division of North American Aviation, Inc.

General practice has been to paste down on plywood boards paper blackline prints made from the original layout tracing. Errors occurred because paper prints—however accurate the original layout may have been—are stretched or shrunk during printing, developing, or mounting on the wood. Errors as much as 1/2 in. in 6 ft—and more in longer boards—have been measured.

In the Radio-Electric Department at the Columbus Division of North American Aviation, Inc., a Master Stabilene Film layout is being compared to a duplicate copy which is printed on plywood. The plywood forms a jig used for the manufacture of wiring harness assemblies.

The new method uses a stable base material—Keuffel & Esser's 130 H Stabilene Film, a re-stabilized Mylar, with a pencil and ink surface—for the preparation of the master layouts for wiring harnesses. Stabilene Film comes in thickness of 0.003, 0.005 and 0.0075 in., has a dimensional stability that averages 0.000006 in. per in. in both directions at temperatures from 80 to 220 F, and from 0 to 98 per cent relative humidity.

Once the master layout has been completed on Stabilene Film, the layout is printed directly on plywood that has first been coated with white shellac and sanded smooth and then sensitized with a daylight type diazo emulsion. Printing is done by contact to insure accuracy in a contact printer 6 ft wide and 30 ft long. If more than one harness board is required, additional sheets of plywood can be printed. There is no limit as to the number of reproductions that can be made.

Once printing has been done, the Stabilene Film can be rolled for storage to save space. It contains no plasticizer and will not deteriorate in storage.

Report Briefs

Radar Screen Diffraction

This report describes the results of tests to termine the effectiveness of shielding screens surveillance radars in reducing the strength ground-clutter signals in critical areas. Although scope of the experimental tests was very limited was found that properly designed screens can p vide a worthwhile reduction in ground-clutter nal strength in areas where the subclutter visibi performance of the radar is inadequate. *PB 1219 Diffraction and shielding effects of radar scre A. W. Randall and Roger L. Williams. U.S. C Aeronautics Administration, Indianapolis, Ind. O U.S. Dept. of Commerce, Washington 25, D Mar. 1957, 12 pp, $0.50.*

Light Magnetic Cores

A method of calculation useful wherever wei is a factor in the design of magnetic amplifier co ponents has been devised at the Naval Resea Laboratory. The method enables calculation of configuration of the magnetic core, case and yielding minimum weight for a given volt-sec capacity of a magnetic core and coil. The anal is very general and takes into account limit quantities such as winding resistances and mag tizing currents. It can be extended to incl weights of other related components such as associated batteries merely by the addition of appropriate terms to the total weight equat *PB 121776 Design of Minimum Weight Magn Cores, J. W. Kallander, NRL, OTS, U. S. Dept Commerce, Washington 25, D. C., Jan. 1957, 8 $0.50.*

Log Recording System

A logarithmic recording system was designed provide information concerning the side-lobe st ture of the radiation pattern of an antenna. system is not limited to use with antenna pat ranges, but will plot any function that can be pressed as a voltage. The system obtains the l rithm of the input voltage by electromechan serve techniques. A comprehensive descriptio the system is given, including derivation of necessary design equations, a step-by-step out of the design procedure, and diagrams and pa eters for one of the SRI-built recording systems. *124296 Economical Logarithmic Recording Sys Lloyd A. Robinson, Stanford Research Instit Menlo Park, Calif., Library of Congress, Wash ton 25, D.C. June 1956, 40 pp. Microfilm $ photostat $7.80.*

...eld Electron Emission

...oron is found to be strongly bonded to the ...gsten substrate as indicated by activation ener...s of 2.8 electron volts for surface migration and ... ev for disappearance. The activation energy of ...e molybdenum for surface migration is 3.1 ev ...d for the silicon deposit 2.5 ev for surface migra...n and about 4.0 ev for evaporation. *Field Elec...n Emission, Russell D. Young and Earl C. ...oper, Pennsylvania State University, PB 123961, ...y 1956, 91 p, Microfilm $4.80, Photocopy $13.80. ...der from Library of Congress, Washington 25, ...C.*

...kward Wave Amplifier

...A new form of microwave amplifier known as the ...kward-wave amplifier has recently become ...ible due to new discoveries. This electron tube ...apable of covering a wide band of frequencies, ... is actually a narrow band filter which is tunable ... varying the anode voltage. In addition to the ...ring effect, the tube can have as much gain in ... pass band as the better known traveling-wave ...plifier. The history of the backward-wave ampli... is briefly discussed, its present status is out...d, and possibilities for future work are sug...ted. *PB 121797, Backward-wave amplifier, a ...ge tunable micro-wave amplifier, Daniel G. ... Wright Air Development Center, Dayton, ... OTS, U.S. Dept. of Commerce, Washington ...D.C., Sept. 1955, 16 pp, $0.50.*

...lectric Panel Design

...his report contains a series of graphs of phase ...rdation design curves for solid lossless flat di...tric sheets. The thickness of the flat dielectric ...ts is plotted as a function of incidence angle for ... perpendicular and parallel polarization and ...he following constant phase retardation values: ...90, 135, and 180 deg. The curves are plotted for ...ries of dielectric constants. For reference pur...s on the same graphs the thickness of the flat ...ts are plotted as a function of incidence angle ...he following cases: (1) with the electrical thick... equal to 90 deg, the transmission efficiency is a ...mum for both polarizations, (2) with the elec...l thickness equal to 180 deg, the transmission ...ency is a maximum for both polarizations, (3) ... the electrical thickness equal to 135 deg, the ...smission efficiency is again a minimum for both ...izations, and (4) with the electrical thickness ...l to 360 deg, the transmission efficiency is again ...ximum for both polarizations. The graphs are ...ded for use as a design tool by radome de...rs. *PB 121783, Phase retardation design curves ...olid lossless dielectric panels, Eino J. Luoma. ...ht Air Development Center, Dayton, Ohio. ... U.S. Dept. of Commerce, Washington 25, ... Feb. 1956, 27 pp, $0.75.*

Patents

Magnetic Device

Patent No. 2,794,164. Shou-Hsien Chow. (Assigned to Burroughs Corp.)

A sub-harmonic generator of the magnetic type uses a single magnetic core having a substantially square hysteresis loop. The core has a first winding and a capacitor in series with the winding to form a charging and discharging path. An alternating current source is in series with the capacitor and the first winding for charging the capacitor. A resistor shunts the first winding and capacitor and lies in the discharge path for the capacitor. A biasing magnetic flux is induced in the magnetic core through a circuit inductively coupled to the core.

Stabilized Two Stage Oscillators

Patent No. 2,792,498. B. D. Pewitt. (Assigned to Radio Corp. of America)

A sine wave oscillator is described which uses a first and a second tube each having input and output electrodes. A regenerative oscillation amplifying loop includes a coupling from an output electrode of said first tube to an input electrode of the second tube and a coupling from an output electrode of the second tube to an input electrode of the first tube. A circuit is coupled to the input electrode of the second tube which develops a gain-limiting self bias voltage. A portion of this bias voltage is applied through a suitable coupling to an input electrode of the first tube.

