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HIGHLIGHTS OF ISSUE

Design '59—Challenges Facing Design Engineers (Cover) 20

In Year Two of the Space Age, demands on the designer's talents are heavy, not only in "glamour" fields like missiles, spacecraft, radar and computers, but in the prosaic but nonetheless vital areas of communications, consumer products, components, industrial and medical electronics. New and old problems are many, ranging from rfi to less-than-perfect reliability.

Mesa Switching Transistor . . 42

The TI2N559 offers high switching speeds, high alpha cutoff, and higher power in one tiny package. It is in full scale production.

FM Tuning Unit 44

Practical approach in consumer product design achieves economy without sacrifice in performance or quality.

NEXT ISSUE
A Microminiaturization Series Starts

Starting in the next issue, the first articles of an exclusive series on microminiaturization based on papers delivered at the Symposium on Microminiaturization of Electronic Assemblies sponsored by the Diamond Ordnance Fuze Laboratories.

Russian Book on Nonlinear Radio Engineering to be offered by ELECTRONIC DESIGN. See 120.

January 7, 1959 Vol. 7

NUMBER 1

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

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NBP BPA

ELECTRONIC DESIGN is published bi-weekly by Hayden Publishing Company, Inc., 830 Third Avenue, New York 22, N.Y., T. Richard Gascoigne, President; James S. Mulholland, Jr., Vice-President & Treasurer; and David B. Landis, Secretary. Printed at Hildreth Press, Bristol, Conn. Accepted as controlled circulation publication at Bristol, Conn. Additional entry, New York, N.Y. 32,000 copies this issue.

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BEHIND THE NEWS

Challenges Pinpointed at Communications, Computer and Connector Conferences

IN SUNNY St. Petersburg and windy Chicago, in Philadelphia and in Dallas, delegates gathered last month to discuss a theme universal to all electronic design engineers, regardless of their specialties. Their common topic was the challenges facing them in the immediate as well as the far future, and the developments they anticipated ranged from a 10,000 mc "information pipe" to electrical connections rugged enough for outer space.

The delegates, thousands of them, pinpointed design problems in technical sessions at the Second National Symposium on Global Communications at the Ninth National Conference of the IRE Professional Group on Vehicular Communications, at the Eighth Eastern Joint Computer Conference, and at the Third EIA Conference on Reliable Electrical Connections.

Looking to the far future, IRE president Don G. Fink told the Globe-Com II delegates in Florida that one day a 10,000-mc "information pipe" would be wired into every city and suburban home, just as water and gas connections are today. Over this super-bandwidth cable would come almost every conceivable service—TV, video telephone, audio-visual magazines.

Rapid advances in wire communications in the next few decades will make this possible, said Fink. Already, he told the 900 delegates, Bell Labs engineers have a submarine-type cable on their drawing boards capable of 3 mc bandwidth. Such a cable would make trans-Atlantic television possible.

It may be another 10 years, however, before transoceanic TV goes into operation, Fink said. Installation date of the first such cable will be governed by demand for service, and by economics of operation.

Wireless Overloaded

Wireless, dominant for 40 years or so, is choking itself out of existence because of its own rapid growth. Now, said Fink, wire and cable will become all the more important.

High reliability and efficiency are the major advantages of wire communication links, he pointed out. Except in unusual circumstances, there is no fading or interruption from man-made interference.

Today's methods of point-to-point communication are inefficient, said Fink. Broadcast techniques are used to communicate between two stations. Microwave links are directional, but equipment efficiency is low—and tropo-scatter links are even more inefficient. Again, cable networks would seem to be the answer, he said.

Faster and more reliable global communications was the theme of Globe-Com II technical papers. James E. Hacke, Jr., of GE predicted demand for message facilities will double in the next 12 years. But he anticipated no major technical advance in that period.

By 1970, Hacke said, air travel also will double. And this will add to demands on communication facilities, probably forcing the industry into the age of machine-to-machine communication. In

IRE president Don G. Fink predicts: An "information pipe" for everyone.

For the challenges facing the entire industry, read the special report starting on page 20.

BEHIND THE NEWS

global telephone traffic, he said, human operators will become extinct.

Two rival systems of world-wide communications were explored. Dr. Joseph Vogelman, Rome Air Development Center, presented a paper by RADC's Charles Strom and Allan Kunze evaluating development trends in Air Force global communications, dwelling particularly on AF Project 456L. The paper outlined goals in radio relay and scatter equipment, and disclosed the switching complex and tentative system standards.

The Army's rival Universal Integrated Communications System (Unicom) was the subject of a discussion by a panel of Signal Corps experts, moderated by Col. George P. Sampson, Chief, Army Communications Service Division.

Mark Time on Both

Unicom has the same basic objectives as the AF 456L system. Reports indicate both may be temporarily curtailed by the Defense Department until it is decided which project will be developed into a working system.

Looming importantly in any discussion of global communications was the use of earth satellites. Several technical paper authors discussed parameters necessary for reliable long-distance networks using active and passive satellite relays. One stated that if 72 satellites were equally spaced, revolving around the earth, there would be a maximum wait of less than three seconds before a message could be successfully relayed.

In Chicago, meanwhile, vehicular communication engineers were unanimous in stressing the urgent need for getting additional frequencies allocated to them.

EIA studies to support the demand for additional 40 mc frequency allocations for land-mobile radio services cited figures showing that mobile communication transmitters have increased from 37,000 in 1947 to 700,000 in 1950. Within 10 years, the studies indicated, 2,800,000 such transmitters will be in operation (excluding telephone service) for such fields as mining, agriculture, taxi, utility and manufacturing.

GE's Harrison Van Akens said the future of land-mobile radio may hinge on FCC hearings this year and stressed the urgency of FCC reallocation of service priorities. A reasonable sequence of priorities, he said, might start with national defense, then continue with public safety, travel safety, communications, education, entertainment, research, public correspondence and, finally, hobby purposes.

Efforts to increase available spectrum space have resulted in splitting the 25-50 mc spectrum into 20 kc rather than 40 kc channels, and the

152-162 mc spectrum into 30 kc instead of 60 kc channels. But delegates among the 350 engineers at the sessions said these changes have imposed severe restrictions on both transmitter and receiver design and operation.

Indicating how tight the space situation will grow, Bell Telephone System said that in the next 10 years, 7,000,000 to 15,000,000 autos will be equipped with mobile radio equipment.

Whether the answer is frequency reallocation, or whether newer transmission techniques also will be required, remained unanswered.

Computer for Every City

Future needs also dominated the Philadelphia gathering of 2400 computer engineers. Typical of the ideas presented at the "blue sky" panel discussions was this vision:

"Every major city will have a computer center. Computer services will be available to anyone for a fee—just like telephone or power distribution services. The computers may help people fill out their income tax returns . . ."

Papers ranged over a wide area, from "Data Processing in Banking and Other Service Industries" to "New Logical and Systems Concepts."

Perhaps the most significant news to emerge from the meeting was the fact that there are no new vacuum tube computers. All computers now on drawing boards use solid-state electronics.

In Dallas, engineers concerned with reliable connections entered into controversy on almost all aspects of the field, but reached agreement on one dictum: good workmanship and cleanliness are essential at all stages during the production of electrical connections. Poor workmanship was blamed for defeating many of the best efforts of engineers to design improved systems.

But areas of contention included hand vs. automatic soldering of printed circuit boards, crimp vs. solder connections, and the basic definition of what constitutes a connection failure.

Some engineers said resistance meant failure; others said it was a definitely open circuit. In printed circuit boards, some insisted hand soldering was the only reliable method, others said the whole purpose was to attain automated soldering techniques. Agreed was that there are practically no prosaic problems in electronics.

For the future, engineers were warned of the need for electrical connections that will withstand the high stresses of outer space. Already, it was testified, there is a necessity for soldered connections to function at 400 to 500 F or down to —200 F.

(A special report on electrical connections will appear in the Feb. 18, 1959, issue of ELECTRONIC DESIGN.)

BEHIND THE NEWS

Large Reciprocating Gas Compressors Controlled From 40 Miles Away

Reciprocating gas compressor station at Linden, shown with entire operating staff.

Sole attendant at Linden compressor station replaces chart paper about once a month.

This console at Lambertville, N. J. controls three compressors at Linden, 40 miles away. It starts and stops the engines; it controls and monitors all vital parameters; it even detects fire, explosive mixtures, and unauthorized entry of personnel.

FOR THE first time, a large reciprocating gas compressor station is under complete remote control. Three 2050 hp natural gas compressors at Linden, N.J., are controlled from another station at Lambertville, N.J., about 40 miles away. Controlling signals are sent over telephone lines or over a microwave link in the form of discrete tones.

The Linden station of the Texas Eastern Transmission Corp. has one man in attendance on a forty-hour a week basis. He keeps the building clean. He wipes and oils the engines. He replaces oil filters and chart paper and sees that things are shipshape. But he has nothing to do with the plant's operation.

All controls are either pneumatic or electronic. The principal objection to the electronic controls is the requirement for costly, explosion proof housings for switches, relays, and other equipment. So, where line length permits, pneumatic controls are used.

Electronic equipment records all vital information for correct operation of the station, and controls most of the important engine parameters. Engine controls such as starting air, jet air, cylinder end-pocket clearance, cylinder valves, and fuel gas are all operated by electronically sequenced controls.

Sylvania Packaging Its Maser for Aircraft

Sylvania Research Laboratories announced that the maser in the near future will be reduced from unwieldy laboratory size and packaged for military aircraft.

This revolutionary device is expected to increase the range of radar up to seven times, and boost substantially the "seeing" power of other electronic equipment.

Dr. Robert M. Bowie, vice president of the laboratories, said Sylvania is engaged in a program to ruggedize, miniaturize and package the maser so it may be used initially in military applications, and ultimately in industry and peacetime scientific research.

WRITE IN 7 ON READER-SERVICE CARD ➤

BEHIND THE NEWS

Fiction Plots Made Real For American Rocketeers

Science-fiction's classic plots were translated into near-future possibilities at the American Rocket Society's 13th annual meeting, first since dawn of the Space Age. Sober discussions ranged from invisible force fields to international V-mail via satellites, from mice and man in space to heat and acceleration effects on cosmic travelers.

Delegates to the sessions had the mood set for them by Princeton's Russell M. Kulsrud, who declared that the new science of hydromagnetics (or magnetohydrodynamics) may turn into reality the fiction writer's dream of an invisible force field to deflect enemy missiles.

Intangible Field vs. Tangible Object

The Project Matterhorn researcher said intangible magnetic fields not only could deflect but could handle missiles and other concrete objects so long as they are highly conducting.

For more immediate application, Kulsrud said, hydromagnetics offers obvious advantages in the field of rocket propulsion, where burning fuel reaches such temperatures it can damage combustion chamber walls.

Magnetic fields, said the physicist, constitute the only known way to keep a thermonuclear plasma away from walls of a containing chamber long enough to allow nuclear reactions to take place, and to permit the removal of useful power from the fusion reaction.

The Re-Entry Problem

In addition, hydromagnetics can be useful in re-entry, where hot ionized gases can severely damage a vehicle hitting the atmosphere at very high speeds.

This re-entry problem also was analyzed by North American Aviation's Earl T. Carter and M. W. Jack Bell from the standpoint of crew survival. Minimal performance could be expected of men working just below 250 F, they said. But as that top limit would be reached in the vehicle's cabin 250 to 300 seconds after re-entry begins, unprotected occupants could not perform effectively after that time, and probably would be fatally burned before completion of the descent. The answer: pressure suits design to reduce interior temperatures.

Keeping the Crew Alive

Crew survival also was the problem discussed by Wright Air Development Center's Col. John P. Stapp of rocket sled fame, but his concern

as protecting men against acceleration. The Air Force officer, president-elect of the Society, told members that man definitely is capable of enduring the accelerations necessary for attaining orbital or escape velocity with present three-stage rocket systems. He also can sustain the prolonged exposure to low acceleration required for re-entry.

Man will not enjoy these ordeals, nor will he be spared them until space vehicles are designed in compliance with parameters of human effectiveness rather than man's survival limits, said the Aeromedical Lab chief.

The research goal, a promising one, is development of propulsion systems with continuous low acceleration. Man, Stapp said, can effectively handle extremely long accelerations that do not exceed 4 g's. And one hour at only 3 g's would get a vehicle to a speed 10 times greater than escape velocity.

Man Can Take 10 g's

But if no method of propulsion can be developed within man's range of physiological adjustment, if the present means of three-stage rockets must be relied on to propel him into space, man can take it. Stapp warned, however, that 10 g's is the limit, and crewmen must be optimally positioned for forces above 4 g's.

For transverse accelerative forces, such as Stapp personally tested in his rocket sled rides, survival limit for lightly anesthetized chimpanzees restrained by nylon webbing, he said, was reached at 236-g peak with 11,250-g per sec rate of onset and 0.35 sec total exposure duration.

Not only chimpanzees, but mice too can stand high-g stresses. F. L. van der Wal and W. D. Young of Space Technology Labs, in the first full public report on the Air Force Mouse-in-Able (MIA) program, revealed at least two mice survived re-entry from 1400 miles up.

First U.S. Space Travelers

On April 23, July 9 and July 23, Able vehicles carried mice in special MIA packages mounted in nose cones, but only the last two mice—named Laska and Benji—were instrumented.

Telemetry data on the July flights indicated take-off conditions were not severe enough to produce violent or continuing response from Laska and Benji. There was no evidence of distress due to weightlessness, though they were weightless for longer periods than any animal except Sputnik II's Laika. (The American mice went some 350 miles higher than the apogee of 1000 miles reached by the Russian dog.)

Instrumentation showed the mice were alive when they hit the surface of the Atlantic Ocean, but the nose cones could not be retrieved.

(Continued on following page)

BEHIND THE NEWS

Tomorrow's Mainliner

Weightlessness—or nearly that condition—w a factor reckoned with in Convair's plastic mod of a spaceship displayed for Society delegate It simulated 1/10th-g conditions in the forwa sections, the working and living sections of t multicompartmented ship.

The axis of ship rotation that provides parti gravity for the forward sections leaves the cent section at zero g. Spacemen arriving at the orbi ing ship via "taxi" would debark at the stern an move past engines in a corridor containing sub way-strap-like handgrips to enable them "swim" forward.

Besides orbiting spaceships, earth's immediat cosmic neighborhood in the foreseeable futu might also contain a satellite "post office" repea ing station traveling at earth-rotation speed, fixe at a longitude midway between Europe an America. Its proposed purpose: to handle all fir class and air mail letter traffic between the co tinents at lower cost and substantially great speed than present postal services.

U.S.A. to Europe via Space

The system, mapped after preliminary studi at RCA's Astro-Electronic Products Divisio was outlined by communications engineerin manager Sidney Metzger. He proposed usin standard letter forms similar to WWII's V-Ma gummed forms.

At major post offices, letters' contents wou be converted to microwave radio signals, tra mitted through a 5-mc "party line" circuit t ground station, and relayed across the ocean v the orbiting satellite. Said Metzger:

"A satellite at an altitude of thousands, or eve of hundreds of miles above the earth, can pro vide line-of-sight paths between cities separate by thousands of miles. These paths permit use o microwave frequencies—from 1000 to 100,000 m —and their attendant wide bandwidths capabl of handling . . . a high-speed facsimile signa which can be converted into print at a rate o 600 pages per minute."

A Boost from ICBM

The satellite, weighing several hundred pound and equipped with low-power receivers, ampli fiers and a transmitter, could be boosted 22,00 miles up by an Atlas or Titan, plus upper stages he said. For conversion of written letters int transmission signals, Metzger proposed the RC "Ultrafax," and for reconversion, the "Electrofax electronic printing process. This could be com bined with a thin-window display tube now under development by RCA for high-speed

printing directly onto "Electrofax" paper.

Unlike most Rocket Society proposals, this one, Metzger said, would save money. He estimated costs at 12 to 15 cents per letter.

Propulsion by A-power

Most of the Society's sessions discussed the conquering of space in terms of traditional rocketry, but Raemer A. Schreiber, Los Alamos Scientific Lab engineer, told of work under the Rover nuclear rocket propulsion program.

The Kiwi-A reactor, first to go into operation under the program, is only the first in a series of experimental devices in which more and more advanced ideas will become incorporated as they become available, said Schreiber.

In other parts of the program, he indicated, research is going forward in the development of new materials and new concepts for the conversion of nuclear energy, from which a practical propulsion system may be developed. "Very attractive performances," he said, can result from use of liquid and gaseous reactor systems—if they can be made to work. But these new concepts in turn require new materials and a more thorough understanding of extremely high-temperature phenomena.

Among models displayed for meeting delegates was GE's pulsed plasma generator, which is designed to change space vehicle direction in flight (*ED*, Oct 29, p. 5).

Sealing Sapphire to Glass

Technique perfected by Philco seals sapphire window of infrared detector to glass tube in rf furnace. Seal can be immersed in liquid nitrogen for 60 seconds, then be transferred without harm to boiling water.

BEHIND THE NEWS

Nose Cone Work Brings Hypervelocity Instruments

Hypervelocity instruments today are sophisticated enough to permit study of transient phenomena which have associated velocities equivalent to those which would be encountered in space travel.

Avco Research and Advanced Development Division, as part of its work on the Titan ICBM nose cone, has developed instruments to measure shock waves, flow patterns and other events occurring at high Mach numbers in shock tubes and on ballistic ranges.

A high-speed shadowgraph system includes a collimating and an objective lens. A projectile fired between the two lenses in the collimated light beam is detected in the center of the optical field by a Catadioptic Light Screen, whose photomultiplier sends a signal through a video amplifier to a trigger unit.

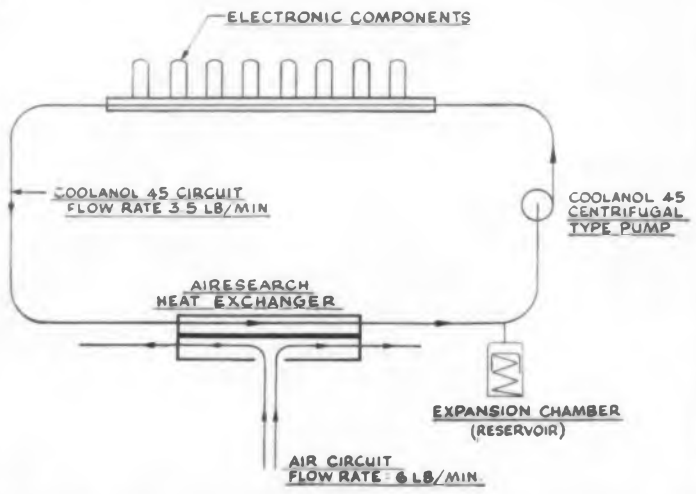
With a high-voltage pulse, it triggers a Synchronized Pulse Generator-Light Source. The action of the light source and a Kerr Cell photographic shutter are mutually synchronized with the projectile's position. The action takes place with a jitter of less than 0.1 microsecond, enabling study of the projectile's drag, attitude and associated flow patterns. Exposure times in the range of 10^{-8} and 10^{-7} seconds prevent image blur.

The Synchronized Pulse Generator-Light Source, key to the system, consists of a coaxial transmission line and a spark gap. The two-in.-aperature Kerr Cell shutter is connected directly across the load resistor on the line, therefore does not require an impedance matching network.

Rotating mirror and rotating drum cameras are streak cameras driven by an air turbine. Heart of the rotating mirror camera is a hexagonal, first-surface mirror rotating at 3000 rps, which provides writing speed of 4 mm./microsecond for a total writing time of 50 microseconds.

UNIT No. 173030
Performance Data
Heat rejection: 1233 watts
Fluid flow (Coolanol 45): .5 GPM
Coolanol 45 temp. in:
122 degrees C.
Coolanol 45 temp. out:
101 degrees C.
Unit dimensions:
7 x 6.4 x 20 in.
Wet weight: 11.63 lbs.

Coolanol 45 dissipates heat from electronic components of the XQ-4 through this liquid-cooling system (above) designed by The Garrett Corporation, AiResearch Manufacturing Division. System utilizes liquid cooling with Coolanol 45, forced air and cold plate as shown in the diagram.



AiResearch uses Coolanol 45 in all these missile cooling components to assure precise temperature control of electronic equipment . . . a key factor in missile reliability.

MINIATURE CENTRIFUGAL PUMP
Performance Data
Operating temperatures:
65 degrees to 275 degrees F.
Fluid flow (Coolanol 45):
0.5 GPM at 10 psig. and
160 degrees F.
Motor: 10,000 rpm, 3-phase,
400-cycle ac (1⅛ inches)
Net weight: Less than 1 lb.

UNIT No. 172018
Performance Data
Heat rejection:
2 kw at 15,000 ft. under the
following conditions:
Ambient air: 50 degrees C.
Fluid flow (Coolanol 45): 2 GPM
Fluid temp. in: 117 degrees C.
(Max. system temp.)
Envelope dimensions:
8.2 x 6.8 x 4.12 in.
Wet weight: 3.81 lbs.

UNIT No. 172038
Performance Data
Heat rejection:
10 kw at 5000 ft. under
following conditions:
Ambient air: 53 degrees C.
Fluid flow (Coolanol 45): 5 GPM
Fluid temp. in: 135 degrees C.
(Max. system temp.)
Envelope dimensions:
11 x 9.06 x 6.34 in.
Wet weight: 9.48 lbs.

UNIT No. 172048
Performance Data
Heat rejection:
2 kw at 60,000 ft. under
following conditions:
Ambient air: 22 degrees C.
Fluid flow (Coolanol 45): 1 GPM
Fluid temp. in: 147 degrees C.
(Max. system temp.)
Envelope dimensions:
7.5 x 8.5 x 6.6 in.
Wet weight: 9.06 lbs.

UNIT No. 171600
Performance Data
Heat rejection: 175 watts
Fluid flow (Coolanol 45):
1.5 GPM
Fluid temp. in: 50 degrees C.
(Max. system temp.)
Compartment temp.:
63 degrees C.
Unit dimensions: 13x24x6 in.

...reliability in missile cooling systems

...ds . . . cooling and power transmission. ... can eliminate the variables of multi- ... fluids and fluid systems by standard- ... g on Coolanol 45. For complete techni- ... data, write today for Technical Bul- ... n AV-3 on Coolanol 45.

Monsanto

MONSANTO CHEMICAL COMPANY
Aviation Fluids Dept. AV-7
St. Louis 24, Missouri

• When you need a synthetic fluid, come to Monsanto—creator of fluids for the future.

Infrared Detector Now Responds 10 Times Faster

An ultra-sensitive detector that can respond to less than one-twentieth of a billionth of a watt of infrared radiation has been developed at Westinghouse Research Laboratories, Pittsburgh, Pa.

The photoconductor is gold-doped germanium. The detector has good sensitivity throughout the range of infrared frequencies. It is highly sensitive to infrared up to a wavelength of 10 microns, corresponding roughly to the peak radiation at room temperature. At the same time, it is about 10 times faster than any previously measured photoconductor detector, Westinghouse reports.

Because of the fast response of the new detector a mechanical light chopper had to be developed in order to test its speed. The chopper breaks infrared into pulses only a few billionths of a second long. The pulses, reflected to the surface of a detector, show its time constant to be two-tenths of a millionth of a second.

Since the sensitivity and frequency response of a photoconductive infrared detector is increased by operating it at low temperatures, the new detector is cooled to a temperature of —320F by surrounding it with liquid nitrogen in a special container.

Encyclopedia in One Fast Gulp

Engineers work on some of 40 racks of equipment for Emidec 2400, which, when completed at Hayes, Middlesex, Eng., will rank with the world's most advanced computers. Made by E.M.I. Electronics, Ltd., it should be able to absorb all *Encyclopedia Britannica*'s data in less than four minutes.

◄ WRITE IN 12 ON READER-SERVICE CARD

BEHIND THE NEWS

TV Sees Supersonic Dogfights

Using TV camera (Dage transistorized, foreground) fo the first time to monitor supersonic jets in intercept action, Florida's Tyndall AF Base transmitted to H such "live" pictures as Falcon (inset) fired from F-10 Three Model 320 Dages recorded ground activitie while airborne cameras in F-102 and TF-102 jets se air views from 150 miles away.

Makes Ions, Will Travel

Experimental rocket engine creating ions and harness ing them for propulsion is due soon from North Ameri can's Rocketdyne Div. Program Engineer R. H. Bode holds full-scale model of engine designed to develop ¼-lb thrust—enough to send 5-ton vehicle through space at 250,000 mph. Ions are formed by knocking loose an electron from each molecule of vaporized propellant (mercury, thorium, uranium tetrachloride, etc., are "ideal.")

NEWS BRIEFS . . .

. . . **ULTRA HIGH-SPEED INFORMATION** handling system combining advantages of microfilm, punched cards and digital computing techniques now is being used by the Air Force in the Pentagon. Not yet generally available, the Kodak Minicard System records documents, pictures or other material photographically on film the size of a postage stamp. Information is retrieved by searching film records automatically at speeds up to 1000 per min. Magnavox built some components of the system for Eastman.

. . . **SPERRY GYROSCOPE'S SUBMARINE** celestial altitude recorder (SCAR) more and more is winning submariners' respect, now is being hailed as a scientific breakthrough ranking with development of the snorkel and the high-speed Albacore hull design. Still highly classified, it is installed in both Nautilus and Skate, operates independently of inertial systems, permits navigators to automatically "shoot the stars" through periscopes while submerged.

. . . **CHICAGO'S STATE ST.** regained its title of "world's best-lighted street" with installation of GE's new radio tone control system, which activates 280 street lights in a seven-block Loop area. First in the U.S., it uses radio techniques similar to those employed for programming traffic signals. A 60-watt radio station transmits to receivers in 28 of the 70 poles, setting up tone codes which go out in pulses. The sender unit consists of motor-driven code wheels to operate microswitches keying an audio oscillator, which modulates the transmitter. Time switches with astronomic dials operate relays at pre-set times, compensating for seasonal changes in daylight periods. The 70-pole system generates 15,624,000 lumens, providing a maintained illumination level of 14 footcandles via 280 GE fluorescent luminaires.

. . . **ELECTRONIC SYSTEM** being furnished Curtis Publishing Co. by Stromberg-Carlson will register address information, perforate paper to size and print address labels 10 times faster than electro-mechanical printers. Each eight-hour day 1,000,000 labels will be printed for *Saturday Evening Post, Holiday, Ladies Home Journal*. An S-C 5500 high speed label printer utilizes a Charactron shaped beam tube and XeroX Copyflo printer impressing simultaneously on four inexpensive, untreated paper rolls. Combined with it is an M-60 auxiliary editing buffer handling four magnetic tape inputs.

BEHIND THE NEWS

. . . **A BRITISH ELECTRONIC** detector now measures a car's speed and prolongs duration of a green traffic light exactly long enough to permit the car to get across the intersection before the light changes. Developed to Ministry of Transport specifications by Automatic Telephone and Electric Co., it detects car speed by measuring time taken for wheels to pass over two channels five inches apart. Operating from the channels via relays, the timer translates speed into a time factor corresponding to intersection distance.

. . . **SEVENTH-DECIMAL MEASUREMENT** accuracy—tenth of a millionth of an inch—probably will be attained in the U.S. within 10 years, Louis F. Polk told the Ninth National Conference on Standards in New York. Polk, president of Sheffield Corp., a Bendix Aviation subsidiary, said sixth-decimal accuracy already is achieved by some plants manufacturing grinding, honing and other machine tools and measuring equipment for volume production of precision parts. In aircraft and missile work, however, seventh-decimal accuracy is needed "right now," he said, adding: "Projected piloted plane speeds of more than 4500 mph and missile altitudes of up to 240,000 miles, with speeds of more than 24,000 mph, present incredible precision requirements in making such parts as gyros, control systems, power linkages and various sensing devices."

. . . **NEW FAMILY** of solid-state devices that serve as tiny contactless thermal switches has been developed by Westinghouse and put to work providing over-temperature protection of hermetic motors in large air conditioning and refrigerating systems. The switches are new-type thermistors which function as closed switches when temperatures drop below a certain critical value, and as open switches above that value.

. . . **RE-ENLARGEMENT OF MICRO-REDUCTIONS** with no loss of original drawings' detail is a feature of Paragon-Revolute's new Retrievable Miniaturization system. Designed to expedite data communication, minimize file space and cut print-making cost, the equipment includes a continuous-flow-type camera with optical system to produce various ratios of reduction, an enlarger for blowbacks, and automatic processors. Copyable material may be 42 in. wide, any length, and can be processed at 30 ft per min. Card stock miniatures reduced to 1/6 full size proved excellent for reference without a "reader."

. . . **AIR TRAFFIC CONTROL** simulator system is scheduled for completion in May, 1960, under $2,951,920 CAA contract awarded to eight-year-old Aircraft Armaments, Inc. Designed to improve study of local control problems, evaluation of traffic control systems and training of controllers, the system utilizes the "building block" design approach to permit future flexibility. Each of 60 consoles is designed to simulate flight of a plane within a 400 x 400-mile area, and four radar simulators furnish all data normally supplied by radar. Equipment also provides simulated wind conditions, data collection and reduction devices, electronic "noise," and associated power supply.

. . . **IBM MACHINES** are being integrated to form prototype systems for the "automatic library" of the future. Eventually, say IBM engineers, vast quantities of data on all fields will be automatically read, summarized, coded, distributed, and filed by machines within a network of linked libraries. By electronic means a researcher will gain access to information in his field wherever it exists. Newest technique developed toward that goal is "auto-abstracting," a process by which an IBM 704 analyzes articles word by word, selects the most significant data, and reproduces them on a printer. The auto-abstract is a source of key words which pinpoint significance of a document and form the basis of various automatic coding and indexing systems. The new IBM Special Index Analyzer meanwhile provides fast, accurate and automatic reference to catalogued data.

. . . **FLIGHT SYSTEMS SIMULATORS** that test flight characteristics of missiles before they are launched have been sold for $500,000 each by Bendix Aviation to the Army Ordnance Missile Command, Huntsville, Ala., and Convair Aircraft, Ft. Worth, Tex. A 7,000-lb, electronically controlled flight simulation table simulates pitch, roll and yaw. An analog computer, 7 ft high and 21 ft long, contains some 5,000 vacuum tubes and more than 12 miles of signal wiring.

. . . **SOLAR TELESCOPE** several times larger than any now in existence will be built with $4 million allocated to the Association of Universities for Research in Astronomy, Inc., by the National Science Foundation. Allocation raises to $7,545,000 the amount committed for erection and operation of a national astronomical observatory on Kitt Peak, in Arizona's Quinlan Mountains. The 80 x 60 in. telescope's mirror will have a focal length of some 300 ft, twice that of the 150-ft tower telescope on Mt. Wilson.

EDITORIAL

Design '59—A Challenge

Despite undisputed wonders already accomplished by the electronic design engineer, the need to do more is, in this year 1959, greater than ever before.

Electronics has not yet met the challenges put to it by the transportation and manufacturing industries. And hard to recognize is the fact that communication and control technology is not keeping up with the technology of propulsion.

Until last month, U. S. rockets appeared to lag the Soviet's. But we have always been smug about our electronics being ahead because it was miniaturized to weigh little.

The hard truth is: electronics more often than not is the limiting factor in aircraft and spacecraft design.

Propulsion advances, such as they are, already have outstripped man's ability to control the power at his disposal. Electronics must match the man to the machine—and so far it has not succeeded. Not in spacecraft, in aircraft, or even in groundcraft—as demonstrated by America's highway jams.

Nor has electronics met the challenges posed by automatic manufacturing. Industry often uses pneumatic and hydraulic controls, despite the relative inflexibility of these techniques. But in planning and inventory control, fortunately, computers are fulfilling their destined role, and are doing well for commerce as a whole.

Demanding serious attention, though, is the fact that electronics has not fulfilled its own prime function—that of providing adequate world-wide communications. The challenge this year is real.

The year 1959 will see a few engineers cast in glamorous leading roles, with the great majority in unpublicized supporting roles. The engineer working in astro-electronics and computers will continue to make headlines and amaze laymen. But while there will be no headlines for the thousands of others, the plodding, anonymous engineers, history will be determined by their output.

In either role, leading or supporting, the professional must supply the same crucial need, and that is for sound engineering. The theories of space flight have been worked out; what is needed now is engineering to prove or modify the theories.

For the few, 1959's challenges will be aimed at conquering space or developing fusion power. But for the many, the challenge will be the same this year as it was last year: engineering for more exacting, wide-range performance, full-environmental reliability, producibility, maintainability, and operability.

A CHALLENGE **Engineering digital communications equipment, low-noise masers, accurate check-out equipment, faster computers, more reliable components and equipment, are but a few of the challenges to be met in 1959. Many more are pinpointed in the pages that follow. Needed is a frontal attack on the entire spectrum, from dc through the gamma rays.**

DESIGN

Starting from Scratch—on ALL Communications

COMMUNICATIONS problems in 1959 will encompass every presently known mode. Much work will be done in wire communications, tropospheric scatter and ionospheric scatter systems. Old problems—telephone line phase distortion, switching speeds—will get increased attention.

Reason for all this activity is the strong possibility that industry will be called upon to design a completely new world-wide communications system. Air Force project 456L proposes a system that will enable designers to start from scratch. Rather than patch up existing equipment, the Air Force wants a completely new system tying together all its military bases. Objective is to be able to send a message from any point to any other point in the world automatically—and swiftly.

All modes of communications are to be incorporated into the system: wire links, microwave, tropospheric scatter, ionospheric scatter and low, medium and high frequency radio bands.

Digital Esperanto

A common language for translating all intelligence must be developed. Possible signal sources will include voice, video, teletype, telegraph and facsimile. Each of these forms will be converted into some sort of digital code—the same code no matter what is being transmitted. Decoders at the receiver will unscramble the code and recreate the original signal.

It is not as simple to design as to functionally describe, however. Some of the problems:

- How to choose whether the message will be sent by wire, radio, microwave, or other means?
- How to work priority of the message into the system?
- How to handle low priority messages being sent or about to be sent when a message of high priority comes through?
- How to store them?
- How to accomplish high-speed switching without distorting the coded message?
- How to insure security?

The answers to these broad questions are but a part of the challenge for the coming year. They involve complex problems of computations, switching and priority, as well as the problem of getting engineers to decide upon a workable digital code. (Some of them remain "analog" men, and promise to fight a conversion to a digital system. One reason: analog signals can be measured in real time.)

Modernizing Wire

One important link in any communications systems is wire. This oldest form of electronic communication is going to require some major modernization. Old problems will have to be revived and increased efforts made to solve them.

A major advance will be made in adopting the 4-wire telephone system. Signaling and voice cir-

cuits then can be separated, thus simplifying much system design.

There has been a trend toward changing from dial to pushbuttons. Many telephone systems engineers feel there is no good reason for a change, except, they say, to provide an opportunity to design a new signaling system. One system now being tested uses 10 transistorized tone oscillators instead of dial pulses.

Phase distortion in wire communications has been a problem for a long time. There are many ways to compensate for phase distortion, but newer, better methods will have to be devised.

Stability, Hot or Cold

Single sideband communications will be exploited further. Many engineers feel that it has not yet been used to its full advantage. More stability over wide temperature variations must be achieved. In airborne SSB equipment, work will have to be aimed at overcoming the doppler effect.

There has been a recent resurgence of interest in very low frequency. These bands offer very reliable, long range communications, but bandwidth is limited. At 100 kc, bandwidth is only about 5 kc. Systems in the vlf range may prove desirable as a means of communication in bad weather.

To the military services, communications remains a prime problem. Each service wants to carry heavy traffic over existing circuits. They seek 3 kc bandwidths on channels that carry cw, teletype, even voice messages.

UHF Can't Do It

There are other problems. Uhf techniques, for instance, are not adequate if the pilot of the Air Force's newest super-Mach F-108 wants to communicate with his base 1000 miles away. The Air Force believes the problem may be solved by the Hughes "Long Arm" technique in the hf region of the frequency band. But officials are not sold on the technique, and remain on the lookout for others.

Development of more efficient microwave links will depend largely upon development of better components. Masers and parametric amplifiers seem to promise improvements throughout the entire microwave range. By improving receiver signal-to-noise ratio, transmitted power can be reduced and more reliability can be achieved. How to incorporate these new developments into present equipment in the shortest possible time will be one of the design engineer's problems in 1959.

And Now Tropo-scatter

Tropospheric scatter, a relatively new means of communication, will be much improved, and find many new uses. Over short ranges, tropo-scatter achieves good reliability and bandwidth. The Florida-Cuba link installed by IT & T, operating over a distance of 180 miles, has a bandwidth of two television channels. A new parametric amplifier announced by IT & T recently will increase the system's range one-third. But still unsolved is the problem of pushing tropo-scatter to 600 miles without frequency restriction. Engineers will be thinking in terms of 400 to 10,000 mc operating frequencies.

Work remains to be done in standardizing scatter communications equipment. Some method must be devised for changing from a microwave relay to a tropo system without frequency conversion.

Diversity systems will be under more intensive study this coming year. At present space diversity is used; two independent paths require a pair of

antennas at each end. Angle diversity is an interesting and promising new system; here one antenna radiates four or eight beams. (Two experimental links are under test now. One operates at 8000 mc, the other at both 900 and 2000 mc.)

Meteors A Target

Ionospheric scatter has become the "glamor" communications system in the past year. Emphasis on space travel has drawn more attention to the technique of bouncing radio waves off ionized meteor trails and the ionosphere itself.

