ELECTRONIC DESIGN

JUNE 6, 1960

DIGITAL COMMUNICATIONS

An ELECTRONIC DESIGN Special Report ...p 51

COVER: This issue's cover has been labeled "Mola" by our Art Department. Mola stands for Multi-Ordinated Linear Abstraction—the technique used by Art Director Ray Schulze to transform the concept of pulse code modulation and time sharing into a visual pattern capable of being processed by a printing press.

Selected Topics In This Issue

Highlights of This Issue

Current developments in the field of digital communications represent a new challenge for the design engineer. Because of the development of solid-state devices, smaller, less complex and less costly digital equipment can now be designed for more widespread use.

Alert to both the present and future needs of its many readers, our editors have assembled the latest information on the latest techniques in digital communications. This issue contains the first part of a three-part ELECTRONIC DESIGN SPECIAL REPORT on the subject.

Appearing in this issue are an over-all summary of digital communications, an article on pulse code modulation, an article on digital transmission over wire, and an article on the role of digital techniques in industrial radio communications systems.

This is the first time that the field of digital communications has been so thoroughly treated from the design engineer's standpoint.

ED's editors, in compiling this report, contacted the top companies engaged in digital-communications work. Experts from such companies as Bell Laboratories, Stromberg-Carlson, Motorola and International Telephone and Telegraph agreed with *ED* on the need for this report. They gladly contributed feature articles covering their special fields.

Much of the material appearing in the three parts of this SPECIAL REPORT has never before been presented.

Following this issue's opening articles, the next issue of *ED* will include a continuation of the articles on pulse code modulation and applications.

The third and final part of the series on digital communications will include the last part of the article on pulse code modulation, as well as an article on delta code modulation.

As a designer, you will want to be prepared to meet the increasingly stringent requirements military and industry is demanding in its digital equipment. Our editors are pleased to present such thorough coverage of this rapidly expanding field—called by many the most important area for exploitation in the future.

CONTENTS FOR JUNE 8, 1960 VOL. 8 NUMBER **12**

Coming Next Issue

Electronics has rapidly assumed a major role in the rapidly expanding science of oceanography. The complexities of precision measurement of the sea, with attendant problems of instrumentation, have created a vast new field for ingenious design ideas. To compile a SPECIAL REPORT detailing the opportunities, ELECTRONIC DESIGN Assistant Editor Manfred Meisels and West Coast Editor Tom Mount talked to leaders in government, science, and industry. The first of two articles, dealing with the problems posed in this unique field and the instrumentation needed, will appear in the June 22nd issue. The second article, a discussion of broad areas where design ideas are badly needed, will appear in the July 6th issue.

ELECTRONIC DESIGN

Hayden Publishing Co., Inc.,
830 Third Avenue, New York 22, N. Y.

ELECTRONIC DESIGN is published bi-weekly by Hayden Publishing Company, Inc., 830 Third Avenue, New York 22, N. Y., T. Richard Gascoigne, Chairman of the Board; James S. Mulholland, Jr., President. Printed at Hildreth Press, Bristol, Conn. Accepted as controlled circulation at Bristol, Conn. Additional entry, New York, N. Y. 35,050 copies this issue.

Army Shifting It's Molecular-Circuit Research

Signal Corps Beginning Program This Summer On Vapor-Phase Decomposition Technique

A RESEARCH shift to vapor deposition methods of producing molecular circuits is planned for this summer by the U. S. Army Signal Corps Research and Development Laboratories, Fort Monmouth, N.J.

The vapor phase decomposition method, developed by Merck & Co., Inc., Rahway, N.J. (*ED*, March 16, p 66), will supplant current Signal Corps efforts in molecular circuitry in which single-crystal silicon slabs are diffused and etched to produce circuit functions. This work is felt to be paralleling research being done by the Air Force, Texas Instruments, and Westinghouse Electric.

Some of the major advantages seen for the vapor phase decomposition process, according to William B. Glendinning, deputy branch chief, advanced device development branch of Fort Monmouth's Evans Laboratories, are:

- Complex layer structures of eight or more oriented single-crystal layers of p, n, or intrinsic material might be produced.
- High-resistivity layers can be introduced at the center of a sandwich, permitting isolation between circuit elements to be achieved.
- Production of devices from the layered material would require only simple, easily handled etching processes.
- Low-temperature electrochemical etch processing could eliminate high temperature conversion problems—in which p or n characteristics or resistivity change from desired values.
- The structure can be adapted to simple processes for interconnection of circuit elements.

The decomposition process involves the heating of silicon tetrachloride to the vapor phase,

FCC Sets Space-Radio Data Deadline

Agency Seeks to Set Spectrum Allocations for Industry, Calls for Latest Information by July 8

THE FEDERAL Communications Commission, determined to make adequate allocations of spectrum for space communications, has called on all segments of the industry to come forth and state their needs, both short- and long-range.

The FCC has long had an extensive inquiry in the works to determine all spectrum users' requirements in the range above 890 mc. All testimony had been placed in the record by Nov. 15, 1957, and the Commission has been wrestling with the job of proper spectrum division ever since.

What FCC Needs to Know

However, with demands for space communications suddenly burgeoning, the Commission recently decided it better update its information. Therefore, it asked all interested parties to hurry in with statements containing the latest information by July 8. Then, on July 18, the Commission will listen to oral justifications by each organization. The FCC wants to know:

- The nature and extent of any experiments which have been conducted involving utilization of frequencies for space communications of various kinds.
- What segments of the radio spectrum are now known to be required for the various space-communications functions to be performed—earth-space-earth, space-space, telemetry, tracking, guidance, command, etc.? How much spectrum space is required for each such function? At what point of time will access to these bands be required for each such function? Does each function require the same degree of protection from interference?
- Can and should frequencies used for space communications be shared with other services and under what conditions?
- Present plans of non-government entities for launching either active or passive communication satellites.
- If there are no plans for active satellites, by

(continued on page 6)

Current Signal Corps research program using diffused and etched silicon single crystal slabs has led to the am demodulator circuit shown here. Raised diode and capacitor sections are n material with p material making up the lower portion of the 5-mil slab. Circuit will operate from —65 C to +150 C, environmental tests indicate.

and then passing silicon-carrying hydrogen gas formed over a single crystal of silicon. Some of the silicon carried by the hydrogen is deposited during this pass. Impurities in vapor form can be introduced into the process to achieve the desired layer characteristics.

A reaction furnace and associated equipment for performing vapor phase experiments are already being used for preliminary studies at the Evans Laboratories.

Although the primary work on the process has been done by Merck, International Business Machines Corp., New York, has also begun to study the technique, according to Mr. Glendinning. This work is being tied in with resistor-capacitor network layer deposition work on micromodule wafers being done by IBM for the Signal Corps.

The passive components for an OR circuit have been produced by IBM by depositing 17 layers on a wafer. The vapor phase decomposition technique is being studied as a possible method of adding active elements to this type of layered circuit.

Molecular Circuit Already Built

An am demodulator circuit, containing a resistor, a capacitor and a diode, has been built by Signal Corps researchers during the current program. Further development work, expected to last for about three months before program termination, is expected to result in a 100-mc transistor structure suitable for use in the molecular circuits.

Low frequency units have been built according to Robert Yatsko, physicist in the laboratory, however narrower base widths must be achieved to reach higher frequency. Base widths on the order

(continued on page 6)

NEWS

SIGNAL CORPS (continued from page 5)

of 1 micron should give the 100-mc performance, he said.

The integrated circuits being built by the laboratories begin as a 5-mil thick slab of single-crystal silicon. This is diffused to produce p material, and then antimony is diffused into a surface layer to produce n material.

A rectangle about 1/8 x 3/16-in. is cut from the slab with a diamond saw. The surface is then

FCC (continued from page 4)

what means should access to active relay satellites be achieved for non-government use?

- Whether separate frequency allocations are required for government and non-government space communications or whether such allocations should be made jointly.
- Whether the receiving sites for space communications systems will be generally distributed throughout the United States or limited to specific areas thereof.
- The purposes to be served by space communications which are not met by other systems.

In its long-range inquiry, almost exactly the same questions are asked. However, in the latter proceeding, the Commission set a March 1, 1961, deadline, preparatory to international conferences in 1962 and 1963—so that the United States can determine its position in bargaining with other nations.

International Allocation for Research

Last year in Geneva, an international allocation of frequencies for space use was made—but for research only, not for regular communications traffic. In Geneva, the International Telecommunications Union concluded that a regular communications service might be established by 1965 and that preparations should be made to provide adequate spectrum space. In light of that, the FCC said in its latest action:

"In view of the expected rapid developments in space communications, it is appropriate for the Commission to initiate a general inquiry concerning the needs of frequency bands for space communications. The complex nature of this subject and the imminence of international conferences make it imperative for the Commission to initiate a proceeding to obtain such technical information

masked and a fast etch is used to form the resistive region. The surface is remasked and a slow etch is used to remove all the n layer except in the diode and capacitor regions. Back biasing of the capacitive area provides the storage capability.

The transistor under development is a double-diffused silicon type. After further work, the researchers may build an if stage, using the high-frequency transistor, which will feed through a demodulator to an audio-driver circuit, showing the feasibility of the concept for many useful circuit requirements. ■ ■

and assistance as might become available before these conferences."

Indicative of the kind of demand for space is the current report that AT&T will seek no less than 500 mc in the area between 890 and 10,000 mc for space communications. Though usage of frequencies becomes less and less as one goes higher and higher in the spectrum, FCC engineers point out that there never has been a surfeit of usable frequencies and that serious organizations would do well to state their needs, estimates and claims now. ■ ■

Radio Guidance System in Atlas

Atlas radio-command guidance system used in recent 9,000-mile shot is shown here being checked over by Chuck Whitington, General Electric's Defense Systems Department. Black box at left is the tracking beacon which transmits signal through two antennas—white stripes on the panel—to ground station, which returns command signals to the missile.

Serious Talk About Parametric Amplifiers

THE SPOTLIGHT was on parametric amplifiers during three days of intensive microwave discussions at the National Symposium of the Professional Group on Microwave Theory and Techniques. In supporting roles were solid-state materials as such and the generation of millimetric waves. These three topics were the subject of 22 of the 39 papers presented. Masers, the center of microwave interest last year, were brought up only by way of odious comparison.

The intense interest in parametric amplifiers, according to Dr. Eric Strumwasser of Micromega Corp., is based on economic factors. Improved system sensitivity, which, R. Weglein of Hughes Research Laboratory said, has exceeded 6 db, can be achieved in existing radars at low price. There are thousands of such radars in the country, creating a ready market for such devices.

Further work at Bell Labs using gallium arsenide, described by Dr. William Sharpless, has produced solid-state parametric amplifiers approaching masers as far as noise figures are concerned. Using multiple resonator filters such as coupling networks, according to George L. Matthaei of Stanford Research Institute, provides bandwidths as great as 27 per cent in non-degenerative parametric amplifiers.

A modulator-demodulator parametric amplifier, described by Fred Sterzer of RCA's Electron Tube Div. at Princeton, provides stable gain that is not limited by any frequency ratio, such as is the case with upper-side-band up-converters. The narrow-band L-band parametric amplifier, has a forward gain that peaks at nearly 30 db. Noise figures as low as 2.5 db were obtained, he said.

In an unscheduled paper presented during the Monday-evening panel discussion, Richard T. Denton of Bell Laboratories described a new ferrite parametric amplifier in which longitudinal pumping is employed (rf magnetic field applied parallel to the dc magnetic field). A 42-mil diameter single crystal ferrite was used. In this device, pumping reduced the losses in the ferrites. The purported advantage of the device is that it can probably be used to amplify at very high frequencies, since ferrites are used now at millimetric wavelengths. In addition, the external circuitry of such a device is simple, and the crystal will not burn out. A narrow line width is obtained by the very fine finish of the sphere's surface. Since power required increases with line width squared, this leads to a low power requirement, solving one of the main disadvantages of ferrite amplifiers of the past.

In a paper delivered for George Heilmeier by Fred Sterzer, both of RCA, Princeton, the higher molecular activity and lower capacitance of gallium arsenide material were cited as resulting in a higher cut-off frequency. The device can be driven farther into the forward direction where nonlinear capacitance is

greatest, without drawing much current.

Mr. Heilmeier's conclusion, that nonlinear capacitance devices are superior to resistance devices, met with some disagreement from the floor.

The ability of ferrites to store energy in their electron spin was cited by H. J. Shaw of Stamford as allowing use of an intermittent-pulsed magnetic field. The energy thus stored is then re-radiated at the characteristic microwave and millimetric frequencies. The high electron-spin density and the ability to operate at room temperature were also cited as advantages for ferrite materials. Bernard Epsztein of Microwave Research Institute of Brooklyn, stated that although a multiplicity of schemes are underway for generation of millimetric energy, no clear-cut solution toward an optimum generator has been found.

Dr. Stuart Miller, Director of Microwave Research at Bell Labs, Holmdel, N.J., took a broad look at a microwave communication system now becoming possible as a result of advances in microwave components. Out of current development work on circular waveguide, Dr. Miller predicts 7/8-in. pipes carrying 100,000 telephone conversations or 100 TV channels. Pulse-code modulation is being used with these links.

In his banquet address, Dr. William A. Edson of GE's Microwave Lab, Palo Alto, Calif., foresaw trends to multi-vacuum-tube feed of large arrays, involving hundreds or thousands of smaller tubes. He also saw the trend vary from the microwave oscillator as the output tube and toward the generator-amplifier-antenna arrangement, common at lower frequencies.

The symposium was attended by more than 500 people, remarkable considering its off-the-beaten-path location. The relative remoteness probably contributed, along with the selection of papers in very current areas, to the high level of interest obvious throughout the meeting. ■ ■

CIRCLE 9 ON READER-SERVICE CARD ➤

NEWS

110,000 Engineers

Companies Total Nearly 3,500; Hull Calls Future 'Unlimited'

AMONG THE estimated 760,000 persons currently employed in electronics manufacturing are more than 110,000 engineers, reports the 1960 edition of the Electronic Industries Association Fact Book.

These engineers work in 4,500 to 5,000 plants of an estimated 3,500 companies scattered in all parts of the country. However, states the Fact Book, nearly three-fourths of the total dollar volume of electronic production is concentrated in the seven states of New York, Illinois, California, New Jersey, Pennsylvania, Massachusetts, and Indiana. This production comprises well over 2,000 classes of equipment.

In its review of 1959, the Fact Book points to a quick recovery from the 1958 recession. This comeback brought total factory sales to a record high of $9.2 billion in 1959. Revenues from distribution, servicing and broadcasting pushed the total to more than $14 billion, the Fact Book states.

The Fact Book credits rising missile expenditures and greater electronic content of military equipment with boosting military electronic sales

L. Berkeley Davis, vice president of General Electric Co. and general manager of GE's electronic components facilities, has been appointed president of the Electronic Industries Association. Mr. Davis succeeds D. R. Hull of Raytheon Co.

Work in Electronics

to an estimated total of $4.7 billion, 7 per cent over the $4.4 billion total of 1958.

Industrial, commercial and non-military government sources reached an estimated $1.6 billion in 1959, a figure substantially greater than the $1.38 billion of the previous year.

Factory sales of tubes, semiconductors and parts increased from $2.3 billion in 1958 to $2.8 billion last year. Semiconductors scored the heaviest advance, with factory sales of transistors alone totaling an estimated $222 million. Component sales for replacement purposes made up $900 million of the 1959 total. The corresponding figure for 1958 was $860 million. At the annual EIA meeting in Chicago, president David R. Hull said the industry, already favored by almost unparalleled expansion, can look forward to "unlimited" future growth. He added that he hoped "we will not lose our adolescent enthusiasms as we grow older and more mature." Hull handed over his presidency to L. Berkley Davis of General Electric.

THREE YEARS OF ELECTRONIC GROWTH

	1957	1958	1959
Factory sales, In million $	8,000	8,240	9,200
Consumer	1,700	1,600	2,000
Replacement	900	860	900
Industrial	1,300	1,380	1,600
Military	4,100	4,400	4,700
TV set production, In thousand sets	6,399	4,920	6,349
Factory Value of Sets in thousand $	833	668	896
Stations in U.S.			
AM	3,180	3,318	3,450
FM	537	571	665
TV	521	546	570
Receiving tubes Factory sales, Millions of tubes	456	397	433
Transistor sales, Factory, thousands	28,738	47,051	82,294
Transistor value, Thousand $	69,739	112,730	22,010
Semiconductor diode And rectifier sales, Factory, million	103	113	155
Component sales, Factory, million $	2,435	2,200	2,833
Employment in mfg. of communications monthly av., thousands	579.8	551.4	627.3

Electron-beam welding in a high vacuum was one of the recent electronic developments useful in machine design described at the 1960 Design Engineering Conference. This welder was developed by Air Reduction Co., New York.

NEWS

Commercial Uses Growing for Space Hardware

DESIGNERS should be alert to the possibilities of adapting space-age developments to commercial equipment, panelists urged during a session of the 1960 Design Engineering Conference in New York.

Some specific recent defense and space research developments already appearing in commercial applications, cited by speakers at a session on New Horizons in Engineering Design, include:

- New materials.
- Virtually frictionless bearings—air and magnetic types.
- Auxiliary power supplies.
- New fabrication processes.
- Weather-forecasting aids.
- Communications improvements.
- Navigation devices.
- Medical electronics equipment.

Unfortunately, commented Dr. Hugh L. Dryden, deputy administrator, National Aeronautics and Space Administration, it is easier to get funds for defense projects than for promising scientific programs. Because of the close relationship between defense and industrial research, however, often military developments make important commercial contributions.

Power-sources research was singled out as an outstanding example of this. Fuel cells will soon be used in civilan equipment and are expected eventually to find many non-military applications. It is still too early to predict what industrial uses may be found for current experimental propulsion methods, such as ion accelerators, plasma jets, and methods of propelling gases magnetically, commented Dr. Arthur R. Kantrowitz, director, Avco-Everett Research Laboratory, Everett, Mass.

Electronic Welding Methods Described

Some electronic welding advances were described at another session by John J. Chyle, director of welding research, A. O. Smith Corp., Milwaukee, Wis. Improvements in ultrasonic welding equipment are broadening use of this technique, he said, particularly where dissimilar metals must be joined. High vacuum electron-beam welding has already proved successful on tungsten, molybdenum, beryllium, tantalum, zirconium, and hafnium, according to Mr. Chyle.

Power sources are also improving, he said. A new ac square-wave source for arc-welding has already been used with aluminum and some other metals. Self-correcting resistance welding sources using computer control are now commercially available, he added.

Cites Reliability Design Factors

Basic prerequisites in designing for reliability were outlined by Harry R.

Powell, member of the senior staff, Space Technology Laboratories, Los Angeles. Component derating and the avoidance of complexity to achieve super-performance at the expense of reliability were cited.

Design reviews are a valuable aid in achieving reliability, he said. This permits the engineer's knowledge to be supplemented by that of other specialists—in such fields as materials, processing, testing, procurement, human factors, and quality control.

Reviews also increase chances for optimum trade-offs in performance, size, weight, cost, producibility and maintainability, according to Mr. Powell. Design weaknesses are more likely to be spotted.

He stressed the importance of careful design of experiments. Usually the number of tests are limited on complex, expensive systems so that they should be planned for maximum usefulness. Design engineers should be familiar with the statistics of small samples in order to meet this requirement.

The use of elapsed-time meters or counters on equipment to provide data needed to investigate reliability in field use was recommended by Mr. Powell.

The inadequacy of manual logging methods have often been demonstrated, he said, and also dependence on central clocks, stop watches, timers attached to cables, and similar methods have proved unsatisfactory.

Mechanical Role for Electronics Cited

The growing importance of electronics in mechanical designs was apparent in displays and in the remarks of speakers during the show, sponsored by the American Society of Mechanical Engineers' Machine Design Div.

Machine designers must familiarize themselves with electronic controls, Dr. Dryden commented. The need for automatic machines to deposit complex molecular electronics networks was pointed out by Elmer P. Wheaton, vice president for engineering, missiles and space systems, Douglas Aircraft Co., Santa Monica, Calif., at one session.

Technical papers on control systems, automation, and the use of computers in design kept electronics in the limelight throughout the four-day meeting. ■ ■

NEWS

Wooldridge Sees Design Challenge In Process-Control Automation

Instruments for industrial process control must be designed to accept instructions from and feed back data to centralized process-control computers, designers were told at the recent Summer Instrument-Automation Conference and Exhibit of the Instrument Society of America. Dr. Dean E. Wooldridge, president of Thompson Ramo Wooldridge, Inc., made the statement.

"One of the things this will mean," he said, "is that measuring instruments will have to be designed to provide electrical rather than pneumatic outputs."

He said it did not necessarily follow, however, "that instruments will need to be designed to provide digitally coded electrical outputs." This conversion can be handled by a computer, he said. These specific areas of challenge to the instrument designer were pointed out by Dr. Wooldridge:

- ***Reliability.*** The growing complexity of computers and their ability to offset individual component failure will demand auxiliary instruments of equal reliability.
- ***Higher accuracy.*** Computer control will allow closer process control than is otherwise practical, making higher instrument accuracy economically worth-while.
- ***Shorter time constants.*** Computer control speeds up the response of industrial processes to input parameter changes. Instruments with parallel reflexes, or with known and reproducible dynamic response characteristics, are needed.
- ***Auto-analysis.*** There will be an increasing need for instruments such as gas chromatographs, spectroscopes, mass spectrometers, viscometers, density, thickness and color measurement devices, and surface finish measuring equipment which can provide electrical information as to chemical type and proportion in a stream of material.

San Francisco Mayor Proposes World Science Center There

A World Technical Information and Exchange Center to promote international cooperation of science and scientists has been proposed by George Christopher, mayor of San Francisco.

Speaking at a luncheon meeting during the ISA conference and exhibit (see above), Mr. Christopher said such a center would provide a world reservoir of technical knowledge that can be made available to all peoples for the common good. "We need means for bringing scientists

together, and better ways to collect and distribute information on . . . space, the mining of the seas, the development of underdeveloped countries, and the control of armaments," he said.

The center would be affiliated with the United Nations and would be supported by contributions from member nations.

Computer College to Specialize in Systems Research and Design

A proposed Systems Research Institute to be located in New York City will specialize in training people in computer system solutions, according to Thomas J. Watson Jr., president of International Business Machines Corp. (IBM).

The curriculum will include such subjects as case studies in systems-design, workshops in system planning, advanced programing, and business simulation techniques, Mr. Watson told a meeting of GUIDE, an international organization of business computer users.

The faculty will include senior IBM systems personnel and visiting lecturers from industry and universities, Mr. Watson said. The director of the institute will be IBM Vice President John C. McPherson. The first group of 30 students is expected to be enrolled this fall.

Eight Students Named Fellows At Systems Research Center

Eight graduate students have been awarded fellowships for work in the Systems Research Center at Case Institute of Technology, Cleveland, Ohio. They are:

Irwin Gross, BS in Electrical Engineering, New York University, and MS in Electrical Engineering, the University of Southern California.

William R. King, BS in Industrial Engineering, Penn State.

Lee Johnson, Jr., BS in Electrical Engineering, Vanderbilt.

Joseph A. Marquisee, BS and MS in Physics, Syracuse.

Robert N. Linebarger, BS in Mechanical Engineering, Stanford, and MS in Instrumentation Engineering, University of Michigan.

George A. Coulman, BS in Chemical Engineering, Case, and MS in Chemical Engineering, Michigan.

Donald S. Macko, BS in Mechanical Engineering, Case.

Richard W. Rodgers, BS in Mathematics, Cornell College (Iowa), and MS in Mathematics, Iowa State.

NEWS

Ionosondes Help Predict B

NBS Probes Ionosphere Layers; IGY Contributed Valuable Data

THE National Bureau of Standards' radio propagation prediction service, widely used in long-range radio communications, has recently increased in scope and reliability. Experience gained over 18 years of predictions got a boost through data gathered during the International Geophysical Year to make possible the improved service.

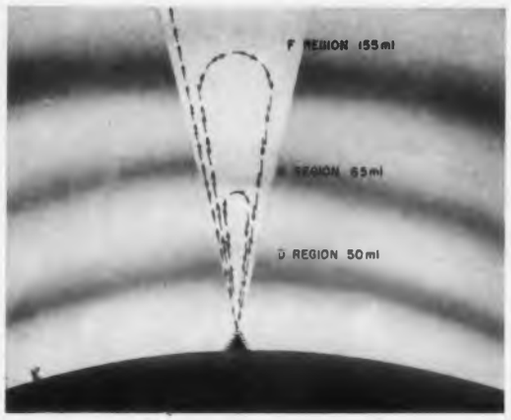
The studies have centered around the reflection of electromagnetic waves by electrons or ions in that part of the atmosphere between 40 and 350 miles above the earth's surface, since much of the world's radio transmission depends on that reflection. The four levels of the ionosphere—labeled D, E, F-1, and F-2—are ill-defined amorphous groupings of particles.

These layers differ from each other in characteristics of height, density, and critical frequency (the highest frequency transmissions normally reflected by that level) and act much as mirrors, reflecting high-frequency radio waves back toward the earth. By alternate reflection from the ionosphere and the earth's surface, radio signals in the range between 3 and 30 mc can be transmitted up to 2,500 miles. The E and F regions are the most important ones to long-range communication.

Information about the ionosphere is collected and analyzed by the Bureau's Central Radio Propagation Laboratory at Boulder, Colo., and these data are used to predict optimum frequencies for communications between any two points in the world. The three-month predictions are based on vertical incidence for one-hop, F-2 transmissions with average layer height for 2,500 miles over a great circle path. They are published monthly as the CRPL-D series.

Characteristics of the ionosphere vary with geographic location and with sunspot activity, primarily, although there are other phenomena not completely explained. For effective radio transmission between two points, a frequency must be chosen which is low enough to be reflected off the upper layers of the ionosphere and yet high enough to pass through the denser lower levels without absorption. Intensified study of the ionosphere was made during IGY and the 161 reporting stations were more than double the number reporting before that 18-month period.

Best Radio Frequencies



Schematic representation of ionosphere, showing the D, E, and F regions, or layers, together with pulse-sounding technique of vertical ionosonde.

Sunspot activity was particularly important in the activity, and hence IGY was timed to take place during a period of intense solar activity. During this period, maximum usable frequencies rose high enough to create many interference problems, particularly on mobile communication circuits and on forward-scatter transmission in the 25-60 mc range.

The Bureau of Standards feels that a similar intensive study should be made during a period of minimum sunspot activity, predicted to occur sometime between 1965 and 1967.

C-4 ionosonde in use at Boulder Laboratories. Technicians keep careful notes of meter readings to make predictions on maximum frequencies for radio communications.

NEWS

Conference Sees Increased Need For Electromagnetic Relays

An increase in the demand for electromagnetic relays was predicted by Dr. L. T. Rader, a vice president of the International Telephone and Telegraph Co. at a recent relay conference held at Oklahoma State University.

Dr. Rader, addressing the 238 conferees at the Eighth Annual Electromagnetic Relay Conference in Stillwater, Okla., said that not only would there always be a need for relays but that engineers throughout the IT&T system supported him in this view.

Accent on Reliability

Other speakers at the meeting, however, said that this need would have to be coupled with the production of reliable relays in the face of heavy competition from transistor switching techniques. W. O. Hansen of the General Electric Co. said that in a particular aircraft circuit, studies had shown that the failure rate of the transistorized version was more than double that of the electromagnetic.

"Reliability has been used as a blind justification favoring the use of transistors over relays," Dr. Hansen said, "because of the intuitive feeling that static devices which have no moving elements that can wear or stick or consumable elements that can be expended are more reliable."

This assumption, he said, is fallacious and cited the aircraft circuit which transfers load from the main electrical system when a fault occurs which does not clear itself after being reset. The transistorized version of the circuit, he said, is far more complex than the electromagnetic version and showed a failure rate of 18.77 per cent per 1,000 hours versus 7 per cent for the relay version.

Contamination Causes Failure

Main cause of relay failure, according to Horace Robertshaw of Union Switch and Signal, was contamination introduced during manufacture. Eugene T. Sliwinski of Guardian Electric Mfg. Co. described his company's elaborate precautions to prevent contamination during manufacture.

This contamination is a prime cause of contact failures and, L. D. Carr of Sperry Gyroscope said, contact failures are responsible to up to 75 per cent of total relay failures at Sperry. He called for adequate specifications on contact loads such as nature of inductance, peak currents and voltages, time constant, duration of inductive kicks, and required number of contact operations.

The association's committee on testing said a

shock test machine would soon be available to assure uniform testing procedures.

Considerable interest at the conference was generated by discussion of the proper method of specifying inductive loads. Louis D. DeLalio of Filtors, Inc., pointed to what he called the inadequacy of current user and military specifications and recommended that all inductive-load ratings be specified in terms of maximum current and maximum inductive load energy.

Correction Notice

The audio circuit booklet put out by Amperex Electronic Corp. of Hicksville, N.Y., is not free, as implied in *ED*, May 11, p 203. The booklet is priced at $1.50.

Nike Zeus Zooms in Test

Anti-missile missile Nike Zeus is shown streaking skyward from a new underground launcher. The successful test indicates that the missile, when it becomes operational, might be fired from attack-resistant underground cells. The test was conducted at White Sands Missile Range in New Mexico. The Army Rocket and Guided Missile Agency supervised Bell Telephone Laboratories and Douglas Aircraft Corp. launching crews. Western Electric Co. is prime contractor for the over-all development of the system.

NEWS

Mobile Communications Systems Designed For MARS Network

Five hundred mobile transmit-receive systems are being built for use in the Air Force communications network known as MARS (Military Affiliate Radio Systems). The single side-band systems consist of a transmitter and receiver, each measuring 12 in. long and 7 in. high, a control unit, and power supply. All units and parts are said to be completely standardized.

Dynamics Corp. of America is building the systems under a $500,000 contract with Griffiss Air Force Base of Rome, N.Y. The equipment is being manufactured at the company's plants in Long Island City, N.Y., and Farmingdale, N.J.

Radiosonde Data Helped Ensure Safe Saturn Firings

Data gathered by balloon-carried radiosondes helped predict sound levels near the Saturn static test firings at Redstone Arsenal, Ala. Because of

Army personnel prepare to release balloon-carried radiosonde to gather information on atmospheric pressure, temperature, and humidity. Data will be used to help insure that static test firings of the Saturn space rocket can be conducted with complete safety.

Saturn's 1.5 million-lb thrust, measurements were necessary for safety.

Radiosonde instruments measured atmospheric pressure temperature and humidity. A miniature radio transmitter sent the measurements to the ground.

Data derived from the radiosonde flights predicted what the sound intensity of the Saturn firings would be at any given location on the ground.

The balloon burst at an average height of 90,000 ft and a small red parachute attached to the balloon carried the radiosondes gently to earth.

Each radiosonde has a return tag on it, asking the finder to mail it to the Lexington, Ky., Army Signal Depot. There the device is rebuilt for further use whenever possible.

Rocket Radiosonde Gathers High-Altitude Weather Data

The Army is gathering weather data with a new rocket-borne radiosonde which probes the atmosphere at altitudes up to 40 miles.

The device, developed by the Army Signal Research and Development Laboratory of Fort Monmouth, N.J., reportedly offers a more economical and flexible method than the complex rocket system now in use above balloon ceilings.

The radiosonde has a radio transmitter and silver zinc batteries encased in an 18-in. fiberglass shell. The sensory and radio system are packed into the nose cone of a 77-lb Arcas rocket, specially developed by the Office of Naval Research for upper atmospheric conditions.

After release from the rocket, the radiosonde floats earthward on a 15-ft parachute. Wind speed and direction are plotted by an automatic ground tracker called a rawin set, originally developed by the Army Signal Corps for monitoring balloon flights.

Rocket-borne radiosonde is loaded into the nose of a 77 lb Arcas rocket by Army personnel for its trip 40 miles into the atmosphere. After separating from the rocket at that height, the radiosonde parachutes to earth, transmitting weather information as it falls.

WASHINGTON REPORT

Ephraim Kahn

ELECTRONIC FIRM'S ERROR in bidding on a military contract has prompted a clarification of the government's responsibility in evaluating bids. The Judge Advocate General's Office says it should try to protect low bidders against "gross error." This duty need not apply "merely because a particular bid is low in relation to the existing economic climate." In the case at issue, the bidder said that four years ago it had offered the same price for the electronic item that was under bid. Since then, costs have gone up. Truly competitive bidding "would be adversely affected if the contracting officer were under a duty to assure that the low bid was computed in accordance with current conditions and prices," the Army noted.

CENTRALIZED DATA PROCESSING is being considered by the Federal Government. Officials think that it may be more efficient to set up a single data-processing agency and make it responsible for all computer activity. The agency would advise other government bodies on the best way to make use of available computer time, and it would standardize machine language so that all government data would be interchangeable. A single federal buyer for computers would, of course, constitute a major market—and selection by the government could influence other purchasers.

TIGHTER NEGOTIATING RULES for fixed-price incentive contracts are urged in a bill introduced by Chairman Vinson (D, Ga.) of the House Armed Services Committee. He would limit incentive payments severely. They would be allowed only when a contractor can prove that the government actually saved money because extra efforts were made to heighten efficiency. Widespread use of negotiated buying would be allowed only in emergencies "hereafter declared" by the President or Congress. Under present conditions, the military would have to justify in writing its use of negotiation rather than advertised bidding, "setting out facts and circumstances sufficient to clearly and convincingly establish that use of formal advertising would not have been feasible and practicable."

ANTI-SUBMARINE WARFARE management by the Navy will not be changed despite strong suggestions from the House Appropriations Committee. The Congressmen doubted that the Navy could meet its anti-submarine warfare goals without establishing a "single manager" system. Complaining that the Navy had not been vigorous enough in this area, the group added $321 million to the fiscal 1961 budget request.

As the Navy sees it, anti-submarine activity is "a multitude of weapons systems meeting requirements for all phases of naval warfare." It is "managed as an integral part of the entire Navy management plan," and the present set-up is believed "both adequate and appropriate to cope with" the anti-submarine warfare problem.

AUTOMATED PRODUCTION of high-reliability electronic parts for the Nike-Zeus anti-missile system seems assured. The Army, which had asked $25 million to set up automatic production of miniature electronic components, will get about $18 million for the job. The Army's Director of R&D, Richard S. Morse, says that even though Nike-Zeus is not going into production right away, "advanced production methods and automated techniques will be required in order to insure the future capability of producing such new and complex components in the required quantity and with the required reliability." The $18 million is to be used for "new automatic processes for production of mesa type transistors, precision resistors, and other Zeus components which require an extreme degree of reliability and ultimately will be required in large quantities."

DEFENSE COMMUNICATIONS AGENCY, to handle long-haul high-level military traffic, has now been established. It will take another eight months or so before unified communications control will start working at all appropriate levels. The agency will run communications centers, allocate frequencies and circuits, and specify standards for maintenance. It will have a key role in communications R&D and in purchase of equipment, though it is not going to do much buying itself. It has been directed to "insure effective integration, standardization and compatibility" of communications systems "and to eliminate unnecessary duplication in research and development effort and expense." The Director of Defense Research and Engineering will, however, be given recommendations for the "progressive improvement" of the system through R&D, and the agency will draw up plans for meeting new needs.

PROGRESS PAYMENTS POLICY on defense contracts may change sharply. Senator Byrd (D, Va.) has taken sharp exception to the 80-20 plan on the ground that it is excessively costly to the government. Furthermore, he persuaded the Senate to pass a bill forbidding the Defense Department to pay more than the going rate of interest on Treasury bonds to reimburse contractors for the 20 per cent of required funds that they must supply. This could involve a loss to the contractor of two per cent or more, depending on the rate he must pay to borrow money. Adoption of the Byrd proposal by the House would make it well-nigh impossible for the military to stick to its 80-20 policy and still offer "just compensation" to the firms which provide this financing. Modification is likely in any event, since it is clear that Congressional opposition to the practice is widespread, and the General Accounting Office has made it clear that it thinks some of the "additional fees" paid under 80-20 contracts have been far too high.

NEWS

Report Finds Science Interest Diverts Many From Engineering

Fewer qualified students are studying engineering because they believe there is more glamour in sciences such as physics or chemistry or because they do not feel they can meet the demands of an engineering education.

This was the conclusion of a recent study by the Engineering Manpower Commission of the Engineers Joint Council, New York.

The study found that the schools most affected by the decline in engineering enrollment were public institutions in the Southern, South Central and Rocky Mountain states. Private schools, particularly those in the East and Midwest, did not report as great a decline.

The study concluded, however, that the 1960-61 engineering freshman class will be larger than this year's class of 67,704. Last year's class of 70,029 was the first since 1950 to number fewer students than the one of the year before.

CHANGES IN PRICES & AVAILABILITY

MICA CAPACITORS of all types, paper and plastic film capacitors, and electrolytic capacitors have been increased 10 per cent in price by Sangamo Electric Co. of Springfield, Mo.

SILICON RECTIFIERS have been reduced in price from 4 per cent to 75 per cent by General Instrument Corp. of Elizabeth, N.J. The price reductions affect 123 standard types of medium power silicon rectifiers, used in military, industrial and commercial electronic equipment. Typical reduction on the seven JAN types of silicon rectifiers are as follows: JAN IN253, from $1.95 per unit, in quantity lots of more than 100, to $1.85; JAN IN254, from $2.25 to $2.09; JAN IN255, from $3.90 to $3.70; JAN IN256, from $7.40 to $4.47; JAN IN538, from $1.55 to $1.33; JAN IN540, from $2.50 to $2.19; JAN IN547, from $4.80 to $2.80. The IN435 has been reduced from $3.40 to 84 cents.

TEST CHAMBERS have been increased up to 7-1/2 per cent by Tenney Engineering, Inc. of Union, N.J. Tenney produces a standard catalog line of chambers as well as custom units. The price change affects both areas.

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FULL-RANGE TESTED microwave measuring instruments

Your hp representative offers two very important advantages

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- **complete assurance that the equipment will perform precisely as specified**

hp makes sure you get what you pay for by rigid quality control plus 100% electrical testing using hp developed methods including reflectometer and swept frequency techniques. hp *knows* when a parameter is out of spec; never gambles your money and time that 3 or 4 sample measurements taken across an instrument's range truly indicate its full-range performance.

See your hp rep now for FULL-RANGE TESTED microwave equipment . . . *get what you pay for.*

FREE TEST METHOD DESCRIPTION

Interested in swept frequency testing? Ask your rep, or write direct for "Applications of hp 416A Ratio Meter," describing reflectometer systems and hp swept frequency measuring techniques.

NEW hp NOISE MEASURING EQUIPMENT

hp 344A Noise Figure Meter

Quickly, accurately measures noise figure of operating radar sets. Automatic operation; simple front panel calibration. Militarized, transistorized, reliable in extreme environments, minimum size and weight. Continuous noise figure presentation on most radar receivers. Extremely high sensitivity permits decoupling noise source up to 20 db from main transmitter line to minimize system degradation. Provision for automatic alarm, remote noise figure monitoring, modulating. Meter scale/excess noise options; 30 MC input frequency, 1 MC bandwidth, 75 ohms input impedance. Approx. $1,600.00 (depending on options and modifications selected).

hp 340B/342A Noise Figure Meters

General-purpose instruments making possible, in minutes, receiver and component alignment jobs that once took hours. Simplifies accurate alignment; encourages better maintenance; better performance.

hp 340B automatically measures, continuously displays IF or receiver noise figure at 30 or 60 MC; other freq. on order. $715.00 (cabinet) $700.00 (rack).

hp 342A, similar, operates on 30, 60, 70, 105, 200 MC. 30 MC and 4 other frequencies between 38 and 200 MC on order. $815.00 (cabinet) $800.00 (rack). (Note: Models 340B and 342A available only in the U.S.A. and Canada)

hp 343A vhf Noise Source, temperature limited diode broadband source, 10 to 600 MC, 5.2 db excess noise, $100.00.

hp 345B IF Noise Source, 30 or 60 MC (others to order); 4 impedances, 5.2 db excess noise. $75.00.

hp 347A Waveguide Noise Source, Argon gas discharge tubes in waveguide section; for bands S, G, J, H, X, P, 2.6 to 18.0 KMC, 15.2 db excess noise. $190.00 to $250.00.

Basic test, power and impedance measuring equipment

World's largest line of FULL-RANGE

BASIC TEST EQUIPMENT

382A Precision Attenuators

Popular 382A series precision attenuators now include in "K" and "R" bands, 18.0 to 40.0 KMC. "K", "R" band attenuators are of new, space-saving design (see photo). Direct reading, one-control setting, high power handling capacity. Attenuation 0 to 50 db full range, independent of frequency. Phase shift constant with attenuation. G, J, H, X, M, P, K, R bands, $275.00 to $500.00.

421A, 420A/B Crystal Detectors

421A (shown), silicon crystal detector of rf signals in waveguide systems. High sensitivity, for H, X, M, P bands, 7.05—18 KMC. 421A, $75.00 to $105.00. 420A, similar but for Type N coax lines, 10 MC to 12.5 KMC. $50.00 each. Also 420B, same in matched pairs, $150.00 pair.

532 Waveguide Frequency Meters

New design for H, M, P, K, R bands. Wide band, direct reading, no interpolation or charts. Has a high Q resonant cavity tuned by choke plunger; no sliding contacts. Transmits almost full power at resonance; resonance indicated by 1.5 db dip in output. Similar model for X-band. $150.00 to $275.00.

914 Moving Loads

Waveguide section containing sliding, tapered, low-reflection load. Plunger controls load position, travels ½ wavelength at lowest frequency to reverse phase of residual load reflection. Models for S, G, J, H, X, M, P, K, R bands, 2.6 to 40.0 KMC. $55.00 to $250.00.

P932A/934A Harmonic Mixers

Mixer for wide band beat detecting, beat frequency mixer for stabilizing a signal source. P932A 12.4 to 18.0 KMC; 934A (coaxial) covers 1 to 12.4 KMC. Both models: max. input power 100 mw. P932A, $250.00 934A, $150.00.

POWER MEASURING EQUIPMENT

434A Calorimetric Power Meter

Connect and read powers 10 mw to 10 watts, dc to 12.4 KMC. No barretter, thermistor needed, no external terminations or plumbing. Measures CW or pulsed power. Two simple controls. Dc input impedance 50 ohms approx.; input SWR less than 1.7 full range, less than 1.3 to 5 KMC. Accuracy within 5% full scale. $1,400.00 (cabinet) $1,385.00 (rack mount).

430C Microwave Power Meter

No computations! Provides instantaneous, automatic power readings *direct* in dbm or mw at all frequencies for which there are suitable bolometer mounts. For CW measurements, uses either 1/100 amp fuse or Sperry 821 barretter. Also measures CW or pulsed power with negative coefficient thermistor. Provides up to 16 ma bias current. Operates with 476, 477, 485, 487 mounts. Range 0.02 to 10 mw. $250.00 (cabinet) $255.00 (rack mount).

IMPEDANCE MEASURING EQUIPMENT

-hp- 809B and 810B

-hp- 814B, 815B, 446B

Quick, easy waveguide interchange

809B/814B Universal Probe Carriages

Models 809B and 814B are precision built mechanical assemblies operating, respectively, with 810B and 815B series slotted sections.

Combination of the 809B carriage and 810 slotted sections covers 2.6 to 18.0 KMC. Combination of 814B carriage and 815B series sections covers 18.0 to 40.0 KMC.

On either carriage, waveguides can be interchanged in seconds. Only one probe (for each carriage) covers full frequency range. Manufacture is of highest quality, assures positive mechanical positioning of interchangeable waveguides and precise installation of mating probes. 809B has vernier scale reading to 0.1 mm, is equipped for dial gauge mounting. 814B has dial read directly to 0.1 mm, interpolated to 0.01 mm. 809B, $160.00. 814B, $200.00.

444A/446B Untuned Probes

444A (shown) is modified crystal (1N76 or 1N26) plus small antenna in convenient housing. Probe penetration easily variable; locks in position. No tuning; sensitivity superior to elaborate single, double tuned probes. Range 3.0 to 18 KMC; fits ¾" bore. *New 446B* for 814 Probe Carriage, similar but covers K and R bands, 18.0 to 40.0 KMC. 444A, $40.00. 446B, $145.00. also offers model 440A, for barretter or crystal, Type N coaxial, $85.00.

TESTED *waveguide and coaxial equipment*

752 Multi-Hole Coupler

Precision directional couplers, 3 models, coupling factors 3, 10 and 20 db. Coupling accuracy ± 0.4 db or 0.7 db. Directivity better than 40 db full range, SWR less than 1.05. S through R bands, 2.6 to 40.0 KMC. $100.00 to $375.00.

372 Precision Attenuators

Rugged, broadband fixed attenuators retaining precise calibration regardless of humidity, temperature or time. Invariant attenuation assured by permanent, "multi-hole coupler" joining of two waveguides. 10 and 20 db models for S, G, J, H, X and P bands, 2.6 to 18.0 KMC. $100.00 to $375.00.

764D-767D Dual Directional Couplers

High directivity dual coaxial couplers make reflectometer measurements practical in vhf and uhf coax systems. Flat response, high power capacity, low insertion loss. Four models, covering 216 to 4,000 MC collectively. 764D/765D $160.00. 766D/767D $150.00.

375A Variable Flap Attenuators

Simple, convenient for adjusting waveguide power or isolating source and load. Max. SWR less than 1.15 full range; attenuation variable 0 to 20 db. dissipates average powers up to 0.5 or 1 watt. S through R bands, 2.6 to 40.0 KMC. $90.00 to $180.00.

870A Slide Screw Tuners

For flattening waveguide systems, matching, etc. Probe position, penetration adjusts to set up reflection canceling existing reflection. Precision lead screw or micrometer varies probe insertion; vernier adjusts probe position. Corrects SWRs of 20 with accuracy of 1.02 SWR. For S, G, J, H, X, M, P, K, R bands. 2.6 to 40.0 KMC. $125.00 to $300.00.

WR75 Components—10 to 15 KMC

An increasing number of precision waveguide instruments shown here are available in the M-band, recently allocated for private microwave communications.

SEE TABULAR LISTINGS NEXT PAGE FOR DETAILS

476A, 477B Detector Mounts

476A Universal Bolometer Mount, for rf power measurement 10 to 1,000 MC; no tuning, SWR less than 1.25. $85.00. 477B Coaxial Thermistor Mount (shown) for rf power measurement 10 MC to 10 KMC; no tuning, SWR less than 1.5, $75.00.

485 Detector Mounts

Three basic series offered: S485A for S band (no tuning, 1.35 SWR, 821 element); 485B, for G, J, H, X bands (tunable, uses 1N23, 1N21, 821 element, 1.25 SWR using barretter); 485D for S, G, J bands (factory-installed 821 barretter). $75.00 to $170.00.

487B Thermistor Mounts

Each covers full range of its waveguide. No tuning, SWR 1.5 or 2.0 max. Max. power 10 mw. Rugged construction, negative temperature coefficient thermistors virtually eliminate burnout. G through R bands. 3.95 to 40.0 KMC. $75.00 to $225.00.

810/815B Slotted Sections

810B Slotted Sections 810B, for 809B carriage, flanged, waveguide section with accurately machined slot. Slot tapered at ends to minimize reflection. Available in 6 waveguide bands (including M-band), 3.95 through 18.0 KMC. $90.00 to $110.00.

S810A. Complete slotted section assembly including probe carriage. In 2.6 to 3.95 KMC (S-band) size only. $450.00.

815B Slotted Sections For mounting in 814B carriage. Available in K and R bands, 18.0 to 40.0 KMC. Accurately machined; easy interchange, precise positioning. $265.

806B Coaxial Slotted Section 3 to 12 KMC, mounts in 809B, has Type N connectors. $200.00.

805A/B Slotted Lines

Utmost mechanical rigidity, less leakage, greater accuracy, SWR 1.02 or 1.04. Range 500 MC to 4 KMC, reads in cm and mm to 0.1 mm. 805A, for 50 ohm Type N, 805B, for 46.3 ohm RG 44/U. 805A/B, $450.00.

415B Standing Wave Indicator

For all waveguide and coaxial slotted sections. Gives readings in SWR or db. Single frequency operation; 315 to 2,020 cps. Low noise level, 0.1 μv (full scale) sensitivity, 60 db calib. attenuator. $200.00 (cabinet), $205.00 (rack mount).