Gain-Modulated Amplifier

Patent No. 2,974,077. C. L. Olson. (Assigned to Radio Corp. of America)

The amplifier described uses an amplifying tube having an input grid to which the input signals are applied and an anode. A pair of series connected controllable-resistance tubes have a unidirectional supply voltage applied to the anode of one of these tubes. A direct current connection is made between the common cathode anode junction of the pair of tubes and the anode of the amplifier tube. Other signals such as modulating signals are applied to the control grids of the pair of tubes with the same phase which signals control the resistance of these tubes.

Stabilized Direct Current Setting Apparatus

Patent No. 2,792,496. R. N. Rhodes. (Assigned to Radio Corp. of America)

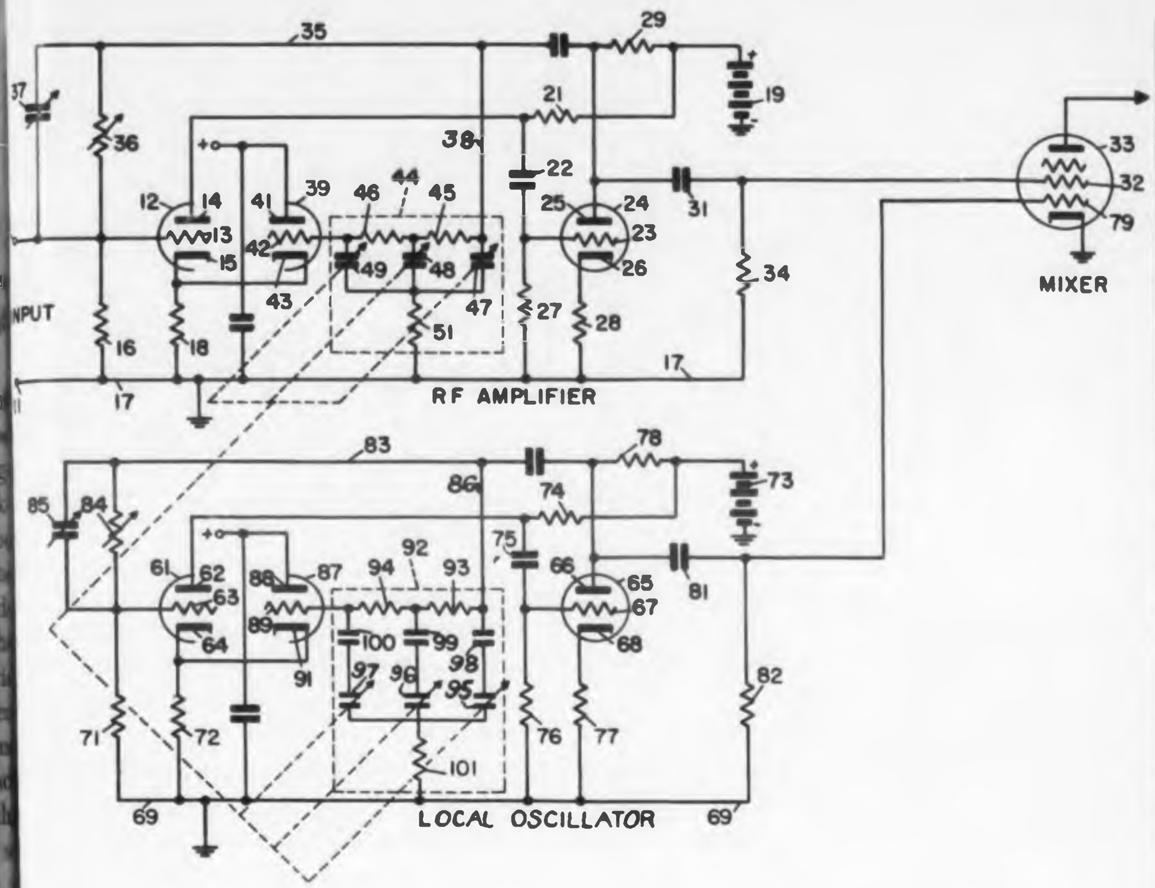
It is desirable to control the level of conduction of an electron discharge tube which is supplied with a signal having regularly recurring reference portions but lacking its direct current component. The tube has a first and a second grid such that the difference in potential between the grids determines the level of conduction of the tube. A circuit is connected to the first grid for clamping the regularly recurring reference portions of the signal to the same voltage level. A direct current path including an impedance is provided from the second grid to a point of fixed potential so that the voltage across the impedance is proportional to the degree of conduction of the tube.

A normally conducting electronic switch and an isolating device connects a source of reference potential and a point of the direct current path for the second grid. This switch is periodically opened coincidentally with the recurring portions of the signal to produce a control signal which is proportional to the difference between the reference potential and the voltage across the impedance. The control signal is measured and applied to the clamping circuit to establish the clamping level.

Forcible Reversion Of Magnetic Amplifier

Patent No. 2,792,507. J. P. Eckert Jr. (Assigned to Sperry Rand Corp.)

A control system of the magnetic amplifier type is described. The amplifier has a core of magnetic material and a control winding on the core. A first circuit is responsive to the input for selectively affecting a current flow through the control winding so that the output of the amplifier changes from a predetermined no-signal state to a secondary output state. A second circuit is coupled to the amplifier which circuit is responsive to the output state of the amplifier for reverting the amplifier from the secondary output state to a no-signal output state upon cessation of the input signal.



...erheterodyne Receiver Using Resistance-...acitance Tuning in Local Oscillator ...Radio Frequency Stage

...nt No. 2,783,373. C. J. Fowler. (As-...d to United States of America)