Many challenges exist here. Some novel tricks are being used to achieve measurable results. But tests show some surprising effects. There is no relationship, for example, between phase at one frequency and another 1000 cps away. The maximum signal does not always come from the Great Circle route—it varies. Receiving the signal is more difficult, since the receiving antenna must be varied electrically to follow these variations.

One of 1959's challenges will be to figure out the rhyme or reason for these variations. Where does the maximum signal come from? Answers would help antenna systems designers.

More problems are added when the system is extended to ground-to-air communications. Here antenna size becomes a problem requiring a great deal of study. Work is needed on electronic steering of antennas, and on new means of power multiplication. Better control of side lobe-beams is necessary.

How To Hit Meteors?

Air Force engineers working with scatter over 1000-mile links envision scatter from meteor trails as eventually having a capacity of 2000 words per minute. Bouncing waves off meteor trails holds great promise for long range communications. But a big problem is: How to tell when a good meteor is coming around, and how to send the message before it gets away? Design engineers will have to come up with something to detect a useable trail, start a transmitter, aim it correctly, and automatically cut it off when the trail becomes untrustworthy.

(Fulfilling the role of a meteor trail, Pioneer I became a passive reflector during its flight last October.)

Reliability will always be a problem. But as component quality continues to improve, other ways to improve reliability will have to be devised. Engineers this year will be finding new ways to trade bandwidth, time and power for more reliable operation.

Faster Printing Needed

Display and encoding devices must be made to operate at increased speeds. While it now is possible to transmit at a rate of 2000 words per minute, there are few practical ways yet of printing words that fast. [Burroughs last month demonstrated a 3000 wpm electrostatic printer.]

By the end of 1959 it may be possible to convert typewritten messages directly into teletype signals. But a problem is to devise something to read the 46 different fonts of typewriter type now being used in the U.S.

Information Theory May Help

Recent activity by information theorists may pave the way for the advanced system designs of tomorrow. Here are some of the concepts under active study.

System with noise disturbed feedback channels. One of the ways to insure faithful signal reception is to transmit part of the information re-

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ceived back to the sending station. The problem lies in how to make best use of the return channel to improve forward transmission.

Data links with different message values. If some of the information to be transmitted is less important than other information, it might be feasible to use a faster message rate for the less important information.

Channel capacity of a channel with varying signal to noise ratio. Perhaps signal channels can be used more efficiently if message rates can be varied with the signal to noise ratio.

Sequential encoding and decoding. Some important theoretical work indicates that it may be easier to minimize incorrect sequences by sequential coding than by block coding.

Multipath signals. There is a growing interest in systems to combat the effects of multipath transmission. If the receiver can recombine the energy reaching it by different paths and get the separate signals in proper phase sequence, the demands on receiver sensitivity and transmitted power can be substantially reduced.

Nonbinary codes. Binary systems provide least ambiguity. Analog systems provide the best information rate. Perhaps some compromise (more than two levels of coding) can provide an optimum rate with minimum ambiguity. ■ ■

Telemetry's Job: Study Space

PERHAPS THE most exciting challenge this year is the one facing the telemetering engineer—learning about space. The challenge is immediate, for space will not be conquered until the telemetering engineer fulfills his role and functions.

He must gather information about radiation of all kinds, about temperature, space density, gravities, magnetic fields, and the effect of these on equipment. He must know how spacecraft respond to control signals.

New Concepts for Space

In space, the straightforward approach—sensing phenomena, transmitting it to the ground, recording it, later playing it back and analyzing it —isn't good enough.

Not all the data from the thousands of points now telemetered during missile and aircraft flight can be transmitted from spacecraft or from satellites. They do not have enough power or bandwidth to permit the sending of mass data. Nor is there enough manpower or enough time to study such a collection of data.

This means that the decisions as to what is to be observed on the ground should be made in space. The ground observer, however, should be able to take command of the situation and ask for more data to be transmitted if there is some phenomenon he wants to study closely.

Computers and switching techniques must be developed which present less of a weight and power burden than do existing methods. Optimum information coding techniques must be worked out.

Systems Thinking Now

Aircraft and missile telemetering evolved in a helter-skelter fashion, with no coordination and no direction from the top. But the Space Age is being ushered in under the aegis of the National Aeronautical and Space Administration, and this means systems thinking is possible.

The aircraft and missile telemetering engineer this year will face as big a challenge as the spacecraft instrumentation engineer. And he will continue to despair, for he will continue to be frustrated in putting his ideas into practice.

If he finds a new and better way of doing something, there will be no one with the authority to say that it is an improvement and to okay spending money on it.

DOD Direction Needed

A missile manufacturer cannot install new equipment if the range testing facilities do not include the proper receiving equipment. Department of Defense direction is needed—and the designer must ask for it.

The telemetering engineer will still have the challenge of working with an inadequate frequency spectrum. He may have to move into the 1100 mc range, as it is likely he will lose his present bands.

Calibration of oscillators before and in flight is a problem still to be licked. The ultimate in eliminating drift and nonlinearity of subcarriers has not been reached. There is a real challenge in finding means of sending more information in smaller bandwidths.

For Space, Simplify

Efficient pulse coding schemes are needed. Pulse code modulation systems show great promise for testing aircraft, but they must be simplified for missile and spacecraft use. Different and better encoders for code modulation are needed.

Although large tracking antennas have reduced the necessary amount of transmitter power, all equipment can be improved; to name a few—pickups, commutators, multiplexers, subcarrier oscillators, modulators, transmitters, amplifiers, antennas, channel-splitters, and discriminators.

Phase-lock fm discriminators have proved a boon. But more improvement is possible if narrow band fm can be used, or if discriminators are employed on subcarriers. Noise in subcarriers must be reduced.

The recording and using of information pose equally large problems. Recording of all kinds of modulation on one recorder is desirable. Automatic data reduction must become practical, and advances in high speed printers, plotters and calibrators are needed. ■ ■

High Power, Big Antennas NOT Radar Answers

THE SINGLE instrument on which the preparedness of this nation most depends is the radar set. Without it Americans would not have the minimum required 15-minute warning of the approach of enemy missiles and planes, should another D-Day dawn. Yet present radar technology—married to tremendous power amplifiers and huge turnstile antennas—is quickly approaching the limit of its capacity.

To get away from megawatts of power and 1000-foot-plus diameter antennas is a major goal of the military services. The masers, parametric amplifiers, and frequency scanning techniques only scratch the surface of the problem. What is needed is a whole new concept for the signal processing field.

Some researchers are looking into the fine structure of signals for a means of carrying intelligence. Once this breakthrough is made, a whole multitude of applications would open up.

Too Many, Too Fast

The problem revolves around the fact that today's targets travel too fast and in too large numbers for the average detecting instrument to record them efficiently. In addition to a slow response time, the signal-to-noise ratio is inadequate.

Today the Army and the Navy are looking for higher data rate equipment, electronic scanning with fixed antennas, phased rays, beyond-the-

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horizon search capability. They see new data processing techniques as helpful in countering countermeasures. They want small, tactical radars for field forces, radars with capabilities far above those now on the drawing boards.

And Too Big, Too

With the advent of space technology, the volume-mass problem has become further aggravated. Power requirements must be reduced, equipment must become digitalized.

The parametric amplifier should increase radar and communication ranges considerably, require less transmission power, and allow reception of weak signals.

The device also should find important applications in radio astronomy and space communications.

Amplifier vs Maser

Engineers predict that the parametric amplifier will find many more microwave applications than the maser. It is more simply designed, for the parametric amplifier does not require helium or a magnet to operate. R & D activity in gaseous and solid-state masers, however, will be intensified in order to exploit the maser's almost noise-free operation.

Development of variable reactance diodes should advance the art considerably in the microwave field during 1959. Parametric amplifiers, using these mesa diodes, will operate at better than 22 db gain, with less than 1 db noise figure. The diodes will become commercially available in a few months.

TWT's Better

Traveling-wave tubes will continue to find many transmitter applications, particularly now that they are available with wide bandwidth (more than one octave). Their frequency range can be expected to be extended considerably at both ends of the spectrum—to 200 mc as well as to 10,000 mc.

More high power, low duty cycle tubes will become commercially available, and more rugged tube types—possibly of metal-ceramic construction—will be produced. Designers should n overlook the improved ruggedness of TWT (a lengths have been cut to 30 in.)

The Temperature Problem

Much work will be done in 1959 on overco ing still further the temperature limitations periodically focused traveling-wave tub

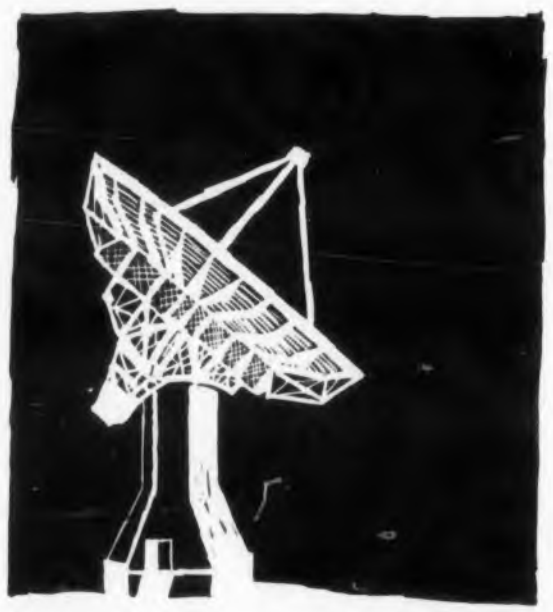
In 1959, development of appropriate shu within the magnetic assembly of the periodica focused traveling-wave tube should extend operating range from —50 to 80 C.

Electrostatically focused traveling-wave tub requiring no magnet for operation, will be e phasized because of their simplified constructio and their power range should be extended up 1 kw.

Radar engineers will be able to redesign pow supplies. Smaller, lower voltage units will emerg as lower operating voltage klystrons becom more readily available.

Ferrites will continue to be applied in modu lating and phase shifting devices. Because o their long life, ferrite devices will replace man more gaseous tubes. They will find importa applications in ferromagnetic parametric am plifiers, which use a ferrite as a nonlinear var able inductor.

All-Mechanical Antenna Scan On It



DESIGN of very large antennas will keep engineers busy in 1959. Much work is in progress in radio astronomy, and large antennas are necessary to pick up the very weak signals emanating from celestial objects.

To obtain the necessary resolution, reflector tolerances must be kept to within 1/16 wavelength. At wavelength of 30 cm, this is about 1 in.

The problem is largely mechanical: How do you make a 100-ft-diam antenna to withstand snow, wind, heat and cold, yet still maintain mechanical tolerances to within 1 inch? One solution may be digging a parabolic hole in the earth and covering it with a conductive material.

Low Side Lobes, Or None

More emphasis will be put this year on decreasing radar antenna side lobes, or at least finding better ways to define side lobes. Antenna gain, susceptibility to jamming and coupling to ground all are affected by side lobes. Low side lobes, or no side lobes at all, are goals for both airborne and ground radar antenna designers.

Scanning is being attacked from many angles. Industry experts feel that mechanical scanning is on its way out. Systems already have been perfected that offer the reliability of nonmechanical methods with speeds up to 1000 looks per second.

Scanning, Old and New

Three scanning methods, all purely electrical, will occupy antenna engineers' time this coming year:

- Frequency scanning.
- Ferrite scanning.
- Ferroelectric scanning.

Frequency scanning is an old system in which frequency determines the phase shift between driven elements. New devices will be under investigation here.

Ferrites in feed lines to the radiators change phase of the driven elements. This phase change is controlled by application of a magnetic field to the ferrites. But the trouble is that ferrites are nonreciprocal. They may be used in a purely receiving antenna, but not for both transmitting and receiving. Someone will be working up a

Ferrite vs Yttrium

Significant advances will be made in design of ferrite devices as isolators, Faraday rotation devices, duplexers and filters. New materials such as yttrium and yttrium-gadolinium garnets, however, will compete with ferrite materials.

Range of operation of microwave solid-state isolators will be extended to frequencies below 1000 mc; a better than 50 db to 1 db reverse to forward wave attenuation ratio at 1000 mc also will be attained.

In the field of Faraday rotation devices such as variable power dividers, switches, modulators and isolators, good performance will be realized over bandwidths as broad as 45 per cent in waveguide.

Important advances will be made in the field of microwave filters. Microwave solid-state filters will be designed with low vswr both inside and outside the passband.

From Lab To Field

But the basic problem confronting the microwave engineer in 1959 is how to exploit the potentials of such promising devices as parametric amplifiers, solid-state masers and variable reactance diodes. Interest will necessarily shift from the laboratory to the field, from research to systems application. ■ ■

It Way Out

way to achieve reciprocity.

Ferroelectric elements are reciprocal. This planning method is expected to get fair scrutiny by workers in the field. Something must be done about losses, however.

New Shapes Emerge

New shapes of antennas will become more evident. One of the more interesting arrays is the Luneberg antenna. It looks like a huge ball with the feed point rotated around the outer periphery. Made of artificial dielectric, the antenna remains focused at infinity at all times.

Another new configuration to undergo more tests this year is the stacked end-fire array developed by General Bronze Corp. More evaluation of its side lobes now is necessary, say some industry engineers.

More attention is to be given to feed systems. Wanted is improved efficiency and a more sophisticated system. ■ ■

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For Instrumentation—Lab Accuracy in Field

ONE OF THE crucial needs in electronic instrumentation is accuracy, particularly in time measurements. This year more than ever it will be necessary to bring laboratory accuracy out into the field.

Especially in missile and spacecraft instrumentation, standards of stability and accuracy of time measurements are as demanding as those met in many of the toughest laboratory projects.

In the lab itself, meanwhile, equipment will have to be ruggedized if end products developed from prototypes are to meet requirements of an ever widening range of applications.

A New Technology

Since dawn of the Space Age, quite unobtrusively a whole new form of electronic technology has grown out of the initial assignment to manufacture missiles, and that is the technology of ground support and check-out equipment.

Such equipment eventually will provide a major proportion of the industry's income, according to informed observers. But techniques now are fraught with complications.

In this era of the weapons system concept, a whole new array of test and ground equipment must be developed each time a new system is developed. The Defense Department soon will clamp down on this costly, self-perpetuating process, and begin to impose more stringent demands on design engineers.

DOD's first step will be to lay down an across-the-board policy on testing and check-out instrumentation for all missiles. Certain parameters will be established for quantitative read-out, qualitative measurements, and go-no go checking.

But instrumentation problems are not confined exclusively to the missile field. Among the more intriguing challenges are those facing designers of equipment used in aircraft and spacecraft. The emphasis here is on reducing weight and volume, and it has resulted in development of many miniaturized components and systems.

Helping The Pilot

Aircraft must fly in all kinds of weather, day or night, at high level or close to the ground.

Instruments for novel approaches on unimproved fields, for blind landings and for tree-top navigation must be within the capabilities of each type of aircraft.

With more and more planes crowding the sky, a greater degree of automatic operation is required to bring a pilot in for a landing and at the same time allow other pilots to take off. A panel display giving full, detailed pictures, rather than instrument readings, may prove to be the answer.

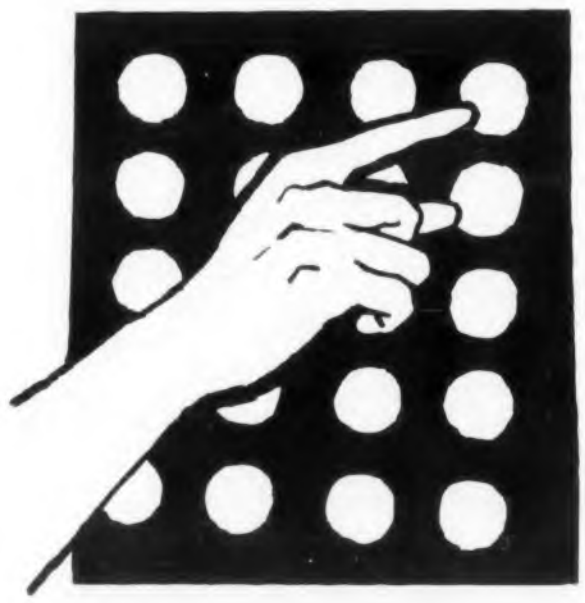
Says Dr. George L. Haller, General Electric v-p:

"The major problem still facing us is how to uncomplicate the cockpit. The pilot still has to watch dozens of instruments. He still has to tune two or three receivers. He still has to make split-second decisions. The man at a missile control center is faced with the same problems. We need electronics to take over as many of these functions as possible."

Faster Computers Still the Goal

From the marketing standpoint, computers will be a booming business in 1959. But to the design engineer, it largely will be more of the same. Last year's challenges are this year's, with the major emphasis remaining on means of increasing switching speeds—in the millimicrosecond range, possibly with plumbing.

Digital systems are coming into their own, and will be used extensively in process control. This will be a big step forward, for very few if any two-way-control digital computers now are being used. The major problem here is not so much hardware design as function design. Says Packard-Bell's V. Van Praag:



"Hardware's not so much of a problem. You can now pretty well build what you want. But how do you blend the computer into the system? How do you use it in your organization? That's going to be the biggest problem to solve."

Parallel vs. Serial Operation

For most purposes, Van Praag believes, serially operated computers will give way to parallel operated computers—except for such functions (as accounting) that are inherently serial in nature.

The year 1959 will see continued emphasis on low temperature devices. Most companies are at about the same level of technology, and have the same problems—materials, fabrication techniques, and how to get information in and out. (The latter problem can be troublesome. For instance, if a copper wire runs down the side of a helium tank, it conducts away heat.)

There remains hope in some quarters that a material will emerge which will prove to be a super-conductor at room temperature. No one knows what such a conductor would be like, and there are no immediate prospects that it will be found.

No Smaller, Yet

Eventually there will be a reduction in computer size—but not in 1959. Computers in the foreseeable future will remain the same size, but they will get more complex as technology improves and as materials get cheaper.

One problem engineers will tackle this year is getting the computer closer to the original data. To eliminate the necessity for a secretary's transcribing the data to feed into the computer, transducers will have to be developed to feed the information directly into the machine.

Industrial Requirements Stiff

If electronics is to increase its penetration of industry, and all signs point that way, new levels of reliability will be required. Many industrial control applications call for reliability

's as high as those required by the military—
d higher than what the military often gets.

The near future should see the beginnings of a
w class of electronic equipment, developed
ecifically for industrial use. As industrial re-
irements are so varied, the shift to such
ipment probably will be a slow one.

Industrial environments can be just as severe
military ones—but the environmental spread
rtunately is not so great. Military gear, for
mple, may be subjected to an extremely wide
ge of temperatures. But industrial gear, if it
to withstand high temperatures, probably
er will have to take extremely low tempera-
es as well.

Eliminate The Man

In automatic control, the challenging require-
nt is to eliminate the man who now has to
ke the control decisions. Most processes still
pend on monitoring parts of the process and
ng set-point controllers to keep certain vari-
les within limits. When the final product does
t meet specifications, a man has to adjust one
more of the set points—often on the basis of
ucated guesswork.

The future should see more overall control,
th instruments and computers making the de-
ions instead of men. More often than not, the
adblock will prove to be the process itself. The
chnology already is here for controlling most
ocesses, once the processes are fully under-
od.

Wanted: Transducers

The near future will see considerable activity
the transducer field. The history of automatic
ntrol has been pendulum-like. Efforts first
uld be concentrated on improving the actua-
rs, at the tail end of a system, until actuators
came much better than the transducers at the
nt end. Then there would be a swing toward
proving the transducers.

The industry is in just that kind of a swing
w, according to Dr. J. E. Ward of MIT's
rvomechanisms Lab. It is faced with many
easurement problems yet to be solved—prob-
ms of measuring more accurately, more rapidly,
re dependably, and problems of measuring
-stream parameters that could not be meas-
d before.

Nonlinear Systems—Not Yet

So far there is no real trend toward nonlinear
stems. There have been some analyses of self-
aptive and self-optimizing systems, and non-
ear concepts have been used as theoretical
s to find out why certain systems did not
k. But there has been very little work in
berate nonlinear designs. ■ ■

DESIGN 59

Urgent: Reliability, Less RFI

LAST YEAR'S problems of reliability remain as this year's challenges to design engineers. As never before, there is a great need for components which operate reliably under the severe stresses of vibration and high temperature. And there are new challenges.

The year 1959 will see more encapsulation to help reduce the vibration problem, and miniaturization will continue to occupy designers' thoughts. But two areas will win increasing attention: equipment operation at high voltages, and packaging.

Higher, Higher Voltages

The Space Age has seen voltages rise to the hundreds of thousands in ground support equipment. Development of reliable components is a priority order of business if equipment is to handle the voltages required for transmission over great distances, as in satellite communications.

Packaging of electronic equipment essentially is a mechanical problem—but it must be mastered if the equipment is to function reliably. Too many electronics engineers have been satisfied if the equipment operates in the laboratory.

"Hot spots" in packages must be avoided by intelligent placement of components. Heat must be evenly distributed throughout the entire package.

More Than Statistics

On the general subject of reliability and quality control, to many people this has come to mean statistical control, or, in effect, statistical analysis. So much work has been done on determining probabilities of failure that there has been a tendency to neglect designing to minimize failures.

Many engineers have become so entranced by reliability curves that they forget these mathematical tools do not in themselves impart reliability to a system.

This year should see acceleration of the trend towards spending more time in designing reliability into a system. More and more engineers are recognizing that mathematics is an important tool, but not a panacea.

Companies are paying more attention to reliability factors not considered before. Some have set up lists of preferred parts for engineers to design into equipment, and samples have been displayed so the engineers can see the part.

Companies also are setting up internal standards to improve quality. They are paying more attention to suggestions made by workmen on production lines, and are teaching such personnel the importance of top-quality workmanship and careful handling of equipment. They are promoting feedback of information to catch mistakes.

The greater efforts devoted to designing reliability into systems have not negated the statistical efforts, nor will they in the future. Many manufacturers now are insisting that their vendors supply reliability statements with their equipment.

Components are not being purchased under the most stringent specifications, however. MIL-C-125, for example, is more popular with industry and with the military than the tougher spec, MIL-C-14175. The reasons: lower cost and faster delivery.

Testing Costs High

Extensive tests are fine for reliability—but the price is high in dollars and time. A failure rate of 0.1 per cent for the lifetime of the component generally is being accepted as satisfactory.

More reliability of equipment provided under military contracting is expected to result from implementation of recommendations made by Task Group 4, the Advisory Group on Reliability of Electronic Equipment (AGREE). The Department of Defense now is selecting equipment to evaluate by criteria cited in the recommendations, and segments of the industry will be invited to cooperate.

Government analyses of reliability have demonstrated that the major problems arise in the use of vacuum tubes and relays. Quality control of transistors and diodes also proved troublesome. But as might be expected in a growing technology, use of components often was found to be faulty because of ignorance of the components' true performance.

Some Department of Defense officials feel it is too early to even use the term "reliability" in guided missile work. Some believe that the ratio of mission "success" to "opportunity to fail" is an erroneous basis for assessing missile reliability; they feel that missile sub-systems must be analyzed in much the same way mean-time-between-failures of individual electronic parts is determined.

There is a tendency, unfortunately reported to be growing, to design into a missile the capability to perform only through a 10-hour test plus the period of its mission. In practice this means an overall operating reliability of 90 per cent—and in time of emergency, this kind of reliability could spell disaster.

Using 10^8 unit hours as a goal for equipment reliability—a goal considered adequate—we see that a missile as complicated as the Nike Zeus, with about 2,000,000 parts (units), would have a 50-hour lifetime.

The challenge to the designer is to develop uncomplicated units which work, yet build in redundancy to compensate for part failures.

RFI Makes Missiles Miss

An ever-rising flood of demands to eliminate radio-frequency interference—demands from the Pentagon, from military installations, from systems manufacturers—is bringing into prominence one of the most glaring weaknesses in the design of electronic equipment. It is ranking in importance with reliability.

To RFI is attributed such events as missile failures, blackouts of communication and radar contact, and submission of false information by computers. Far more important than the vast

amount of money thus wasted is the dangerous disruption of defense facilities resulting from RFI signals.

Recognizing the specific source or sources of RFI is the major problem confronting the design engineer if he is to bring the problem under control. Like a small brush fire, the cause must be stamped out before the situation gets out of hand.

While conventional methods such as shielding and use of low-loss feedthrough components often reduce RFI, no universal set of rules can be presented. Individualized investigation of cases is required since factors such as operating frequency, power output, size and mode of operation tend to individualize equipment.

Check At Each Stage

Perhaps the most universally applicable prescription for controlling RFI is maintaining a close watch along the various stages of the engineering project and applying appropriate remedies as interference develops. If RFI is neglected until the equipment is in field use, brute force filtering may then require considerable increases in size and cost.

Future designs must be devised with maximum freedom from spurious radiation. This will result in more reliable communication and data transmission, and a subsequent decrease in the number of headlines announcing missile and satellite failures. ■ ■

Remember Man? He's In It, Too

PERHAPS MORE overlooked than any other factor in system design is the man. According to Henry P. Birmingham of the U. S. Naval Research Lab, there is too much tendency to view a system as one to be "operated" by the human.

For proper design, man must be considered an integral part of a system.

Many of the design parameters of the human component in a system already are known. It is known that man has a limited bandwidth (about 1/2 to 1 cps); he is basically a single-channel, single-process device; he is not very precise or stable; and he is noisy. It is known that man is very poor in processing analog information; he cannot measure velocity or distance very well.

But there is a good deal about man still to learn. We must know more accurately what his figure of merit is, how his gain is likely to vary, and how much noise he contributes. These are important factors in overall system design—factors the design engineer would do well to ponder more deeply in 1959. ■ ■

DESIGN 59

Components Demand Outstrip Advances; Goal's Reliability

THE ELECTRONICS industry's customers today are far from getting the ultimate in reliable components.

This is evident from the problems and sore spots outlined in the preceding section. Progress toward component reliability is imperative, but in 1959 the design engineer may not succeed in making a great deal of headway. Demands may outstrip developments, for the range of requirements over which reliable component operation is needed will inevitably continue to increase.

Among today's pressing demands is development of components which can stand up to vibration, both acoustical and mechanical.

How Much Stress?

In missile and avionic applications, this is particularly important; but here no one quite knows how much vibration the components are subjected to inside the high-flying equipment.

Looming just over the horizon is the need to develop components capable of withstanding nuclear radiation. And again there is no one to say just how much radiation a component should be able to take without damaging effects. The problem faces not only the design engineer working with missiles and spacecraft destined to cross radiation fields in space, but those concerned with radiation in nuclear-powered aircraft or in nuclear plants.

The need for components to operate in extreme environments can be overemphasized, however. In military applications roughly 95 per cent of all components are used in ground support equipment. They do not have to withstand the extreme temperatures, humidity, vibration, radiation and other stresses to which the remaining five per cent of missile and avionic components are subjected.

Improve Today's Components

Undoubtedly much work is needed in developing components immune to extreme stresses, in order to supply this five per cent segment of the military market as well as limited industrial users. But most of the developmental work—at least in 1959—must continue to be concentrated on improving reliability of existing components, those needed for less glamorous and less stressful uses.

If a rough estimate were to be made of how far existing components have been refined, it might be said that they are about 90 per cent perfect. Improving existing components, aiming at the 100 per cent mark, is 1959's challenge—and in military applications cost is a secondary consideration. But the challenge for the years beyond 1959 is the development of utterly new and different components. The Leyden jar principle and a coil of wire will still serve well but newer combinations are needed.

Focus On The Lab

The real need in the coming years is for a fresh approach in the laboratory. Materials will have to be investigated, and new theories evolved. Such fundamentally new components as the transistor must be thoroughly developed. For without new components based on new concepts, the electronics industry may turn into a dead end.

Among challenges for the future are these needed components:

- Batteries of the primary cell variety which have an almost indefinite life and cost little.
- Variable bandwidth filters.

More efficient utilization of the radio frequency spectrum would result from more rapid and more efficient control of the bandwidth of signals sent through space.

- Resonant circuits that can operate at 125 C for a sustained period, return to normal temperatures, and perform satisfactorily in both environments—R-L-C's must be stable.

The Do-It-Yourself Man

One of the biggest challenges in components design constitutes a burden falling on the shoulders of a relative newcomer to the field—the designer for a weapons system contractor. This engineer has been telling management that he can build a better component than the long-time component manufacturer can. But can he?

The contractor's designer must face up to the responsibility of deciding if those portions of the nation's defense dollars which come within his purview are being properly spent. A good deal can be at stake in making these decisions, for the military is turning more and more responsibility and funds over to the weapons system contractor. The component designer must ask himself:

- Am I producing a standard part or a special one?
- Can the part be mass produced in case of emergency?
- Am I using money wisely by investing contract funds in lab equipment and study phases, or could an experienced component producer make the money go further?

Compete For Market

To the components manufacturer, the challenge is to move into competition with the weapons system producer.

He must be able to produce the components that will be needed in the Space Age. And with only five per cent of his sales resulting from all of his research effort, the challenge is a demanding one.

What is needed, say military officials, is a breakthrough in production techniques. Systems are required which can produce components in small quantities, but components that are precise and reliable.

Use of standard parts is one of the greatest boons to overall reliability. Component manufacturers must agree among themselves on standards for the industry.

Speedier Semiconductors Seen

If he is to satisfy demands for faster transistorized computers, the semiconductor engineer must develop devices with greater switching speeds—and all signs indicate the challenge will be met successfully.

In 1959 it is expected that the 4-layer switch will reach speeds on the order of 10 millimicrosec. And commercially available within the next few months will be very high speed diodes with a

verse recovery time of 1 millimicrosec.

The mesa transistors, already finding applications in missile work, will become more readily available on commercial markets, at lower cost. Alpha cutoffs of about 10,000 mc are visualized for these devices, but a range of 1000 to 3000 mc will be more typical. [See recent development, p 42.]

Unipolar transistors will be in greater demand because of their resistance to radiation, and the demand will increase as missiles reach the stronger radiation fields of outer space.

The silicon controlled rectifier, which got off to an auspicious start in 1958, will find many more applications. The demand for these devices in order to handle higher currents will stir up considerable R & D activity.

For Reliability, Stability

The problem of temperature compensation of transistors, many semiconductor engineers feel, is far from solved. Clearly a big challenge for 1959 is development of new circuit techniques to stabilize transistor performance.

Nine-Year Transistors

One of the brightest pictures of progress today is in the transistor field. In GE's labs are transistors on life test which so far have exceeded 26,000 hours with no change of characteristics. This is the equivalent of nine years at eight hours a day—longer than most electronic equipment will last. One group of transistors was fired from a mortar, withstanding about 15,000 g's shock, then continued to operate, GE reported.

The 1959 trend in transistor production will be towards automation. The year will see additional segments of the assembly line becoming automatic, such as the measuring of wafer thickness, and the testing and separating of transistors according to characteristics. The semiconductor engineer also will continue experiments with new packaging techniques, such as the use of kovar glass seals.

A Transistor Plateau?

But the industry may well have reached a plateau in transistor developments. No radically new technology will greatly affect the kinds of transistors to be used in the next five years. "We have come to a mesa in changing technology," observed J. J. Ebers of Bell Telephone Labs.

With transistor manufacturers shifting emphasis to automatic production, reliability and tolerances will improve. But this goal cannot be achieved for 900 different types. The result will be fewer, but preferred, types. A new challenge before the design engineer is to use fewer transistor types in developing his circuits. ■ ■

DESIGN 59

For Consumers: Price, Quality

COMPETITION from abroad has placed a heavy burden on the U.S. consumer-product designer, one which will grow heavier in 1959.

Particularly difficult to meet is steadily growing competition from Japanese firms in the transistor radio field, and from West German and Italian companies in the packaged high-fidelity market.

Increased labor and other costs have boosted the price range of American components to a relatively high level. Cost reduction must be achieved by means of improved circuit design, multipurpose components, and improved production techniques. But since most engineers for many years have been applying the policy of "economy design," the necessity for further stretching poses a distinct challenge.

For A Competitive Market

In an effort to combat the foreign-import deluge, compact multiband receivers (covering the 200-400 kc range and up) are being made available to U.S. consumers.

Television designers will continue their quest for better noise immunity, improved sync stability in fringe areas, and simplification of remote-control devices. Development groups are busy on transistorizing portable TV sets, but they will need a major assist from the battery manufacturers to achieve their goal.

Reflecting insistent public demand is the growing trend toward designing receivers so that subsequent servicing and repair work is simplified.

Improved audio quality and inclusion of tone controls are new features calculated to meet the demands of the swelling hi-fi public this year.

Color television perhaps poses the greatest challenge for 1959, as drastic reductions in consumer-product cost must be realized if the market is ever to develop.

Full-scale advertising campaigns have given color receivers a $350 price tag. This figure, unfortunately, is not even close to the actual cost of the item, and most manufacturers do not wish to sell at a loss in order to promote the product.

Towards Low-Cost Color

Simplification of circuitry and components may not furnish a satisfactory solution to this cost-price problem. What is needed is a breakthrough providing simplified color kinescope.

With its associated major decrease in cost, this would eliminate convergence assemblies and controls, as well as set-up time. New concepts in the technique of color broadcasting could simplify the overall system, and ultimately bring the receiver's cost down to an attractive price.

Hearing Is Believing

Problems faced by designers of high fidelity equipment this year will be more psychological than technical. Engineers will be reading up on experimental psychology more than ever.

This is predictable because at long last, audio engineers are beginning to realize that the old adage—"the final test is in the listening"—contains more fact than fancy. Audio equipment designed to reproduce sound between both extremes of audibility within ±0.1 db can be no better than the conditions under which it is heard. Sound reproduction has been developed to the point where further improvement probably could not be heard.

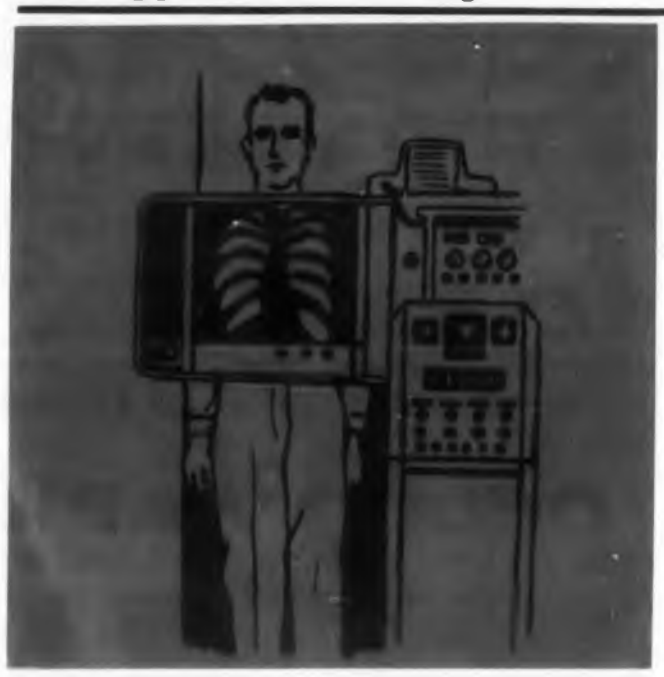
The Listening Ear

The problem now is to take advantage of this fine reproduction by presenting it properly to the listener. More attention therefore is going to be paid to problems of sound as received by the listener.

With the advent of stereo, the necessity for doing it justice has come to the forefront. Design requirements will have to be tightened. The requirements will have to be tightened. Stricter quality requirements must be met.

Turntable signal to noise ratio, for example, must be improved because of the response of the stereo cartridge to the vertical component. This mechanical problem in turntable isolation will face some engineers this year.

Turntable speed control and speed regulation also will haunt a few engineers this year. While hysteresis synchronous motors maintain constant speed within close limits, the 60 cps line frequency seldom is 60 cps. Many engineers have awakened to the fact that power companies often vary frequency as much as 3 cps above and below 60 cps, depending upon system load conditions. While it all comes out even in 24 hours



Medicine Rx: Bring Engineer, MD Together

IN MEDICAL electronics the challenges to the design engineer are as varied and complex as the human body itself. But perhaps the most important problem is improving communications between the engineer and the doctor.

The engineer is not equipped to study medical literature, and he simply does not know what the doctor needs in the way of new equipment. He cannot build an item, then ask the doctor, "Can you use this?"

The physician, on the other hand, has little idea of what the engineer can do. Coupled with this unfamiliarity with engineering's potentialities is the doctor's suspicious attitude toward the engineer and his products, based on past history of charlatanism by advocates of therapeutic and diagnostic "magnetic belts" and similar devices.

Cut X-ray Exposure

Potential applications of electronics to medical research are almost infinite. A boon would be, for example, a machine to produce X-ray pictures without using X-rays—which can be

(keeping electric clocks on time), frequency at any one time may be as much as five per cent off. Induction motor designers have a slight advantage here; speed of these machines may be regulated over a limited range. But to check them, the strobe light will have to be operated from a separate 60 cps precision oscillator.

Kill That Hum

Another problem facing audio designers is hum pickup by the stereo cartridge. Stereo pickups are more sensitive to hum than monaural types; they will require shielding without added weight, and some study of hum paths.

In the design of speakers, the important technical area of transient and intermodulation distortion needs more concentrated study. New forms of mechanical construction must evolve before some of the knotty loudspeaker problems can be solved.

Delusion Compounded

The entire high-fidelity component field must face up to the important problem of measurement. Consumers, confused by sales-type specifications, are beginning to demand more honesty in measurements. Even designers complain that they have been fooling themselves. No one seems to be able to compare, for example, the noise level of one manufacturer's turntable with that of any other manufacturer. Some standardization of test procedures must be achieved—preferably before the end of 1959.