416A Ratio Meter

Displays ratio between two signals, irrespective of common amplitude variations. Ideal with directional couplers and swept frequency sources for swept frequency measurement of VSWR, reflection coefficient, gain, insertion loss and other microwave parameters. Calibrated in VSWR, % reflection, db. Oscilloscope, recorder output. $475.00 (cabinet) $460.00 (rack mount)

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WAVEGUIDE TEST EQUIPMENT—2.6 to 40 KMC

Instrument	Coaxial Type N	"S" 2.6 - 3.95 KMC	"G" 3.95 - 5.85 KMC	"J" 5.2 - 8.2 KMC	"H" 7.05 - 10 KMC	"X" 8.2 - 12.4 KMC	"M" 10 - 15 KMC	"P" 12.4 - 18 KMC	"K" 18 - 26.5 KMC	"R" 26.5 - 40 KMC
Adapter, Waveguide to Coax		S281A $50	G281A $40	J281A $35	H281A $30	X281A $25				
Cover to Choke Flange		S290A $65	G290A $50	J290A $35	H290A $30	X290A $15		P290A $25		
Waveguide to Waveguide		-hp- 292 Series: HX292B $25, MX292A $40, MP292A $40, NP292A $40, NK292A $40								
Attenuators Fixed 3, 6, 10, 20 db		S370A $75	G370A $75	J370A $65	H370A $60	X370A $55		P370A $60	K370A $100	R370A $100
Precision Fixed		S372 $375	G372 $250	J372 $140	H372 $120	X372 $100		P372 $115		
Flap, 25 db max.		S375A $120	G375A $110	J375A $100	H375A $90	X375A $90		P375A $100	K375A†† $140	R375A†† $180
Calibrated, precision		S380A $260	G382A $500	J382A $350	H382A $350	X382A $275	M382A $300	P382A $275	K382A†† $425	R382A†† $450
Detector Mounts	420A $50	420B $75			H421A $95	X421A $75	M421A $125	P421A $105		
	440A† $85									
		S485D* $170	G485D*$170	J485D* $170						
		S485A† $140	G485B† $95	J485B† $90	H485B† $85	X485B† $75				
Thermistor Mounts (Fixed tuned)■	477B $75		G487B $95	J487B $90	H487B $80	X487B $75	M487B $110	P487B $110	K487B†† $150	R487B†† $225
Frequency Meters, Reaction				J530A/B**	H530A $120	X530A $120		P530A $150		
Direct Reading					H532A $195	X532B $150	M532B $275	P532A $210	K532A $230	R532A $250
Directional Coupler, Cross Guide: 20, 30 db		S750 $150	G750 $120	J750 $80	H750 $70	X750 $50				
Directional Couplers, Multi Hole: 3,10, 20 db		S752 $375	G752 $250	J752 $140	H752 $120	X752 $100	M752 $130	P752 $115	K752†† $175	R752†† $200
Slotted Sections, Waveguide		S810A* $450	G810B§ $110	J810B§ $110	H810B§ $110	X810B§ $90	M810B§ $110	P810B§ $110		
Slotted Sections, Waveguide									K815B†† $265	R815B†† $265
Tuners, Slide Screw		S870A $225	G870A $185	J870A $150	H870A $130	X870A $125	M870A $130	P870A $130	K870A†† $250	R870A†† $300
E - H						X880A $130		P880A $150		
Waveguide Phase Shifter				J885A $500		X885A $400		P885A $550		
Terminations, Low Power		S910A $60	G910A $50	J910A $35	H910A $30	X910B $25		P910A $30		
Terminations, High Power		S912A $200				X912A $75				
Moving Load		S914A $100	G914A $75	J914A $70	H914A $60	X914B $50	M914B $65	P914A $55	K914B†† $250	R914B†† $250
Standard Reflections						X916 $100				
Adjustable Shorts		S920A $150	G920A $125	J920A $100	H920A $75	X920A $75	M920B $75	P920A $75	K920A†† $140	R920A†† $150
Waveguide Shorting Switch						X930 $100				
Harmonic Mixer		934A $150 1 to 12.4 KMC						P932A $250		
Broad Band Probe, Untuned			442B§ $40,	444A $40	2.4 to 18 KMC			446B $145	18 to 40 KMC	

†For use with barretter or crystal. ‡For use with barretter only. *Complete assembly including carriage. §Mounts in 809B Carriage.
■Includes Thermistor, installed. **J530A, 5.85 to 8.2 KMC, $120; J530B, 5.20 to 7.05 KMC, $150. * Includes barretter; checked for square law characteristics.
††Available with circular flanges equivalent to UG-425/u for K bands and UG-381/u for R bands. Specify by adding suffix "C" to model number: i.e., K487BC.

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MICROWAVE EQUIPMENT

Check these tables for detailed information, prices on hp microwave equipment you need. Call your hp representatives for more details, technical application help.

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MICROWAVE POWER MEASURING EQUIPMENT

Instrument	Primary Uses	Frequency Range	Characteristics	Price
-hp- 430C Microwave Power Meter	Measurement of rf power	Depends on Bolometer Mount	0.02 to 10 mw ±5% accuracy	$ 250.00
-hp- 434A Calorimetric Power Meter	Measurement of rf power	dc to 12.4 KMC	Direct reading, no barretters, thermistors or terminations; CW, pulsed	1,115.00△
-hp- 475B Tunable Bolometer Mount	Measurement of rf power (with 430B/C)	1,000 to 4,000 MC	Matches 50 ohm line to 100 or 200 ohms	225.00
-hp- 476A Universal Bolometer Mount	Measurement of rf power (with 430B/C)	10 to 1,000 MC	No tuning required SWR less than 1.25	85.00
-hp- 477B Coaxial Thermistor Mount	Measurement of rf power (with 430C)	10 MC to 10 KMC	No tuning required SWR less than 1.5	75.00
-hp- 764D/767D Dual Directional Couplers	Reflectometer and rf power measurements	764D, 216-450 MC; 765D, 450-945 MC; 766D, 940-1,975 MC; 767D, 1,900-4,000 MC	Coupling attenuation* 20 db, directivity 30 or 26 db	764D, 765D, $160 766D, 767D, $150

*Power handling capacity all 764/767 series couplers 50 watts CW, 10 Kw peak.

MICROWAVE IMPEDANCE MEASURING EQUIPMENT

Instrument	Primary Uses	Frequency Range	Characteristics	Price
-hp- 415B Standing Wave Indicator	SWR indicator or null indicator	Uses external detectors	0 to 70 db. attn. Max. sensitivity 0.1 μv	$200.00
-hp- 416A Ratio Meter	Reflection coefficient measurements	Uses external detectors	Continuous swept freq. presetting; accur. ±3%	475.00△
-hp- 417A vhf Detector	vhf bridge detector (for -hp- 803A)	10 to 500 MC	Approx. 5 μv sensitivity	350.00
-hp- 803A vhf Bridge	Measurement of vhf impedance, SWR	52 to 500 MC	2 to 2,000 ohms impedance —90° to +90° phase angle	800.00
-hp- 805A Coaxial Slotted Section	Measurement of SWR	500 to 4,000 MC	For Type N Connectors flexible cables	450.00
-hp- 805B Coaxial Slotted Section	Same as above	Same as above	For rigid ⅞" RG44/U line	450.00
-hp- 806B Coaxial Slotted Section	Same as above (mounts in 809B)	3,000 to 12,000 MC	For Type N Connectors flexible cables	200.00
-hp- 809B Universal Probe Carriage	G, J, H, X and P 810 Waveguide Sections Supports 806B section, also		Accepts 442B, 444A probes	160.00
-hp- 814B Universal Probe Carriage	Supports K and R 815B Waveguide Slotted Sections		Accepts Untuned Probe 446B	200.00

Make Milady Want Components, Hi-Fi Manufacturer Says

Special selling techniques intended to win women over to component high-fidelity have been described by a Midwest advertising man. In a statement to manufacturers and distributors, H. T. Harwood, advertising director of Shure Bros., Inc., Evanston, Ill., deplored the industry's emphasis on hardware. This nuts-and-bolts approach has made women feel that components are strictly for audiophiles and hobbyists, he said.

To win women as customers, the industry must cater to their tastes, Harwood added. He listed several approaches which his company is studying to stimulate female awareness and appreciation of components.

First is a program of advertising and promotion intended to stress the playing of pleasant background music to ease the housewife's chores, and to provide a soothing atmosphere when her husband comes home.

The second area in need of attention is the hi-fi retail outlet, he said. These should be made more attractive, with less emphasis on hardware and more on beauty. Harwood recommended that distributors hire an interior decorator to make the high-fidelity "salon" more attractive to women.

Third, specialized floor selling must be used. In this area, Harwood thinks that a woman salesperson can do a better job than a man.

Finally, Harwood suggests that distributors take component high fidelity out to the women instead of waiting for the women to come to them. Special Ladies' Day demonstrations at the showroom, with promotion and door prizes, are suggested to bring in the women.

"In short," Harwood said, "it takes salesmanship and homemanship to win the women over."

Correction

The illustrations used in Paul Wrablica's article entitled "Concepts in Packaging" in *ED*, March 30, p. 60, were part of a design study accomplished for the Applied Science Corporation of Princeton, a division of Electro-Mechanical Research, Inc. The article failed to point out that the material shown was a specific assignment dealing with new approaches to packaging sub-carrier oscillators designed by Electro-Mechanical Research as well as those manufactured by the Hoover Company, which was mentioned in the article.

The techniques referred to in the article are expected to be applied to other ASCOP telemetering products.

NEWS

Regular Telephone Lines Can Send Punched-Card Data

A teleprocessing system said to permit transmission of complex data over ordinary telephone lines has been successfully tested by the Firestone Tire & Rubber Co. of Akron, Ohio.

The system enables Firestone to transmit punched-card data without leasing a telephone line or converting the card information into paper tape for transmission over teletype circuits. International Business Machines Corp. and American Telephone & Telegraph made the equipment used in the system.

To transmit, a field office operator phones the teleprocessing room at Firestone's main office in Akron, gets a clearance, then starts an IBM transceiver he has previously loaded with cards. The transceiver reads the cards and produces impulses that pass through an AT&T dataphone. The impulses are then converted into signals suitable for phone transmission.

At the receiving end, the process is reversed. Should an error occur, both transceivers stop and buzzers sound at each end. The erroneous data are corrected and retransmitted. When transmission is completed, operators at both ends hang up their phones and line charges cease.

The new system, said to be the first of its kind in industry, is expected to be put into operation immediately. Its primary use will be in assembling payroll and retail accounting data.

Time-Code Standardization Tested for Missile Sites

A standardized timing code for satellite and missile ranges in the U.S. is now being tested at the National Bureau of Standards Radio Station WWV in Beltsville, Md. Transmitted during the third minute of 10 five-minute periods, the signal indicates day-of-the-year in hours, minutes and seconds. The data are read out 60 consecutive times during the one-minute period.

The experimental signal is generated by the ZA-810 solid-state time code generator. The output of the unit is in two forms—dc level shift and modulated 1,000 cps carrier. The 36-bit code is read out once per second at a 1000 pps rate, according to the developer Electronic Engineering Co. of Calif.

At station WWV, the generator's accuracy is said to increase from three parts in 10^8 to about one part in 10^{10}. The increase in accuracy is said to be due to the high accuracy crystal oscillator input possible at the bureau's facility. At the re-

ceiving end, accuracies of 1 msec are said to be possible.

The testing, still in the first experimental stages, was undertaken as a cooperative effort by the bureau's Boulder Laboratory, the Electronic Engineering Co. of California and Convair Astronautics Div.

Magnetic-Field Plotting System Helps Evaluate Cyclotron Design

A new magnetic-field plotting system enables designers to evaluate the performance of cyclotrons before they are built.

The heart of the system is a wafer of semiconductor material that is positioned in the field by electronic and mechanical devices. A voltage generated in the probe is proportional to the intensity of the magnetic field.

The measuring device has been used to record data on many types of field configurations. Hence new designs can be compared quickly with the known data by computers. The evaluation procedure takes about 36 hr.

Knowledge of the magnetic field configuration is needed to calculate the paths of the particles to be accelerated. In the past this often was done by the lengthy process of building a machine and then modifying it to give the desired results.

The system was developed and is being used by the Oak Ridge (Tenn.) National Laboratory.

AM-FM All-Transistor Radio

Zenith's new portable radio is reported to be the first U.S.-made, all-transistor am-fm model. Fm sensitivity is said to be 15μv for 30 db quieting; and for am reception, 18 μv/m at 50 mw above noise. The radio is priced to sell for about $190.

NEWS

Company Seminars— New Tool for Engineering Education

COMPANY-SPONSORED seminars are fast becoming an important vehicle for post-graduate engineering education. Most recent of these was the "Space-Flight Symposium" which was held by Kearfott Co. on May 21 at its Little Falls, N.J. plant.

At this symposium, some 150 invited engineers heard presentations on various design aspects of space flight by Dr. Coleman Donaldson (Aeronautical Research Associates of Princeton), Bernard Lichtenstein (Kearfott), Robert Abrahams (Kearfott), and Dr. Charles Stark Draper (MIT).

Two other important seminars, both on measurements, were held in April. A two-day seminar sponsored by the Weston Instruments Div. of Daystrom, Inc. used classroom sessions on derivation

At a G-R workshop session, Anthony LaRosa (Douglas Aircraft) checks the effect of hand capacity in measuring the impedance of standard capacitors; Herbert Ingraham (RCA Camden) reads the G-R 1605 Impedance Comparator; and Brown Wiggins (North American Aviation) records data.

Measuring capacity to five significant places.

At the General Radio seminar, Dr. John F. Hersh shows why a precision 3-terminal capacitor, calibrated at 1 kc, cannot be used to calibrate a bridge at 1 mc. In his presentation on capacitance measurements, Dr. Hersh used material which can be found in his article "How Connection Methods Affect Capacitance Measurements" (*ED*, Aug. 19, 1959).

of primary electrical units; principles, selection, and application of electrical instruments; and problems in measurements, calibration and standardization.

A four-day seminar on standards, calibration, and measurements at General Radio Co. in West Concord, Mass. used both classroom and workshop sessions to highlight approaches to measuring inductance, capacitance, and resistance.

At each seminar, emphasis was placed on concepts rather than proprietary products. This absence of commercialism seems to characterize the latest seminars just as these seminars seem to represent a new trend in engineering education.

Calibration procedures explained at Weston's measurements seminar.

NEWS

Self-Teaching Computers Urged At Fieldata Meeting

A plea for the development of self-teaching computers—machines that can program themselves and learn as they go along—was voiced at the Fourth Fieldata Applications Systems Techniques Meeting in Los Angeles.

Dr. Martin Klein of Franklin Electronics told the meeting that computers "are being used indiscriminately for process control. They are being ingeniously programed to operate like a wild man who is randomly trying all possibilities until one works," he said.

Computers, he said, were often used as "a cesspool into which data are poured from high-speed automatic data-processing machines." This approach, he said, is "simply not working" and refineries and like installations need a machine which programs itself and learns as it goes along from human beings who know how to operate a process successfully. Although such a machine is possible, it is not being built, he said.

He called for a machine built to throw away all numbers that are wrong and to operate only with numbers that are right.

In other business at the meeting:

- A charge of "premature disclosure" was leveled at industry by Milton A. Lipton, chief of the Signal Corps' Data Equipment Branch of the Communications Division at Fort Monmouth, N.J. Mr. Lipton said military requirements for privacy went beyond mere considerations of security in cases where products had not been fully tested and put into final production form.
- Standards were set for program documentation and for tape data formats. The new standards, to be adopted by all Fieldata members, will be published in a short time.

Mobile Computer Provides On-the-Spot Checks in Refineries

A mobile data-processing system said to provide a wide range of uses in the petroleum, chemical and petrochemical fields has been developed by Hagan Chemical & Controls Inc. of Pittsburgh, Pa.

Called the Kybernetes 2000, the system is transported by trailer to sites of new processing plants so that engineers can check on initial plant performance. After that, it can be used for periodic data-processing needs throughout the plant.

The trailer carries its own power supplies permitting input data to be fed directly into the

system. In addition to logging flows, levels, temperatures, pressures and other functions, the 100-point system scans all points for off-normal or out-of-limit conditions, Hagan says.

Process engineers can also use the system for dynamic analyses, it is reported. In this application, the system scans selected points at the rate of four points per second, and transfers data to punched tape for examination.

The mobile system is expected to go into operation in late 1960. To fit space requirements of the trailer, it will consist of six basic racks of components, each 22 in. wide and 6 ft high.

Off-the-Shelf Programs Planned for Computer Users

Pretested computer programs for industry are under development by the Data Processing Division of International Business Machines Corp. The programs, each designed to handle a major data-processing function within a specific industry, will be made available to users of IBM equipment through the company's new Programmed Applications Library.

The programs are expected to perform about 80 per cent of the computer user's particular data-processing job. Each program will include instructions, block diagrams and the problem definition which a customer needs in preparing for computer processing of his industry application. To meet specific requirements, the customer will have to make only limited additions or modifications to the library program, the company says.

The first library program is expected to be available by September, 1960. This is described as a public utility customer-accounting program which is designed for the solid-state 7070 data-processing system.

Computer Business May Double RCA Volume in Next Decade

A program of all-out activity in the area of electronic data processing is expected to double Radio Corp. of America's present corporate income within the next decade, president John L. Burns said at the company's annual meeting.

He indicated that present orders for computer systems made by the company have reached $125 million, and probably will exceed $200 million by the year's end. The company's major systems include the RCA 301, 501 and 601, said to provide a complete range of data-processing services to both large and small businesses.

NEWS

Five Firms Start Work On Army's Mauler Missile

A five-company team has begun work on the Army's highly mobile Mauler missile system under a $5.5 million contract covering the first year of development.

General Dynamics Corp.'s Convair Div., Pomona, Calif., is the prime contractor. Other team members and assignments are: Raytheon Co., Waltham, Mass., fire-control system; Burroughs Corp., Detroit, digital computers; Food Machinery and Chemical Corp., San Jose, Calif., pod assembly and single-track vehicle; and Stromberg-Carlson Div. of General Dynamics, Rochester, N.Y., communications equipment.

Convair is developing the solid-fuel missile which will be designed for battlefield use against tactical missiles and jet aircraft employed by the enemy on close-support and forward-echelon harassment missions.

Mauler units will include the missiles and a single-track vehicle which carries the missile guidance and fire-control radar and associated equipment. The units will be light enough to be transported by air.

The Army Rocket and Guided Missile Agency, a part of the Army Ordnance Missile Command at Redstone Arsenal, Huntsville, Ala., has overall charge of Mauler development.

TV Observes Missile Impacts With Rocket-Borne Camera

Remote observation of missile impacts has been accomplished with a TV monitor device tested by the Army.

A TV capsule ejected from a Redstone missile during flight sent back views of the impact during recent tests at the White Sands Missile Range, N.M. The TV equipment and receivers located at a command observation post were supplied by Radio Corp. of America, Camden, N.J.

Army's Mobile Missile Monitor Aiding Air Defense Abroad

Missile Monitor, said to be the first mobile air-defense, missile-fire direction system, is now being deployed to operational sites in Europe, the Army has announced. Designated AN/MSG-4, the system can detect, track and store information on hundreds of airborne targets. It also stores infor-

mation on the readiness and action of each defense missile battery.

The system uses a corps command post with equipment mounted in Army trucks and vans. The equipment includes Frescanar detection radar, a digital computer that identifies and tracks airborne objects, and four large screen consoles to provide command personnel with a graphic picture of the ground-to-air battle.

The command post is electronically linked to the missile batteries, either Nike or Hawk units. Information flowing to the batteries includes track data on assigned targets. Missile batteries send a constant report back to the command post on firing readiness and hostile airplane destruction results.

The mobile system, developed jointly by the Army Signal Corps and the Ground Systems Group of Hughes Aircraft, is said to "eliminate the old grease-pencil and voice-telling methods for coordinating air defense units."

Army missile systems, used to track and assign targets using digital techniques, are going to operational Army sites in Europe. Interior of one of the vehicles shows how transistor circuits are packaged in pull-out drawers. The system, using Frescanar 3-D radar for multi-target tracking, was designed by Hughes Aircraft Co. The Army is tracking Hawk and Nike missiles with the system.

NEWS

Airline Gets Weather Radar Under New RCA Lease Program

Allegheny Airlines has contracted to receive 23 airborne weather radar units under a new leasing program set up by the Radio Corp. of America. The equipment includes the RCA AVQ-10 and AVQ-50 radars, and AVQ-60B air-traffic control transponder.

The AVQ-10 is said to peer through fog, darkness or storm to a distance of 150 miles. Its weight is less than 125 lb. The AVQ-50, a smaller radar weighing 57 lb, is said to have a range of 80 miles. It is intended for small commercial aircraft or private planes.

The transponder is carried in the aircraft and can be triggered as soon as it comes within range of a ground interrogator station. It broadcasts the plane's identification in coded form and this is indicated on a radar scope in the traffic center.

The lease agreement is on a five-year basis with a two-year option at reduced rates. Allegheny is said to be the first commercial air carrier to use the lease program.

Research Shifted by Avco-Crosley To Cincinnati Facility

Research work of Avco Corp.'s Crosley Div. will be consolidated at the division's Cincinnati plant, according to a Crosley spokesman.

Researchers for the division now attached to various Avco facilities in the Boston area will move to Cincinnati under the consolidation plan. The exact number of people to be shifted has not yet been determined, the spokesman said.

Test Sphere Simulates Altitudes Up to 285 Miles

Materials and components for space vehicles will be tested at simulated altitudes of up to 285 miles in a new spherical test facility developed by the Guardite Co. of Wheeling, Ill. This is three times "deeper" into space than earlier tests.

In addition to simulating the vacuum encountered in outer-space travel, the test chamber will duplicate such extra-terrestrial conditions as:

- Solar radiation from the soft X-rays and ultraviolet rays through the visible and infrared range

of the solar spectrum at an intensity as measured at the earth's orbital radius.

- The 420-F temperature of outer space.
- High-energy radiation, such as the hard X-rays, electrons and low-energy protons.
- Simulated re-entry of a test vehicle from outer space to level, duplicating the true effects of atmospheric friction.

Larger test chambers with diameters up to 300 ft are now being planned by Guardite. These units will permit future astronauts to experience precise conditions of extended space travel and re-entry without leaving the ground.

Correction Notice

In "Find Transistor Gain and Impedance Quickly Using Hybrid-Pi Equivalent" (*ED*, May 11, 1960), there is an error. The first paragraph on page 55 states that since the impedance is capacitive, it will increase with frequency. The impedance, of course, will decrease with frequency.

TV Minds Fires at Power Plant

Fire watching has taken on a new dimension at the Dept. of Water and Power in Los Angeles. Using a closed-circuit TV system, this operator at the department's Scattergood Steam Plant monitors the fires inside the plant's boilers. The system, built by Kin Tel Div. of Cohu Electronics, consists of four Vidicon cameras mounted outside the boilers. Each camera sends its picture to one of four 14-in. monitors in the control room.

NEWS

Air Force's Project Gusto Seeks Ultrastable Oscillators

Ultrastable oscillators for use in radio-guidance systems for space travel are being developed under the Air Force's Project Gusto—Guidance by UltraStable Oscillators.

Oscillators with an atomic-clock order of stability promise a new standard of performance in radial acceleration measurements, according to Jack Yolles, technical advisor to Wright Air Development Div.'s Navigation and Guidance Laboratory.

Signals from a ground transmitter compared with those of a local oscillator in the space vehicle could provide a rate of change of phase-shift output proportional to the velocity of the vehicle with respect to the ground station. Radial acceleration might be obtained by differating the velocity measurement.

Project Gusto is part of an over-all Air Force program to achieve the extreme coherence and stability required for long-range space guidance systems, Mr. Yolles explained.

Future Space Transmitter May Use Solar Radiation

Interplanetary communications using radiation from the sun as a means of transmission is the object of a development program at Electro-Optical Systems, Inc., Pasadena, Calif., under an Air Force contract.

The solar communications system (SOCOM) would collect radiation from the sun in one Cassegrainian mirror unit, intensity modulate the resulting beam, and retransmit in any desired direction. The system would be most useful outside of the atmosphere, where there is almost no attenuation of optical signals.

SOCOM offers systems designers narrow beamwidths, low weight and power requirements, and high signal-to-noise ratios, according to Electro-Optical.

EOS engineers estimate that a system using 10 to 15 w, exclusive of control system needs, with a 30 to 40 lb transmitter, could provide a signal-to-noise ratio of 10 db at 10 million miles, if the mirror antenna is 1 sq m in area and bandwidth is 10 cps. A factor of 10 improvement in signal-to-noise would result from cooling the cathode of the photomultiplier detector.

Variable-orientation Cassegrainian arrays would be used for both receiving and transmitting. The receiving system might have a detector mounted behind the primary parabolic mirror,

or the detector might be mounted at the focal point of the primary. The transmitting array would have a series of mirrors so that the radiation can be directed independently of the location of the source.

The sun must be tracked accurately in order to orient the collecting system properly. This might be possible using a radiation tracking transducer recently developed by EOS. The modulator must be designed to radiate away heat absorbed from the beam to prevent overheating, since there is no convection or conduction cooling in space.

Transformer Can Resist Heat Up To 1,200 F, Developer Says

A newly developed transformer is capable of resisting the heat in a missile nose cone or temperatures up to 1,200 F.

Under a two-stage Navy contract, the Raytheon Co. of Waltham, Mass., is constructing the high-temperature-resistant units for final testing.

The temperature limit of transformers currently in use is about 400 F. Under the first stage of the contract Raytheon engineers developed a transformer which could withstand up to 700 F.

The goal of prototypes now under construction is a minimum operation time of 2,000 hr with the units' internal temperatures 200 F above an ambient temperature of 1,000 F. The prototype will represent the various types of transformers.

Although the new transformers will be using a glass-fabric-covered wire and mica-layer insulation, new high-temperature-resistant insulating materials have been developed by Raytheon under this contract. A bentonite clay compound, which can resist temperatures up to 1,000 F, can be made in sheets of 0.0005 in. thickness. It is mixed with inorganic fibers such as glass, quartz, or asbestos, depending upon the extent of heat resistance needed.

Another Raytheon development is a copper-tantalum wire. Upon being anodized, the wire receives a tantalum oxide insulated coating which resists high temperatures.

Engineers have also developed a chromium-plated copper wire to which a ceramic formulation is fused. Nickel-coated wiring now on the market has limited heat resistance because it will alloy with copper in high temperatures and has 50 per cent more conductivity than nickel-plated wire. The chromium-plated wire is coated with a ceramic mixture and fired at a high temperature, resulting in the chromium oxidizing on the wire's surface forming a good bond between the ceramic and the chromium.

FAA Seeks Interim Air-Collision Systems

Agency Looks to Designers for Prevention Suggestions

Alan Corneretto
Assistant Editor

THE FEDERAL Aviation Agency is about to move into second-phase tests of a promising collision-prevention system, but it is still a long way from committed to any one approach to the problem. It is a wide-open field for design engineers.

This was brought out during an IRE section meeting in Boston last month by a panel of aviation specialists representing the FAA and other organizations.

At the meeting, which was arranged to brief Boston-area engineers on the air-collision problem, J. A. Weber, chief of the Data Acquisition Branch, Bureau of Research Development, FAA, reported that FAA policy on collision systems extends only to the idea that positive, ground-based air-traffic control is the optimum way of preventing aircraft collisions. Beyond this, the FAA's only commitment in anti-collision work is to see that all proposals are reviewed.

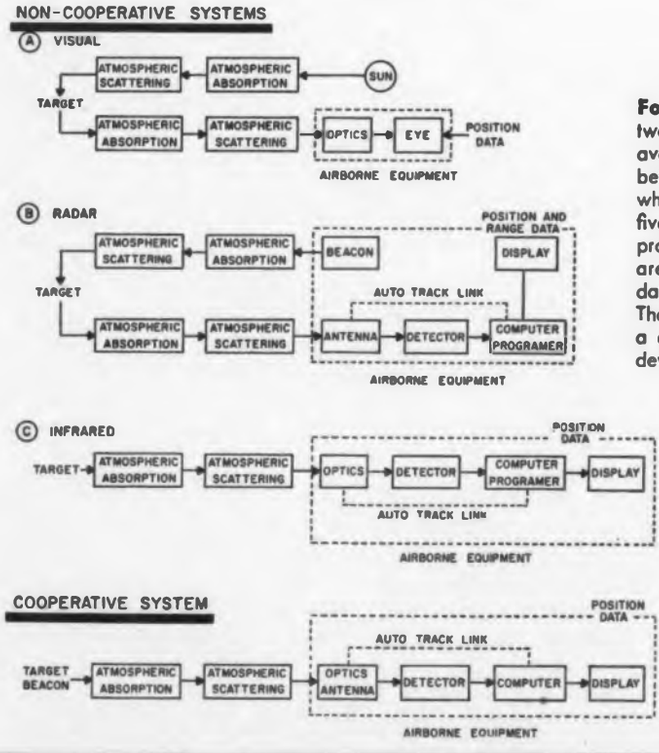
Until positive air-traffic control is achieved the FAA will continue looking for an interim system, Mr. Weber reported. He said that in the last two years more than 200 proposals for collision prevention systems were submitted to the FAA.

Out of these and earlier proposals and out of much military work have come only two developments that the FAA considers promising. One is a collision-avoidance system developed by Bendix Radio; this system is about to be put through second-phase tests at FAA's NAFEC facility near Atlantic City. Tests just completed have established the validity of the ground-bounce ranging technique used in the Bendix system.

The other development is the growing confidence in infrared detection as a potential collision-

Airborne breadboard version of the Bendix collision-avoidance system that is about to undergo tests of system capability at the FAA's National Aeronautical Facilities Experimental Center in New Jersey. The system uses a 400-mc pulse-separation coded signal to broadcast range and altitude data via a ground-bounce communications technique. The company is developing a special airborne computer for the system.

Proposed Anti-Collision Systems Are of Two Types



For designers, the difference between the two classes of collision-avoidance systems means choosing between problems of measurement, which are inherent in non-cooperative (or self-contained) systems, and problems of communication, which are a result of the need to transfer data between cooperating systems. The FAA and industry expect that if a collision-avoidance system is ever developed it will be cooperative.

Wide Variety of Anti-Collision Proposals Cover Electronic Art

The hundreds of proposals for anti-collision systems considered by the FAA and the Air Transport Association in only recent years involve most of the areas of electronics, ranging from radar to nucleonics, from infrared to radio. Here's a rundown of what some companies have suggested to prevent aircraft collisions.

Pilot Warning Instruments

SELF-CONTAINED SYSTEMS

Aerojet General—infrared, possible using lead selenide or indium antimonide sensors.

Collins—constant-rate-of-closure, radar-type system.

Farnsworth—infrared.

ITT—limited-use attachment to weather radars.

Nevada Air Products—infrared.

RCA—weather-radar attachment.

Raytheon—IR system and optical system.

COOPERATIVE SYSTEMS

Aviation Instruments Mfg. Co.—nuclear emitter in wings and tail of craft, to act with directional radiation detector.

Decker—Modulated polarized light with photomultipliers and scanners.

Minneapolis-Honeywell—dual-mode infrared.

Sperry—modified Air Force rendezvous equipment.

Sylvania—directional ultraviolet scanners detecting μv sources in all aircraft.

Collision Avoidance Systems

Bendix—omnidirectional altitude transfer broadcasts via ground-bounce uhf (see story).

Fairchild—PADAR ground-bounce system derived from countermeasures work.

Norden—altitude-coded transponder signals.

Panoramic Radio Products—coding of rf carrier for measurement and display of relative altitude.

Other organizations in air-collision work include Stanford Research Institute, Diamond Ordnance Fuze Labs, Packard Bell, Melpar, Thompson-Ramo-Wooldridge, Curtis Wright, Motorola and Boeing.

avoidance method. Many companies are working on infrared systems, and the Navy is conducting tests for the FAA that will result in a catalog of IR signatures of small aircraft. Signatures of most military and large commercial aircraft have already been developed.

In organizing its attack on the air-collision problem, the FAA classifies equipment into two categories:

■ Collision Avoidance Systems (CAS) detect the presence of other aircraft, evaluate the colli-

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sion risk by measurement and computation, and, at the proper time, alert the pilot and indicate or initiate evasive maneuvers.

■ Pilot Warning Instruments (PWI) are simpler; they alert pilots to the presence of nearby aircraft and indicate the direction to look for them.

CAS and PWI equipment can be either cooperative or self-contained. Cooperative devices require equipment to be installed in other aircraft for greatest effectiveness.

Self-contained systems do not require the help of beacons or other equipment on other aircraft.

Currently the FAA thinks that the CAS, when and if it comes, will be cooperative and complicated, and that it will be the only type of system practicable for jets. Small craft will probably not be able to carry a CAS, which will include a computer. But the PWI gear of small aircraft will contribute to the effectiveness of collision avoidance systems of larger craft.

The FAA expects that rather than a successful CAS appearing complete on the scene there will probably be an evolution of devices leading to a practical system. The agency's program is geared to steady methodical development of anti-collision equipment.

Limited R&D Funds Available

Government money is available for development of such interim equipment but the amount is small compared with that earmarked for the eventual nationwide automatic air-traffic-control system.

Designers of anti-collision equipment have two basic problems to surmount, Mr. Weber told his Boston audience: accuracy of measurement and capacity of communications.

Measurement difficulties hamper self-contained collision-avoidance systems, which must, in effect, predict an event at ranges of 20 to 30 miles. The predicted event is the future position of two or more aircraft, or the magnitude of the collision threat. The range of 20 to 30 miles is determined by the closing speeds of modern aircraft.

Such values as altitude, heading, airspeed and others must be measured accurately. The intruder bearing angle, Θ, must be measured, in a self-contained system, to accuracies of less than 1 deg.

Cooperative systems, which are able to transfer information from one craft to another, do not require such great accuracies. But they are subject to communications problems that result in a trade-off between information capacity and traffic capacity. The greater the number of aircraft that must exchange collision-avoidance information, the lower the capacity of the communications system.

The problems of measurement and communication are relatively insignificant in pilot-warning instruments, but the protection provided by a PWI is proportionally less than that afforded by a CAS.

Because the FAA will continue to base its air-traffic control system on altitude separation, with aircraft flying in specified layers of airspace, most anti-collision systems need to consider only aircraft at the same altitude.

Systems Use These Basic Equations

Three basic ways of evaluating the threat of collision underlie most of the systems proposed to the FAA. Two methods are frequently suggested for self-contained systems: $\Theta' = 0$, where collision is expected when the angle, Θ, between two aircraft is constant; and $R'' = 0$, where the time rate of change of the closing speed between two aircraft is zero.

A common threat-evaluation criterion for cooperative systems is $M = 0$, where collision is expected when the magnitude of minimum approach, M, equals zero—minimum approach being the smallest distance between two aircraft.

The cooperative Bendix system is based on what the FAA calls a unique idea: $\tau = R/R'$ where R is the range between two aircraft and R' is the closing speed between the craft; τ becomes in effect, the time-to-minimum approach, which is what the Bendix CAS computer uses as a basis for evaluating the collision threat.

Dual-Path Transfer of Data

The Bendix system transfers data via a dual path, to-whom-it-may-concern signal that carries pulse-separation-coded altitude information. Range is determined by receiving equipment capable of comparing signals received directly with those received via a ground bounce. A computer determines the time to nearest approach and whether this time will approach minimum escape time.

The collision threat is indicated (and escape can be initiated) automatically before time to nearest approach equals minimum escape time. Because only the range between aircraft and the time-rate-of-change has to be measured, the difficult-to-make measurement of closing angle are avoided in the Bendix system.

So far, the system's theoretical performance as it applies to ranging has been verified by tests. The FAA is about to test the complete system. Bendix is readying a breadboard version of what will be a specially designed transistorized digital computer for the tests. At NAFEC, the FAA hopes to determine the collision-threat-measuring and escape-decision capability of the system. ■ ■

NEWS

Packages Take Bumps, Grinds On Transport Test Machine

A testing machine said to subject packaged objects to the accelerations, bumps, jars and weaving which are typical of railroad freight cars and motor trucks is now being manufactured by the L.A.B. Corp. of Skaneateles, N.Y.

Called the 1,000-SC transportation simulator, the machine consists of a wooden platform supported by two shafts, one near each end of the table. It produces a circular motion in a vertical plane with the table top always horizontal, and reportedly can produce up to 2 g when testing maximum loads of 1,000 lb. A variable speed drive permits operation at speeds from 160 to 300 rpm.

The simulator can provide testing conditions equal to 1,000 miles of normal transportation in about one hour, according to the company.

Servicing for Radiation Equipment Offered on Nationwide Basis

A nation-wide organization to service nuclear and radiation equipment has been formed by the Service Co. division of Radio Corp. of America. Known as Atomic Energy Services, the organization, through its activities, is expected to free customers' scientific personnel for important projects, relieving them of installation and maintenance work.

One service the organization offers is providing warranty and non-warranty maintenance for manufacturers of nuclear equipment. Other services will include installation, maintenance, inspection and instrumentation of equipment and systems. Training and technical publication preparation are also offered.

Four regional service offices have already been opened. They are: Northeast region, New York, N.Y.; East Central region, Camden, N.J.; Western region, Woodland, Calif., and Northwest region, Livermore, Calif. Service centers for the Midwest and South are in the planning stage.

Powder Metal Parts Makers Start Major Expansion Plans

The Powder Metallurgy Parts Manufacturers Association has recently initiated two major expansion activities for the metallurgy industry. One is the development of standards and specifications for products; the other the expansion of

a program of public relations and industry development begun several years ago.

These plans are said to be feasible at this time because of the added strength the association gains through its union with the Metal Powder Industries Federation. Negotiations to unite were completed during the federation's sixteenth annual meeting in Chicago.

Other trade groups within the federation include the Metal Powder Producers Association, Powder Metallurgy Equipment Association, Metal Powder Core Association and the Ferrite Manufacturers Association.

WESCON Distributor-Rep Meeting Expected to Attract Over 600

WESCON's sixth annual Distributor-Representative Conference will attract more than 600 persons to the Ambassador Hotel in Los Angeles, chairman W. Bert Knight predicted.

The conference will be held on Monday, August 22, a day ahead of WESCON's official opening. It will bring together distributors, factory sales managers and sales representatives from throughout the West for a day-long series of bedrock business discussions.

The program will include 20 individual 20-minute conference sessions divided between morning and afternoon. Booking for companies at each session is planned in advance, Mr. Knight said. The program of sessions is expected to end at 5:00 p.m.

Forms for participation in the conference have been received or are now on their way to distributors, WESCON exhibitors and reps.

COMPANY BRIEFS

AN ELECTRONICS-PRODUCTION UNIT manned entirely by handicapped people has been established at the Institute for the Crippled and Disabled in New York City.

A PROPOSED SILICON-RECTIFIER plant that is expected to increase production by eight times the present capacity is planned by the Syntron Co., Homer City, Pa.

TELECHROME MANUFACTURING CORP. of Amityville, N.Y., now has complete ownership of the Hammarlund Manufacturing Co. of New York City. Combined sales exceeding $7 million are expected for the next fiscal year.

NEWS

Experimental DME Equipment Tested on Voice Channels

Experimental aircraft distance-measuring equipment operating on voice-communications channels has been demonstrated for the Federal Aviation Agency and the Signal Corps Research and Development Laboratory.

The prototype DME equipment, weighing 5.3 lb, has been developed by Bendix Aviation Corp. for possible use in light aircraft. One unit can serve as either an interrogator or a responder.

An interrogator unit in the airplane transmits a closely controlled 750 cps tone over a voice channel—interrupting communications for about 0.5 sec. A transponder on the ground returns a signal matched in phase and frequency to the one it receives. Phase shift between the signal originally sent from the plane and the one received from the ground transponder is used to give a meter read-out of distance.

Schools Spent $186.4 Million On Engineering R&D in 1958

American colleges and universities spent $186.4 million on engineering research and development in 1958, the National Science Foundation reported.

In a preliminary report called "Funds for Research and Development in Colleges and Universities, Fiscal Year 1958," the foundation said the money spent on R&D was 25 per cent of the total expenditures by the schools on science and technology.

The Federal Government supported the bulk of the engineering R&D with grants totaling $158.4 million, according to the report. Basic engineering research by the schools cost $49 million, of which $39 million came from the Government, the report said.

Cable-Insulation Tests Use Radioisotopes

Radioisotopes are now helping to test cable insulation over a continuous period.

In a new device, developed by Britain's Atomic Energy Authority, radiation from two isotope sources is split by lead blocks into two slightly divergent pairs of thin beams. These form a frame of radiation around the conducting wire. As long as the wire remains in the middle of the frame while the cable moves through the device,

the intensity of the four beams emerging from the cable will remain the same, since they will be passing through appreciably equal thicknesses of the same material.

However, if there is a thin spot in the covering material or if the wire core moves to one side, one of the two beams will be affected since the metal will have a different degree of absorption of the radiation.

Detectors employed to pick up the emergent beams indicate this change in intensity and can be linked to show on which side the thinning lies.

Army Forming New R&D Div. At Redstone Arsenal

A Research and Development Div. has been set up by the Army Ballistic Missile Agency at Redstone Arsenal, Huntsville, Ala., replacing the Development Operations Div. which will be transferred July 1 to the National Aeronautics and Space Administration.

A total of $216,328,000 will be budgeted to the new division in fiscal year 1961, primarily for tactical missile systems. Key positions in the new unit are now being filled and a manning level of about 1,000 is expected to be reached by July 1, the Army says.

Field IR Scanner Will Catch Mice

Thermograph T-2 is the Army's designation for this mobile infrared scanner developed by the Engineer Research and Development Laboratories and shown here at Hunter Liggett Military Reservation, Calif., where it is being evaluated by the Army's Combat Development Experimentation Center. Sensitivity is claimed to be good enough to spot a mouse.

NEWS BRIEFS

ELECTRONIC COMPUTER EQUIPMENT, bound for the Lawrence Radiation Laboratory in Livermore, Calif., is being transported by special moving vans from the Remington Rand Univac Division plant in N. Philadelphia. The vans contain the $5 million Univac Larc computer.

1105 DIGITAL COMPUTER has been put to work helping industry select new locations for plants and improve efficiency of distribution systems. This is a result of the development of new techniques in the location-allocation field by Armour Research Foundation of the Illinois Institute of Technology.

THE AIR FORCE BALLISTIC MISSILE CENTER awarded the Ford Motor Co.'s Aeronutronic Division at Newport Beach, Calif., a $2,676,000 contract for system and test work on the high-altitude rocket-space program called Hyper-Environmental Test System 609A.

A NEW ELECTRONICS FACILITY of Sparton Corp., Jackson, Mich., is scheduled for completion by about December 1. The facility, to be located in the South-West, will cost $1 million.

AN ELECTRONIC COMPUTER, the GE-210, will be installed in the Marine Trust Co. of Western N.Y. in Buffalo. General Electric's Computer Dept. expects the system to be installed by October, 1960.

HIRING OF SKILLED WATCH MAKERS is becoming a desperate must for the nation's instrument makers, according to Dorothy Vogel, vice-president and general manager of Colvin Laboratories, Inc., East Orange, N.J. "The watchmaking industry is the proving grounds for sorely needed, highly skilled instrument personnel," she said.

A NEW HEARING-AID DESIGN developed by Telex, Inc., St. Paul, Minn., for eyeglass-mounted sets, eliminates connections between the eyeglass bow and earpiece. The bow-mounted detector and amplifier detects sound, and operating as an oscillator, transmits an amplified 200-mc carrier at 1 mw, a distance of less than 1/2 in. to a receiver coil in the earpiece. Two subminiature cells power the device, which uses one transistor in the oscillator and five in the receiver.

TRAVELING-WAVE TUBE type RCA-6861 has completed a life-span of more than 19,200 hours of continuous service in the surveillance-radar equipment of Switzerland's Zurich Airport, reports Radio Corp. of America.

ENVIRONMENTAL TEST LABORATORY simulating space conditions at altitudes up to million ft and at temperatures from minus 100 F to plus 200 F is under construction by Fairchild Camera and Instrument Corp., Syosset, L.I. Additional equipment will be used to gage equipment reaction to heat, rain, salt spray, vibration and G forces.

AN AIRBORNE RECORDER-COMPUTER EQUIPMENT for anti-submarine warfare will be made by Packard Bell Electronics Corp. of Los Angeles, Calif., under a $600,000 contract awarded by the Navy Bureau of Weapons.

AN ELECTRONIC COMPUTER for the Mauler air defense system will be developed by the Burroughs Corp. of Detroit, Mich., for the Convair Pomona Division of General Dynamics Corp.

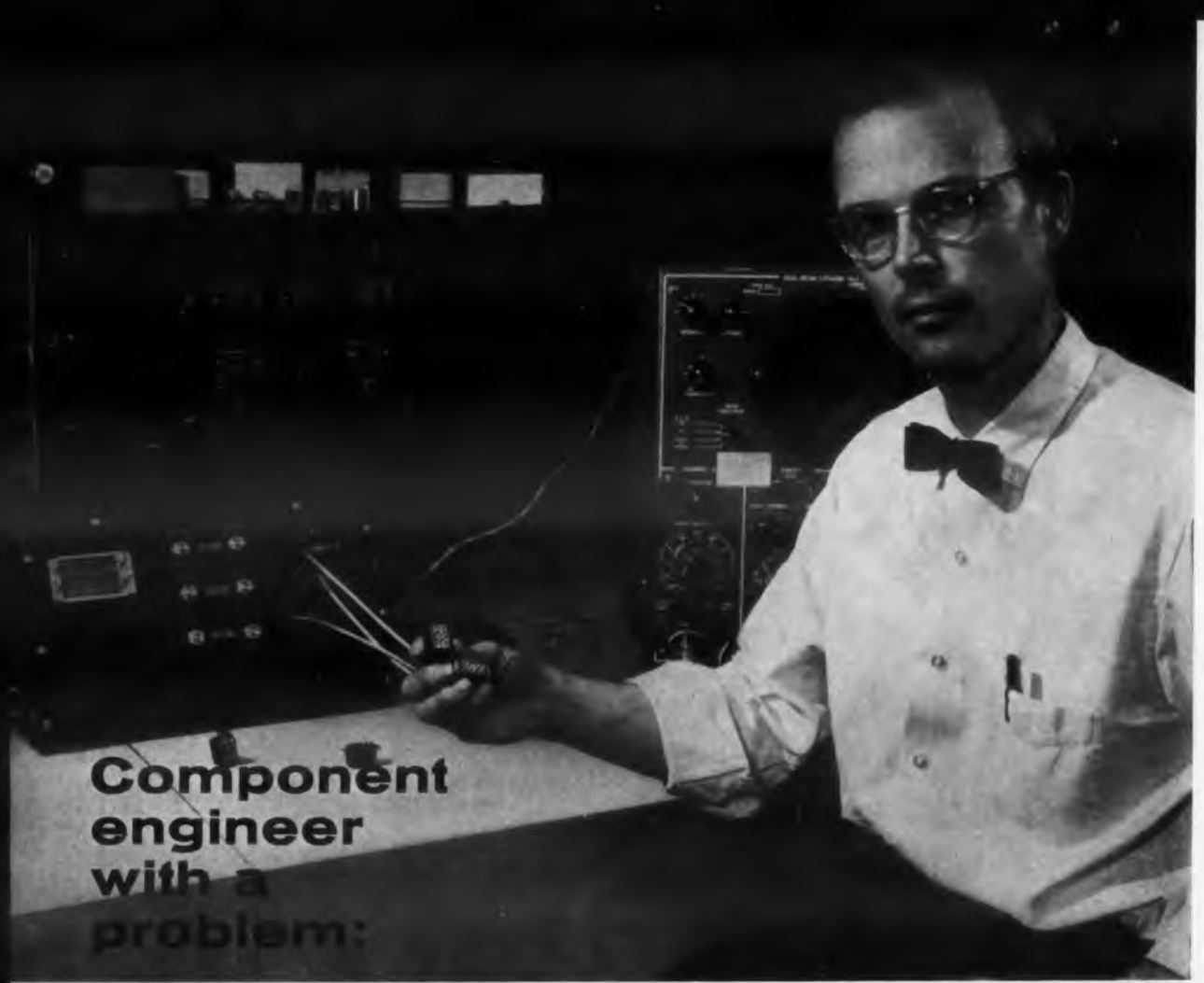
INFRARED DETECTOR COOLING SYSTEMS will be studied by the Garrett Corp's AiResearch Manufacturing Co. of Los Angeles, Calif. The Wright Air Development District awarded the contract.

ELECTRONIC POWER SUPPLY SYSTEMS for Air Route Traffic Control Centers will be made by Kaiser Electronics, Inc. of Union, N.J. under a contract with the Federal Aviation Agency.

RADAR ALTIMETER SYSTEMS for use in the Navy A3J attack aircraft will be made by Emertron, Inc., Silver Spring, Md. Prime contractor North American Aviation Inc. of Columbus, Ohio awarded the contract.

ELECTRONICALLY-CONTROLLED master caution systems for the F-104G Starfighter will be made by Radar Relay, Inc. of Santa Monica, Calif., under a contract awarded by the Lockheed Aircraft Corp.

A NEW ELECTRONIC SYSTEMS Division has been created by Mechanical Products, Inc. of Jackson, Mich., as part of its expansion program. The company recently announced its entry into the electronics field.



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EDITORIAL

The PGMTT "Retreat"

The 1960 meeting of the Professional Group on Microwave Theory and Techniques might have been like any one of the other several hundred technical meetings held each year. But from the start this one was different. A conference at a resort hotel is not unusual but PGMTT people picked one farthest from the reaches of the microwave center.

The PGMTT conference was not planned as a vacation, nor did it turn out to be one. From all reports, it was among the most successful symposia ever held under the auspices of the IRE. The conduct of the meeting definitely shattered some old myths about the narrow bandwidth and information-handling capabilities of the human being. Information passed steadily soon after 8 in the morning until midnight. Whenever the neuron activity rose too high or existed for too long a duration, signal sources were shut down temporarily and nerve conductors were cooled by a dip in the ocean. Buffer storages were cleared by a quick inhalation of sea breeze. Within a few minutes the flow of information would continue.

The quality of the information was high. The best papers of the year, in this field, were programed for this convention.

If one calculated the figure of merit of the convention as the dividend of information received over miles traveled, even the Boston visitors fared well. Cost of travel proved no barrier as attendance at the southwestern tip of the United States was as high as if the conference were held in the center of the microwave industry.

The convention did not try to be all things to all people. All papers focused on only a few themes. There were no commercial exhibits so the noise level of all communications was exceptionally low.

One thinks of a religious retreat as a place where one can withdraw from worldly tensions to study and think in quiet. In many respects the 1960 PGMTT conference was such a retreat. The conference committee is to be congratulated.

James C. Kyhos

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Write for complete property values on these eleven materials, and let us know what your particular problem is. If you wish samples and price information, drop us a note on your letterhead. National Vulcanized Fibre Co., Dept. D-6, Wilmington 99, Delaware.

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XXXP-475	Paper	Phenolic	<1-1½
GP-9202	Glass Mat	Polyester	<1
GP-9204	Glass Mat	Polyester	<1
G-5-813	Glass Cloth	Melamine	<1
G-7-832	Glass Cloth	Silicone	<1
GH-871	Glass Cloth	Phenolic	<1
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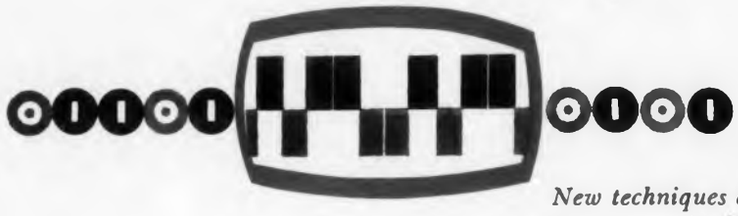
digital communications



New techniques enable man to digitalize his voice for communication with other men, or even with machines. Some day digital systems will be so refined that the machines will be communicating with one another.

IN AN ERA of ever-growing, ever-more-promising electronic developments, digital techniques are offering exciting challenges to the designer of communications equipment. With digital systems, great stores of information can be transmitted speedily and accurately. The human voice can be converted for communication not only with humans but with machines. With more and more refinements in digital methods, engineers are looking forward with confidence to the day when machines will be communicating with one another.

But what of today? What specifically is the present state of the art? How are designers thinking? What are some of the major problems still to be solved?

Advantages and Disadvantages

Most engineers are agreed that the advantages of digital techniques in communications systems include:

- Ability to eliminate noise and distortion at each repeater.
- Ability to use poor-quality bandwidth.
- Greater accuracy than analog systems.
- Ability to use error-detection and correction codes.

The disadvantages:

- Fairly complex equipment.
- Limited transmission speed.
- Need for increased bandwidth.
- Need to quantize analog signal.
- Possibility of quantizing noise.