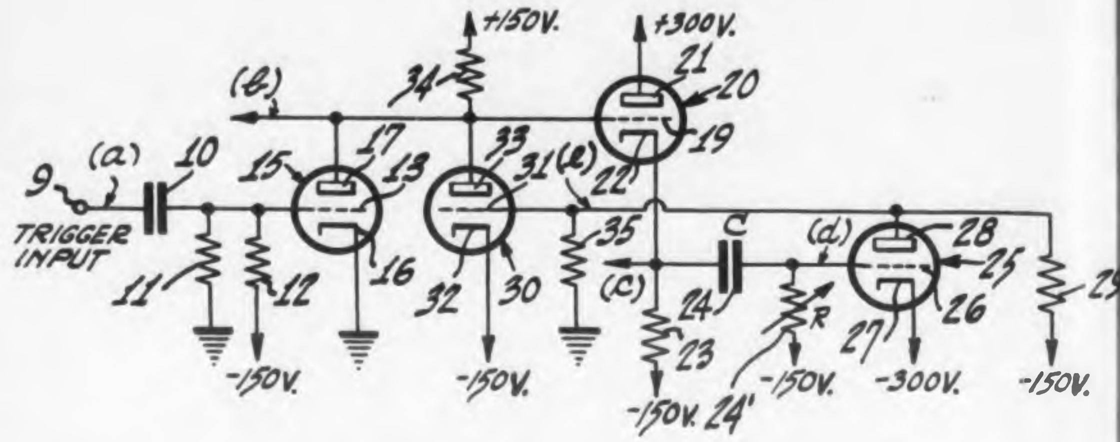
...perheterodyne receiving circuits have ... tuned by using inductances and ca-...tors which rendered exact tracking ...ult. The inductances also have to be ...uately shielded to avoid undesired ...back and in addition they are rela-... susceptible to damage because of ...fine wire used in the windings. The ...nt describes a circuit which uses re-...s and capacitors in the tuning unit. ... the circuit illustrated, the amplifier ...two amplifying triodes *12* and *24*. Pos-...feed back is provided through the wire ...d resistor *36* which is adjusted so that ...feedback is insufficient to produce os-...tion. Negative feedback to the triode ... provided through the tuning network ...nsisting of resistors and capacitors and ...olling current through a triode *39*. ... tuning network functions as a band ...nation filter which passes signals other ... those in the narrow band of fre-...cies. In this narrow band the imped-... of the network *44* is balanced and ... not pass the frequencies within the ...w band. Control of the current ...gh the triode *39* controls current ...gh a cathode resistor *18* which is ...the cathode resistor for the amplifier tube *12* and hence cancels out the positive feedback to amplifier tube *12* excepting those frequencies within the rejection band of the network *44*.

The local oscillator of the circuit is essentially the same as that of the amplifier excepting that the resistor *84* is adjusted so that the feedback sets the oscillator into oscillation. The tuning capacitor for both the amplifier and the oscillator are ganged together.

Sweep Generator Using Nonlinear Sweeps

Patent No. 2,791,688. B. Cutler and G. B. Crane. (Assigned to Gilfillian Bros., Inc.)

The sweep generator includes an amplifying discharge tube which is controlled by recurrent sawtooth waves. A source of substantially continuous voltage is applied to the anode of the tube through a series circuit including an impedance and an inductive load. A capacitor is coupled to the junction point of the load and impedance. It is charged by the potential through the impedance. The voltage developed on the anode of the tube controls means which effectively decrease the magnitude of the impedance in accordance with decreased current flow through the tube. The impedance has a finite impedance value at all times and provides a charging circuit for the condenser when and as the condenser is discharged through the tube.



Monostable Multivibrator Circuit

Patent No. 2,784,309. J. D. Sable. (Assigned to Radio Corp. of America)

Multivibrators in their simpler form include two vacuum tubes cross coupled so that when one tube is conducting the other is non-conducting. A monostable multivibrator is one in which one tube is normally conducting and a second tube is normally non-conducting. Upon application of an input pulse the condition of conduction is reversed for a period determined by circuit values whereupon the initial co[ndi]tion is restored. When this type of m[ulti]vibrator is used with a radar system i[t is] particularly desirable that the circuit h[ave] as short a recovery time as possible in o[rder] to secure a wide range for the system.

In the multivibrator illustrated in [the] figure, the first multivibrator tube 2[5 is] normally conducting and the second m[ulti]vibrator tube 30 is normally non-cond[uct]ing. The buffer tube 15 is norm[ally] non-conducting and upon the applicatio[n]

◄ CIRCLE 299 ON READER-SERVICE CARD

sitive input trigger pulse at the ter- al 9, this tube becomes conducting. The ode follower tube 20 also is normally ducting. When the tube 15 becomes ducting the potential on the plate of this is lowered, due to the increased cur- through resistor 34. As a consequence, potential of the control grid of the ode follower tube 20 is decreased be- cut-off so that this tube becomes non- ducting. With the tube 20 becoming conductive, a negative pulse of sub- tial value is generated at the cathode h is transmitted through the capacitor the control grid of the first multivi- r tube 25 and this tube is biased to conduction. The plate voltage of tube ncreases which increases the potential he control grid of the second multi- ator tube 30 so that it is biased to duction. The circuit is now in its "on" ition.

pid transition of the circuit from "off" on" condition is secured through the t feedback connection between the e of tube 25 and the control grid of second multivibrator tube 30. This di- connection is available because the t current supply potentials to the ivibrator tubes 25 and 30, as shown in the figure, have values which permit this direct connection.

This "on" condition, that is of non-conduction of the first vibrator tube 25 and conduction through the second multivibrator tube 30 continues for a period dependent upon the time constant of the capacitor 24 and the resistor 24'. The negative charge on the capacitor 24 discharges through the resistor 24' until the potential on the control grid 26 reaches a value above cut-off whereupon the tube 25 again begins to conduct current. Conduction increases rapidly through the first multivibrator tube 25 which quickly lowers the potential on the control grid of the second multivibrator tube 30 below cut-off and it is restored to non-conducting condition. The circuit is restored thereby to its initial or "off" condition to receive a second input pulse.

The rapidity with which the transition is made from "off" to "on" condition is dependent upon the rapidity with which the capacitor 24 is charged after tube 25 begins to conduct. Since this charging occurs through the very low impedance of the cathode follower tube 20, charging time and hence recovery time is very short. The patent gives specific values which may be used for the resistors and capacitors.

Books

Proceedings of the 1956 National Electronics

Conference, Volume XII, 1095 pages, $5.00.

Proceedings of the 1956 National Electronics Conference are available in book form. 105 technical papers, and three luncheon addresses presented at the 12th Annual Meeting in Chicago make up the book. Papers are grouped and indexed in the table of contents to provide easy access without laborious title searching.

The conference is sponsored by the American Institute of Electrical Engineers, Illinois Institute of Technology, Institute of Radio Engineers, and Northwestern and Illinois University, in co-operation with Radio - Electronics - Television Manufacturers Association, Society of Motion Picture and Television Engineers, and Michigan, Michigan State, Notre Dame, Purdue and Wisconsin universities.

Proceedings of the Sixth Weather Radar Conference

Cambridge, Massachusetts, 1957, 372 pages, $10.00.

Microwave engineers should find the Proceedings of the Sixth Weather Conference interesting and informative. The 55 papers included in the proceedings constitute a representative cross-section of current research in the field of radar meteorology. The text of most papers is well illustrated with graphs and photos. A list of symbols and abbreviations recommended by the AMS is given at the beginning of the text.

Engineering Electronics

John D. Ryder, McGraw Hill Book Co., Inc., 330 West 42nd Street, New York 36, N.Y. 666 pages, $9.50.

Fundamental concepts of electronics—particularly the areas of instrumentation, computation and general industrial usage—are projected to industrial applications and completed systems. Without letting his treatment become an instruction book in the operation or maintenance of a particular piece of apparatus, Dr. Ryder discusses operating principles important to computers, industrial control, and servomechanisms.