Multiplexing of stereo signals from fm broadcast stations may be standardized within the next year. Now five different methods exist. Development of the proper system, engineers say, involves study of many psychoacoustic factors, as well as study of the economics of broadcasting and receiving the signal. ■ ■

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damaging both to the patient and the doctor.

Short of that achievement, there is need for a good image intensifier for X-ray photography so the patient will not have to be exposed to so much radiation. Several companies now have such items in development, but none perfected.

Also needed by the medical researchers is apparatus that could measure the long-range effect of low energy radiation on humans. So far the evidence available is not conclusive.

Dr. Urner Liddel of the National Institutes of Health asks for means of measuring blood flow in the heart or in an artery without the necessity for intruding instruments into the blood stream. Since hemoglobin contains iron—which can be magnetic—and serum is conductive, medical electronics design engineers have two starting points for development of such instrumentation

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(moving conductors and moving magnets). But nobody really has tackled this problem.

Do Brains Emit Waves?

Many doctors would like to see proof that the human brain emits "waves." The electroencephalograph, which measures voltage changes from electrodes on the head, does not prove the existence of such waves. But measurements with a detector placed a distance from the head, without physical contact, might constitute proof of wave emission.

An outstanding problem is electromechanical duplication of functions of the vital organs. That has been accomplished for the heart, permitting "dry field" operations during which the blood supply bypasses the heart. Similar apparatus is needed to perform functions of the liver and pancreas, organs which need rest to heal.

Another challenge is the need for development of transducers for measuring body conditions, thus simplifying diagnosis. One urgently required is a transducer to indicate eyeball pressure without having to touch the eye. This would permit speedier and more accurate diagnosis of glaucoma, a hardening of the eyeball which blinds 150,000 Americans annually.

Automatic Hospitals

Automation of hospitals also is on the "needed" list. Applications might be devised for routines followed at all stages from diagnosis to cure. Automation would prove particularly beneficial in the operating theater. For instance, a quick analysis of cells suspected of being malignant would permit the surgeon promptly to isolate and excise cancer while an operation is in progress. This would eliminate the necessity for follow-up operations in cases where the biopsy proves positive.

In another field, for investigating effects of high altitudes or the pressures encountered in deep-sea diving, a useful device would be one measuring the nitrogen in exhaled air. The mass spectrometer would seem to suggest itself here. But its use is ruled out by the fact that nitrogen has a molecular weight of 28—and so does carbon monoxide. Basal metabolism measurements still are crude; they depend on measuring the time it takes to inhale a known amount of oxygen and going on the assumption that all the exhaled air is carbon dioxide. How much oxygen is exhaled, if any, remains unknown. ■ ■

Basic Research, Inventions Needed

There are many areas where engineers are virtually stymied. One is underwater communications and underwater detection.

Sonar has apparently gone as far as it can using today's known techniques. Use of high frequency systems show some promise but submarines are small and hf requires large equipment and large power supplies.

The latest "Inventions Wanted by the Armed Forces" bulletin poses the following challenges: a man-made "electric eel" to power underwater cable repeater amplifiers, a small acoustic transducer to detect signals as low as 5 cps.

At the other end of the spectrum, receivers sensitive in the 9-14 micron region with a response time of a few microsec and more sensitive, narrow-band infra red devices are needed. The general need for better infra cells is well known; just what is needed is not known. As some engineers put it, the biggest challenge in infra red is to overcome the security bottleneck so that information can be more readily disseminated. ■ ■

Our Thanks

We sincerely thank the following persons, and the several who preferred to remain anonymous, for their help in preparing this report.

R. L. Mattingly, Bell Telephone Laboratories
Dr. Joseph Vogelman, Rome Air Development Center
Dr. V. Van Praag, Packard Bell Computer Corp.
Richard Whelan, Hycon Eastern, Inc.
Dr. George L. Haller, General Electric Co.
Dr. V. Wouk, Beta Electric Company
P. K. McElroy, General Radio Company
Louis Kahn, Aerovox Company
J. E. May, Jr., Bell Telephone Laboratories
Dr. David Van Meter, Melpar, Inc.
Dr. Urner Liddel, National Institutes of Health
Charles C. Doersam, Sperry Gyroscope Company
L. Gardenhire, Radiation, Inc.
L. Thomas, Navy Bureau of Ships
C. W. North, Martin Co.
J. Berliner, Rome Air Development Center
Carl Berkley, Rockefeller Institute for Medical Research
William Thurston, General Radio Company
P. S. Darnell, Bell Telephone Laboratories
J. E. Ward, Servomechanisms Laboratory, MIT
Henry P. Birmingham, U.S. Naval Research Laboratory
W. Jarva, Filtron Company, Inc.
Max Astrachan, Air Force Institute of Technology
W. H. Huggins, Johns Hopkins University
Dr. V. K. Zworkyn, Rockefeller Institute for Medical Research
David Klem, Sperry Gyroscope Company
H. K. Ishler, Lansdale Tube Co., Philco Corp.
Dr. Colin Bowness, Raytheon Manufacturing Co.
Theodore Saad, Sage Laboratories
Dr. Arthur Uhlir, Microwave Associates
Richard Smedes, Sperry Gyroscope Company
William Sichak, ITT Laboratories
Paul Lighty, ITT Laboratories

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William Sichak, ITT Laboratories
Paul Lighty, ITT Laboratories

Microwave Test Instruments

Test Sets—Part III

Different types of microwave instruments were described in the first part. Signal generators were taken up in Part II. They were classified into different types and described both as a source of signal power and as an accessory to supply a calibrated signal for companion purposes.

Microwave test sets are now taken up. Such accessory units as microwave attenuators, impedance matching devices, termination and directional couplers are also described.

David Fidelman
Roslyn Heights, N.Y.

THE MOST common type of test set consists of a signal generator, a power meter and a frequency meter. The power and frequency meter section can be used both to monitor the output of the signal generator itself, for greater accuracy, and to measure external signals.

A block diagram of a microwave test set is shown in Fig. 1. The signal generator uses a klystron oscillator, of the type described in Part II, coupled to the load through a calibrated attenuator. The generator usually has some form of internal modulation available.

Power is measured by a thermistor bridge in conjunction with a calibrated attenuator. An absorption type wavemeter is used to indicate frequency. A suitable switching arrangement selects the specific functions of the units. The block diagram shows a typical microwave test set, although there may be differences in the design and the features included in different units. Some include a spectrum analyzer, which in certain units can also be used as a synchroscope.

Since the test set includes a power meter and a frequency meter, it can be used without accessory equipment for a number of different types of measurements. Such measurements include: measurements of receiver sensitivity; selectivity measurements; transmitter tuning and power level measurements; measurement of external microwave power or frequency; signal-to-noise ratio; antenna gain; and transmission line characteristics. Test sets are especially useful in testing of complete radar, fire control, or beacon systems, and in field-testing of microwave relay sta-

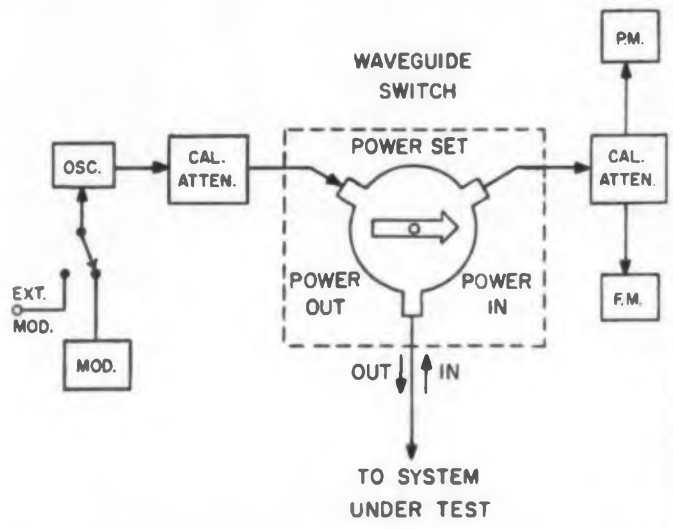


Fig. 1. Basic block diagram of a typical microwave test set.

Table 8. Common Microwave Test Sets

Manufacturer	Model No.	Signal Generator			Power Meter		Frequency Meter			
		Frequency Range	Power Output	Modulation	Range	Accuracy	Range	Accuracy	Price	Other Features; General Comments
Amerac, Inc.	1000	900-4600 mc (using 20 separate oscillators)	Up to 2 kw pulse (0.001 duty cycle)	Int: Pulse	Output power of unit	—	Covers individual ranges	±0.5%	—	Supplies high power output; power meter measures average power and chart used to convert peak power
Telerad Mfg. Co.	TSG-147D	8500-9600 mc	−7 to −85 dbm	Int: cw, fm Ext: Pulse	+7 to +30 dbm	±1.5 db	8470-9630 mc	—	—	Output power continuously variable; accurate to ±1.5 db
Espey Mfg. Corp.	385	8500-9600 mc	−42 to −83 dbm	Int: fm Ext: Pulsed	+7 to +30 dbm	—	8500 to 9600 mc	±2 mc	—	Output power continuously variable by attenuator accurate to ±1 db
General Communication Co.	CBX	8500-9600 mc	−7 to −85 dbm	Int: cw, fm Ext: Pulsed	+7 to +30 dbm	±2 db	8500 to 9600 mc	±2.5 mc	—	Output power continuously variable by attenuator accurate to ±2 db
	BHS	8500-9600 mc	−7 to −85 dbm	Int: cw, fm, Pulsed Ext: Pulsed	+7 to +30 dbm	±2 db	8500 to 9600 mc	±2.5 mc	—	Contains internal pulse and delay generator; output continuously variable, accurate to ±2 db
	BDX	8500-9600 mc	0 to −105 dbm	Int: cw, fm, Pulsed Ext: cw, fm, Pulsed	+1 to +30 dbm	±1.5 db	8500 to 9600 mc	±1 mc	—	More versatile and accurate than Models CBX and BHS
Hewlett-Packard	623 B	5925-7725 mc (in 3 ranges)	0 to −70 dbm	Int: fm Ext: Pulse, fm, square wave	−6 to +3 dbm	±1 db	5925-7725 mc	±0.1%	$1750	Output continuously variable, accurate to ±2 db; unit supplied with klystron for any one of the three operating ranges
	624C	8500-10,000 mc	0 to −100 dbm	Int: Pulse, fm Ext: Pulse, fm, square wave	−6 to +28 dbm	±1 db	8500 to 10,000 mc	±0.03%	$2265	Output continuously variable, accurate to ±2 db
Kearfott Co., Inc.	W309-1B-2	5200-5900 mc	20 MW max	Int: cw, fm, Pulse square wave	0 to +33 dbm	±2 db	(same as frequency range of signal generator)	±0.05%	—	These units contain built in spectrum analyzers with 3 inch CRT for display; output power of signal generator continuously variable; See also under Spectron Analyzers
	W109-2C-2	8500-10,000 mc	20 MW max							
	W509-1B-2	15,500-17,000 mc	10 MW max							
New London Instrument Co.	TS-155C/UP	2700-3400 mc (in 3 ranges)	−20 to −100 dbm	Int: Pulsed	Up to 200 mw	—	—	—	—	Does not have frequency meter; contains internal pulse and delay generator; output power continuously variable
Polarad Electronics Corp.	SG-1218	12,400-17,500 mc	−10 to −90 dbm	Int: cw, square wave Ext: Pulse, fm	+10 to +30 dbm	±2 db	12,400-17,500 mc	±20 mc	$4330	Output power continuously variable, accurate to ±2 db
Sperry Gyroscope Co.	38A	8500-9600 mc	−42 to −85 dbm	Int: cw, fm Ext: Pulse	+7 to +30 dbm	±1.5 dbm	8500-9600 mc	±2.5 mc	—	Output power continuously variable
	590	2700-3550 mc	+3 to −100 dbm	Int: cw, fm, Pulse	+5 to +30 dbm	±1 db	2700-3550 mc	±1 mc	—	These units contain built in spectrum analyzers which can also be used as synchroscopes; contain internal pulse
	570	8500-10,000 mc	+3 to −100 dbm	Int: cw, fm, Pulse	+5 to +30 dbm	±1.5 db	8470-10,500 mc	±3.5 mc	—	and delay generators; output power continuously variable, calibrated from −5 to −100 dbm, accurate ±1 db

tions and communications equipment, as well as general tests.

Accessory Units

The equipment and units listed in Tables 9, 10, and 11 are not strictly microwave test instruments, but are rather accessory units used in most measurement setups. These units include: microwave attenuators (both fixed and variable); impedance matching devices; terminations; and directional couplers. Since they are primarily measurement accessories, their characteristics are not listed in the same detail as the major types of microwave test instruments. The listing is primarily one of manufacturers and of the different types of units which they manufacture as stock items. There are other manufacturers of many of these various types of units, but the listing has arbitrarily been restricted to manufacturers of test instruments listed in other tables in this series.

Since there are such a wide variety of accessory units, having only slight differences in characteristics, they are simply listed by type of unit and frequency band for which they are used. Thus, a single manufacturer may make a series of fixed attenuators having 3, 6, 10 and 20 db attenuation in each frequency band from L to E band. These are listed only by frequency bands, and any further information should be obtained from the individual manufacturers.

Attenuators

Many microwave measurements require attenuation of the power in a transmission system. Attenuators may be used: as standards in power and attenuation measurements; as a means of extending the range of available equipment; to vary signal level by a known amount; to reduce the power level of available sources; for isolating different parts of the setup from one another; and for many other purposes which arise in the course of making microwave measurements. There are, in general, two different types of attenuators for use at microwave frequencies: the waveguide-beyond-cutoff type, and the dissipative type.

The waveguide-beyond-cutoff attenuators make use of the exponential attenuation characteristic of a waveguide below its cutoff frequency, and have excellent accuracy and stability characteristics. Their prime advantages:

The rate of attenuation is known analytically and can be calculated to a high degree of accuracy.

The power level at which they operate is not limited by the heat dissipation of a resistive element. Because of the latter characteristic, they are useful in coupling from the output of a high-level microwave generator.

The more widely used type of attenuator makes use of a resistive strip inserted into the waveguide (or coaxial line) to absorb part of the power. The resistive element may be inserted into the waveguide in a number of different ways. In fixed attenuators, the amount of insertion and position of the element are fixed. Variable attenuators may be either the flap or the vane type. In the flap attenuator, a resistive strip is inserted in the broad face of the waveguide, and the amount of attenuation is varied by changing the amount of the strip insertion. The more accurate calibrated attenuators make use of a resistive vane whose position or orientation in the waveguide can be precisely varied. Dissipative types of attenuators are generally designed for maximum average input power of the order of 1 to 2 w.

Fixed attenuators are generally available in attenuation values of 3 to 40 db, and are particularly useful in applications requiring a fixed accurately known attenuation, for reducing the power flowing in a waveguide system, for reducing reflections of loads or sources, or for isolating parts of a waveguide system. Variable attenuators have ranges of 0 db to about 50 db maximum, depending upon the type. Uncalibrated and general-purpose calibrated variable attenuators are useful for power level adjustments and applications where the attenuation need not be accurately known, or need not be known. Precision calibrated attenuators are designed for applications requiring a highly accurate and reliable knowledge of attenuation.

Impedance Matching Devices

Impedance matching devices are used in microwave measurements for correcting discontinuities or "flattening" waveguide systems, as well as to match loads, terminations, bolometer mounts or antennas to the characteristic admittance of the waveguide.

Slide-screw tuners consist of a waveguide slotted section upon which is mounted an adjustable probe whose position and depth of insertion can be varied. They are useful in determining experimentally the position and magnitude of matching structures required in waveguide systems. E-H tuners consist of a straight section of waveguide to which series and shunt tuning arms with movable short circuits are attached. They are particularly useful when low power leakage and high power handling capacity are required. Phase shifters provide accurate, controllable phase variation, and

Table 9. Microwave Attenuator

Manufacturer	Fixed attenuators	Variable attenuators		
		Uncalibrated	Calibrated, general purpose	Calibrated precision or high-stability
Admittance-Namco Corp.	X, coax	X	—	X
Amerac, Inc.	S,C,XN,XB,X,KU,K,V,M	S,C,XN,XB,X,KU,K,V,M	—	—
B J Electronics	—	—	10-3000 mc	—
De Mornay-Bonardi	all bands from S to E	S,C,J,H,X,KU	18.0 to 90 kmc	all bands S to E
Diamond Antenna & Microwave Corp.	S,C,XN,XB,X,KU,K,V, coax	S,C,XN,XB,X,KU,K,V, coax	X,KU, coax	S,C,SN,SB,X,KU,K,V
F-R Machine Works, Inc.	L,S,C,XN,XB,X,KU	all bands L to E	—	all bands L to E
General Radio Co.	coax	coax	coax	—
Hewlett-Packard Co.	S,C,XN,XB,X,KU,K,V	—	S,C,XN,XB,X,KU,K,V	S,C,XN,XB,X,KU,K,V
Lieco, Inc.	—	all bands S to E	—	all bands S to E
Microwave Associates, Inc.	L,XB,X,KU,K,V,M	X,KU,K,V,M	X,KU,K,V,M	—
Narda Microwave Corp.	all bands S to E; coax	all bands S to E	coax	S,C,XN,XB,X,KU
Polarad	—	—	coax	—
Polytechnic Research & Dev.	X, coax	XN,X,K,V,M	X,M, coax	S,C,XN,XB,X,KU,K,V
Radiation, Inc.	—	—	coax	—
Radio Corp. of America	coax	—	—	—
Radar Design Corp.	coax	—	—	—
Sivers Lab.	—	X	—	—
Sperry Gyroscope Co.	X	X,KU,V	X	—
Waveline, Inc.	S,C,XN,XB,X,KU,K,V	S,C,XN,XB,X,KU	S,C,XN,XB,X,KU	S,C,XN,XB,X,KU,K,V
Weinschel Engineering	S, coax	—	—	—
Roger White	—	—	S,C,XN,X,KU,K, coax	—

are useful in measurement of transmission, attenuation and impedance in microwave systems, in introducing differential phase shift, and in otherwise studying the design of microwave systems and antennas. Adjustable shorts consist of a section of waveguide containing a movable short-circuiting plunger, and are useful for introducing a variable element in waveguide systems.

Directional Couplers

A directional coupler extracts a small amount of energy from a waveguide system. It consists of a main waveguide which is inserted in the system, with another waveguide section coupled to it. The important characteristics of directional couplers are the coupling factor which may range from 3 db to 30 db and the directivity which is generally at least 20 to 40 db.

Directional couplers are either of the cross-guide or the multi-hole type. The former consists of two waveguide sections joined at right angles across their broad faces. The latter consists of two parallel joined waveguides coupled together through a series of holes in their common wall. The multi-hole type has better coupling and directivity characteristics, while the cross-guide type is useful in applications which do not require the precision of the multi-hole coupler.

Directional couplers are useful for extracting a known fraction of the power flowing in a transmission line, or for introducing power into a line without disturbing its characteristics. They are used in measuring and monitoring power and frequency, mixing signals, isolating signal sources or wavemeters, and a variety of other applications requiring the connection of auxiliary equipment to a transmission line. Because of their directional characteristics, they are extremely useful in measuring reflections in waveguide systems.

Terminations

Terminations are used for absorbing the power in a microwave system, and are designed to absorb virtually all the power and assure a low SWR. They consist of a section of waveguide containing a tapered dissipative element which absorbs the power. Low-power terminations (up to 2 w average power) and high-power terminations (up to 600 w average power in some bands) are commercially available in all the microwave band.

A moving load consists of a section of waveguide in which is mounted a sliding tapered low-reflection load, and permits the accurate determination of the reflection coefficient of the termination itself. Standard reflections are precision loads used to set up exact reflections for standardizing SWR measurement setups.

Table 10. Impedance matching Devices

Manufacturer	Slide-screw tuners	E-H tuners	Adjustable shorts	Phase shifters	Stub tuners
Admittance-Namco Corp.	X	X	X	—	coax single, double, triple stub
De Mornay-Bonardi	—	all bands from S to E	all bands from S to E	all bands from S to E	all bands from S to E
Diamond Antenna & Microwave Corp.	L,S,C,XN,XB,X,KU	S,C,XN,XB,X,KU,K,V	L,S,C,XN,XB,X,KU,K, V, coax	—	coax double stub
F-R Machine Works, Inc.	L,S,C,XN,XB,X,KU	all bands S to E	bands L to E	—	coax double stub
General Radio Co.	—	—	coax	—	coax
Hewlett-Packard Co.	S,C,XN,XB,X,KU,K,V	X,KU,K,V	S,C,XN,XB,X,KU,K,V	XN,X,KU	—
Lieco, Inc.	—	all bands S to E	all bands S to E	—	—
Microwave Associates, Inc.	—	X,KU,K,V,M	X,KU,K,V,M	—	V,M
Narda Microwave Corp.	L,S,C,XN,XB,X,KU	all bands S to E	all bands S to E	C,XN,XB,X,KU	coax
Polytechnic Research & Dev.	S,C,XN,XB,X	KU,K,V,M	—	—	coax double stub
Radar Design Corp.	—	—	S,C,XN,XB,X,KU,K	—	coax double stub
Sierra Electronic Corp.	—	—	—	XB,X	coax double stub
Sivers Lab.	S,C,XN,XB,X,KU	—	S,C,XN,XB,X,KU	—	coax single, double, triple stub
Sperry Gyroscope Co.	—	—	C,XN,X,KU,K, coax	S,C,X	S,C,XN,XB,X, coax, double, triple stub
Waveline, Inc.	—	S,C,XN,XB,X,KU,K,V	S,C,XN,XB,X,KU,K,V	S,C,X,K	XN,XB,X,KU,K,V
Weinschel Engineering	—	—	—	—	coax double stub

Table 11. Terminations and Directional Couplers

Manufacturer	Terminations				Directional couplers	
	Moving loads	Standard reflections	Low or medium power terminations	High-power terminations	Cross-guide	Multi-hole
Admittance-Namco Corp.	coax	—	X, coax	—	X, coax	—
Airtron, Inc.	—	—	—	S,C,XN,XB,X,KU,K,V	—	—
Amerac, Inc.	—	—	S,C,XN,XB,X,KU,K, V,M	C,XN,X	—	S,C,XN,XB,X,KU
Bird Electronic Corp.	—	—	—	to 3300 mc	—	—
Bogart Mfg. Corp.	—	—	—	L,S,C,XN,XB,X	L,S,C,XN,XB,X	S
California Technical Industries	—	X	—	—	—	X
Chemalloy Electronics	—	—	—	L,S,C,XN,XB,X,KU,K,V, and coax	—	—
Cubic Corp.	—	—	—	to 6000 mc	—	—
De Mornay-Bonardi	all bands from S to E	—	all bands from S to E	all bands from S to E	all bands from S to E	—
Diamond Antenna & Microwave	S,C,XN,XB,X,KU,K, V, coax	—	L,S,C,XN,XB,X,KU,K, V, coax	—	L	S,C,XN,XB,X,KV,K, V,M
F-R Machine Works, Inc.	L,S,C,XN,XB,X,KU, K,V	S,C,XN,XB,K,KU, K,V	all bands from L to E	—	X	S,C,XN,XB,X,KU, K,V
General Radio Co.	coax	—	coax	—	coax	—
Hewlett-Packard Co.	S,C,XN,SB,X,KU,K,V	X	S,C,XN,XB,X,KU,K,V	S X	S,C,XN,XB,X	S,C,XN,XB,X,KU,K,V
M. C. Jones Co.	—	—	—	coax	—	coax
Lieco, Inc.	—	—	all bands L to E	all bands L to E	S,C,XN,XB,X,KU,K, V, coax	S,C,XN,XB,X,KU,K,V
Microwave Associates, Inc.	—	—	L,X,KU,K,V,M	L,S,C,XB,X,KU,K,V,M,E	L	X,KU,K,V,M
Narda Microwave Corp.	all bands L to E; coax	S,C,XN,XB,X,KU	all bands L to E; coax	L,S,C,XN,XB,X,KU, coax	L,S,C,XN,XB,X,KU	all bands S to E; coax
Polytechnic Research & Dev.	—	—	S,C,XN,XB,X,KU,K,V, M, coax	—	—	S,C,XN,XB,X,KU
Radar Design Corp.	S,C,XN,XB,X,KU,K; coax	coax	S,C,XN,X,KU,K, coax	—	S,C,SN,X,KU,K,V, coax	S C,XN,X,KU
Sierra Electronic Corp.	—	—	coax	XB, coax	—	coax
Sivers Lab.	—	—	S,C,XN,XB,X,KU	—	S,C,XN,XB,X,KU	—
Sperry Gyroscope Co.	X	—	S,C,XN,X,KU,K,V, coax	S,C,XN,XB,X	S,C,XN,XB,X,KU,K,V	V, coax
Telered Mfg. Corp.	—	—	—	—	all bands	all bands
Waveline, Inc.	S C,XN,XB,X,KU,K,V	—	S,C,XN,XB,X,KU,K,V	C,XN,XB,X,KU	S,C,XN,XB,X,KU,K,V	C,XN,XB,X,K,V
Weinschel Engineering	—	—	coax	—	—	—

The tabulation of accessories as attenuators, impedance matching devices, terminations and directional couplers are restricted to manufacturers of test instruments mentioned in other tables in this series.

TI 2N559 mesa transistor offers high switching speeds, high alpha cutoff frequency along with high collector dissipation. (Opposite)

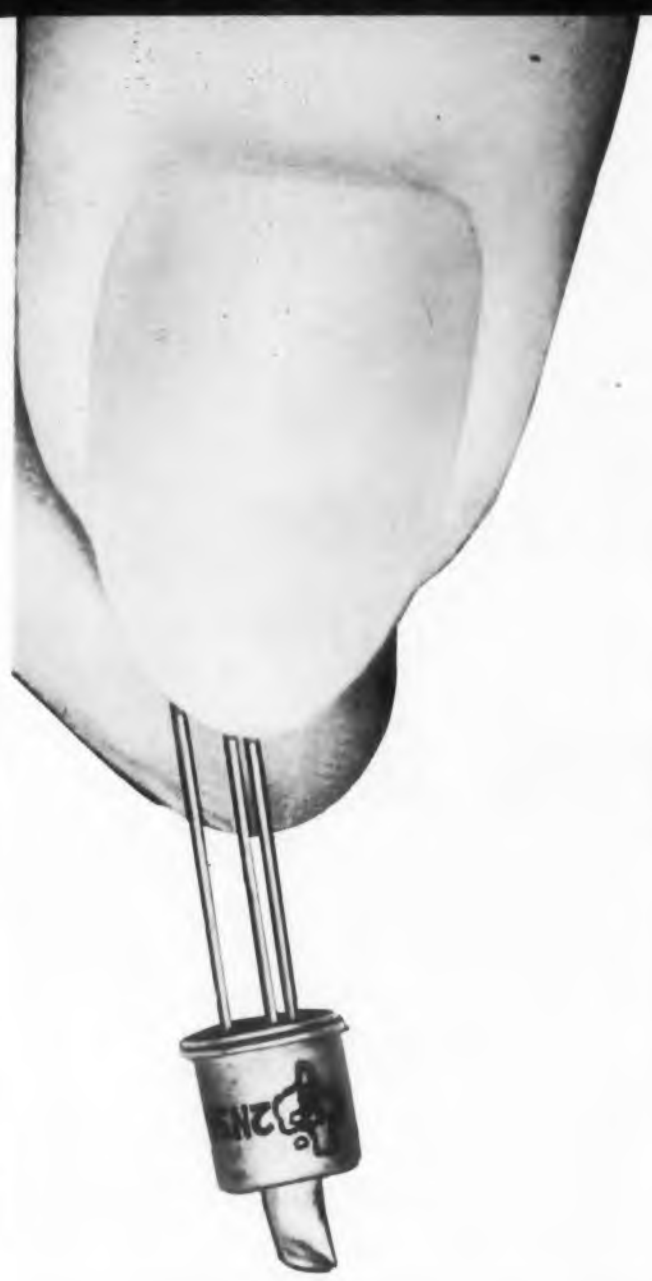
Mesa Switching Transistor Reaches Millimicrosec Range

FOR THE first time a mesa transistor is in production that can reliably offer:

- Switching speeds of 275 millimicrosec max total.
- Alpha cutoff frequency of 250 mc.
- Collector dissipation in excess of 150 mw in free air.
- Operating temperatures up to 100 C.

In our Design '59—a *challenge* report elsewhere in this issue, such an advance in mesa techniques was predicted, it was not visualized as coming quite so soon. Although there are semiconductor devices with higher switching speeds, higher alpha cutoff frequencies or higher power capabilities, the TI 2N559 is the first transistor to offer all three characteristics in a package not very much bigger than the size of a small diamond. Tested for high reliability, it is designed for use in advanced missile and airborne electronic circuitry.

Designed by Texas Instruments Inc., P. O. Box 312, Dallas, Tex., the TI 2N559 is packaged in a miniature round-welded case less than half the size of the standard JETEC-outline TO-5 unit. The case is compatible with the 100-mil grid mounting system. Its germanium wafer is



mounted directly on a gold header and the active area of the wafer is about the size of the diameter of one of the leads. High dissipation is obtained through direct contact between header and element consisting of just three materials—germanium, aluminum and gold.

The TI 2N559 has a switching range of 275 millimicrosec max total. The rise, storage and fall time was measured in a hard saturated circuit with parasitic capacitance. Although it is rated at 100 C, all units are stabilized well above their rated junction operating point.

The 2N559 is produced by gaseous diffusion and high-vacuum techniques similar to those used for the 2N623 90-megacycle germanium transistors introduced by TI in March, 1958. This type of construction, called the "mesa" configuration, provides the highest frequency response, switching speeds and power capabilities now attainable. These parameters, combined with high mechanical stamina to resist impact, acceleration and vibration, make the TI 2N559 well suited for military applications in missile and airborne electronics.

For more information about this mesa transistor, turn to Reader's Service Card and write in **104.**

DESIGN FORUM

Many Money-Saving Ideas in this FM TUNING UNIT

DOZENS of cost-saving features, both mechanical and electrical, were designed into this fm tuning assembly and receiver. Chassis knockouts serving as tuning pads are but one example. The unit represents the imaginative design thinking so essential today to meet the threat of the cheap foreign import market. Since hourly labor costs and component prices are continually moving upwards, savings were brought about by multipurpose use of parts, circuit simplification, and reduction of assembly time.

Padders Eliminated

It's quite a trick, and a healthy saving, to eliminate padder capacitors or coil slugs necessary for alignment of the low end of the band. This is cleverly accomplished by Granco Products, Long Island City, N. Y., by the use of chassis knockouts bent up adjacent to the end turns of the rf and oscillator coils. During alignment, the technician simply alters the spacing of the "shorted-turn" to obtain the proper inductance.

Mechanical Savings

"Why spend money to chop metal out of a chassis and then spend more money to buy it back in the form of brackets and shields?"—This question was posed and then investigated by Seymour Napolin, chief engineer of Granco. His answer came in the form of knockout dies inserted during chassis fabrication to:

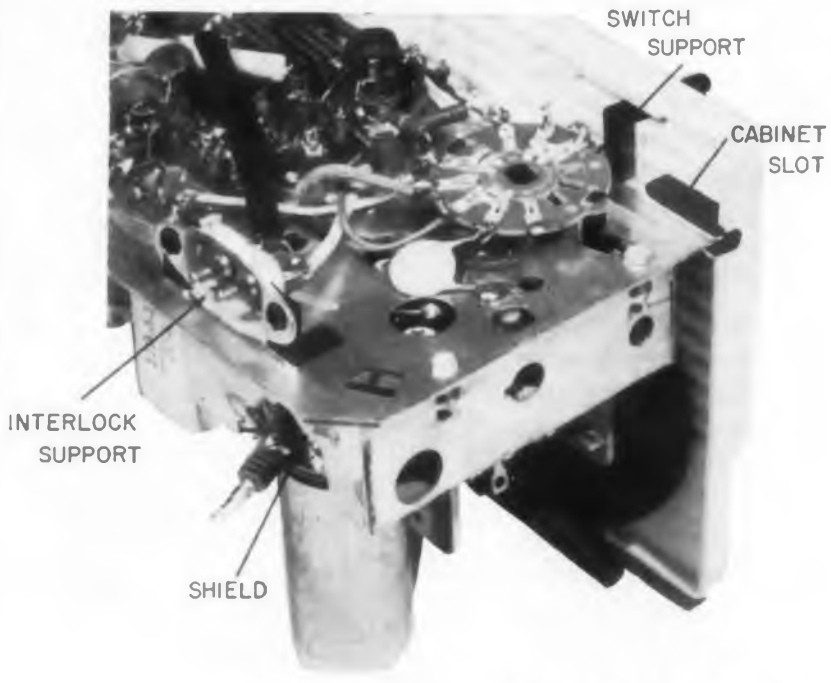


Fig. 2. Note use of chassis knockouts to support interlock and switch wafer. Chassis slides into slots along front panel for ease of assembly.

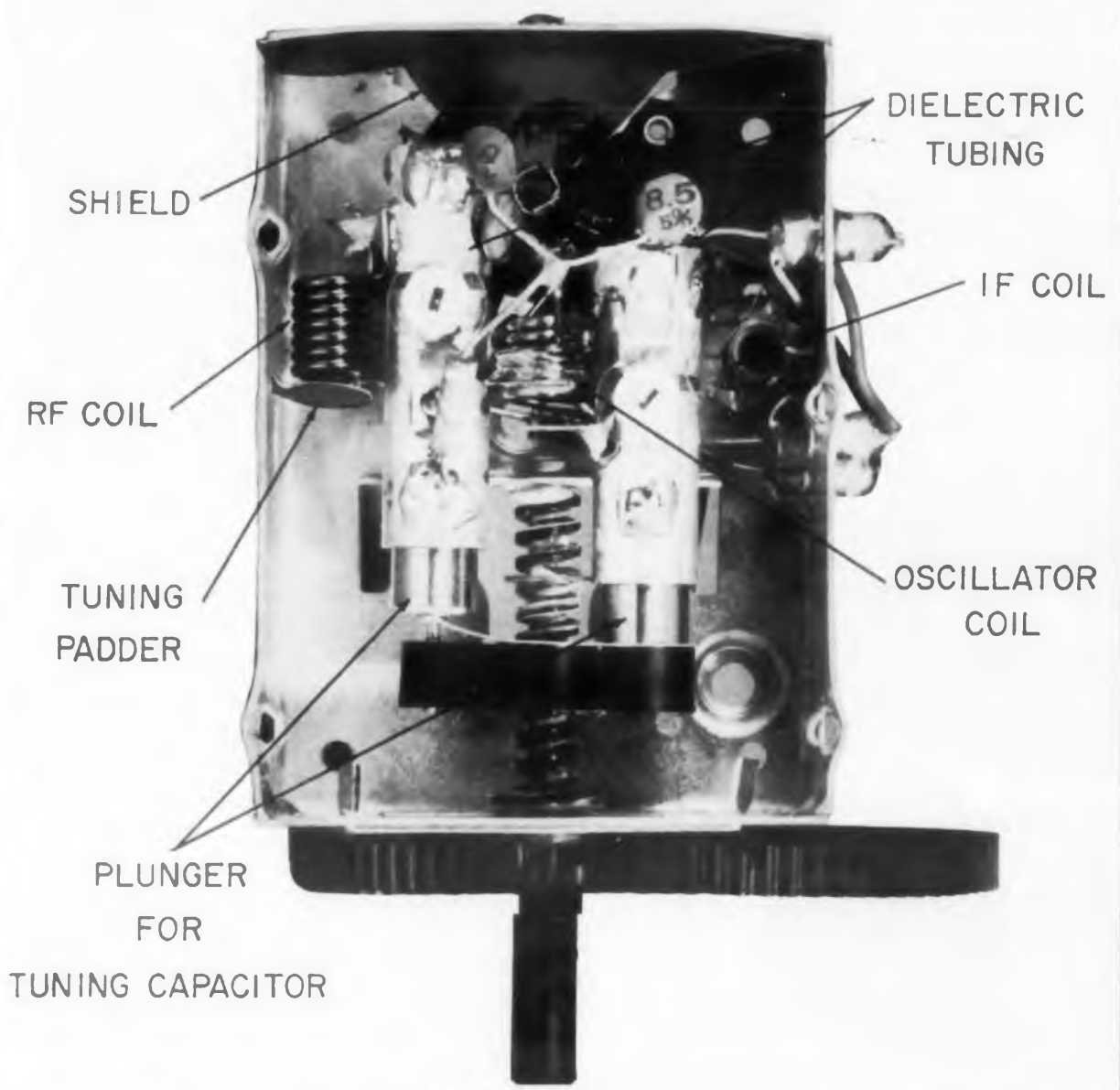


Fig. 1. Note dielectric tubes, chassis "bulge-in" for circuit shielding, and "shorted-turn" adjacent to each coil. During alignment, "shorted-turn" is adjusted for proper inductance.

- "Bulge-in" a section so as to magnetically shield the tuner input from the rest of the circuit.
- Form a retaining grip for the tube shield, thereby eliminating the need for a special, more expensive socket.
- Provide a bracket to hold the glass dielectric tubes.
- Support the interlock assembly in the complete am-fm receiver.
- Mount the am-fm selector switch wafer.