These factors make up some of the elementary knowledge now available to the design engineer seeking to improve communications systems. What lies ahead?

Experts are quite emphatic about at least one area that needs further investigation. That is the medium-frequency (3-30 mc) band. Very little research has attempted to understand propagation characteristics in this band. Equipment designers, some experts contend, do not know enough about, and fail to appreciate, the characteristics of the propagated signal, especially in the transmission of digital data. Fading, for example, is not recognized as it should be. Selective fading has been utilized to gain greater diversity.

Engineers have a long way to go, many communications specialists believe, to make present digital systems work better.

Most experimental data, have been based on experience. Engineers have had, they say, such experience over many years in the medium frequencies, but it has yielded hit-and-miss data. Relatively little formal research effort has been expended. Thus the background data available to today's equipment designers has a patchwork quality.

Another area that needs study is that of modulation techniques. One expert believes that improvements here could result in a 10-db improvement in transmitter performance.

Still further areas in need of research include:

- Antenna design.
- Diversity reception.
- Frequency selection.
- Filtering.
- Reduction of bandwidth
- Coding.
- Receiving and demodulation techniques.

Industry has started to demand more precise reliability from communication systems. Existing knowledge of transmission channels is inadequate. "Blind-fold engineering" cannot provide the answers, the experts say, and a sound, coordinated program of evaluation and research is urgently needed.

As industry leaders become more aware of the advantages of digital systems, they will demand more efficient, less complex and less costly equipment. New system circuits, such as ties between computers, will be required.

How will engineers meet these challenges? In what areas should they be working? Experts have some very definite answers to these questions.

Solid-state devices now permit the design of smaller, more efficient equipment. New circuit designs are possible, utilizing some of the new diodes and transistors. These devices especially are opening the way to high-speed operation at much higher frequencies with equipment that costs less.

An important consideration in the design of a system is the means of transmission—that is, wire or radio. Two basic design problems involved in digital transmission over wire are distortion and impulse noise (see article on p 58, this issue).

Many Systems in Use Today

As to techniques, many digital systems are in use today. Pulse duration modulation (PDM) or pulse width modulation (PWM) are commonly used. Pulse amplitude modulation (PAM), delta modulation and pulse code modulation (PCM) are other methods of digital data transmission. Frequency modulation is also used in digital systems, especially for telemetering. In the case of amplitude modulation systems, a tone-modulated carrier is used.

Each of these systems has its own advantage. For example, though fm equipment costs more than am, it will operate satisfactorily through up to 10 db more noise than am. Am frequency stability is superior to fm, but fm is unaffected by all but extreme level variations.

Most of the top communications experts feel that PCM offers the greatest possibilities for future exploitation. With it, the information is carried in a form of a pulse code. PCM, according to studies, is nearly ideal as a means of transmitting information.

The article on p 52 in this issue, the first of three parts, takes up in detail the design aspects of PCM. ■ ■

Pulse Code Modulation Terminal and Repeater Methods

Part 1

R. L. Carbrey
Bell Telephone Labs., Inc.
Murray Hill, N.J.

Of all of the digital transmission methods known today, pulse code modulation seems to offer the most promise for future applications. It is so worthy of detailed investigation that Bob Carbrey (photo below) has prepared this article dealing with PCM in depth. This first of a three-part series includes a discussion of sampling, time separation multiplex and binary code representation. Coding and timing will be covered in subsequent parts.

"Signals ranging from slow telemetering data to broadband multiplex and video have been reduced to a common denominator of simple pulses and spaces by Pulse Code Modulation techniques. We appear to be at the beginning of an era of widespread application of digital coding, transmission, and switching to almost all phases of communication. Applications for transmission circuit capacities from a few bits per second to several hundred megabits per second are already apparent, and path lengths should stretch as far as man is willing to send the appropriate hardware on earth and into space."

OF ALL THE pulse modulation systems, those employing digital techniques* appear to offer the greatest advantage over the more conventional analog and carrier signal processing and transmission methods. The reason is that signals can be regenerated. Noise, crosstalk and distortion effects on the transmission line can be nearly eliminated. (*This discussion will be confined to binary signals although higher order signals can be used.)

When information signals such as voice or television are transmitted in continuous (analog) form, there is no way of separating band noise, distortion, and crosstalk from the signal. When the signal reaches a repeating amplifier, the best it can do is to reproduce precisely an amplified version of the signal and noise which appeared at its input. Therefore, the noise and crosstalk which is picked up in any link is added to that of all the other links. In addition the distortion in all of the amplifiers can be cumulative.

The art of designing negative feedback amplifiers has been developed to such a high state that even with a thousand repeaters in tandem (such as in a transcontinental transmission system) this distortion can be kept to the order of 40 to 50 db below the signal. But the repeaters must be both expensive and complex, and they cannot eliminate unwanted disurbances.

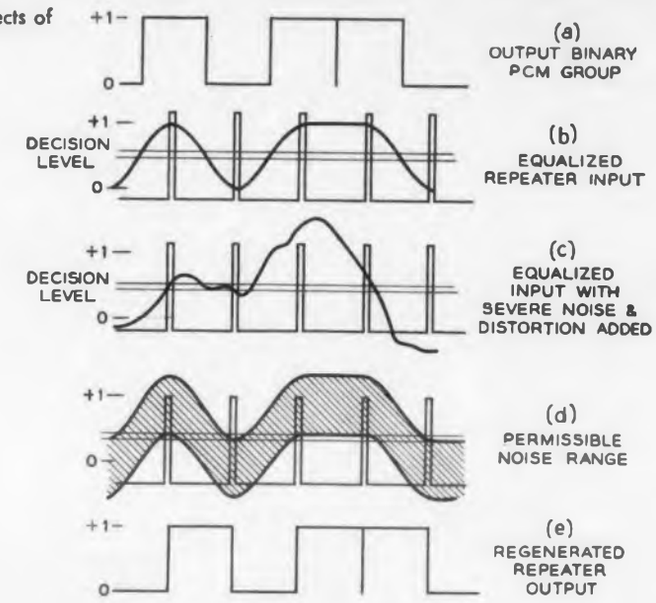
Analog-to-Binary Conversion

When analog signals are converted to binary signals, they are transmitted as simple pulses or spaces of known shape, amplitude, and spacing, as shown in Fig. 1. Either a pulse or a space must appear in each of the time slots. Repeaters for this type of signal are not designed to reproduce the wave forms which arrive at their input. Instead they are designed to regenerate the signals. That is, they make a completely fresh set of new pulses and spaces at the output of each repeater to pass on to the next repeater. To do this a simple "yes or no" decision has to be made once in each time interval.

A signal sequence which started out as shown in Fig. 1a might appear at the input to a repeater decision circuit as shown in Fig. 1b. The pulses are assumed to be band limited, but no other noise or distortion is indicated. Whenever the signal exceeds the double horizontal line at the half amplitude level, it can be assumed that a pulse is present. Whenever the received signal amplitude is below this double-barred line it can be assumed that a space is present. A doubled barred line is shown because decision circuits do have a finite region in which they cannot decide on a "yes or no" and come out with a "maybe." The narrower this "maybe" region the better the regenerative repeater.

Amplitude regeneration is only half the story, however. Regeneration in time is also provided. This is indicated by the narrow gating pulse

Fig. 1. Input of a coded sequence to a repeater, effects of noise and distortion, and the regenerated output.



Although the first electrical communications systems were pure pulse systems and early multiple channel transmission was accomplished by switching in one channel after another onto a common transmission path[1], pulse modulation and time separation multiplex methods did not receive any real impetus until World War II. Carrier frequency multiplex using filter separation techniques had proven to be easier to develop because the bandwidth requirements could be met by adding one channel at a time to the basic single channel capacity requirements. Pulse systems, on the other hand, are basically wideband systems, and it was not until pulse techniques were developed for radar and fire control computors that a substantial amount of serious consideration was given to pulse modulation methods.

Contributing to the impetus for this development is the search for less expensive terminals, the use of new transmission media and extension of the old into ranges where a "rugged" circuit is required, and the possibilities digital circuits offer for cryptography.

occurring at the center of each time slot. Retiming restricts the final decision to only those signal levels occurring during the gating pulse and assures that the pulses will maintain their original separation. A pulse will be produced only when the signal is above half amplitude at the time the gate is passing signals. The significance of this is indicated in Fig. 1c where the same received signals are shown as they might appear with a severe interfering signal added to them.

Regeneration Reduces Noise and Interference Effects

Although the first pulse is depressed by almost half the normal base-to-peak pulse amplitude, it still exceeds the amplitude threshold during the timing interval, so a fresh new pulse will be generated as shown in Fig. 1e. The space in the second time slot will also be regenerated correctly in spite of the high level interfering signal. When the interference adds to the pulse magnitude or further decreases the space magnitude, as shown in the third and fifth slots, a correct decision is obviously easy to make.

In the limit, with an ideal amplitude regenerator and an infinitely narrow timing interval, the peak impulse noise and distortion can be half the peak-to-peak signal magnitude. Although such ideal characteristics are difficult to obtain, practical repeaters have been designed which operate within 1 db of the theoretical 6-db signal-to-impulse noise margin. Operating this close to the margin is not good practice, however. When an interfering signal is ac in character, the peak-to-peak interference can approach the peak-to-peak amplitude of the signal. See cross-hatched section of Fig. 1d.

Because a new set of signals is developed at the output of each repeater, it is only necessary to design the circuits to be able to get the signal from one repeater to the next. The signal degradation need not be cumulative. When the repeaters are not perfect, only partial regeneration occurs, and some small part of the input disturbance may be passed on. Following regenerators will wipe out this small residue so that the effective regeneration is complete. Precise recovery of the control timing wave from information transmitted over the circuits is difficult with simple circuits so that timing disturbance may accumulate. When many repeaters are connected in tandem, this will not interfere with the correct regeneration of the individual bits of information at each repeater. It may be necessary, however, to use special timing clean-up at the final terminal. Although most of the emphasis on PCM has been concerned with multiple repeater circuits, it should be pointed out that there are many applications where direct transmission from the coder to a repeater at the decoder will permit transmission where noise would completely mask analog signals.

This marked improvement in protection against disturbances is not obtained without cost. A much greater bandwidth is required to transmit the information signal in binary form, and an inherent distortion called quantizing noise is produced. This latter is due to the transmission of a finite number of signal amplitudes. These will be discussed under the sections on repeaters and coders.

There are eight basic phases to digital voice frequency communications. They are: sampling, time separation multiplexing, coding, transmission via regenerative repeaters, decoding, synchronization, demultiplexing and filtering. Most of the discussion will be concerned with the first four.

Sampling

A rigorous discussion of sampling and the sampling principle is given by Black[2]. Loosely stated, the sampling theorem says that uniformly spaced short samples of the instantaneous amplitude of a continuous signal wave, taken at a rate slightly higher than twice the highest signal frequency, contain all of the information in the continuous signal. The information may be recovered by passing the samples through an appropriate low-pass filter with a cut-off equal to half the sampling frequency. If the samples are not infinitely narrow, a modest aperture effect correction must be made by inserting an equalizer in the output which gradually reduces the loss as the upper edge of the signal band is approached.

For normal telephone speech in which the maximum frequency is limited to about 3600

cps, a sampling rate of 8000 cps is used. A sample of the signal magnitude is, therefore, taken every 125 μsec, as represented in Fig. 2. A pulse generator closes an electronic switch for a few microseconds every 125 μsec and thus gates a short sample of the signal magnitude through to the output load resistor. When the switch is open, no current can flow so the output remains at ground potential. Note that the information content of the signal is maintained, although there may be appreciable power loss because the signal is present for only a small fraction of the time.

This sampling process is really nothing more than double-sideband modulation except that a pulse with a substantial number of harmonics of the sampling frequency is used instead of a sine wave carrier. Usually, too, the carrier frequency is many times higher than the signal frequency while here the fundamental sampling frequency is just slightly greater than twice the maximum signal frequency. An arbitrary frequency spectrum showing the upper and lower sidebands about zero frequency and the first three harmonics of the sampling frequency is shown in Fig. 3. The signal recovery filter is usually arranged to pass the band from zero to half the sampling frequency thus passing the baseband signal and avoiding the lower sideband of the fundamental sampling frequency.

The signal could be recovered by filtering off any double sideband pair and using conventional double sideband detection. Similarly the input information can be recovered from the sampled signal when the input frequency band is less than half the sampling frequency wide but displaced to one of the sampling frequency harmonics.

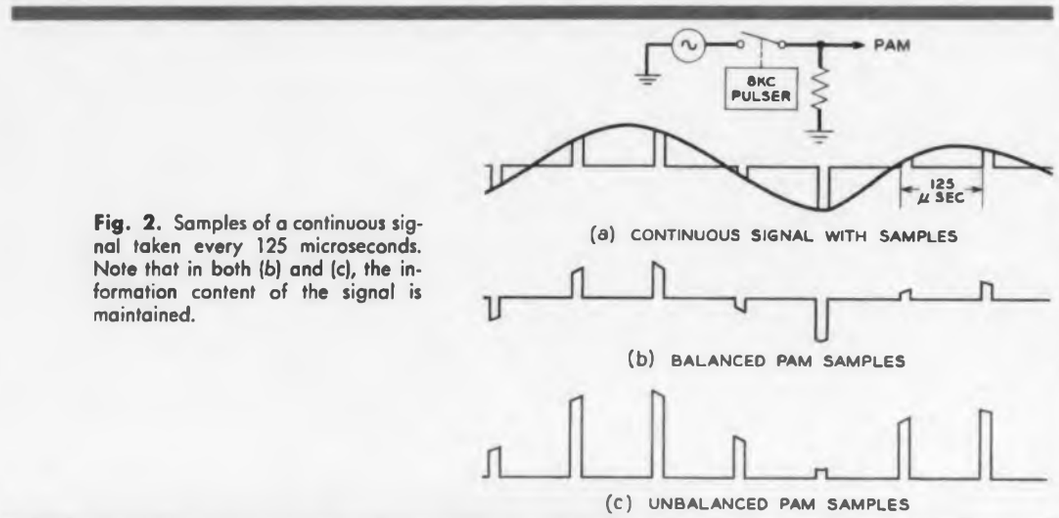


Fig. 2. Samples of a continuous signal taken every 125 microseconds. Note that in both (b) and (c), the information content of the signal is maintained.

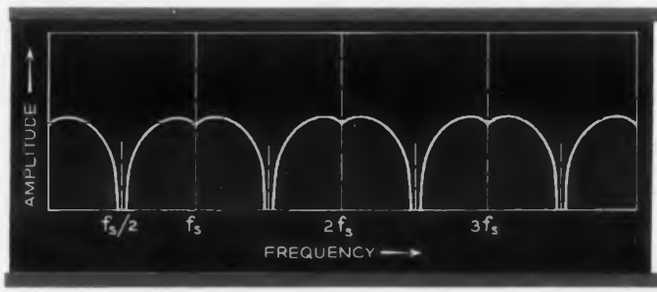


Fig. 3. Upper and lower side bands and first three harmonics of the sampling frequency.

Time Separation Multiplex

The amplitude-modulated pulses from a single channel could be converted to pulse code modulation. However, it is usually desirable to multiplex a number of channels together, so one high-speed coder can be used for a number of channels. This multiplexing operation is done by systematically connecting one after another of the input signals to the common load during the idle time between samples of the first channel.

This is illustrated in Fig. 4 where the input and output switching circuits are represented by synchronous commutators. For speech, the electronic commutators are revolving around 8000 rps. The resulting sequence of PAM samples is shown in Fig. 4b. At the common load point, the individual channels can be identified only by knowing the particular time at which they appear. These input signals are thus multiplexed onto a common circuit by separating or dividing the total time up into individual time slots. Hence the terms Time Separation Multiplex (TSM) or Time Division Multiplex (TDM). The signals occupy discrete time intervals, the frequency spectra of the pulses all overlap. Frequency separation multiplex signals, on the other hand, occupy discrete frequency bands while they overlap in time.

In order to properly recover the TSM signals which ultimately appear at the output of the decoder in the same sequence, a demultiplexing or distribution commutator must be used which re-

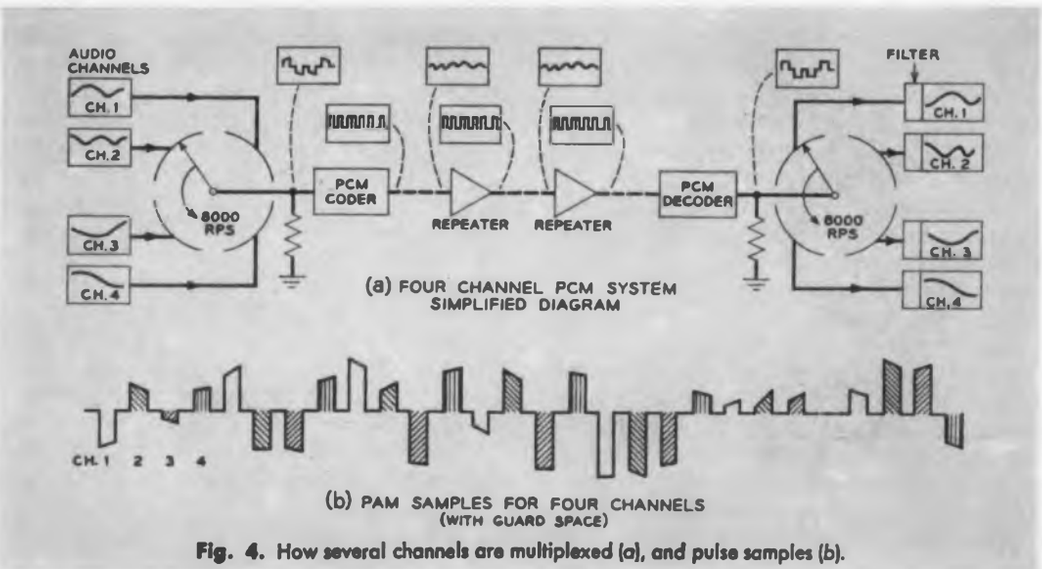


Fig. 4. How several channels are multiplexed (a), and pulse samples (b).

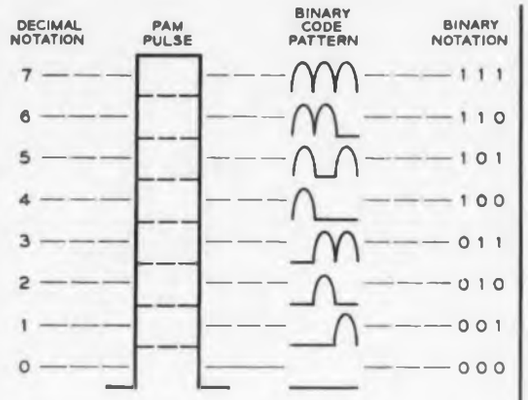


Fig. 5. Binary notations for each of eight signal levels.

volves at the same rate and in the same relative phase as the input commutator.

Although the sampling process converts the continuous signals to short amplitude modulated pulses, the signal is still in analog form because the pulses can have any amplitude within the input signal range. They are subject to all of the disturbances of ordinary analog signals, and in addition the bandwidth must be maintained wide enough to keep the pulses from stretching out to fall in adjacent time slots. Accordingly it is desirable to encode the signals into digital form before transmission or subsequent switching.

Binary Code Representation

The number of possible combinations of signal magnitudes which it is possible to represent with a code of base b and number of digits n is b^n. This discussion will be limited to the representation of the input signals by a simple binary (base 2) code. Each digit can have only one of two states—a unit height pulse which is frequently listed in binary notation as a "1" or a space which is listed as a "0".[3] Binary signals have the greatest margin against disturbance and usually require simpler apparatus than higher order codes.

When $n = 3$, 2^3 or 8 combinations of pulses and spaces are possible. Because only eight combinations are possible, the peak-to-peak amplitude pulse must be quantized into eight discrete ranges, with one code combination representing each, Fig. 5. All signals falling within the range zero to one will be coded as three spaces. Those between one and two will be coded as two spaces followed by a pulse, etc. Although the pulses are all alike, the time or place of their appearance is important. The first pulse represents one-half the peak-to-peak magnitude, the second one-quarter, and the third one-eighth. Three-digit intervals are required for each PAM sample; so 24,000 bits per sec are needed to represent the 8000 PAM sam-

Fig. 6. Television picture transmitted using a three-digit binary code.

Fig. 7. Television picture transmitted using a four-digit binary code. Note the higher picture quality compared to Fig. 6.

ples from each channel. Obviously considerably more bandwidth is required than for the 4 kc speech signal even with three digits which are not sufficient for good quality.

Quantizing Distortion in Speech and Video

It is difficult to describe the effect of quantizing a speech signal to the nearest one of eight discrete levels, but the photograph of Fig. 6 shows what happened to a television picture which was transmitted as a three-digit binary code. Quantizing video displays results in a distortion which is called contouring. In speech it is called quantizing noise and sounds similar to white noise.

Eight levels are obviously not enough for high quality pictures, and it is certainly not enough for high quality speech. Low level sounds may fall entirely within a step and be lost altogether. This latter adds clipping to the quantizing noise. When another digit is added $2^4 = 16$ combinations of pulses and spaces are possible. A four-digit television picture is shown in Fig. 7. One digit can be added at a time until the desired quality is obtained. Each digit reduces the quantizing noise by 6 db.

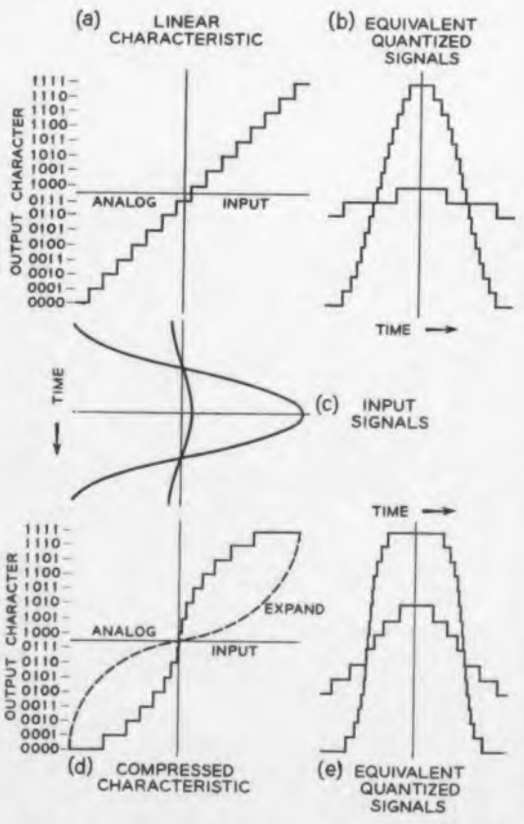


Fig. 8. Comparison of input-output characteristics for a linear four-digit coder and a combination of a compressor and coder.

It is very difficult to distinguish between a television picture which was transmitted as seven digit PCM and an unquantized signal. The intelligibility of speech signals is very good with as few as five digits when the talker speaks at a volume which uses the full range. Even seven digits (S/N ratio of 45 db) are not enough, however, to handle the range of talker volume which must be met in good telephone practice unless some form of speech compression and expansion is employed. An instantaneous "compandor"—contraction of compressor and expandor—is usually used which operates on the individual speech samples so that the weak sounds of even loud talkers benefit.[4,5,6,7]

A comparison of the input-output characteristic for a linear four-digit coder and a combination of a compressor and coder is shown in Fig. 8. The high-level speech sounds are assigned relatively few of the 16 possible code combinations in the compressed characteristic. If the low-level sine-wave used to illustrate a weak sound such as a whisper had been drawn 25 db down on the peak signal instead of 20 db, it would have been lost altogether on the linear characteristic. Although the steps are large at high levels, the signals are so loud that the noise is not heard. Subjective tests have shown that noise is masked when it is at least 26 db below the corresponding signal.

The signals are restored to their original relative levels by an expansion process at the decoder terminal. The expansion characteristic is shown as the broken line of Fig. 8d. Coders and decoders can be built which are self companding, but the most common practice is to use balanced diode circuits in the common PAM busses to provide the desired nonlinear characteristic. Any crosstalk in the PAM signals between the compressor and expandor is effectively reduced by the amount of the companding margin. Compression ratios of 22 to 26 db appear to be desirable for speech with seven digits.

Part 2 of this three-part series will cover methods of coding.

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Digital Data Transmission by Wire

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Digital transmission over wire presents some unique problems. In this article, author Charlie Fisher discusses various phases of operating under these conditions using amplitude modulation techniques.

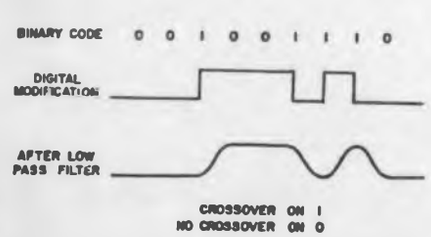


Fig. 1. Effect of passing the digital signal (top) through a low-pass filter.

MUCH HAS been written on information theory that would at first appear to be applicable to the wire transmission problem. Designers soon realize that the anomalies of the medium demand changes in concept to allow maximum utilization of the available bandwidth. The classical approach has been directed toward overcoming the problems encountered in radio transmission (fading and random noise). The problems in wire line transmission are primarily delay distortion and impulse noise.

Statistic properties of impulse noise are such that the types of redundancy used to overcome random noise are not very efficient. It appears more efficient to strive for very high bit rates between noise impulses. Logic can then be built into the terminal equipment to correct errors when they occur.

Delay distortion is a property germane almost only to wire lines. Many early attempts were made to overcome delay distortion, but recent efforts have almost all been toward cancelling it out rather than trying to live with it.

Predistortion

Nyquist has shown that all the essential information in any transmission of binary information is contained in bands of frequency spectrum consisting of 1/2 the bit rate each. That is, all of the necessary information to reconstruct the original signal is contained in a band extending from zero cycles per second to 1/2 the bit rate and the

same information is contained in a band from 1/2 the bit rate to 1 times the bit rate, etc. up the spectrum. Therefore, a transmission system generally can be made more efficient by choosing one of these bands and eliminating all components outside the one band chosen. This can be accomplished by passing the original step function signal through a bandpass filter. This is commonly called predistortion.

In addition to bandwidth limiting filters, there are other types of predistortion which can be applied to the signal to obtain a signal which has characteristics more desirable for transmission on a limited bandwidth. One of these is modifying the signal so that the marking or "yes" conditions correspond to transitions in the signal at the bit rate, and spaces or "no" conditions correspond to lack of transitions in the signal. It is apparent that we have eliminated any consideration of polarity from our received signal. If we are using a transmission medium wherein we transmit only the base band, we can eliminate any difficulties from transpositions of transmission conductors.

It should also be noted that this type of signal modification causes the average signal (even though certain repetitive codes are transmitted) to remain at a level one-half way between the two signalling conditions. An advantage to this may be on lines which have compandors. The saturation level on the compandor would be relatively constant with this type of signal. If we place the restriction on transmitted signal that there be at least one mark every eight bits, this would mean that no more than eight bits could go by without a transition from one level to the other level. If this time is less than the time constant of the compandor, the level at which the compandor stabilizes will remain constant. Fig. 1 shows this type of signal and the result of passing such a signal through a low-pass filter.

Besides transition modification, the binary signal can be shunted by a shorted delay line which will reflect equal and opposite amplitude signal back onto the line one bit length later. This, in essence, causes the signal to always return to zero in the absence of transitions. It does, however, give a trinary signal.

A major advantage of this modification is that the shorted delay line amounts to what is commonly known as a cone filter and gives a great deal of attenuation to the low-frequency components of the transmitted signal. Since the information is carried primarily by the higher frequencies, the lows which have been removed were superfluous and were only adding to the level put on the line without carrying any information. Therefore, by removing these lows, a higher average level of the remaining frequency components can be accommodated and a greater immunity to noise and other interference is obtained. In addition, the absence of the low frequencies may make the design of the modulators and demodulators less stringent. Fig. 2 shows a typical design and response curve for such a shorted delay line.

Modulation

When information is transmitted over commercial telephone facilities which have single sideband carrier equipment, the received or demodulated signal may vary in frequency from the modulated signal. This is due to the absence of phase lock between the modulating oscillator and the demodulating oscillator.

Therefore, it is necessary to transmit information in a manner which is not frequency-translated in going through the various commercial telephone facilities.

The most logical and efficient method of doing this is to use a vestigial sideband type of modulation. It is theoretically possible to transmit the same bandwidth as that of the baseband information with a vestigial sideband system. An additional advantage of the vestigial sideband transmission is that the transmission need not take place at bandwidths which are multiples of the original baseband bandwidth.

Normally, the amount of modulation which can be applied to a vestigial sideband transmission is limited by the quadrature distortion which occurs in the envelope detection normally used. However, it may be well to limit the per cent modulation on transmissions so that the level of signal as seen by compandors on the circuit may stay more nearly constant. Fig. 3 illustrates the typical arrangement of a vestigial sideband data transmitter.

Delay Equalization

Equipment is on the market which allows an adjustable degree of delay equalization and the techniques for achieving the optimum adjustment are quite simple and straightforward. Generally, delay correction can best be done at the subcarrier frequencies rather than at the baseband frequency. This eliminates any frequency shift which could occur in a baseband frequency due to the translation effects of the common carrier's single sideband equipment. Filters therefore have been designed which have a constant differential phase delay.

Demodulation

Use of vestigial sideband in transmission was to achieve a method of eliminating the frequency translation effect. This can generally be done only by using ordinary envelope detection. More sophisticated means of detection such as multipliers do not have the reference frequency readily available at the receiver.

Using a vestigial sideband signal, and demodulating it with envelope detection, a quadrature effect will be noticed. This gives rise to distortion. Since the signal is essentially a binary signal, the distortion in some cases will present itself only as a lack of symmetry above and below a central axis and, therefore, certain detectors can be used to detect the signal without being adversely affected by this lack of axis symmetry.

Digital Detector

A simple cross-over detector is the most straightforward. In many cases it is the most reliable detector of the baseband information. In fact, if there is no phase distortion at all present, the cross-over detector will give the least amount of time jitter of any type detector. Regardless of amplitude distortions, assuming no change in relative phase position between the components of the original signal, all frequencies have zero tran-

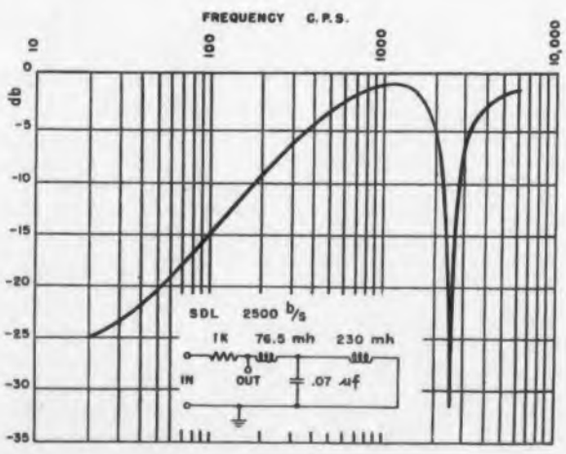


Fig. 2. Typical response curve for a shorted delay line for 2500 bits per sec.

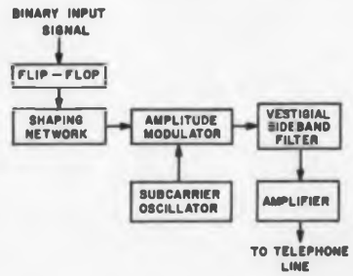


Fig. 3. Vestigial sideband data transmitter.

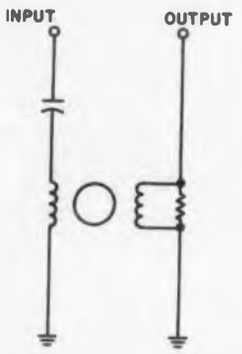
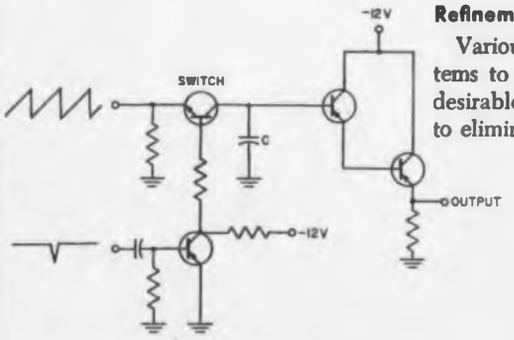


Fig. 4. Magnetic core detector using a magnetic square hysterisis loop core.

Fig. 5 (Below) Circuit for automatic frequency control from the received cross-over.



sitions at equal time intervals which are in turn equal to the bit rate.

It is not entirely feasible to eliminate all delay distortion. More sophisticated detectors can be used to detect transitions in the baseband information. One such type detector makes use of a magnetic square hysteresis loop core as shown in Fig. 4. This type of detector is capable of less distortion in the presence of nonlinear phase delay than is the simple cross-over detector. It may also eliminate some of the errors that the simple cross-over detectors might give in the presence of impulse or a high level of white noise.

Timing

Because of the time jitter added to the signal due to uncompensated differential phase delay, it is generally expected that the receiver will have an automatic frequency control circuit which is tracking the transmitter. In order to get into synchronism, this automatic frequency control should be very rapidly correcting at the original seizure of the receiver and, once it is recognized that the receiver is in synchronism with the transmitter, then the corrective factor per bit should be reduced to give the equivalent of a large flywheel on the receiver clock.

A typical circuit for gaining automatic frequency control from the received cross-over (even though there may not be a cross-over present at each cycle of the receiver clock) is shown in Fig. 5. For commercial applications, parity bits can usually be depended upon to furnish the sync pulse every so-many-bits of information. These will be of sufficient regularity to keep the receiver in synchronism with the transmitter. In the cases where even parity is used, this can be converted to odd parity for the purposes of transmission, and reconverted simply to even parity at the receiver or an inversion of the original signal can be used which is, of course, reinverted at the receiver; thus, giving the equivalent of odd parity.

Refinements

Various refinements can be added to these systems to increase their reliability, speed or other desirable parameters. One of these refinements is to eliminate some of the granulation effect in the

envelope detector at the receiver by using a frequency translation in the received signal and translating it from its relatively low frequency at approximately 2500 cps to a frequency which is one or more magnitudes above the bit rates and envelope-detect this. This eliminates some inherent noise problems as well as the slight granulation effect that is present with the lower frequency demodulation.

The use of phase coherence between the bit rate and the subcarrier frequency may achieve an increased operational efficiency in the equipment. In general, there has been little variation noticed as the vestigial sideband carrier frequency is swept through various frequencies relative to the bit rate frequency.

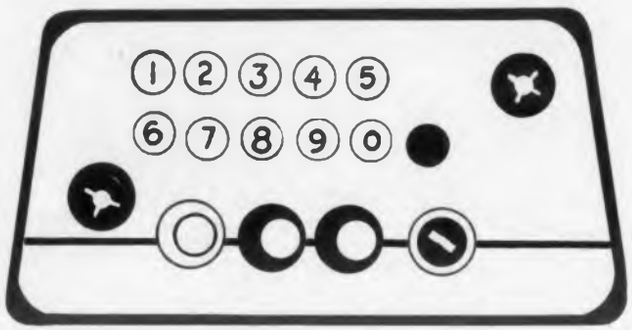
Unfortunately, use of the lower sideband for vestigial sideband type of modulation gives a distribution of frequencies which is exactly converse to the distribution the common carriers would like to see applied to their lines. The interference effect of frequencies is greater at higher frequencies, and the vestigial sideband type of modulation gives the highest amplitudes at lower frequencies on the line.

If by the use of frequency translation the upper sideband of vestigial sideband transmission was derived and translated down to a frequency band within the baseband, it might be possible to have the frequency distribution be more nearly the distribution which the common carriers desire.

Homodyne Detection

One other possible improvement is the use of homodyne detection. By careful filter design and other rather complicated techniques it should be possible to derive a pilot signal on the transmission which is not used for envelope detection but is filtered out at the receiver. Then the pilot signal is amplified and reapplied into a multiplier type detector so that single sideband system could be essentially applied. This, at most, would gain a 2 to 1 ratio of the amount of energy being transmitted. This is insignificant in view of the increased cost of the homodyne detection. In addition, this type of signal would be more susceptible to changes in level added by compandors because the compandor would not be running in nearly a constant saturation value as in the 50 per cent modulation vestigial sideband case.

The area which has received the least amount of attention is the digital detector. Much more sophisticated correlation techniques could be applied to the digital detector to reconstruct the signal. By correlating such factors as amplitude, rise time, zero crossing and other parameters of the received signal, it may be possible to derive much more information than is now derived from our somewhat fundamental detectors of both cross-over and magnetic core types. ■ ■



Part 1

Digital Techniques in Industrial Radio Communications

Newly developed design techniques and solid-state components have resulted in new highs in reliability and efficiency in lower-cost digital systems. This article discusses some of the general concepts of industrial digital systems and describes some current practices.

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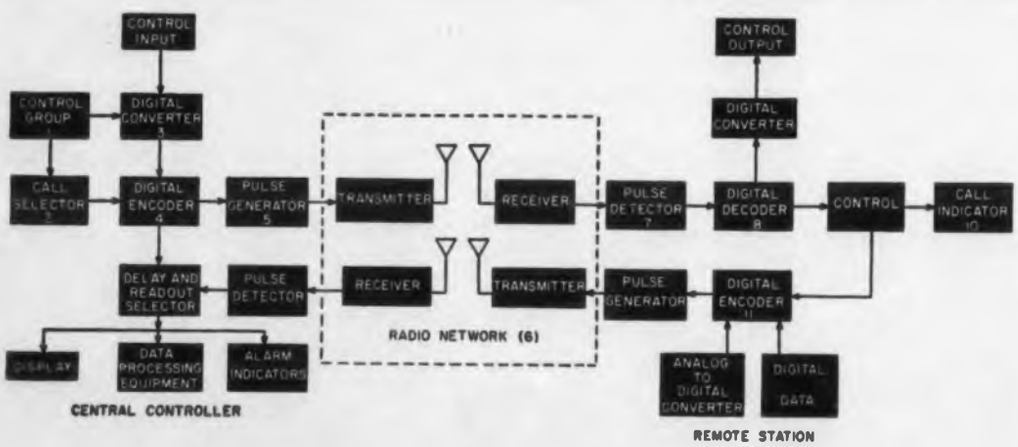

Fig. 1. Block diagram of a typical radio digital communications system.

DIGITAL communication refers to the transmission and processing of numerical information described by a set of discrete electrical signals capable of being transmitted over a radio communication system. On this basis digital communication encompasses the implementation of a number of radio system functions which include:

- Selection of an individual station or group of stations which comprise the total system
- Remote control
- Alarm and status reporting
- Data gathering
- Digital data transmission

All radio digital communication systems which provide the preceding functions can be described by a set of generic equipment building blocks. In practice these building blocks will vary in physical implementation from system to system.

However, in each case, the same basic system function will be provided. The major building elements are:

- Pulse generator
- Pulse detector
- Digital encoder
- Digital decoder
- Control
- Call selector
- Call indicator
- Digital converter
- Analog to digital converter
- Display and indicators
- Terminal processing equipment

The system incorporates all of these system functions and is shown graphically in Fig. 1. The system represented is a two-way system in which a central controller collects and processes data from a large number of remote installations and provides supervisory control.

In tracing the signal flow from the central controller to the remote installation (left to right in Fig. 1), we first encounter the block labeled Control Group (1). It governs the sequence of operations at each station, exercising some degree of control on each of the other blocks. For example, one of its functions might be to control the sequence of operation so that a specific call number is transmitted followed in order by a specific supervisory control instruction. In doing so the control group (1) would first initiate the readout of the call selector (2) containing the desired call number, and then the readout of the digital converter (3) which might in this example contain the supervisory control instruction, into the digital encoder (4) for subsequent transmission to the remote installation.

The specific purpose of the digital converter (3) is to transform digital signals from one coded form to another. At the central controller station in Fig. 1, it converts a supervisory control input to a common code for insertion into the encoder (4). For example, a number provided in a teletype baud-dot code might be converted to a straight binary code.

Encoder Operation

The purpose of the digital encoder (4) is to arrange its various digital inputs into the proper order and time sequence for input into the pulse generator for subsequent transmission. For example, the output of the encoder (4) might consist of a serial train of pulses, which denotes the address of the recipient remote stations, followed by another train of pulses corresponding to a supervisory control instruction. At a responding remote installation the encoder output (11) might correspond to the address of the responding station or information corresponding to a measured quantity. The inputs to the encoder (4) may come

from different sources.

As noted earlier, an input might be provided by a digital converter. An input may be provided by an analog-to-digital converter (3) which transforms a measured quantity whose output is in analog form, that is, voltage or current into a suitable digital form. Another input may be provided by a set of contact closures which represent the conditions of functions being monitored, or the output of a call selector (2) which sets up the address of a remote unit to be called.

The pulse generator (5) develops the audio modulation signals which correspond to digital signal inputs, normally in binary form, for transmission over the radio link. The outputs of the pulse generator (5) may be in various forms since digital information can be transmitted in a number of ways by using the available signal properties. For example, digital information can be transmitted by utilizing discrete frequencies, phase relations and signal waveshapes, each denoting a different digit. The digits which are associated with a given variable may be transmitted simultaneously or sequentially.

Transmission Method

The particular form of transmission used will depend to a large extent upon the application and the communication facilities employed. Such factors as the phase and amplitude characteristics of the equipment, the available bandwidth, the transmitted signal power, the characteristics of the propagation medium, the coding techniques employed, and the degree of transmission reliability required will be important in the selection of the modulation techniques.

The hub of the system is the radio communications network (6) which interconnects the central and remote installations. In most industrial applications, the radio network consists of vhm-fm equipment operation in the 30-, 150-, 450-, and 900-mc bands or microwave equipment operating in the 6000-mc band. Although the microwave equipment is capable of handling wideband signals, the band is normally multiplied into a number of 3-kc channels. The usual vhf-fm audio channel is nominally 2700 cps wide, with a low-frequency cut-off at 300 cps and a high-frequency cut-off at 3000 cps, and has usually been designed specifically for the speech transmission.

The output of the receiver is coupled into a pulse detector (7) which recovers and retimes the digital signals from the audio modulation signals

Fig. 3. One type of a pushbutton control head that is now in mobile service.

transmitted, and provides outputs which are in the correct form for future processing.

The digital decoder (8) receives the output of the pulse detector (7). It may be used to store the digital signals for further processing, or to process the received digital signals to initiate the required control action. For example, if the signal corresponds to the address of the receiving station, the decoder would activate the call indicator (10), which would indicate that the station has been selectively called.

Typical Industrial Systems

First, a one-way mobile selective calling system will be examined, Fig. 2. In terms of elementary building blocks, such a system, at the transmitting end, would consist of a call selector, by which the address of the unit to be called is chosen and a digital encoder which converts this output into a digital form for activation of the pulse generator. The receiver equipment would consist of the pulse detector which converts the received signal to a suitable digital form. This in turn is fed into the digital decoder which, upon recognition of the correct address, alerts the call indicator.

The system under discussion is characterized by the simplicity of the coding and modulation techniques employed and its compatibility with standard telephone signalling practices. Selection of a particular number is accomplished by means of a standard telephone dial. The address is generated by dialing five digits. The sum of digits will normally add up to a prescribed total, say 23 or 25, to permit error checking in the remote selector. Under these conditions the selector is capable of

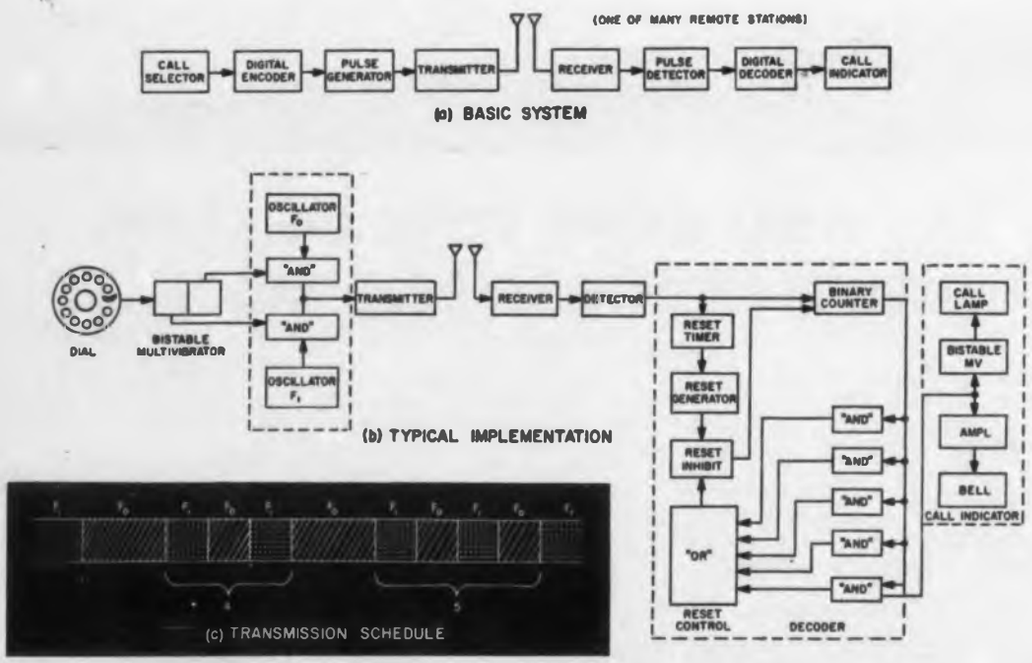

Fig. 2. Basic one-way mobile selective calling system (a), detailed block diagram of the vital components (b), and (c) a typical transmission schedule.

recognizing 18,000 compatible codes. With an expansion of the number of digits this number can easily be increased to over 100,000.

The output of the dial, as each digit is dialed, is a group of pulses at about a 10-pps rate. The number of pulses in the group is equal to the digit dialed. The digit "1" is reserved as a system cleared symbol and therefore is not available as an address digit.

These pulses are translated into a frequency shift-keyed signal by the pulse generator. A pulse is defined as a transition from one frequency to another. In practice the signal frequencies employed are 600 cps and 1500 cps. The essential elements of the pulse generator are a bistable multivibrator, which changes state with the receipt of each dial pulse; two oscillators, which generate the signal frequencies; and two "AND" gates, which select one of the two signal frequencies depending upon the state of the bistable.

A typical transmission schedule is shown in Fig. 2c. Note that the first portion of the signal corresponds to a single pulse, preceded and followed by a continuous tone of at least 0.5 sec. This fact is used to sense the completion of each digit.

The pulse detector consists of two resonant circuits, whose outputs are differentially summed and fed to a level sensitive bistable, to reproduce the train of transmitted pulses. These pulses are fed into a decoder consisting of a five-stage binary counter and a decoding matrix which has five outputs. The decoding matrix configuration is such that each output is energized when the counter contains a sub-total which is equal to a sub-total of digits comprising the call number. For example, if the call number of the selector is 45365, the decoding matrix will be arranged so as to provide an output when the binary counter contains the sub-totals, 4, 9, 12, 18, and 23.

Upon recognition of the interdigital spacing by the reset generator in the control section of the selector, a reset pulse is produced which, unless inhibited, resets the selector to a zero condition. When a correct sub-total exists in the counter during the interdigital period, the reset is inhibited, permitting the counter to continue to store the sub-total. When the correct total is received, the call indicator, consisting of a call lamp and bell, is activated.

A somewhat different approach using pushbuttons (Fig. 3) instead of a rotary dial as a call selector was placed on the market and is now in use in a number of independent telephone companies. It permits a mobile radiotelephone subscriber to dial numbers directly into the land telephone system as well as to call other mobile radiotelephone units and to receive dialed calls itself.

Part 2 of this article will discuss some of the more complex digital data transmission systems.

Synchronous Switches
Their Many Forms and How to Use Them

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Ray Goldstein doesn't believe in tiptoeing apologetically over fundamentals. He wrote this article, frankly, because there's a need for it. Synchronous switches aren't covered in most text books. In others, they are lightly glossed over. Mr. Goldstein discovered this deficiency through helping experienced electronics engineers absorb the circuit fundamentals in this article.

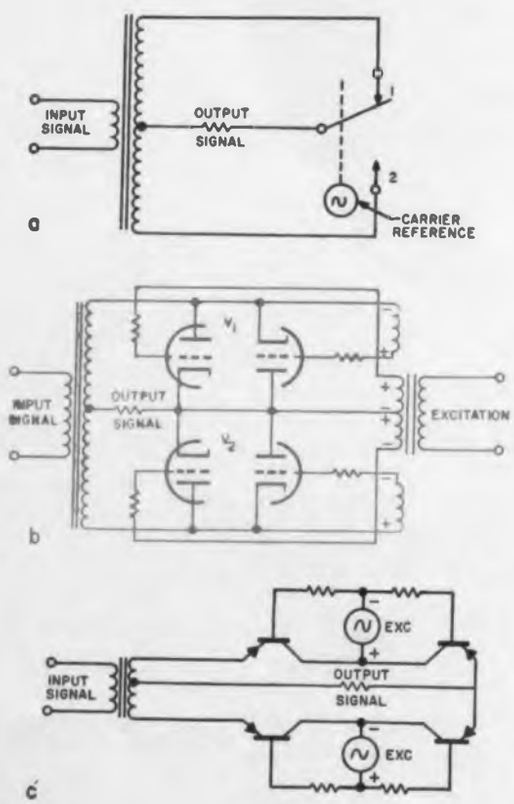


Fig. 1. In essence, a synchronous switch vibrates an arm between two contacts. The input signal is rectified when it reverses phase in synchronism with the movement of the switch arm as shown in *a*. Vacuum tube and transistor versions of a passive synchronous demodulator appear in *b* and *c*.

TO USE synchronous switches to best advantage, and to select the best of many types for a given application, it is necessary to understand their basic features, advantages and limitations.

An important but inadequately-understood servo component, the synchronous switch plays many roles. It serves as modulator, demodulator, phase filter and frequency filter.

Synchronous Switch Applications

In servo systems, it is necessary to extract modulating intelligence from a suppressed carrier. Then, simple *RC* networks can be used to make mathematical computations on the modulating signal. The synchronous switch separates the modulation from the carrier, then recombines them after necessary computations.

Most electromagnetic transducers, such as synchros and tachometers, generate unwanted quadrature signals. These may cause amplifier saturation or may obscure low-level, in-phase signals. In this application, the synchronous switch can be used as a demodulator to eliminate quadrature components. It thus functions as a phase filter as well as a frequency filter.