The emphasis throughout is on understanding principles and basis circuits applicable to various electronic devices and equipment. Mathematics and circuit theory are emphasized only when they are necessary for a lucid description or advantageous in completely analyzing a system.

In the chapter on semi-conductors and transistors, Ryder treats the four-terminal network theory for transistor equivalent circuits. This chapter is probably the "strongest" in the book. Fundamentals of analog and digital computation and circuits common to both computers are treated in chapters 8 and 9. Material is included on the frequency response of amplifiers from both a sinusoidal and a pulse standpoint.

The portion of electronics which is exclusively "radio" is not discussed in the text.

Advanced Calculus

R. Creighton Buck, McGraw-Hill Book Company Inc., 330 West 42nd Street, New York, N. Y., 423 pages, $8.50.

R. Creighton Buck believes in applied mathematicians—not applied mathematics. With this conviction, he has directed his treatment toward a development of fundamentals of analysis, simultaneously for one variable and multi-variable functions. Both are regarded as functions of a point. Because of the tendency in American colleges to present Elementary Calculus from a purely theoretical point of view, certain topics are often slighted. The subject most neglected because of this type of treatment is theory of function of several variables.

A number of clever innovations in subject and treatment are used to present material in a lucid manner. For instance, the definite integral appears before the fundamental theorem of calculus is discussed. This emphasizes the essential distinction between integration and anti-differentiation. The theory of (exterior) differential forms ialized to 3-space to permit a unified ment of Stokes' and Green's theorems. ddition, the 3-space technique is easily ed and greatly simplifies calculations lving transformation of coordinates.

good balance is maintained between y and application. Consistent with his ion of an applied mathematician rather applied mathematics Mr. Buck pro- many "tools" not found in traditional eering advanced calculus course.

ical Engineering Circuits

Hildreth Skilling, John Wiley & Sons, 440 Fourth Ave., New York 16, N.Y., pages, $8.75.

ectrical engineering circuits are Prof. ng's contribution to the "cold-war" be- obsolete text books and a college in- tor's obligation to his students. To Mr. Skilling from the preface, "we ed a book in touch with modern ht, and at the same time a good class- book. First of all, indeed, the book d fit the needs of students."

text has twenty-one chapters. The fourteen chapters and the last two in standard material treated from a mporary viewpoint. In all probability sign engineer has a text in his library dequately covers this material. It is ters 15 to 19 which will prove most ble to the design engineer. The mod- ncepts covered in these chapters are: rk theorems; loop and mode equa- of networks; locus curves and other ical methods; resonance of high-Q ts; impedance and admittance func- poles and zeros in the complex fre- y plane; the transform concept, and place transformation. The design en- r interested in a reference work on subjects as well as the engineer who to "self-educate" himself will find t valuable.

ission Circuits

Williams and J. B. Woodford, Mac- Co., 60 Fifth Ave., New York 11, 156 pages, $4.25.

ting this text for teaching rather than ference work has forced Messrs. Wil- and Woodford to eliminate much of tail which is important to the work- gineer. In spite of this limitation the engineer will find the book has many le features.

Transmission line parameters and the theory of generalized transmission circuits are discussed in chapters 1 and 2. The significance of *"times"* peculiar to transmission circuits is presented in a lucid manner. The remaining four chapters of the book are so organized that a portion or chapter can be omitted without impairing the flow of thought. Subject matter is straightforward and rich in basic fundamentals. The engineer wishing to acquire a background in transmission circuits can use this text as a stepping-stone to more detailed treatments.

Relatively little on "technique" is included by the authors when they give practical applications of the theory. The omission of semi-empirical "aids" will undoubtedly be praised by some as a thought provoking stimulus for the student. Others will view it as a foolish denial of practical information used by all engineers. A special appendix is included with the text on "Solution of Transmission Circuit Problems by means of Electro-magnetic Theory".

The Electrical Production of Music

Alan Douglas, Philosophical Library, Inc., 15 East 40th Street, New York 16, N.Y., 223 pages, $12.00.

Advantages and limitations of the electrical production of music are treated in simple and interesting terms by Mr. Douglas. Only an elementary knowledge of music and electronics is assumed. The book travels the practical middle road between academic treatises on vibrating systems, and personal opinions which tend to be too traditional.

The experimentor or potential designer of electrical musical instruments is often at a loss to decide whether the strong peculiarities of the traditional instruments are really material to tonal effect or whether they are due to some limitation of design. At times these peculiarities are the result of a conflict between theoretical capabilities of the instrument and the effect attempted. By treating music as frequencies or bands of frequencies, which can be adjusted for pitch, reinforcement by harmonics, attack, vibrato, reverberation and phase relationship to form a tone-colour, the author presents his reader with a clear cut definition of tone-colour.

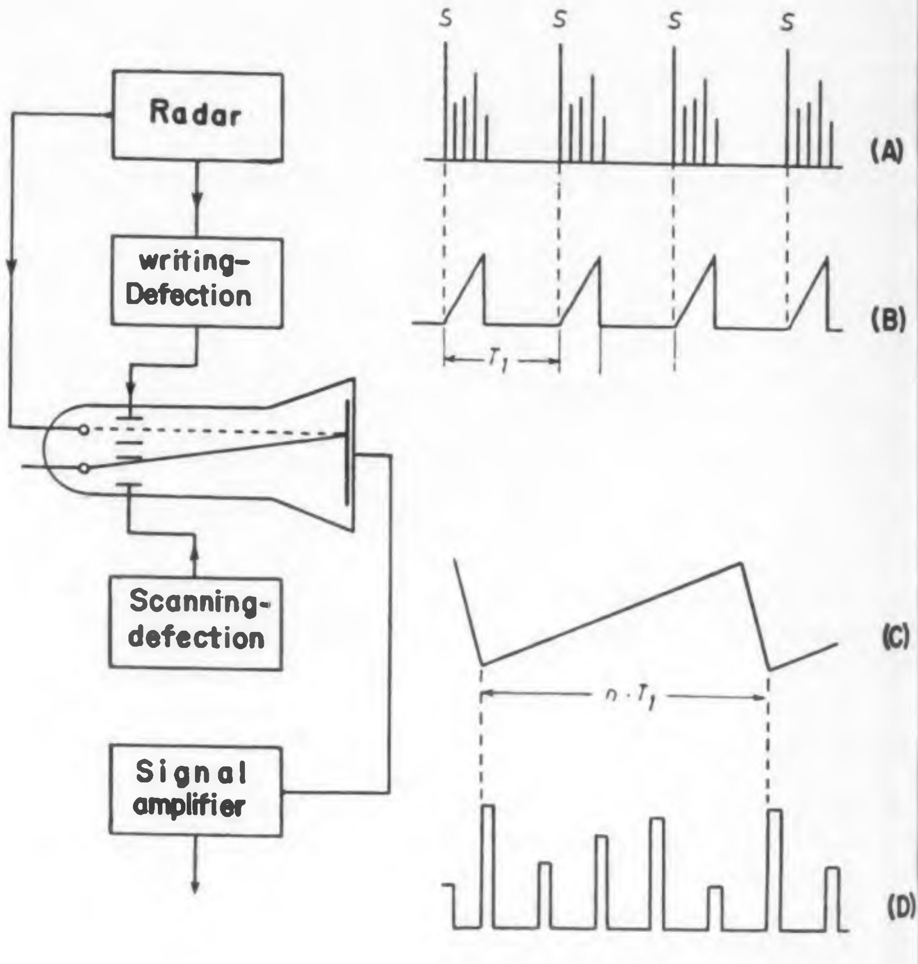
Treatment of the subject matter is simple without becoming trite. Adequate references are given for those who feel they would like to consult additional reading material.