Simple Cabinet Assembly

Final assembly time is reduced to a minimum by having the cabinet molded as a two-piece assembly with slots or runners along the inner edge of both sections. The chassis is slid into the front panel runner and secured by means of a single screw, see Fig. 2. The rear section is then slipped along the chassis and the entire assembly is firmly fastened together with one screw.

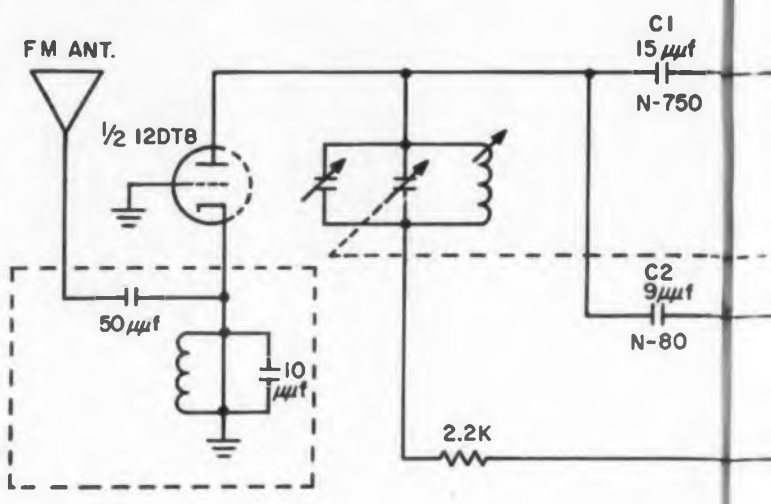
No Mess, No Fuss Dial Drive

Complicated drive pulleys, springs, and lengths of dial cord are not to be found in this unit. Instead, a simple lead-screw, direct-drive arrangement is used. Five complete revolutions of the drive gear covers the entire fm band with ample smoothness to separate even the closest of adjacent stations. A concentric slot along the face of the driven gear allows sufficient pliability during gear teeth engagement so that backlash is eliminated without using close tolerance parts. Dial scale figures are molded onto the driven gear thereby eliminating the need for a separate escutcheon plate.

Coaxial Tuning

Side-stepping the traditional variable capacitor, with its inherent disadvantages of large size and cost, microphonic and temperature-sensitive characteristics, and mechanical wiper noise, was the first

Fig. 3. (Below) Schematic diagram of tuning section. A single tube performs function of rf amplifier, oscillator, and mixer.



move by Granco. Instead, coaxial tuning, using the travel of a metallic plunger in a low-loss glass dielectric tube, was adopted. Cylindrical end sleeves on the glass tube act as plates of a capacitor; their relative spacing determines the minimum capacity. Capacitance is increased as the plunger is inserted into the tube to apply greater coupling between end sleeves, see Fig. 1.

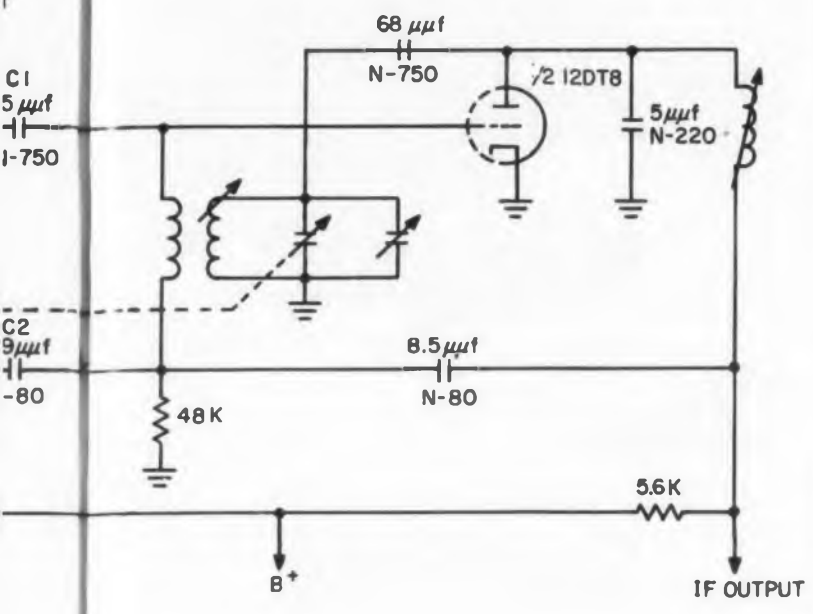
Many Advantages Offered

Since the glass cylinders and metallic plungers can be machined with a high degree of accuracy at nominal cost, a close fit can be obtained with resultant absence of microphonics. Noise problems are nonexistent since mechanical wiper contact is not involved. Use of a low temperature-coefficient glass material provides excellent stability characteristics. Size is substantially reduced.

The tuning element for the unit covers 88-108 mc, the standard fm band. By altering the dielectric tube and coil structure, operation up to 1200 mc is possible for uhf tuners and test equipment.

Simple, One-Tube Circuit

One tube, double-triode tuners are not new in fm and TV design. However, use of conventional L-C circuits cannot achieve the optimum gain and stability demanded and compromise performance



must be accepted. Coaxial tuning, with a higher effective circuit Q due to the low-loss dielectric, provides superior tuner gain with excellent oscillator stability in this unit. Frequency drift after several hours is less than 20 kc from initial power application eliminating the necessity for a complex and costly afc system.

The first triode section of the 12DT8 is a grounded-grip rf amplifier, plate tuned with one section of the coaxial assembly. The amplified rf output is capacitively coupled to the grid of the combination mixer-oscillator triode, as shown in Fig. 3. To eliminate the annoying "pulling" effect generally encountered in fm receivers, balanced-bridge oscillator design was selected. Oscillator coupling back to the rf plate coil takes place through capacitors *C1* and *C2;* since their signals are 180 deg out of phase, cancellation results and interaction is at a minimum. Oscillator tuning is varied by plunger movement in the second section of the coaxial assembly.

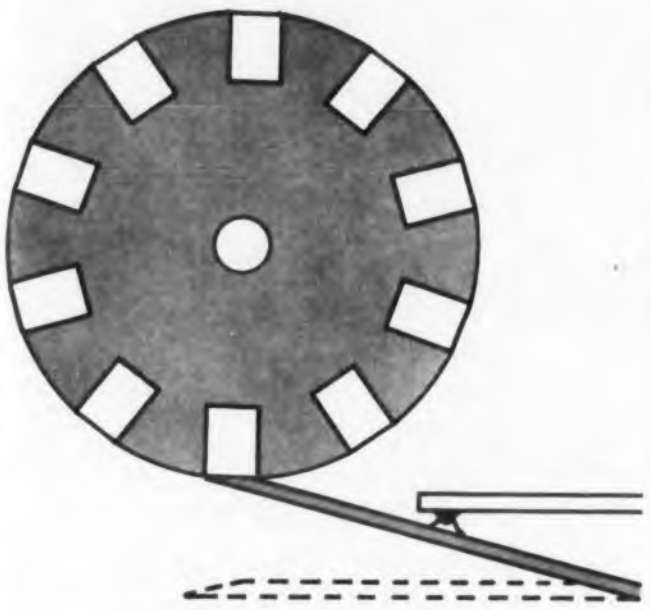
While the "gimmicks" outlined have a strong bearing in consumer product design where economy is a prime requisite, the ideas may be applied where compact space and unit simplicity are mandatory. Re-evaluation of existing equipment may well result in substantial cost and size reduction. ■ ■

Rotating Magnets Close Switches Rapidly

HIGH-SPEED, low-torque switching is achieved by placing a number of small ceramic magnets on a rotor and allowing them to rotate past sealed magnetic switches in this new switch type. Switches can operate as high as 250 closures per sec with appreciable contact bounce at 120 closures per sec with no contact bounce. Current ratings as high as 3 amps at 120 v ac are available.

Designed by Summers and Mills, Inc., 911 W. Commerce St., Dallas 8, Tex., the switch, containing 12 magnets, can be used to step a 30 deg stepper motor to produce economical torque amplification. Closures of the magnetic switches actuate the stepper motor providing intermittent unidirectional high level follow-up torque at the output of the motor. Had nine magnets been used the follow-up torque would have been at three-fourths synchronous speed. Ways are available to make the follow-up bidirectional.

The switch can be also used for mounting purposes. In Fig. 1 an operational switch is coupled by bevel gears to the output shaft of a ball disc integrator. The integrator reads the area of a curve plotted on the front side of the recorder. The operational switch closes ten times for each rotation of the output shaft and for each ten square inches of area. The switch closures are used to operate a "kick pen" and to plot the integrand as a series of pips alongside the curve. By the simple expedient of making one of the



The rotating magnets, attracting the contact arm, close the switch rapidly.

magnets of double width every tenth pip is of double width, thus providing easy counting of the area accumulated between any two points on the curve.

For more information about this low-torque switch, turn to Readers Service Card and circle 103.

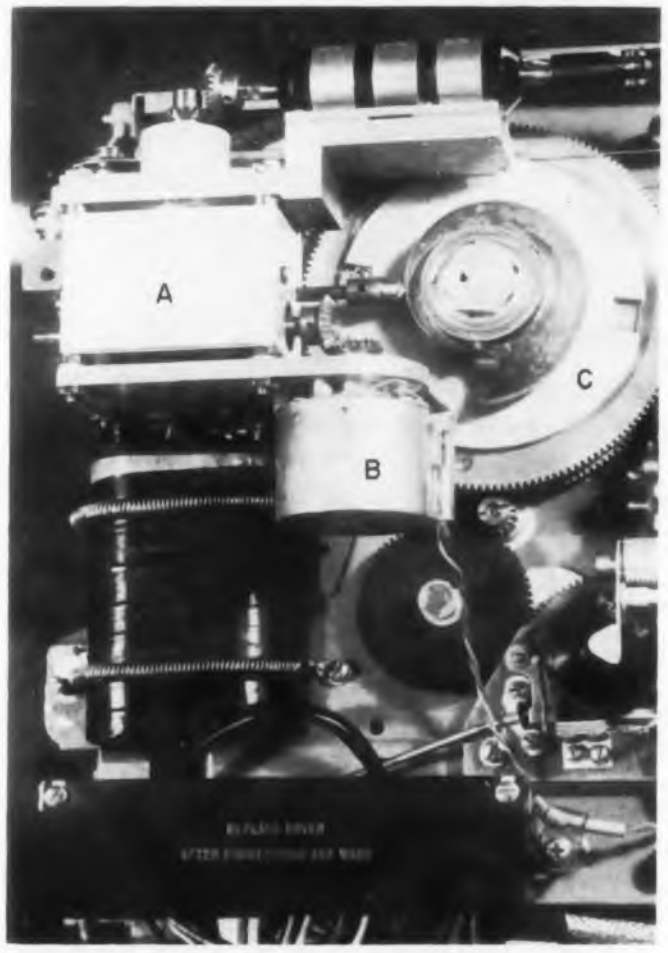


Fig. 1. Low-torque switch coupled by bevel gears to the output shaft of a ball-disc integrator. *A*—ball-disc integrator; *B*—operational switch; *C*—motion converting cam.

NEW PRODUCTS

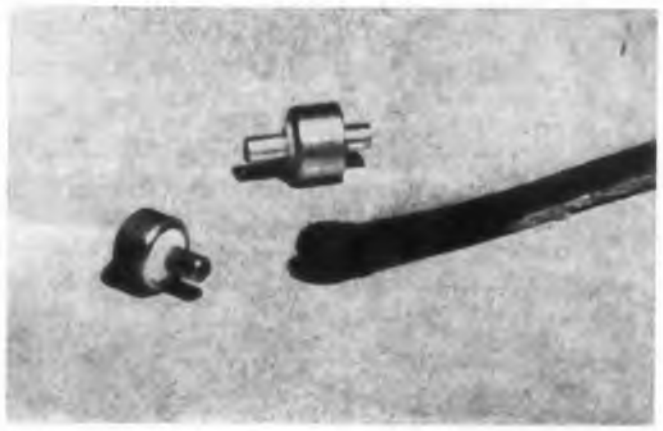
Covering all new products that might generally be specified by an electronics engineer engaged in the design of original equipment.

PANEL METERS

Measuring 1-1/2 in. sq., these meters are accurate to within 2%. They have a front zero adjustment and a scale length of 1-3/4 in. Units are available from 100 μa. And, using an external shunt, they can be rated at over 5 amp. As self-contained rectifier types, they can be used as voltmeters up to 300 v.

Hoyt Electrical Instrument Works, Inc., Dept. ED, 42 Carleton St., Cambridge 42, Mass.

WRITE IN 41 ON READER-SERVICE CARD

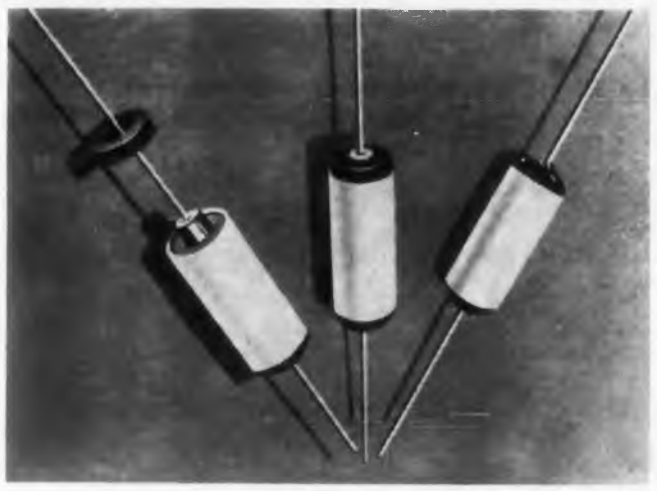


THERMAL SWITCH

This thermal switch is normally open and non-repetitive. After switching it maintains a closed circuit regardless of subsequent temperature changes. Current rating is 5 amp, ac or dc continuous duty. Maximum working voltage is 220 v. Called the MiniTherm, it is available for switching temperatures of 150, 175, 200, 225, 250, 275, 300, 325, and 500 F. Accuracy is ±2%. Applications include operation of power devices and telemetering.

MiniTec, Dept. ED, 5423 Delaware Ave., Los Angeles 41, Calif.

WRITE IN 42 ON READER-SERVICE CARD



PREFORMED EPOXIES

These preformed epoxies permit uniformity of appearance and performance in seals and bonds. They are premolded, or precut, to the exact shape, and formulated to flow and cure at specified temperature requirements. Filmex, Series 800-D, comes in sheet or film form. It ranges in thickness from 0.0015 to 0.02 in. Pressex, Series 800-C, is made from prepressing of epoxies in powder form. They range in thickness from 0.02 in. up. Use of a Pressex preform is shown in the photograph. The catalyst or hardening agent is embodied in the preforms. Both materials have excellent storage characteristics and shelf life.

Mansol Ceramics Co., Dept. ED, 140 Little St., Belleville, N.J.

WRITE IN 43 ON READER-SERVICE CARD

SYNCHRO RECEIVER

Designed for indicator applications, this size 10 synchro receiver meets MIL-I-7057. Type 10-4085-19 has a −55 to +71 C ambient temperature range. The unit has a 1 deg dynamic test accuracy and 5 sec damping. Internal damping is by rotor bar technique. Rotor moment of inertia is 2 gm-cm², input voltage is 26 v, 400 cps and the output is 11.8 v.

John Oster Mfg. Co., Dept. ED, 1 Main St., Racine, Wis.

WRITE IN 44 ON READER-SERVICE CARD

NEW PRODUCTS

Blower Unit

For aircraft use

For ventilating and cooling aircraft enclosures and electronic equipment, the SK 1991 high altitude blower unit meets all environmental conditions of MIL-E-5272A. Also suited for ground and marine use, it is furnished with a fully enclosed, explosion proof aircraft motor rated at 1/3 hp and 27 v dc. Air delivery is 500 cfm at a static pressure of 2.4 in. of water at 65,000 ft. A 400 cps ac motor is optional.

The Torrington Mfg. Co., Dept. ED, Torrington, Conn.

WRITE IN 46 ON READER-SERVICE CARD

Silicon Transistors

High power

Rated at 2 and 5 amp, types WX1015 and WX1016 are high power npn silicon transistors for switching and amplifier use. They have a collector-to-emitter voltage range from 30 to 300 v and can switch up to 1 kw. Their respective saturation resistances are 0.7 and 0.5 ohms maximum. Up to 150 C, they have small case-to-junction temperatures. In hermetically sealed, stainless steel cases, they are designed for mounting on an external heat sink by a threaded stud. The units are 1-1/4 in. in diameter and 1-7/64 in. high.

Westinghouse Electric Corp., Dept. ED, P.O. Box 2099, Pittsburgh 30, Pa.

WRITE IN 47 ON READER-SERVICE CARD

Power Supply

Transistorized

Model M102 transistorized power supply provides an output of 0.5 to 30 v, continuously variable. Output current is 0 to 1 amp maximum. Regulation from 0 to 1 amp is 0.6% or 50 mv, whichever is greater; from 0 to 250 ma it is 0.4% or 30 mv, whichever is greater. The unit is protected from load shorts by fuses in the output and line input leads. Stabilization is ±1% for line voltage variation of 105 to 125 v, and ripple voltage is less than 10 mv.

Alto Scientific Co., Inc., Dept. ED, 855 Commercial St., Palo Alto, Calif.

WRITE IN 49 ON READER-SERVICE CARD

Analog-Digital Converter

Provides six selectable output codes

The Radicon converter, for use in modular data systems, converts analog information to digital, and digital to analog. It provides visual display and six selectable output codes compatible with most commercial digital computers. Operation is asynchronous at word rates up to 24 kc, and accuracy is ±0.025% full scale. With companion modular blocks, the unit can perform many on-line computation functions such as scale factoring, linearization, and zero correction. It features compact, solid-state construction.

Radiation, Inc., Dept. ED, P.O. Box 37, Melbourne, Fla.

WRITE IN 50 ON READER-SERVICE CARD
WRITE IN 48 ON READER-SERVICE CARD

NEW PRODUCTS

Transistorized Preamplifier

Low noise

Low noise, transistorized preamplifier model TA-2 is designed mainly for use with low impedance infrared detectors such as indium antimonide cells and thermocouples. It is also suitable for use with transducers with impedances from 5 to several thousand ohms. The unit has a maximum gain of about 100,000, frequency response from 5 cps to 10 kc, and noise equivalent resistance of 5 ohms. The amplifier package measures 2.75 x 2.25 x 2.25 in.

Radiation Electronics Corp., Dept. ED, 8241 N. Kimball Ave., Skokie, Ill.

WRITE IN 52 ON READER-SERVICE CARD

Dry Air Supply

For electronic equipment

Providing clean air with a dew point of —100 F, the DASR-1030 dry air supply is designed for electronic equipment such as pressurized waveguides and enclosed chambers. It supplies 30 psi discharge air at flow rates to 4 cu ft per min. A continuous duty, self-contained unit, the supply automatically reactivates itself. It has a weather-proof housing that is easily removed for servicing.

Wells Industries Corp., Dept. ED, 6880 Troost Ave., North Hollywood, Calif.

WRITE IN 53 ON READER-SERVICE CARD

◀ WRITE IN 51 ON READER-SERVICE CARD

Automatic Cycling Switch

Generates pulses of 10 amp

Suited for driving stepping motors, relays, or solenoid actuators, model 24 transistorized cycling switch generates current pulses of up to 10 amp. It is designed to operate from a nominal 28 v dc and will deliver a 15 cps square wave of 28 v peak to peak. The unit has no contact arcing or bounce and operates under severe vibration. Sealed in a 1.5 in. diameter case, it weighs about 6 oz.

Crane Electronics Co., Dept. ED, 4345 Hollister Ave., Santa Barbara, Calif.

WRITE IN 54 ON READER-SERVICE CARD

Switching Transistors

Dissipate up to 150 mw

In hermetically sealed, inverted base TO-5 packages, these pnp switching transistors offer heat dissipation up to 150 mw at 25 C. Type 2N404 has a collector to base voltage of —25 v, a junction temperature of —65 to +85 C, and controlled leakage current. Types 2N425 through 2N428 have —30 v collector to base voltage, 150 mw power dissipation, and —65 to +85 C junction temperature. All units pass MIL-T-19500A electrical, mechanical, and environmental tests.

Sylvania Electric Products Inc., Semiconductor Div., Dept. ED, Woburn, Mass.

WRITE IN 55 ON READER-SERVICE CARD

WRITE IN 56 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Generator

Pulse and square wave

Model PSG-1 pulse and square wave generator is designed for frequencies of 1 cps to 1 mc with pulse widths of 0.1 μsec to 0.3 sec. The rise and fall time is 0.02 μsec with a 10 v, 100 ohm output, and 0.1 μsec with a 50 v, 500 ohm output. Calibration accuracy is 2%.

Available for use with the PSG-1 is the model DG-1 double pulse adapter (shown above). It provides a variable, time-delayed second pulse of the same width and amplitude as the main pulse output.

Gruen Applied Science Labs, Inc., Dept. ED, 60 Hempstead Ave., Hempstead, N.Y.

WRITE IN 57 ON READER-SERVICE CARD

DC Power Supply

Rated 5 ma at 120 v

For industrial and experimental applications, model 120-5-1 dc power supply operates on a standard 115 v, 60 cps line and is rated 5 ma at 120 kv. Output is delivered through a shielded polyethylene cable. In a steel cabinet 33.25 x 21.5 x 61 in., the unit has a three range milliammeter and a three range kilovoltmeter, both with 4.5 in. scales. Its ripple is less than 2% rms. Selenium rectifiers provide rectification, and plug-in internal connections are easily changed to reverse polarity. For safety, the high voltage components are mounted in a metal frame and immersed in a tank filled with insulating oil. This tank is enclosed in a metal housing with the control section mounted on its front panel. External interlocks are provided so that the high voltage is turned off and the output short-circuited when these circuits are open. The control of the unit is arranged to provide coarse and fine adjustment of the output voltage. Overload relays are settable over the full range from 5% to 115% for both current and voltage.

Del Electronics Corp., Dept. ED, 521 Homestead Ave., Mt. Vernon, N.Y.

WRITE IN 58 ON READER-SERVICE CARD

th Dow Corning Silicone Dielectrics

Electronic "Package" on B-58 by Emerson Electric.

SILASTIC PROTECTS ELECTRONIC "PACKAGES"

Silastic® the Dow Corning silicone rubber, remains resilient from −70 to 250 C, has excellent dielectric strength and offers superior resistance to moisture, ozone, corona and corrosive atmospheres. Available in many forms, including molded parts, extrusions, tapes, sheets and pastes, Silastic is ideal for insulating, sealing and cushioning delicate electrical and electronic equipment.

WRITE IN 60 ON READER-SERVICE CARD

SILICONE GLASS LAMINATES HAVE HIGH ARC RESISTANCE, STRENGTH

Silicone-glass laminates are easily molded into one-piece core and flange structures. Strong even at flange joints, they are lightweight and moisture-resistant, retain excellent physical and dielectric properties at 250 C. Finished shapes are available from leading laminators.

WRITE IN 61 ON READER-SERVICE CARD

SILICONE VARNISH MAKES MOTORS TOUGHER, MORE DEPENDABLE

Dipped or impregnated with Dow Corning 997 Varnish, the insulating components of motors, servos, generators, transformers and other assemblies are bonded into an integrated moisture resistant insulation system with high dielectric strength. This silicone varnish combined with other silicone components permits operating temperatures up to 250 C . . . protects against moisture, many chemicals and corrosive atmospheres.

WRITE IN 62 ON READER-SERVICE CARD

AiResearch miniature motors for B-52A Bomber.

For further information on these products, write Dept. 1613

Shift Register Elements

Need minimum driving power

One 50 mw low voltage transistor will drive 16 of these miniature core-transistor magnetic shift register elements in series. The units operate from a 6 to 12 v unregulated power supply. In three ranges from 0 to 250 kc, they have a 30 to 1 signal to noise ratio and occupy 0.39 cu in. They last 40,000 hr.

Di-An Controls, Inc., Dept. ED, 40 Leon St., Boston 15, Mass.

WRITE IN 63 ON READER-SERVICE CARD

Solenoid Valves

For missile use

Designed for missile applications, series V-27200 in-line solenoid valves have Teflon bubble-tight sealing and operate from −320 to +500 F. They can be used with cryogenic fluids, ethylene oxide, jet fuels, high pressure pneumatics, liquefied gases, and hydraulic oils. Media contacts are made of Teflon, stainless steel, and nickel-plated steel. In various orifice sizes, units are available for operation from 750 to 4500 psi. Response is 15 msec, and voltage ranges are from 18 to 30 v dc. The units are 1.25 x 2.6 in. and come in two-way, three-way, and diverter configurations. The coil bobbin assembly is inert gas welded, and the coil construction is potted in high temperature epoxy resin.

Valcor Engineering Corp., Dept. ED, 5370 Carnegie Ave., Kenilworth, N.J.

WRITE IN 64 ON READER-SERVICE CARD

Power Supply

Provides constant dc voltage

From a 115 v ac source, this small supply provides a constant, calibrated dc voltage. Its output stays within ±0.05% for ±20% voltage changes, and within ±0.0015% for each degree C of ambient change. Drift is ±0.08% for 10,000 hr. Standard output is 1 v dc at 2 ma into a 500 ohm load.

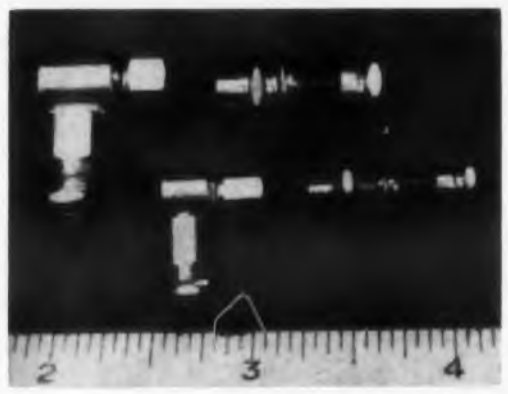
The Hays Corp., Dept. ED, Michigan City, Ind.

WRITE IN 65 ON READER-SERVICE CARD

NEW PRODUCTS

RF Cable Connectors

75 and 95 ohm sizes



The 75 and 95 ohm ConheX rf cable connector series include cable plugs and jacks, bulkhead receptacles and jacks, cable feedthroughs, and right-angle plugs. The units feature strong pull-out resistance and captivated contacts.

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

WRITE IN 67 ON READER-SERVICE CARD

DC Power Supplies

0.1% regulation

Series T-200 transistorized power supplies provide suitable outputs for both transistor and vacuum tube circuitry. The eight standard models have output ranges of 0 to 10 v at 0 to 3, 0 to 10, or 0 to 30 amp; 0 to 32 at 0 to 1, 0 to 3, or 0 to 10 amp; and 5 to 150 v at 0 to 0.75 amp or 0 to 2 amp. Regulation for line or load is 0.1% or 30 mv, whichever is greater; recovery time is 50 μsec; ripple is 1 mv rms or 0.01%; and 24 hour stability is 0.2%. The units feature forced air cooling and short circuit proof design.

Armour Electronics, Inc., Dept. ED, 4201 Redwood Ave., Los Angeles 66, Calif.

WRITE IN 68 ON READER-SERVICE CARD

Zener Diodes

Dissipate 500 mw

These double-ended miniature zener diodes dissipate 500 mw. Types PS6465 through PS6470 have a zener voltage range from 2 to 8 v; types PS6313 through PS6318, 7.5 to 27 v; types PS6319 through PS6327, 25 to 145 v. Except for their higher power dissipation, the units are equivalent to EIA types 1N465 through 1N470, 1N1313 through 1N1318, and 1N1319 through 1N1327 respectively.

Pacific Semiconductors, Inc., Dept. ED, 10451 W. Jefferson Blvd., Culver City, Calif.

WRITE IN 69 ON READER-SERVICE CARD

Solid-State Switch

Senses metal proximity

The nearness of metal triggers this solid-state switch. Called the Proxor, the unit puts out a continuous dc voltage which drops to zero and stays there when a metal object enters its sensing zone. A screwdriver adjusts the sensing zone over a range of 100 to 1. The switch can furnish voltage steps at low rates down to a standstill and also distinguish magnetic metals from others. It can serve as a digital tachometer, a shaft position indicator, a noncontacting limit switch, and a control. There are two models, the P-1 12 F for magnetic, the P-1 12 N for nonmagnetic metals.

Parametrics, Dept. ED, P.O. Box 629 Costa Mesa, Calif.

WRITE IN 71 ON READER-SERVICE CARD

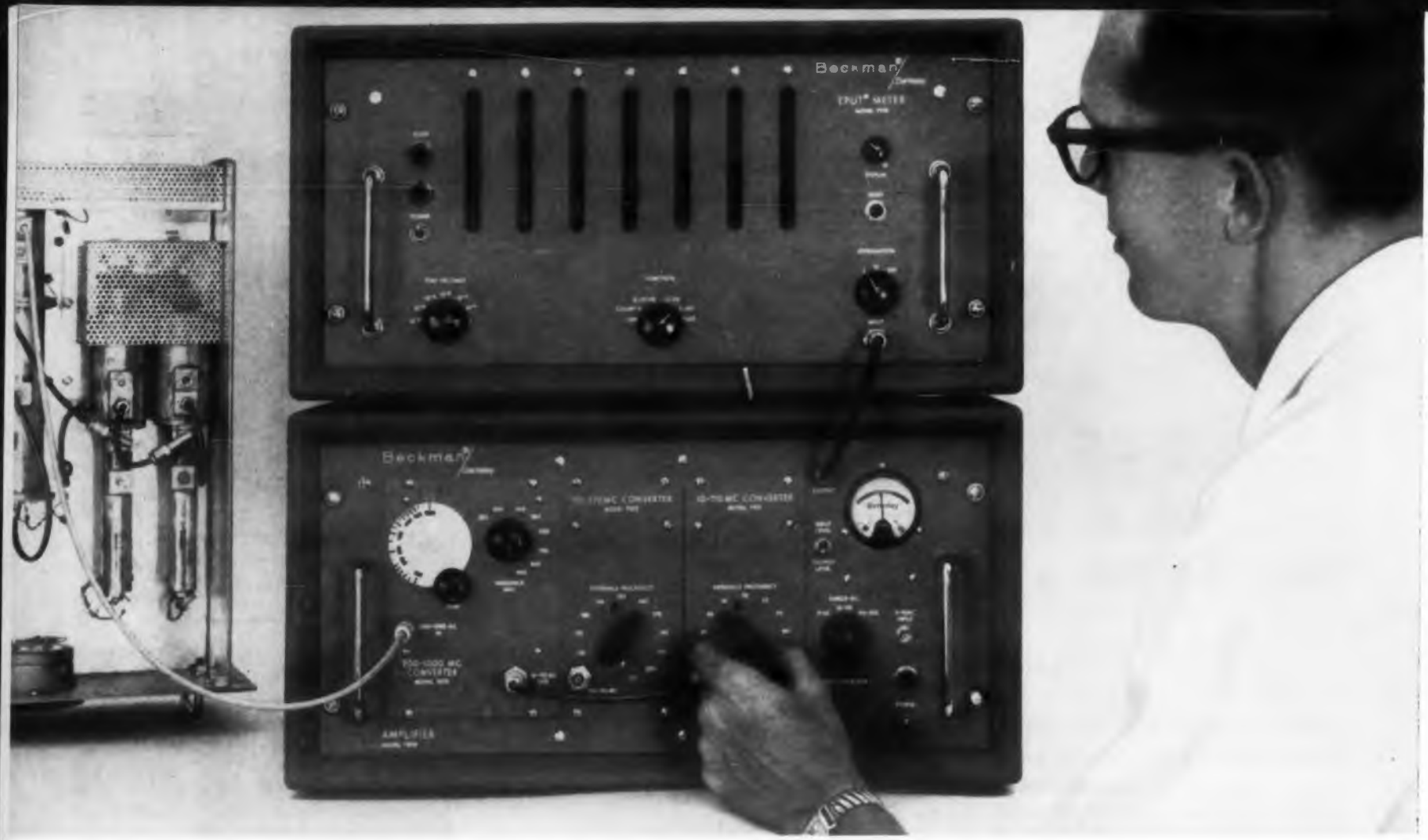
Flight Simulator

Accurate within 15 sec of arc

This two-axis flight simulator permits control of a wide range of rates and amplitudes from 0.004 to 240 deg and 0.01 to 30 cps. Its total error is below 15 sec of arc. The unit will test components or systems up to 12 x 12 x 14 in. and 50 lb, subjecting them to rates of 200 deg per sec and accelerations of 6×10^4 deg per sec^2. The complete equipment includes a 60 hp, 1500 psi hydraulic unit and an electronic control system.

Task Corp., Dept. ED, 1009 E. Vermont Ave., Anaheim, Calif.

WRITE IN 72 ON READER-SERVICE CARD
WRITE IN 73 ON READER-SERVICE CARD ➤



Heterodyne converters extend range of EPUT® Meter to 1000 Mc

Model 7570 Series Amplifier & Converters (bottom cabinet) used with Model 7170 EPUT Meter (top cabinet) or with Model 7370 EPUT & Timer (not shown).

Frequency measuring range with EPUT meter:

Model 7571 converter only	dc to 110 Mc
7571 & 7572 converters	dc to 220 Mc
7571, 7572 & 7573 converters	dc to 1000 Mc

Sensitivity (rms) & input impedance:

dc to 10 Kc	100 mv into 1M ohm
10 Kc to 10 Mc	1 mv into 1M ohm
10 Mc to 220 Mc	10 mv into 50 ohm
220 Mc to 1000 Mc	1 mw into 50 ohm

Video amplifier:

All converters are installed in the Model 7570 cabinet which includes a video amplifier used independently to increase the sensitivity of the counter. See 10 Kc to 10 Mc sensitivity above.

Prices:

Model 7570	$300	Model 7573	$ 500
Model 7571	$250	Model 7370	$1975
Model 7572	$250	Model 7170	$1675

159

Shown above measuring the output frequency of a 1000 Mc cavity resonator is a full complement of frequency converters operated with a 10 Mc counter. The bottom cabinet *permanently* houses all three converters covering the full range from 10 Mc to 1000 Mc. Initial requirements for a more limited range can be accommodated by installing only one or two converters – without affecting the ease of future expansion. Extraordinary sensitivity (see specs.) insures that loading effects will not distort measurements of weak signals.

Measurements are extremely easy to make. No tuning is required up to 220 Mc. Simply select range, couple signal, adjust output level with aid of "low-satisfactory-high" meter and read counter indication, adding reference frequencies. Percentage accuracy exceeds that of counter alone.

For more information on this and other recent advances in digital frequency measuring techniques, write for the new Data File 111. Address department D-1.

Beckman®

Berkeley Division

2200 Wright Avenue, Richmond 3, California

a division of Beckman Instruments, Inc.

WRITE IN 74 ON READER-SERVICE CARD

NEW PRODUCTS

AC Voltage Divider

Has 0.01% accuracy

The DT-35 Dekatran, accurate to 0.01%, is an ac voltage divider with high input impedance, low output impedance, and small phase shift. It has a two-decade ratio transformer and an interpolating potentiometer which gives four-place readings of voltage ratio. The circuit design provides for the suppression of switching transients, and a brake locks the interpolating potentiometer. The unit is 4.5 in. long with a 2.25 in. diameter. It has a panel mounting plate which may be removed and replaced by the panel itself.

Electro Measurements, Inc., Dept. ED, 7524 S.W. Macadam Ave., Portland 1, Ore.

WRITE IN 75 ON READER-SERVICE CARD

Scalers

Have interchangeable plug-in components

These scalers are composed of interchangeable slide-out units that plug in quickly to give any combination of features. Amplifier input sensitivities range from under 1 mv to 9 v for binary or decade scaling units, allowing any scaler function within the limits of binary 64 to 4096 and decade 100 to 1 million. Individual units available include 3 amplifiers, 4 binary scalers, 6 strip or glow tube decade scalers, 5 registers, 6 timers, 2 high voltage supplies, and an analytical rateme-ter.

Nucleonic Corporation of America, Dept. ED, 196 DeGraw St., Brooklyn 31, N.Y.

WRITE IN 76 ON READER-SERVICE CARD
WRITE IN 77 ON READER-SERVICE CARD ➤

One Pallet of Quality -Coming Up!

Whatever packaging you choose for the Roebling Magnet Wire you buy, you are certain the wire is of *unsurpassed quality!*

Modern manufacturing methods . . . quality ingredients . . . wire-making skill based on decades of experience . . . exacting testing and inspection—all these factors combine to assure this one high standard. Yet *quality* Roebling Magnet Wire costs no more than others!

Roebling Magnet Wire comes in types and sizes exactly suited to your applications . . . and packaged to give you utmost flexibility, efficiency, economy. Write Electrical Wire Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey, for all the facts.

ROEBLING

Branch Offices in Principal Cities
Subsidiary of The Colorado Fuel and Iron Corporation

Need a Fastener that Hasn't Been Invented?

Chances are you'll pay top price for it. But by following these six rules you can avoid the high cost of becoming an inventor!*

IT'S natural to assume that, after designing a piece of equipment, you'll have no trouble finding standard fasteners to fit it. Usually such fasteners will be readily available. But what happens when you find yourself with a finished design that doesn't lend itself to any known fastening method?

The most expensive thing you can do at this point is to start inventing fasteners. Valuable man hours go into research, design, prototypes and testing. And unless you can make these fasteners in very large quantities the unit cost will be high, particularly if tooling is necessary.