Passive vs Active Switches

Synchronous switches can be divided into two broad classes: passive and active. The passive type performs commutation without contributing power or voltage gain to the input signal. It converts ac to dc or dc to ac with optimum efficiency.

The principal difference between using diodes and amplifiers as passive switches is that the amplifier requires less switching power. However, this represents inefficient use of amplifier gain. Fig. 1 shows versions of a passive switch.

An active switch contributes power or voltage gain to the input signal in addition to performing commutation. This circuit uses the self-rectifying properties of tubes or transistors and exploits gain possibilities. Examples of half-wave demodulators are shown in Fig. 2.

The Beam-Switching Tube as a Demodulator

The 6AR8 serves to show how to apply a synchronous switch as a demodulator. It is the first commercial tube built specifically to operate as an spdt electronic switch; to date no semiconductor equivalents have been built.

The 6AR8 also has pentode characteristics, providing gain as well as signal conversion. Through electronic coupling, it obviates a double-ended signal for the demodulator, thus effectively including a five-terminal, biphase coupling system between the pentode and demodulator functions of the tube. Though designed as a TV-color phase detector, its characteristics suggest potential usefulness in the servo field.

Schematically, the 6AR8 is like a twin pentode with a common cathode and grids as shown in Fig. 3. Its constant-current E_b-I_b curves seem to classify it fully under this type. There is, however, this fundamental difference: there are two deflection electrodes which may position the electron stream on either plate. The tube thus resembles a one-axis oscilloscope having a pair of plates rather than a viewing screen.

Conventional vs Beam-Switching Tubes

It is worthwhile to compare the methods of cutting off electron flow in a conventional tube and in a beam-switching tube.

In conventional-tube circuitry, switching results from turning plate current on or off. The tubes operate more as controlled rectifiers than as linear amplifiers (for which their ratings apply). As such, they may have life-span limitations due to high peak inverse voltages and peak forward currents.

The 6AR8 overcomes these disadvantages. It switches by using deflection anodes to position the beam rather than by cutting the beam off and

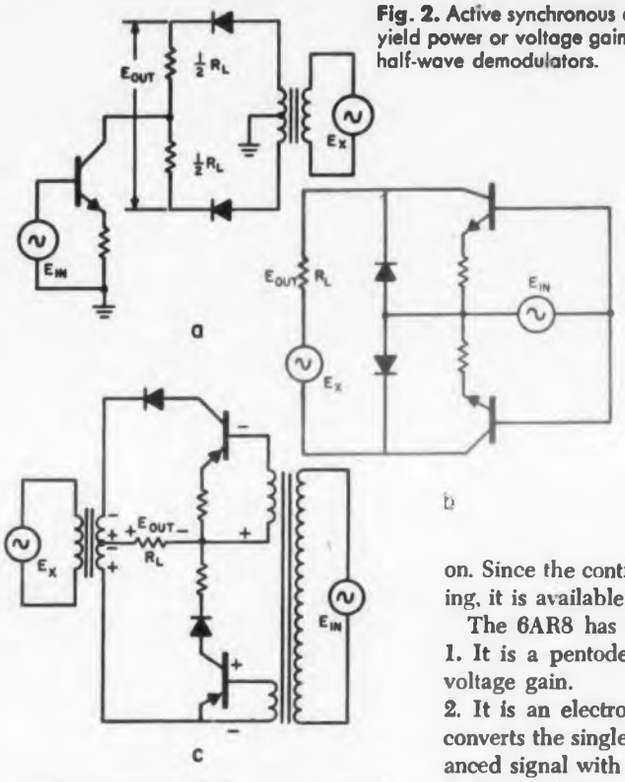


Fig. 2. Active synchronous demodulators yield power or voltage gain in these half-wave demodulators.

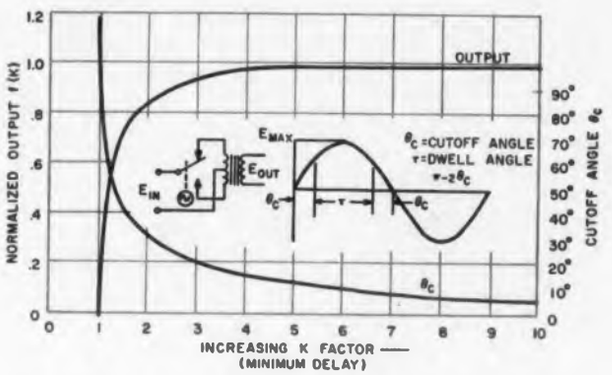


Fig. 4. Curves show that switching rations (K factors) from 4 to 5 yield optimum commutation.

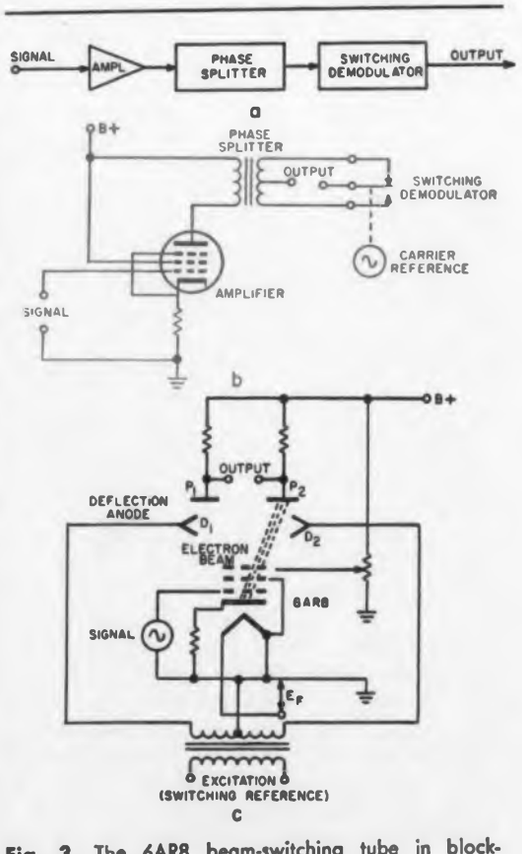


Fig. 3. The 6AR8 beam-switching tube in block-diagram and functional form.

on. Since the control grid plays no part in switching, it is available for amplification.

The 6AR8 has three notable characteristics:

1. It is a pentode amplifier which is capable of voltage gain.
2. It is an electron-coupled phase splitter which converts the single-ended pentode signal to a balanced signal with respect to ground.
3. It is a full-wave switching demodulator. The same results can be obtained with the dual twin-triode circuit of Fig. 1 if a gain stage is added.

How to Determine Demodulator Gain

In designing a demodulator using the 6AR8, the gain may be closely approximated by the standard pentode equation Gain $= G_m R_L$. A conversion factor $E_{dc} = (2/\pi)\, E_{peak}$, applied to the resultant gain, gives the full-wave demodulated output as a function of the ac input signal.

Following this procedure, a gain of 11.86 was calculated for one circuit and 11.50 measured.

How Large Should Excitation Be?

To assure commutation early in each half cycle, a minimum sinusoidal switching voltage is required. A greater excitation contributes no more than a minor increase in demodulated output but does cause increased deflection-anode dissipation.

A few simple equations can yield the best compromise. In these equations, E_d is the deflector voltage necessary to transfer the beam current from one anode to the other; K is the ratio of the peak excitation voltage to the voltage to be commutated, in this case E_d, ω_c is the carrier frequency, and $I_{av\,o}$ is the average output current.

For $K > 1$, and with constant input signal, the average output current is

$$I_{av\,o} = \frac{K \csc^{-1} K + 1 - 1/K^2}{\pi} \qquad (1)$$

For $K \leqslant 1$, fractional commutation occurs, and

$$I_{av\,o} = K/2 \qquad (2)$$

As K increases indefinitely, $I_{av\,o}$ in Eq. 1 approaches $2/\pi$, the maximum theoretical average value of a rectified sine wave in terms of its peak.

When a transistor switch serves as a modulator, the delayed commutation resulting from its energy gap reduces the fundamental output as a function of the K factor by

$$e(t) = \frac{4E}{\pi}\left(1 - \frac{1}{K^2}\right) \sin \omega t \qquad (3)$$

Fig. 4 shows that commutation delays of up to 14 deg are quite acceptable in terms of net output for a switch having a cut-off characteristic, such as a mechanical chopper or a transfer.

Avoid High Switching Ratios

Excessively high-switching ratios, above a K factor of 5, should be avoided. The null voltage may go up in direct proportion to excitation, while the output will not. In general, K factors from 0 to 2 should be avoided as the commutated output is a linear function of the line excitation supply, and switching efficiency is low.

"Swamping" the modulator or demodulator with excess switching voltage is not advisable for best performance. A K factor of 4 to 5 is adequate for efficient commutation.

To some extent, a square-wave supply can minimize the problem. A clipper-operated double-based Zener can supply the square waves. But this method requires more components. Furthermore, too abrupt switching in a high-Q circuit can shock-excite ringing transients.

Constant Ratio vs Constant Excitation

Analysis of the K-factor problem suggests that an improved type of diode switch may be con-

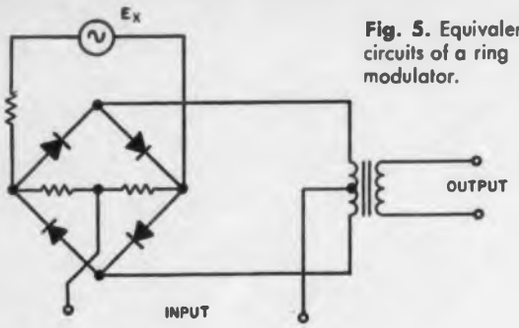


Fig. 5. Equivalent circuits of a ring modulator.

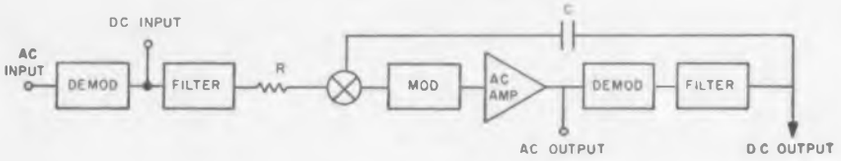


Fig. 7. An electronic feedback integrator in block-diagram form.

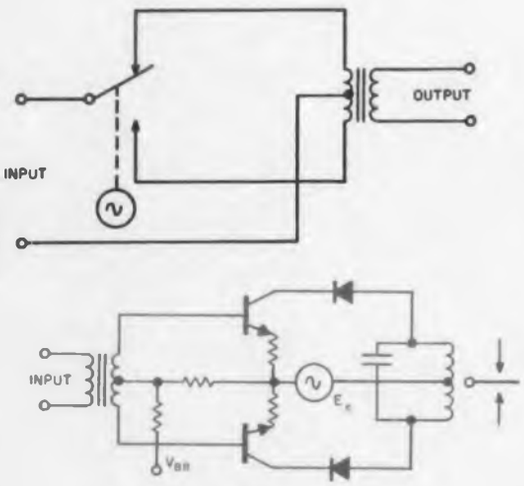


Fig. 6. This sensor provides quadrature rejection.

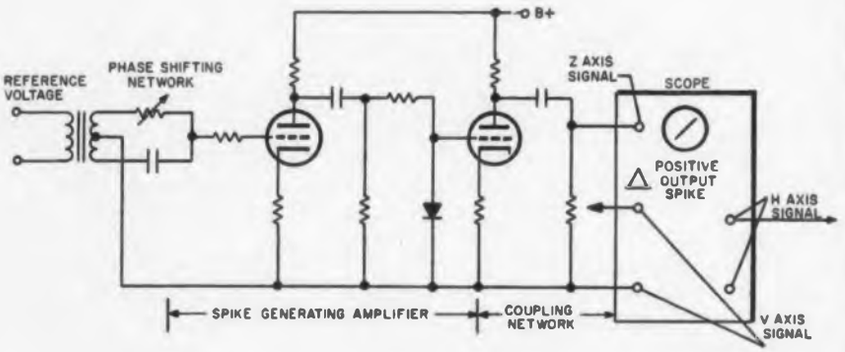


Fig. 9. Circuit for using beam-switching in optical modulation.

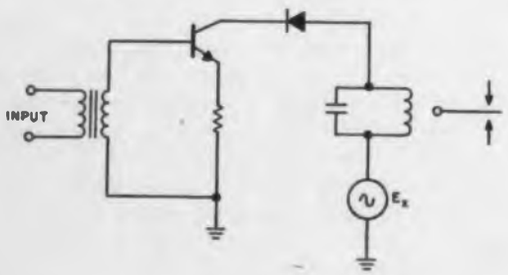


Fig. 8. This signal sensor allows selective control of the polarity of relay response.

structed with a constant K for all inputs instead of constant excitation. A switch designed to exploit this concept would have optimum signal-to-noise characteristics for a far greater range of signals than a conventional circuit.

Such a switch could make the excitation a continuously variable function of the input signal. A test circuit built on this principle resulted in better than a 5 to 1 improvement in signal-to-noise ratio over a fixed-excitation modulator.

Synchronous Switches in Many Roles

Phase Discriminator or Filter. The average output of a demodulated sine wave including the effect of phase shift between the signal and reference is

$$I_{av\,o} = 0.637\, I_m \cos\theta \qquad (4)$$

where θ is the phase angle between the signal and excitation voltage. When $\theta = 90$ deg, the average output of the demodulator is zero; when $\theta = 0$, the output is maximum in accordance with the cosine function. Thus the switch behaves like a phase discriminator or filter.

The harmonic components resulting from demodulating a quadrature signal are easily removed with a low-pass filter. Summing a number of signals derived from electromagnetic transducers is usually followed by quadrature removal.

Ring Modulator. Conversion of low-level signals (150 mv, maximum) is rather difficult. Such signals may be derived from an instrument-landing-system cross-pointer indicator. Silicon diodes help solve this problem with standard circuitry, eliminating the usual requirement for nonlinear temperature-compensating networks.

The circuit in Fig. 5 has given good results using a simple, two-point matching procedure to select individual diodes in the ring.

Quadrature Rejection Sensor. It is often necessary to operate relay-type sensors from signals with a large quadrature component, and to make the relay respond only to the in-phase component. Fig. 6 shows how a pair of ac-on-the-collector transistors can furnish power gain for relay operation and simultaneously reject quadrature components. The diodes block inverse switching peaks and thus protect the transistors from damage.

Dc Amplifier. Direct-coupled, high gain, dc amplification is difficult with miniaturization tech-

niques because of circuit complexity and the need for drift stabilization. By converting the dc signal to an easily-manipulated carrier frequency, one can amplify it by using standard ac techniques, then demodulate it to obtain a higher-level dc output. The results depend almost wholly on the quality of the signal converters.

Integrator. An electronic feedback integrator has been developed which uses silicon diodes as switches. It has a 1000-sec time constant with a basic feedback time constant of 0.75 sec. Its block diagram is shown in Fig. 7.

Variations have been used in place of servo integrators in some applications. Either tubes or transistors can be used in the ac amplifier.

Asymmetric Signal Sensor. The circuit of Fig. 8 will energize a relay for a given phase of an input signal and will desensitize the relay for opposite-phase signals. In this circuit, a single transistor is operated class B with ac applied to its collector. Thus, relay current flows only when the switching voltage on the collector is positive, provided the signal to the base is also positive during this time. Should the input signal reverse phase during the half cycle when the collector is positive, the transistor will be driven further into cutoff.

Optical Demodulator. The Z-axis, or optical demodulator is an interesting application of beam-switching. In servo measurements, it is customary to demodulate the reference and output signal of the system to measure phase displacement with an oscilloscope and a phase-shifting synchro.

This method requires two critically-designed demodulators whose filters may introduce lag errors.

Since the Z axis is common to both *V* and *H* axes, one may gate the Z axis synchronously, once per cycle, and thus provide simultaneous demodulation of the *V* and *H* axes. See Fig. 9.

The positive-spike generating amplifier is coupled to the Z axis with the intensity turned down to remove the pattern. Once per cycle, as the spike makes the intensity grid more positive, a dot appears on the screen. The output appears as a circle, ellipse, or line, depending on the phase displacement between the *V* and *H* axes.

In the presence of noise, the position of the carrier spike may be adjusted by a phase-shifter which gates the most intelligible portion of the signal. This method causes no filter lags.

A further refinement requires a circular sweep reference on the *V* and *H* axes. The intensity spike, now generated from the signal, would then turn on the beam at a time depending on the phase displacement between signal and sweep reference. Relative phase angle can then be read directly on the crt screen from a transparent dial calibrated from 0 to 360 deg. ■ ■

Magamp Regulator For DC-to-DC Converters

Baruch Berman
Chief Engineer, Avion Division
ACF Industries Inc.
Paramus, N.J.

Author Baruch Berman feels that a magnetic amplifier makes an excellent regulator for solid-state dc-to-dc converters. He presents a design for an efficient, light-weight unit that will provide ±2 per cent regulation over a wide range of input voltages and loads.

TRANSISTORIZED multivibrators, of the push-pull transformer-coupled type, are highly efficient and are ideal for dc-to-ac or for dc-to-dc power conversion (*ED*, Sept. 16, 1959, p 40; Sept. 30, 1959, p 36). They usually provide a square-wave output which is ideal for full wave rectification. Both the frequency and amplitude of the square wave are directly dependent on the dc supply voltage. If the output is to be rectified, the change of output frequency with input voltage is of little concern. However, if constant output voltage is desired with changing input voltage, an output regulator must be added.

Light-Weight, Fast Magamp Regulator Outperforms Transistor Circuit

A circuit has been developed which controls the output to maintain a constant voltage. A magnetic amplifier is used as the regulating element. The pulse-width modulation principle is utilized. Although filtering has to be heavier than with transistor regulators, several advantages are gained.

In a transistor regulator, the series transistor has to absorb the difference between line or battery voltage and the regulated voltage, and must dissipate it as direct loss in the form of heat. The magnetic amplifier regulator, on the other hand, impedes the flow of current until the right instant in the cycle, as determined by a Zener type error detector, and only then allows load current to flow. This results in appreciably improved efficiency.

The common drawbacks of magnetic amplifiers are their excessive weight and slow response time as compared with transistor circuits. This is overcome in the circuit described. The transistor-coupled magnetic oscillator is designed to operate at a relatively high 1000-cps frequency. This makes for an appreciable size reduction. The response time problem is also overcome by using the high operating frequency.

The regulated circuit is shown in Fig. 1. To show the versatility of application, more than one output is regulated, although only one will be

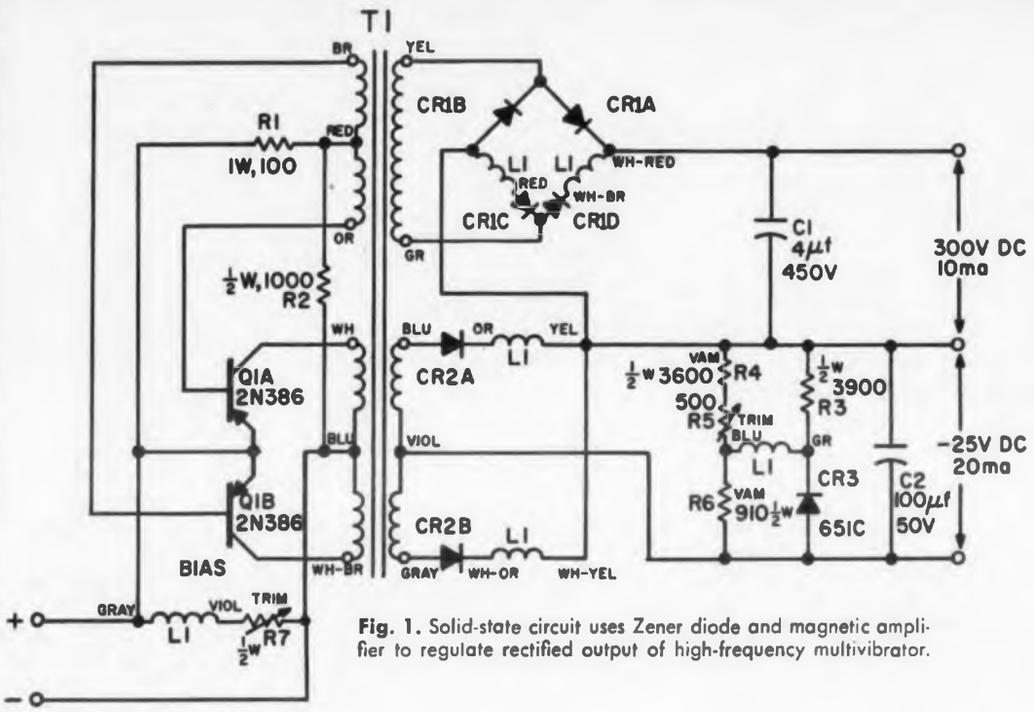


Fig. 1. Solid-state circuit uses Zener diode and magnetic amplifier to regulate rectified output of high-frequency multivibrator.

detected. The detected output will be the one which requires the most exact regulation with respect to load variations. Regulations with respect to varying input voltage is in the same order of magnitude on both outputs, for constant load.

Input and output specifications, for the circuit shown, are as follows:

Input: 12.6 vdc $\begin{matrix}+10\\-5\end{matrix}$ per cent

Output #1: −25 vdc at 0-20 ma, regulated ± 2 per cent
Output #2: +300 vdc at 10 ma constant, regulated ± 2 per cent
Temperature: −55 to +71 C ambient
Ripple: 0.1 per cent

Duration Of Current Flow Reduces With Increasing Line Voltage

Fig. 2 illustrates the mode of operation involved. Three oscillograms tracing the voltage across transformer *T1* are shown. Trace *a* indicates the condition of low-input voltage. This trace approaches an ideal square wave. When the input voltage is low, the magnetic amplifier is saturated always and allows full collector current to flow from time zero. This condition is the same as the one existing with conventional non-pulse width modulated inverters. Maximum power output (P_{load}) may be computed in this case for 50 per cent efficiency from the equation:

$$P_{load} = \frac{V_s^2}{4\,Rcs} \qquad (1)$$

where *Rcs* is the saturation resistance of the transistors used.

Traces *b* and *c* demonstrate what happens when the input voltage V_s is raised. The output voltage attempts to follow the input as in a non-regulated converter. However, the error detector provides a signal to the magnetic amplifier that retards its firing angle. The square-wave of traces *b* and *c* develop a step at the point where the magnetic amplifiers saturates.

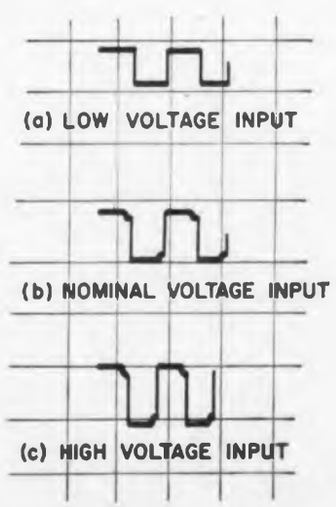


Fig. 2. Waveforms across transformer *T1* illustrate action of regulator as input voltage rises.

Transistor Ratings Must Take Account Of Varying Duty Cycle

The full collector current starts flowing only after the magnetic amplifier has saturated. Duty cycle rating of the transistors, with respect to peak current and mean dissipation is therefore necessary. As the supply voltage is raised higher, the duty period becomes shorter and the collector current peaks are higher. With the highest rated input voltage, the transistors have to supply the full load current in a fraction of the cycle. Base drive of the transistors has to be computed to allow the transistor to pass the peak current anticipated. This has to be done while keeping in mind that β, (transistor current gain,) falls off at high collector current.

Although dissipation will go up because the equivalent rms collector current has gone up, better than 65 per cent over-all efficiency can be easily obtained. What is more important, most of the losses incurred will not have to be dissipated by the transistors. They will appear, instead, as magnetic *IX* and *IR* drops in the core.

A safe supply voltage is half the open circuit emitter breakdown voltage. The base breakdown voltage of the transistor should preferably also be twice the supply voltage. The power dissipated by the transistors is of great importance because the flow of collector load current is not continuous over the full cycle.

Three Sections Of The Circuit

The regulator circuit is comprised of three major sections:

1. Magnetic multivibrator and transformer.
   a. Transistors *Q1a* and *Q1b* = 2N386, Philco
   b. Bias resistors
   c. Transformer *T1* = Core #1050, orthonol, 2 mils (G & L electronics or equivalent,) primary turns 200, #26, center-tapped. Feedback turns 80, #31 center-tapped. Secondary turns—as determined by design.
2. Error Detector
   a. Zener diode = 651 C.
   b. Resistor *R3* = 3900 ohms, 1/2 w, composition.
   c. Resistor *R4* = 3600 ohms, vamistor.
   d. Resistor *R5* = trimming resistor approximately 500 ohms.
   e. Resistor *R6* = 910 ohms, vamistor.
   f. Control winding = blue and gray leads of *L1* in the magnetic amplifier.
3. The magnetic amplifier *L1* comprises two cores, A1010-02, (G & L Electronics or equivalent.)

In addition, filtering is obtained with capacitors *C1* and *C2*. A 0.1 per cent ripple was obtained with *C1* = 4 μf, 450 v and *C2* = 100 μf, 50 v. Capacitance requirements are determined under worst conditions: (1) high input voltage, when the conducting period is short with high peaks;

(2) full load, when the filter time constant is shortest ($R_{load}\ C$ = minimum); (3) low temperature, when the capacitor changes from rated to lowest value.

The theory of the basic transistor-coupled magnetic multivibrator is covered adequately in technical publications and textbooks published to date. Therefore only the features typical to the type of regulator described here will be dwelt upon.

Magnetic Multivibrator Designed Around Transformer *T1*

The frequency of oscillation f is determined from the equation:

$$f = \frac{V_s}{4B_{sat}N_1AK} \qquad (2)$$

where: V_s = supply voltage in volts
B_{sat} = Saturation flux density of transformer *T1* core in kilolines
N_1 = Half the number of primary turns, Np.
$N_1 = Np/2$
A = Cross section of transformer *T1* core area in square inches.
K = stacking factor

For this circuit,

$$f = \frac{V_s \times 10^8}{4B_{sat}N_1A} = \frac{12.6 \times 10^8}{v \times 90 \times 103 \times 100 \times 0.035} = 1000 \text{ cps}$$

where N_1 = 100 turns #26 hf;
N(feed back) = 40 turns #31 hf
Np = 200 turns
$2N$(feed-back) = 80 turns #31 hf

The effective load is 3.5 w, while the actual load is 5.5 va. For 300 vdc output, the secondary of the transformer should be designed to provide 300 vdc + 10 per cent. The output is a square wave with low voltage input.

If regulation is to start at 10.7 vdc and full wave-bridge circuit is used, then:

$$N_{(Sec\ \#2)} = \frac{330}{10.7} \times 100 = 3080 \text{ turns, \#38 hf.}$$

For 25 vdc, diode drop should also be considered. To continue with the example, a center-tap circuit will be used.

Transformer *T1* has to supply to the magnetic amplifier, *L1*, the voltage:

$$25 \times 1.1 + 0.7 = 28.2 \text{ v ac}$$

$$1/2N_{(Sec\ \#1)} = \frac{28.2}{10.7} \times 100 = 263 \text{ turns \#38 hf}$$

Magnetic Amplifier Design, *L1*

The design of the magnetic amplifier is carried out at nominal conditions. Conditions above and below nominal adjust themselves automatically. As the input into the multivibrator rises, so does the output of *T1*. However, simultaneously with it, the frequency of this output rises. Thus the magnetic amplifier has to block a higher voltage, but at a proportionally higher frequency. The impedance rises automatically even though the control current of the magnetic amplifier has not changed.

Fig. 3 shows an oscillogram of the voltage impressed across the magnetic amplifier gate winding under conditions of nominal input. *L1* absorbs the voltage until a specific angle is reached, as determined by the control winding. At this angle the magnetic amplifier *L1* saturates and lets the transformer *T1* voltage be impressed on the capacitors and load.

Because of the fast switching, a spike appears across the gate winding of the reactor *L1*. This spike is not troublesome as long as its peak amplitude does not exceed the rated inverse voltage of rectifiers *CR1* on the high voltage output, and *CR2* on the low voltage output. At nominal conditions, the ac outputs of *T1* will be:

Low voltage (25 vdc): $2.63 \times 16.2 = 33$ v (to center tap)
High voltage (300 vdc): $30.8 \times 12.6 = 390$ v (across full winding)

The magnetic amplifier *L1* will have two sets of gate windings. One set will have to support 8 v at nominal conditions and the other 90 v. To improve production lot yields, a safety factor of 33 per cent will be added. This will cover manufacturing variations of core saturation flux density, stacking factor variation, winding tolerance, forward drop of the transistors, etc. Thus, the high voltage gate will have to support V_L = 120 v, and the low voltage gate V_L = 11 v.

$$N(\text{turns of high-voltage gate}) = \frac{V \times 10^8}{4fB_{sat}AK} =$$

$$\frac{120 \text{ v} \times 10^8}{4 \times 1000 \times 90 \times 10^2 \times 0.156 \times 0.87} = 2460$$

turns, #40 hf

$$\frac{N}{2}(\text{turns of low-voltage gate}) =$$

$$\frac{11 \times 2460}{120} = 226 \text{ turns, \#38 hf.}$$

Space factor check of the magnetic amplifier winding is obtained by adding the areas occupied by all the gate winding plus the bias and control winding and dividing by the core case window area. The design above gives 50 per cent space factor and the actual measured temperature rise is a comfortable 20 C. Class A insulation, as contemplated, is quite adequate even under the high ambient condition of 71 C.

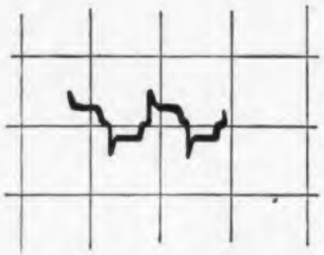


Fig. 3. Waveform across magnetic amplifier *L1* shows spikes that must not exceed rated peak inverse voltage of *CR1* and *CR2*.

Error Detector Design

The magnetic path length of the magamp core is 1.96 in. With good low-leakage silicon rectifiers in the saturating legs, one-half ampere turn will drive the cores from cut-off to saturation. A bias winding, in series with a trim resistor *R7*, is connected across the supply voltage. This allows setting of the outputs to the desired level without making use of the control winding. The control winding loop may then be closed to a point on the error detector resistor leg which exactly equals the Zener voltage of *CR3*. Null is thus established at nominal conditions.

The control current will operate the magnetic amplifier in a push-pull mode and the impedance it will present to the error detector will be high. This is most desirable from the point of view of gain and signal level power availability. The bias is connected to help retard the firing angle with rising input voltage. The control ampere-turns will also be assisted by the fact that frequency is proportional to input voltage. With 2000 turns #42 AWG control turns, wrapped around both cores in pineapple fashion, the maximum control current that will flow through the control winding is 100 μamp.

The maximum error voltage allowed across the detector bridge is ±2 per cent, that is ±0.5 v. Bridge input impedance is 0.5 v/0.1 ma = 500 ohms, minimum. Bridge output impedance is made up of *R4* in parallel with *R6*, and in series with *CR3* in parallel with *R3*. *R3* is high with respect to the impedance of *CR3* and may be neglected, *CR3* presents an impedance of not more than 10 ohms. Thus the output impedance consists mainly of *R4* in parallel with *R6*, which is 700 ohms. The bridge presents a low output impedance to the control winding of the magnetic amplifier which has an input impedance of 5000 ohms minimum.

The unit was designed and packaged into a unit having minimum size and weight requirements. Actual size comes to less than 14 cu in., and actual weight to less than 370 g, including the case and epoxy potting compound. ■ ■

Recommendations Of Ad Hoc Study Group On Components Reliability Program Unveiled

HIGHLIGHTS and implications of the long-awaited report of the Ad Hoc Study on Parts Specifications Management for Reliability were covered at the 1960 Electronic Components Conference (*ED*, May 25, p 16).

The central recommendation of this recently concluded study is the establishment of an Advisory Group on Management of Electronic Parts Specifications (AGMEPS) as an activity of the Office of the Assistant Secretary of Defense for Supply and Logistics reporting directly to that Assistant Secretary, said Paul S. Darnell, chairman of the Ad Hoc Study Group.

The function of this new advisory group would be to provide, on a continuing basis, technical advice that will aid the Defense Dept. in planning and directing an adequate, economical, and effective program of specification development and technical documentation in component parts.

The new advisory group would also provide similar advice to the Director of Defense Research and Engineering and to the individual services relative to their interests in these areas.

Explaining the consequences of this recommendation, Mr. Darnell said that it would:

- Place the centralization, coordination, and administrative direction of all electronic part specifications at the Defense Dept. level and thus consolidate what are now diversified specification activities carried on in various areas of the three military services.
- Establish a central point at an operating level for producers and users of electronic parts as well as industrial and technical societies to approach when they wished to have existing parts specifications revised or new ones initiated.

"The recommendations of the Ad Hoc Study Group constitute the most advanced step in reliability ever taken in the United States," said J. M. Bridges of the Office of the Director of Defense Research and Engineering. A reported 7,000 to 8,000 man hours went into the study, which was jointly sponsored by the Offices of the Assistant Secretaries of Defense (R&E and S&L).

Reliability Needs Put In Prototype Specifications

Other highlights and recommendations of the Ad Hoc Study Group were covered by E. J. Nucci, the group's co-chairman.

Three prototype specifications were prepared by the group. They covered paper dielectric capacitors, relays, and electron tubes. These units were selected to provide features representative of the wide range of problems inherent in the mission of the over-all Ad Hoc Group and in the total range of electronic parts. Significant features of the prototype specifications are:

1. There will normally be four or five reliability levels specified in terms of failure-rate per cent per 1,000 hours under a specified test condition. The highest level will represent the level representative of present military specifications items and the other levels aimed at 1, 0.1, 0.01, and 0.001 per cent per 1,000 hours.
2. The specifications will provide the necessary life-test sampling plans to prove compliance with the reliability levels specified and provide a means or methodology for accumulating the necessary failure-rate data and of computing failure-rates for monitoring. The exponential distribution of failures has been assumed and used in the prototype specifications. To cut down sample sizes and test time, the statistical plans used deviate from a lot-by-lot acceptance on the reliability requirements and treat the accumulated lot-by-lot life-test data sequentially. Acceleration factors are used where known.

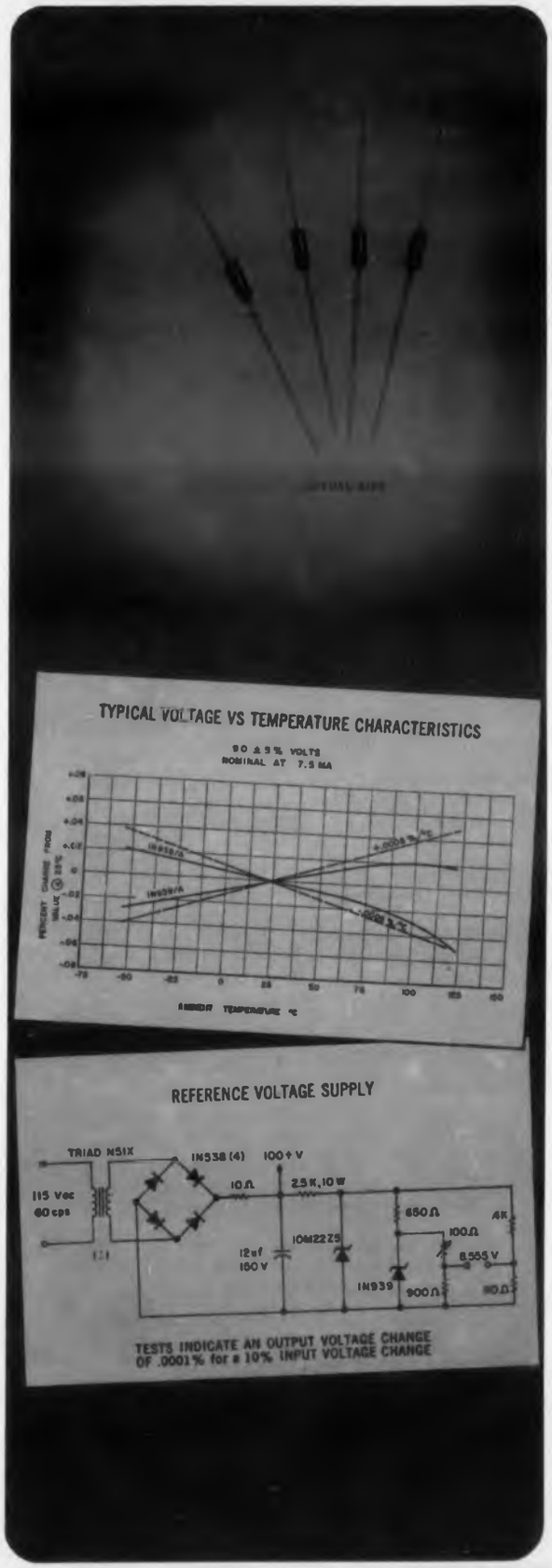
3. Modified qualification approval procedures are recommended wherein qualification approval shall be established for a specific reliability level that will be monitored during production. The manufacturer shall maintain life-test data for periodic audit and requalification. If the audit shows that the failure-rate increases, qualification is dropped to the next higher failure-rate level; if the manufacturer can lower the failure rate, he can qualify for the next level. Prior to submission of samples for qualification approval, the manufacturer should show evidence that he has (a) the test equipment to conduct the tests required by the specification and (b) satisfactory in-plant process control. Qualification approval should be given only on submission of sufficient data representative of production quality; the manufacturer should conduct all qualification tests under surveillance of the appropriate government inspection agency.
4. Sampling plans being proposed for acceptance inspection propose greater consumer protection.
5. The report recommends that equipment manufacturers require parts manufacturers to conduct acceptance testing and to supply certified test data with each shipment of parts as evidence that the parts do conform to the specification.

Specification Writing Standards Recommended in Report

With respect to specification writing and coordination procedures, the report contains an Outline of Form and Instructions for the Preparation of Design and Procurement Documentation for Military Components. It recommends a standard format, standard sequence of requirements and tests, consistent organization of test procedures groupings for sampling levels, the addition of the reliability requirement and test plans to assure conformance, establishment of environmental requirements in standard groups to conform with MIL-STD-446, the Environmental Guide for Electronic Parts.

Coordination of Specifications Within Six-Month Period

As for coordination of specifications, the report recommends that the program establish a control to effect full military and industrial coordination within a 26-week period. Also, existing definitions, regulations and, perhaps, the name "Limited Coordinated Military Specifications" should be revised to ensure that they will be binding upon all other services immediately upon issuance, except that a period of 60 days will be allowed any service to show why the specification is not



satisfactory for its use. For purposes of service coordination, approval of a specification should be based upon a majority vote of the working group preparing the specification.

Parts Characteristics Data And Control Called For

In the development of parts characteristics data (including failure rates and application data) the recommendations include suggestions to improve failure reporting systems, establishment of a parts-evaluation program to obtain failure-rate data, and the establishment of a control organization to collect and disseminate technical information on parts defined by military specifications. It recommends that, for those items not completely described by military specifications, military contractors and subcontractors be required contractually to submit copies of their electronic-parts procurement documents to a central organization in the DOD, along with test data substantiating the conformance of these parts to such documentation.

Finally, the report recommends that there be established an appropriate time schedule for the revision of specifications and that a period of 12 months be considered the objective time table for implementing these recommended procedures in specifications for essential items.

Possible Improvements Suggested by Darnell

Some of the impacts the group's recommendations, if adopted, would have on government and manufacturing organizations were outlined by Mr. Darnell. He said parts producers would be required, on the average, to do considerably more testing of their products and to apply increased process control in manufacturing. Measures to improve product-quality control may also result in increased yield of product, thus offsetting to some degree the cost of increasing quality. It appears likely that considerable expense would be incurred in establishing sufficient testing facilities to perform all of the testing required for parts having very low failure rates. However, the required testing programs could start at once with the present facilities and additional testing facilities acquired over a reasonable period of time. The net effect of greater amounts of testing would be to increase the load on the Government inspection services responsible for the surveillance of such testing.

The impact on the equipment contractor would be to increase very significantly the cost of parts he uses in equipment. If marked improvement in reliability of these parts enabled him to get his equipment out with major reduction in parts replacement and repair operations during produc-

tion, the higher cost of parts would be offset to some extent.

The impact on the military services will be greater initial first cost of equipment. This greater initial cost should be more than balanced out by major reductions in service maintenance costs. The strategic capabilities of systems would be greatly enhanced by significant increases in the meantime between equipment failures resulting from use of better components.

AGMEPS: What It Will Do And How It Will Work

The AGMEPS Advisory Group, the Ad Hoc Study Group recommends, should review all proposed DOD programs relating to electronic-parts specification development and technical documentation and the management thereof. The Advisory Group will assist the ASD (S&L) by submitting recommendations regarding: (1) the most efficient implementing actions, (2) the most effective program, and (3) changes to any proposed program that will ensure the implementation of the report's detailed recommendations. The advisory group will provide similar advice to the Director of Defense Research and Engineering and the services according to their interests in these areas.

The Ad Hoc Study, to be specific, provided in the report a Proposed DOD Instruction Establishing the Advisory Group on Management of Electronic Parts Specifications. The members of this group should be (1) appointed by the ASD (S&L) after their selection has been coordinated with the Director of Defense Research & Engineering and (2) drawn from representatives of OASD (S&L), ODDR&E, the Military Departments and consultants to OSD.

Administrative Control of the AGMEPS should be delegated to the OASD (S&L) office that has been delegated the responsibility for standardization.

The members selected for AGMEPS should represent a balanced team, with management and technical experience in the areas of electronic parts, tubes and semiconductors, electronic-system design area, and the engineering, procurement, and logistic areas of the DOD.

The chairman of the Advisory Group should be an OSD Consultant rather than a representative of the OASD (S&L), the ODDR&E, or the services, so as to gain a greater objectivity in directing the Advisory Group's activities.

The Advisory Group should of necessity maintain liaison with the Advisory Group on Electronic Parts, the Advisory Group on Electron Tubes and other OSD Advisory Groups that have programs relating to parts specifications.

(continued on page 78)

Comments On The Report Made By The Ad Hoc Study On Parts Specifications Management For Reliability:

E. J. Nucci: "To gain maximum benefits from these recommended procedures, immediate implementation is necessary."

J. M. Bridges: " . . . Most advanced step in reliability ever taken in the United States."

P. S. Darnell: "The Ad Hoc Study Group believes that it has proposed a practical and workable operation which will lead ultimately to monetary savings of a major magnitude."

Related to the establishment of the Advisory Group as a control unit, the report recommends that the Armed Services Electro-Standards Agency (ASESA) be organizationally relocated in the Office of the Assistant Secretary of Defense (S&L), reporting to the (S&L) office that is responsible for standardization. In this position, ASESA should provide administrative support to the program of electronic-parts specifications management and secretarial support to the Advisory Group (AGMEPS). By providing a single point of responsibility at an OSD level, ASESA's production capacity will be more directly used to improve its efficiency and effectiveness.

In pursuit of its functions, AGMEPS shall:

1. Review all proposed DOD programs relating to the development of electronic-parts specifications and technical documentation and the management thereof, and recommend to the Assistant Secretary of Defense (S&L) the most effective programs and changes to proposed programs that will ensure the timely implementation of the parts specification programs.
2. Prepare and recommend DOD policy, program and implementation plans for the development of specifications, standards and handbooks for electronic parts regarding:

(a) Priorities and schedules for the specification-development program that will be consistent with the operational needs of the Military Departments,

(b) All specifications programs and actions to ensure their adherence to established schedules,

(c) Techniques and guidelines, to be used in preparing military specifications, that will ensure the completeness and adequacy of specifications for procurement. This shall include the specification of performance and reliability in standard levels; test plans necessary to prove compliance with specification requirements; procedures for qualification approval; and the development and dissemination of parts application data, including failure rate as a function of time and levels of application severity,

(d) The collection, analysis and use of parts characteristics data in the development of new specifications or the revision of existing ones.

3. Review of the programs on specifications development and technical documentation in relation to the many other programs of the Military Departments, such as the Long Range Parts and Tubes Research and Development Program and the Industrial Mobilization Planning Program, to ensure that the programs are properly coordinated. This coordination shall be extended to ensure the programs' compatibility with industrial facilities and with activities in the areas of electronic parts.
4. Assist in resolving areas of conflict in the over-

all program and detailed problems which will be arising in the preparation and coordination of parts specifications.

5. Develop and recommend criteria for the generation of preferred-parts lists to be contained in military standards and approved sources of supply for qualified electronic parts list to be included in military specifications or procurement documents, where applicable, so that:

(a) Preferred parts lists are developed or brought up to date and promptly issued,

(b) Efficient methods and techniques are employed by the Military Departments to ensure maximum use of parts on the preferred parts lists. Where necessary, the Advisory Group shall recommend actions to improve the methods and techniques,

(c) Application data, including failure rates, are developed and promulgated,

(d) A Parts Qualification Activity for each specification category is established,

(e) Qualified product lists are developed and promptly issued.

6. Review budget requirements for the programs relating to specification development, technical documentation and standardization and recommend adequate required funding levels and recommend action to ensure efficient management and implementation of the over-all program.

In performing its functions, the Advisory Group shall operate under the supervision, administration and control of the Director of Supply Management, OASD (S&L).

The Advisory Group is authorized to establish such working groups or ad hoc groups as may be required, subject to the approval of the Director of Supply Management, OASD (S&L), coordinating with the Director of Electronics, ODDR&E.

The above outline on the operation of the Advisory Group was given by Mr. Nucci.

To put all of the recommendations into effect, Mr. Darnell said, "will require the determined support and wholehearted cooperation of everyone involved."

He added: "The Ad Hoc Study Group believes that it has proposed a practical and workable operation which will lead ultimately to monetary savings of a major magnitude. Without doubt there are questions we have not anticipated and procedural problems we have not foreseen. It is to be expected that there will be disagreements with some of our recommendations.

"However, if these are taken as issues to be resolved in forthright fashion and not as loopholes through which to escape the disciplines imposed by the implementation of the recommendations, the Ad Hoc Study Group will feel well repaid for its efforts." ■ ■

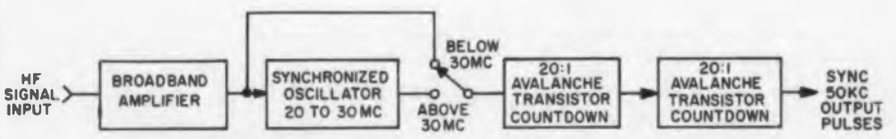
Trigger-Rate Converter Syncs Scopes to 300 Mc

OSCILLOSCOPES which could show high-frequency signals but could not trigger on them can now be triggered reliably by signals as fast as 300 mc. Most 30-mc scopes can now show rock-stable traces of 60-mc signals, while ultra-high-speed scopes whose triggering abilities don't match their bandwidths, can display steady, 300-mc waveforms.

The instrument which eliminates the high-repetition-rate triggering problems of most scopes is the model 602 Trigger Rate Converter manufactured by Lumatron Electronics, Inc. of 116 County Court House Road, New Hyde Park, L.I., N.Y.

The converter uses avalanche transistors to generate extremely fast pulses with 5-nsec rise times at a 50-kc repetition rate. These pulses are synchronized to the input signal.

In use, the 602 is connected between a trigger source and the external trigger input of a conventional oscilloscope. Only one control is necessary to adjust the unit for input frequencies below 30 mc. A second control is used, in addition, to



Two countdown stages provide stable, low-frequency output triggers from high-frequency input signals.

tune for higher frequencies.

In the instrument, a single-stage, broadband, transistor amplifier feeds the high-frequency input signal to an oscillator, tunable from 20 to 30 mc. The signal synchronizes the oscillator.

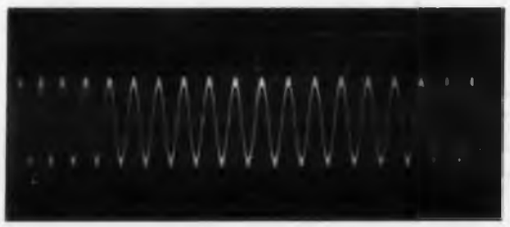
A countdown stage, basically a 1-mc relaxation oscillator, generates a single pulse for every 20 pulses from the oscillator. For inputs below 30 mc, this stage is fed directly from the input amplifier, and the synchronized oscillator is bypassed.

The 1-mc pulses out of the countdown stage are further counted down by a similar circuit which delivers the synchronized output pulses at about 50 kc. The pulses, about 40-nsec wide, have a positive amplitude of 10 v.

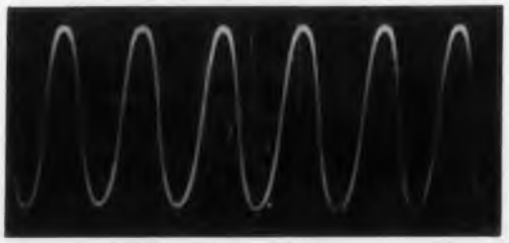
Available from stock, Lumatron's model 602 costs $440. A model 603, featuring an additional low-frequency trigger output at about 700 cps, costs $480.

For more information on these trigger-rate converters, turn to the Reader-Service Card and circle 350.

High-speed scope shows 60-mc sine wave but can't trigger on it.



Same scope, triggered by new trigger-rate converter, shows clean, stable 60-mc signal.



Same scope, uisng a sampling converter and trigger-rate converter shows clean sine wave at 300 mc.

NEW PRODUCTS

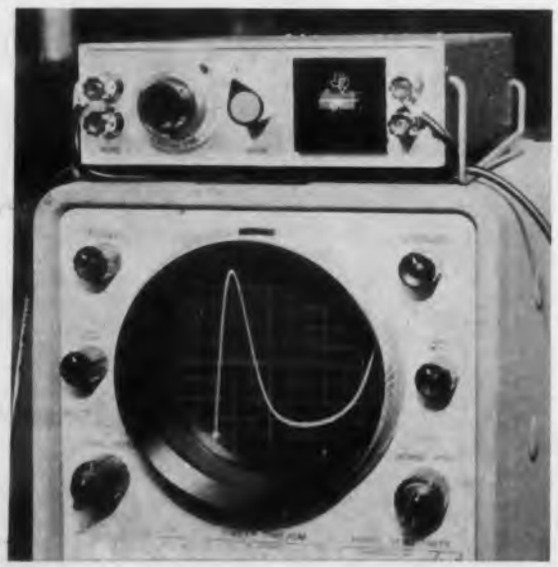
Covering all new products that might generally be specified by an electronics engineer engaged in the design of original equipment.