German Abstract

Frequency Compression of Radar Imag

E. Bren

FOR the transmission or recording of radar tures on magnetic tape frequency compressi almost always desirable because the bandw (which lies between 5 and 20 mc) can be pressed by a factor of 20 to 500 without loss formation. This reduction is possible becaus the low information content of radar pictures.



Block diagram and examples of waveforms for frequency compression by mean storage tube. The four signal pulses (S) are shown together with their echos (A). The signal is shown in line (B), the deflection voltage of reading beam in (C), and line (D) the scanned signal.

quency compression method was used successfully of harbor-traffic radars.

The basis of the frequency compression results m the following considerations: If the highest quency component of 20 mc corresponds to the rtest echo-pulse duration of about 0.05 μsec, then number of distiguishable echos is 400 (or smaller he range is less than 3 km). The azimuth resolu-n may be taken as 0.5 degrees so that the typical dar picture consists of about 720x400 or 288,000 tinct points. At an antenna speed of 20 rpm the tire picture content must be transmitted every ee seconds so that a maximum bandwidth of 288,-$0 \div 3 = 96$ kc is required.

For frequency compression a storage tube which s a dual beam system is used. The "writing" beam, hose deflection is synchronously controlled by the ginal radar pulse, has its intensity controlled by e amplitude of the echo and charges an insulating er, controlled by the video signal of the radar paratus, along a line. The "reading beam," which constant intensity scans the same line and pro-des for the discharge of the charging produced by "writing" beam. These changes in charge pro-ce the output signal of the storage tube on the tal plate which is located behind the insulating er. Since the deflection of the "reading" beam is wer than that of the writing beam, the output nal has wider pulses and consequently requires maller bandwidth for transmission. If n is the num-ber of echos which are reflected from a target then e scanning frequency of the "reading beam," f_2 is lated to the repetition frequency of the original dar pulses f_1 by the ratio $f_1/f_2 = n$.

A simplified black diagram of the system is shown the figure. As an example four signal pulses *(S)* shown together with their echos *(a)*. The writing nal is shown in line *(b)*; the deflection voltage of "reading" beam is shown in line *(c)*. The factor 3 is used in the example. Line *(d)* shows the nned signal. *(Abstracted from an article by H. ll, K. Dinter, and K. Lange,* Elektronische ndschau, *Vol. 12, No. 5 May 1957, pp. 155-157.)*

Abstract

Improved Transistor Biasing

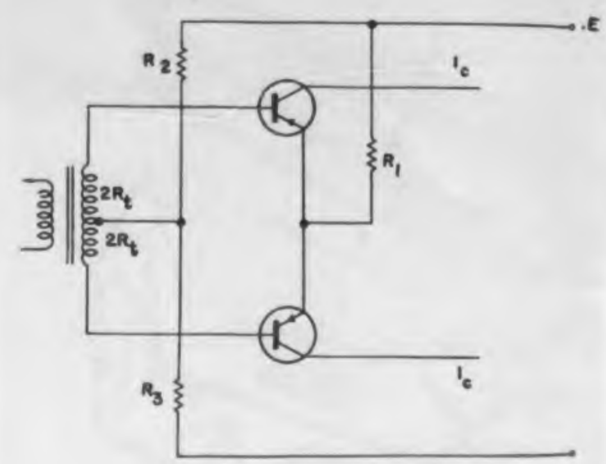


Fig. 1. Schematic diagram, normal Class B output stage.

A N AMENDED transistor bias arrangement offers advantages over the conventional circuit in normal as well as critical applications. During the design of a transistorized servo-amplifier intended for airborne applications, it was found that the stabilization of the output stage needed careful attention. The resistance of the input transformer secondary winding, usually considered negligible, had an adverse effect on the bias stabilization. The influence of this resistance, and a means for overcoming it, are indicated here.

In Fig. 1 the usual arrangement of a Class B output stage is shown. The transformer secondary resistance is denoted by $4R_t$. This resistance acts in series with the base of the transistor, and degrades the stability factor. In practical designs, it is difficult to achieve a stability factor

$$S = \frac{\partial I_c}{\partial I_{co}}$$

of less than about three without enlarging the input transformer to obtain a lower resistance, or increasing R_1. Both these steps are undesirable, as the first wastes space while the second causes a loss of gain and maximum power output. In any case, the power dissipated in the bias network, denoted by P_b, is unnecessarily large.

The circuit of Fig. 2 overcomes these difficulties by using the transformer resistance as an active part of the bias network in place of R_2. The design equations used for the two circuits are given in the table.

Comparative Design Formulas for Two Methods of Transistor Biasing

Parameter	Circuit of Fig. 1	Circuit of Fig. 2
$S = \frac{\partial I_c}{\partial I_{co}}$	$\dfrac{1 + \dfrac{R_1}{R_t + R_2R_3/(R_2 + R_3)}}{(1-\alpha) + \dfrac{R_1}{R_t + R_2R_3/(R_2 + R_3)}}$	$\dfrac{1 + \dfrac{R_1}{R_3} + \dfrac{R_1}{R_t}}{(1-\alpha) + \dfrac{R_1}{R_3} + \dfrac{R_1}{R_t}}$
R_3	$\dfrac{E\left\{(S-1) - \dfrac{R_t}{R_1}[1 - S(1-\alpha)]\right\}}{2(I_c - SI_{co})}$	$\dfrac{E(S-1)}{2(I_c - SI_{co})}$
R_2	$\dfrac{R_3\{(S-1)R_1 - R_t[1 - S(1-\alpha)]\}}{(R_3 + R_t)[1 - S(1-\alpha)] - (S-1)R_1}$	—
R_1	Determined from allowable gain and voltage loss.	$\dfrac{R_3R_t}{R_3 + R_t} \cdot \dfrac{1 - S(1-\alpha)}{S - 1}$
R_t	—	$\dfrac{R_1R_3(S-1)}{\alpha SR_3 - (S-1)(R_1 + R_3)}$
P_b	$\dfrac{E^2}{R_3}$	$\dfrac{E^2}{R_3}$