Now, here are six tips that can get you out of trouble—and keep you out:

1. Remember—not all standard specialty fasteners are listed in fastener manufacturers' catalogs. The fastener company that serves you is probably tooled up for hundreds of non-standard devices, designed and produced to solve problems like yours for other customers. Maybe one would meet your requirements. You'd save the development and tooling charges.

2. There may be a stock fastener available for this job that hasn't come to your attention. Discuss the problem with the fastener manufacturer. If he has nothing in stock, he may be able to modify one of his standard devices at very nominal extra cost.

3. Don't overlook free professional help! Your fastener manufacturer will be glad to offer advice and design service—he does it for everyone else. Unload the problem on him, and let his experience work for you.

But you'll save money if you avoid specifying the fastener that hasn't been invented. By following the next three rules you can usually keep from reaching the point where a non-standard device might be necessary.

4. Go into the fastening problem during the early stages of design. Design your closures with standard fastenings in mind. You won't be left with the costly choice of inventing a fastener or redesigning your product.

5. Keep a complete file of fastener manufacturers' catalogs. Your product designers seldom are fastener specialists too, but they can have complete information available when they need it—at the design level.

6. Work closely with the Fastener Sales Engineer who calls on you. He's trained and paid to help solve your problems. Take full advantage of this service.

Whether you need a standard specialty fastener or the one that hasn't been invented, Southco is well qualified to invite your inquiries. There's no obligation on your part. It's part of our business to offer free consultation at the design or production levels, on items of your own product line, or on those involving military specifications.

Send today for our forty-four page Fastener Handbook No. 8, just printed. Write to Southco Division, South Chester Corporation, 235 Industrial Highway, Lester, Pa.

** Reprints of this page are available on request.*

SOUTHCO FASTENERS

Plastic Capacitors

High voltage

Silicone impregnated, type AG Glasscon capacitors have a plastic film dielectric and glass or steatite tube construction. For high voltage dc or low voltage ac current, they have 0.001 to 1 μf capacitances for use from 600 v to 60 kv dc. They operate from —60 to +125 C.

Electronic Fabricators, Inc., Dept. ED, 682 Broadway, New York 12, N.Y.

WRITE IN 79 ON READER-SERVICE CARD

Automatic Insulation Tester

Meets 30 ASTM specifications

Automatic insulation materials tester model 4501 meets 30 American Society for Testing Materials specifications for electrical insulating materials. These materials include varnishes, paper, tape, glass, phenolics, and rubber in rod, tube, and sheet form. The output of the 35 kv unit terminates in a text fixture contained in a transparent, safety interlocked test cage. Additional interchangeable plug-in testing fixtures are available. The tester features a motor driven rate-of-rise with a manual override and a return of output voltage. The panel has a 4.5 in. kilovoltmeter connected directly across the output for accurate test voltage measurement.

Associated Research, Inc., Dept. ED, 3777 W. Belmont Ave., Chicago 18, Ill.

WRITE IN 80 ON READER-SERVICE CARD

Rheostat

Dissipates 12.5 w at 40 C

Capable of 12.5 w dissipation at 40 C, model E rheostat is 7/8 in. in diameter and extends 11/16 in. behind the mounting panel. It comes in 23 resistance values with linear winding.

Ohmite Mfg. Co., Dept. ED, 3698 Howard St., Skokie, Ill.

WRITE IN 81 ON READER-SERVICE CARD

WRITE IN 78 ON READER-SERVICE CARD

WRITE IN 82 ON READER-SERVICE CARD

NEW PRODUCTS

Current Governor

From 1 μa to 100 ma

Model CS-11 Current Governor furnishes currents from 1 μa to 100 ma in steps of 1 μa at load voltages from 0 to 50 v. Current is set to 5 places by decade knobs arranged to provide a digital readout. Accuracy at any setting is 0.02% +0.1μa. Short term stability is 0.001%, line regulation better than 0.005%, load regulation better 0.002%.

North Hills Electric Co., Inc., Dept. ED, 402 Sagamore Ave., Mineola, N.Y.

WRITE IN 84 ON READER-SERVICE CARD

Reversible DC Motor

1/150 hp

A two-lead reversible dc motor with an air stabilized Alnico permanent magnet field, model M-114 is rated at 1/150 hp for continuous duty or 1/75 hp intermittent duty. Speed range is 3000 to 20,000 rpm. Available for 6, 12, 24, 28, 32, or 48 v input, the units are 1.3 in. in diameter and 2.75 in. long, including shaft extension. They have precision machined aluminum bodies and dynamically balanced armatures. An extra output dc generator winding is provided for tachometer-generator or control circuits.

Carter Motor Co., Dept. ED, 2759 W. George St., Chicago 18, Ill.

WRITE IN 85 ON READER-SERVICE CARD

Controlled Infrared Source

200 to 600 C temperature range

Made in two separate units, a source and a controller, the PE521-1 is an adjustable source of infrared radiation. It can be used as a secondary standard of radiant energy either by comparison with a primary source or by auxiliary temperature measurement of the conical radiating cavity. A closed loop servo system which senses the radiating core temperature and maintains it by proportional control, the instrument has a range of 200 to 600 C. The source has a temperature stability of ±1.5 C for ambient variations from 16 to 38 C and line voltage variations from 105 to 125 v. It provides radiation distribution over a 20 deg. field of view for the standard apertures of 0.04 or 0.015 in. diameter. The controller consumes 300 w maximum and contains no relays or mechanical contacts.

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

WRITE IN 86 ON READER-SERVICE CARD

Amplitude Modulator

Range of dc to 1000 mc

A battery powered, transistorized amplitude modulator, the Megalator provides 100% modulation over both cw and fm ranges. Modulating frequencies are continuously variable from 15 cps to 15 kc, and rf range is dc to 1000 mc. Input impedance is 50 ohms; insertion loss, about 15 db.

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

WRITE IN 87 ON READER-SERVICE CARD

NEW PRODUCTS

Pushbutton Switches

Piano type

Made by Rudolf Schadow of West Germany, these piano type pushbutton switches are supplied in any ganging arrangement. They are available with up to 15 stations per switch, and with 2, 4, 5, or 6 sets of spdt contacts per station. The contacts are easily removed for cleaning without breaking soldered connections. Maximum contact ratings are 500 ma, 500 v ac or dc, 50 w load. Contact pressure is 100 g. Short or long levers are optional with exchangeable buttons which may be illuminated.

International Electro Exchange, Dept. ED, 2307 Foshay Tower, Minneapolis 2, Minn.

WRITE IN 90 ON READER-SERVICE CARD

In-Line Display

For distances to 100 ft

For use in process, production, and supervisory control panels, this in-line display can be easily read 100 ft away. The characters, 3-3/4 in. high and 2 in. wide, are available in a variety of styles and colors. Rear-projected onto the front viewing screen of the unit, they are of uniform size and intensity. Featuring in-plane presentation, the display can be seen from any angle. Made of aluminum, the body cases are 3-1/4 x 5-1/4 x 11-1/2 in.

Industrial Electronic Engineers Inc., Dept. ED, 3973 Lankershim Blvd., North Hollywood, Calif.

WRITE IN 91 ON READER-SERVICE CARD

Anemometer

Accuracy of 1%

Model 60B hot wire anemometer makes use of the ability of an air stream to absorb heat from an electrically heated thin wire filament. The wire filament forms one leg of a Wheatstone bridge which is driven by a dc amplifier. A feedback circuit maintains constant resistance and temperature in the wire, and the energy input to the wire goes directly into the air stream. The wire current is a measure of instantaneous velocity. For studying airflow in jet engine components, fans, pumps, and similar components, the unit has a dc to 10 kc frequency response. Accuracy is 1%, and noise level is less than 0.03% of wire voltage or 0.3 mv, whichever is greater. Maximum wire current is 300 ma. Power requirements are 115 v at 4 amp.

Shapiro & Edwards, Dept. ED, 1130 Mission St., South Pasadena, Calif.

WRITE IN 92 ON READER-SERVICE CARD

Plug-In VTVM Circuit

For remote metering

A plug-in vtvm circuit, the SPD-21 dc package is meant for use where metering and range switching must be remote. With other components, it measures 1 to 1000 v. Input resistance is 10 meg, and accuracy is ±3%. The unit is 2 x 2.25 x 5.25 in.

Metronix, Inc., Dept. ED, Chesterland, Ohio.

WRITE IN 93 ON READER-SERVICE CARD

NEW PRODUCTS

Silicon Rectifiers

400 and 500 piv ratings

Of wire-in construction, types 1N1763 and 1N1764 are small in size and suitable for high temperatures. Low cost, they can be used in a variety of commercial and entertainment equipment. The 1N1763 has a piv rating of 400 and a dc load current rating of 500 ma at 25 C. The ratings for the 1N1764 are identical except for a 500 v peak inverse. Both types have a maximum reverse current of 100 μa at the peak inverse voltage.

Raytheon Mfg. Co., Semiconductor Div., Dept. ED, 55 Chapel St., Newton 58, Mass.

WRITE IN 95 ON READER-SERVICE CARD

Voltage Regulator Unit

Static exciter-magnetic amplifier type

This voltage regulator unit is a static exciter-magnetic amplifier type that replaces conventional rotating exciters and electromechanical regulators. It is designed for use with a line of the company's ac and dc generators, frequency changers, and synchronous and induction motors. The unit consists of a power magnetic amplifier, a transistorized dc amplifier, and a sensing circuit with a zener diode reference.

Kato Engineering Co., Dept. ED, Mankato, Minn.

WRITE IN 96 ON READER-SERVICE CARD

Crystal Oscillators

Have zero warm-up

Without oven control, these crystal oscillators have near zero warm-up time. Designed by Automatic Telephone and Electric of England, they provide a stability of ±5 ppm over the range −20 to +70 C with aging characteristics of less than ±0.2 ppm. Temperature coefficient is 0.04 ppm per deg C. Any frequency in the 4 to 16 mc range can be supplied, as can multiple frequency units. Of rugged construction, the oscillators withstand accelerations to 10 g. They weigh 9 oz.

Marconi Instruments, Dept. ED, 111 Cedar Lane, Englewood, N.J.

WRITE IN 97 ON READER-SERVICE CARD

Broadband Antennas

For telemetry

For telemetry, countermeasures, and other uses, these broadband, conical helix antennas operate in the 20 to 6000 mc spectrum. Their range can be extended to 10,000 mc. Bandwidths of 10 to 1 are obtainable with these units, and gains of 8 db are normal.

American Electronic Labs, Inc., Dept. ED, 121 N. 7th St., Philadelphia 6, Pa.

WRITE IN 98 ON READER-SERVICE CARD

Matching Network

Adjustable

"Easymatch" is an adjustable matching network that changes approximate matches into accurate matches. The input impedance varies slowly with frequency. The units are available in four frequency ranges: 45 to 85 mc; 85 to 150 mc; 150 to 300 mc; and 300 to 700 mc. Nominal impedance is 50 ohms. The networks will match any 1.1 to 1 mismatch regardless of phase.

Alford Mfg. Co., Dept. ED, 299 Atlantic Ave., Boston 10, Mass.

WRITE IN 99 ON READER-SERVICE CARD

WRITE IN 106 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Primary Phase Standards

For any frequency from 20 to 200 kc

Type 706-A ultrasonic primary phase standards generate two sinusoidal voltage signals whose phase difference can be varied smoothly from 0 to 360 deg with an accuracy of 0.1 deg. Units are built for any single frequency from 20 to 200 kc. They can be used for calibrating high frequency phase meters and detectors, and phase shifting devices in general. Operation is based on the interpretation of a multiple-frequency Lissajous pattern which is the same at every 5 deg phase interval. Calibration of the phase shifter removes the ambiguity of the pattern repetition on the scope. Between 5 deg points, a vernier phase shift dial is used to set incremental angles within ±0.1 deg.

Acton Labs, Inc., Dept. ED, 533 Main St., Acton, Mass.

WRITE IN 108 ON READER-SERVICE CARD

Control Amplifier

Has stabilized circuit

For contactor regulators and servos, this control amplifier has a Varigain circuit that automatically changes the system gain to meet varying dynamic requirements. Threshold sensitivity is 1 mv into a 1.5 K load. Output is 115 v at 2 amp for a power gain of 110 db. The unit operates from −65 to +200 F.

Parameters, Inc., Dept. ED, 195 Herricks Rd., New Hyde Park, N.Y.

WRITE IN 109 ON READER-SERVICE CARD

Antenna Switching Relay

For mobile communications

For mobile communications in the 180 mc range, type FAS 5000 antenna switching relay comes with one or two poles that are normally open, normally closed, or double throw. The contacts, spaced to achieve low cross talk, are palladium in standard units and rated at 3 amp, noninductive load at 115 v ac, 60 cps, or 24 v dc. Silver contacts rated at 5 amp may be ordered. The stack insulation and armature pusher are of Nema grade melamine glass, and the contact arm pusher is ceramic. Designed to withstand a minimum of 3 million operations, the relay has a temperature range of −30 to +85 C. With two 6-32 tapped holes on one side and two 4-40 on the other, it can be mounted from either of two positions.

F. A. Scherma Mfg. Co., Inc., Dept. ED, 424 Broome St., New York 13, N.Y.

WRITE IN 110 ON READER-SERVICE CARD

Trimmer Potentiometer

Rated at 2 w to 70 C

In 11 resistances from 100 ohms to 30 K, the 750 wirewound potentiometer is rated at 2 w to 70 C and operates from −55 to +175 C. It meets MIL-R-19A, MIL-R-12934A, MIL-E-5272A, and MIL-STD-202A specifications. Tolerance is ±5% and resolution 0.1 to 1%. The unit has an 18 turn trimming adjustment screw.

Dale Products, Inc., Dept. ED, Columbus; Nebr.

WRITE IN 111 ON READER-SERVICE CARD

NEW PRODUCTS

Oscilloscope

Panel mounted

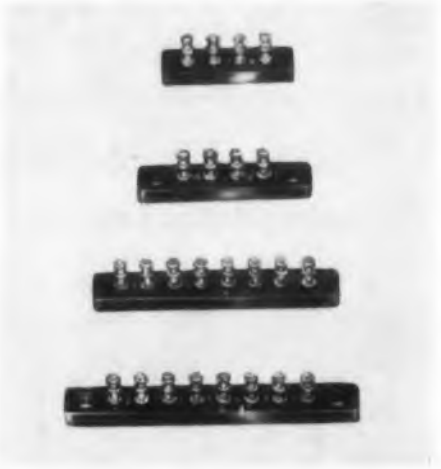
This 3 inch oscilloscope is panel mounted. It is complete with low and high voltage power supply and identical vertical and horizontal push-pull amplifiers. Its sensitivity is 0.1 v rms per in.

Building Blocks Electronic Co., Dept. ED, 2172 E. 36th St., Brooklyn 34, N.Y.

WRITE IN 115 ON READER-SERVICE CARD

Terminal Boards

Voltage breakdown of 2500 v rms



Series MT terminal boards have four or eight turret terminals which are molded directly into the body material. Either size can be supplied with or without 1/8 in. diameter mounting holes. Mineral filled Melamine, MIL-M-14E, Type MME, is the standard molding compound. Also available are glass reinforced Plaskon, MIL-M-14E, Type MAI-60; glass reinforced Diallyl Phthalate, MIL-M-19833, Type DGI-30; and mineral filled Diallyl Phthalate, MIL-M-14E, Type MDG. Voltage breakdown is 2500 v rms at sea level, 600 v rms at 60,000 ft. Minimum creepage path between contacts is 5/64 in.

DeJur-Amsco Corp., Dept. ED, 45-01 Northern Blvd., Long Island City 1, N.Y.

WRITE IN 116 ON READER-SERVICE CARD

Rotary Switch

Has eight positions per wafer

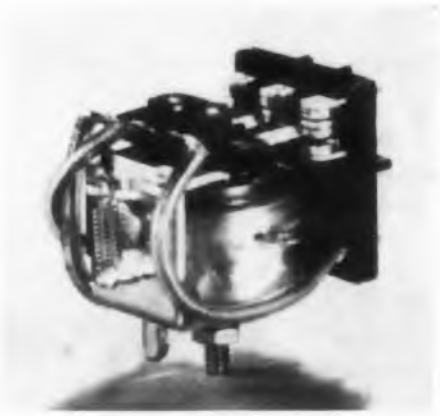
Rated at 5 amp, 208 v dc, 400 cps, series M rotary switch has eight positions. Up to six wafers can be combined for a total of 48 separate circuits. Individual wafers, which may be bussed externally for any sequence, have from one to four rollers, permitting four poles and two positions. Explosion proof under MIL standards, Procedure 2, the switch withstands 60 g acceleration from 2 to 2000 cps and operates at 60,000 ft. Contact resistance averages 0.0005 ohms, and temperature rise at 208 v, 5 amp averages 7 deg F. The unit shows no wear after 250,000 operations. It is 1-7/8 in. in diameter.

Mason Electric Corp., Dept. ED, 3839 Verdugo Rd., Los Angeles 65, Calif.

WRITE IN 117 ON READER-SERVICE CARD

Relays

Have sealed coils



The coils of series 250 relays are sealed with fused wraps. Rated at 8 amp, 110 v ac or 10 amp 28 v dc, noninductive, the relays can be furnished with any coil resistance to 16 K. The armatures are locked to the frames so that they cannot be shocked out of place.

F & B Mfg. Co., Omega Electric Div., Dept. ED, 4248 W. Chicago Ave., Chicago 51, Ill.

WRITE IN 118 ON READER-SERVICE CARD

NEW PRODUCTS

Dip Meter

Covers 1.75 to 260 mc

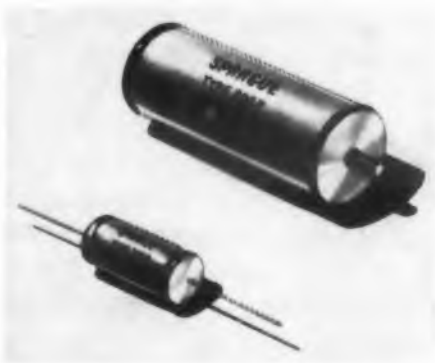
Equipped with color coded coils, model 600 dip meter covers the frequency spectrum from 1.75 to 260 mc. A self-contained unit, it is useful in determining the resonant frequency of tuned circuits such as traps, chokes, tank circuits, and antennas. It can also be used as a signal generator and absorption wave meter.

Barker & Williamson, Inc., Dept. ED, Bristol, Pa.

WRITE IN 121 ON READER-SERVICE CARD

Plastic-Paper Capacitors

High Voltage



For high voltage use, type 205P glass encased tubular capacitors have a dual dielectric of polyester plastic film and paper. Their glass-to-metal end seal practically eliminates impregnant leaks. They are especially suited for solving corona problems in airborne equipment.

Sprague Electric Co., Dept. ED, 347 Marshall St., North Adams, Mass.

WRITE IN 122 ON READER-SERVICE CARD

ERASE HEADS.—Double-gap, laminated heads for use with magnetic tape equipment. ME-100 is a two-track unit, SE-100 is a stacked stereo two-track unit, and SE-50 is a stacked stereo four-track unit. All produce 56 db erasure.

The Nortonics Co., Inc., Dept. ED, 1015 S. Sixth St., Minneapolis 4, Minn.

WRITE IN 123 ON READER-SERVICE CARD

MINIATURE HIGH MU TRIODE.—Type NU 7235 for amplifier and voltage regulator applications where up to 10 kv are used. General characteristics: mu, 550; transconductance, 850 μmhos; plate dissipation, 10 w; height, 2-3/4 in.; OD, 7/8 in.

National Union Electric Corp., Electronics Div., Dept. ED, Bloomington, Ill.

WRITE IN 124 ON READER-SERVICE CARD

HANDLES.—Vinyl coated aluminum handles immune to corrosion and humidity. Type H-5371 has heat treated mounting plate, carries 125 lb, and conforms to MIL-T945A. Type H-5372 is for nonswing fixed mounting on top or sides of cabinets, or front panel protection.

National Radiac Inc., Dept. ED, 475 Washington St., Newark 2, N.J.

WRITE IN 125 ON READER-SERVICE CARD

10 KW KLYSTRON AMPLIFIER.—Model 1042-J for use in multichannel tropospheric scatter communication systems. Available in two ranges: 750 to 958 mc and 1700 to 2400 mc.

National Co., Inc., Dept. ED, 61 Sherman St., Malden 48, Mass.

WRITE IN 126 ON READER-SERVICE CARD

PHENOLIC LAMINATE.—No. 4012-42 Lamicoid has good electrical properties and high impact and flexural strength. Readily machined, it can be punched into intricate parts with conventional equipment. Suitable as a base material for printed circuits.

Minnesota Mining & Mfg. Co., Mica Insulator Div., Dept. ED, Schenectady 1, N.Y.

WRITE IN 127 ON READER-SERVICE CARD

RADIATION MONITORING SYSTEM.—Gamma remote system AMS-II consists of 10 individual stations, alarm system, and centralized power supply. One or more channels can be removed from the circuit without disturbing the others. Accuracy of ±10%.

Riggs Nucleonics Corp., Dept. ED, 717 N. Victory Blvd., Burbank, Calif.

WRITE IN 128 ON READER-SERVICE CARD

SOLDER BATH DECONTAMINANT.—When stirred into a molten solder bath, Rowex-29 permits removal of dissolved copper. An 8 oz. carton contains enough decontaminant for 800 lb of solder.

Rowe Engravers, Inc., Dept. ED, 262 E. 16th St., Paterson 4, N.J.

WRITE IN 129 ON READER-SERVICE CARD

FLEXIBLE CABLE.—Has interwoven twisted figure 8 weave which restricts magnetic field normally radiated from a current carrying wire. Does not unravel. Presently available in No. 24 wire, it can also be furnished in other sizes.

Perfection Mica Co., Magnetic Shield Div., Dept. ED, 1322 N. Elston Ave., Chicago 22, Ill.

WRITE IN 130 ON READER-SERVICE CARD

OPTICAL TRANSDUCER.—Model TL-2 for use with electronic tachometers. Measures rotational speeds above 1 million rpm and also linear speeds. Accuracy is 1%.

Southwestern Industrial Electronics Co., Dept. ED, 2831 Post Oak Rd., Houston 19, Tex.

WRITE IN 131 ON READER-SERVICE CARD

NEW PRODUCTS

Transistor Radiator

Reduces temperature by 30 C

A heat dissipation device for diamond shape power transistors, model 3B-663 radiator helps prevent thermal runaway. It consists of a series of black ebanol-finished metallic radiating fins mounted on a base plate which is interposed between the transistor and the chassis. It may be used with or without a mica insulating washer. Attached to the chassis with four bolt posts, the radiator does not interfere with servicing or operation of the transistor. Especially for use above ground potential, it reduces transistor operating temperatures as much as 30 C. It complies with MIL-E-5272A and MIL-STD-202A requirements.

The Birtcher Corp., Industrial Div., Dept. ED, 4371 Valley Blvd., Los Angeles 32, Calif.

WRITE IN 134 ON READER-SERVICE CARD

Modular Power Supplies

0.5% regulation

Subchassis units designed for use as components in original equipment, power supplies 22-111 through 22-117 provide 0.5% regulation for line and load combined. Fully transistorized, they are available in seven voltage ranges from 5 to 7 v at 3 amp to 27 to 32 v at 1 amp. Maximum transient no to full load is 200 mv; ripple, 2 mv rms; maximum operating temperature, 50 C. The units are short-circuit proof and can be operated in series to supply higher voltages. Extending about 4.5 in. above the chassis and 1.75 in. below, they are 4 in. wide and 12 in. long. They can be provided on panels for standard rack mounting.

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

WRITE IN 135 ON READER-SERVICE CARD

◄ WRITE IN 133 ON READER-SERVICE CARD

Selenium Rectifiers

Have low temperature rise

Cooled by both convection and radiation, Venticool high-density selenium rectifiers have a low temperature rise. The double cooling is effected by spacers mounted between the unit's six vacuum processed plates. The same height as the plates, these spacers extend about 1/4 in. beyond the plate width to form radiating fins. Running vertically up the center of the spacers are multiple corrugations that act like chimneys to draw up surrounding air in continuous cooling convection currents. Designed for compact television sets, the units measure 1.33 x 1.5 x 1.875 in.

Electronic Devices, Inc., Dept. ED, 429 12th St., Brooklyn 15, N.Y.

WRITE IN 136 ON READER-SERVICE CARD

Ultrasonic Cleaner

Stands high temperature

The DR-500-AL ultrasonic cleaning system handles 500 w and can be used at high temperatures. It removes excess solder flux, radioactive soils, etching resists, lint, waxes, and other soils. Tank sizes are 0.5 to 2 gal.

Acoustica Associates, Inc., Dept. ED, 26 Windsor Ave., Mineola, N.Y.

WRITE IN 137 ON READER-SERVICE CARD

Heat Exchanger

Dissipates up to 17 kw

Depending on the coolant used, this heat exchanger can dissipate up to 17 kw. Measuring 24 x 36 x 30 in., the laboratory unit is designed to operate on 208 or 220 v, 3 phase, 60 cps power. It can accommodate large electronic equipment and features variable fluid flow for simulating operating conditions.

The Hallicrafters Co., Dept. ED, 4401 W. Fifth Ave., Chicago 24, Ill.

WRITE IN 138 ON READER-SERVICE CARD

WRITE IN 139 ON READER-SERVICE CARD ➤

NEW PRODUCTS

SILICON INSULATED CABLE.—"Simconex" wires and cables operate continuously at 200 C, maintain flexibility at —75 C.

Simplex Wire & Cable Co., Dept. ED, Cambridge 39, Mass.

WRITE IN 141 ON READER-SERVICE CARD

LAMP SOCKET.—Type LT-47 Lamp Jax mounts singly or on standard switchboard panels, accepts standard switchboard lamps. Nylon lamp housing is molded directly to frame, completely insulating lamp from mounting frame.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.

WRITE IN 142 ON READER-SERVICE CARD

ON-OFF TEMPERATURE CONTROLLER.—Has sensing element that continuously measures temperature and turns heat on or off when it becomes too high or too low. Controls temperatures within ±3 F between 200 and 1000 F. On and off difference is under 1 F.

Electronic Processes Corporation of California, Dept. ED, 2190 Folsom St., San Francisco 10, Calif.

WRITE IN 143 ON READER-SERVICE CARD

SEMICONDUCTOR LIFE TESTER.—Equipment for measuring minority carrier lifetime, drift mobility, and photoeffects in semiconductors. Consists of a 3 μsec spark gap light source intense enough to inject 10^{13} carriers per cu cm.

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

WRITE IN 144 ON READER-SERVICE CARD

TELEMETRY DATA SYSTEM.—PDM-to-digital Mark I system receives pdm flight test data directly or from an analog tape, converts it to digital form, and records it on a magnetic tape in a format compatible with digital computers. Performs with ±0.1% accuracy.

Epsco, Inc., Dept. ED, 588 Comonwealth Ave., Boston 15, Mass.

WRITE IN 145 ON READER-SERVICE CARD

MINIATURE TUBE SHIELDS.—Series T5P and T6P have a pull tab on top of the spring clip to facilitate its removal. Any piece of wire or instrument that will fit into the loop can be used to lift the spring.

International Electronic Research Corp., Dept. ED, 145 W. Magnolia Blvd., Burbank, Calif.

WRITE IN 146 ON READER-SERVICE CARD

FLUXED SOLDER PREFORMS.—Coated with rosin flux, these preforms eliminate the need for separate fluxing operations. Variety of sizes, shapes, and thicknesses.

Hi-Grade Alloy Corp., Dept. ED, 3034 E. 95th St., Chicago, Ill.

WRITE IN 147 ON READER-SERVICE CARD

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

Studying results of antenna pattern measurements — part of the activity of the Space Communications laboratory.

Lockheed Q-5 target missile features telemetry that registers miss-distance and theoretical hits in testing accuracy of other missiles.

Lockheed

MISSILE SYSTEMS DIVISION

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO

Lockheed maintains extensive research capabilities for the development of antennas and telemetering systems and spacecraft applications.

Laboratory studies in antennas and electromagnetic propagation include the application of solid state materials to microwave transmission line components; the design of antennas to survive the rigors of space flight; the effects of space on radio signals and radar detection; and the scattering from missile shapes and space vehicles. Research is also being conducted in the application of ferrites and MASERS; on problems of radio transmission between space vehicles and Earth, re-entry scattering and diffraction by man-made objects and ionized gases; and development of antennas for data link systems between satellites and ground stations.

Telemetering has been brought to a high degree of successful application in the integration of circuits and components into high-performance systems. A completely sub-miniaturized FM-FM system has been developed, along with a complete PAM-FM system characterized by highly efficient band-width utilization, low power consumption and economy of size and weight. This represents a significant achievement in the field of high capacity telemetry.

Scientists and engineers of outstanding talent and inquiring mind are invited to join us in the nation's most interesting and challenging basic research and development programs. Write: Research and Development Staff, Dept. A-21, 962 W. El Camino Real, Sunnyvale, California, or 7701 Woodley Avenue, Van Nuys, California. For the convenience of those living in the East or Midwest, offices are maintained at Suite 745, 405 Lexington Avenue, New York 17, and at Suite 300, 840 N. Michigan Avenue, Chicago 11.

"The organization that contributed most in the past year to the advancement of the art of missiles and astronautics." NATIONAL MISSILE INDUSTRY CONFERENCE AWARD

NEW PRODUCTS

AIR FILTER.—Uses filter cartridges with 10, 25, and 40 micron ratings. Cartridges can be changed without removing filter from the line.

Perfecting Service Co., Dept. ED, 332 Atando Ave., Charlotte, N.C.

WRITE IN 149 ON READER-SERVICE CARD

CIRCUIT BREAKER.— Has pushbutton reset which puts mobile radio systems back on the air instantly when main cable fuses fail. Smaller than a silver dollar.

General Electric Co., Communication Products Dept., Dept. ED, Syracuse, N.Y.

WRITE IN 150 ON READER-SERVICE CARD

INTEGRATING SERVO.—Designed for use in a missile integrating system, this assembly incorporates a size 8 servo motor generator, a precision potentiometer, and a high ratio gear reducer.

Thomas A. Edison Industries, Instrument Div., McGraw-Edison Co., Dept. ED, West Orange, N.J.

WRITE IN 151 ON READER-SERVICE CARD

ROSIN FLUX.—Type 77 contains activating agent that gives rapid fluxing action, leaves no corrosive residue. Suited for automatic soldering operations and printed circuits.

Hi-Grade Alloy Corp., Dept. ED, 3034 E. 95th St., Chicago, Ill.

WRITE IN 152 ON READER-SERVICE CARD

BREAK-PROOF METER CASE.—Made of glass-reinforced polyester plastic, this multimeter case is practically indestructible. Its resilience cushions shocks, reduces meter damage. Variety of shapes and sizes.

Instrument Control Co., Dept. ED, 1556 Nicollet Ave., Minneapolis 3, Minn.

WRITE IN 153 ON READER-SERVICE CARD

AUDIO TUBE.—Model ECF80/6BL8 nine-pin miniature triode-pentode functions as high gain af amplifier and phase inverter.

International Electronics Corp., Dept. ED, 81 Spring St., New York 12, N.Y.

WRITE IN 154 ON READER-SERVICE CARD

RIGHT ANGLE MINIATURE TUBE SHIELDS.—Series T3 assemblies have integral military sockets: MS 35407-1 for round button tubes and MS 35408-1 for flat press tubes. Units withstand 200 C.

International Electronic Research Corp., Dept. ED, 145 W. Magnolia Blvd., Burbank, Calif.

WRITE IN 155 ON READER-SERVICE CARD

HIGH VOLTAGE TRANSFORMERS.—For custom installation. Voltages of 1 to 15 kv with power ratings from 10 to 250 w.

James Vibrapowr Co., Dept. ED, 4050 N. Rockwell, Chicago, Ill.

WRITE IN 156 ON READER-SERVICE CARD

CLOSED-CIRCUIT TV.—Camera features electronic light compensator with no moving parts which instantly and automatically adjusts to light changes. Maximum theoretical control limit is 10,000 to 1 without change in iris setting.

International Telephone and Telegraph Corp., Dept. ED, 15191 Bledsoe St., San Fernando, Calif.

WRITE IN 157 ON READER-SERVICE CARD

FOOT SWITCH.—"Hi-treadlite" switch comes in spdt, spdt double break, or simulated dpdt arrangements. Measures 3.5 x 2.5 x 1.25 in.

Linemaster Switch Corp., Dept. ED, 432 Woodstock Terrace, Woodstock, Conn.

WRITE IN 158 ON READER-SERVICE CARD

PACKAGED VLF TRANSMITTER.—High power output unit in one self-contained cabinet. Uses building blocks to provide outputs from 33 kw to 2 megawatts with one coordinating control console. Transmitters operate from 1 to 50 kc.

Ling Electronics, Inc., Dept. ED, 9937 W. Jefferson Blvd., Culver City, Calif.

WRITE IN 159 ON READER-SERVICE CARD

PANEL VTVM's.—Have 5-1/8 in. scale arc in 6 in. case. Model 300 dc units have ±3% accuracy, 10 meg input resistance. Available in 7 discrete ranges from 1 to 1000 v. Model 310 ac units have 20 cps to 100 kc response and 10 ranges from 10 mv to 300 v rms. Input impedance is 1 meg, 30 μμf.

Metronix, Inc., Dept. ED, Chesterland, Ohio.

WRITE IN 160 ON READER-SERVICE CARD

HEAT-RESISTANT PLASTIC.—Asbestos-filled Diall FS-6 stands up to 500 F, has good electrical properties and stability, does not crack around metallic inserts. For use as an insulator in connectors, switches, and other electrical components.

Mesa Plastics Co., Dept. ED, 11751 Mississippi Ave., Los Angeles 25, Calif.

WRITE IN 161 ON READER-SERVICE CARD

HIGH FIDELITY SPEAKERS.—Model F-8-HF has single cone, frequency response of 60 cps to 12 kc ±5 db. Model F-8-HFD has dual cone and frequency response of 60 cps to 17 kc ±5 db.

Minneapolis Speaker Co., Dept. ED, 3806 Grand Ave S., Minneapolis 9, Minn.

WRITE IN 162 ON READER-SERVICE CARD

RINGS.—Line of Teflon "O" and spiral back-up rings that conform to AN and MS specifications. Can be fabricated to customer requirements.

Allegheny Plastics, Inc., Dept. ED, 105 Thorn Run Rd., Coraopolis, Pa.

WRITE IN 163 ON READER-SERVICE CARD

STROBOSCOPE.—Model 304 Pulse-Strob for visual motion study provides adjustable flashing rate neon light source. A 5 to 1 vernier control adjusts rate in two ranges: 8 to 30 and 32 to 100 pulses per sec.

Aerotronic Associates, Inc., Dept. ED, Concord, N.H.

WRITE IN 164 ON READER-SERVICE CARD

NEW PRODUCTS

VEHICULAR ROOFTOP ANTENNA.—Model ASP-177 1/2 wavelength antenna covers 144 to 174 mc; has 4 db receiving gain. Installs through 3/4 in. hole with solderless mounting system.

The Antenna Specialists Co., Dept. ED, 12435 Euclid Ave., Cleveland 6, Ohio.

WRITE IN 167 ON READER-SERVICE CARD

THIN FOILS.—For use in radiation measurement. Thicknesses from 0.01 to 0.00005 in. Copper, beryllium copper, gold, lead, nickel, palladium, platinum, tantalum, titanium, zinc, and stainless steel.

American Silver Co., Dept. ED, 36-07 Prince St., Flushing 54, N.Y.

WRITE IN 168 ON READER-SERVICE CARD

PRECISION GEARS.—Offered from stock in 32, 48, 64, 72, 96, and 120 diametral pitches of 14.5 and 20 deg pressure angles. Available in 303 stainless steel and 24S-T4 aluminum, units are built to A.G.M.A. standards and tolerances.

Atlas Precision Products Co., Dept. ED, 3810 Castor Ave., Philadelphia 24, Pa.

WRITE IN 169 ON READER-SERVICE CARD

HIGH SPEED PRINTER.—Solid state line printer which selects, edits, and prints out data from a computer or magnetic tape at rates up to 1500 lines per min. Operates on-line or off-line with the company's 220 electronic data processing system.

Burroughs Corp., ElectroData Div., Dept. ED, 460 Sierra Madre Villa, Pasadena, Calif.

WRITE IN 170 ON READER-SERVICE CARD

LOAD DISTRIBUTION ANALOG COMPUTER.—Housed in compact portable cabinet, Belac computer provides instant, visual interpretation of operating data in public utility electric power systems. Does away with need for load slide rules and consultation of charts.

Belock Instrument Corp., Dept. ED, 111th St. and 14th Ave., College Point 55, N.Y.

WRITE IN 171 ON READER-SERVICE CARD

SOLENOIDS.—Using machine tool type bearing as a plunger guide, units survive 100 million operations.

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

WRITE IN 172 ON READER-SERVICE CARD

HANDLE.—Space-saving model 1250 is 2 in. across and 1-15/16 in. high.

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

WRITE IN 173 ON READER-SERVICE CARD

QUICK RELEASE FASTENER.—"Pres-Loc" fasteners lock or unlock with a press of the thumb. For securing inspection ports, modular units, and panels.

Deutsch Fastener Corp., Dept. ED, P. O. Box 61072, Los Angeles 61, Calif.

WRITE IN 174 ON READER-SERVICE CARD

DIGITAL PROCESSOR.—"MicroSADIC" handles up to 10,000 analog signals per sec, converting, programming, and recording in digital form on magnetic tape.