Solid State Microwave Switches Operate In Less Than 10 Mμsec 251

This line of single-pole, multiple-pole, solid-state microwave switches has a switching time of less than 10 mμsec. The single-pole, 10-throw switch, shown here, operates at around 450 mc and presents a total insertion loss of less than 2 db in the line with one leg "on" and the other nine "off." The vswr of the open branches measures greater than 250:1. Double-throw and four-throw switches are also available. Units are available in various frequency ranges from 10 mc to 10,000 mc.

American Electronic Laboratories, Inc., Dept. ED, 121 N. Seventh St., Philadelphia 6, Pa.

Price & Availability: *Prices range from $250 up, depending on the number of braches, rf frequency and other factors. Standard units are available in 1 to 2 weeks; specials, 4 to 6 weeks.*



Tunnel Diode Curve Tracer Tests Forward Characteristics 252

This tunnel diode curve tracer permits the study of forward characteristics of tunnel diodes made by various manufacturers, including gallium arsenide units. A plug-in adapter can be changed to accommodate different package configurations; one adapter is included, others may be purchased. Any sensitive oscilloscope may be used with the tracer to create current and voltage wave forms. The tracer creates a representation of the entire critical region of the forward characteristics. The bench-type case measures 2.5 x 7.5 x 10 in.

Texas Instruments Inc., Geosciences & Instrumentation Div., Dept. ED, 3609 Buffalo Speedway, Houston 6, Tex.

Price: *The standard model is priced at $99.50 and at $137.50 with a variable shunt and calibrated dial for direct readout of negative resistance.*

Multivibrator Module Weighs 0.33 Oz 253

Measuring 0.75 x 0.625 x 0.75 in. and weighing 0.33 oz, model BM-1, 10-mc bistable multivibrator module will trigger on any waveform having a positive slope equal to or greater than 0.11 v per mμsec for an interval of 10 mμsec or longer. Capacitor-coupled set and reset inputs are provided as well as two direct-coupled outputs. Output voltage in the "low" state is −11.2 v; in the "high" state, −0.15 v. Supply voltage required is −12 v at 14 ma and +6 v at 0.21 ma. Operating throughout the range from −55 to +55 C, the module's base is a standard seven-pin miniature configuration with gold-flashed pins.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

Price & Availability: *Available immediately in prototype quantities. One to nine units are priced at $90 each; 100 and over, $80.*

Switch Allows Time Sharing Of Antennas 254

Model R-107H, Ku-band ferrite switch enables two microwave antennas to be time shared by a common transmitter and receiver, maintaining high isolation between the magnetron and load. The switch can handle peak power levels of 100 kw and 100 w average; it can be switched at speeds under 10 μsec. Switching is performed using less than 70 w peak and 2 w average power. The switch operates over a 2% band between 15.7 and 16.9 mc with a loss of 0.5 db.

Gabriel Stern, Inc., Dept. ED, 420 Boylston St., Boston 16, Mass.

Thermoelectric Module Cools Components 255

Using a quaternary semiconductor alloy called Neelium, this eight-thermocouple Frigister module has twice the efficiency of thermoelectric coolers previously available. Mounted on a heat sink with an adhesive, the module can cool transistors and other devices and allow them to operate at higher power levels. Germanium transistors can be operated at levels that would normally raise their temperatures to 150 C and silicon units can operate at levels that would bring them to 300 C.

General Thermoelectric Corp., Dept. ED, Princeton, N.J.

Price & Availability: $258 per module. Delivery time is 30 to 60 days.

CIRCLE 68 ON READER-SERVICE CARD ➤

Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON COMPANY, WALTHAM 54, MASS., Vol. 2, No. 4

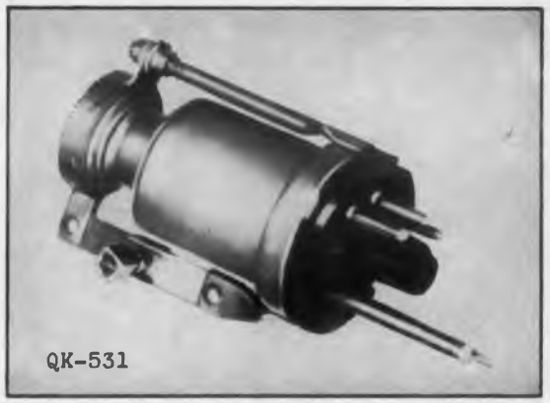
RAYTHEON KLYSTRON CLOCKS 62,000 HOURS OF SERVICE

--tube retired after seven years of continuous operation

We don't send out 62,000-hour warranties; however, you can expect unusual performance from Raytheon klystrons. Take the tube cited above -- the QK-531 -- a 6,575-6,875 mc reflex klystron which we conservatively warrant for 7,500 hours. As the local oscillator in the Houstonia, Missouri, link of the Panhandle Eastern Pipeline Company's 400-mile microwave system, the tube performed a major function in relaying up to ten channels of information between the Odessa and Boonville stations.

How is this kind of performance built into a tube? Advanced manufacturing techniques and rigorous quality control is the answer.

If you need low-power coverage of government, studio link and common carrier frequency bands, look into the characteristics of Raytheon's complete line of klystrons.



QK-531

The QK-531 is particularly suited for local oscillator service in microwave receivers. It is useful, also, as a local oscillator in microwave spectrum analyzers, as a pulse generator for testing circuit response and as a frequency modulated source in microwave relay links.

Homer Marrs of Motorola presents gold-plated klystron trophy to F. J. McElhatton, Panhandle Eastern Pipeline Co. J. A. Fowler, Supervisor of Communications for Panhandle, is at the left. Prized klystron, the Raytheon QK-531, performed for 62,000 hours.

Close control of product quality and costs at every state of production is responsible, in part, for Raytheon's success in meeting industry and government specifications. Every step of assembly is spot checked by inspectors, each with 10 years or more experience in microwave tube production.

Excellence in Electronics

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You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Company, Waltham 54, Massachusetts. In Canada: E. Waterloo, Ontario.

A LEADER IN CREATIVE MICROWAVE TECHNOLOGY

10,000,000 MAKE-BREAK CYCLES -NOT ONE FAILURE!

The control dependability of the A. P. I. meter-relay is fact, not fancy. Ten million perfect operations is just one test result; nearly twenty million decisive make-break cycles were achieved in another test. Exceptional? Not for an A. P. I. meter-relay. Once the contact on the pointer arm "makes" with the set-point contact, the two are firmly locked together by an exclusive A. P. I. design feature; a perfect control circuit is formed every time. This is one of the reasons A. P. I. meter-relays are used for such critical applications as controlling life-sustaining oxygen equipment, monitoring radiation levels and safeguarding vital communications circuits. The meter-relay is both an indicator and controller, sensitive enough to operate on very small microampere or millivolt inputs without amplification. Simple, accurate, applicable to any electrically-measurable variable, the A. P. I. meter-relay is well worth investigating as a low-cost monitoring and control device. You can start by writing for Catalog 4G.

api **ASSEMBLY PRODUCTS, INC.**
Chesterland Ohio

CIRCLE 69 ON READER-SERVICE CARD

NEW PRODUCTS

Sweep Generator 548

For alignment of af circuits

Model M sweep generator is a complete measurement system for alignment of af circuits without point-by-point frequency checks. It makes possible continuously adjustable center frequency sweeps from 20 cps to 200 kc. The narrow sweep range covers 500 cps to 20 kc and the continuously variable sweep widths are 2 to 200 kc, both linear and logarithmic. Flatness is ±0.5 db over the widest sweep. The output level is 5 v into 600 ohms.

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

Price & Availability: Units will be in stock by June 30, 1960. Price is $895 ea.

Alarm Scanners 562

Scan 1000 to 20,000 points per sec

Capable of scanning from 1000 to 20,000 points per sec, the Magne-Alarm solid-state, alarm scanner provides adjustments for both the bogey value and the tolerance on each individual input. Visual and audible alarms can be provided. The unit accepts inputs from thermocouples, strain gages, external voltages or resistances; it provides a minimum of 130 db common mode rejection at 60 cps. The unit can be used in missile checkout systems, and in process control systems.

San Diego Scientific Corp., Dept. ED, 3434 Midway Drive, San Diego 10, Calif.

Price & Availability: Price is $50 to $75 per input when 50 or more inputs are ordered. Units will be available from stock by August 1960.

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CICOIL Super-Flex STRANDED-WIRE FLAT CABLE

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FLEXIBILITY

CICOIL **Super-Flex** multi-conductor cable is ideal for use where extremes of temperature, movement and vibration preclude the use of other materials in missile packages, computers, gyro and radar systems. They provide light, reliable and compact harnessing of even the most complex electronic circuitry.

Super-Flex cables are made of **stranded conductors,** precisely spaced in CICOIL's specially processed silicone rubber base compound. Cables are made in lengths up to 8 feet, and widths determined by the size and number of conductors.

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CIRCLE 70 ON READER-SERVICE CARD

Storage Oscilloscope 551

General-purpose, laboratory type

Type SK1001 general-purpose, laboratory oscilloscope has a 7-in. diam dark-trace tube. Frequency response is dc to 10 kc for the vertical channel, the horizontal channel, and the Z-axis. Storage time can be varied from seconds to days. Erase time is 10 sec max. The unit weighs 55 lb and measures 12 x 15 x 21 in.

Skiatron Electronics & Television Corp., Dept. ED, 180 Varick St., New York 14, N.Y.

Price & Availability: *$2500 ea; 30- to 60-day delivery.*

Stepping Motors 557

Unidirectional and bidirectional models

The size 5 Digimotors are for use as stepping motors or indexing devices. They can be furnished with 8, 10, 12, 18, 20, and 24 steps per revolution and in unidirectional or bidirectional models with or without detent. Stepping rate is 15 to 25 steps per sec; operating voltage range is 6 to 350 v dc. Environmental specs include: vibration of 10 g at 2000 cps, operating temperatures from −55 to +120 C, and altitudes to 100,000 ft. The motor can be used as a power source for driving potentiometers, counters, and control mechanisms; it can also drive gear trains and indicators.

Ledex, Inc., Dept. ED, 123 Webster St., Dayton 2, Ohio.

Price & Availability: *For 1 to 9 units price is from $16 to $26 ea and units are shipped two days after receipt of order.*

NEW PRODUCTS

Servomotor Gearheads 567

For computer, control, and servo positioning systems

Series 11 400-cps servomotor gearheads are for use in computer, control, and servo positioning systems. The units are 2-47/64 in. long and weigh 6 oz. Ratios are from 5:1 to 78125:1, ratios in stock are 5:1 to 2000:1. Maximum recommended load torque is 100 oz-in. and maximum backlash does not exceed 30 min when measured with a 1 oz-in. load on the output shaft. No-load speed is 6700 rpm, torque at stall is 0.63 oz-in., and operating temperature range is —54 to +120 C. Mil specs are met.

Guidance Controls Corp., Dept. ED, 110 Duffy Ave., Hicksville, N.Y.

Microwave Diodes 631

For parametric amplifiers

These miniature, silicon, microwave diodes are for use in parametric amplifiers where variation in stray susceptance effects must be minimized. Other applications include use in stripline circuits, modulators for frequency synthesis, harmonic generation at the higher microwave frequencies, and subharmonic oscillators for microwave computers. Types MA-4255X, MA-4256X, and MA-4257X have capacitance ranges of 0.4 to 1.4 μμf, 1.2 to 2.5 μμf, and 2.5 to 4 μμf, respectively, and cut-off frequencies of 60 to 80 kmc, 50 kmc, and 30 kmc. Called pill varactors, the units have a maximum diameter of 1/8 in. and a maximum length of 1/8 in. The

package shunt capacitance is about 0.2 μμf. Series lead inductance is 10^{-9} h. Matched sets having less than ±10% variation in zero bias capacitance can be furnished.

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

***Availability:** Experimental quantities can be delivered in 30 days.*

Angular Position Transducer 565

Senses 0.012 deg of rotation

Model 903 angular-position transducer, having a range of ±3 to ±5 deg, is sensitive to 0.012 deg of rotation. Response is flat to 30 cps. Life expectancy is over 100,000 cycles. The magnified input of a small angular movement actuates a wiper which moves across a precision potentiometer producing a high-level dc output that can be used without amplification. The unit weighs 11 oz.

Bourns, Inc., Dept. ED, P.O. Box 2112, Riverside, Calif.

Gearhead 372

For servomotors

Model G-21A precision gearhead is for instrument servomotors with the same mounting dimensions as Diehl FPE21L and FPE25L motors with 13T, 96DP pinion. It is available in a motor-gearhead combination or as a separate unit. At 20 C the starting torque is 0.005 oz-in. max. Rated output torque is 50 oz-in. running and 70 oz-in. stalled. The output shaft backlash is 30 min max measured with a 5 oz-in. load.

Feedback Controls, Inc., Dept. ED, 8 Erie Drive, Natick, Mass.

***Price & Availability:** Price is $50 to $100 ea. Delivery time is 30 days.*

CIRCLE 73 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Noise Source Tube 571

Frequency range is 26.5 to 40 kmc

Type T44Q1B noise source tube operates at frequencies from 26.5 to 40 kmc and is capable of producing up to 18 db above KTB. Housed in a waveguide structure that allows for minimum length and voltage requirements, the tube is suited for cw or pulse operation under typical adverse military environments and meets Mil specs. Operating current is 45 ma, filament voltage is 6.3 v ±5%, filament current is 1.25 amp, and a firing voltage of less than 2000 v is employed. The tube operates at 250 v max.

Tucor, Inc., Dept. ED, 18 Marshall St., South Norwalk, Conn.

Price & Availability: *$350 ea for small quantities; $230 ea for 100 or more units. Small orders are filled from stock.*

Coil Winding Machine 561

Winds wire sizes 10 to 31 AWG

Designed for multiple-winding, heavy-duty transformer, bobbin, and field coils, this machine, model 650-AM, winds wire sizes 10 to 31 AWG. The fixed winding speed is 150 rpm with controlled acceleration attained by a clutch brake unit. Maximum winding stroke is 9 in.; maximum loading distance for multiple winding is 40 in. The machine includes a 3-hp induction motor, one-gearing set-up, and a winding width adjustment.

George Stevens Manufacturing Co., Inc., Dept. ED, Pulaski Road at Peterson, Chicago 46, Ill.

Price & Availability: *Delivered 4 to 5 weeks after order received. Price is from $6500 to $7000.*

Driver Amplifier 553

Delivers a high output across 1500 ohms

Model 105B driver amplifier is capable of delivering a high output across a load of 15,000 ohms or more. The impedance looking back into the amplifier is less than 1000 ohms. Designed especially for use with logarithmic attenuators, the unit can be used wherever a high output is needed.

C. E. S. Electronic Products, Inc., Dept. ED, P. O. Box 7504, San Diego 4, Calif.

Price & Availability: $40 ea; from stock.

Magnetic Amplifier 550

Produces 3.5 w

Model JEG-0-101 magnetic amplifier produces a maximum power output of 3.5 w at 400 cps into a rated load of 3800 ohms. A typical load consists of a Kearfott motor R119-2. The amplifier provides a phase-reversible ac output for a polarity-reversible dc input signal. A twin triode tube furnishes ample drive and accepts ac or dc signals to the tube grids. The unit meets MIL-T-27A and operates over a range of −55 to +71 C. It measures 2-7/16 x 53/64 x 1-21/64 in. and weighs about 11.5 oz.

American Research and Manufacturing Corp., Dept. ED, 920 Halpine Ave., Rockville, Md.

Price & Availability: Price is $27 ea. Limited quantities can be furnished from stock. Maximum delivery time is 30 days.

NEW PRODUCTS

Microwave Generators 575

Have a range of 2 to 16 kmc

This 820 series of microwave generators uses a klystron locked to a quartz crystal as a fixed frequency source. Units are available within the frequency range of 2 to 16 kmc with output power up to 1 w. Operating frequency and output power are dependent on the klystron used. Units in the line have a stability of 1 part in 10^6 over a 24-hr period, and contain incidental fm of 1 part in 10^8.

Laboratory For Electronics, Inc., Dept. ED, 1079 Commonwealth Ave., Boston 15, Mass.

Transfer Switch 566

For K-Band use

Designed for K-Band use, this waveguide transfer switch has the following typical specifications: vswr, 1.05; insertion loss, 0.07; and crosstalk, 80 db. The switch can be operated as spdt or double-pole transfer. X-Band switches can also be furnished.

Transco Products, Dept. ED, 12210 Nebraska Ave., Los Angeles 25, Calif.

Price & Availability: *Price varies between $500 and $700 ea when ten units are ordered. The product is made on order and can be delivered in 60 days.*

Bushings 596

Insulate wire and cable

Suitable for use in mounting holes varying from 3/8 to 1-1/2 in. in diameter, these nylon snap bushings are installed under finger pressure,

◀ CIRCLE 75 ON READER-SERVICE CARD

yet will withstand at least a 35-lb push-back test. The nylon material provides complete insulation and mechanical protection for electrical wire and cable, and can be used as a bearing for moving parts. The bushings fit all panel thicknesses up to 1/8 in. and will withstand operating temperatures in excess of 150 C.

Heyman Manufacturing Co., Dept. ED, 100 Michigan Ave., Kenilworth, N.J.

Price & Availability: *Available from stock. Can be delivered 7 days after receipt of order. Price is between $1.30 and $6 per hundred when ordered in quantities of 100 to 10,000.*

TV Gain Control 620

Maintains constant level of 1 db

Designed to prevent fading and overload in master TV systems, model MAC gain control maintains a constant level of 1 db for up to 10 db signal variation. Automatic signal regulation is provided for any amplifier with over 16 db gain and an output between 0.6 and 2.5 v. The unit has an input range of 1900 to 100,000 mv with an insertion gain of +10 to −10 db. Signal compensations respond as fast as 1/8 of a sec. An auxiliary 117 v ac outlet and 75-ohm fittings are included.

Blonder-Tongue Labs., Inc., Dept. ED, 9 Alling St., Newark 2, N.J.

Price: *$121.50 to contractor.*

Aluminum Foil and Strip 573

Comes in widths up to 12 in.

These anodized-aluminum foils and strips come in thicknesses from 0.002 in. foil to 0.06 in. strip and are obtainable in widths up to 12 in. The material is anodized uniformly on both sides, thicker at the edges, in finished widths. Breakdown voltage of the film depends on the alloy, film thickness, texture, and moisture content, but is not affected by increases in temperature up to 400 C.

United Mineral & Chemical Corp., Dept. ED, 16 Hudson St., New York 13, N.Y.

CIRCLE 76 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Synchro System Tester 617

Measures 2 in. in diam and 7 in. in length

Measuring 2 in. in diam and 7 in. in length, this synchro system tester provides two methods of determining faults in synchros. One method is based on substituting the synchro in the tester for a possibly defective unit in the system. The other method is by switching the tester to the zero position; with standard electrical zero connection and voltages, defective wiring or components can be isolated. The instrument can be supplied for 115 or 28 v ac at 60 or 400 cps.

Interstate Electronics Corp., Dept. ED, 707 E. Vermont Ave., Anaheim, Calif.

***Availability:** Units are made on order and can be delivered in 60 days.*

Noise Generator 619

Covers 1 to 3000 mc

The Mega-Node 3000, noise-diode type, calibrated noise source provides a low vswr over the range of 1 to 3000 mc. The generator impedance is held constant across the range. A coaxial, tungsten-filament, noise diode is used. Plate voltage is regulated and diode plate current, which is proportional to noise power output, is adjustable by front panel control. The panel meter reads noise figures up to 20 db for a 3-db Y-factor. Noise figure accuracy is ±0.25 db from 1 to 250 mc. The unit weighs 44 lb and measures 9-3/4 x 19-1/2 x 15-1/2 in.

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

***Price & Availability:** Price is $790 ea; for orders of 10 or more, price is $711 ea. Delivery is in 30 days.*

◀ CIRCLE 77 ON READER-SERVICE CARD

One-Piece Gear and Pinion Combinations 362

Are zinc alloy, die cast

These one-piece gear and pinion combinations, are zinc alloy, die cast, and meet AGMA standards for fine-tooth 14.5 deg involute-form gears. Extra clearance is provided at pitch lines and root diameters. Parts are supplied completely trimmed and ready for use.

Gries Reproducer Corp., Dept. ED, New Rochelle, N.Y.

Availability: *Made to customer specs from stock dies.*

Loading Reactor 364

For inductive load testing

For laboratory, inspection, research, and development, this loading reactor provides an inductive load that can be made adjustable through the use of a variable transformer. Called the Exel, this unit is used primarily for testing apparatus at various lagging power factors to simulate an inductive load. Ratings are: 120 v, 60 cps; 2 amp at 120 v continuous duty; inductive reactance, 60 ohms, dc resistance, 4 ohms; and inductance, 0.16 h.

Superior Electric Co., Dept. ED, Bristol, Conn.

Price & Availability: *$35; from stock.*

Insulation and Protective Coating 626

Can be used above 400 F

HumiSeal type 1H34 insulation and protective coating has a 6-month pot life and offers excellent electrical properties above 400 F. Suitable for military applications, it can be used in radioactive environments. A one-component system on silicone resin basis, the coating may be applied by spray, dip, or brush.

Columbia Technical Corp., Dept. ED, 61-02 31st Ave., Woodside 77, N.Y.

Price & Availability: *Price is $36 per gallon. Delivery time is two weeks.*

CIRCLE 78 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Spaghetti Tubing 563

Comes in wall thicknesses to 0.005 in.

This Teflon spaghetti tubing comes with wall thicknesses to 0.005 in. It can be used for lining small size metal tubing for push-pull applications where a close tolerance is needed. The tubing comes in AWG sizes 0 to 24 with an ID of 0.33 to 0.022 in.

Timely Technical Products, Inc., Dept. ED, S. Jefferson Road, Whippany, N.J.

Automatic Degausser 636

For reeled tapes

Type 5-055A automatic tape degausser can be used with tapes from 1/4 to 2 in. wide, reels from 7 to 14 in. in diameter, and reel hubs of all dimensions. A reel of instrumentation tape recorded to saturation is erased to at least 50 db below normal level. The unit is suited for bench-top operation or can be mounted in standard 19-in. racks or cabinets.

Consolidated Electrodynamics Corp., Dept. ED, 360 Sierra Madre Villa, Pasadena, Calif.

Instrument Motor 559

For remote positioning and control

Model RBC-2410 low-inertia instrument motor is for remote positioning and control applications. Furnished with heavy-duty gear reductions of 4:1 to 1800:1, the motor and gear case occupy 4-1/8 x 4-1/8 x 4-5/8 in. Typical performance ratings are 750 oz-in. minimum starting torque

and 350 oz-in. running torque at 6 rpm and 50% intermittent duty.

National Pneumatic Co., Inc., Dept. ED, 125 Amory St., Boston 19, Mass.

Price & Availability: *Price is $60 ea for orders of 100 units. Delivery is from stock.*

Thermal Switch Tester 558

Full range is 0 to 1000 F

Model X-1A thermal switch tester has an accuracy of ±5 F over the range of 0 to 1000 F. Contained in two sections in moisture-proof cases, the instrument is used to test and permit adjustment of overheat detectors and thermal switches of normally-open or normally-closed types used in missiles and aircraft. A digital readout dial operates with a null-balance circuit, permitting instantaneous readout.

Projects Unlimited, Dept. ED, 1926 E. Siebenthaler Ave., Dayton 14, Ohio.

Price & Availability: *Furnished from stock, the instrument is priced at $650 to $675.*

Wirewound Potentiometer 555

OD is 1/2 in.

Model 55W precision, single-turn, wirewound potentiometer has an OD of 1/2 in. Designed for panel trimmer control and servo applications in low and high torque models, the unit can be furnished with stops or in continuous rotation. Of all metal construction, the unit meets MIL-5272A and applicable portions of JAN R-19.

New England Instrument Co., Dept. ED, 1334 Main St., Waltham, Mass.

Availability: *From stock.*

NEW PRODUCTS

Angular Position Transducers 547

Have ranges of ±30, ±20, and ±60 deg

These angular position transducers are available in three standard capacities with useful ranges of ±30, ±20, and ±60 deg. The units can operate on ac or dc and have internal stops to prevent damage from overloads. They can be used in servo systems on aircraft control surfaces, valve positioners, and radar scanners.

Baldwin-Lima-Hamilton Corp., Electronics and Instrumentation Div., Dept. ED, Waltham, Mass. ***Price & Availability:*** *Units will be in stock by October. Price is $250 ea or $237 ea for 11- to 25-unit orders.*

Safety Latches 625

For locking cabinets

This double-safety latch for locking electronic cabinet drawers provides leverage action to inject and reject the drawer through the final 1/2 in. of travel. Requirements of MIL-E-5400C are met.

Hartwell Co., Dept. ED, 9035 Venice Blvd., Los Angeles 34, Calif.

Silicon Transistors 552

For power-switching and amplifier applications

These diffused-junction, npn silicon transistors are for power-switching and amplifier applications in the temperature range of −65 to +200 C. Collector-to-emitter voltage is 80 v for types 2N1047 and 2N1049 and 120 v for types 2N1048 and 2N1050. Power dissipation at 25 C is 40 w. The units meet MIL-S-19500B.

Silicon Transistor Corp., Dept. ED, Carle Place, N.Y.

Availability: *From stock.*

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a new pattern in semiconductor progress...

SHOCKLEY TRANSISTOR JOINS CLEVITE

In keeping with its program of advancement in semiconductors, Clevite has acquired the Shockley Transistor Corporation of Palo Alto, California.

Dr. William Shockley, noted solid state physicist and co-winner of the 1956 Nobel Prize for his work in the development of the transistor, joins Clevite, together with his research and development organization.

NEW PRODUCTS

In addition to Clevite Transistor's broad line of diodes and transistors, the corporation now offers to the industry Shockley devices which represent new advances in the semiconductor art. The Shockley 4-layer diode is a nearly ideal switch for pulse generation, pulse counting and high power switching in such applications as computers, telephone and control circuits. A new plant in Palo Alto, California, is underway to fill the growing demand for these new devices.

NEW PLANTS

Besides the new plant for the Shockley organization in California, Clevite Transistor is nearing completion of its new $4,000,000 Waltham, Massachusetts facility which will employ 2,000 people. The present Waltham plant will continue as a supplementary operation. Clevite's overseas operation, Intermetall G.m.b.H., now employs 1,000 people in a new plant at Freiburg, West Germany to serve the European market.

To find out more about our progress and our products, write:

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SHOCKLEY TRANSISTOR UNIT — STANFORD INDUSTRIAL PARK, PALO ALTO, CALIFORNIA

Single Sideband Receiver 396

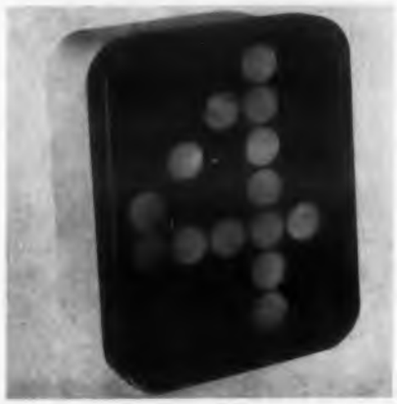
Is made up of two modules

Model 605 hf, single sideband receiver is made up of two module sections: separate rf and if-audio strips. The if-audio unit, shown, converts a hf tunable receiver to SSB use. Six bands, each covering about one octave, are used to cover a 2 to 32 mc range with overlap in the rf chassis. Reception modes include USB, LSB, simultaneous USB and LSB, AM, MCW, and FSK. Units are suited for military and commercial applications.

Wilcox Electric Co., Inc., Dept. ED, 14th & Chestnut, Kansas City 27, Mo.

Counting Indicators 376

Have 4.5 in. numbers



Displaying 4.5-in. numbers, the 1121 series counting indicators accept input pulses, register the decimal count, and generate an output pulse to count to 10, to drive the next counting indicator. Light is produced with neon gas tubes and optics; the numerals can be seen at distances over 100 ft and at angles up to 70 deg. The counters and decoders are all solid state and require 2.5 w. Models 1121 and 1122 are counting indicators that count at rates up to 100 kc and 1 mc, respectively. Models 1123 and 1124 accept 10-line inputs from switches and transistor circuits, respectively. Models 1125 and 1126 accept four line binary-coded-decimal inputs from transistor circuits.

Navigation Computer Corp., Dept. ED, 1621 Snyder Ave., Philadelphia 45, Pa.

Price & Availability: *Can be delivered 4 weeks after receipt of order. Prices start at $97.*

◀ CIRCLE 81 ON READER-SERVICE CARD

NEW PRODUCTS

DC Multimeter 394

Has full scale readings from 100 mv to 1000 v

Designed for a variety of applications, this battery-operated, transistorized dc multimeter provides nine voltage ranges with full scale readings of 100 mv to 1000 v. The instrument also has 12 current ranges, providing readings of 1 μa to 300 ma, and five resistance ranges with center scale reading of 10 to 100,000 ohms. It weighs about 8 lb and measures 10 x 6 x 5.5 in.

Motorola Inc., Dept. ED, 4501 W. Augusta Blvd., Chicago 51, Ill.
Price: *$195.*

Frequency Calibrator 391

For mobile fm systems

Known as the Zerobeat, this frequency calibration instrument is suited for netting in mobile fm communication systems, where all mobile and base stations must be maintained to the exact frequency assigned by the FCC. A 100-kc crystal oscillator controls harmonic generators and multivibrators to produce hf, vhf, and uhf signals. Output signals can saturate the limiter of receivers at all frequencies in the 30 to 50 mc, 150 to 170 mc, and 460 mc bands. Accuracy in field service is 2 ppm from −10 to +125 F. The instrument can also function as a secondary frequency standard.

The Haddam Manufacturing Co., Inc., Dept. ED, 30 Rockefeller Plaza, New York 20, N.Y.
Price: *$495.*

Ferrite Isolators 387

Frequency range is 8.2 to 12.4 kmc

Designed for operation over the entire waveguide frequency range of 8.2 to 12.4 kmc, this resonance-absorption type isolator has an insertion loss of 1 db max, 30-db min isolation, and a vswr of 1.15 max in either direction. Designed with an insertion length of 5-7/8 in., the unit is equipped with an RG-52/U size waveguide and UG-39/U flanges.

DeMornay-Bonardi, Dept. ED, 780 S. Arroyo Parkway, Pasadena, Calif.

Price & Availability: *$225 ea; 30-day delivery.*

Oscilloscope 384

General purpose, laboratory type

Model ES-525 laboratory-grade oscilloscope can be used for industrial testing as well as laboratory applications. The push-pull, vertical amplifier has a response of 3 db from 10 cps to 500 kc and 6 db up to 700 kc. Its sensitivity is 20 mv per in. The three-position vertical step attenuator is frequency-compensated. The horizontal amplifier has a response of 3 db from 10 cps to 150 kc at full gain and 60 mv per in. sensitivity. The internal linear sweep is 10 cps to 100 kc with retrace blanking and as low as 2 cps with external capacitor. Synchronization is negative, positive, external, and line. A 60-cps, sine-sweep phasing control is built in.

Precision Apparatus Co., Inc., Dept. ED, 70-31 84th St., Glendale, L.I., N.Y.

Price: *$179.95.*

NEW PRODUCTS

Shift Register 431

Permits shift rates to 700 kc

This voltage-controlled shift register, permitting shift rates to 700 kc, uses low peak and average shift pulse power. It is immune to noise and residual currents. Operating temperature range of −50 to +125 C. The unit is suited for military applications.

General Electric Co., Heavy Military Electronics Dept. ED, Court Street Plant, Syracuse, N.Y.

Power Transistors 385

Are rated at 5 amp

Types 2N1529 through 2N1538 medium-gain power transistors and types 2N1539 through 2N548 high-gain power transistors are rated at 5 amp and have a 2:1 beta spread. Germanium pnp, alloy-junction units, the transistors are for industrial switching control and amplifier applications from dc through the audio range. Collector-base breakdown voltages are 40 to 120 v, current gains are 20 to 150, and power level of switching can be up to 500 w. inductance is as high as 10 ohms and saturation resistance is as low as 0.03 ohms. The units meet MIL-S-19500.

Motorola Inc., Dept. ED, 5005 E. McDowell Road, Phoenix, Ariz.

Price: OEM price ranges from $2.50 to $12.75 ea for quantities of 1 to 99.

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GENERAL INSTRUMENT

SUBMINIATURE

silicon power diode/rectifiers

PIV up to 600 V.

high conductivity

150 ma @ 150° C.

low leakage

400 ma @ 25° C.

designed to meet USAF MIL-E-1/1143 specs

These fine silicon diode/rectifiers meet and exceed the USAF specs . . . and retain their outstanding characteristics and reliability at temperatures of 150° C. and more. **General Instrument also has available a new series of subminiature diode/rectifiers to operate at 200° C.!** Complete technical information is available upon request.

	MAXIMUM RATINGS			ELECTRICAL CHARACTERISTICS			
JEDEC TYPE NO.	PEAK INV. VOLTAGE (V)	MAX. AVG. RECTIFIED CURRENT (mA)* @ 25° C.	MAX. AVG. RECTIFIED CURRENT (mA)* @ 150° C.	MINIMUM SATURATION VOLTAGE @ 100° C. (VOLTS)	MAXIMUM REVERSE CURRENT @ PIV (uA) @ 25° C.	MAXIMUM REVERSE CURRENT @ PIV (uA) @ 100° C.	MAXIMUM VOLTAGE DROP @ 400 ma DC @ 25° C. VOLTS DC
1N645	225	400	150	275	0.2	15	1.0
1N646	300	400	150	350	0.2	15	1.0
1N647	400	400	150	480	0.2	20	1.0
1N648	500	400	150	600	0.2	20	1.0
1N649	600	400	150	720	0.2	25	1.0

*Resistive or inductive load

Semiconductor Division
GENERAL INSTRUMENT CORPORATION
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Western office 11982 Wilshire Blvd. Los Angeles 25

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CIRCLE 86 ON READER-SERVICE CARD

NEW PRODUCTS

DC Power Supply 393

Is rated at 2 to 300 v

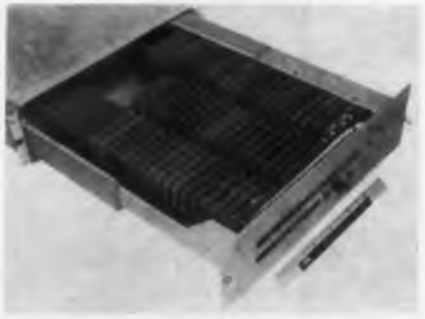
Model CS-58TRM72B power supply is rated at 2 to 300 v dc and at 0.6 to 30 amp. The preselected current is maintained during the initial charging interval to within ±2%. Voltage rises in proportion to load impedance until the preselected level is reached; voltage is then maintained within ±0.5%. Ripple does not exceed 0.2 v rms. This unit measures 82 in. in height, 22 in. in width and 24 in. in depth.

NJE Corp., Dept. ED, 20 Boright Ave., Kenilworth, N.J.

Price & Availability: *Price is from $5500 to $6000. Delivery time is six to eight weeks.*

Magnetic Core Memory Tester 380

For 19-bit core memories



Designed for testing 19-bit, 4,096 address core memories, this magnetic core memory tester measures 5.25 x 19 x 20 in. and operates from 105 to 125 v ac at 50 or 60 cps. The test may be made on selected addresses and bits or in sequence on all addresses with every combination of the 19 bits. Register indicators on the front panel show each 19-bit word written in or read out and the relevant memory address.

Packard Bell Computer Corp., Dept. ED, 1905 Armacost Ave., Los Angeles 25, Calif.

Price & Availability: *Price is $10,500; delivery time is 90 days.*

Interval Timer 389

Occupies 1 cu in.

Designed to fit into 1 cu in. of space, model 550 interval timer has a time delay range of 1 to 60 sec. The unit is built for operation in ambient temperatures of −60 to +250 F. It stands an acceleration of 60 g along each of three major axes, vibration of ±10 g sinusoidal from 10 to 2000 cps, and shock of 300 g with a duration of 20 msec. Overall accuracy is ±2%. Applications are in missile and target drones to release recovery parachutes.

The Sloan Co., Dept. ED, 7704 San Fernando Road, Sun Valley, Calif.

Price & Availability: *$100 ea; from stock.*

Frequency Standards 486

Have 1-v peak-to-peak outputs

The two models in the FS-100 series frequency standards provide an output of 1-v peak-to-peak into a 1-K sine wave or square wave. A transistorized and portable model for laboratory and field use has a stability of ±1 part in 10^8 in any frequency from 10 kc to 20 mc. It has a life expectancy of 25,000 hr with minor maintenance. The other model has a stability of ±1 part in 10^9 for the range from 50 kc to 10 mc. Both units measure 6 x 8 x 8 in. and weigh 12 lb.

Bulova Watch Co., Electronics Div., Dept. ED, 40-01 61st St., Woodside 77, N.Y.

Price & Availability: *Delivered 8 to 12 weeks after order received. Price ranges from $675 to $2700, depending on stability.*

NEW PRODUCTS

Time Standards 483

Come in 60, 200 and 400 cps

This line of time standards, the 790K series, includes standard units at 60, 200 and 400 cps. Adaptable for airborne applications, the solid state units have a stability of 0.002% or better. Frequency is derived from a precision cut oven temperature controlled crystal oscillator in conjunction with a solid-state divided circuit. Standard units come in hermetically sealed plug-in housings. Other frequencies, and special units to 100 w, are available on special order.

Systems Research Corp., Dept. ED, 18323 Parthenia St., Northridge, Calif.

Price & Availability: *Can be delivered 45 days after order received. Price is between $300 and $600 for 1 to 99 units.*

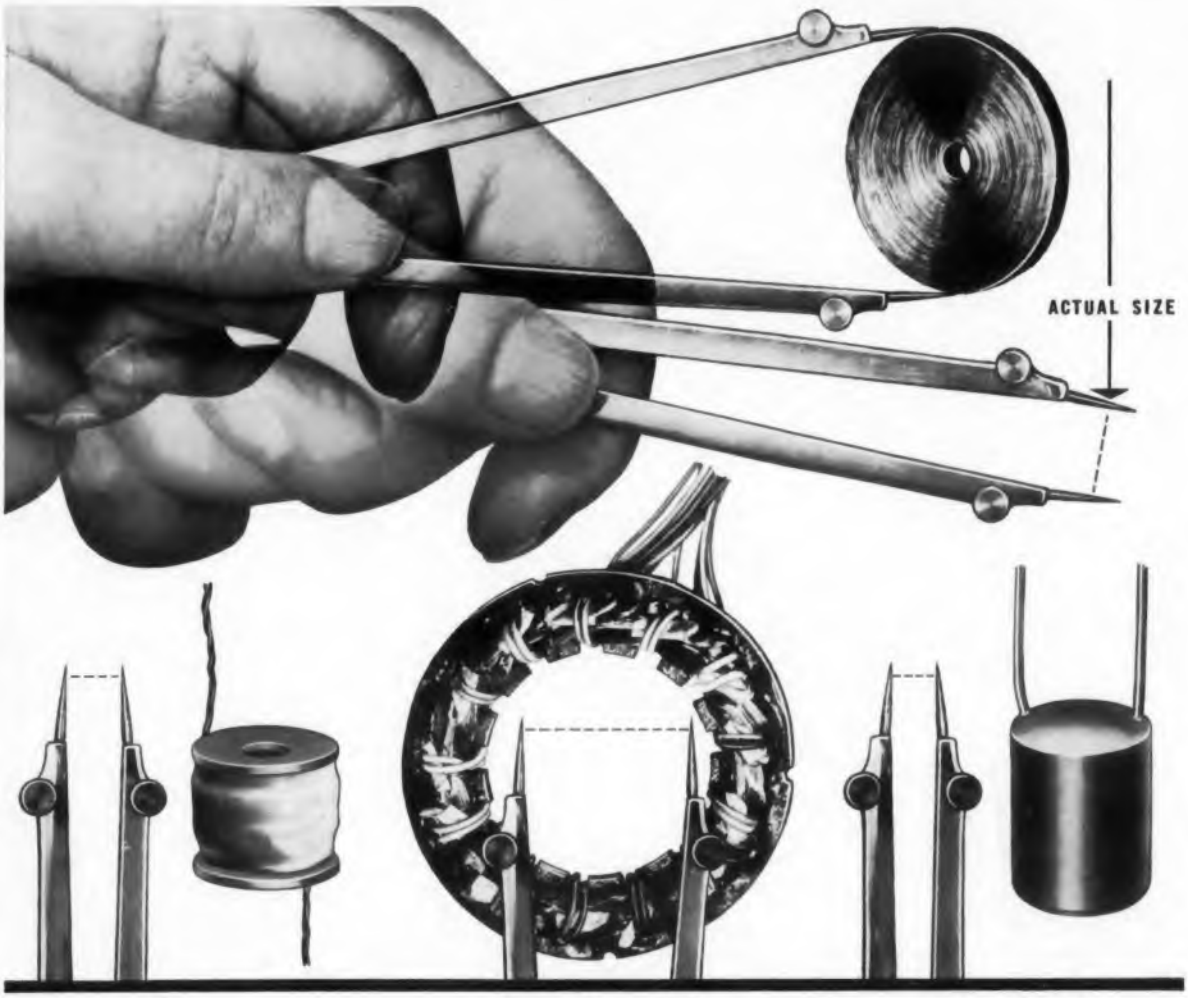
Semiconductor Networks 439

Binary multivibrator is standard unit

The standard solid circuit semiconductor network, type 502, is a binary multivibrator capable of operation at a 200-kc repetition rate. The device measures 0.25 x 0.125 x 0.031 in. and contains the equivalent of 16 conventional components. Designed to operate with a 6-v power supply, type 502 can be interconnected for use as a shift register, binary counter, or set-reset flip-flop. It is encased in a glass-to-metal hermetically sealed package.

Texas Instruments, Inc., Semiconductor-Components Div., Dept. ED, Box 312, Dallas, Tex.

Availability: *Immediately available from stock.*



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. . . manufactured on a production basis

We have the facilities to produce consistent quality miniature coils, components, and Luxolene molded fine wire coils on a production basis, and engineered to fit your exact specifications.

The Miniature Products Division was founded to furnish electrical and electronic manufacturers with **bobbin wound miniature coils—molded fine wire coils—self supported coil assemblies—completed assemblies** (plain or encapsulated)—**molded inductors—printed circuit board assemblies,** etc.

The facilities of the Miniature Products Division are especially designed and equipped to produce up to and including 56 gauge ultra-fine wire coils and other custom built components.

Luxolene encapsulated fine wire coils resist moisture, acids and abrasive conditions.

MINIATURE PRODUCTS DIVISION

Deluxe COILS, INC. WABASH, INDIANA

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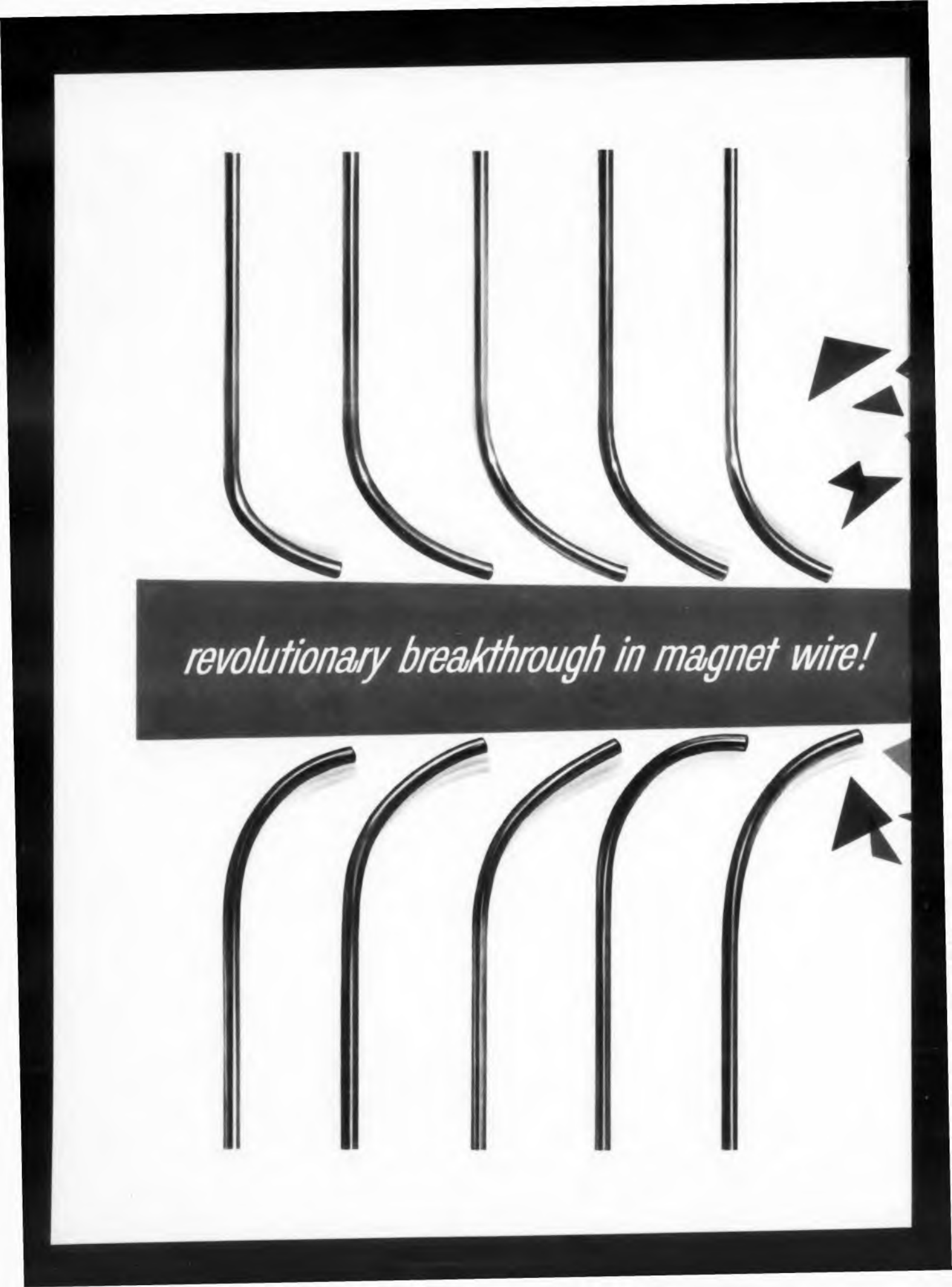
CIRCLE 207 ON READER-SERVICE CARD FOR PHELPS-DODGE COPPER PRODUCTS CORPORATION ➤


revolutionary breakthrough in magnet wire!

Now one film wire can replace six or more standard films . . .

IT'S PHELPS DODGE POLY-Thermaleze

It's possible because POLY-THERMALEZE combines the best properties of:

FORMVAR® (105C)	High abrasion—no heat shock
NYFORM (105C)	Windability—varnishability—no heat shock
EPOXY (120C)	Compatibility
NYLEZE® (130C)	Windability—varnishability
THERMALEZE B® (130C)	High cut-through resistance
THERMALEZE F® (155C)	High thermal life—high dielectric

Another Example of Phelps Dodge Applied Research!

In developing **POLY-THERMALEZE**, the industry's first multipurpose magnet wire, Phelps Dodge has made a major contribution to the electrical equipment field. This polyester film wire combines the outstanding properties of six or more conventional wires for motor, coil, dry type transformer use. **POLY-THERMALEZE** does not sacrifice one property for another—is completely balanced in all. It offers a ready means of reducing cost by standardizing inventory to one wire for most applications.

Any time your problem is magnet wire, consult Phelps Dodge for the quickest, surest answer!

FIRST FOR LASTING QUALITY— FROM MINE TO MARKET!

PHELPS DODGE COPPER PRODUCTS
CORPORATION
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Electronic Products NEWS
by CARBORUNDUM®

Temperature Compensation in Electric Eye Movie Camera provided by GLOBAR® Thermistor

Energy from a built-in photoelectric cell automatically sets the lens opening for correct exposure in the Bell & Howell "Electric Eye" movie camera. The high standard of accuracy usual in Bell & Howell products is indicated by the use of a GLOBAR Type 479H Thermistor for temperature compensation.

The output current of the photocell varies with temperature. In addition, the resistance of the coil in the operating mechanism varies with temperature because of copper's positive temperature coefficient. A negative coefficient thermistor, in parallel with a fixed resistor, provides the necessary compensation.

GLOBAR thermistors are your answer to a variety of problems where a temperature-sensitive resistor is required. Disc and rod shaped bodies are available in a wide range of sizes, providing desired resistance values, thermal time and dissipation constants and temperature coefficients. For information, write to Globar Plant, Refractories Division, Dept. EDT-60, Carborundum Co., Niagara Falls, N. Y.

ALUMINA BUBBLES... new transformer potting material can withstand temperatures over 1000° C.

Trends to higher temperatures and upgrading of insulation systems have spurred the search for new potting materials for metal-encased electronic power transformers.

Research by Bell Telephone Laboratories suggests unusual possibilities in a special form of aluminum oxide developed by Carborundum's Refractories Division. The material is made by a process which converts alumina powder into microscopic, light-weight, free-flowing, non-abrasive bubbles. Ordinary granular alumina won't serve the purpose.

Since the material can withstand over 1000° C., all practical temperature limitations are removed. Electrical insulating properties are excellent. A particular advantage is the simplicity of the potting operation. The powder is simply poured into the transformer case and tapped or vibrated so that it fills all cavities. No curing or heating facilities are necessary. Because of these factors, the material may merit consideration even in applications where high temperature is not involved. For more information, write Refractories Division, Dept. EDP-60, Carborundum Co., Perth Amboy, N. J.

Metallized Ceramics permit high-temperature soldering or brazing

Carborundum's Latrobe Plant can supply metallized steatite which can be used with any soft solder including those melting at approximately 600° F. Re-soldering can be done without adverse effects. This offers advantages over the usual silver or platinum firing of steatite material, which requires a silver bearing tin-lead eutectic solder melting at about 360° F. These joints cannot be re-soldered without dissolving the metallizing. Further, top use temperature is only 320° F. With the Carborundum metallizing, use temperature is determined only by the solder alloy used.

This type of metallizing is also used with high-alumina material for brazing. When assemblies are copper brazed, installations can be made with comparable hard solders.

For information, write Latrobe Plant, Refractories Div., Dept. EDC-60, Carborundum Co., Latrobe, Pa.

NEW BOOKLET AVAILABLE ON GLOBAR® TYPE BNR VARISTORS

Non-linear, voltage sensitive resistors are finding many electronic applications. This booklet gives full information on characteristics and sizes of GLOBAR Varistors. For your copy, write Globar Plant, Refractories Division, Dept. EDV-60, Carborundum Co., Niagara Falls, N. Y.