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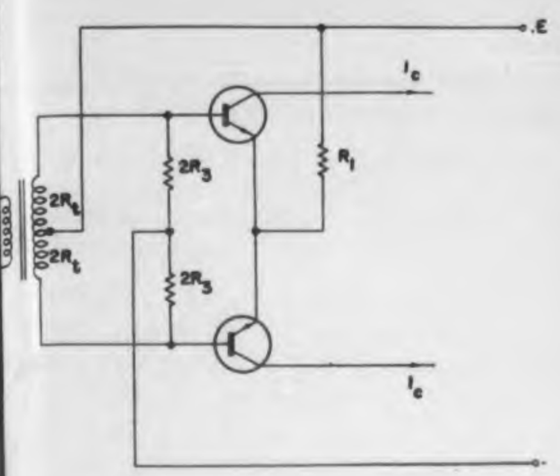

Fig. 2. Schematic diagram, improved output stage circuit.

he following example will illustrate the su- ority of the amended circuit.

ata: α = current gain of transistor, common case = 0.92

I_c = required collector current per transistor = 10 ma

I_{co} = collector cut-off current of transistors ~ 0

E = supply voltage = 28 v

$$S = \text{bias stability factor} = \frac{\partial I_c}{\partial I_{co}} = 3$$

typical value for the transformer resistance $R_t = 48$ ohms.

the case of Fig. 1, an acceptable value for s 10 ohms. We then have:

$$R_3 = 1530 \text{ ohms}$$
$$R_2 = 14.3 \text{ ohms}$$
$$P_b = 0.52 \text{ w}$$

r the case of Fig. 2 the same transformer is l, and

$$R_3 = 2800 \text{ ohms}$$
$$R_1 = 4.6 \text{ ohms}$$
$$P_b = 0.14 \text{ w}$$

he new arrangement gives the same stability r with only 25 per cent of the power loss. It also yield more gain and maximum power put owing to the lower value of R_1.

With the data given in this example, it is pos- e to reduce the S factor to two if the power and the value of R_1 remain at the original es. A value of S as low as this cannot be eved at all with the original circuit.

ote that the dc in the transformer secondary ains balanced and will not alter the trans- er design except for the small heating effect.

his article originally appeared in Electronics ineering of Canada, *Vol 1, No. 1, May 1957.* *author is Maurice Price, P.Eng., of Comput- Devices of Canada Ltd.*

What the Russians Are Writing

J. George Adashko

RADIO ENGINEERING AND ELECTRONICS

(Contents of Radiotekhnika i Elektronika, No. 1, 1957)

DISTRIBUTED AMPLIFIER ANALYSIS

Distributed Amplifier as a System of Multi-Terminal Networks, Yu. N. Prozorovski, (8 pp, 7 figs).

In conventional analysis the distributed amplifier is represented as two equivalent long lines formed by the input and output capacitances of the tube and by the inductances of the added coils. (See, for example, Ginzton, Hewlett, Jasberg, and Noe, Distributed Amplification, Proc. IRE, 1948, vol 36, p 956). This approach is satisfactory only at relatively low frequencies, breaks down near the critical frequencies of the elements comprising the lines, and makes no provision for unequal individual sections, complex loads, and other factors. The author proposes a method where the amplifier is considered as a system of a finite number of multi-terminal networks (Fig. 1) and derives matrices for the individual sections of the amplifier and for the amplifier as a whole. Any irregularities in the distributed parameters of the amplifier can be accounted for in the pertinent matrix element.

The matrix element for sections I (and V) is:

$$A_I = A_V = \begin{bmatrix} 1 & 0 & R_{oa}F_a & 0 \\ 0 & 1 & 0 & R_{oc}F_c \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & R \\ 0 & 1 \end{bmatrix}$$

where R_{oa} and R_{oc} are the ohmic resistances of the coils and F_a and F_c are coefficients characterizing the dependence of the losses on the frequency. Similar matrices can be written for the other elements, and the matrix of the entire amplifier is merely the product of the individual matrices.

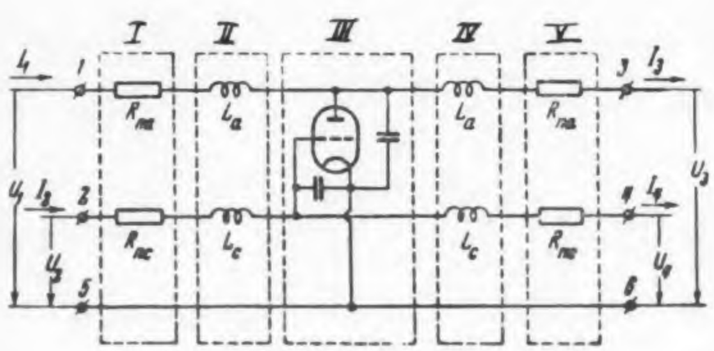

Fig. 1. Section of a distributed amplifier, broken up into several multi-terminal networks. (R_{na} = resistive loss in plate circuit, R_{nc} = resistive loss in grid circuit.)

PULSE BANDWIDTH

Bandwidth Occupied by Transmitted Pulses, M. S. Gurevich (6 pp, 4 figs).

An "ideal" pulse shape was derived by the author in a previous article ("Signals of Finite Duration, Containing the Maximum Energy Fraction in a Specified Frequency Band," Radiotekhnika i Elektronika, March 1956, ED December 15, 1956). In this article he determines the frequency bandwidth occupied by several standard pulse shapes, arriving at the interesting results given in the following table:

Pulse Shape	Bandwidth (bauds)
"Ideal"	2.5
Rectangular	20.6
Trapezoidal	
ratio of parallel sides 0.8	6.5
ratio 0.5	3.9
Triangular	2.6
Cosine	2.6
Cosine-squared	2.8

WAVEGUIDE DESIGN

Variational Method for Design of Waveguides with Periodic Irregularities, I., Sh. E. Tsimring, (112 pp, 2 figs).

The Ritz method is used for the analysis of the propagation of electromagnetic waves in a periodically-corrugated waveguide. A decelerating system with rectangular corrugations is used as an example.

UHF TROPOSPHERIC PROPAGATION

ffect of the Form of the Structural Function of Ir-egularities in the Dielectric Constant of Air on ong-Distance Tropospheric Propagation at UHF, . N. Troitski, (4 pp, 1 fig).

Continuing his work on this subject (earlier rticles appeared in the May and September 1956 ssues of Radiotekhnika, ED December 1, 1956 and une 15, 1957), the author derives equations for the median value of field intensity and for the possible andwidth of waves propagated in air subject to specified variation of the dielectric constant.

MAGNETIC FIELD MEASUREMENT

nstrument for Relative Measurements of Alter-ating Magnetic Fields, I. S. Shpigel', M. D. Rayzer, . A. Miae, (9 pp, 7 figs).