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

WRITE IN 175 ON READER-SERVICE CARD

HUMIDITY PROOF COATING.—"Humiseal" type 1F12 has infinite pot and shelf life, withstands —60 to +150 C. May be applied by dip, spray, or brush to glass, ceramic, plastic, and metal. Humidity cycling meets MIL-STD-202A specifications.

Columbia Technical Corp., Dept. ED, 16-02 31st Ave., Woodside 77, N.Y.

WRITE IN 176 ON READER-SERVICE CARD

DIAZO SENSITIZED FILM.—For producing duplicate originals, Perma-Scale intermediate film has Mylar base, erases easily and repeatedly. Retains original flexibility and transparency almost indefinitely and is impervious to water.

Eugene Dietzgen Co., Dept. ED, 2425 N. Sheffield Ave., Chicago 14, Ill.

WRITE IN 177 ON READER-SERVICE CARD

SILICONE RUBBER.—Liquid Silastic RTV 502 vulcanizes to a rubber in 30 min at room temperature. Retains flexibility from —70 to +500 F; has good electrical properties. Suitable for sealing, caulking, potting, and encapsulating. Dow Corning Corp., Dept. ED, Midland, Mich.

WRITE IN 178 ON READER-SERVICE CARD

AUTOMATIC ANALYTICAL BALANCE.—Model 301A features 1 sec measurement time and 0.2% accuracy in five ranges from 30 to 3000 mg. Meter can be zeroed with container on the balance, thus showing weight of added contents directly.

E-H Research Labs, Dept. ED, 2161 Shattuck Ave., Berkeley 4, Calif.

WRITE IN 179 ON READER-SERVICE CARD

SERVO MOTORS.—Incorporate inertial damper within size 10, 11, or 15 frame. Units are ruggedly constructed and operate to 150 C.

Eastern Air Devices, Inc., Dept. ED, 391 Central Ave., Dover, N.H.

WRITE IN 180 ON READER-SERVICE CARD

PUMP AND MOTOR ASSEMBLY.—Model 1213-HBG-221 is designed to drive the nose antenna in a missile. Assembly operates from —65 to +165 F, weighs 8 lb.

Eastern Industries, Inc., Dept. ED, 100 Skiff St., Hamden 14, Conn.

WRITE IN 181 ON READER-SERVICE CARD

100 KV X-RAY SPECTOGRAPH.—Analyzes metals, alloys, minerals, ores, chemical mixtures, and compounds. Covers a range of 87 elements in the atomic scale extending from magnesium to californium. Has stepless voltage control with 15 to 100 kv range.

Philips Electronics, Inc., Instruments Div., Dept. ED, 750 S. Fulton Ave., Mt. Vernon, N.Y.

WRITE IN 182 ON READER-SERVICE CARD

PRODUCTION PRODUCTS

Metal Marking Machine

All pneumatic

An all pneumatic bench model, the 501 metal marking machine makes permanently indented inscriptions. The die head is vertically adjustable and the gap can be varied for small or large parts. The marking head is variable up to 1 in. Marks can be up to 2.5 in. long.

Noble & Westbrook Mfg. Co., Dept. ED, Westbrook St., East Hartford 8, Conn.

WRITE IN 185 ON READER-SERVICE CARD

Surface Grinder

For close tolerance work

This small precision surface grinder has a wheel head elevation control that reads to 0.0001 in. on a vernier scale. The transversal vernier reads to 0.0005 in. The magnetic chuck has fine laminations for holding small parts securely, and the wheel head elevating mechanism is sealed against grit and dirt. The unit has a built in demagnetizer. Magnetic chuck surface is 4-1/8 x 6 in.; transversal table travel is 4-1/4 in.; and longitudinal table travel is 8 in. Vertical movement of the wheel head is 5 in., and the maximum height between chuck and wheel is 4 in. The grinding wheel is 4-3/4 in. in diameter.

American LIP Corp., Dept. ED, 610 Fifth Ave., New York 20, N. Y.

WRITE IN 186 ON READER-SERVICE CARD

Sleeving Cutter

Handles up to ¼ in. OD

Hand or power operated, these sleeving cutters handle dimensions up to 1/4 in. OD and will cut in lengths from 1/4 to 8 in. They can be used for all types of insulation tubing including Fiberglas and silicon coated nylon, and also for wires that are no. 16 or smaller. The hand models are designated 101 and 141; the powered models, 201 and 241. All units are bench type and can be anchored with two screws. The steel cutting knives are easy to remove and the adjustment screws can be set instantly for any cutting length. Dimensions are from 5 x 5.5 x 6 in. to 8 x 11 x 7 in.

Macdonald & Co., Dept. ED, 1324 Ethel St., Glendale 7, Calif.

WRITE IN 187 ON READER-SERVICE CARD

Coil Winding Machine

Has 30 speeds to 5000 rpm

Made by Frieseke & Hoepfner of West Germany, the FH 88 K56 coil winding machine uses a stepless wire-feed control to handle wire sizes from 52 to 17 AWG. It incorporates a transformer rectifier operated dc motor which provides 30 winding speeds to 5000 rpm. With special purpose, easily affixed attachments, one machine can make many coil types, including layer, universal, strip, subminiature, thread-interlaced, yoke, small rotor, trapezoidal, bifilar, and relay. The unit has a built in wire break detector and an electronic control panel which can be used to program stops or slowdowns at layer ends for paper insertion or taps.

Electromatic Equipment Co., Dept. ED, 175 Fifth Ave., New York 10, N. Y.

WRITE IN 188 ON READER-SERVICE CARD

SERVICES FOR DESIGNERS

Branch Service Expansion

One of the West's leading Electronic Manufacturers' Representatives organizations with home offices in Los Angeles has established five new factory authorized Service Departments. Located in San Carlos, Sacramento, San Diego, Phoenix and Albuquerque, they are strategically located to serve the four state area of California, Arizona, Nevada and New Mexico. Each new department is staffed with factory trained technicians and is equipped with the finest electronic instrumentation. Customers are assured of prompt service, maintenance, and calibration on all in-and-out of warranty repairs.

Neely Enterprises, Dept. ED, 3939 Linkershim Boulevard, North Hollywood, Calif.

WRITE IN 191 ON READER-SERVICE CARD

R & E Office Opens

A new research and engineering organization, Flight Sciences Laboratory, Inc., was formed on the Niagara Frontier recently to engage in theoretical and experimental research, advanced engineering analysis, and selected development work in aerophysics, areodynamics and related technical areas of aeronautics and astronautics. They will deal directly with government and military agencies on contractual research, as well as supplying advisory and consulting services to aircraft, missile and related equipment manufacturers in the aircraft and rapidly growing spacecraft fields.

Flight Sciences Laboratory, Inc., Dept. ED, 1965 Sheridan Drive, Buffalo, N.Y.

WRITE IN 192 ON READER-SERVICE CARD

Information Center

A central source of welding news and information has been established by the American Welding Society to disseminate data relating to the welding industry as a whole. Products, equipment, and personnel will not be included, but handled by the individual companies. It is felt that both the industry and the press will gain by the establishment of this fact-checking center.

American Welding Society, Dept. ED, 33 W. 39th St., New York 18, N.Y.

WRITE IN 193 ON READER-SERVICE CARD

Rare Earth Metals Supplied

Now you can obtain these rare earth metals in commercial quantities—praesodymium, neodymium, terbium, holmium, thulium, ytterbium, and lutetium. Other rare earth metals such as europium and samarium will be supplied on a custom basis by Michigan Chemical Corp., which has made gadolinium, dysprosium, erbium, and yttrium similarly available for about a year. These rare earth metals are cast in ingots 1, 1-1/2, 2, 3, and 3-1/2 in. in diameter. Custom ordering of special shapes is possible. Purities of these metals is 99+%. The entire group of rare earth metals supplement the company's high-purity rare earth oxide products.

Address questions about prices and quantities to Rare Earths and Thorium Division, Dept. ED, Michigan Chemical Corp., St. Louis, Mich.

Vibration Tests for Missile Parts

Test equipment which simulates the random and complex waveform vibration of rocket engines has been installed at Wyle Research Corp. The new types of vibration can be combined with the natural environments along with electrical, electronic, mechanical, pneumatic, hydraulic, or cryogenic functional tests. The system includes an MB C-25 3500-lb exciter powered by a Ling 20/20C amplifier, Ling peak-notch filters and broadband equalizers, a General Radio random noise generator, and a Moseley x-y plotter. The C-25 exciter is available for sinusoidal as well as random vibration.

Wyle Research Corp., Dept. ED, 128 Maryland St., El Segundo, Calif.

WRITE IN 234 ON READER-SERVICE CARD

Assuring Reliability

In response to a growing need for component reliability assurance processing equipment, The Daven Company has created a Reliability Assurance Division, which will provide the equipment required by the "meantime-to-failure" contract provisions now in effect in a majority of weapons systems programs.

Daven's modular design is an integrated system utilizing novel component part-holding modules, automated test sets, automatic data recording and data reduction devices, and unique environmental chamber designs. Except for variations in circuitry and test instrumentation, the system can be employed to process large quantities of any type of component.

Address inquiries to Mr. Richard J. Newman, General Manager, Reliability Assurance Division, The Daven Co., Livingston, N.J.

NEW LITERATURE

Metal Degreasing 237

Methods of degreasing metal surfaces are examined in the bulletin. The methods utilize emulsion cleaners which eliminate the fire hazards of older methods and are more effective in removing dirt and soil. The bulletin also discusses the principles and how they should be used. L. Sonneborn Sons, Inc., 300 Fourth Ave., New York, N.Y.

Missile, Rocket Valves 238

Illustrated product manual gives data on high-pressure hydraulic and pneumatic valves for aircraft missiles and rockets. Dimensional drawings, flow charts, and production test specifications of 48 different solenoid valves are included. Production specifications include dielectric and resistance data for coil and connector; and tests on cycling, pull-in voltage, proof pressure, and minimum operating line pressure. For multiple-position valves, schematic material is included with solenoid data. Skyvalve, Inc., 831 West Fayette St., Syracuse, N.Y.

Gas-Vapor Chromatography 239

Bulletin No. 838 gives facts about temperature control in gas and vapor chromatography. In 8 pages, illuminated by tables and curves, questions are posed and answered about column temperature, retention time, detector temperature, resolution and temperature programming. Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.

Electronic Go-No-Go Gage 240

Four page bulletin describes electronic go-no-go gage. It is designed for frequency stability and comparison checks, motor speed control, pressure and flow control, material flow control, and other limiting situations occurring between 1 and 40,000 times per sec. Computer Measurements Corp., 5528 Vineland Ave., North Hollywood, Calif.

Soldering Tools 241

Catalog illustrates and describes the complete line of Vulcan electric soldering tools. Vulcan Electric Company, 88 Holten St., Danvers, Mass.

Servo Calculator 242

"Servo Calculator" is used as plotting tool aid in the solution of network problems in servo analysis. Design engineers may obtain the aid at no charge by writing on company letterhead to Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N.Y.

Test Equipment 243

Brochure #2060 covers the complete line of test equipment, volt-ohmmeters, vacuum tube volt-ohmmeters & microtesters. Simpson Electric Co., 5200 W. Kinzie, Chicago 44, Ill.

Thermocouples 244

Complete description and specifications of Bristol's new ARMOROX Thermocouples are given in bulletin P1281. Available types, materials sizes and thermocouple curves are detailed, and applications are suggested. The Bristol Co., Waterbury 20, Conn.

Communication Accessories 245

A 20-page catalog features illustrations of products, dimensional drawings, performance curves and general environmental information on toroidal coils, filters, magnetic amplifiers, dc to dc converters and laminated transformers. Communication Accessories Co., Lee's Summit, Mo.

Panel Instruments 246

General Electric's new "Big Look" in small panel instruments, dc and ac is described in booklet GEA-6678, a 6-page brochure of text, pictures and tables. Information is given on ratings, dimensions, size and panel drilling plans. General Electric Co., Schenectady 5, N.Y.

Synchro Test Sets 247

Bulletin describes and specifies the various integrated units which test synchros for electrical error, fundamental null, total null, phase shift, and transformation ratio. Theta Instrument Corp., 48 Pine St., E. Paterson, N.J.

Miniature Threads 248

Catalog No. 98 contains dimensions, tables, and other data on miniature threads between 56 and 160 per inch as well as prices for stock taps, dies, screws and tools. J. I. Morris Co., Southbridge, Mass.

IMPULSE

A DIGEST OF NEW DEVELOPMENTS IN ELECTRONICS AND AUTOMATION

PUBLISHED BY **ROME CABLE CORPORATION**, ROME, N. Y.
PIONEERS IN INSTRUMENTATION CABLE ENGINEERING

BRUSSELS SCOREBOARD. With the Brussels World's Fair past, the big question is: How did we do? Answers can't be measured, of course, but the U.S. provided the world with an interesting look into the future—as well as a dazzling impression of American life today—mainly through the efforts of electronics companies. One fifth of the 50 U.S. firms participating in the Brussels Fair were electronics companies. Two of the 55-foot spheres within the 320-foot Atomium, symbol of the Fair, were occupied by U.S. electronics firms. A good indication, we think, of the growing role electronics is playing in civilization today.

STRIPE TELLS TYPE. One way of making quick, positive circuit identification of multi-conductor instrumentation cables is by the tracer method. Tracers are colored stripes or bands marked on the surface of the insulation or jacket of the Rome instrumentation cable shown here. It affords distinctive circuit coding throughout the entire length of each wire. Other color-coding methods—plus a basic run-down on the types of insulation and jacketing materials suitable for instrumentation cable—are all explained in Rome's Bulletin RDC-400: "Instrumentation Cables for Telemetering, Data Recording, Circuit Control Testing, and Electronic Computers." Write for your copy.

BILLION-DOLLAR BACKSTOP. Ground-support equipment for modern weapons systems will cost over $1.5 billion in 1959, according to an aviation publication source (name furnished on request). That means more and more business for electronics—as electronic support gear becomes more and more an integral part of the weapons system. Main role of electronics in GSE: testing, controlling, computing, simulating.

"ELECTRIONIC" CONTRACTORS WANTED. "Electrionic" (electric-electronic) control and instrumentation systems are opening up new opportunities for electrical contractors. Contractors team up with electronic equipment manufacturers to install electrionic systems, then maintain them as well. As the demand for automatic controls in industry grows, the electrical contractor is offered a new, rapidly developing market. An analysis of that market—plus a description of the basic types of control systems involved—is all reported in an article that appeared recently in a publication of a field unrelated to electronics. In case you missed it, write to IMPULSE, c/o Rome Cable Corporation, 421 Ridge Street, Rome, New York and ask for a reprint of the article.

CABLEMAN'S CORNER. Since 1932, polyvinyl compounds have become one of the most popular insulating and jacketing materials available. In 1954, over 100 million pounds were used by the wire and cable industry alone. In the fields of automation and instrumentation, where greater stress is being put on both smaller and more complex cable constructions, the use of polyvinyl chloride components has become more and more important.

These compounds consist of polyvinyl, or a co-polymer of polyvinyl chloride and polyvinyl acetate, thermoplastic resins mixed with plasticizers for flexibility, fillers for strength, pigments for color, and stabilizers for resistance to aging and acidation. The combined properties of the ingredients determine the properties of the components.

Because polyvinyl chloride insulations and jackets derive their properties from the materials they contain, it is possible, through proper ingredient selection, to "engineer" compounds for specific end uses. Here are a few special applications:

a. cold—low-temperature applications—down to −54° C.
b. heat—high ambient temperatures—up to 105° C.
c. environmental hazards, i.e., oils, solvents, chemicals
d. deformation—special compounds or special cable design can reduce this effect.

(As we've said before, when you need reliability—call on a Cable Specialist.)

WRITE IN 250 ON READER-SERVICE CARD

NEW LITERATURE

Synchros and Resolves 251

Two new reference sheets for design engineers, covering general mechanical and electrical specifications for synchros and resolvers, discuss application of synchros and resolvers in design of control systems, computers, fire control mechanisms & missile settings. Induction Motors of California, 6058 Walker Ave., Maywood, Calif.

Pulse Generators 252

Four-page two-color brochure covering specifications and prices for line of pulse generators, block units for special purpose pulse instrumentation, magnetic core testing equipment, and electronic counters. Electro-Pulse Inc., 11861 Teale St., Culver City, Calif.

Plastics 253

"A Ready Reference for Plastics" is the eleventh revision of a nontechnical book on plastics which brings out essential facts. How they come about, how they are used and why, physical properties, types of molding, elements of part design, designing pitfalls, notes on machining and inserts on almost every type of plastic material included. Available with letterhead request to Boonton Molding Co., 326 Myrtle Ave., Boonton, N.J.

Frequency Shift Equipment 254

A 2-color, 64-page catalog on line of frequency shift terminal equipment contains 34 items. The line includes multi-channel FS & AM tone systems, telemetering systems, twinplex equipment, frequency shift keyers, monitors, diversity receivers, frequency shift converters and master oscillators. Northern Radio Co., Inc., 149 W. 22nd St., New York 11, N.Y.

Retainers 255

Catalog No. 2-TT covers top holding tube and component retainers. Specifications for three types of top holding retainers are listed in the 12-page catalog: Top Tainers, Type 2 Tube Clamps, and Type 2 Crystal Clips. Sizes and modifications are available to retain every miniature and standard tube and nearly every cylindrical, rectangular, and wafer shaped component in present usage. The Birtcher Corp., Industrial Div., 4371 Valley Blvd., Los Angeles 32, Calif.

Environment Chambers 258

Four-page, two-color, photo-illustrated Bulletin #6 describes new line of environmental test equipment designed for mass-testing of production components. Among environments obtainable are high-low temperature altitude, humidity, vibration, shock, and immersion. Elmer R. Easton, Gen. Mgr., Wyle Associates, 128 Maryland St., El Segundo, Calif.

Batteries 259

Design improvements in new line of stationary batteries reviewed in 8-page bulletin. Among the innovations are new corrosion-resistant positive grids made of Silvium, a patented alloy 100% more corrosion-resistant than pure lead. Bulletin 6205, Exide Industrial Div., The Electric Storage Battery Co., P.O. Box 8109, Philadelphia 1, Pa.

Beryllium-Copper Tubing 260

Small-diameter beryllium-copper tubing described in Data Memorandum No. 7 which includes mechanical and physical properties, applications, corrosion resistance, production limits, heat treatment, fabrication and standard size tolerances of the tubing. Superior Tube Co., 1521 Germantown Ave., Norristown, Pa.

Electronics Catalog 261

The 1959 catalog, 192 page volume, includes components and equipment for service and industrial use. Electronic Publishing Co., Inc., 180 North Wacker Drive, Chicago 6, Ill.

Electronic Flash Tubes 262

Uses, physical make-up and typical control circuits of electronic flash tubes described in 4-page brochure. Standard units, limitations of special units listed. Kemlite Laboratories, Inc., 1819 W. Grand Ave., Chicago 22, Ill.

Magnetic Core Testing 263

A new 12-page Technical Bulletin, MM-2, covers testing of rectangular hysteresis loop magnetic cores. The bulletin includes an analysis of the parameters of core characteristics and the test requirements that must be met to ensure the selection of cores to specific levels of performance. General Ceramics Corp., Keasbey, N.J.

NEW LITERATURE

Instruments and Apparatus 266

This new, 175-page catalog illustrates and describes more than 450 different pieces. The 1959 catalog covers such items as constant temperature baths; drying ovens; environmental units for humidity, altitude and low temperatures; ovens; and meters. Labline, Inc., 3070 W. Grand Ave., Chicago 22, Ill.

Laminates 267

Technical Data Bulletin 4.5.1 gives the minimum and maximum property values for sheet stock, rolled tubes and molded rods made from Grade G-5. It also gives the size range, color and finish for these forms and also for molded tubing. Taylor Fibre Co., Norristown, Pa.

Analog Computer 268

Fully-illustrated 18-page brochure and folder describes the MC-5800 Master Precision Analog Computer. Specifications and descriptions are included. Mid-Century Instrumatic Corp., 611 Broadway, New York 12, N.Y.

Relays 269

Twenty-page catalog includes illustrations, specifications and dimensional diagrams of the latest developments in microminiature rotary relays and extremely sensitive telephone type relays having long life. Magnecraft Electric Company, 3350 D, West Grand Ave., Chicago 51, Ill., Attention: H. D. Steinback.

Fiberglas Sleeving and Tubing 270

Selection guide for the electrical trade includes a Selection Factor Chart, charts showing "Nema Standard Sizes" and "Identification of Grades and Summary of Performance Characteristics," photographs of typical applications, government specification information and types of Fiberglas sleevings and tubings. Textile Products Div., Owens-Corning Fiberglas Corp., Dept. 860, 598 Madison Ave., New York 22, N.Y.

Power Supplies 271

A two-page catalog sheet illustrates and describes standard line of zero to 32 volt dc power supplies. Eight models are covered, for both rack and bench use. Opad Electric Co., 69 Murray St., New York 7, N.Y.

Coatings 273

A new 36-page brochure on clear and colored "Coatings" for use on metal, plastics, glass, and wood. Information on numerous coatings for application to the various surfaces by spraying, screening, and roller coating is provided. Data is given on standard colors available. Bee Chemical Co., 12933 South Stony Island Ave., Chicago 33, Ill.

Medical Electroncs

The 91-page "Bibliography on Medical Electronics" is organized into three sections. The main section groups related topics with arbitrary numbers. The subject index is cross-referenced and a section listing authors is included. *Cost of the bibliography is $2.50 and available from the Institute of Radio Engineers, 1 E. 79th St., New York 21, N.Y.*

Resistance Welding Equipment 274

A new 16-page catalog describes complete line of resistance welders, welding heads, power supplies, handpieces, and accessories. Sections devoted to basic resistance welding, a comparison of stored-energy vs ac welding, and points to consider in selecting the proper equipment. Weldmatic, Div. of Unitek Corp., 380 North Halstead Ave., Pasadena, Calif.

Electronics Catalog 275

Over 32,000 items listed in 452-page general catalog. Among the items listed are standard and special-purpose electronic tubes, transistors, semiconductors and diodes, test instruments, transformers, resistors, capacitors, printed circuit components, rheostats, relays, switches, rectifiers and fuses. Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

Pilot Lights 276

Latest advances in pilot light and lamp design offered in following technical bulletins: High Brightness Neon Lamps (#100); Heavy Duty Oil Tight Pilot Lights (#101); Dialites—the Ultra-Miniature Indicator Lights (Form L-160); 2-Terminal Sub-Miniature Indicator Lights (Form L-156-C); 1-Terminal Sub-Miniature Indicator Lights (Forms L-157-A and L-158-A). Available from: Mr. R. E. Greene, Dialight Corp., 60 Stewart Ave., Brooklyn 37, N.Y.

NEW PRODUCTS

Electrical Tape 279

Pocket data book provides technical and comparative cost information on new Hesgon line of Fiberglas electrical tapes. Comparative data on Fiberglas and other fibers included. Horace Linton Div., Hess, Goldsmith & Co., 1400 Broadway, New York 18, N.Y.

Power Supplies 280

Bulletin 350 A is an up-to-date version of the original four-page bulletin. Models listed according to application: transistor and lab work, automatic control, computer, and general utility. Electronic Measurements Co., Inc., Eatontown, N.J.

Computers 281

Detailed, colorfully illustrated booklet, describes analog computing equipment installed at company's computation centers in Princeton, N.J. Substantial list of problems suitable for solution by analog computation are included to aid individuals and firms seeking possible application of analog simulation to their engineering problems. Electronics Associates Inc., Long Branch, N.J.

Dry Batteries 282

Comprehensive manual of 100 pages covers use and selection of dry batteries for industrial designers and research specialists. Types of dry cells described in literature include familiar cylindrical cells such as those used in flashlights, rectangular-shaped cells and wafer cells. Engineers engaged in the design of battery-powered equipment can write to: Burgess Battery Co., Dept. PR-1, Freeport, Ill.

Magnetic Amplifiers

A 36-page illustrated bulletin covers the construction, operation, and uses of magnetic amplifiers. Bulletin 1105-1 has performance curves to illustrate operating characteristics. Simplified schematic drawings show how the amplifier is incorporated into such equipment as autopilots, servo systems, and speed regulators.

A copy of the bulletin is available on company letterhead request only from Vickers Inc., Electric Products Div., Dept. ED, 1815 Locust St., St. Louis 3, Mo.

Missile Accessories 285

Basic types of air valves and actuators manufactured by company described in 4-page brochure. Temperature control and positioning systems, and specialized electrical test equipment included. Bulletin F 5910-1, Barber-Colman Co., 1400 Rock St., Rockford, Ill.

Miniature Transformers 286

This circular fully describes and illustrates a new line of mu-metal shielded, epoxy impregnated miniature transformers explicitly designed for transistor application. This literature gives features of thirteen basic types of input, driver, output and interstage transformers which can be used in 90 different impedance matching circuits. Amplifier Corp. of America, Transformer Div., 398 Broadway, New York 13, N.Y.

Transit Cases 287

The catalog describes all kinds of Transit cases, which are essentially custom built containers or shipping cases especially designed to protect electronic equipment and built to military specifications: T4734, C4150, and T945. Basic construction is of laminated sheet aluminum and plywood, or all aluminum. White Aircraft Corp., Palmer, Mass.

Adjustable Speed Drives 288

Bulletin GEA-6234B, 8 pages, describes General Electric's general-purpose Thymotrol adjustable speed drives, one horsepower half-wave and one to four horsepower full wave. The bulletin fully explains standard and optional features, electrical and performance characteristics. General Electric Co., Schenectady 5, N.Y.

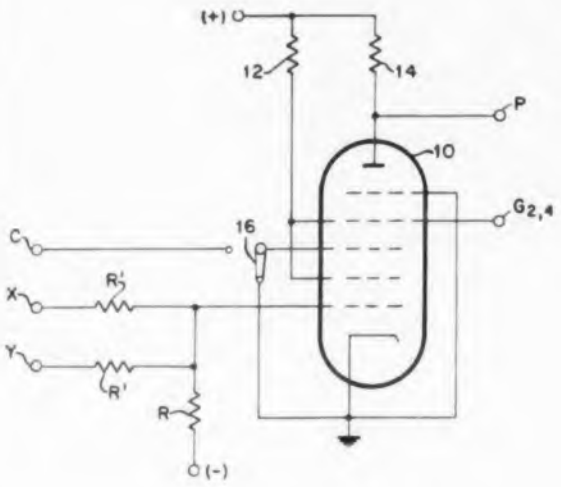
Preamplifiers 289

New four-page brochure illustrates and gives detailed electrical and mechanical data on a complete line of low noise, high frequency preamplifiers. Special models are also described. A.R.&T. Electronics, Inc., Sub of Baldwin Piano Co., 1101 McAlmont St., P. O. Box 627, Little Rock, Ark.

Light Metal Castings 290

"Light Metals" brochure describes light alloy castings of particular interest to electronics producers. The brochure lists the mechanical properties of other aluminum and magnesium casting alloys. American Brake Shoe Co., Dept. A, 530 Fifth Avenue, New York 36, N.Y.

PATENTS



Electronic Logical Circuits

Patent No. 2,841,708. Leonard R. Harper (Assigned to International Business Machines Corp.)

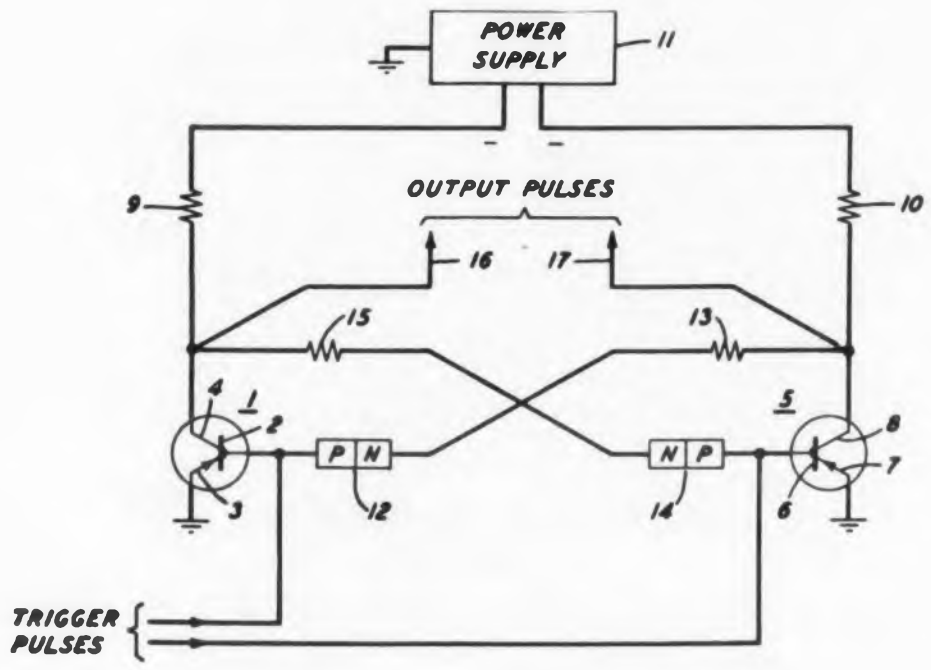
The special characteristics of a pentagrid tube such as a 6BA7 are essential in this simple and inexpensive logical circuit. Plate current in the pentagrid tube is less than the saturation current when either the control grid or suppressor or both are beyond cut off, or when the control grid is driven positive to a point where the plate current is reduced to 10 per cent of saturation.

The circuit arrangement is shown. Initially, switch *16* may tie the suppressor to ground. The circuit is the OR type since a voltage may be applied to either the *X* or *Y* input to produce saturation. However voltages applied simultaneously to both *X* and *Y* produce less than saturation current. Cut off is thus effected in this AND NOT condition.

Now if the suppressor grid is connected to terminal *C* and a negative voltage is applied to the grid, the tube will cut off. This is the BUT NOT condition.

When the suppressor is positive, a positive impulse to *X* or *Y* will cause saturation: the OR condition. Similarly, positive voltages applied simultaneously to *C*, *X* and *Y* will reduce the plate current to less than saturation.

Typical circuit components are illustrated and operating voltages are suggested in the patent.



Semiconductor Trigger Circuit

Patent No. 2,831,986. Eric E. Sumner. (Assigned to Bell Telephone Laboratories, Inc.)

This bistable high speed transistor multi-vibrator has high current sensitivity and stability even without a separate source of bias voltage. Cut-off of the non-conducting transistor is obtained by means of a silicon diode operated below the critical conduction voltage.

The circuit consists of transistors *1* and 5 which are cross-coupled through diodes *12* and *14*. Initially, transistor *1* may be conducting. The voltage on collector *4* will approximate 0.2 v when the power supply is set at 10 v and resistor 9

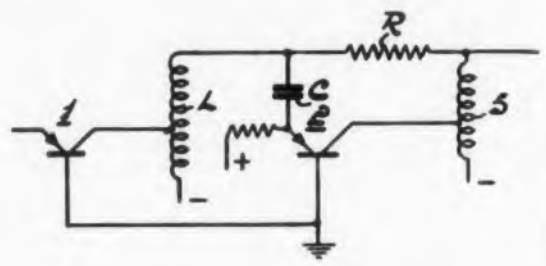
PATENTS

(as resistor *10*) is fixed at 1000 ohms. For forward conduction the diode voltage must be at least 0.5 v. Hence transistor *5* is cut off, since with diode *14* open-circuited, base *6*, current is zero. The multi-vibrator will flip to the second stable state with transistor *5* conducting when a negative trigger of at least 0.5 v in magnitude is applied to base *6*. Maximum current will flow into base *2* causing transistor *1* to rapidly cut off. A subsequent negative impulse applied to base *2* will flop the multivibrator back to the initial state.

Transistor Amplifier

Patent No. 2,843,681. A.J.W.M. Van Overbeek (Assigned to North American Phillips Co. Inc.)

When common base transistor amplifiers in cascade are operated at high frequency the output ordinarily reacts on the input because a leading voltage is fed back in the collector-base circuit.



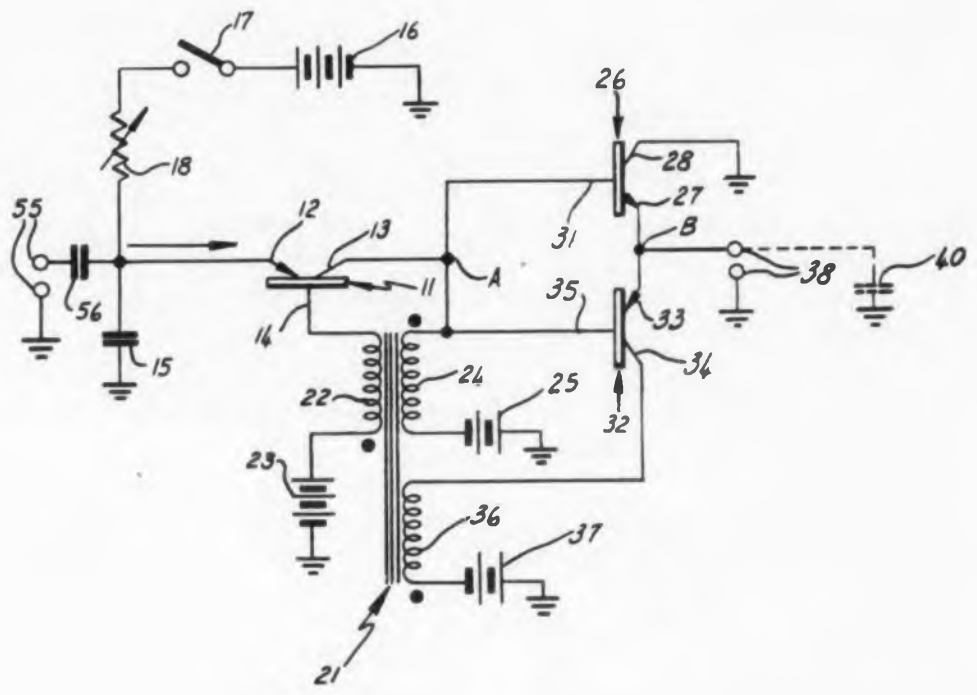
Placing a resistor between collector and emitter introduces a lagging voltage which compensates for this leading voltage.

Pulse Generator

Patent No. 2,843,743. Douglas J. Hamilton (Assigned to Hughes Aircraft Company.)

The transistor pulse generator consists of two relaxation oscillators. They generate 1 μsec pulses having rise and fall times of 0.3 μsec. The load is a capacitor of 0.01 μf.

When switch *17* is closed, capacitor *15* charges until emitter *12* rises above the voltage of base *14*. Pnp transistor *11*

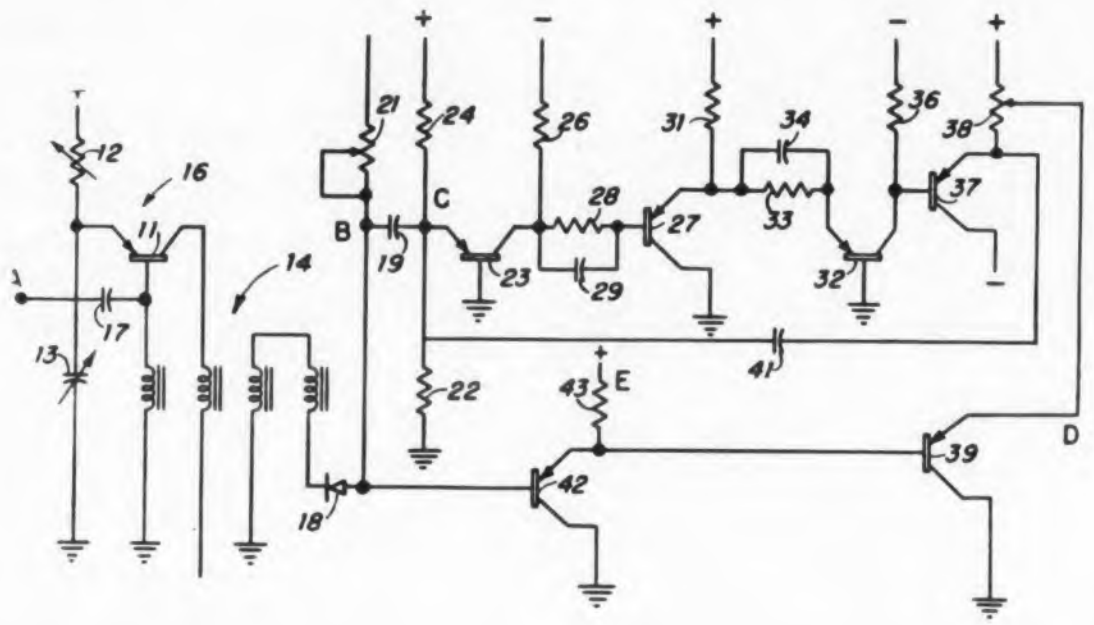


conducts due to regenerative feedback in transformer *21*. Voltage of base *31* connected to *13* moves to ground level. This forward biases npn transistor *26* which immediately goes into saturation and charges load capacitor *40* to peak voltage.

Thereafter capacitor *15* discharges through transistor *11* and inductance *22* until capacitor *15* can no longer supply the required current. Transistor *11* regeneratively cuts off and collector *35* tied to collector *13* moves towards ground. Pnp transistor *32* conducts. Load capacitor, *40*, discharges.

Transistor *11* cuts off and open circuits transistors *26* and *32*. The cycle may then be repeated.