For ceramic parts and metallized assemblies, Kovar alloy, ceramic resistors, varistors and thermistors . . . count on CARBORUNDUM®

CIRCLE 208 ON READER-SERVICE CARD

Switch Light 709

Has a dpdt snap-action switch

Type 6B miniature switch light, incorporating a replaceable incandescent lamp with a large plastic lens, has a dpdt snap-action switch rated at 28 v dc, 7 amp resistive. Other ratings are: 4 amp, inductive, at sea level; 2.5 amp, inductive, at 50,000 ft, and 24 amp maximum inrush. The lamp and switch can also be used separately. They meet Mil specs.

Eldema Corp., Dept. ED, 1805 Belcroft Ave., El Monte, Calif.

Resistor Networks 707

Have tolerances to 0.01%

These resistor networks have resistor ratio matching accuracies to 0.005% and absolute tolerances to 0.01%. The standard temperature coefficient is 10 ppm. Distributed capacitance as low as 0.5 pf and rise time as low as 0.1 msec can be supplied. The frequency range extends to 250 kc. A variety of physical configurations are possible. The resistors are noninductively wound. Applications are summing networks, voltage division and other uses.

Kelvin Electric Co., Dept. ED, 5509 Noble Ave., Van Nuys, Calif.
***Availability:** Prototype and production quantities are immediately available.*

Time Delay Relays 354

Accuracies are ±1% and ±5%

Available in fixed and adjustable versions, these solid-state, time delay relays have nominal accuracies of ±1% and ±5% in the time period of 0.5 to 110 sec over the temperature range of −20 to +85 C. Current ratings are 2 and 5 amp with voltage inputs from 6 to 250 v ac or dc. Timing accuracy is maintained when the unit is subjected to up to 30% voltage variation.

Marstan Electronics Corp., Dept. ED, 204 Babylon Turnpike, Roosevelt, L.I., N.Y.
***Price & Availability:** $35 to $85 ea; from stock.*

CIRCLE 90 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Dual Flip-Flop 379

High speed

Type TF4 dual flip-flop is one of a series of 3-mc transistorized, digital modules. Neither eyelets nor printed circuit connectors are used. The one-voltage is —7 to —10 v; the zero-voltage is 0 to —0.3 v. Maximum rise time is 0.04 μsec, no load, and 0.08 μsec, full load. Dimensions of the laminated epoxy mounting board are 3-3/4 x 4 in.

Packard Bell Computer Corp., Dept. ED, 1905 Armacost Ave., Los Angeles 25, Calif.

***Price & Availability:** $100 ea; 15 to 60-day delivery time, depending on quantity ordered.*

Storage Tubes 413

Minimum resolution is 1200 lines per diameter

Model CK7702 dual-gun storage tube has a minimum resolution of 1200 TV lines per diameter. The stored signals can be held for many hours, read several thousand times, or erased in a fraction of a second. Signal-to-noise ratios of better than 30:1 are possible over a 28-mc bandwidth. The tube measures 25 x 2-7/8 in. and has a 1-1/2-in. neck diameter. Anode voltage is 4000 v dc.

Raytheon Co., Industrial Components Div., Dept. ED, 55 Chapel St., Newton, Mass.

Wirewound Resistors 425

Range is 10 ohms to 1 meg

Available in a range of 10 ohms to 1 meg, these precision wirewound resistors have a temperature coefficient of 15 ppm per deg C and can be furnished with a tolerance as close as 0.1%. Designed for high-frequency circuits, the resistors meet MIL-R-93R and MIL-R-9444A. Sets of values or ratios can be matched to within 0.01%. A 1-meg resistor has a capacitance of 0.5 pf.

Ultronix, Inc., Dept. ED, 111 E. 20th Ave., San Mateo, Calif.

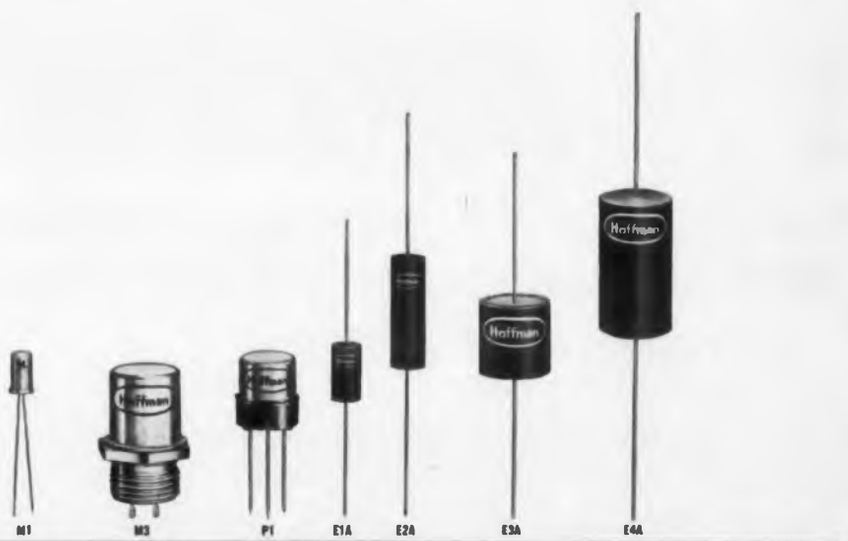
***Price & Availability:** Price ranges from $1.50 to $10 ea. Delivery time is 30 days.*

Hoffman

Hoffman

offers you more silicon zener reference devices than any other manufacturer

Mil type units now available*



YOU CAN SELECT FROM 23 TYPES

SILICON ZENER REFERENCE DIODES AND DEVICES—8 TYPES

	JEDEC TYPE NO.	CASE TYPE	OPERATING VOLTAGE AT 10mA AND 25°C (VOLTS)	MAXIMUM CHANGE IN OPERATING VOLTAGE OVER TEMP. RANGE —55°C TO 25°C AND 25°C TO 100°C	MAXIMUM DYNAMIC IMPEDANCE AT 10mA AND 25°C (OHMS)
*	1N429	M1	5.9 (Min.) 6.5 (Max.) ①	±0.05 ①	20 ①
*	1N430	M3	6.0 (Min.) 8.0 (Max.)	±0.014	15
	1N430A	M3	6.0 (Min.) 8.0 (Max.)	±0.007	15
	1N430B	M3	6.0 (Min.) 8.0 (Max.)	±0.011 ②	15
	1N1530	P1	6.0 (Min.) 8.0 (Max.)	±0.014	15
	1N1530A	P1	6.0 (Min.) 8.0 (Max.)	±0.007	15

① Operated at 7.5mA and 25°C ② ±0.007 (−55°C to +25°C) ±.0011 (+25°C to +150°C)

SILICON ZENER DECADE REFERENCE UNITS—15 TYPES

JEDEC TYPE NO.	CASE TYPE	OPERATING VOLTAGE AT 7.5mA AND 25°C (VOLTS)	MAXIMUM CHANGE IN OPERATING VOLTAGE OVER TEMP. RANGE —55°C TO 25°C AND 25°C TO 100°C	MAXIMUM DYNAMIC IMPEDANCE AT 7.5mA (OHMS)
1N1735	E1A	6.2 ± 5%	±0.050	20
1N1736	E2A	12.4 ± 5%	±0.100	40
1N1736A	E2A	12.4 ± 5%	±0.050	40
1N1737	E3A	18.6 ± 5%	±0.150	60
1N1737A	E3A	18.6 ± 5%	±0.075	60
1N1738	E3A	24.8 ± 5%	±0.200	80
1N1738A	E3A	24.8 ± 5%	±0.100	80
1N1739	E4A	31.0 ± 5%	±0.250	100
1N1739A	E4A	31.0 ± 5%	±0.125	100
1N1740	E4A	37.2 ± 5%	±0.300	120
1N1740A	E4A	37.2 ± 5%	±0.150	120
1N1741	E4A	43.4 ± 5%	±0.350	140
1N1741A	E4A	43.4 ± 5%	±0.175	140
1N1742	E4A	48.0 ± 5%	±0.400	180
1N1742A	E4A	48.6 ± 5%	±0.200	180

* USN-1N430 meets requirements of MIL-E-1/1060. USAF-1N429, MIL-E-1/1134A.

1N429: Used to maintain constant DC voltage under conditions of severe shock, vibration, and temperature. Ideal where stability of ±1% or better is specified over temperature range of −55°C to +100°C. **1N430 SERIES:** Ideal where stability of ±0.2% or ±0.1% required. **1N1530, 1N1530A:** Electrically equivalent to 1N430 and 1N430A, but intended for printed circuit use.

DECADE REFERENCE UNITS: Units, whose building block is the 1N429 zener reference diode, are used where a single zener diode does not meet the voltage output and temperature coefficient requirements. Recommended where a total stability of ±0.5% or ±1.0% over a temperature range of −55°C to +100°C is necessary. Stable under severe environmental conditions.

Request Data Sheets No. 114-859 ZD and No. 115-859 ZD.

ALL UNITS AVAILABLE OFF THE SHELF (Mil-qualified units stocked in bonded warehouses only). WRITE FOR THE ADDRESS OF YOUR LOCAL HOFFMAN SALES OFFICE OR INDUSTRIAL DISTRIBUTOR.

Hoffman / ELECTRONICS CORPORATION
Semiconductor Division
1001 Arden Drive, El Monte, California
TWX: El Monte 9735, Evanston 398
Plants: El Monte, California and Evanston, Illinois

CIRCLE 92 ON READER-SERVICE CARD

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PHOENIX, ARIZ.: Radio Specialties & Appliance Corp., 917 N. 7th St., AL 8-6121

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TUCSON, ARIZ.: Standard Radio Parts, Inc., 218 North 1st Ave., MA 3-2545

CANADA

POINTE CLAIRE, QUEBEC: Aeromotive Engineering Prod., Ltd., 147 Hymus Blvd., OX 7-0810

TORONTO: Aeromotive Engineering Prod., Ltd., 1912A Avenue Rd., RU 3-4288

FOREIGN

AUSTRALIA: Long Industrial Equipment, Sydney

BELGIUM-YUGOSLAVIA: Belram Electronics, Brussels

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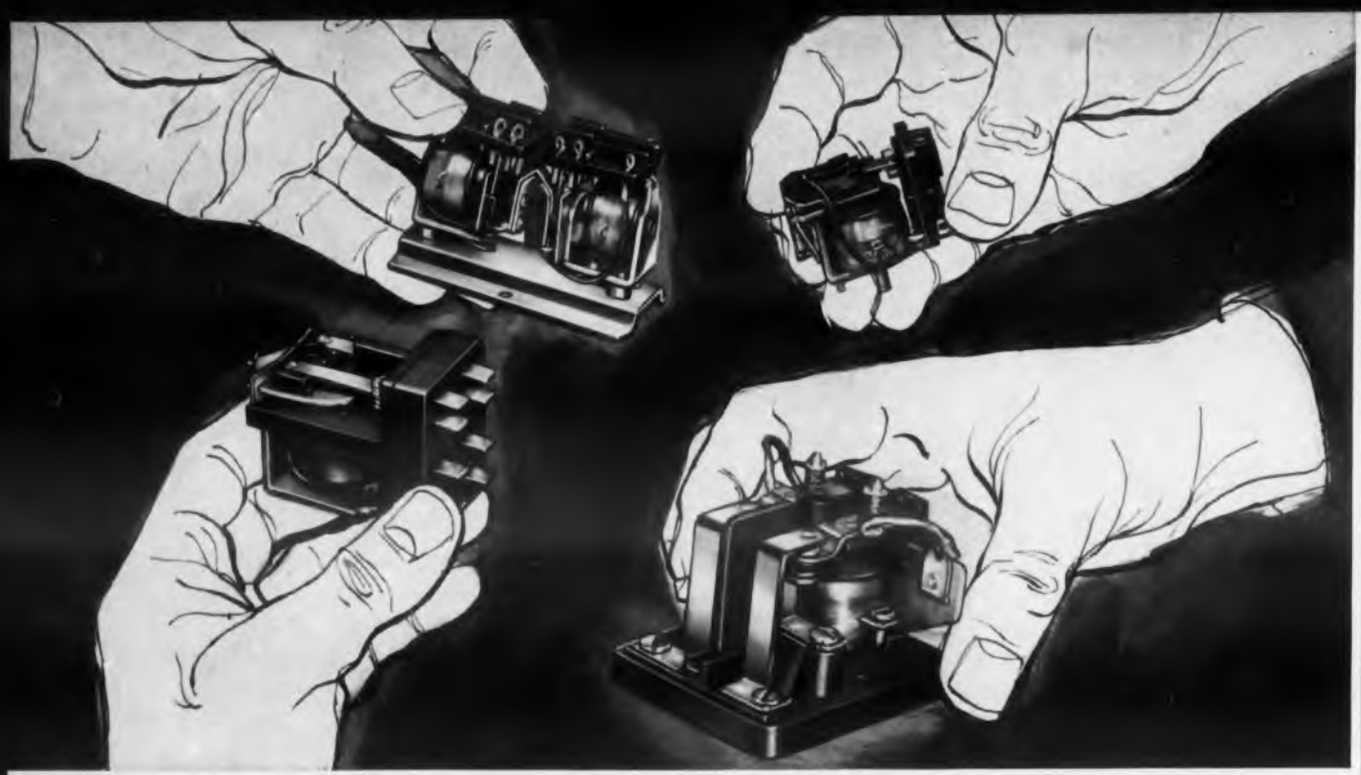


NEW PRODUCTS

Porous-Anode Capacitors 353

Measures 0.075 x 0.25 in.

Measuring 0.075 x 0.25 in. over the insulation sleeving, the porous-anode tantalum capacitor provides a high-capacitance retention at —55 C. Rated at 50 v and at 1 μf, the unit can be furnished with tolerances of ±15% and ±20% at 25 C. It stands 15 g vibration at 2000 cps. At —55 C, nominal impedance is 1600 ohms.

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

Price & Availability: *Units with a ±15% tolerance are priced at $0.68 ea in quantities to 1000; units with a ±20% tolerance, $0.75 ea. Delivery time is about 20 days after receipt of order.*

Temperature-Measurement System 717

Modular

Series G2 temperature-measurement system consists of a 20-channel signal conditioner, a calibration unit, and associated temperature transducers. The system provides for adjustable range, rapid recalibration, and direct high-level voltage readings. Total range is —320 to +1000 F. The system can be used in military, industrial, and laboratory applications.

Arnoux Corp., Dept. ED, 11924 W. Washington Blvd., Los Angeles 66, Calif.

Frequency Meter 355

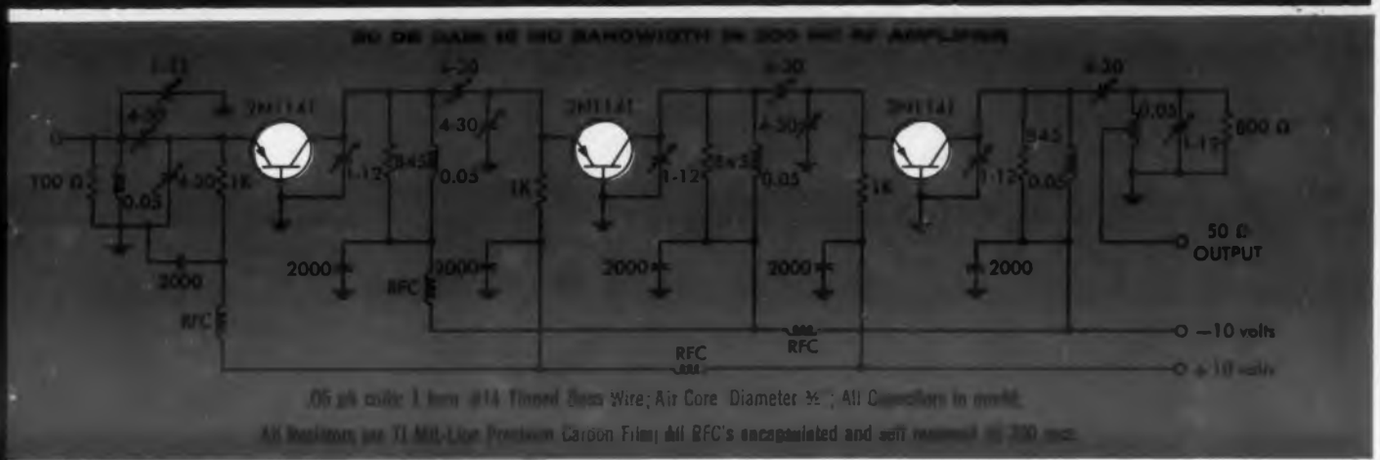
Accuracy is better than ±1%

This solid-state frequency meter has an accuracy of better than ±1%. Ranges are 0 to 20 cps, 100 cps, 500 cps, 2 kc, 10 kc, 50 kc, and 200 kc. Input is 0.2 to 300 v and input impedance is 250 K min at 1 kc. The unit is compact.

Marstan Electronics Corp., Dept. ED, 204 Babylon Turnpike, Roosevelt, L.I., N.Y.

Price & Availability: *$150; stock to two weeks.*

30 db gain in 200 mc RF amplifier

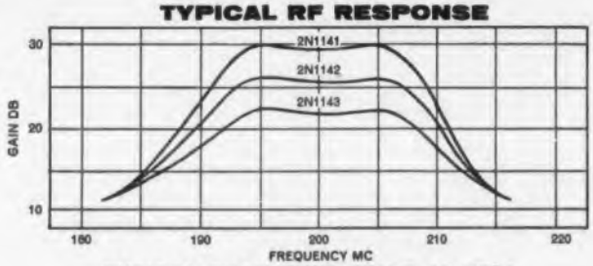


...with TI 2N1141 series germanium mesa transistors

Exceptionally high ac beta TI 2N1141 germanium mesa transistors provide 30 db gain — *with 16 mc bandwidth* — in a 200 mc RF amplifier. Ideal for your high frequency amplifiers and power oscillators, 2N1141 series diffused base transistors give you . . . maximum dissipation to 750 mw . . . voltage ratings to 35v at 100 μa I_C . . . 750 mc alpha cutoff.

These devices are backed by *more than 3,500,000 unit hours* of life test reliability data . . . see curves below.

TYPICAL RF RESPONSE

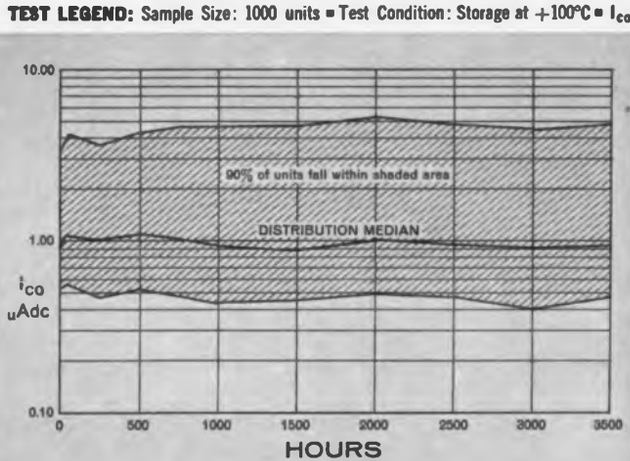


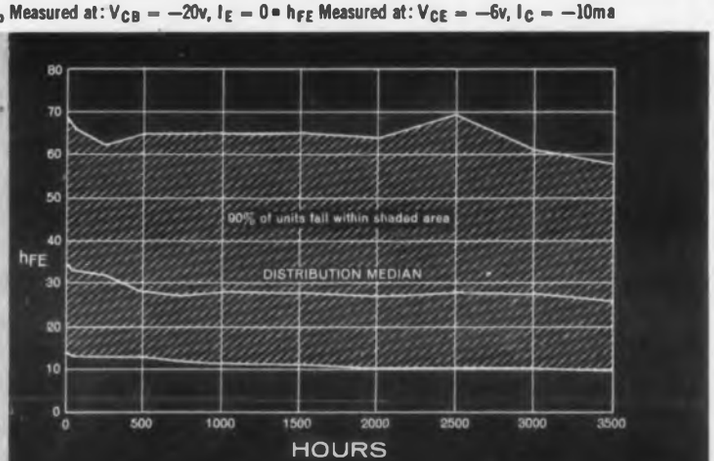
TYPICAL CHARACTERISTICS AT 25°C

	2N1141	2N1142	2N1143	unit
f_{ab}	750	600	480	mc
C_{Tc}	1.2	1.4	1.5	μμf
$r_{b'}$	65	80	110	ohms

UNIT TYPE 2N1142: I_{CBO} AND h_{FE} VS HOURS OF STORAGE AT +100°C

TEST LEGEND: Sample Size: 1000 units ▪ Test Condition: Storage at +100°C ▪ I_{co} Measured at: V_{CB} = −20v, I_E = 0 ▪ h_{FE} Measured at: V_{CE} = −6v, I_C = −10ma





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CIRCLE 94 ON READER-SERVICE CARD

CIRCLE 95 ON READER-SERVICE CARD

NEW PRODUCTS

Thermistors 352

Tolerance is ±20%

Having a tolerance of ±20%, types K and D thermistors are recommended for problems involving temperature control, temperature compensation, time delay, and voltage regulation. Type K has resistances of 1 to 100 K at 25 C and operates to 300 C. Units can be furnished for operation to 600 C. Type D has resistances of 0.1 to 100 K at 25 C. A disc-type unit, it has a maximum operating temperature of 150 C.

Walter Kidde & Co., Inc., Dept. ED, Main St., Belleville, N.J.
Price & Availability: *Type K is priced at $1.95 ea for orders of 10 to 50 units; type D is priced at $0.50 ea for orders of 20 to 50 units. Delivery is in one week.*

Insulator Wafer 351

For stud-mounted diodes

This hard-anodized, insulator wafer for stud-mounted diodes provides excellent dielectric insulation and thermal conductivity. It is for installation between diode and chassis and between hex-jam-nut and chassis. Five diameter sizes are offered for the following stud sizes: No. 8-32, No. 10-32, and No. 1/4-28.

Monadnock Mills, United-Carr Fastener Corp., Dept. ED, San Leandro, Calif.
Availability: *From stock.*

Power Triode 367

Is rated at 10 kw

For use into the vhf spectrum, type X762 ceramic and metal triode is for variable load service such as industrial-heating oscillator applications. Typical operation as an oscillator at 110 mc results in over 20 kw of useful output. The unit has a large thoriated-tungsten filament with reserve emission and an integral, finned, air-cooled anode rated at 10 kw dissipation.

Eitel-McCullough, Inc., Dept. ED, San Carlos, Calif.

◀ CIRCLE 96 ON READER-SERVICE CARD

UHF Preamplifier 693

Noise figure is better than 5 db at 500 mc

Designed for use in the range of 500 to 900 mc, model 1003 uhf preamplifier has a noise figure of better than 5 db at 500 mc and 6 db at 900 mc with a nominal gain of 20 db. The unit is pretuned to the required frequency with a bandwidth up to 15 mc. A two-stage, grounded grid cavity amplifier, the unit incorporates two planar triodes. Input and output impedance is 50 ohms. Connectors are standard type N.

Community Engineering Corp., Dept. ED, P.O. Box 824, State College, Pa.

***Price & Availability:** $495; 45-day delivery.*

Frequency Counters 511

Have in-line readout

These frequency counters have an in-line display with all digits formed on the surface plate. The display is readable from the top or sides at angles as close as 30 deg. Digits are 1-1/2 in. high and are red for visibility in high ambient light.

Beckman Instruments, Inc., Berkeley Div., 2200 Wright Ave., Richmond, Calif.

***Price & Availability:** Price is $30 to $45 per digit more than standard counter. Shipment will begin in July.*

Low-Pass Filter 516

Minimum attenuation is 40 db

Designed for use in the output stage of a personal page transmitter operating on a 60-kc carrier frequency, model LF-122 filter provides a minimum attenuation of 40 db throughout aircraft and citizen-band frequencies. It carries 75 w peak and 25 w normal and can be driven from source impedances of 5 to 10 ohms. Output is to the transmitter's loop antenna.

Control Electronics Co., Inc., Dept. ED, 10 Stepar Place, Huntington Station, L.I., N.Y.

CIRCLE 97 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Precision Potentiometer 435

Can provide 0.05 in. full travel

For measuring extremely short mechanical travel or deflection, this precision potentiometer provides full travel as small as 0.05 in. with a resolution of 0.5%. Uses are in measuring distortion or expansion of missile parts due to heat. It is also suited to measuring deflections in structural testing. A spring-loaded, rectilinear unit, it stands temperatures from −65 to +275 F, 50 g acceleration on all axes, and shock of 100 g for 3 msec.

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

Miniature Test Clips 399

With hex nuts

These test clips with hex nuts for adjustment of tension are for use in testing resistors, transistors, capacitors, and other pigtail-type components. They can also be used for single-wire connections and for bread-board work. The single unit, type 2-41, requires 3/16 x 1/8 in. and the double unit requires 1/4 x 1/8 in., exclusive of the tension-adjusting nut. All metal parts are nickel-plated brass.

Grayhill, Inc., Dept. ED, 561 Hillgrove Ave., LaGrange, Ill.

Price: Type 2-41, $0.25; type 2-42, $0.30.

CIC PRECISION FILM POTS

AVAILABLE FROM STOCK!

You can have any of these precision film pots on their way to you within hours. No need to wait for "custom" pots.

LINEAR SINGLE TURN FILM POTENTIOMETERS

Diameter	Resistance	Linearity
1/2"	1K	± .5%
	10K	± .5%
	50K	± .5%
7/8"	1K	± .5%
	10K	± .5%
	50K	± .5%
	1K	± .25%
	10K	± .25%
	50K	± .25%
1-3/32"	1K	± .5%
	10K	± .5%
	50K	± .5%
	1K	± .25%
	10K	± .25%
	50K	± .25%
2"	5K	± .25%
	20K	± .25%
	50K	± .25%
	5K	± .1%
	20K	± .1%
	50K	± .1%
3"	5K	± .1%
	20K	± .1%
	50K	± .1%
	5K	± .05%
	20K	± .05%
	50K	± .05%

SINE-COSINE SINGLE TURN FILM POTENTIOMETERS

Diameter	Resistance	Conformity
1-3/32"	10K	± .75%
	20K	± .75%
2"	10K	± .25%
	20K	± .25%
3"	10K	± .15%
	20K	± .15%

LINEAR MOTION FILM POTENTIOMETERS

Size	Resistance	Stroke	Linearity
1" Sq.	10K	1" Stroke	± .5%
	20K	1" Stroke	± .5%
	10K	2" Stroke	± .25%
	20K	2" Stroke	± .25%
	10K	3" Stroke	± .1%
	20K	3" Stroke	± .1%

Write or call in your order! Potentiometers will be in your plant within 24 hours.

COMPUTER INSTRUMENTS CORPORATION

90 MADISON AVE., HEMPSTEAD, L. I., N. Y.

CIRCLE 99 ON READER-SERVICE CARD

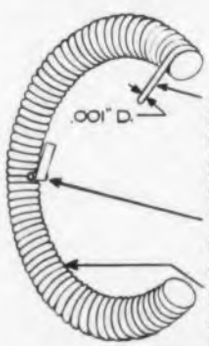
WHY GAMBLE?

RELIABILITY

is a NATURAL...

WITH CIC PRECISION FILM POTS!

HERE'S WHY!

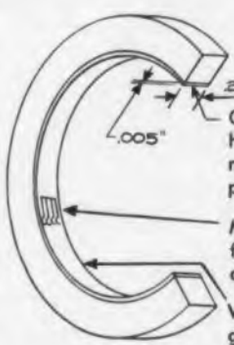


WIRE-WOUND... THE HARD WAY

All current carried by a single fragile hair-like wire. Cutting *any* one turn causes no-warning, catastrophic failure—for 2,000 turns, 2,000 chances for element failure!

Single bar contact wiper — one microscopic dust particle can cause an open — 1:1 odds on failure!

In one traverse wiper must make switch-like contact to *each* turn for continuity — for 2,000 turns, 2,000 chances for opens!



FILM POT... THE EASY WAY

Current carried by broad band of hard carbon film with an *infinite* number of current paths — *ZERO* probability of element failure!

Multiple fingered wiper — each finger with different natural frequency — odds on opens 1:16!

Wiper rides on continuous film, glass smooth, self-lubricating carbon — *ZERO* probability of opens!

Precision film potentiometers are *inherently* four million times more reliable than wire-wound types! Write for our Tech Note "Reliability Factors in Precision Potentiometers" for the whole story.

FIRST IN FILM POTS

COMPUTER INSTRUMENTS CORPORATION

92 MADISON AVENUE, HEMPSTEAD, L.I., N.Y.

CIRCLE 100 ON READER-SERVICE CARD

NEW PRODUCTS

Millivoltmeter 478

Measures down to 100 mv

This transistorized, portable audio-rf millivoltmeter provides accurate measurements down to 100 mv over a frequency range of 20 cps to 20 mc. Battery operated, the meter has full-scale reading in 12 ranges from 1 mv to 300 v. The unit has a built-in video amplifier for use with the meter to drive an oscilloscope. An input impedance of 10 meg shunted by 7 pf is provided in the 1 to 300 v ranges; an input impedance of 1 meg shunted by 14 pf is provided in the ranges of 1 to 300 mv. Accuracy is within ±3% of full scale from 100 cps to 5 mc and within ±5% from 20 cps to 20 mc.

Motorola Inc., Communications and Industrial Electronics Div., Dept. ED, 4501 W. Augusta Blvd., Chicago 51, Ill.

Permanent Magnet Shaker 414

For testing and calibrating light components

The Permag 25-lb permanent magnet shaker is for testing and calibrating light electronic components. The use of a phenolic-impregnated textile suspension system provides strict linearity from 5 to 10,000 cps. The system requires no special rigs or mounting devices for back-to-back calibration of accelerometers.

Ling-Altec Electronics, Inc., Dept. ED, 1515 S. Manchester, Anaheim, Calif.

Plate Circuit Relay 434

Operates to 125 C

This 6 pdt relay operates directly in the plate circuit of a vacuum tube. The coils operate at

150 to 200 v with 0.01 to 0.013 amp. Temperature range is −65 to +125 C. The relay has no bounce and can stand 30 g vibration to 2000 cps and 100 g shock. Dimensions are 1.86 x 1.18 in.

Pacific Scientific Co., Dept. ED, 6280 Chalet Drive, Bell Gardens, Calif.

Cathode-Ray Tubes 432

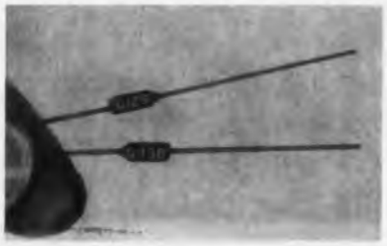
Storage-type

These Tonotron direct-viewing, storage-type cathode-ray tubes have 7- and 10-in. flat-surface viewing screens. They can be used in ground systems or in airborne applications to provide navigators and operators with a large viewing area having a minimum of distortion. Both tubes use high-speed axial writing guns, magnetic deflection, and a standard erase circuit.

Hughes Aircraft Co., Vacuum Tube Products Div., Dept. ED, Los Angeles 45, Calif.

Silicon Diodes 470

Have controlled forward characteristics



Silicon diodes types G129 and G130 are low-voltage reference diodes that utilize the forward characteristics rather than the reverse characteristics. They are for low-level switching applications and are suited for use in transistor bias networks, temperature-sensing circuits, and voltage stabilizers. Type G129 is made by the diffusion process and type G130 is made by the alloy process for replacing alloy stabistors.

Texas Instruments, Inc., Dept. ED, P.O. Box 312, Dallas, Tex.

Price & Availability: Price is $1.30 ea for quantities of 1 to 99. Delivery is from stock.

NEW PRODUCTS

DC Power Supply 395

Regulation is better than 0.1%

Designed for laboratory use, this transistorized, dc power supply has an automatic current limiting circuit and a voltage regulation of better than 0.1%. Short-circuit current can be selected on the front panel from the following: 40, 100, 200, and 350 ma. Voltage range is 0 to 32 v. Input is 105 to 125 v at 50 to 400 cps. Ripple is less than 1 mv and output impedance is less than 0.2 ohms.

Power Instruments Corp., Dept. ED, 235 Oregon St., El Segundo, Calif.

Price & Availability: *Price is $198. Delivery is from stock.*

Thyristors 412

Germanium, pnp type

Types 2N1213, 2N1214, 2N1215, and 2N1216 high-speed, bistable switching transistors, using the JEDEC TO-5 package, are designed for use in industrial and military data-processing systems and automatic-control systems. Germanium, pnp, diffused-junction types, these units combine the useful characteristics of Mesa transistors and thyratrons, are bistable, and perform like a switch with a memory. At 50 C, the dissipation rating is 75 mw.

Radio Corp. of America, Semiconductor & Materials Div., Dept. ED, Somerville, N.J.

Connectors 433

For coaxial cable

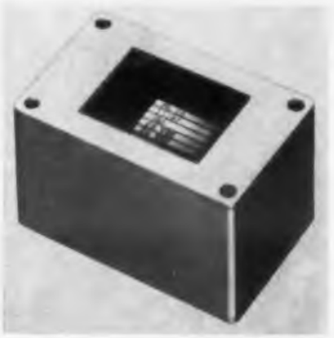
The K-Grip rf connectors for coaxial cable eliminate the need for a captive contact. Connector parts can be readily removed for inspec-

tion or replacement without impairing the electrical characteristics of the cable assembly.

King Electronics Co., Inc., Dept. ED, 40 Marbledale Road, Tuckahoe, N.Y.

DC Voltage Regulator 482

Is a 20-v power source



Model PR-10 dc voltage regulator provides a dual plus and minus 20-v power source for as many as 18 subcarrier oscillators. Each regulator section supplies 20 v, regulated to ±0.5%. The unit withstands vibration loads of 20 g from 50 to 2000 cps, and shock and acceleration of 200 g. Sealed in an all-aluminum case, the regulator measures 3 x 1-7/8 x 1-5/8 in. and weighs 9.8 oz.

United ElectroDynamics Inc., Dept. ED, 200 Allendale Road, Pasadena, Calif.

Price & Availability: *Available from stock and delivered 10 to 30 days after receipt of order. Price is $465 for 1 to 9 units, $445 for 10 to 49, and $430 for 50 to 99.*

Coaxial Terminations 398

Handle 1 w, cw

Designed for use where a low-reflection, coaxial load is required, these coaxial, type N terminations have a vswr of 1.05 max from dc to 1000 mc, a nominal impedance of 50 ohms, and a power handling capacity of 1 w, cw. Not affected by humidity or temperature changes, the units are supplied with individual calibration charts.

Maury & Associates, Dept. ED, 10373 Mills Ave., Pomona, Calif.

Price: *$27.50 ea.*

NEW PRODUCTS

Digital Capacity Meter 480

Scans large numbers of capacitors

For scanning large numbers of capacitors, this digital capacity meter measures capacitance and dissipation factors. The analog parameters are converted to their digital equivalents; the digital data is presented in both visual and 10-line decimal contact closure form. Capacitance range is 10 pf to 999.9 μf, dissipation-factor range is 0.001 to 0.999, and accuracy is 1% ±1 digit. Test frequencies are 120 and 1000 cps.

Electro Instruments, Inc., 3540 Aero Court, San Diego 11, Calif.

Analog Integrator Networks 447

With double-trimming

These analog integrator networks consist of 1 to 18 input branches and a feedback, integrating capacitor in an oil-filled, hermetically sealed can. Both the initial RC product and the drift coefficients of the RC product are individually, independently trimmed during manufacture without the use of variable resistors or trimming controls. The absolute time-constant accuracy at 25 C is ±0.01%. Maximum voltage retrace is ±0.0005% during five cycles of 150 v for 30 min. Applications are as analog computer integrators, timing system operational amplifiers, timing devices, and control devices.

Julie Research Labs., Inc., Dept. ED, 556 W. 168th St., New York 32, N.Y.

Availability: *Networks are made on order for six-week delivery.*

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Available now for reliable, high-speed switching!

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2N705
2N710
2N711
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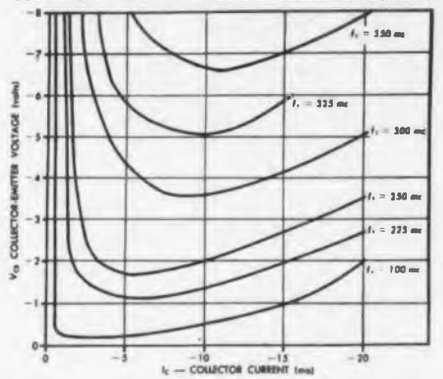
New, PNP diffused-base germanium units . . . designed, produced and controlled specifically for reliable performance in high-speed switching service.

As with all Sylvania computer-type semiconductor devices, rigid quality controls are applied to the manufacturing processes and materials for Mesa Transistors. These assure exceptionally high performance, electrical uniformity and long life. Tests that simulate extreme environments give maximum assurance of reliability.

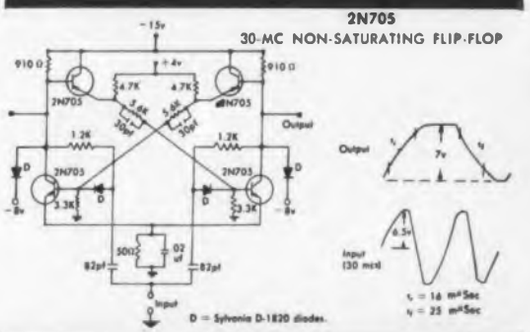
Sylvania Mesa Transistors are available through your Sylvania Field Office or your local Sylvania franchised Semiconductor Distributor. For technical data, write Semiconductor Division, Sylvania Electric Products Inc., Dept. 186, Woburn, Mass.

2N705 GAIN BANDWIDTH PRODUCT vs. COLLECTOR-EMITTER VOLTAGE and COLLECTOR CURRENT



Note: The product of high frequency beta times the frequency of measurement gives the frequency f_T at which beta is unity.

2N705
30-MC NON-SATURATING FLIP-FLOP



ELECTRICAL CHARACTERISTICS AT 25°C

Characteristics	2N705 Min.	2N705 Typ.	2N705 Max.	2N710 Min.	2N710 Typ.	2N710 Max.	Units
BV_{CBO} $I_C = -100\ \mu A$, $I_E = 0$	−15.0	–	–	−15.0	–	–	V
BV_{CEO} $I_B = -100\ \mu A$, $I_C = 0$	−3.5	–	–	−2.0	–	–	V
BV_{CES} $I_C = -100\ \mu A$, $V_{BE} = 0$	−15	–	–	−15.0	–	–	V
h_{FE}	25 @ $V_{CE} = -3V$, $I_C = -10$ mA			25 @ $V_{CE} = -5V$, $I_C = -10$ mA			
V_{BE} $I_B = -.4$ mA, $I_C = -10$ mA	−.34	–	−.44	−.34	–	−.50	V
I_{CBO} $V_{CB} = -5V$, $I_E = 0$	–	–	−3.0	–	–	−3.0	μA
V_{CE} $I_B = -.4$ mA, $I_C = -10$ mA	–	–	−.30	–	–	−.50	V
$t_d + t_r$ $I_{B1} = -1.0$ mA, $V_{CC} = -3.5V$, $V_{BE}(off) = 0.5V$, $R_L = 300\ \Omega$	–	60	75	–	60	75	mμSec
t_s $I_{B1} = -1.0$ mA, $V_{CC} = -3.5V$, $I_{B2} = 0.25$ mA, $R_L = 300\ \Omega$	–	75	100	–	75	100	mμSec
t_f $I_{B1} = -1.0$ mA, $V_{CC} = 3.5V$, $I_{B2} = -0.25$ mA, $R_L = 300\ \Omega$	–	80	100	–	80	100	mμSec

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CIRCLE 107 ON READER-SERVICE CARD

CIRCLE 108 ON READER-SERVICE CARD

NEW PRODUCTS

Amplifier 485

Has a bandwidth of 10 to 10,000 cps

Developed for use as a buffer preamplifier, model AMP-677 amplifier has a bandwidth of 10 to 10,000 cps (3-db points) and a noise equivalent voltage of 3 mv for a 5-meg input impedance. Phase shift is negligible between 300 to 500 cps. Adjustable gains are possible by applying a proper summing resistor to the summing junction pin; a 500-K resistor gives a gain of 10, and a 50-K resistor, a gain of 100. The summing junction impedance is 500 ohms max and typically 200 ohms. The 1-oz unit meets MIL-E-5400 and MIL-E-5272.

Bulova Watch Co., Electronics Div., Dept. ED, 40-01 61st St., Woodside 77, N.Y.

Price & Availability: *Available after June 1; delivery time will be 12 weeks. Unit price is $325.*

Epoxy 416

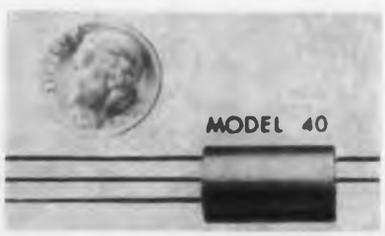
Is flame-resistant

Type 1202 flame-resistant epoxy is suitable for such applications as computers. Several forms, including molded cylindrical and square shells, custom-molded components, and liquid resin, are offered. Dielectric constant at 1 meg is 5.6 and dissipation factor is 0.028.

Epoxy Products, Dept. ED, 137 Coit St., Irvington, N.J.

Silicon Transistor Choppers 479

Temperature range is —55 to +150 C



Models 40 and 40P silicon transistor choppers

are solidly encapsulated units designed to alternately connect and disconnect a load from a signal source. They may be used as synchronous demodulators to convert ac to dc. Able to operate over the temperature range of −55 to +150 C, the units perform linear switching or chopping of voltages from less than 1 mv to ±15 v. They can be driven from dc to 50 kc. Model 40P is a plug-in unit.

Solid State Electronics Co., Dept. ED, 15321 Rayen St., Sepulveda, Calif.

Price & Availability: *Model 40P is priced at $79; model 40, $75. Delivery is one week after receipt of order.*

RF Toroidal Coils 400

Inductance range is 1.5 to 18.7 mh

Series 1218 rf toroidal coils cover an inductance range of 1.5 to 18.7 mh. Typical Q-values are 150 to 180 from 3 to 12 mc. Hermetically sealed, the units are for applications in rf filters, rf amplifiers, receivers, and general communications equipment. The case is 2-1/32 in. OD and 3/4 in. high.

North Hills Electric Co., Inc., Dept. ED, 402 Sagamore Ave., Mineola, N.Y.

Price & Availability: *Samples are priced at $4.75 ea and can be delivered from stock.*

Power Transistors 421

Are rated at 15 amp

Designed for high current switching, dc-dc converters, and audio applications, these 15-amp transistors have collector-base breakdown voltages from 40 to 120 v and narrow beta spreads. Types 2N1549 through 2N1552 have a gain of 10 to 30, types 2N1553 through 2N1556 have a gain of 30 to 60, and types 2N1557 through 2N1560 have a gain of 50 to 100. The units can be used as switches at power levels up to 1200 w and have switching speeds from 15 μsec to 30 μsec.

Motorola Inc., Dept. ED, 5505 E. McDowell Road, Phoenix, Ariz.

Price & Availability: *Price ranges from $3.35 to $12.75 ea when ordered in quantities of 1 to 99. Units are available through distributors.*

NEW PRODUCTS

Linear-Variable-Differential Transformer 392

Linearity is 0.25%

Type 360-1 linear-variable-differential transformer has a range of ±0.15 in. and a linearity of 0.25% or better. The unit operates from 6.3 v at 60 cps and has a sensitivity of 10 v per in. Operating temperature range is −60 to +220 F. For measuring or sensing linear motion, the transformer consists of a primary winding and two secondary windings spaced axially along an encapsulated bobbin. It can be used to measure changes of linear motion as small as 0.0001 in.

Magnetic Instruments Co., Inc., Dept. ED, 546 Commerce St., Thornwood, N.Y.

***Price:** Standard production models are priced at $25 to $95 ea in small quantities.*

Terminal Attaching Machine 426

For sizes 10 to 22 wire

This high-speed terminal-attaching machine installs a variety of terminal styles on sizes 10 to 22 wire. Terminals may be ring, spade, fork, hook, snap-on, and snap-in types, with or without insulation grip. A change in the wire size is accommodated by turning the selector dials, which automatically provide necessary adjustments.

The Thomas & Betts Co., Dept. ED, Elizabeth 1, N.J.

***Price & Availability:** Machines are for lease or rental.*

Welding Device 419

Is rated at 2700 w-sec

For installation in drying chambers where transistors and other electronic components are assembled, type M welding device is rated at 2700 w-sec or 50 kva ac. The unit permits the use of low welding currents and low electrode pressures. An electronic timer provides for precise control. Welding is initiated by foot or palm switches or by automatic programing.

Raytheon Co., Product Equipment Operations, Commercial Apparatus & Systems Div., Dept. ED, 87 S. Bedford St., Manchester, N.H.

***Price:** $1250 ea.*

Radar Camera Test Set 515

Provides four test phases

Model LM-56A radar-recording-camera test set, for testing the quality and reliability of radar film recordings, provides the following test phases. Phase I provides a simulated sweep display to check shutter operation and film shift. Phase II photographs the display of the camera being tested to determine shutter-open and shutter-closed time periods within 0.001 sec. Phase III inspects exposed film to check camera accuracy for alternate photographing of a radar scope display and the target, which are simultaneously viewed through a bombsight. Phase IV provides electrical pulses to check camera controls.

Mast Development Co., Inc., Dept. ED, 2212 E. Twelfth St., Davenport, Iowa.

***Availability:** Units are made on order and can be supplied in 90 days.*

Multivibrators 521

Weigh less than 2 oz

These plug-in multivibrators are for use in pulse and gate generation, delay, counting, and amplitude comparison. Each unit weighs less than 2 oz and measures 7/8 x 7/8 x 1-7/8 in. Nuvistor vacuum tubes are used. The MMV monostable units provide rectangular output pulses or gates lasting from 1 μsec to 1 sec. The AMV astable series provides symmetrical or asymmetrical gate outputs at rates to 10 mc. The BMV bistable series has a flip-flop for gating and binary counting applications and comes in three types with switching rates of 0.1, 1, and 10 mc. Capable of switching rates to 1 mc, the ST Schmitt trigger series requires a quasi-descript input signal and can be used for amplitude comparison applications.

Mini-Rad, Inc., Dept. ED, 7416-E Varna Ave., N. Hollywood, Calif.

***Price & Availability:** Prices range from $28 to $125 ea for 1 to 9 units. Delivery is in two to four weeks.*

NEW PRODUCTS

C-Band Cavity 440

Tunable from 5350 to 5950 mc

Used in beacons, transponders, and similar applications, this miniaturized C-band oscillator cavity is tunable from 5350 to 5950 mc. It uses GE tube type 7486, an oscillator version of 7077. Depending on the individual tube selected, output powers over 50 w are possible at the low end of the band. Minimum peak powers are put at 10 w for the entire band. The unit withstands a shock of 100 g for 3 msec in each of three major axes. It weighs about 4 oz and measures 1 in. diam by 2-1/2 in. long, excluding mounting brackets and output connector.

Trak Electronics Co., Microwave Components Dept., Dept. ED, 49 Danbury Road, Wilton, Conn.

Vacuum Pump 423

High-speed type

Model PDV-30 vacuum ion pump has the following pumping speeds: air at 25 liters per sec, argon at 8 liters per sec, methane at 28 liters per sec, and hydrogen at 15 liters per sec. Speeds are constant over the entire pressure range. Pressures to 1×10^{-10} mm Hg are possible. Applications include semiconductor processing, thin film work, vacuum tube processing, and electron microscopy.

Consolidated Vacuum Corp., Dept. ED, Rochester, N.Y.

***Price:** $1630 fob Rochester.*

Feedthrough Capacitors 448

For use up to 1000 mc

Designed for use in radio interference suppression, these miniature feedthrough capacitors are for use up to 1000 mc. Attenuation charac-

teristics are excellent. Suited for many radar and communications applications, the units come in non-magnetic tubular cases made to stand environmental extremes. Standard types are mylar, foil, metallized paper, polystyrene, metallized mylar, and hermetically sealed paper.

Hopkins Engineering Co., Dept. ED, 12900 Foothill Blvd., San Fernando, Calif.

Reference Diodes 438

Voltage ranges from 3.3 to 12 v, ±5%

Designated USN 1N746, this glass reference diode series includes 14 standard types of silicon diodes with voltage ranges from 3.3 to 12 v ±5%, and dissipates 400 mw at 25 C. The series meets MIL-E-1/1258 (Navy) and/or MIL-E-1/1259 (Navy). Another diode series, USN 1N1816, includes 42 standard types of silicon power regulator diodes with voltage ranges from 10 to 150 v ±5%, and dissipates 10 w at 50 C. It meets the same requirements.

Texas Instruments, Inc., Semiconductor-Components Div., Dept. ED, Box 312, Dallas, Tex.

Electronic Counter 474

Bi-directional

Model 500T add-subtract electronic counter operates in a control counter having bi-directional capability, anti-coincidence input circuits for add-subtract inputs, a digital-to-analog converter, and an excess error alarm. The unit can be used for digital control of such parameters as flow, rpm, positioning of parts, and shearing.

Erie Pacific, Dept ED, 12932 S. Weber Way, Hawthorne, Calif.

Availability: *Units can be delivered in 60 days.*

NEW PRODUCTS

PAM/PDM Multicoder 388

For rocket test stands

The RL series of solid-state, low-level, PAM/PDM multicoders is built for ground environments, such as rocket test stands, wind tunnels, and similar ground installations. Output signal level is 5 v, full scale. Gating circuitry eliminates switch transients at the beginning and end of the pulses. Input is 115 v at 60 cps. The unit shown is a 90-channel, universal type with a linearity of within 0.25%.

General Devices, Inc., Dept. ED, Princeton, N.J.

Availability: Delivery time is 30 days.

Product Recorder 429

For multiple measurements

Model 6717 product recorder is suited for watt and kilowatt recording and for multiple measurements such as weight and speed or flow and density. The recorder houses two independent measuring systems within a single case. Employing two electronic amplifiers, the instrument operates on a null-balance principle. Chart speeds are 1 in. per hr to 0.5 in. per min. The scale measures 10 in.

Weston Instruments Div., Daystrom, Inc., Dept. ED, 614 Frelinghuysen Ave., Newark 12, N.J.