Most instruments designed for the purpose (bal-istic, electronic integrators, etc.) do not take into ccount the residual magnetization. This instru-ent, developed to measure the field of the injec-on electromagnetization of the 10 Bev synchro-phasotron of the USSR Academy of Science employs uclear magnetic resonance and is free of this hortcoming.

PULSE SYSTEM STABILITY

tability of Linear Pulse Systems with Variable arameters, G. P. Tartakovski, (8 pp, 4 figs).

The author continues his investigations of the characteristics of linear pulse systems with variable parameters (an article on the theory of such systems was published in the November 1956 issue of Elektrosviaz', ED July 15, 1957, and a discussion of their time and frequency characteristics appeared in the December 1956 issue of Radiotekhnika i Elektronika, ED August 1, 1957). The stability anal-ysis is based on the derivation of an equation for the transfer function of the system, and the illustra-tive example used is a frequency-pulse modulated system with pulse feedback.

WIDE EAM AMPLIFICATION

High Frequency Oscillations in Electron Beams with Periodically-Varying Velocities, P. V. Bliokh, (12 pp).

There has been considerable recent interest in the possibility of amplifying radio waves by periodic variation of the parameters of an etectron beam, so as to dispense with the decelerating system em-ployed in travelling-wave tubes (see, for example articles by Birdsall in Proc. IRE, 1954, vol 42, p 1628 and Peter-Bloom-Ruetz, RCA Review, 1954, vol 15, p. 113). In principle, unlike the situation in traveling wave tube, it is possible here to effect amplification even in an infinitely wide beam, with only the thermal motion of the electrons imposing an upper limit on the frequency.

The author uses kinetic theory to derive a dispersion equation (in the small signal approximation) with which the stability conditions in the beam are established.

DIRECTIONAL COUPLER

H_{01} Wave Directional Coupler for Round Waveguide, M. V. Persikov, (10 pp, 9 figs).

Description of an azimuthal system of rectangular waveguides, coupled to a round waveguide by a longitudinal system of apertures (Figs. 1 and 2). Several modes propogate in the round waveguide, but the rectangular guide is single-mode. A model of this coupler was used to indicate the presence of the H_{01} mode, to measure low reflection coefficients (on the order of 30 to 40 db) in the round waveguide, and to measure the power flowing past a given section of the guide. It also measured the attenuation of the H_{01} wave in the individual waveguide elements and the losses involved in the transformation of the H_{01} wave into other modes. A theoretical analysis of the coupler is given.

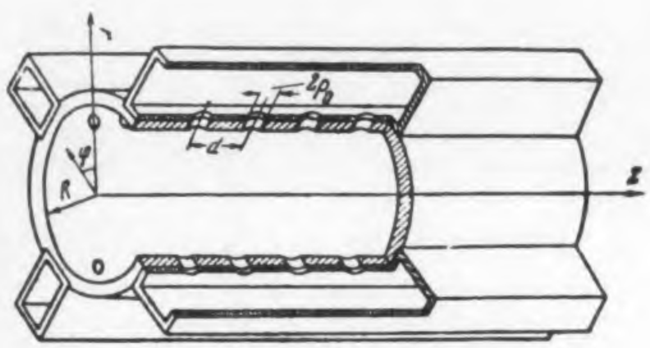

Fig. 1. Cutaway isometric view of the rectangular waveguide coupled to the round waveguide. (Note the longitudinal system of apertures.)

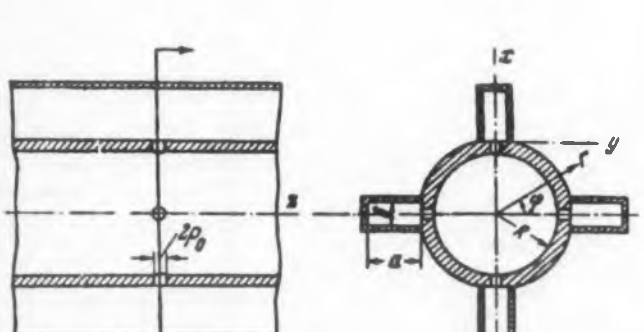

Fig. 2. Cross sections of the waveguide.

SYNCHRONIZATION

Mutual Synchronization of Self-Excited Generators at Multiple Frequencies, G. M. Utkin, (13 pp, 6 figs).

It is customary in the literature to treat this topic in a highly simplified manner, and to neglect the reaction of the "synchronized" oscillator on the "master" oscillator. Actually, however, this reaction is quite substantial over a certain band (synchronism zone), the width of which is determined in this article as applied to both frequency multiplication and frequency division.

SELF EXCITED OSCILLATIONS

On the Transformation of Fluctuations of the Amplitude and Phase of Self Excited Oscillations in Resonant Systems. G. S. Gorelik, G. A. Elkin, (6 pp, 2 figs).

A signal with random phase and amplitude fluctuations is traced theoretically through a circuit comprising a linear (resonant) and non-linear (detector) element. Equations are derived for the statistical nature of the phase and amplitude of the output of such a system, given the statistical characteristics of the input amplitude and phase variations. Refers to work by R. Mueller, G. Dalman & A. Rhoads, W. Gottschalk, D. Middleton (all in Trans. IRE, Electron Devices, vol 1, 1954), and several other American investigators.

ENERGY INTERACTION

Analysis of Interchange of Energy between an Electron Stream and an Electromagnetic Wave. V. N. Shevchik, (7 pp, 4 figs).

Certain problems in the interaction between an electron stream and a traveling electromagnetic wave are analyzed in this kinematic approximation. The grouping of electrons in the traveling wave, identical with the grouping process in a klystron, is analyzed and other factors such as maximum current, efficiency and synchronization are discussed. The calculations are extended to include traveling-wave tubes and the optimum operating modes of backward wave oscillators at low amplitudes.

Other Articles In This Issue

"Emission of Electrons from Complex Surfaces," P. V. Timofeev (7 pp, 2 figs). "Concerning the Mechanism of Electron Emission from Thin Dielectric Layers under the Influence of a Strong Electric Field Malter (Malter effect)," M. I. Elinson, D. V. Zernov, (10 pp, 4 figs). "Influence of Differentiation and Integration of Fluctuations on the Average Number of Swings," V. I. Tikhonov, (5 pp, 1 fig.) (Statistical discussion.)

Standards and Specs

Sherman H. Hubelbank

Gage Blocks

NBS Circular 581, Metrology of Gage Blocks, April 1, 1957

By far the most widely used precise standards of length in the mechanical industry are precision gage blocks which by nature of their accuracy, range of sizes, and relatively low cost have been made available to even the smallest industry. This circular presents the 15 papers presented at the Symposium on Gage Blocks, held at the National Bureau of Standards in August 1955. This 119-page publication may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., for $1.50 per copy.