PATENTS



Variable Time Base Generator

Patent No. 2,845,547. Charles F. Althouse (Assigned to United States of America.)

A transistor blocking oscillator combines with a diode pick-off arrangement and a clipping amplifier to produce a continuously variable time base having constant width. The time-base is not sensitive to the triggering input frequency.

Blocking oscillator *16* triggers in response to a negative impulse applied through capacitor *17*. The peak negative voltage is passed by diode *18* to charge capacitor *19*. Then capacitor *19* discharges through variable resistor *21* and

the sawtooth waveform is clipped as it passes through the dc coupling limiting amplifier stages. When capacitor *19* reaches ground voltage, diode *18* rapidly discharges the remaining charge and transistor *23* cuts off sharply to develop a negative impulse which couples back through transistor *39*. As a result a sawtooth waveform is produced having a period fixed by the time constant determined by capacitor *19* and resistor *21* and independent of the rate of the input trigger.

Temperature Stabilized Transistor Amplifier

Patent No. 2,848,564. Edward Keonjian. (Assigned to General Electric Co.)

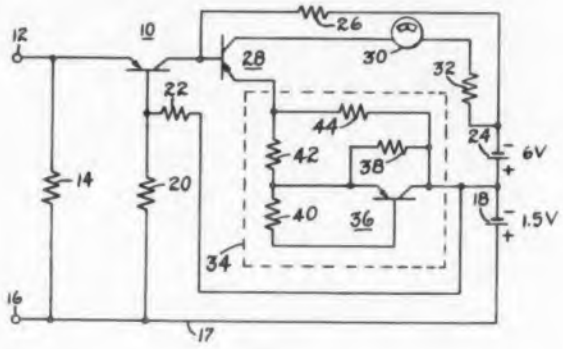
When several transistor stages are cascaded, temperature changes may cause considerable variation in output current of the output stage quite independent of any signal change at the input section.

In the circuit shown, current flows from emitter to base of transistor *10* in the absence of any signal applied to input terminals *12* and *16*. The large collector current flow causes the base of transistor *28* to become positive resulting in reduced emitter current in transistor *28*. Negative signals applied to the input terminals cause the collector of transistor *10* and emitter of transistor *28* to become more negative; this results in increased current flow through resistor *32* and indicating device *30*.

As ambient temperature rises, assuming no signal input, collector current in transistor *10* increases due to increased intrinsic thermal condition. This tends to decrease the emitter and collector current of transistor *28*. At the same time the increased temperature tends to increase the collector current of transistor *28*. The net effects are compensated by a decrease in resistance presented by the network in rectangle *34*, resulting in relatively constant current flow in the collector circuit of transistor *28* with no input signal applied.

An equation is presented expressing the temperature-resistance characteristic of a network to be placed between the emitter of transistor *28* and the negative supply in order to achieve immunity

PATENTS



from ambient temperature changes.

Network *34*, consisting of transistor *36* and its associated components, is connected between the emitter of transistor *28* and the negative supply source and acts as a temperature variable emitter resistance.

A graph is included to show the comparison between an uncompensated and compensated amplifier in terms of output vs variation of ambient temperature.

Frequency Modulating Transducer

PatentNo. 2,850,631. Robert M. Tillman. (Assigned to Burroughs Corp.)

Low frequency subcarrier oscillators, used for telemetering applications, are handicapped by the bulk of the tuning components, limited range of linear frequency variation, and "pull-in" effects between adjacent channel oscillators.

Transistor *20*, is an npn type in a common base oscillator circuitwiht resonant frequency set by inductance *21* and capacitors *22* and *23*. Emitter resistor *37* is unbypassed; therefore, the rf voltage across capacitor *23* is effectively across this resistor.

Transistor *30* is connected to an almost identical type oscillator circuit, with inductance *31* and capacitors *32* and *33* determining the resonant frequency. The emitter returns to the supply through resistor *37* common to transistor *20*.

The first transistor oscillator, *20*, is adjusted to optimize the second harmonic voltage across resistor *27* while transistor *30* is tuned to the subcarrier frequency difference. For example, if a 22 kc subcarrier frequency is desired, transistor *20* oscillates at 40 kc with a second harmonic output across resistor *37* of 80 kc; transistor *30* is tuned to 102 kc. Their difference frequency, 22 kc, is produced by heterodyning action in transistor *40*,

which is a pnp type, common emitter amplifier. Emitter *44* is grounded and positive with respect to base *46*. This produces nonlinear response to base input signals with subsequent rectification and amplification of the products developed.

Signals appearing across resistor *37* are applied to base *46* where rectification occurs; the subcarrier component, 22 kc in the example given, appears in amplified form across the collector tuned circuit of inductance *41* and capacitance *42*. The tuned circuit, being in an amplifier rather than an oscillator, is not high "Q" permitting the use of compact parts.

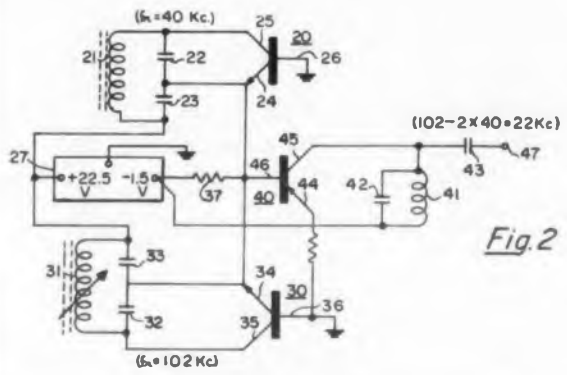


Fig. 2

Inductance *31* of transistor *30* is varied by the parameter to be telemetered, and frequency-modulates the subcarrier output. Variations of coil *31*, operating at 102 kc, produce a small percentage but linear change in frequency. The resultant variation on the 22 kc subcarrier developed is of relatively greater percentage.

Since a fairly large and nonharmonic frequency difference exist between oscillators *20* and *30*, there is no "pull-in" effect encountered.

An entire telemetering subcarrier transducer has been provided in the same space previously occupied by the inductance section of a low-frequency subcarrier oscillator.

Also discussed is a circuit utilizing two similar oscillators whose fundamental frequencies differ by the subcarrier frequency. Since their frequencies are fairly similar, 100 kc and 122 kc for the example given, their physical structure and temperature drift is similar. Thus, fundamental frequency changes for both are about the same which results in a constant frequency difference.

BOOKS

Aircraft Communications Systems

J. H. H. Grover, Philosophical Library Inc., 15 E. 40th St., New York 16, N.Y., 127 pp, $4.75

A compilation of the details of modern British airborne radio communications equipment, this volume deals specifically with equipment carried for air-to-ground communications. Catering to the student and serving as a reference guide for the veteran flight radio operator, this book is divided into three parts: Part I contains theoretical circuit descriptions of contemporary equipment; Part 2, setting up and practical operating instructions; Part 3, brief details of vhf transmitter receivers, contemporary American equipment, and auxiliary equipment.

Transistor Technology Vol. 3

F. J. Biondi, Editor, D. Van Nostrand Co., Inc., Princeton, N.J., 416 pp, $12.50.

Representing a five-year compilation of data, this final volume of a transistor series is equally divided between general technology and that which is specific to germanium and silicon. Subject matter is separated into four areas: the preparation of junction structures, fabrication technology, measurements and characterizations, and transistor reliability.

Reports on the principles and methods of impurity control, their formation by variation of crystal growth parameters, redistribution of solutes, temperature gradient zone processing and their formation by diffusion techniques, includ-

ing silicon diffusion technology, are covered in the preparation of junction structures.

Chemical processing methods are detailed in the discussion of fabrication, which includes several papers on etching techniques, ohmic contacts to silicon and germanium, alloying, and important diffused devices.

The measurements and characterization of transistors incorporate materials properties measurement, and such devise measurement as transistor meteorology, methods of testing and IRE standard on solid state devices.

Reliability is highlighted by laboratory studies and reports on use in the field.

Volume 3 is dependent on the first volume, which develops the fundamental concepts and descriptions of earlier techniques and processes, and is supplementary to Volume 2, which contains recent material on technology of materials and design principles.

Electronics of Microwave Tubes

W. J. Kleen, Academic Press Inc., 111 Fifth Ave., New York 3, N.Y., 349 pp, $9.00.

This presentation of the fundamentals of microwave tube physics answers the need for a consolidated source of information in this rapidly developing field. The author concentrates on the qualitative and quantitative explanation of effects governing the operation of those microwave tubes now used in telecommunications. Tubes in circuits, properties of resonant circuits and delay lines used as tube elements, and production and focusing of electronic beams are topics included. Physical and mathematical presentation on the post-graduate level serves as a daily reference guide for the specialist. First published in a German edition in 1952, the revision has been updated to include latest developments in the field.

IDEAS FOR DESIGN

Get $10.00 plus a by-line for the time it takes you to jot down your clever design idea. Payment is made when the idea is accepted for publication.

Breadboarding The Easy Way

A BREADBOARD setup that is easy to build and use was developed after many different methods of jungle wiring were tried. It has many desirable features.

- Solderless connections
- Circuit components which may be used and reused without deterioration
- Ease of circuit construction
- Ease of dismantling circuit
- Ease of changing circuit components
- Small size and orderly arrangement of circuit layout
- Low cost
- Most circuit components need no special mounting before use.
- Clip leads may be attached to each other or directly to components.

Construction

The clip leads are constructed from commercially available material. They cost about five cents each, and take about three minutes to construct. Their construction is shown in Fig. 1. Clip leads vary in length from two to six inches, in half-inch increments, and are color coded by length. Soldering should be done carefully as the solder flows easily and may flow up into the spring portion of the clip, rendering it useless.

The circuit board needs only one, one-inch mount in each of the four corners and it is ready for use.

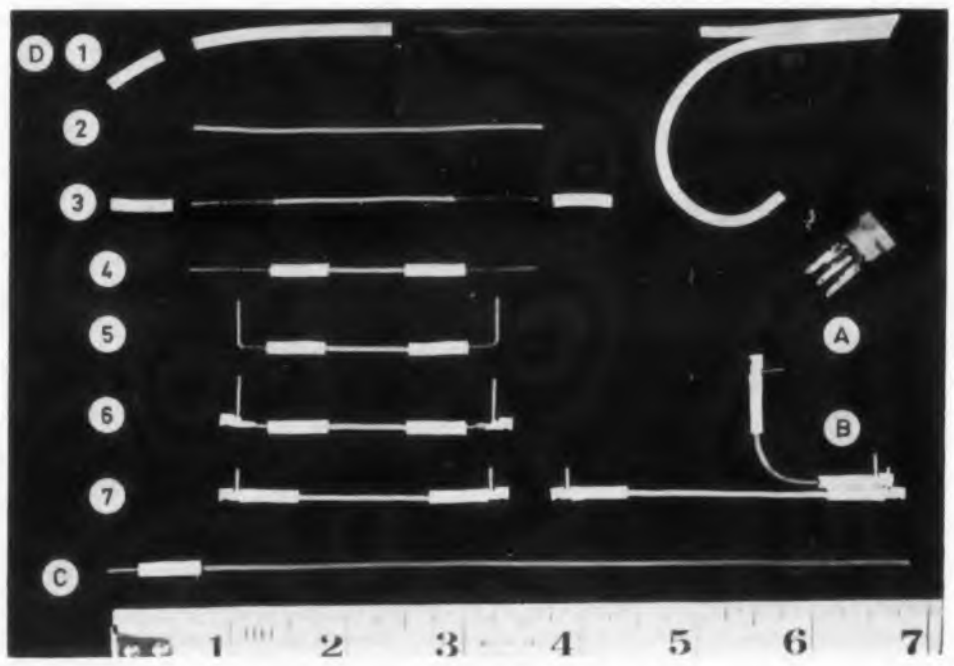
The circuit component leads should be left long enough to enable sliding the components in and out of their mountings on the circuit board. Similar components such as resistors, should all be of the same overall length if possible, for interchangeability in the completed circuit.

Use of Breadboard Materials

Since the breadboard is small, it should be used carefully. The clips break easily if forced in the wrong direction.

Mounting of circuit components on the top of the circuit board is illustrated in Fig. 2.

Use of clip leads in wiring the circuit



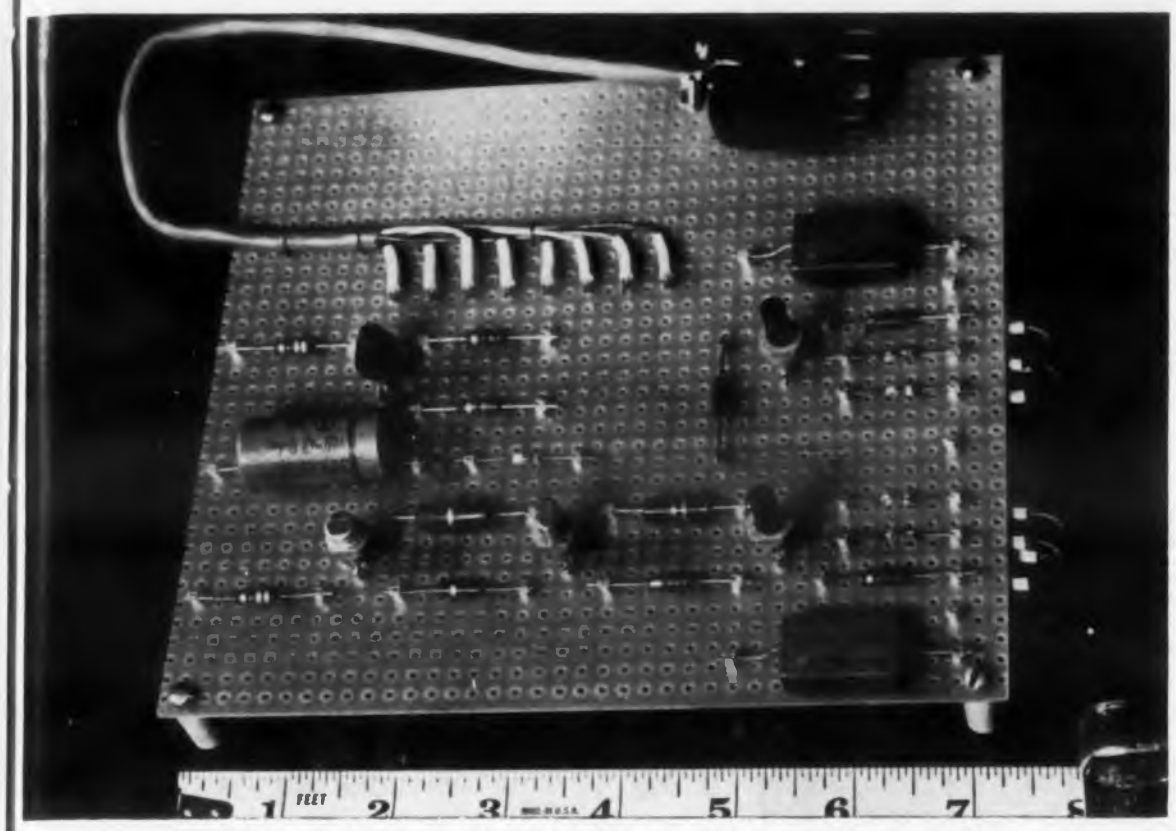


Fig. 2. The components of a test circuit mounted in their final positions. Plug at rear is for connecting the power supply.

is shown in Fig. 3 and is done on the reverse side of the board. The clip leads should be oriented carefully when connected to the ends of the clips protruding from the board as the clips are just barely long enough.

Parts are obtainable from most distributors and are inexpensive. The specific parts used here were ordered from Lafayette Radio, 165-08 Liberty Ave., Jamaica, N. Y. Prices and order numbers from their Catalog 305 (1958) are shown in the accompanying table.

Fig. 1. (Facing) Breadboard components
(A). Transistor socket for mounting on the circuit board.
(B). Connection of clip leads to one another.
(C). A plug for use on the top side of the circuit board.
(D). Clip lead construction.
(1) Insulators for clip leads with soft plastic insulation on white extension cord.
(2) Blank piece of flexible, stranded wire.
(3) Stripped and tinned ends of wire.
(4) Insulation on the wire, over other insulation.
(5) Wire with bent up ends.
(6) Clip soldered to the wire.
(7) Insulation over the solder with ends of the wire cut off, leaving the ends just long enough to accommodate another clip lead as shown in (B).

Wayne A. Kearsley, Electronics Engineer, Edgerton, Germeshausen & Grier, Inc., Boston, Mass.

Parts List

	Perforated Bakelite Boards	
MS-304	2-7/16 x 3-3/8	$0.25
MS-305	3-11/16 x 6-3/4	0.40
MS-306	7-3/8 x 6-3/4	0.75
	Flea Clips	
MS-263	package of 12	0.25

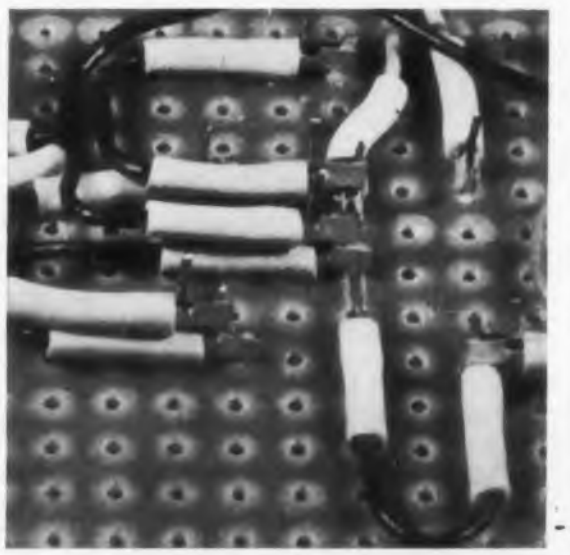


Fig. 3. Wiring is on the under side of the circuit board with clip leads.

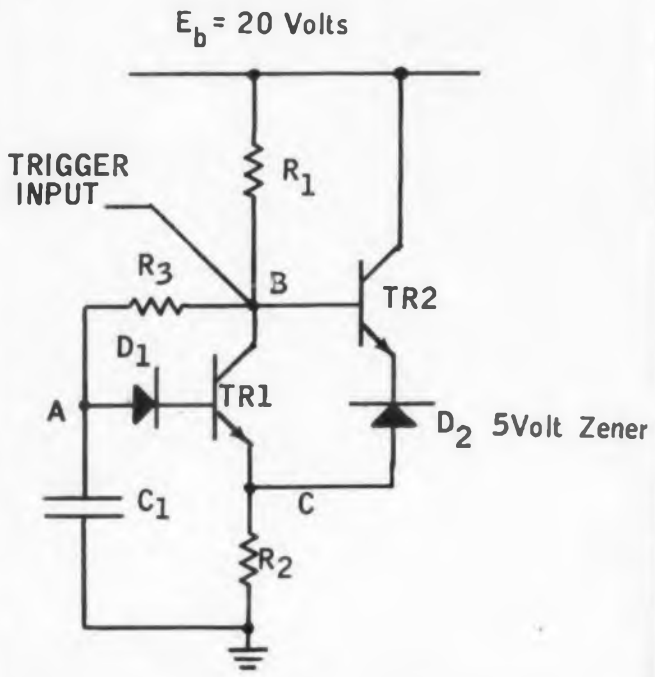


Fig. 1. In this monostable multivibrator, the timing capacitor *C1*, can be charged or discharged readily.

Flexible Monostable Transistorized Multivibrator

The problem is to build a monostable multivibrator, using transistors, in which the timing capacitor can readily be charged or discharged by an external source. In a normal multivibrator circuit, which uses differentiator timing, it is very difficult to change the charge on the timing capacitor with an external source.

The circuit of Fig. 1 uses integrator timing. It is relatively simple and has an added advantage of having a low output impedance.

Transistor *TR1* is normally "ON" and the collector to emitter voltage is less than five volts. Since the zener diode *D2* is back biased, transistor *TR2* is biased "OFF."

The circuit is triggered with a positive pulse at point *B*. As *TR2* goes "ON" the voltage at point *C* rises, and since the base of *TR1* is held constant by the capacitor charge, *TR1* is turned off.

The capacitor then charges toward the supply voltage (minus a small amount due to *TR2* base current flow through *R1*) with a time constant of C_1 (R_1 — R_3). As the waveform crosses the voltage on the emitter, *TR1* starts to conduct and the circuit regenerates back to its stable state.

Diode *D1* is required to keep from breaking down the base to emitter junction of *TR1*.

An analysis of the "ON" condition of *TR1* results in the following equation.

$$V_{ce} = \frac{Eb}{K(B+1)+1}$$

where $K = (R_1 + R_2)\, R_3$, $B =$ dc beta of $TR1$, and $V_{ce} =$ collector to emitter voltage on $TR1$.

From this relationship the resistor values can be established. $TR1$ must be kept out of saturation and V_{ce} must not exceed 5 volts under the extremes of variation in beta.

J. R. Siconolfi, Farnsworth Electronics Co., Ft. Wayne, Ind.

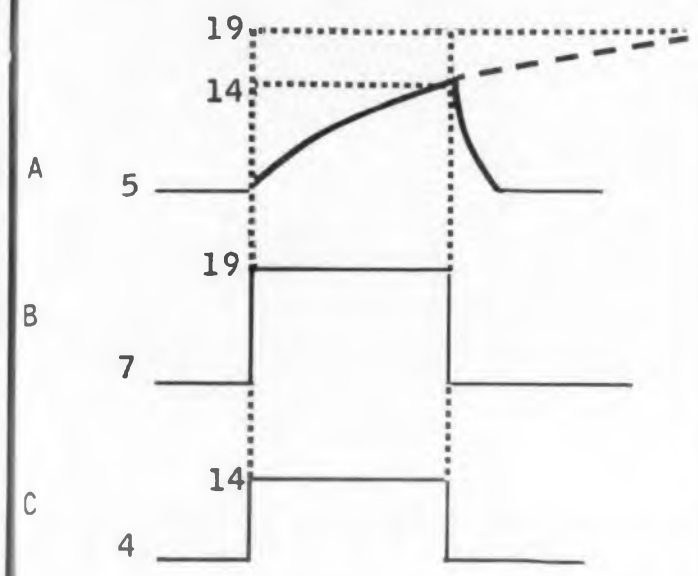


Fig. 2. Representative waveforms and voltage levels for the monostable multivibrator.

Build Your Own Tiny Mercury Switch

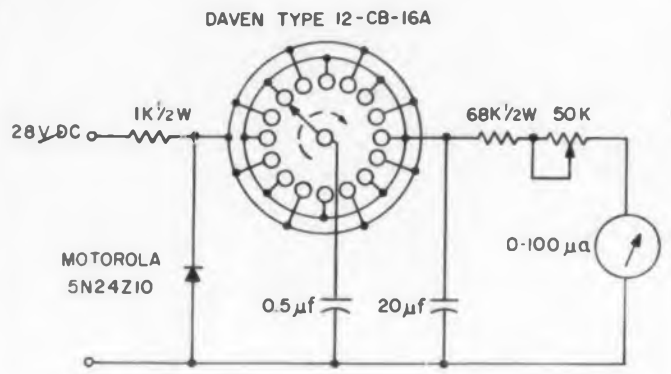
With the corner of a file, scratch the glass of an NE-2 neon lamp near the tip just below the solid part of the end. The tip can now be broken off with pliers. This leaves a tiny opening thru which a few drops of mercury can be introduced with an eye dropper (with a pumping action). The correct amount of mercury can be ascertained by holding the opening closed with the finger and visually determining the least amount that will consistently make contact when the tube is tipped upright and still allow an open condition with the tube in the opposite position. Excess can be removed with a salt-shaker action.

The tiny hole in the end is then sealed with a torch, being careful to pre-heat the glass before applying the direct flame to the end of the tube. Holding the tube upright by its connecting wires in a vise will reduce the expansion cracking during the re-sealing.

After sealing, allow the tube to cool slowly. The connecting wires can then be used in the switching circuit.

Heri T. Schulze, Los Alamos Scientific Lab., Los Alamos, N. Mex.

IDEAS FOR DESIGN



Slow speed tachometer. Only the switch need be mounted on the shaft.

Small, Low Cost Tachometer

We needed a small, low-cost, electromechanical tachometer for direct indication of shaft speeds from 0 to 120 rpm.

The circuit shown solved the problem. We used a long life single pole 16 position rotary switch measuring only 1-3/4 diam by 1-1/4 long, mounted on the shaft, to commutate a 28 vdc supply. The rest of the circuit was placed elsewhere.

Since the power supply varied by as much as 20 per cent, a zener diode was used for voltage stabilization. The output of a charge-discharge capacitor was integrated and displayed on a 100 μa meter with a special direct reading dial.

The circuit is linear to 30 rpm, and can be made linear throughout its range. It presents a stable output and is accurate to better than 5 per cent of full scale. Total cost of components is about $35.

Leo L. Grinius, Engineer, Motorola, Inc., Riverside, Calif.

Pulsing Latching Relays With Little Power

When available power is limited, it's hard to pulse most latching relays. Normally, only half the coil is used at a time, as in Fig. 1, one bucking and the other aiding the permanent magnet in the relay. With the typical coil resistances shown in Fig. 1, one requires a current pulse of about 100 ma.

But with the circuit arrangement of Fig. 2, only half the normal current pulse is required. In each pulsing position, one half of the coil is used in the proper direction while the other half is used with the opposite intent. The result is

either a total bucking or a total aiding magnetic field.

The disadvantage of this scheme, though, is that it requires a set of contacts and a small current limiting resistor.

R. C. Van Dick, Test Engineer, Convair, Pomona, Calif.

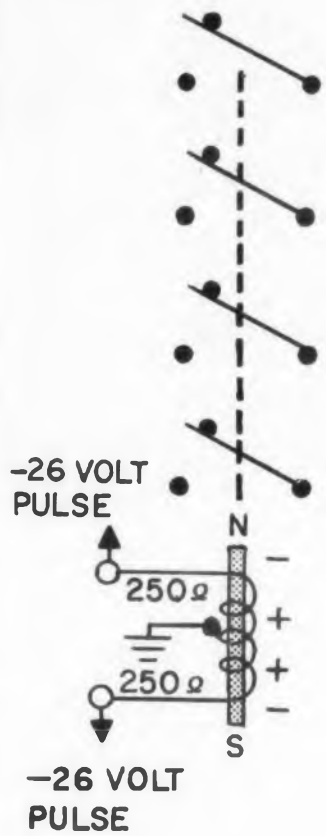


Fig. 1. Normal arrangement of latching relay requires about a 100 ma pulse.

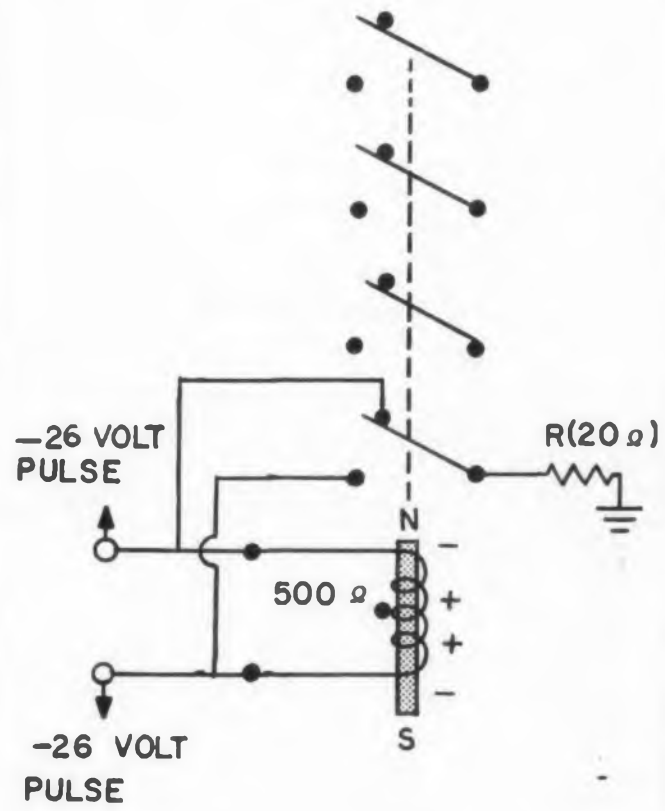
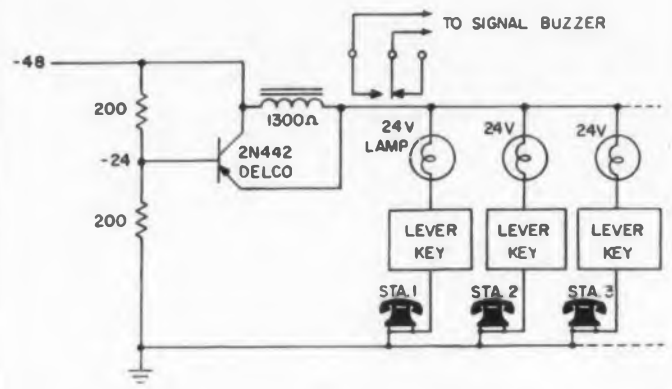


Fig. 2. This latching relay arrangement requires only about half the normal current, but uses a set of contacts.

IDEAS FOR DESIGN



This simple switchboard circuit does away with an expensive, sensitive relay.

Simple Circuit Replaces Expensive Signalling Relay

A sensitive (expensive) signalling relay had to be replaced in a cordless switchboard. The new circuit had to operate reliably with a one-lamp circuit, yet provide low enough resistance to preserve the voltage regulation (hence the lamp brilliance), when a group of calls is made simultaneously.

In the diagram, the transistor is cut off when the phones are idle. One phone and lamp draw enough current to drop the emitter voltage to —23.5 v, at which point the transistor conducts, stabilizing the signalling voltage.

The relay operates from the collector to emitter voltage which remains essentially constant regardless of the number of lamps (calls being made). The total lamp load must not exceed the transistor current or dissipation.

Elbert S. Kennedy, Chief Engineer, E. S. Kennedy & Assoc., Kansas City, Mo.

Pressure Scanner Checks 12 Pressures

This pressure scanner sends data from up to 12 sources to one transducer for conversion into electrical output. It uses 1/8 in. tubing to feed pressure to one point and avoids the need for calibrating 12 different transducers.

Designed by Datex Corp., a Division of Giannini, 1307 S. Myrtle Ave., Monrovia, Calif., it consists of a stator with 12 input ports and a rotor to connect any of the inputs to a single output.

A 12 position switch inside the scanner is connected to the same kind of switch outside the unit so that when both switches are in the same position, the motor circuit is broken and the motor stops. An additional bank of contacts can

Pressure scanner feeds 12 pressures to a common transducer.

be used to provide a visual or digital indication of the rotor position.

By hooking up 12 scanners to a thirteenth, 144 pressures can be measured by one transducer.

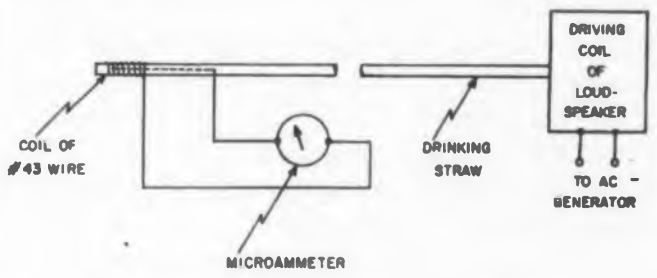
Inexpensive Flux Meter For Deep Recesses

It's difficult to investigate the flux distribution in deep recesses with standard magnetometers. Furthermore, the price of adequate instruments of this type is often prohibitive.

The simple scheme shown in the diagram solves the problem neatly. A drinking straw is fastened to and vibrated by a loudspeaker. An aluminum tube, such as is used for ammeter pointers, may be used instead. A miniature fine wire coil is wound around the protruding end of the tube.

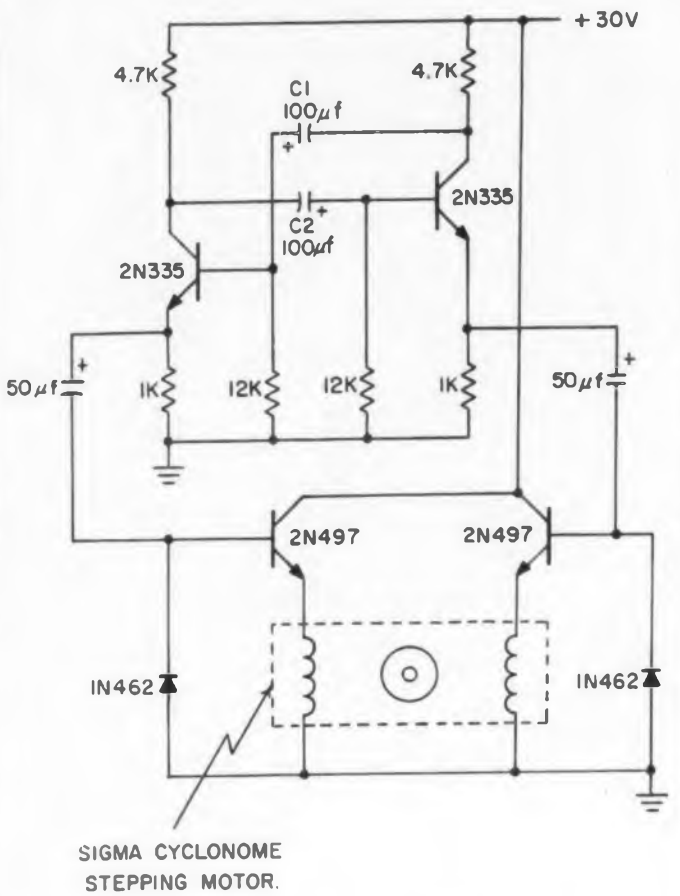
Current induced in the coil by its movement in the magnetic field is read on a sensitive microammeter. For weak fields, an amplifier may be used ahead of the microammeter.

Dr. Erwin J. Saxl, President, Tenistron, Inc., Harvard, Mass.



Vibrating coil fluxmeter for deep fields.

IDEAS FOR DESIGN



SIGMA CYCLONOME STEPPING MOTOR.

Slow speed multivibrator takes only 50 mw to drive stepping motor.

A Slow Turn With Little Power

We needed to rotate a commutator assembly at 2 rpm, but the available power was very limited.

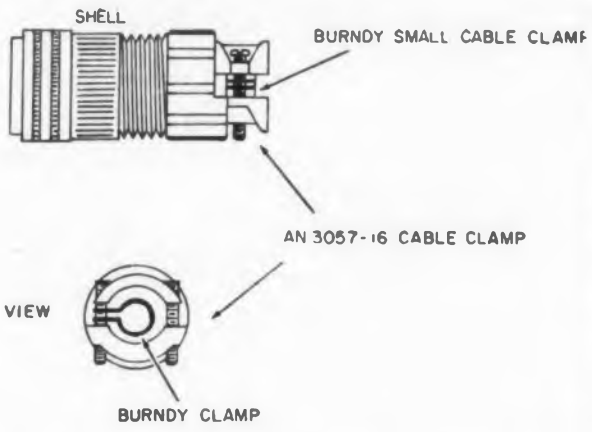
We used a Sigma Cyclonome stepping motor to provide the mechanical force to actuate the commutator. The Cyclonome delivers torque in discrete steps on command. The motor has two 13.5 ohm coils. Pulsing the coils alternately causes the motor to move 18 degrees per pulse.

The driving circuit uses two 2N335 transistors as a slow speed multivibrator. Output from the multivibrator emitters, drives a pair of 2N497 medium power transistors. They send current pulses to the Cyclonome coils, in step with the multi.

Speed can be regulated by varying *C1* and *C2* in the multi circuit. With the components shown in the circuit, the Cyclonome motor rotates at 2 rpm, but the speed can be varied by changing the multi frequency. The 1N462 diodes prevent a dc voltage buildup on the 50 μf coupling capacitors.

The entire device consumes 50 mw, quite a bit less than the 4 or 5 watts needed for conventional motor and gear drives.

Jeffry Wisnia, Jr. Engineer, Comstock & Wescott, Inc., Cambridge, Mass.



Large Amphenol connector holds small Burndy clamp for secure cable connections.

Secure Cable Clamp

Here is an idea for preventing a cable from pulling out of its terminals when used in conjunction with a large AN Amphenol or similar connector. A plastic Burndy cable clamp is placed on the small diameter cable and the one screw of the Amphenol end cable clamp AN-3057 is set through the Burndy clamp hole and tightened, as shown in the figure. Thus the cable cannot be pulled loose and is not visible, making for a neat cable termination.

Ralph Rinaldi, Theta Instrument Corp., East Paterson, N.J.

New Light Modulator

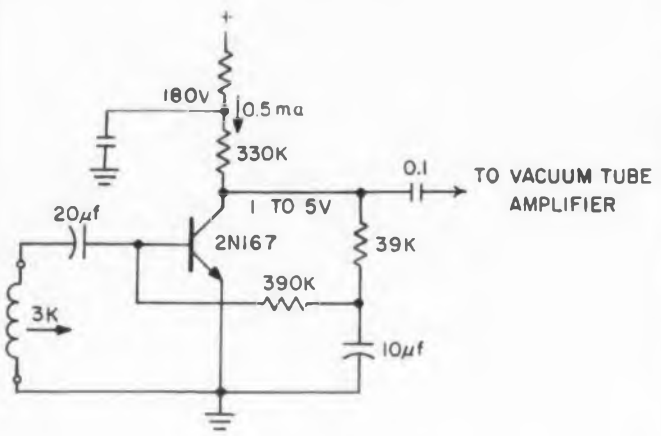
A well known way of obtaining very thin conducting sheets is to evaporate metals in vacuum. A number of substances can be used as supports and be disposed of after metalizing, generally by dissolving and evaporating. This process has been applied to glucinium by M. Auphan in France (Onde Electrique, Dec. 1956) to provide sheets of thicknesses varying between 200 and 2000 angstroms. The most interesting aspect is in the use to which such thin sheets can be put.