Ferrite Isolators 484

Come in six models

These six models of ferrite isolators each consist of rectangular waveguide with a permanent-magnet transverse field and ferrite sections built

into the unit. The following frequency ranges are covered: 2:6 to 3.95 kmc; 3.95 to 5.85 kmc; 5.85 to 8.2 kmc; 7 to 10 kmc; 8.2 to 12.4 kmc, and 12.5 to 18 kmc. Most models have a 1.15 vswr. Average power ranges from 5 to 20 w.

General Precision Inc., Kearfott Div., Microwave Products, Dept. ED, 14844 Oxnard St., Van Nuys, Calif.

Vibration Test Chamber 477

Access ports are in bottom and side

Model FBV-8-3-3 temperature-vibration test chamber has vibration access ports through the bottom and through the side. A hydraulic lift assembly is used. Standard temperature range is —100 to +300 F. The chamber is mounted on heavy-duty 5-in. casters with wheel locks. Interior size is 26 x 26 x 24 in.

Conrad, Inc., Dept. ED, 141 Jefferson St., Holland, Mich.

Price & Availability: *Price ranges from $6500 to $7500. Delivery is 45 to 60 days after ordering.*

Microminiature Connectors 444

Have 2, 3, 4, 5, and 7 contacts

Available with 2, 3, 4, 5, and 7 contacts, the 4A connectors have a 0.5-in. diam. They are waterproof and resist high breakdown voltages. Positive locking is by means of a lockband that latches automatically. Sockets are closed-entry type.

Viking Industries, Inc., Dept. ED, 21343 Roscoe Blvd., Canoga Park, Calif.

Price & Availability: *Price is about $5 ea when ordered in quantities of 100. Delivery requires two to four weeks.*

NEW PRODUCTS

Electric Gyro 377

Has 2 deg of freedom

Type PHU miniature electric gyro has 2 deg of freedom and is able to maintain its accuracy in severe operating conditions. The unit measures 2 x 2.5 in. and weighs 250 g. Scorsby drift is 1 deg per min, with outer gimbal readout.

Greenleaf Manufacturing, Div. of Mandrel Industries, Inc., Dept. ED, 7814 Maplewood Industrial Court, St. Louis 17, Mo.

***Availability:** Built to production order only, units can be delivered in about 60 days.*

Furnaces 428

For use in semiconductor manufacture

For use in the semiconductor industry, the DZ series gas-diffusion furnaces provide stepless temperature control with controlled rectifiers. Single and two-zone diffusion types are offered.

BTU Engineering Corp., Dept. ED, 179 Bear Hill Road, Waltham 54, Mass.

***Price & Availability:** Price ranges from $3500 to $6950 ea, depending on unit. Delivery requires eight to ten weeks.*

Magnetic Memories 436

Have apertured ferrite plates or core arrays

The Series 3100 magnetic memories, high-speed, coincident-current, random access storage units, have apertured ferrite plates or core memories. The range of storage capacities is 128 to 4096 words and 4 to 64 bits per word, permitting

exact match of memory for telemetering, multiplexing, and data distribution, communication links and displays, and control equipment. Input signals are pulses or levels at 0 to −6 v; output data is taken as a level from flip-flop register at 0 or −6 v.

Rese Engineering, Inc., Dept. ED, 731 Arch St., Philadelphia 6, Pa.

Power Supply 457

Dual range type

Model TP-36/18 dc power supply delivers up to 2 amp at 0 to 18 v in the first range and up to 1 amp at 0 to 36 v in the second range. For both ranges line regulation is 10 mv and load regulation is 5 mv. Ripple is 0.2 mv rms. Short-circuit protection, remote-programing, and remote-sensing are provided for.

Invar Electronics Corp., Dept. ED, Pasadena, Calif.

Price & Availability: $275 ea; from stock.

Resistor Circuit 475

Is stable to 500 C

Stable to 500 C, this metal resistor circuit is available on ceramic substrates made to customer specifications. A resistance range of 30 to 70,000 ohms per square is offered, making it possible to obtain resistance values of 100 ohms to several megohms in a short straight path without the use of grid or lattice patterns. Resistance patterns can be designed to permit the addition of capacitors, diodes, transistors, inductors, and other components.

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

Availability: Made to customer requirements.

NEW PRODUCTS

Servo Amplifier 382

Has a ±2-μv stability

This high-gain servo amplifier is sensitive to a 3-μv change in input signal and has a stability of ±2 μv. The unit can be used in self-balancing instruments in laboratory applications and in industrial process control systems. It is able to differentiate the polarity of a low-level, dc input signal, converts it to ac and amplifies it sufficiently to drive a servo motor. A servo motor is supplied with the amplifier. Operating power is 117 ±10 v at 50 or 60 cps.

Thermo Electric Co., Inc., Dept. ED, Saddle Brook, N.J.

Data Logger 415

For strain gage, thermocouple, or millivolt inputs

Model 179 100-channel data logger is for strain gage, thermocouple, and millivolt inputs. Elapsed time is 20 sec. Accuracy is ±0.5% of full scale for strain and ±1% for temperature. Range is 0 to ±10,000 μin. per in. for strain and 0 to 3000 F for temperature.

Gilmore Industries, Inc., Dept. ED, 13015 Woodland Ave., Cleveland 20, Ohio.

Transistor Tester 441

For power and signal transistors

For testing power and signal transistors, model 2590 tester provides for testing I_{ceo} at 9.5 v, I_{cbo}

at 9.5 v and beta amplification at 3 v. Both npn and pnp types can be tested. The unit also checks leakage and forward currents of diodes. A transistor socket and external leads permit testing with any type of base arrangement.

Triplett Electrical Instrument Co., Dept. ED, Bluffton, Ohio.

Price & Availability: Price is $49.50 ea. Units are in stock.

Wirewound Resistors 450

For continuous operation at 300 C

Coated with humidity-resistant, high-temperature vitreous enamel, type VAL wirewound resistors are made for continuous operation at 300 C. The cores are of ceramic material with the axial leads and cup assemblies of low-expansion alloy. Units are compact and have dissipating power equal to that of larger tab-type terminal resistors.

TRU-OHM Products, Dept. ED, 2800 N. Milwaukee Ave., Chicago 18, Ill.

Availability: From stock.

Graphic Recorder 454

Null-balance, servo-type

Made for general purpose laboratory use, model JY-100 null-balance, servo-type graphic recorder has a response time of 0.5 sec full-scale and a sensitivity of 0.25% of span with zero adjustment anywhere on the chart. Accuracy is 0.5%. Chart speeds range from 1 in. per hr to 16 in. per min. The chart measures 5 in.

Nesco Instruments, Inc., Dept. ED, 638 W. 17th St., Costa Mesa, Calif.

Price: $320.

NEW PRODUCTS

Latch-In Relay 397

Comes with 8, 12, or 20-pin plug

The Class 11LP latch-in relay with plug-in mounting and hold-down clamp comes with an 8, 12, or 20-pin plug. The relay is made of two miniature, telephone type relays; the armatures of the relays are mechanically interlocked. When one armature is energized, it releases the other and becomes latched-in. Over-all dimensions are 4-31/32 x 2-11/16 x 1-11/16 in. The units are available for dc continuous or intermittent duty.

Magnecraft Electric Co., Dept. ED, 33500 W. Grand Ave., Chicago 51, Ill.

Price & Availability: *Price is about $18 ea for orders of 1 to 9. Delivery time is two weeks.*

Pressure Switch 422

Range is 5 to 100 psig

Able to stand 300% overpressure, model 5126 pressure switch has a range of 5 to 100 psig. The operating temperature range is —65 to +200 F; the unit stands 1000 F for 15 min without rupture of the pressure chamber. The switch is an spdt type, rated at 2 amp at 120 v dc. Weight is 2 oz and dimensions are 3 x 3/4 in.

Aero Mechanism, Inc., Dept. ED, 13918 Saticoy St., Van Nuys, Calif.

Magnetic Amplifier 458

Minimum input gives ±120-mv output

Model 1508 magnetic amplifier has an input voltage variability of from 0 to ±15 mv to 0 to +50 mv. With a minimum input signal it produces an output of ±120 mv. Load impedance is

variable from 50 ohms to infinity. Amplifier power requirement is less than 1 w; excitation voltage is 26 v, center tapped, 400 cps, regulated to ±10%. The amplifier output will not vary more than ±1.5% with any combination of line voltage and frequency changes. Operating temperature range is 0 to 75 C.

Lumen, Inc., Dept. ED, Box 905, Joliet, Ill.

Price & Availability: *The unit can be delivered 4 to 6 weeks after receipt of order. Price ranges from $250 for one unit, to $93 ea when ordered in quantities of over 400.*

DC Power Supply 481

Outputs range from 12 to 24 v

Model M-1325 dc power supply has a range of outputs from 12 to 24 v on an input of 115 v ±10%, 400 cps 380 to 420, three-phase. Ripple is given at 0.2% rms. Voltage regulation is ±2% under any output and input conditions specified. The unit contains silicon rectifiers and all-static circuitry; there are no vacuum tubes, brushes or vibrating contacts. Dimensions are 11 x 17 x 9 in. The all-aluminum unit has a removable cover and is forced-air cooled.

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

Price & Availability: *Made on order only and delivered in 120 days. Price is $2682 ea; $2601.54 for 3 to 10 units; $2574.72 for 11 to 24 units.*

Pressure Switch 418

Weighs less than 0.5 oz.

Weighing less than 0.5 oz, model PS375-1 pressure switch provides positive snap-action switching in response to changing pressures in air, fuels, lubricants, and gases. Operating range is 0 to 500 psi. Repeatable accuracy is within ±0.5% of the original setting. The spdt snap-action microswitch is rated for 6 amp at 125 to 250 v ac. Operating temperature range is −65 to +300 F. The unit meets MIL-E-5272A.

Pamar Electronics Co., Dept. ED, 103 Marine St., Farmingdale, N.Y.

NEW PRODUCTS

Hysteresis-Synchronous Motor 446

Measures 1.25 in. in diameter

Type CMC hysteresis-synchronous motor, measuring 1.25 in. in diameter, is epoxy-encapsulated for environmental protection. It develops 0.75 oz-in. of torque at 1800 rpm synchronous speed and is normally wound for 110 v ac at 60 cps. Suitable for both industrial and military use, the units are recommended for applications in miniature recorders, timers, computers, and similar devices.

Globe Industries, Inc., Dept. ED, 1784 Stanley Ave., Dayton 4, Ohio.

High-Resolution Dial Assembly 456

For synchro and pot shafts

For use on the shafts of synchros and potentiometers, model DR high-resolution dial assembly can turn a synchro shaft 16 min of arc from one rotation of a vernier knob. Movements as small as 10 sec of arc can be made. Rotation range is continuous from 0 to 360 deg cw or ccw. Markings are graduated in 1-deg intervals and vernier dial, in 0.1-deg intervals. Accuracy is 0.1 deg; readability is 0.1 deg. Ratio of the vernier knob is 1350:1.

Theta Instrument Corp., Dept. ED, 520 Victor St., Saddle Brook, N.J.

Price & Availability: $170; four-week delivery.

Microwave Spectrum Analyzer 451

For frequencies from 2000 to 38,600 mc

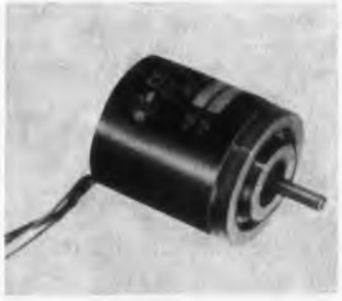
Model SA-40 microwave spectrum analyzer has interchangeable rf heads for frequencies from 2000 to 38,600 mc. The 40-mc amplifier has bandwidths of 5, 25, and 200 kc. Other features include a flat-face cathode ray tube with illuminated reticule, independent regulated Klystron power supply with dc filament source, positive and negative dc supply, stabilized safety high-voltage supply, and direct-coupled deflection amplifiers for stable 2 to 20 cps sweep.

Applied Dynamics Corp., Dept. ED, 330 Bear Hill Road, Waltham 54, Mass.

Price & Availability: *The basic unit is priced at $2395. Delivery time is 30 days.*

Servo Motor 452

Has all-plastic body



Integrally cast in thermosetting epoxy resin, type R2404 servo motor resists physical shock, salt spray, and corrosive fluids. The unit shown is size 11; other sizes can be furnished. An O-ring mounting is used to seal the motor and gear train from coolant fluids or gasses in applications where the unit must be immersed. Weight is 3.5 oz, rotor inertia is 1.07 gm-cm², stall torque is 0.62 oz-in., no load speed is 6200 rpm, and maximum power output is 0.9 w.

Cedar Engineering Div., Control Data Corp., Dept. ED, 5806 W. 36th St., Minneapolis 16, Minn.

Price & Availability: *Type R2404 is priced at $35 to $40 ea. Delivery time is 30 days.*

NEW PRODUCTS

Strain-Gage Power Supply 383

Regulation is 0.1%

Model SR 150 strain-gage power supply has a regulation of 0.1%. The output is floating; internal impedance is less than 0.2 ohms. Noise-to-ground is less than 10 mv, peak-to-peak, when measured with a 350-ohm bridge. Leakage resistance is in excess of 10,000 meg. The unit is compact and transistorized.

Video Instrument Co., Inc., Dept. ED, 3002 Pennsylvania Ave., Santa Monica, Calif.

Price & Availability: *$68 fob Santa Monica; from stock.*

Ceramic Foam 424

For vhf loads

Eccosorb WG high-loss, low-weight ceramic foam block is suitable in constructing vhf loads. Useful frequency range is 100 to 1000 mc. Blocks measure 10 x 15 x 3 in. and weigh less than 3 lb.

Emerson & Cuming, Inc., Dept. ED, Canton, Mass.

Price & Availability: *$33 per sheet; from stock.*

Electronic Timer 381

Time period is variable from 0.1 to 1 sec

Capable of handling 25 amp, 32 v, inductive over the temperature range of −55 to +125 C, model 303 electronic timer provides a variable

period of 0.1 to 1 sec with a pulse width of 25 to 100 msec. The unit is designed for applications where multiple pulsing can be used to trigger a number of programed functions. It stands vibration of 5 to 2000 cps at 10 g and shock of 50 g for 11 msec. Output is a square wave. Weight of the unit is 75 g.

The Sloan Co., Dept. ED, 7704 San Fernando Road, Sun Valley, Calif.

Limit Switch 691

Is subminiature

This 32-turn, subminiature limit switch is for applications requiring a fixed number of revolutions of the rotating shaft, such as servo mechanisms in which mechanical stop protection is required. The switch supports four 11SM1 microswitches; two micro-switches are mounted at each end of the slide bar. The use of 21- and 22-tooth pinions allows approximately 1-deg adjustments throughout the range of 32 turns or 11,520 deg.

Arch Instrument Co., Inc., Dept. ED, 101 Holmes St., N. Quincy 71, Mass.

Price & Availability: *Price is about $38. Units are in stock and can be delivered in 10 days.*

Dollies 417

For laboratory and shop use

Model 32957 D dollies accommodate all laboratory type oscilloscopes. For laboratory and shop use, the dollies measure 17 x 12 in. and have three power outlets. The supporting top is tilted 20 deg for better viewing.

PBR Manufacturing Co., Dept. ED, 863 E. Luzerne St., Philadelphia 24, Pa.

Price: *$67.50 with drawer and $62.95 without drawer.*

Pyrometer Indicator 427

Has many ranges

Model 859-3 pyrometer indicator permits changing of range by means of replaceable plug-in units. Consisting of a Zener type cold-junction reference, a high-gain stabilized dc amplifier with 60-cps rejection, and a floating power supply, the indicator has an accuracy of 0.5 F or 0.5% on all ranges. Amplifier output is 0 to 1 ma dc into 1500 ohms. Standard ranges are between 32 and 212 F to between 32 and 3000 F.

Magnetic Instruments Co., Inc., Dept. ED, 546 Commerce St., Thornwood, N.Y.

Price & Availability: *Price is $235; delivery time is two weeks.*

NEW PRODUCTS

Servo-Motor Tachometer Generator 455

Modular design

Type 9805-20 plug-in module consists of a servo-motor, tachometer generator coupled through a reduction gear train to a synchro control transformer with a top speed of 10 deg per sec. Modules are hermetically sealed and filled with inert gas. Dimensions are 4 x 2-1/8 x 1 in. and weight is 9 oz. Uses are in automatic stabilization amplifiers, autopilots, and similar applications.

John Oster Manufacturing Co., Dept. ED, 1 Main St., Racine, Wis.

Availability: *Delivery time is three to four months after receipt of order.*

TV Camera 420

For closed-circuit telecasting

This miniature TV camera for closed-circuit telecasting uses RCA Nuvistor electron tubes. Suited for military and industrial applications, the unit stands environmental extremes. Picture definition of up to 850 lines of horizontal resolution can be delivered on the CCTV monitors.

Packard-Bell Electronics Corp., Dept. ED, 12333 W. Olympic Blvd., Los Angeles 64, Calif.

Analog Data Transfer System 430

Resolution is 0.006% of full scale

Type 200 data transmission provides for transmission of up to three channels of analog information with an over-all accuracy of 0.05% of full range and a resolution of 0.006% of full scale at rates of 10 samples per sec. The system permits parity checking and identification of data source and accommodates a wide range of input-output signal levels in addition to the standard ±10 v. Construction is modular.

Vitro Laboratories, Inc., Dept. ED, 200 Pleasant Valley Way, W. Orange, N.J.

Vacuum Gages 539

The series comprises models IG-50 and TIG-50, having a range of 10^{-8} to 10^{-9} mm Hg, and models IG-60 and TIG-60, having a range of 10^{-8} and 10^{-10} mm Hg. The TIG units combine a thermocouple gage circuit with the ionization stage.

F. J. Stokes Corp., Dept. ED, 5500 Tabor Road, Philadelphia 20, Pa.

Heat-Resistant Encapsulent 540

Serviceable in the range of −60 to +250 C, Sylgard 191 is applied to electronic parts with the fill-in-place technique.

Dow Corning Corp., Dept. ED, Midland, Mich.

Coaxial Conectors 541

This series of crimp, rf connectors allows faster assembly; only four basic parts and a weatherproofing boot must be assembled. The termination is strong.

Amphenol-Borg Electronics Corp., Industrial Products-Daybury Knudsen Div., Dept. ED, 33 E. Franklin St., Danbury, Conn.

Tube Shield 542

This zinc-plated tube shield, for use with miniature 7- and 9-pin tubes, is finished in black for better heat dissipation. A vertical seam automatically adjusts to tube diameter and four serrations on the base clip prongs compensate for variations in length.

The Staver Co., Dept. ED, 47 N. Saxon Ave., Bay Shore, L.I., N.Y.

Air Filter 543

Type V-10 filters protect miniature, ventilated electronic equipment. Rectangular, they are 0.5 to 4 in. thick and are made of aluminum, steel, bronze, and stainless steel. They stand severe shock and temperature changes.

Air Filter Corp., Dept. ED, 4604 W. Woolworth Ave., Milwaukee 18, Wis.

Silicone Mold Release 545

For laminating, casting, and pressure molding, Super A is heat-stable, oxidation-resistant, and virtually non-volatile. It can be used on non-metallic as well as metallic surfaces to 500 F.

Hastings Plastics, Inc., Dept. ED, 1551-12th St., Santa Monica, Calif.

Price & Availability: *The product is in stock and is priced at $2.20 per can for up to 12 cans.*

Twin-Gyroscope Controller 546

This device is to be used instead of reaction jets or inertia wheels to control the attitude of a space vehicle. It consists of two single-axis gyroscopes gimbaled to a common frame.

Chance Vought, Electronics Div., Dept. ED, Dallas, Tex.

NEW PRODUCTS

Power Supplies 500

This series of dc power supplies operates from either 115 or 230 v ac, 50 to 60 cps single phase, and provides an output of 125 or 250 v dc. Twelve models are available with continuous duty current capacities ranging from 1/2 to 16 amp.

Opad Electric Co., Dept. ED, 43 Walker St., New York 13, N. Y.

Price & Availibility: *Can be delivered 10 to 14 days after order received. Prices start at $53.*

Temperature Control 491

Power-O-Matic 60 temperature control is used with the 60 series of mechanical convection ovens. The built-in, control proportional bandwidth is 4% of scale range and allows full power during the initial heat period only. Line voltage variation does not cause the controlled temperature to become unstable.

Blue M Electric Co., Dept. SD, 138th and Chatham Sts., Blue Island, Ill.

Welding Tweezers 544

For precise welding operations, model ST-101 provides continuously adjustable pressure from 8 oz to 2 lb. A variety of tips permit welding of many metals. Uses include welding thermocouples, strain gages, high-temperature assemblies, and components designed for high shock and vibration.

Pacific Scientific Instruments Laboratory, Dept. ED, P. O. Box 25115, Los Angeles 25, Calif.

Price & Availability: *$85; from stock.*

Adapters 538

Model 1285 phone-plug adapter adapts a phone jack to 3/4-in. spaced bonding posts. Model 1296 BNC binding post adapter adapts a BNC receptacle to 3/4-in. spaced bonding posts.

Pomona Electronics Co., Inc., Dept. ED, 1126 W. Fifth Ave., Pomona, Calif.

Price & Availability: *Available for immediate delivery, both units are priced at $4.85 ea or $3.75 ea in quantities of 25 to 49.*

Socket Screws 498

These socket screws have plastic inserts that are self-locking, perform over a wide range of temperatures, and stand impact, shock, and other environmental conditions found in missile applications.

Parker-Kalon, Dept. ED, 4331 W. Lake St., Chicago, Ill.

Stroboscope 499

For measuring speed without physical or mechanical contact, this instrument emits a blue-white

electronic flash on a 60-cps basis. It is for checking tachometer, frequency, amplitude, and points of stress. Dimensions are 6 x 6 x 4 in.

Electronic Lights, Dept. ED, 1713 N. Ashland Ave., Chicago 22, Ill.

***Price & Availability:** Made on order, units are priced at $50 ea.*

Transparent Adhesive Film 490

All types of title blocks, standard parts, wiring diagrams, and other printed matter used repeatedly on drawings can be quantity printed in advance on Dulseal, a transparent adhesive tape. Made of 0.0015 in. thick acetate, the material also provides a durable protective coating for documents which receive frequent handling.

Keuffel & Esser Co., Dept. ED, Third and Adam Sts., Hoboken, N.J.

Right-Angle Male Plugs 568

Reli-Acon plugs are ruggedly constructed for such uses as in guidance systems, airborne communications equipment, and automatic control devices. They are suited for military applications.

Methode Manufacturing Corp., Dept. ED, 7447 W. Wilson Ave., Chicago 31, Ill.

***Availability:** Delivery time is 21 to 30 days.*

Silicon Transistors 569

Types 2N696 and 2N697 diffused mesa, silicon transistors combine linear beta characteristics with mechanical and thermo ruggedness. They are for hf, medium power applications.

Transitron Electronic Corp., Dept. ED, 168 Albion St., Wakefield, Mass.

***Price:** Type 2N696 is priced at $21.75 ea for 1 to 99 units and $14.50 for 100 or more units. Type 2N697 is priced at $22.70 for 1 to 99 units and $15.15 for 100 or more units.*

Multiconductor Cables 570

Short lengths of various types of multiconductor neoprene jacketed cables are fabricated by a new technique. Cables of this type are suitable for ground support equipment.

Cable Designs, Inc., Dept. ED, 66 Rushmore St., Westbury, N.Y.

Clamps 462

Series 105 tiny-toggle clamps, having holding pressures to 42 lb, are furnished with solid or U-shaped work-holding bars. Bases can be flanged horizontal, vertical, double-strength horizontal on the right side only, and double-strength horizontal on the left side. Weight is 1 oz.

Detroit Stamping Co., Dept. ED, 330 Midland Ave., Detroit 3, Mich.

***Price & Availability:** $1.65 ea in quantities of 1 to 49; from stock.*

DRAFTING TRENDS

A GLUTTON FOR PUNISHMENT. *The image, pencil or ink, on POST Polytex stays put. Won't rub, flake or peel off accidentally, yet can be erased. Duralar pencil lines bond to the surface readily. Soiled originals can be washed with water and detergent!*

New POST-perfected Polytex takes pen or pencil perfectly

TAPE TEST *proves remarkable adhesion of inked lines to the surface of POST 126 Drafting Film, lines which do not feather out or spread.*

You already know that drafting films offer the advantages of tremendous durability and dimensional stability. Now, thanks to an exclusive, precision process, POST offers a drafting film with superlative drafting characteristics. The surface of POST 126 Polytex is unmatched for ink receptivity, has a coating that stands up, erasure after erasure. Ink lines won't pull off when cellophane tape is applied firmly over them and then suddenly yanked off. Transparency is excellent.

If you prefer pencil, use a POST Duralar lead for permanence. Plastic-based Duralar lines actually bond themselves to the Polytex surface. Drawings won't easily smudge or smear . . . can even be washed with soap and water.

By using new Polytex, with DuPont Mylar base, you avoid the drawbacks which show up in some films . . . a drawing surface too slick to retain a pencil or pen line . . . too soft for use with hard pencil after erasures.

Enjoy the flexibility and long life of a drafting film with an ideal drafting surface. Try new 126 Polytex Drafting Film.

For a test sample and more information, see your local POST Blueprinter, or write Frederick Post Company, 3644 N. Avondale Avenue, Chicago 18, Illinois.

POST

SENSITIZED PAPERS & CLOTHS • TRACING & DRAWING MEDIUMS • DRAWING INSTRUMENTS & SLIDE RULES
ENGINEERING EQUIPMENT & DRAFTING SUPPLIES • FIELD EQUIPMENT & DRAFTING FURNITURE

CIRCLE 150 ON READER-SERVICE CARD

SERVICES FOR DESIGNERS

New Random Vibration Lab Uses Ling Testing System 259

A laboratory facility utilizing a Ling analyzer-equalizer system is now offering to run random vibration tests. Unknown variations can be analyzed at a glance and spectrum shifts equalized while testing is in progress, the laboratory says. Testing equipment includes a control console, shaker, amplifier, and oil table.

The facility is said to permit:

- Reduced equalization time.
- Equalization on the actual test specimen.
- Shaping of many different power spectral density curves.
- Detection of changes in test specimen behavior through constant narrow band monitoring.
- Equalization readout directly in g^2 per cycle.
- Random and sine wave excitations to be readily superimposed.

Exciter capabilities are put at 5000 lb sine wave and 3500 lb random, rms force pound output. Peak force pound output is given at 10,500 lb random.

The Ling analyzer-equalizer system installed at the Rototest Laboratories consists of four major units: control console, amplifier, shaker and oil table.

The equipment has 29 filters covering the range from 10 to 2000 cps, and one for 2000 to 5000 cps, with individual controls for each. Sine wave cycling is automatic with adjustable sweep rate and servo control of acceleration level.

Rototest Laboratories, Inc., Dept. ED, 2803 Los Flores, Lynwood, Calif.

High-Speed Action Equipment Can Be Studied By Film 260

A photographic service has been established to provide high-speed film evaluations in engineering and technical fields. All types of study applications from small switching mechanisms to large jet installations are said to be possible.

As an example of its methods, the company cites an application to a cam-shaft with several banks of microswitches. Filming this setup with a high-speed camera at 1000 frames per second would show the exact sequence of operation in slow motion when viewed at the standard film projection rate.

The company maintains a complete staff of electronics and mechanical engineers to study and evaluate specific requirements for each customer.

Photographic Illustration Co., Motion Inc. Div., Dept. ED, 2220 W. Magnolia, Burbank, Calif.

Tape Slitting 261

Users of Teflon, silicone and cloth pressure sensitive tape can have tape custom slit to their requirements. Any width desired can be slit and shipped the same day the order is received. A variety of widths can be cut from the same roll. Orders for experimental purposes or production use can be handled. Slitting to the exact width required for specific applications instead of using standard widths saves material and allows better, more uniform wrapping.

R. S. Hughes Co., Inc., Dept. ED, 4515 Alger St., Los Angeles 39, Calif.

Rocket and Satellite Instrumentation 262

A new division at Acton Laboratories, Inc., is prepared to offer a complete service in packaged rocket and satellite instrumentation. The service includes: conception of a basic idea; plan of measurement procedure; selection of a vehicle; designing and fabrication of a package complete with necessary telemetry and fully tested to withstand various environments; and supervision of flight with required block-house controls for check-out and telemetry. If preferred, evaluations and reports of collected data will be made.

Typical examples of instrumentation are given as: nose cone tip ejection mechanisms, timers for sequencing, pressure cells, extendable arms as micrometeorite sensing devices, transmitters for telemetry, subcarrier oscillators, and block-house consoles for check-out.

Acton Laboratories, Inc., Space Instrumentation Div., Dept. ED, 533 Main St., Acton, Mass.

NEW LITERATURE

Chopper Catalog 315

This eight-page general instrument chopper catalog covers specifications and definitions, standard chopper specifications, base diagram and mechanical specifications and miniature chopper specifications. Also included is a description of chopper inspection procedure. James Electronics Inc., 4050 N. Rockwell St., Chicago 18, Ill.

Cores for Magnetic Components 316

The company's HyperCores for magnetic components are listed in this 31-page catalog. Mechanical tolerances and physical dimensions are given in table form; performance curves illustrate typical core loss, typical excitation, and pulse magnetization. The catalog also contains a section covering formulae used in determining test limits. Moloney Electric Co., St. Louis 20, Mo.

Porous Barium Oxide 317

Properties of porous barium oxide as a drying agent, dehydrator and desiccant are pointed out in this four-page booklet. Excerpts from Research Paper RP 649, U.S. Dept. of Commerce, Bureau of Standards, indicate the drying efficiency of porous barium oxide to be greater than any other drying agent tested. Barium & Chemicals, Inc., Willoughby, Ohio.

Switching Transistor 318

The Transwitch, a silicon device for computer applications and switching operations, is described in this four-page bulletin, No. TE-1357A. Included are absolute maximum ratings at 25 C, typical characteristics, various voltage and current performance curves, and mechanical data given through an outline drawing. Transitron Electronic Corp., Wakefield, Mass.

Building Blocks 319

This short-form catalog contains a reference table showing all 85 of the company's building block and 22 accessory units by type and price. The folder also describes two models of computers and memory testers built from the standard line of logic modules. Digital Equipment Corp., Maynard, Mass.

Valve Data 331

This 36-page booklet entitled "Abridged Valve Data," gives brief details of all types of electronic valves and tubes made by the company. Included are sections on: mercury vapor, xenon and high vacuum rectifiers; germanium rectifiers; natural, forced-air, water and vapor-cooled triodes;

tetrodes; rare gas and hydrogen thyratrons; voltage stabilizers, voltage reference tubes and stabilovolts; klystrons; magnetrons; travelling wave tubes and solenoids; television camera tubes; and backward wave oscillators. English Electric Valve Co., Ltd., Waterhouse Lane, Chelmsford, Essex, England.

Heating Element 324

The Electro-Mesh heating element is described in this 16-page catalog. Complete technical data includes physical properties and thermal characteristics, as well as a visual description of the varied components now being used in the aircraft, missile and space age fields. Electrofilm, Inc., 7116 Laurel Canyon Blvd., N. Hollywood, Calif.

Elastometers 325

Bulletin No. 902, six pages, contains a chart that covers physical and chemical properties, and environmental resistance of ten general elastometer types. Some of the types covered are: silicone rubbers, styrene butadiene rubber and fluorinated elastomers. Lord Manufacturing Co., Erie, Pa.

Relays 326

This 12-page booklet discusses the complete line of relays for various applications. Relays described include: general purpose, machine tool, mechanically held, pneumatic time-delay and synchronous motor-driven timing. The illustrated booklet, No. GEA-7021, contains wiring diagrams, dimension drawings and tables. General Electric Co., Schenectady 5, N.Y.

Fractional Horsepower Motors 327

Characteristics of the full line of fractional horsepower Form G general purpose motors appear in this 12-page brochure. Capacitor-start, split-phase, permanent-split capacitor, shaded-pole and polyphase motors are included. Sixteen different kinds of motors are shown in NEMA frame sizes 48 through 56. General Electric Co., Schenectady 5, N.Y.

Servometer-Amplifier 329

Type R1040-6 servometer-amplifier is described in this four-page bulletin, No. 910-4B. Specifications include resistance and capacitance balance, temperature characteristics, frequency response, and output indication. Associated equipment described in the bulletin includes a stick force, a rudder force and a wheel force dynamometer. Radiation, Inc., Melbourns, Fla.

IDEAS FOR DESIGN

Holding Resistor Allows Narrow Pulse Triggering of SCR Circuit

When using a silicon-controlled rectifier, scr, as a switch in an inductive circuit, Fig. 1, the exponentially increasing load current did not reach the minimum "holding" level at the end of the triggering pulse. By adding a resistor across the inductance, shown dotted in the figure, the load current quickly reached the level required for continued rectifier conduction.

In our actual circuit application, the maximum width of the trigger pulse was 2 μsec. The load was a high-inductance solenoid, drawing 250 ma steady state. Because of the slow current buildup, a much longer trigger pulse was needed for turn-on of the rectifier, Fig. 2. With the holding resistor across the solenoid, the additional resistive component of load current allowed the pnpn switch to read the holding current level before the trigger pulse terminated. The value of the holding resistor is given by:

$$R_H = \frac{V_{cc}}{I_H \times SF}$$

where V_{CC} is the supply voltage, I_H is the holding current and SF is any desired safety factor.

The only expense was a few per cent increase in the total load current.

We have a number of such circuits currently in use in some of our data processing equipment. In many cases reliable operation has been obtained with trigger pulses as short as 0.6 μsec.

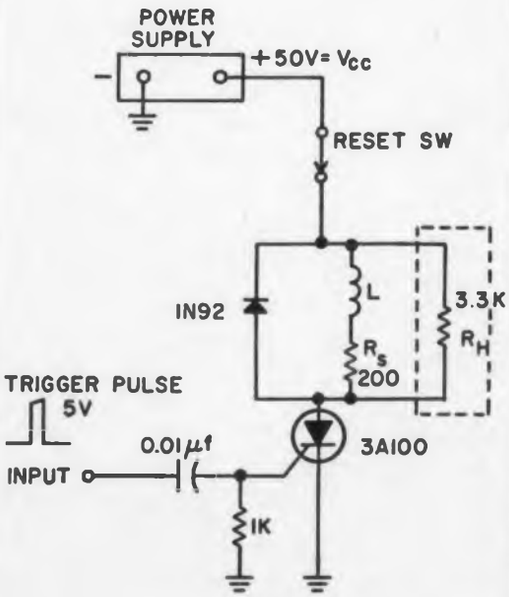


Fig. 1. By adding a "holding" resistor across the inductive load, the silicon-controlled rectifiers can be fired with very narrow pulses.

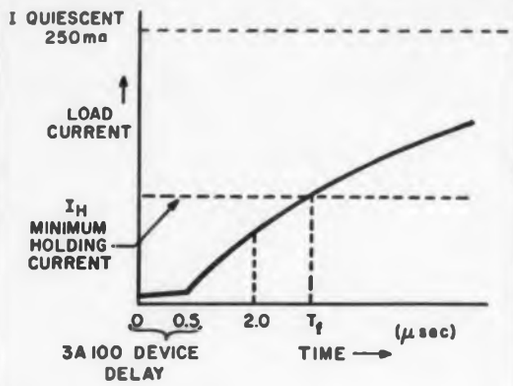


Fig. 2a. Because of inductive current build-up, a wider pulse width is necessary to keep SCR turned on.

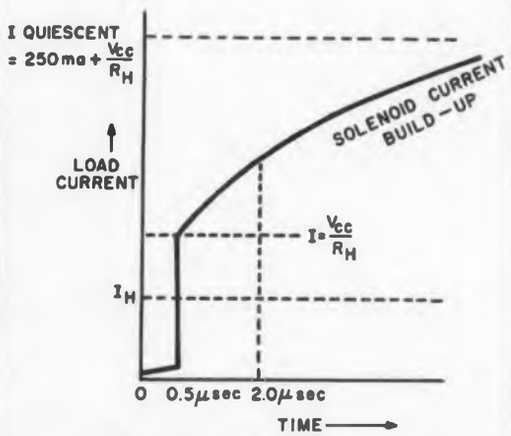


Fig. 2b. With holding resistor load current increases, quickly passing the minimum conduction current level.

John V. McMillin, Project Engineer, Measurement Research Center, Iowa City, Iowa.

Corrected Formula

The equation for the power density level given in the Idea for Design article by R. L. Thomas "Microwave Mixer Diode Makes Sensitive, Broadband Video Detector," (*ED*, April 27, 1960, p 118) was printed incorrectly. It should have been given as:

$$Pd = \frac{Pt \cdot Gt}{4\pi \cdot d^2}$$

where Pd = power density level in mw/cm²
Gt = numerical gain of transmitting antenna
Pt = power transmitted in mw
d = distance between throat of transmitting antenna and the aperture plane of the receiving antenna in cm.

IMPULSE

A DIGEST OF NEW DEVELOPMENTS IN ELECTRONICS AND AUTOMATION

PUBLISHED BY ROME CABLE DIV. OF ALCOA, ROME, N. Y.
PIONEERS IN INSTRUMENTATION CABLE ENGINEERING

PATENT-LY ABSURD appears to be the way the House Space Committee feels about patent procedures currently in effect with NASA contractors. Provisions of the 1958 law establishing NASA spelled out restrictions on patent advantages when such came about through government-financed research. Complications arose when an individual firm also had contracts with the Pentagon, since these permit keeping patent rights. A new amendment reverses the original policy, even allows NASA to change provisions in existing contracts.

WHY NYET? Two items of interest to electronic men in reference to Russian developments: First, a Russian engineer reports at length in a Soviet periodical that lack of electronic standardization, particularly in coupling devices, is a serious problem. Second, *we* have put a technique called *predictive analysis* to work with a computer in order to simplify English translations of Russian scientific articles. Up to now the computer could produce only rough word-for-word translations. With predictive analysis, the machine approaches a sentence as a human does. As a result, the output contains not only the English translation, but also the grammatical relation of each word.

FM ON THE MOVE. One industry spokesman predicts that FM sales will hit 4 million units in 1963, including a million sets for use in automobiles. Still to be resolved is the big question of stereophonic broadcasting.

INTEREST in electric cars seems definitely on the increase. Considerable attention to fuel cells (a comprehensive book is almost ready for release), introduction of a silicon solar-cell panel, and advances in printed motor armatures all point to big things in the future.

CABLEMAN'S CORNER. To help you in replacing or reordering cable, it has become standard practice for most cable manufacturers to identify their cable in one of several ways. These include the stamping of solid conductors, the inclusion of marker threads or tapes within the cable structure, and surface printing or molding the insulations or jackets. Of these methods, the use of marker threads or tapes is the most popular. Manufacturers of Underwriters-labeled products are assigned specific colors for their marker threads, and most manufacturers extend the use of these same threads in other cable products whenever it is practical. Other information appearing on marker tapes often includes unit length markings and the date that the cable was manufactured. Phone Rome 3000, or write: Rome Cable Division of Alcoa, Department 400-B, Rome, New York.

These news items represent a digest of information found in many of the publications and periodicals of the electronics industry or related industries. They appear in brief here for easy and concentrated reading. Further information on each can be found in the original source material. Sources will be forwarded on request.

CIRCLE 167 ON READER-SERVICE CARD

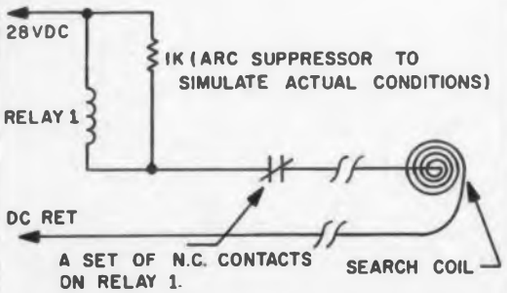
IDEAS FOR DESIGN

Search Coil Locates Noise-Sensitive Circuit Trouble-Spots

A handy little noise generator was constructed to help design certain high-impedance, voltage-sensitive circuits to be insensitive to relay contact noise and arcing.

The circuits, containing thyratrons and Shockley diodes, worked quite well in the breadboard stage. However, when wired into a cabinet with many operating relays, they were constantly being prematurely triggered.

The noise generator shown was used in the design of new circuits which would be insensitive to the relay noise. It was also used to check out the existing ones. The search coil, consisting of several turns of hook-up wire, was held near suspected leads and circuit points. The opening and closing of the contacts simulated in the search coil the fields actually encountered in the completed equipment. Possible areas of premature triggering were quickly located while the circuits were still in the breadboard stage.



The search coil, held near points suspected of being sensitive to relay noise and arcing, quickly locates possible circuit trouble spots.

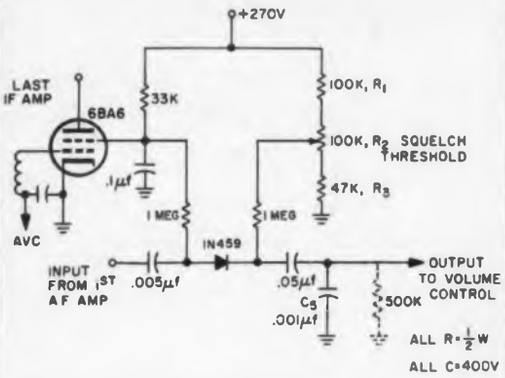
Carl R. Faix, Design Electrical Engineer, RCA, Moorestown, N. J.

Simplified Squelch Circuit Uses Back Biased Diode

The squelch circuit shown was designed to be added to communication receivers. Its simplicity allows negligible receiver modification.

The circuit uses the switched diode principle, obtaining the switching voltage from a screen grid in the avc-controlled if amplifier. A larger than usual screen-grid dropping resistor is used, since the if amplifier is also operating as an avc amplifier.

The af from a high-impedance source is impressed on the anode of the IN459 diode and is effectively blocked by the back bias from R_2.



When a signal is detected, the avc voltage rises and the back biased diode is switched to its forward conducting state.

When a signal is detected, the avc voltage rises. The screen voltage also rises and switches the diode to a relatively low forward resistance of about 10 K. Thus, the audio rides through with slight loss due to the voltage dividing action of the 10 K forward diode resistance and the approximately 500 K load resistance. This is a loss of only about 2 per cent. In the absence of avc voltage, the back bias raises the diode to a resistance on the order of 20 meg.

Capacitor Can Eliminate Residual Leak-Through

The signal can be allowed to ride through to verify, in the absence of a strong signal, that the receiver is operating although squelched. However, to almost completely kill this residual leak-through, capacitor C_5 is added. This bypass is usually already present, in the af circuit, to attenuate the very high frequencies. It need only be moved to the output side of the diode and it will serve the former function of bypassing highs on conduction, and also silence the small feed-through in the squelched condition.

The voltage swing at the screen grid for switching is about 10 v. R_1, R_2 and R_3 are proportioned so the lowest voltage of R_2 is below the voltage on the screen grid with only receiver noise present. This will allow turning the squelch off in the absence of any signal by rotating pot R_2 to that end. The upper voltage of R_2 is 10 v above that on the screen grid for the strongest received signal expected. The values given are used on a SP600JX type receiver.

If the limiter is used on the audio prior to its passage through the squelch the false alarms due to noise peaks are greatly reduced.

This squelch performs beautifully in communication work where interference is present but somewhat weaker than the desired signal. In this case R_2 is set to let through only the strong signal and quiet is obtained between transmissions.

E. Dusina, Electronic Engineer, Hollis, N. H.

IDEAS FOR DESIGN

Shield Circuit Ups Megohmmeter's Input Impedance

An inexpensive megohmmeter was developed that gives reasonably accurate (±5 per cent) measurements over the range of 50 meg to 500,000 meg. This instrument was developed specifically to test two-conductor shielded cable. It tests each conductor for line-to-line and line-to-shield resistance. The test potential is 500 v and metering is accomplished with a laboratory-type micro-micro-ammeter. A one-ma-scale meter is used as a shorts indicator.

The megohmmeter is designed in such a manner that the operator is required to use both hands to accomplish any measurement. This lessens the risk of the operator measuring himself.

A basic circuit designed for the measurement of resistance is shown in Fig. 1. In this circuit,

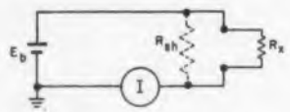


Fig. 1. Basic circuit for the measurement of resistance has leakage resistance in parallel with the unknown.

currents developed across R_{sh} represent spurious currents generated within the test set and greatly reduce the high-ohm accuracy of any ohmmeter. This spurious current effectively reduces the value obtained for R_x (as expressed in the formula $R = E/I$).

This is not true for the circuit developed in the megohmmeter. In the basic circuit, Fig. 2, cur-

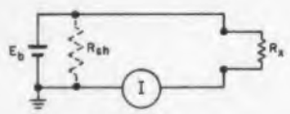


Fig. 2. In the basic circuit developed for the megohmmeter the paralleled resistance is shunted past the meter by a shield to ground.

rents created across R_{sh} (representing the internal impedances of the meter circuit) are shunted past the meter by "guarding" with a shield to ground. Therefore, very high effective input resistance can be developed.

The actual circuit, as developed, is shown in Fig. 3. A three-deck, four-position selector switch is used to switch between line-to-line and line-to-shield. The extra positions and decks allow "guarding" techniques to be applied to the switch wiring. The one-meg resistor is a current-limiting device that will reduce injury should a person get across the 500-v supply.

When calibrated, the meter shows a stable output resistance of greater than 0.5 x 10^{15} ohms.

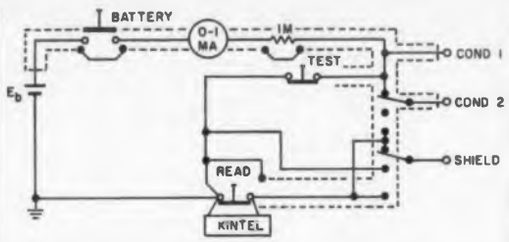


Fig. 3. Megohmmeter can make line-to-line and line-to-shield cable resistance measurements. When calibrated, unit has stable output resistance greater than 0.5×10^{15} ohms.

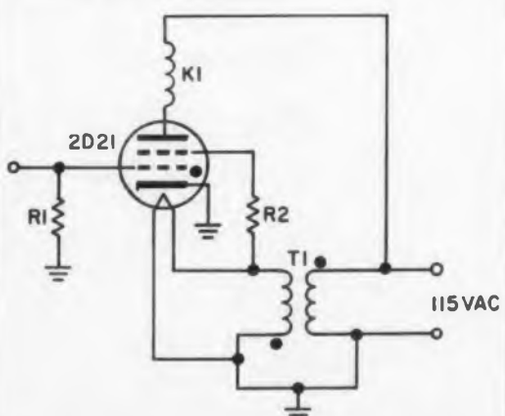
The use of a calibration formula will allow measurement of resistance of that magnitude. Without the calibration formula, the megohmmeter will measure greater than 5×10^{12} ohms to approximately 5 per cent.

Walter B. Morton, Jr., Project Manager, Epsco-West, A Division of Epsco Inc., Anaheim, Calif.

Filament Controls Thyratron Bias

In certain relay control circuits, 115 v ac is applied across the series circuit consisting of a relay and a thyratron. The relay is energized by bringing the control grid of the thyratron from some negative potential to the firing point.

In the circuit shown the negative potential is eliminated by applying the filament voltage to the shield grid out of phase with the plate voltage. During the ac supply's positive half cycle the shield grid is negative, and the tube is cut off. During the next half cycle no conduction occurs because the plate is negative. However, if a positive potential is applied to the control grid, the tube will fire during each positive half cycle and the relay will be energized.



Negative voltage to hold thyratron cut-off is eliminated if the shield grid is connected to the filament supply through an inverting transformer.

R. L. Fusfield, Hughes Aircraft Co., Culver City, Calif.

PATENTS

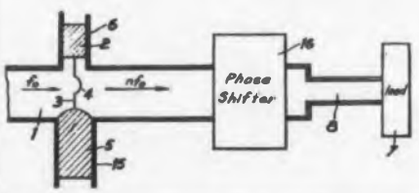
Benjamin Bernstein

Measuring Devices for Millimeter Waves

Patent No. 2,922,955. H. Leboutet (Assigned to Compagnie Generale de TSF.)

An impedance match to couple millimeter wave power is obtained by using the internal conductor of a coaxial line as the probe. The outer conductor is a hollow cylinder connected as a stub to a millimeter waveguide.

In the frequency multiplication version shown, the coaxial stub contains a crystal in the *3-4* center conductor. The load is connected through a millimeter cavity *8*. Thus the phase shifting and positioning of the assembly *2,3,4,5* sets the impedance to be matched. By matching the load to the generator, a harmonic frequency, nf_o, is produced.

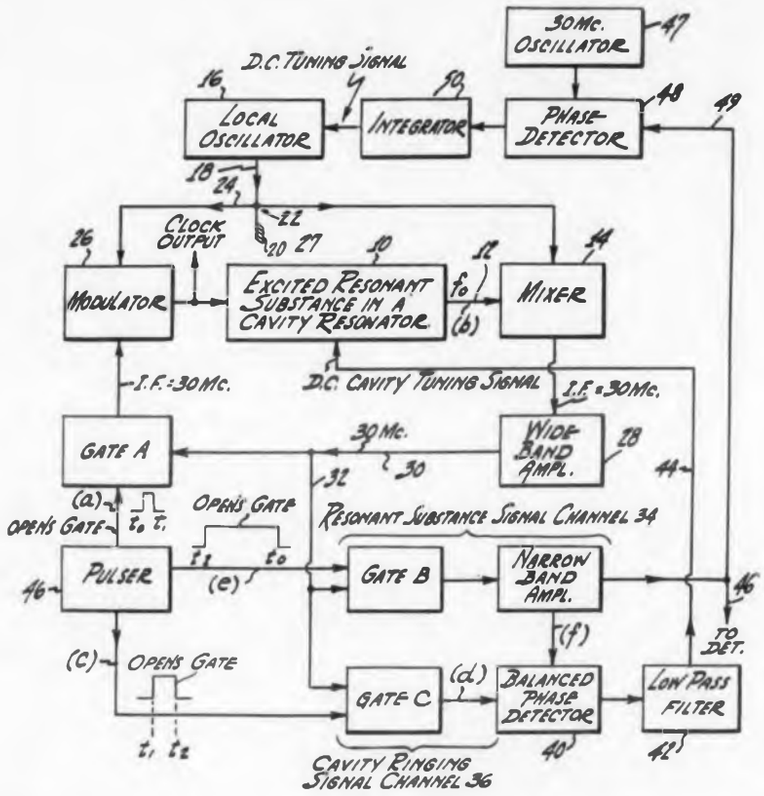


Stable Oscillator

Patent No. 2,927,278. R. H. Dicke.