Tubes

RETMA RS-190, NEMA 502-D, Pin Straighteners and Wiring Jigs for Electron Tubes, June 1957

This standard covers miniature button 7 pin and 9 pin straighteners, T-3 subminiature pin straighteners, locking-in pin straighteners, and wiring jigs for miniature tubes. Copies of this standard are available from the Radio-Electronic-Television Manufacturers Association, 11 West 42nd Street, New York 36, N.Y. for 50 cents per copy.

Vibrators

RETMA RS-187, Vibrators for Auto Radios, June 1957

Standards are established for vibrators having a nominal input voltage of 6.3 volts dc at 115 cycles and 12.6 volts dc at 115 cycles. Included are the mechanical and electrical standards, incoming inspection tests, interrupter vibrator test circuit, and method of vibrator transformer buffer capacitance determination. Copies of this standard are available from the Radio-Electronics-Television Manufacturers Association, 11 West 42nd Street, New York 36, N.Y. for $1.65 per copy. This standard is a revision of REC-113-D.

Sockets

RETMA RS-185, Dimensional and Electrical Characteristics Defining Miniature Receiver-Type Tube Sockets for Printed Circuits, June 1957

This 42-page standard includes data sheets for twenty 7-pin miniature (molded phenolic) and twenty 9-pin miniature (molded phenolic) receiver-type tube sockets for printed circuits. A typical type number for a socket meeting this standard is TSE7R102. Copies of this standard are available from the Radio-Electronics-Television Manufacturers Association, 11 West 42nd Street, New York 36, N.Y. for $2.80 per copy.

Automation Dimensions

RETMA RS-188, Standard Dimensional System for Automation Requirements, June 1957

A series of dimensional systems and nomenclature to serve as a guide in the coordination of equipment design, component design, and the design of machinery for automatic manufacture are established by this standard. In the design of electronic equipment which may be built on automatic machines, it shall be standard to make all dimensions, which must be controlled for automation purposes, to be multiples of 0.025 inch. This modular dimension shall apply to all three axes of Cartesian coordinates. Copies of this standard are available from the Radio-Electronics-Television Manufacturers Association, 11 West 42nd Street, New York 36, N.Y., for 25 cents per copy.

Capacitors

MIL-C-3871, Capacitors, Fixed, Electrolytic (A.C., Dry-Electrolytic, Nonpolarized), Amendment 3, 6 June 1957

The list of referenced specs and publications, the requirements for packing, packaging, and marking for shipment have been revised. The time limit for shelf life has been changed to 18 months.

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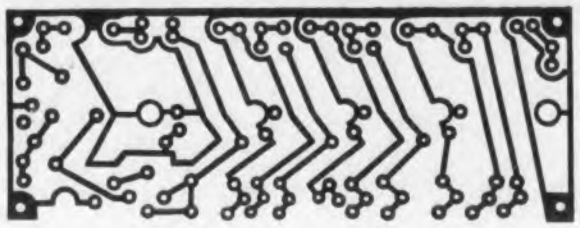

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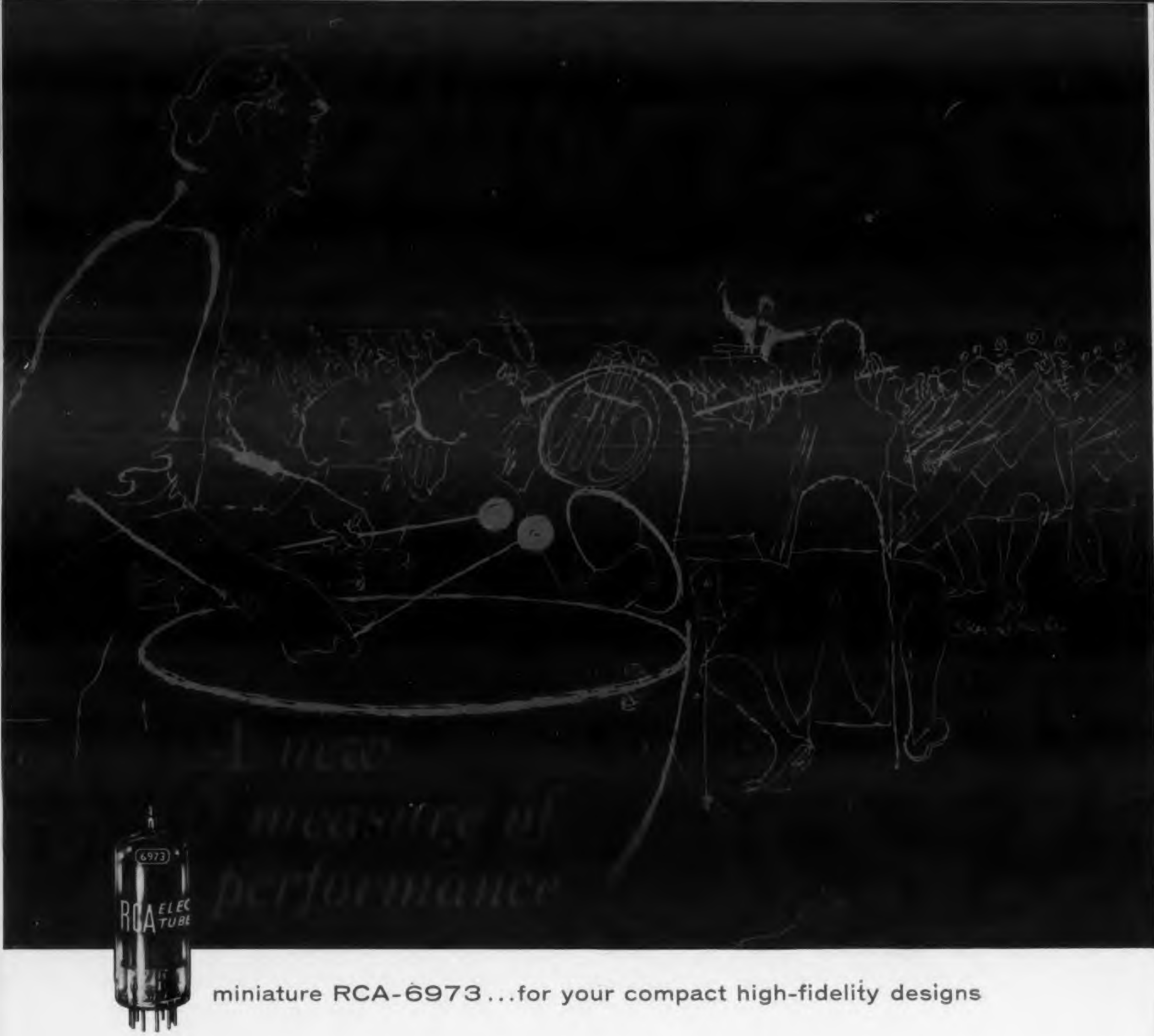

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