An atomic or molecular clock operates satisfactorily when the cavity and its resonant substance both oscillate at the same frequency. This invention supplies a method for separately detecting the oscillations of the resonant substance rubidium) and to compare them with the oscillations of the cavity.

A pulsed tuned cavity is used to produce a very large output which quickly damps out. During the time interval t_0 to t_1, pulser *46* gates modulator *26* to shock excite the cavity resonator. Gate *C* passes the cavity oscillations in the interval t_1 to t_2 and the circuit rings at the cavity frequency. Gate *B* passes the resonant substance signal for comparison in the phase detector. This detector tunes the cavity to resonance according to the error signal. The local oscillator may be a klystron set to beat with the cavity output to produce 30-mc waveforms.



BOOKS

Modern Probability Theory And Its Applications

Emanuel Parzen, John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N.Y., 464 pp, $10.75.

Written as a textbook for a course in probability, this book introduces the concepts and ideas of modern probability theory, details applications of the theory to real phenomena, and provides techniques for solving problems involving both discrete and continuous probability theory. The major ideas are presented without assuming that the reader knows the advanced mathematics required for a rigorous discussion.

More than 160 examples, 120 theoretical exercises and 480 exercises are contained in the text. The non-theoretical exercises are numerical problems concerning concrete random phenomena and illustrate the variety of situations to which probability theory may be applied.

Statistical Methods In Radio Wave Propagation

Edited by W. C. Hoffman, Pergamon Press Inc., 122 E. 55th St., New York 22, N.Y., 334 pp, $14.00.

Collected here are papers presented at a 1958 symposium on the subject held at the University of California, Los Angeles. The symposium's purpose was to bring to the attention of the worker in the radio wave propagation field statistical methods for reducing and interpreting his experimental data.

The collection is divided into three sections. Section I deals primarily with statistical theory and methodology. Pa-

pers include: A Study of Sea Clutter Spectra, The Multidimensional Prediction Problem, and Some Theoretical Investigations on Fading Phenomena. Section 2 contains papers which emphasize radio propagation phenomena having both a statistical and physical structure. Included are papers on antenna tolerance theory, trans-horizon measurement techniques, and diversity statistics in scatter propagation. The third section describes instrumentation for processing radio-propagation data.

Control System Analysis and Synthesis

John J. D'Azzo and Constantine H. Houpis, McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N. Y., 580 pp, $13.50.

This treatment of feedback control systems begins by presenting the principles of obtaining differential equations for electrical, mechanical, hydraulic, and heat flow systems. The Laplace transform approach is used and the block diagram method is shown. Basic servo characteristics are discussed in detail.

Various methods of analysis are then taken up: root locus and frequency (Nyquist's stability criterion) techniques. The same system is used with each method for ease in correlating the results. Compensation techniques to improve performance are presented for each method. Other topics included are ac systems, optimum response, non-linearities and computers. The last chapter includes some experimental techniques and ties together all the methods presented in the book.

Extensive appendices include much material useful to the feedback control system engineer: root solving tables, angle loci methods, a rigorous development of Nyquist's stability criterion, and a description of the automatic plotting of the root locus by an analog computer.

The scope of the text is such that it can be used for both undergraduate and graduate courses. Numerous examples and figures illustrate important principles. Examples of feedback control systems pertaining to various branches of engineering are presented. An extensive group of problems is included at the end of the textbook.

TUNNEL DIODE NOISE PROBLEMS

by
Dr. Walter K. Volkers,
Millivac Instruments Division,
Cohu Electronics, Inc.,
Schenectady, New York

Always on hand to spoil a new amplifier's glorious entrance to the engineering field are two electronic "delinquents" that persistently demand our attention. One is *impedance*, the other is *noise*.

The *transistor* — as you undoubtedly recall — turned out to be a considerable disappointment at the time of its first blush. Its input impedance was low — its noise sky high. Many years went by before there was even a promise of surmounting these setbacks. Yet, today, they are well on the way to being solved. High input impedances are being obtained by suitable circuitry and low noise is being attained through "hushed transistor operation." •

In the *tunnel diode* — the most recent comet in the sky of electronic amplifiers — we are again being plagued by the old basic problems. It has an input impedance which is startlingly low (even lower than that of the transistor); its noise (at this time) is disturbingly high. Yet, judging from past experience, we can be reasonably certain that this new arrival will overcome these difficulties as well as the transistor (its predecessor) did. However, keep in mind, that suitable instrumentation is needed to analyze and solve the problems of every newcomer — and that it is incumbent on the "older brothers" to "tutor" the young child.

You will find a classic example of how this helpful role works in our ultra-sensitive transistor voltmeters (2 uV lowest possible reading) and in the "hushed transistor amplifiers", which we developed against overwhelming odds, several years ago.

These low-noise devices now stand ready to help the newly-born tunnel diode infant by analyzing and helping to reduce its early, lusty "noise cries", so that it can eventually assume its rightful place in the family of well-groomed amplifiers.

Millivac's low-noise amplifiers are becoming increasingly popular in a variety of fields — and especially where noise problems are severe. They are available with high or low input impedance, high or low frequency response in strictly AC, or both AC and DC types.

• Millivac's VS-64A Hushed Transistor Amplifier has less than 0.5 uV RMS noise voltage over a 60 KC passband, less than 0.2 uV with 10 KC bandwidth.

CIRCLE 183 ON READER-SERVICE CARD

RUSSIAN TRANSLATIONS

J. George Adashko

Ferrite Attenuation Measured on CRT Scope Face

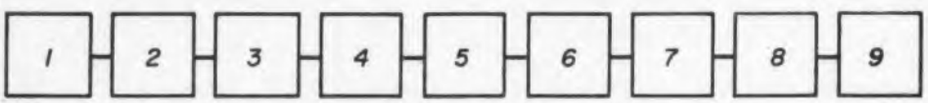


Fig. 1. Block diagram of apparatus for visual observation of the attenuation-frequency characteristic of ferrite devices.

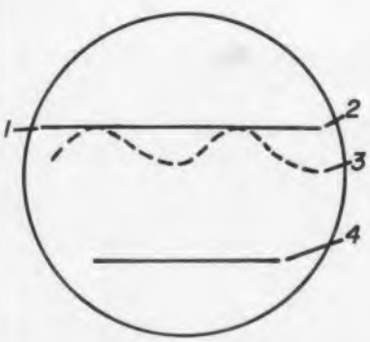


Fig. 2. The level line 1-2 of the calibrated attenuator is lined up with the ferrite characteristic, 3, traced on an overlay.

AN IMPORTANT property of ferrite devices is their ability to distinguish between different frequencies. In multi-channel communications systems they are used to separate the information in the various channels. However, to be sure that the separation is complete, a specified attenuation level, which is above a given minimum, is maintained.

Attenuation Characteristic Displayed on CRT Screen

With the instrument described here, the attenuation within a given frequency band can be quickly measured. Instead of measuring the attenuation point-by-point, the instrument displays the frequency dependence of the attenuation on a crt screen.

The block diagram of the instrument is shown in Fig. 1. A swept high-frequency signal from a klystron generator, 2 and 3, is audio-modulated and fed through ferrite element, 3, wavemeter, 4, calibrated attenuator, 5, and decoupling attenuator, 7, to a detector section 8. After it is detected it goes to the input amplifier of the indicator block 9.

The output signal is then applied through a dc

paraphase amplifier to the vertical deflection plates of a crt. At the same time a sweep voltage, proportional to the frequency of the hf generator, is applied to the horizontal plates. The resulting display is a plot of amplitude versus frequency. The attenuation of a ferrite element can be determined in the following manner.

Ferrite Element Substituted for Calibrated Attenuator

The ferrite to be tested is connected in the high frequency channel, replacing the calibrated attenuator, 5. Using a grease pencil, the oscilloscope display is drawn on a screen overlay.

The tested element is then removed and the calibrated attenuator, 5, is re-inserted. It is adjusted so that the level line (1-2) observed on the crt screen moves to coincide with the desired point of the ferrite characteristic drawn on the overlay. For example, the minimum attenuation of the ferrite can be determined by moving the level line to the valley or to the peak of the overlay curve.

The attenuation introduced by the unknown element can then be read on the scale of the calibrated attenuator. Using this method, the accuracy of the measurement is determined by the accuracy of the calibrated attenuator, not by the subjective operator accuracy. The accuracy of the attenuator, and therefore the accuracy of the instrument, is ±0.8 db.

The instrument is packaged in three sections: high frequency, indicator, and power supply. The generator used is a type K-29 klystron. The frequency retuning is mechanical with the aid of a reversible motor with simultaneous correction of the voltage on the deflecting electrodes. The retuning frequency range is ±5 per cent from the mean value. The time of retuning is 3 to 4 sec. The calibrated attenuator is of the polarization type, and its attenuation is practically independent of the frequency. The adjustment range is from 0 to 30 db.

To measure the frequency, a resonant wavemeter is provided. The resonance is noted as a hump (or trough) in the observed curves.

A 13L036 after-glow tube is used in the instrument, which is fed from a 50-cycle, 220-v line.

Translated from Instrument For Visual Observation of Frequency Characteristics of Ferrite Devices, Radio Engineering and Electronics, *No. 1, 1960, pp 171-72.*

Distributed R and C Elements Make Sharp Rejection Filters

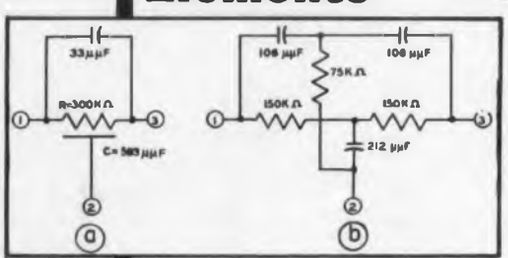


Fig. 1. The distributed element notch filter, a, has characteristics similar to the conventional Twin-T filter, b.

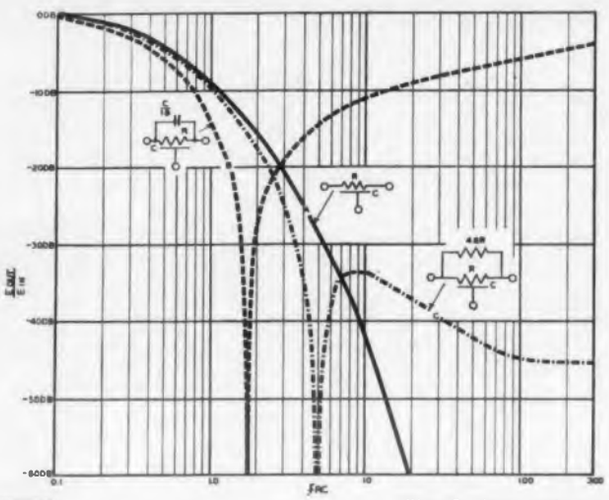


Fig. 2. Attenuation vs fRC plot for: A-distributed low pass filter, B-distributed shunt capacitor filter, C-distributed shunt resistor filter.

FILTER ELEMENTS having both distributed resistance and distributed capacitance result in filter designs with some very useful characteristics. Modern techniques for printing resistance elements on high-dielectric constant ceramic substrate make it possible to manufacture these filters for use at frequencies from the low audio through the vhf band.

Characteristics of Distributed RC Lines

The schematic diagram of such a distributed *RC* filter is shown in Fig. 1a. Its attenuation characteristic is similar to that of a conventional twin-T filter, Fig. 1b. The circuit values of these "notch" filters are chosen to produce a rejection frequency of 10 kc. The value of capacitance, *C*, shown in Fig. 1a is the total distributed capacitance under the resistor, while *R* is the dc value of the distributed resistance.

The distributed filter is far easier to adjust to a desired frequency than the conventional twin-T since only one circuit element (either *C* or *R*) need be adjusted.

The distributed *RC* element is essentially a transmission line which has only resistance and capacitance. Curve *A* in Fig. 2 shows the attenuation characteristic of such a network. (The additional capacitor of Fig. 1a is necessary to make it a notch filter.) The characteristics of the distributed *RC* element are plotted against the variable *fRC*, where:

f = the frequency of the applied voltage

R = the dc resistance of the distributed element

C = the total distributed capacitance between the resistive element and the conducting electrode beneath it.

The variable *fRC* is used in plotting these data since it allows the resultant plot to be completely general. If, for example, $R = 1$ meg and $C = 0.001$ μf, the horizontal scale reads directly in kilocycles.

Distributed RC Equivalent Circuit

Perhaps the best way of showing how the low pass distributed *RC* filter of Fig. 2a can be transformed into a notch filter is by referring to its π-equivalent circuit, Fig. 3. The variation of each of the elements with frequency is shown in Figs. 4 and 5. In these two figures, the dimensionless ratios Y_1R and Z_2/R are plotted instead of the admittance, Y_1, or the impedance, Z_2. Thus the

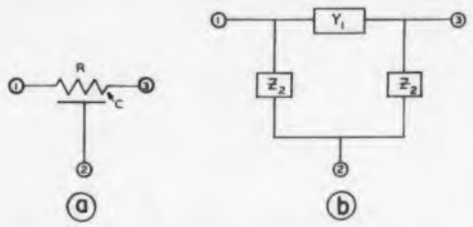


Fig. 3. The distributed *RC* filter of *a* can be represented by its π-equivalent circuit, *b*.

curves are applicable for any value of R.

Fig. 4 shows that as frequency increases, Y_1 decreases in magnitude while its phase angle becomes more and more negative. When the curve crosses the −90 deg line (that is, when Y_1 is purely inductive), the magnitude of Y_1R is about 0.65. If Y_1 is shunted with an admittance which also has a magnitude of $0.65/R$ but whose phase angle is +90 deg, the resultant total admittance between terminals *1* and *3* will be zero. There will be no transmission through the filter at the frequency at which this occurs.

It is not necessary to have a purely capacitive shunt element to transform a distributed *RC* element into a notch filter. Notch filters can also be formed by placing other impedance elements

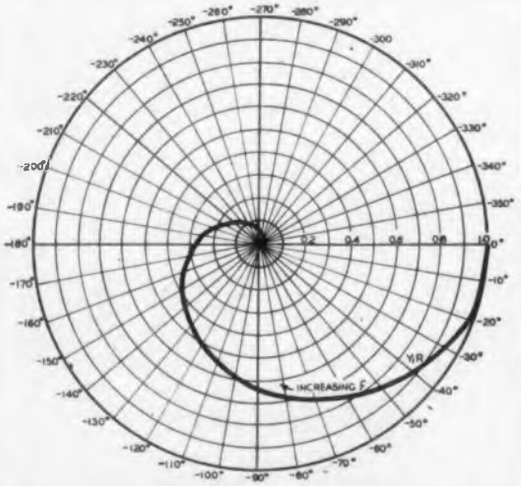


Fig. 4. Polar plot of the product Y_1R (Y_1 and R are defined in Fig. 3b.)

between terminals *1* and *3*. There will be complete rejection at one frequency. The magnitude of the admittance of the shunt element is equal to the magnitude of Y_1, and the phase angle of the shunt admittance is 180 deg from that of Y_1.

Notch Filter Characteristics

The attenuation characteristics of two distributed notch filters are shown in Fig. 2. Curve *B* in this figure is for a unit of the type shown in Fig. 1a. Curve *C* is for one formed by using a resistor for the shunt element. Of these two filters, the type using a shunt capacitor is more generally useful. It has less attenuation at frequencies both

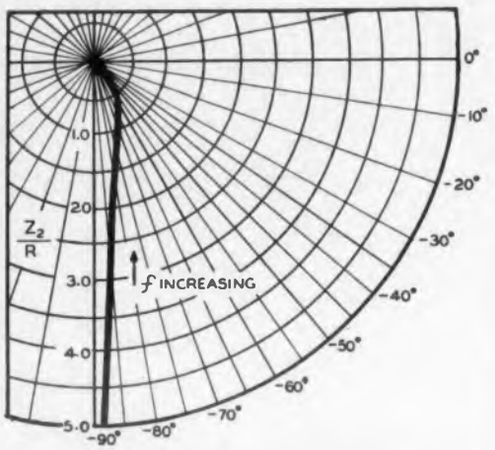


Fig. 5. Polar plot of the quotient Z_2/R (Z_2 and R are defined in Fig. 3b.)

above and below the notch frequency. Also, the shunt capacitor type requires a smaller RC in the distributed element for a given notch frequency than the shunt resistor type.

Curves B and C in Fig. 2 show the attenuation characteristics of notch filters which have been perfectly tuned, that is, the shunt element has been adjusted to have exactly the proper relationship to the distributed element for infinite rejection of one frequency. The variations in the characteristics of these filters when the shunt element deviates slightly from the ideal value is shown in Fig. 6. This deviation might be expected in an actual production unit. The characteristics of a shunt capacitor type notch filter are drawn for a perfectly tuned filter, A, and for a filter, B, with a shunt capacitor deviating by 12 per cent from the ideal value. This latter curve shown that, even with shunt capacitors which deviate by so great an amount from the ideal value, the attenuation of the filter at the notch frequency is still 40 db. Only the portion of the complete attenuation curve in the immediate vicinity of the notch is plotted in this figure. Small deviations in the shunt capacitor do not affect the rest of the curve.

Tapering Distributed Element Alters Filter Characteristics

The attenuation characteristics of the shunt capacitor notch filter can be altered by tapering the distributed element so that the resistance per unit length and capacitance per unit length change from one end of the filter to the other. This can be done by making the resistance film wider at one end than at the other. The smaller end will then have less capacitance per unit length as well as a higher resistance per unit length. For greater tapering ratios, the dielectric constant of the substrate and the resistivity of the resistance film can also be varied.

Fig. 7 shows the variation in the attenuation characteristics obtained by tapering the notch filter. In this figure, the attenuation characteristics of a tapered filter are plotted with the filter connected in each of the two possible ways. For this particular unit, the product of resistance per unit length and capacitance per unit length was tapered by a factor of 1600 from one end to the other. For comparison, the attenuation characteristics of an untapered filter are also included.

Applications

The shunt capacitor type notch filter has phase-shift characteristics which make it much more desirable for certain amplifier applications than a conventional twin-T. The measured phase shift vs frequency characteristics of a typical shunt capacitor notch filter are shown in Fig. 8a; phase characteristics of a conventional twin-T in Fig. 8b.

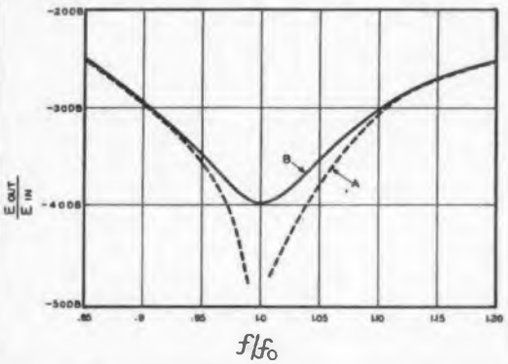


Fig. 6. The attenuation of a shunt capacitor notch filter is still 40 db down, curve *B*, at the rejection frequency even when the shunt capacitor is 12 per cent from the ideal value, curve *A*.

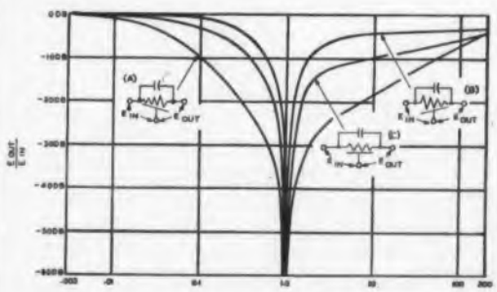


Fig. 7. Attenuation vs normalized frequency f/f_o for both tapered and untapered shunt capacitor distributed notch filters.

The significance of the difference between these curves may be seen by referring to Fig. 9. This figure shows the block diagram of a typical amplifier circuit using a twin-T filter for tuning. The phase shift from input to output of the high gain amplifier at mid-frequency is about 180 deg. As shown in Fig. 8b, there is a frequency at which the twin-T filter will also have a 180 deg phase shift. Unless all the components of the filter are

DIGEST

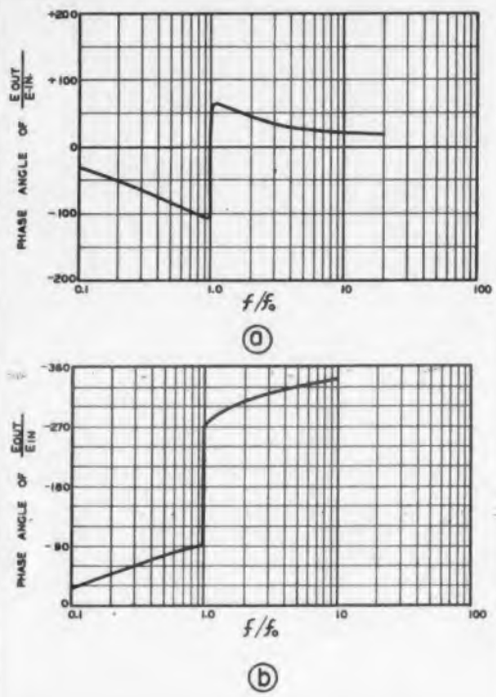


Fig. 8. Phase angle of E_{out}/E_{in} vs normalized frequency f/f_o for a distributed shunt capacitor notch filter, *a*, and for a Twin-T lumped component filter, *b*.

perfectly matched for infinite rejection at that frequency, an in-phase voltage will be fed back to the input of the amplifier.

When using twin-T filters for tuning, the filter components are adjusted so that this in-phase voltage will have just the right magnitude to give a sharply tuned response curve without causing self-oscillation. Such operation requires fairly critical adjustment of the filter. All of the six components of the twin-T must be held to tight tolerances. Also, the performance of the circuit is very much dependent on the changes in gain of the tube used in the amplifier.

If a shunt capacitor type distributed filter is used in place of the twin-T in the circuit of Fig. 9, the possibility of instability can be greatly reduced. With a distributed filter, as long as the amplifier phase shift is about 180 deg, the circuit will be stable no matter how large the gain K is. At both very high and very low frequencies, the distributed notch filter contributes very little phase shift to the system. Therefore, it is possible to place the filter around a properly designed high gain amplifier without danger of instability at any frequency.

Production Tolerances

The precision with which a notch filter can be manufactured to a specific frequency is approxi-

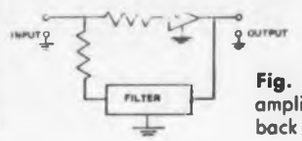


Fig. 9. Block diagram of amplifier using filter in feedback loop.

mately equal to the precision with which a resistor made from the same resistance film could be held to a specific resistance. Variations in the dielectric constant or thickness of the dielectric substrate between units need not affect the frequency tolerance. The resistor on each unit can be adjusted to yield the desired frequency, thus compensating for variations in the dielectric constant.

As may be seen from Fig. 2, the maximum attenuation of a shunt capacitor notch filter occurs when the product of fRC is approximately equal to 2. As long as practical values of R and C can be found which will cause fRC to have this value at a desired frequency, a distributed notch filter can be constructed.

With current techniques, notch frequencies from 100 cycles to 200 mc are possible.

Conclusion

In addition to the notch filter described above, there are an unlimited number of other possible filter characteristics. These can be achieved by properly combining distributed elements and shunting them with various lumped and/or distributed impedances. For example, one of the simpler combinations of lumped and distributed elements provides a filter with an attenuation slope of 10 db per decade rather than the usual 20 db obtained with single section RC filters. Such a filter might find use in the compensation of feed-back amplifiers.

In another possible filter configuration, a low pass distributed filter (one with the characteristic of curve A in Fig. 2) and a distrbuted notch filter are cascaded. If the notch frequency occurs at the knee of the low-pass filter characteristic, the combination will have a much sharper cut-off than the distributed low pass filter element alone.

Another possible arrangement is to cascade two notch filters tuned to slightly different frequencies. This yields an overall attenuation characteristic in which a wider band of frequencies is attenuated than with a single notch filter.

These are only a few examples of the filters possible with some of the simpler combinations of distributed and lumped elements. Many complex filter combinations are yet to be explored.

Digested from "Rejection Filters With Distributed R and C" by Alan B. Smith, Sprague Electric Co., North Adams, Mass. Originally presented at the Electronic Components Conference, Washington, D. C., May 10, 1960.

REPORT BRIEFS

Ferrite Attenuators

Several ways of employing ferrites in traveling wave amplifier attenuator systems are evaluated. The properties of conventional attenuators are reviewed with special attention given to the interrupted-circuit type. In a discussion of the experiments using ferrites in conjunction with TWT's, several difficulties are pointed out, including dielectric loading, beam defocusing, and alteration of circuit phase velocity. A description is also given of the design and operation of a high power circuit for a traveling wave amplifier circuit that uses a ferrite attenuator. *Ferrite Attenuators For Traveling-Wave Tubes, L. C. Bacon, Stanford Electronics Laboratories, Stanford University, Calif., 181 pp, Microfilm $8.40, Photocopy $28.80. Order PB 138346 from Library of Congress, Washington 25, D. C.*

Switching Circuits

The application of three-terminal negative resistance devices to pulse circuits are studied and discussed. The RCA 1832 Thyristor is used as a representative type in studying: (1) Capacitive type multivibrators using emitter and collector negative resistance characteristics, (2) An inductive multivibrator using the base input negative resistance characteristic, (3) A blocking oscillator using transformer feedback. (4) Ring counters. *Investigation of the Application Circuits, A. W. Carlson, Transistor Applications, Inc., Boston, Mass., 57 pp, Microfilm $3.60, Photocopy $9.30. Order PB 143978 from the Library of Congress, Washington 25, D. C.*

Printed Circuits

Report on investigations regarding the development of high temperature, passive two-dimensional, printed circuitry includes: surface resistivity studies, further development of film capacitors, metal film resistor studies, and development of non-glaze-containing, screen-painted enamel circuits. *High Temperature Printed Circuitry, G. H. Young, C.H.T. Wilkins and others, Mellon Institute of Industrial Research, University of Pittsburgh, Pa., 55 pp, Microfilm $3.60, Photocopy $9.90. Order PB 144545 from Library of Congress, Washington 25, D. C.*

Telemetry Information Reduction

An automatic data reduction system, Tare II, was designed to convert raw telemetry data (FM, PDM or PAM/FM) into digital form. Once in digital form, the data is then separated, reduced, linearized and tabulated at a high rate of speed by an automatic computer. The signal input to the

system is on magnetic tape previously recorded from the range telemetry stations. The digitized output of the system is recorded on six-track magnetic tape in proper format for computer insertion. Periodic time samplings are also digitized and recorded on the output tape. *Telemetry Automatic Reduction Equipment Tare II, E. W. Earle, J. T. Winkler and W. H. Butler, Air Force Missile Test Center, Patrick AFB, Fla., 82 pp, Microfilm $4.80, Photocopy $13.80. Order PB 144441 from Library of Congress, Washington 25, D. C.*

Hybrid Analog-Digital Computers

Conventional analog and digital computers are critically compared as to their relative suitability for scientific and engineering problems. Hybrid computers are defined as those in which computing operations of both types are combined, and the requirements are outlined in which such a union is advantageous. An economical, completely-general-purpose, hybrid computer seems unlikely, but there are many special-purpose applications of advantage, and examples are given. *Requirements For A Hybrid Analog-Digital Computer, D. C. Baxter and J. H. Milsum, National Research Laboratories, Ottawa, Canada, 29 pp, Microfilm $2.70, Photocopy $4.80. Order PB 144508 from Library of Congress, Washington 25, D. C.*

Maser Amplifiers

The theory of operation of both the gas and solid-state maser is presented. Certain aspects of its use as a microwave amplifier, such as bandwidth and noise, are discussed. *A Review of Maser Amplifiers, Naval Ordnance Test Station, Albert J. Jaske, Naval Ordnance Test Station, China Lake, Calif., 21 pp, Microfilm $2.70, Photocopy $4.80. Order PB 144077 from Library of Congress, Washington 25, D. C.*

PDM Telemetry

An all transistor PDM telemetry coder is described that is extremely linear, is unaffected by variations in signal voltage during the information pulse, and is free from the microphonic effects encountered in vacuum-tube circuits. The complete circuit includes an astable blocking oscillator pulse-rate generator, a voltage-controlled delay multivibrator (DMV) encoder and a gated memory circuit which prevents variations in signal voltage from appearing at the input to the DMV during the information pulse. *An All Transistor PDM Telemetry Coder, James S. Sherwin, Naval Ordnance Test Station, China Lake, Calif., 12 pp, Microfilm $2.70, Photocopy $4.80. Order PB 144721 from the Library of Congress, Washington 25, D. C.*

So You've Got to Make a Speech!

DESPITE the complex brain involvements for speech, the ability to speak effectively requires no great genius—just a little knowledge and a lot of hard work. Like most other skills, it can be mastered; the man who wants to speak well must simply learn how.

Facing an audience can be nerve-wracking, but it doesn't have to be. It can, in fact, be an exciting and rewarding experience—if you know what to say and how to say it.

The speaker's first hurdle is the preparation of his speech. This is more a matter of time than talent. If preparing a speech is an obstacle for you, try these simple suggestions:

1. If your topic isn't assigned, select something that you know a great deal about and your audience very little.
2. Limit your subject so you can cover it adequately in the time allotted.
3. Decide what your purpose is, and stick to it.
4. Jot down in outline form what you want to say. Have a look at the books in your library. Talk to friends about your topic. No speaker ever knew too much about his subject.
5. Organize your thoughts. Decide on the points you want to make in your talk, how you will develop each point, how you will begin your speech, how you will end it.

The Divisions of a Speech

Like all Gaul, a speech is divided into three parts—an introduction, a body, and a conclusion.

In the introduction you should do three things —get attention, establish rapport with your audience, and introduce your subject. Get attention with an appropriate and interesting story, arresting facts, an allusion to history, or with a vivid wording of your opening remarks. Establish rapport with your audience by linking yourself to your listeners by a friendly manner and by the use of direct, personal language such as I, you, we, us, etc. Make it clear what you are going to talk about.

In the second part of your speech, the body, present your ideas in logical order. State and develop each point with the use of specific cases, comparisons, statistics, exert opinions, or at least with a clear explanation of your ideas. Since the body of your speech is the longest and most important part, don't put your listeners to sleep by being dull or vague. Be as concrete as you can. Keep your words simple. Never say "comprehend" when "understand" will do or "manufacture" if "make" is better. Don't be afraid to use slang if your audience knows it. And keep your sentences short as possible.

The third part of your speech, the conclusion, is your last chance to get your message across. Let your audience know you are going to wind up. The drowsy ones may arouse themselves. Tie your ideas together and end with a note of finality that sends everyone home feeling that his time was well spent.

Fundamental Principles

A speech, of course, must have more than an introduction, a body, and a conclusion. It must be built according to certain basic principles which, if ignored, can mean failure.

Rhetorical principles have been taught since the days of Corax in ancient Greece. They're so simple most people ignore them. But if you haven't made them your own, you'll never be a good speaker until you do.

The first is this: a speech has to have unity. Unity is achieved by sticking to your purpose, by sticking to your subject and by trying to achieve a singular emotional reaction from your audience.

Secondly, a speech should have coherence. Coherence is achieved by arranging your ideas in a logical order and by having good transitions between them. Let the audience know when you are through with one point before beginning the next one.

Third, a speech must employ the principle of emphasis. Emphasis is achieved by repeating or restating your main ideas as much as you can without boring your listeners, and by developing each idea as concretely and as fully as possible.

How to Control Stage Fright

After you've prepared your speech, the next hurdle that faces you is the audience itself—and this can make the most experienced speaker shaky!

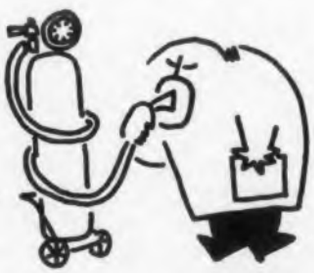
When Mischa Elman celebrated his 50th anniversary as a concert violinist a reporter asked him if he was still bothered by stage fright. "Of

course," he said "and I would think something was wrong with me if I didn't have stage fright before a concert." And most artists and speakers would agree with Mr. Elman.

In other words, practically everybody has stage fright. In fact, it's probably a good thing since it makes you more alert, more dynamic, more effective as a speaker. So don't fight it; accept it. No one likes to show it, however; so learn to control it. Here's how:

1. Be as well prepared for your speaking engagement as you possibly can. Have a few notes if necessary. Know exactly how you want to begin your talk, and how you want to end it.

2. Be familiar with the place where you will speak. Know where you will stand. Test the microphone before the meeting begins. If you need chalk for your talk, make sure some is available. Leave nothing to chance.



3. Before you get up to speak, breathe deeply —slowly but deeply—10 to 15 times. Oxygen helped the American Olympic hockey team win first place at Squaw Valley. It can help you make better speeches.

4. When you get up to speak, stand up straight. Let your weight rest comfortably on both feet, not like a soldier or an awkward teen-ager, but like a man who has confidence in himself, who has something to say, and who wants to say it effectively.

5. Look at your listeners and talk with them as if you were carrying on a lively conversation with each member of your audience.

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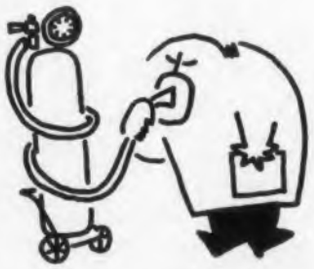

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Use Vocal Variety

Apart from a dull speech, nothing is deadlier than a dull speaker. A dull speech may be ex-

DESIGNING YOUR FUTURE

cusable, but vocal monotony never is. To achieve a lively, conversational manner a speaker has to analyze his voice and discover its flexibility and expressiveness.

Consider the ways you achieve vocal variety in everyday speech:

1. If you are normal, your pitch range is about two octaves. If you express yourself freely, your pitch varies a great deal during the course of a conversation. When you speak to an audience, forget your self-consciousness and talk to your listeners as if they were your closest friends.

2. If you have more or less normal vocal organs, you can say from 100 to 200 words a minute without speaking too slowly or too rapidly. A good conversationalist changes his rate a great deal depending on the importance of his utterances, the way he feels about his subject, and the reactions of his listeners.

3. Unless you are completely hen-pecked, you can speak loud enough to be heard a block away. Sameness in volume is as deadly as monotony in pitch and rate. Don't overdo this, of course. Ex-

cessive loudness or softness will make your listeners restless.

4. A final way to keep your audience awake is to express your feelings as you talk. If you are genuinely interested in your subject, you will during parts of your talk speak in a light, even joking manner, at other times, in a serious or even angry manner.

Regardless of how you achieve vocal variety, it must be real; that is, it must be the natural result of your thinking and feeling.

Another way to keep your audience awake is with the use of visual aids. Most people are visual minded, and a picture may be worth more than a thousand words. But visual aids can't be used haphazardly.

How to Use Visual Aids

1. Make sure your aids are of good quality. Poorly constructed aids may be worse than no aids at all. You don't have to be an artist or an engineer to prepare good aids—just patience and concern for your listeners.

2. Display each aid only when you need it. Remove it as soon as you are through with it.

(continued on page 170)

Advancement Your Goal?

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ELECTRONIC DESIGN's Confidential Career Inquiry Service helps engineers "sell" themselves to employers—*as confidentially and discreetly as they would do in person.* The service is fast. It is the first of its kind in the electronics field and is receiving high praise from personnel managers.

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ELECTRONIC DESIGN will act as your secretary, type neat duplicates of your application and send them to all companies you select—*the same day the resume is received.*

The standardized form permits personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you.

Painstaking procedures have been set up to ensure that your application receives complete, confidential protection. We take the following precautions:

- All forms are delivered unopened to one reliable specialist at *ELECTRONIC DESIGN*.
- Your form is kept confidential and is processed only by this specialist.
- The "circle number" portion of the form is detached before the application is sent to an employer, so that no company will know how many numbers you have circled.
- All original applications are placed in confidential files at *ELECTRONIC DESIGN*, and after a reasonable lapse of time, they are destroyed.

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Position Desired _____

Educational History

College	*Dates*	*Degree*	*Major*	*Honors*

Recent Special Training _____

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Published Articles _____

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Use section below instead of Reader Service Card. Do not write personal data below this line. This section will be detached before processing.

Circle Career Inquiry numbers of companies that interest you

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925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949

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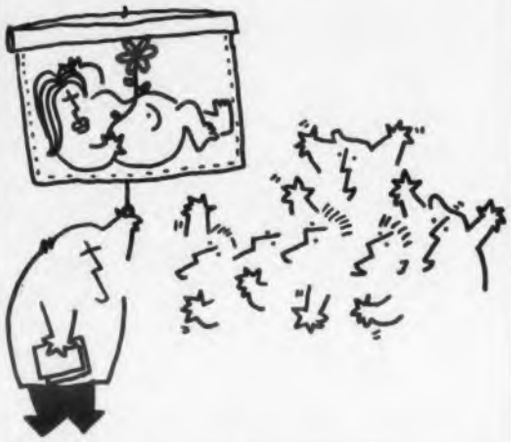

Your aid may be more interesting than you are. So don't divide the attention of your audience by displaying your aid too soon, or by keeping it on display after you have finished with it.

3. If possible, present one and only one idea visually at a time. This makes it easier for the listeners to understand and to remember what you show them.

4. Make sure your aids can be seen by everyone in the room.

5. In using an aid or the blackboard, don't block anyone's view any longer than you have to.

6. When using visual aids maintain as much eye contact with your audience as you can.

7. Don't pass a single object among the members of your audience unless it is absolutely necessary. If you can't supply everyone with a

copy, let those who are interested examine the item at the end of the talk.

Speech-making with or without visual aids requires a lot of effort on the part of the speaker, and usually the most seemingly effortless speaker is the one who has spent the most time preparing his remarks. A good speech is well organized. It is clear. It is concrete. And, most important of all, it makes a deep impression on the listeners.

If you forget everything else in this article, remember this. Speech-making requires no great talent—just a lot of hard work. If you have something to say, don't be afraid to say it. But say it clearly, vividly, and with feeling and people will listen and respond to your ideas. ■ ■

ENGINEERS

ENGINEERS & SCIENTISTS SEMICONDUCTORS

Have you and your company continued to grow as you anticipated? In less than 6 months Pacific Semiconductors, Inc. has expanded from less than 1,200 to more than 2,000 employees. Based on conservative sales estimates, at least another 50% growth is assured for the remainder of 1960—and 1961 WILL BE EVEN BETTER!

In recent months Pacific Semiconductors, Inc. has developed the first micro miniaturized diode as well as transistors ranging in power up to 1500 watts output.

And this is only the beginning! Our rapid growth opens stimulating and challenging opportunities in the exciting commercial field of solid state devices. The following are typical of present openings for engineers and scientists seeking career positions in a field of unprecedented growth:

ADVANCED CIRCUIT DESIGNERS

BSEE or MSEE with minimum of four years experience in original design of advanced instrumentation circuitry. Must have the ability to conceive and bring to fruition circuitry to measure advanced state-of-the-art devices.

APPLICATIONS ENGINEERS

BSEE or MSEE to resolve customer inquiries concerning highly advanced silicon transistors, diodes and rectifiers. Previous experience in circuit design of electronic equipment involving miniaturization is desired.

DEVICE DEVELOPMENT ENGINEERS

Engineers or Physicists to engage in device design and process parameter optimization of high frequency and fast switching transistors. Will study product performance and recommend improvements. Advanced degree preferred.

PROCESS ENGINEERS

Engineering or Physical Science degree with training in semiconductor theory and ability to transform experimental process into pilot and full production operation. Will perform studies on existing processes and formulate improvements. Openings in Diode, Transistor, and Microelectronics groups.

QUALITY CONTROL AND RELIABILITY ENGINEERS

Background in E E, Ch E, or IE with knowledge of statistics to work on complete analysis of semiconductor manufacturing operations, work out final and reliability inspection and test procedures, and specify equipment and reports required.

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Degree in Electrical Engineering to perform measurement of transistor parameters and circuit performance capabilities up to several hundred megacycles. Applicants should have 5 – 10 years experience in high-frequency measurement and/or equipment design, and/or high-speed switching design work, at least part of which should preferably be in transistorized equipment.

U. S. Citizenship not required.

These are but a sample of the many interesting openings available at Pacific Semiconductors, Inc. If you feel that you are qualified for the above or for other positions in the fascinating and rewarding world of semiconductors, write in confidence to:

D. E. Grantham, Technical Staff Recruiting

PACIFIC SEMICONDUCTORS, INC.

10451 West Jefferson Blvd., Culver City, California

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PACIFIC SEMICONDUCTORS, INC.

14520 S. AVIATION BLVD.

LAWNDALE, CALIF.

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CIRCLE 912 ON CAREER INQUIRY FORM

Are you a computer programmer and don't know it?

Many men who have training in engineering and the sciences are now going into computer programming. They find that it makes full use of their special analytical and logical talents, often not fully tapped in their present work.

In the 60's and beyond, the electronic computer will become more and more an important factor in the operations of business, industry, science and government. Computer programmers, the men who direct the computers, will play a vital role in this progress.

One of the most important qualifications for this work is the ability to analyze complex problems and to deduce from them meaningful and useful answers.

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If you have a degree in engineering or one of the sciences, and are interested in this important new profession, I will be happy to give you further information.

Please write, outlining briefly your background, to:

Mr. T. E. Burns, Dept. 555R1
IBM Corporation
2561 Strang Blvd.
Yorktown Heights, N. Y.

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INTERNATIONAL BUSINESS MACHINES CORPORATION

CIRCLE 913 ON CAREER INQUIRY FORM

3 Question Quiz for Senior Level Electronic Engineers and Physicists

1. **Do you enjoy the full measure of creative freedom to which experienced men are entitled?**
2. **Do you have a high degree of respect for your top management's technical competence?**
3. **What about the projects you're working on—are they stimulating enough to fully challenge your talents?**

At General Mills R and D Laboratories in Minneapolis, engineers and physicists answer an enthusiastic "yes" to all these questions.

For nearly two decades we have been developing and manufacturing weapons, sub-systems, and electro-mechanical and electronic instrumentation systems for both military and commercial use. Our growth has been impressive, and it promises to be even more impressive. Right now we have several technical supervisory and purely technical opportunities open to senior level engineers and physicists in the fields of:

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- **Electronic Circuit Design**
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- **Digital Computer Logic**
- **Electronic Packaging**
- **Advanced Pulse and Video Circuit Development**
- **Advanced Inertial Navigational System Development**
- **Optical and Infra-Red Equipment Engineering**

Perhaps you are one of the men we seek. Ideally, you have a graduate degree and 5 to 8 years experience in electronic instrumentation systems development. In any event, if you now hold a technical supervisory position or are capable of doing so, if you have initiative and drive, if you enjoy exploring the unknown in order to find better ways of doing things—we are genuinely interested in you. And you should be interested in us because we promise you a creative environment in which you can quickly achieve the full measure of professional and personal recognition that your finest talents demand.

You'd like living in Minneapolis—some of the nation's most beautiful fishing, hunting and camping sites are just an hour's drive away. We enjoy a friendly, neighborly way of life and, at the same time, have all the advantages a major cosmopolitan center can offer. Our people spend long evenings with their families because travel to and from work is easy, uncongested. Children grow strong and healthy in this wholesome vacation-land. And they're educated in fine, trouble-free schools.

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Manager Professional Personnel

Mechanical Division

2003 East Hennepin Avenue,
Dept. ED-6
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General Mills

CIRCLE 914 ON CAREER INQUIRY FORM

ASSISTANT EDITOR WANTED

Department: Editorial Department

Job Description: Report on new developments and trends. Classification and evaluation of all New Products announced by industry.

Qualifications needed by applicant:

Education: EE degree or equivalent educational background

Experience: One or two years as components engineer and/or work in Engineering Standards Department. Some experience in writing evaluation reports.

Date position open: NOW

Salary to be paid: $6,000 to $8,000 depending on qualifications of applicant.

Approved Edward E. Grazda, Editor-in-Chief ELECTRONIC DESIGN

HOW DO YOU APPLY FOR THIS OPENING?

Send letter outlining your experience and background to

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New technical tests enable you to calculate your probability for success at LMED – in 1 hour at your own home!

BY GENERAL ELECTRIC'S LIGHT MILITARY ELECTRONICS DEPARTMENT

If you've been thinking of changing your job some day—or in the near future—but have hesitated because of the many uncertainties involved, Light Military's new concept in professional job selection will be of paramount interest to you.

What is it?

The new concept is based on a series of technical tests developed and pretested by Light Military engineers. They are designed to be taken, scored and evaluated by the individual engineer, all in the privacy of his own home. And, because the sole purpose is to provide you with a novel, objective means for self-appraisal, your score need not be divulged to us at any time.

Here's how it works:

First, fill out the coupon below and check off the tests which apply to your training and professional experience. Forward the completed coupon to us and in a few days you will receive the tests, a sealed answer sheet and explanatory material.

During a convenient hour at home, take the test and score it with the answer sheet provided. Then, compare your performance with the criterion group composed of Light Military engineers at all levels who took the same test. In most cases you will be able to relate your score to years of experience, from 2 to more than 10.

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If your adjusted score is equal to, or more than the years of experience you possess, the probability is excellent that a significant community of technical interest exists between you and The Light Military Department. In addition, a valid assumption can be made that a high probability for success awaits you here. And remember, your score need not be divulged to us at any time; it is for your own guidance exclusively!

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Facts about the tests

1. Each technical test is composed of 40 multiple choice questions.
2. To find answers for some questions, mathematics is involved—but only to the degree normally associated with the work.
3. The "mix" of questions includes some easy ones, some bordering on the state of the art.
4. None of our engineers achieved a perfect score.
5. The test for Engineering Administration is psychological, designed to reveal aptitudes and abilities most often found in good engineering managers or administrators.

MAIL THIS COUPON FOR YOUR TESTS

Mr. R. Bach
Light Military Electronics Dept.
General Electric Company, French Road, Utica, New York

Please send me tests (limited to 2 subjects per individual) answer and self-evaluation sheets covering the areas checked:

☐ RADAR ☐ MICROWAVE ☐ ELECTRONIC PACKAGING (ME)
☐ COMMUNICATIONS ☐ ADMINISTRATIVE ENGINEERING

NAME _____

HOME ADDRESS _____ HOME PHONE _____

CITY _____ ZONE ____ STATE _____

DEGREE(S) _____ YEAR(S) RECEIVED _____

76-MF

LMED
LIGHT MILITARY ELECTRONICS DEPARTMENT

GENERAL ELECTRIC

Vol. 1, No. 5

Nickelonic News

DEVELOPMENTS IN NICKEL AND NICKEL ALLOYS AND THEIR APPLICATIONS

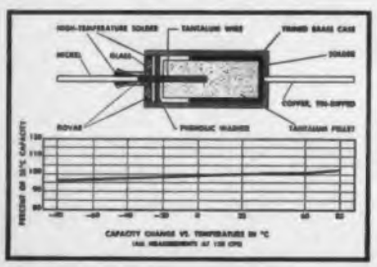
Nickel leads, welded directly to tantalum, boost capacitor ruggedness

DALLAS, TEX. – For maximum reliability, new Texas Instruments *tan*-TI-*cap*** capacitors depend on leads of Electronic Grade "A"* Nickel. This strong, tough nickel wire, welded soundly and easily to the tantalum stubs, helps provide the good connections needed to withstand mechanical and thermal shock.

Electronic Grade "A" Nickel is highly resistant to oxidation and corrosion. What's more, it provides tight hermetic seals (note figure below) and speeds unit installation.

**T. M. of Texas Instruments Incorporated

Pertinent Literature: Write for Technical Bulletin T-15.



Lead wires of Electronic Grade "A" Nickel strengthen this new *tan*-TI-*cap* Solid Tantalum Electrolytic Capacitor.

Nickel materials keep electrons "in line" in new linear accelerator

WALNUT CREEK, CALIF. – Intense electron, neutron and X-ray beams are generated by this new ARCO linear electron accelerator. In order to operate at very high vacuums -10^{-7} to 10^{-8} mm Hg –its vacuum envelope must be de-gassed by baking out at 400°C. ARCO designers specify Electronic Grade "A" Nickel for the envelope because it provides the excellent vacuum properties required. This metal also resists oxidation, corrosion and retains its strength at operating temperatures well above 400°C.

FIRST COMMERCIAL ATOMIC CLOCK... WAVEGUIDES OF LOW PERMEABILITY MONEL "403" HOLD DOWN SIGNAL DISTORTION

No problem fabricating these waveguides of Monel "403" low permeability alloy, reports National. The intricate tubes carry microwaves in the Atomichron atom-regulated frequency standard.

Heart of the "clock" – a cesium beam tube—Monel "403" alloy provides the tube's pole assemblies with excellent mechanical properties plus low magnetic permeability. Manufactured by National Company, Inc., 61 Sherman Street, Malden 48, Mass.

Nickel improves seals

All metal surfaces of the envelope's metal-ceramic seals are nickel-covered. Nickel is easily brazed, protects parts from oxidation. Its purity facilitates the elimination of all organic products from the vacuum envelope, permitting excellent radio-frequency operation.

Pertinent Literature: Write for "Nickel Alloys for Electronic Uses."

For outstanding vacuum properties, key parts of the Mark 1-T4 accelerator are made of Electronic Grade "A" Nickel. Built by Applied Radiation Corp., Walnut Creek, Cal.

*Inco trademark

. . . clock generates frequencies accurate to 5 parts in 10 billion!

MALDEN, MASS. — You can now tell time accurately down to 100 millionths of a second with the Atomichron†, first commercial atom-regulated "clock."

How it works

Waveguides feed a tuned microwave signal through a stream of cesium atoms. As signal reaches the atoms' resonant frequency, it changes some atoms in internal structure. This change is sensed by a detector and signalled to a servo system, which regulates the frequency of a basic oscillator at precisely the atomic resonance value. By means of electronic multipliers and dividers, this oscillator produces standard output frequencies of 0.1, 1.0, 5, 10, and 100 megacycles – the required "clocking" action.

Designers chose Monel "403"* low permeability nickel-copper alloy for the waveguides, radio frequency sections and magnet pole assemblies, because it provides magnetic permeability so low that atomic resonance remains free from distortion. Monel "403" alloy offers excellent vacuum and mechanical properties, is readily machined and formed into intricate shapes.

Like all nickel alloys, Monel "403" alloy is freely available.

Pertinent Literature: Write for "Basic Data-Monel '403' Low Permeability Nickel-Copper Alloy."

†T. M. of The National Company, Inc.

HUNTINGTON ALLOY PRODUCTS DIVISION
The International Nickel Company, Inc.
Huntington 17 West Virginia

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June 8, 1960

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830 Third Avenue, New York 22, N.Y.