Using suitable spacers, a thin sheet of glucinium is stretched over a glass plate; the spacing is very small. When a beam of electrons is shot at such a target, it goes straight through the metal. The thin glucinium sheet is then locally distorted by the electrostatic field due to secondary emission.

Sweeping the electron beam across the metal sheet can thus produce a pattern of deformation determined by the beam modulation. The device constitutes, in fact, a light modulator which could be used, for example in television.

Dr. A. V. J. Martin, Carnegie Institute of Technology, Pittsburgh, Pa.

IDEAS FOR DESIGN



NPN Preamp for Magnetic Pickups Powered From B+

In vacuum tube circuitry, there is a problem in maintaining high signal to noise ratio at low audio frequencies because of the lower signal transfer from a magnetic pickup (phone, tape, or microphone) to the tube grid.

The low input impedance of the transistor more nearly matches the source at low frequencies, so better signal transfer and better signal to noise ratio result. The signal, using the transistor preamp, gets about 40 db of amplification at 100 cps before it reaches the tube grid.

The transistor stage can be powered directly from the same B+ supply used by the vacuum tube circuit. This circuit gives a constant collector current of about 0.5 ma, independent of transistor parameters. A dc feedback network stabilizes the collector to emitter voltage. The circuit has an input impedance of about 3 K.

Dwight V. Jones, Applications Engineer, General Electric Co., Syracuse, N.Y.

Transistor Manufacturers Please Note

In most design work, where any number of transistors may be employed, it is often difficult to keep on hand the various types of sockets to accommodate all transistors. Soldering and resoldering may often damage an expensive transistor or decrease efficiency.

It would be very helpful to have transistors of some styles, designed in two parts, one consisting of the transistor itself and the other consisting of the base or snap-on socket. This base material could also be designed by the manufacturer for best operating conditions for the transistor to which it is attached when purchased.

Robert H. Lemma, Burroughs Corp., Detroit, Mich.

Engineering with Paint

In testing transistorized circuits, burned out or overheated transistors are commonly encountered. This may be due to circuit dipping, wiring, design, etc. By applying a coat of heat sensitive paint or heat sensitive wax emblems to the transistors, overheated transistors will show paint discoloration or emblem distortion. Since most transistors are lacquered by individual companies, the application of paint or wax could be done in one operation.

This idea can reduce cost by reducing the engineering time spent in locating faulty transistors during the initial design and system debugging phases of a program. In addition it may point out equipment hot spots which may be a source of future breakdown.

David E. Miller, Sylvania Electric Products, Waltham 54, Mass.

Interesting Network Property Can Help Transistor Circuit Designers

An interesting property of two terminal-pair, linear bilateral networks is that the forward voltage transfer ratio equals the negative of the reverse current transfer ratio.

The literature abounds in tabulations of voltage transfer ratios for various networks, but the transistor circuit designer is generally interested in the current transfer ratio.

To obtain a network with a specified current transfer function, one need only look for a network with the desired transfer characteristics as the voltage transfer ratio, and reverse the excitation and response terminal-pairs.

Robert B. Craven, Research Engineer, MIT Instrumentation Lab., Cambridge, Mass.

Simple Formula Gives Strength of Small Shafts

This formula, developed experimentally, should help other engineers who've been plagued with this problem. When the power transmitted through a shaft is measured in watts the shaft diameter D, in thousandths of an inch, is given by

$$D = 75\sqrt[3]{\frac{P}{Ns}}$$

where N is the shaft speed in rpm, P is the transmitted power in watts, and s is the design stress of the material in psi.

Herbert Piller, Brooklyn, N.Y.

REPORT BRIEFS

Matrix Switch

The double inhibit magnetic switch described in this report has a similar configuration to the the Rajchman switch, the one most commonly used in memory application, but differs in the manner in which it is driven. The switch circuit selects its output core by removing an inhibit current from each coordinate selecting line. Among the advantages cited for the double inhibit switch is its need for only one driving current source. This simplifies adjustment of the switch drive. Also, since the power of the output pulse is not directly derived from the selection circuits at the time the output pulse is delivered, the selection circuits may be operated at low power. The report states that the switch appeared to possess enough advantages of adjustment and simplicity to warrant consideration as a memory drive switch. It is also described as being useful in any application which requires medium to high speed multiterminal switching. The comparative advantages of this switch over two other types of magnetic switches are listed. *Double Inhibit Magnetic Matrix Switch, L. F. Silva, Aberdeen Proving Ground, U.S. Army, July 1956, 15pp, $.50. Order PB 131353 from OTS, Washington 25, D. C.*

Rotatable-Magnet Permeameter

The device described in this volume is a type of permeameter which derives the variable magnetomotive force across its air gap from the rotation of a permanent magnet. In the common permeameter, the variable magnetic field is provided by an electric current. The general purpose of the device is to determine the magnetic properties of a test specimen and, in particular, visual indication of the major and/or minor hysteresis loops of a test specimen under varying magnetic field conditions. The advantages of the rotatable-magnet over the common type are the following: It is independent of electrical power and current fluctuations, and no heat is developed; it is portable and compact; it is less affected by vibration; its simple design makes operation easy, especially for determining minor hysteresis loops. Two working models are described. *Rotatable-Magnet Permeameter, R. K. Tenzer and M. A. Bohlmann, Wright Air Development Center, U.S. Air Force, July 1956, 9pp, $.50. Order PB 131352 from OTS, Washington 25, D. C.*

Low-noise Backward-wave Amplifier Development

Several trial designs, based upon various considerations of the specifications, have been attempted. A schedule for performing the calculations is evolved based on several predetermined parameters.

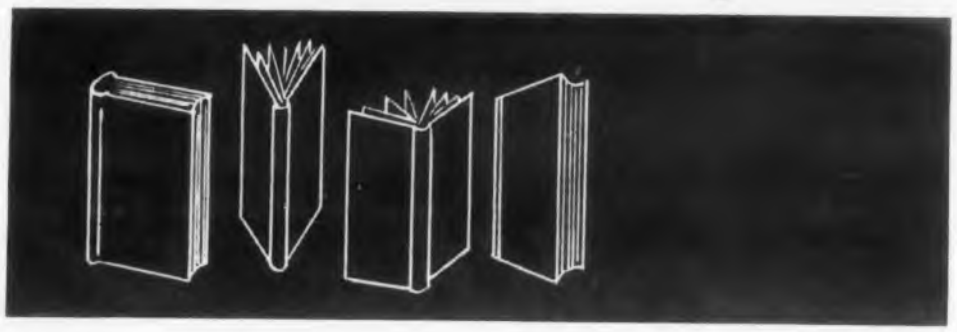
Low-noise gun designs are considered, with some discussion of theory. Predicated magnetic field calculations for various conditions of perturbations are given. Some discussion is devoted to application of permanent magnets to this tube. *Low Noise Backward-wave Amplifier Development Program, K. R. Evans and W. L. Rorden, Varian Associates, Palo Alto, Calif. Jan. 1958, 41 pp, $1.25. Order PB 131822 from OTS, Washington 25, D.C.*

Thin Film Resistance Elements

Vacuum deposited chromium films were prepared and studied and resistance-temperature-thickness characteristics were determined. Substrate temperature and substrate material were found to have a pronounced effect on temperature coefficient but not on the resistivity-thickness relationship. The properties of thin chromium films appeared to be a function of the history of the film rather than any intrinsic property of the film. Some very preliminary work was also done with bismuth films. *Theoretical and Experimental Investigations on Thin Film Resistance Elements, D. M. Hoffman and J. Riseman, International Resistance Co. for Wright Air Development Center, U.S. Air Force. July 1957, 37 pp, $1.25. Order PB 131441 from OTS, Washington 25, D.C.*

Display for Air Traffic Control

An experimental display system was developed which showed promise of satisfying a number of the requirements for display of multi-element data available for air traffic control. The system projects spots of light representing aircraft onto a 10-ft square back-lighted screen. Position, identity, category, heading, and altitude information on a given aircraft is contained within each 3/4 in. spot of light. Main advantages of the system are the large size of display and the large amount of easily read data presented. *A Point-Light-Source Projection Display for Air Traffic Control, R. J. Lampkin and M. F. Williams, Naval Research Laboratory. Feb. 1958, 11 pp, $0.50. Order PB 131524 from OTS, Washington 25, D.C.*



Russian "Nonlinear" Series To Be Sold In Book Form

When on September 17th, we started our serial translation of the Russian book "Nonlinear and Parametric Phenomena in Radio Engineering," we knew we had something good. But we weren't prepared for the flood of bouquets which followed. In response to many requests, we will publish our translation of the entire book at the conclusion of the series. The price will be announced shortly.

Here are just a few samples of the many encouraging letters we received.

"I would appreciate being included in the distribution of your magazine ELECTRONIC DESIGN. If possible, I would like my subscription to start with the September 17, 1958 copy, in order to have a complete collection of the Russian translations of A. A. Kharkevich.

"I am a design engineer of electronic computers . . ."

Robert E. Berri
Librascope Inc.
Glendale, Calif.

"Recently in a friend's copy of ELECTRONIC DESIGN I noticed that you are translating Kharkevich's book. I thought it interesting that someone else has also noticed Kharkevich's work. I also thought it might be of some interest to you to obtain the small portion of the same book which we have crudely translated."

Nick Holonyak, Jr.
General Electric Co.
Semiconductor Products Dept.
Syracuse, N. Y.

"I was very interested to see the first installment of the translation of the Russian book 'Nonlinear and Parametric Phenomena in Radio Engineering' in ELECTRONIC DESIGN. I am sure that this material will be extremely useful to all electronics engineers. However, for future reference, its existence in a stack of magazines will be rather cumbersome, in addition to the difficulty involved in preventing the mislaying of the individual issues. I would therefore like to suggest that after you finish publication, you reprint the entire translation in some more convenient form. Personally, I would be more than glad to pay for a copy of such a reprint."

Roger T. Stevens
Electronics Systems, Inc.
Boston, Mass.

"I happened to miss the September 17 and October 1 issues of ELECTRONIC DESIGN. If it is at all possible to supply, I would greatly appreciate copies of Parts 1 and 2 of the translation of A. A. Kharkevich's book."

H. N. Laden
Chesapeake and Ohio Railway Co
Cleveland, Ohio

"We would appreciate receiving a reprint of the series 'Nonlinear and Parametric Phenomena in Radio Engineering' starting in your Sept. 17 issue."

Seymour Weinstein
Hazeltine Corporation
Little Neck, N. Y.

". . . Another thing I would like you to give me information about is whether the Russian book 'Nonlinear and Parametric Phenomena in Radio Engineering' is at present or will at any forseeable future be available in translated book form, as judging by the first part in your magazine, it is both an extremely clear and valuable publication."

M. P. Peyser
Atlas Engineering Co., Inc.
Roxbury, Mass.

"The book 'Nonlinear and Parametric Phenomena in Radio Engineering' by A. A. Kharkevich which will appear in serial form in ELECTRONIC DESIGN is very interesting.

"We would like to obtain a copy of this book as soon as possible . . ."

H. M. Schlicke
Allen-Bradley Co.
Milwaukee, Wisc.

"It is with great interest that I note your efforts in ELECTRONIC DESIGN concerning the translation of the Russian book on nonlinear circuit elements. After the initial shock of discovering in industrial electronic design that the text book examples of college were of strictly linear problems while my 'real' problems were almost strictly nonlinear, I soon learned to use nonlinearity and finally to depend on it for 'clever' circuit design.

". . . I have noticed that university training does not prepare students for the essentially nonlinear 'real world' and a book such as that by A. A. Kharkevich would be a great boon. As was stressed by the editor of *ED*, this book is for the practical design engineer. We have enough of the pure theoretical I think.

"Now, what I would like to know is the following. Is there any plan to make reprints available of your translation or perhaps an outright publication of the translated book? I suppose there are copyrights to take care of. If it is not possible to secure an English version of Kharkevich's book (one way or another) how about advising me where and how to purchase a Russian copy. I am trying to learn Russian anyway and this book would be an excellent first book to add to my scientific book shelf in the Russian section."

Robert W. Zimmerer
University of Colorado
Boulder, Colo.

"I am writing this letter in regard to Mr. Adashko's translation of 'Nonlinear and Parametric Phenomena in Radio Engineering.' Since no books have been written on this subject directed towards the electrical design engineer, the few scattered articles that have appeared in periodicals have to be used as a foundation for a course on this subject in many colleges. Such is the case at Cornell. Though we try to introduce to those studying electrical engineering here, some of the information that has been made available, students find it very difficult to understand the application of this theory.

In a few short weeks a series of talks will be given in our course 'Principles of Nonlinear Circuits' concerning the application of nonlinear circuit theory. Since I feel that your translation of 'Nonlinear and Parametric Phenomena in Radio Engineering' would make an important contribution to those presently taking the course, I would like to have this information available to them. Also, since the present semester is more than one-half over, 'time' is an important factor.

Therefore, I wonder if it would be possible to obtain a complete translation of this work even though the entire serial translation has not been published. I realize that this request is highly irregular, however, everything you can do for us concerning this matter would be greatly appreciated."

Donald D. Givone
Cornell University
Ithaca, N. Y.

RUSSIAN TRANSLATIONS

Nonlinear and Parametric Phenomena in Radio Engineering

Part 9

A. A. Kharkevich
(Translated by J. George Adashko)

Chapter 1

Nonlinear Circuits and Fundamental Nonlinear Processes

12. Nonlinear Method of Amplitude Modulation

In the preceding section we have shown modulation to be essentially a linear operation, effected in a linear system with a variable parameter. Modulation is nothing but multiplication.

In most practical circuits amplitude modulation is based on a different principle. The point is that it is difficult to construct a correctly operating linear multiplier. We therefore resort to an indirect method of multiplication, in which the sum of the two multiplied voltages acts on a nonlinear circuit. The current will now contain a component proportional to the product of the two voltages. Let us first show qualitatively that a-m oscillations can be obtained in this manner.

Let us take two voltages, one at a carrier frequency $U_1 = U_m \sin \Omega_0 t$, and a modulating voltage $U_2 = (1 + m \sin \Omega t)$. We connect the two voltages in series with a nonlinear element. Let the characteristic of this element be represented by a broken line. The waveform of the

current in the circuit can be plotted by the usual construction, as shown in Fig. 39. It is easy to see that the current is amplitude modulated. In addition, the current contains a dc component, a low frequency component, and a series of high frequency components. All these excess components must be filtered out.

Let us now analyze the nonlinear multiplier in greater detail. Let the characteristic of the nonlinear element be represented by the power series,

$$I = a_0 + a_1U + a_2U^2 + a_3U^3 + a_4U^4 + \dots$$

In our case

$$U = U_1 + U_2$$

so that

$$I = a_0 + a_1 (U_1 + U_2) + a_2 (U_1 + U_2)^2 + a_3 (U_1 + U_2)^3 + a_4 (U_1 + U_2)^4 + \dots = a_0 + a_1U_1 + a_1U_2 + a_2U_1^2 + a_2U_2^2 + \underline{2a_2U_1U_2} + a_3U_1^3 + a_3U_2^3 + 3a_3U_1^2U_2^2 + 3a_3U_1U_2^2 + a_4U_1^4 + \dots \quad (1)$$

We see that the term we need, which contains the products U_1 U_2 (underlined), is obtained only through the quadratic term of the voltage-current characteristic of the nonlinear element. All the remaining terms give extraneous components, so that we do not have pure multiplication, and the current obtained requires subsequent purification by filtering.

However, it is possible, by complicating the circuit, to eliminate many excess terms and thus obtain better multiplication.

Let us turn to Fig. 40. The original nonlinear circuit with the two voltages U_1 and U_2 is shown

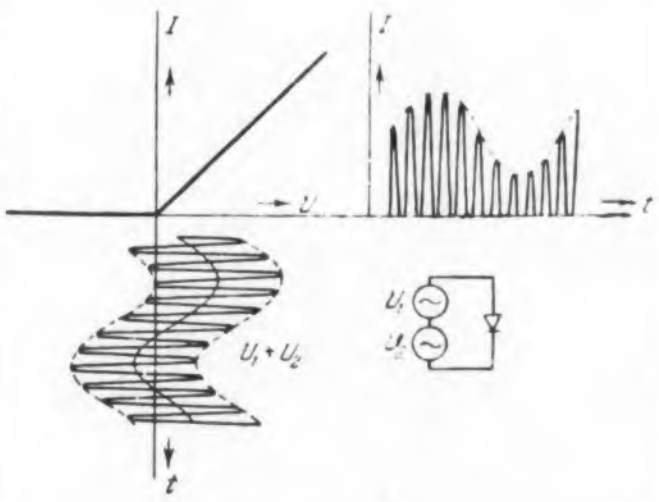


Fig. 39. Characteristics of a basic a-m modulator with two voltages considered in series with a nonlinear element.

in Fig. 40a. Let us combine two such circuits, as shown in Fig. 40b, with the voltage U_1 in the common branch. The voltage picked off the circuit is

$$U = R (I_1 - I_2).$$

We note that U_2 is applied to the circuit twice,

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and in such a way that the effective voltage in the upper half is the sum $U_1 + U_2$, and the difference $U_1 - U_2$ in the lower half. The instantaneous polarities of the voltages are denoted by arrows. For the currents we obtain.

$$I_1 = a_0 + a_1 (U_1 + U_2) + a_2 (U_1 + U_2)^2 + a_3 (U_1 + U_2)^3 + a_4 (U_1 + U_2)^4 + \ldots$$

$$I_2 = a_0 + a_1 (U_1 - U_2) + a_2 (U_1 - U_2)^2 + a_3 (U_1 - U_2)^3 + a_4 (U_1 - U_2)^4 + \ldots$$

The current difference is

$$I_1 - I_2 = 2a_1U_2 + 4a_2U_1U_2 + 6a_3U_1^2U_2 + 2a_3U_2^3 + 8a_4U_1^3U_2 + 8a_4U_1U_2^3 + \ldots \quad (2)$$

(It is assumed that the circuit is symmetrical, i.e., that the coefficients a_k in the expansions of the currents I_1 and I_2 are the same.) We see that subtraction leads to cancellation of a whole series of terms. The only terms remaining are those containing odd powers of U_2. Were the characteristic of the nonlinear element strictly quadratic, i.e.,

$$I = kU^2$$

we would obtain a pure multiplication in accordance with the formula

$$k(U_1 + U_2)^2 - k(U_1 - U_2)^2 = 4kU_1U_2.$$

Circuits of the type shown in Fig. 40b are called balanced. They are used, in particular, to obtain modulated oscillations that contain no carrier. Actually, if U_1 is the carrier voltage, it drops out of Eq. (2). Modulation of this kind is called balanced modulation.

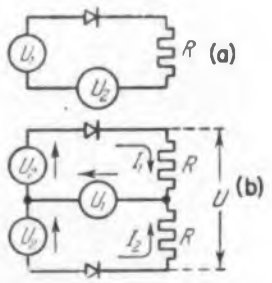

Fig. 40. The basic a-m modulator with two adding voltages in series in a nonlinear circuit (a), and a combination of two such circuits (b).

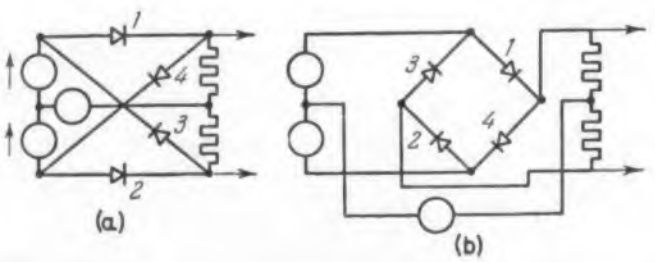

Fig. 41. The ring modulator combines two balanced modulators (a), and is redrawn in more conventional form in (b).

The improvement made to the circuit of Fig. 40a to obtain the balanced circuit of Fig. 40b consists essentially of reversing the sign of one of the voltages and subtracting the currents to get rid of many excess terms. This procedure can be extended further. Let us take two identical balanced circuits, and reverse in one of these circuits the polarities of both voltages U_1 and U_2. The result is a voltage that equals the sum of the voltages obtained across each of the circuits individually.

Such a result is obtained by the circuit in Fig. 41a, which is a combination of two balanced circuits. The output voltage of this circuit can be represented in the form

$$U = U' + U''$$

where U' and U'' are the voltages produced by each balanced circuit individually. For these two voltages we can write [see Eq. (2)]:

$$U' = R\,(I'_1 - I'_2) = 2R\,[a_1U_2 + 2a_2U_1U_2 + 3a_3U_1^2U_2 + a_3U_2^3 + 4a_4U_1^3U_2 + 4a_4U_1U_2^3 \ldots],$$

$$U'' = R\,(I''_1 - I''_2) = 2R\,[-a_1U_2 + 2a_2U_1U_2 - 3a_3U_1^2U_2 - a_3U_2^3 + 4a_4U_1^3U_2 + 4a_4U_1U_2^3 + \ldots].$$

The expression for U'' differs from the expression for U' in that the signs of both U_1 and U_2 are reversed. Adding, we obtain

$$U = U' + U'' = 4R\,[a_2U_1U_2 + 2a_4U_1^3U_2 + 2a_4U_1U_2^3 + \ldots]. \quad (3)$$

This expression shows that more excess terms have been eliminated. In particular, if the characteristic of the nonlinear element is expressed by a polynomial of power not higher than the third, i.e.,

$$I = a_0 + a_1U + a_2U^2 + a_3U^3$$

then the circuit of Fig. 41a (if the circuit is completely symmetrical) produces ideal multiplication. It is possible to redraw this circuit in a more conventional manner, as shown in Fig. 41b. The result is a closed ring consisting of four nonlinear elements. This is why Fig. 41 is called a ring modulator. This circuit is widely used for modulation and frequency conversion.

It must be noted that no further improvement in the circuit can be obtained by successive application of this method. In fact, examination of Eq. (3) shows that the voltage picked off the ring circuit retains only terms that contain products of the odd powers of U_1 and U_2.

Consequently, if we reverse the sign of one or both voltages, all the terms of expressions (3) retain the same sign, and neither can be eliminated individually by addition or subtraction. Therefore, there is nothing gained in a more complicated circuit that comprises two ring circuits.

(To be continued with a discussion of practical modulation circuits.)

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What the Russians Are Writing

J. George Adashko

Possible Use of a System of Orthogonal Functions for Communication Purposes, by A. G. Leont'yev, EC 10/58, pp 3-8.

All modern multichannel communication systems make use of periodic and orthogonal functions. Systems with frequency sharing are based on the orthogonality of the sinusoidal functions. Frequency with time sharing make use of the orthogonality of periodic sequences of pulses shifted relative to each other. Sinusoidal functions are the only ones that do not change form upon transmission through a linear system. But frequency-sharing or time-sharing functions are not the only ones that can be used for electric transmission of information.

Examine, for example, the Laguerre function

$e^{-\alpha t/2} L_n(\alpha t)$, where $L_n(\alpha t)$ is given by

$$L_n(\alpha t) = e^{\alpha t} \frac{d^n}{dt^n}\left(\frac{t^n}{n!} e^{-\alpha t}\right) = \sum_{\nu=0}^{n} (-1)^\nu \binom{n}{\nu} \frac{(\alpha t)^\nu}{\nu!}$$

and is the solution of the following linear differential equation with variable coefficients:

$$t \frac{d^2 L_n(\alpha t)}{dt^2} + (1 - \alpha t) \frac{d L_n(\alpha t)}{dt} + \alpha n L_n(\alpha t) = 0$$

The Laguerre polynominals are orthogonal in the interval from 0 to ∞ with weighting factor

$e^{-\alpha t}$

$$\int_0^\infty e^{-\alpha t} L_m(\alpha t) L_n(\alpha t)\, dt = \begin{cases} 0 & m \neq n \\ 1 & m = n \end{cases} \quad (1)$$

Laguerre functions can be generated with a two-port network having as its transfer function, in operator form, the transform of the Laguerre function

$$\alpha e^{-\frac{\alpha t}{2}} L_n(\alpha t) = \frac{\alpha}{p + \frac{\alpha}{2}} \left(\frac{p - \frac{\alpha}{2}}{p + \frac{\alpha}{2}}\right)^n$$

A unit step applied to the input of this network shown in Fig. 1 will produce a Laguerre function at the output.

Fig. 2 shows the first four Laguerre functions, obtained by multiplying by

$e^{-\alpha t}$ the following four polynominals:

$$L_0(\alpha t) = 1.$$
$$L_1(\alpha t) = 1 - \alpha t.$$
$$L_2(\alpha t) = 1 - 2\alpha t + \frac{1}{2!}\alpha^2 t^2, \quad (2)$$
$$L_3(\alpha t) = 1 - 3\alpha t + \frac{3}{2!}\alpha^2 t^2 - \frac{1}{3!}\alpha^3 t^3$$

It is readily shown that L_n L_m characterizes the interference induced in channel L_n by channel L_m, and that the maximum of this interference will not exceed $\frac{x^{n+m}}{n!\ m!}e^{-x}$. This establishes the value of x required to keep the interference below a specified value.

Evidently, a system employing Laguerre functions must be designed for pulse transmission, for during the lifetime of these function, determined by the integration time t, only two characteristics of these functions can be varied without losing the ability to separate them. These characteristics are the amplitude and the order of the function. This indicates two types of modulation. The first is amplitude modulation, where by each channel has its own order (number) of the function and the amplitude of the function varies from pulse train to pulse train, (analog of PAM). The second is modulation of the order of the polynominal, whereby each channel is allotted several order of Laguerre polynominals.

The block diagram of a system with amplitude modulation is shown in Fig. 3. Here *PG* is a single-pulse generator, *SN* the shaping network shown in Fig. 1, *M* are modulators, *S* is a summing network, *SPS* a synchronizing-pulse separator, *MU* multiplier, *I* integrators and *AMP* an amplifier. The operation of this circuit is analogous to synchronous detection of sinusoidal signals. The most difficult to realize is the multiplier, which should have an accuracy of about 1 per cent while operating in four quadrants.

(Continued on following page)

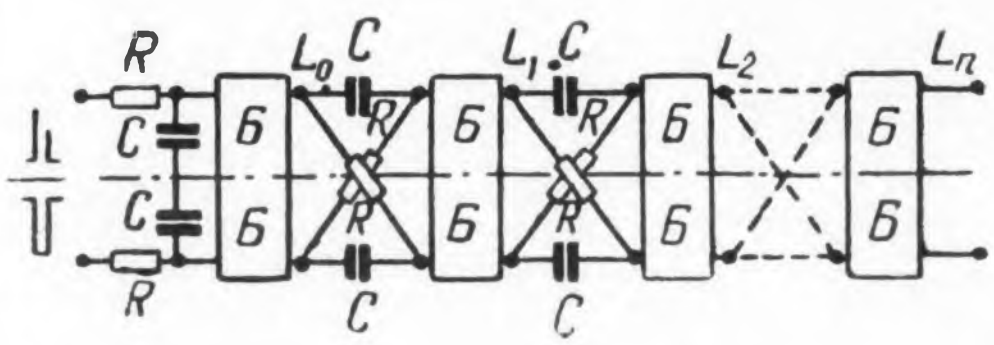

Fig. 1. Circuit for generating Laguerre functions. Here $\alpha/2 = 1/RC$. An ideal buffer stage should have an infinite input impedance, a zero output impedance, and a transfer function of unity. This is approached by a cathode follower.

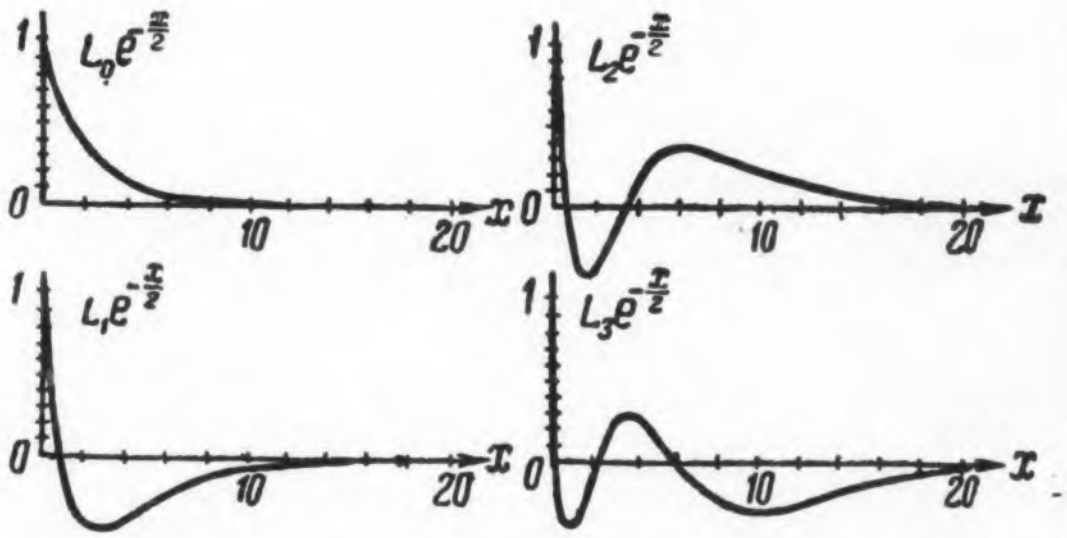

Fig. 2. Four Laguerre functions obtained by multiplying Eq (2) by $e^{-\alpha t}$.

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Fig. 4 shows the block diagram of another communication system, based on the othogonality of the Laguerre polynomials. By Duhamel's theorem, the response of a linear system $Y(t)$ to a signal $x(t)$ is

$$Y(t) = \int_0^t x(t-\tau)\, g(\tau)\, d\tau$$

where $g(\tau)$ is the response to a unit pulse. If $g(\tau)$ is the Laguerre function (as in the case of Fig. 1), then, to reconcile Eqs. (1) and (2) the input signal must be a Laguerre function of reflected time, $x(t) = e^{-\alpha t/2} L_n(-\alpha t)$.

Goldman has shown that "time reflections" of functions giving the response of a linear system to a unit pulse produce, when applied to the input of the system, the maximum ratio of the instantaneous signal to rms noise at the instant of time t.

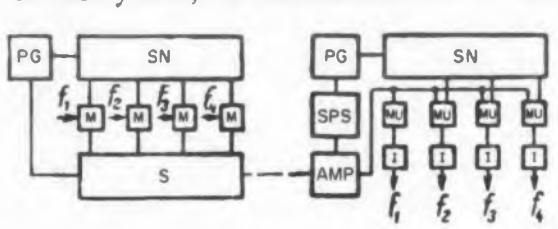


Fig. 3. Amplitude modulation system.

In Fig. 4 PG is a pulse generator, *SN* the shaping network, shown in Fig. 1, *RD* is a recording device (magnetic tape and the like), *PD* is a playback device used to reverse the time (also magnetic tape etc.) *M* represents modulators, *S* a summing network, and *SPS*, a synchronizing pulse separator. *K* is a triggering device and *B* a device that generates pulses to block the trigger during the time of reading. This system is simpler than that of Fig. 3 in requiring no integrator or multiplier.

The receiver proper is similar to the network used to shape the Laguerre functions. The outputs of this network are connected with a triggering system, which operates at the instant of time corresponding to the end of the reflected-time Laguerre function.

The schemes described have been tested and the results of these tests will be reported in the future. It is merely mentioned here that to restrict the error due to the safe finite integration time to a value of 60 db, αt was chosen to be 40. The maximum noise ratios for the systems corresponding to Figs. 3 and 4 were 1/5 and 1/20 respectively.

Communication systems based on Laguerre polynomials can be used in pulse systems and various telecommunication systems where the number of transmitted signals is not too high.

The Spectrovisor, by V. Kol'tsov. R 10/58 pp 21-23, 5 figs.

An interesting instrument, exhibited at the 14th All-Union Exhibit of Amateur Developments, permits instantaneous determination of the spectral characteristics of any object. The wavelengths and intensities of the spectral components are displayed on a suitable calibrated crt. Although designed for use in visible light, the instrument can be adapted for ultraviolet and infrared work.

RC Oscillator with Single Junction Transistor, by Ye N Garmash, EC 10/58, pp 25-28, 8 figs.

Self-excitation of an oscillator calls for phase shift in the feedback loop. In a single tube oscillator this means that the gain of the tube must compensate for the attenuation in the phase-shifting network. In the case of a grounded-emitter transistor, the low input resistance makes the phase-shift-network attenuation too high for the gain of a single transistor.

Stability and Effect of Parasite Reactances in Selective RC Systems, by I. M. Kogan, EC 10/58, pp 9-19. 15 figs.

Although much has been written on selective RC systems, most of the theoretical literature is confined to "idealized" circuits, with fixed values of the elements and negligibly small parasitic reactances (capacitances). Practical design, which must take these into account, is for the most part empirical. The article deals with asymmetrical or phaseshifting RC systems, in which phase shift is produced either by differentiation or integration.

Analysis of Directional Properties of a Corner Antena by B. S. Nadenenko and V. V. Lyalikov. EC 10/58 pp 26-31, 5 figs.

When the reflector dimensions commensurate with the wavelength, the image method for the computation of the directivity pattern becomes too inaccurate. Since a rigorous method involves

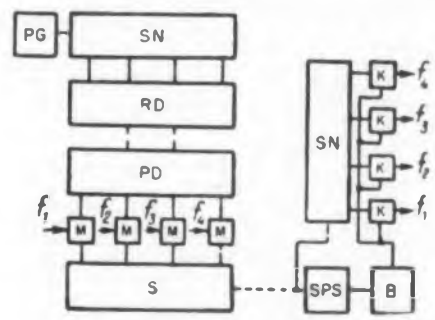


Fig. 4. Another communication system, based upon the orthogonality of the Laguerre polynomials.

great analytical difficulties, the author employs an approximate method, using the asymptotic values of the Hankel functions entering into the exact solution.

Ground Conductivity Map of the USSR

The UUS radio-amateur organization (called DOSAAF—"Voluntary Society for Collaboration with the Army, Navy, and Air Force"), announced (in the July 1958 issue of *Radio*) a radio-amateur contest for the purpose of enrolling a large number of amateurs in a project, involving measurement of ground conductivity as it affects radio wave propagation. In connection with this project, the issue contains an article by V. Kashpirovskiy on "Propagation of Radio Waves and Ground Conductivity" (pp 19-21, 3 figs.), and anonymous article titled "Receivers for Measurement of Ground Conductivity" (pp 22-24, 6 figs.).

Such mass experiments are not new in the Soviet Union. As early as in 1923 a mass experiment was performed on short-wave propagation. In 1936, amateurs in Southern Russia participated actively in a study of the propagation of radio waves during a solar eclipse.

Type E Surface Waves in Round Waveguide, by L. N. Loshakov, RE 9/58, pp 3-7, 3 figs.

A round metallic waveguide, partially filled with dielectric, can carry slow, electromagnetic waves, propagating along its surface. The article derives the propagation equation for E_{01} waves in a round waveguide, coated inside with a thin dielectric layer.

KEY

The sources of the Russian articles and their dates of issue follow the authors' names. Here is the key to the names of the journals in which the articles originally appeared.

AJ	Acoustic Journal *(Akusticheskiy Zhurnal)*
AT	Automation and Telemechanics *(Avtomatika i Telemekhanika)*
CJ	Communications Journal *(Vestnik Svyazi)*
EC	Electrical Communications *(Elektrosvyaz)*
IET	Instruments and Experimental Techniques *(Pribori i Tekhnika Eksperimenta)*
JTP	Journal of Technical Physics *(Zhurnal Tekhnicheskoy Fisiki)*
ME	Measurement Engineering *(Izmeritel'naya Teknika)*
R	Radio
RE	Radio Engineering *(Radiotekhnika)*
REE	Radio Engineering and Electronics *(Radiotekhnika i Elektronika)*

GERMAN ABSTRACTS

Grid Current in Electrometer Tubes

E. Brenner

ELECTROSTATIC voltmeters are not only of importance in nuclear physics and related applications but also in the measurement of nonelectrical quantities using piezoelectric effects, the determination of chemical electromotive forces and in quality determination of high grade insulators. The basic requirements for an electrometer are high input resistance with low input capacitance and high sensitivity.

The input resistance of a vacuum tube electrometer is determined primarily through the quiescent grid current characteristics of the electrometer tube. This grid current can be traced to several components, some of which are controlled by the physical tube structure and materials. Others can be minimized in the design of the voltmeter circuit. Thus the effect of ion current and excitation in the residual gas are controlled by using the lowest feasible pressure. Leakage current between the grid and the other electrodes is controlled largely by the choice of the insulator material in tube construction.

The initial velocity current can be kept low by using the largest practical negative bias since a reduction in the grid current component of three to four orders of magnitude is obtained per volt of negative bias. The methods which can be used to reduce the negative grid current are tabulated in the accompanying chart.

Abstracted from an article by E. A. Frommhold Nachnichtentechnik, *Vol. 8, No. 6, June 1958, pp. 265-268.*

Reducing the Components of Negative Grid Current

Component due to	Reduce: Cathode Temperature	Plate Voltage	Residual Pressure	Ionization Volume	Grid Work Function	Plate Current	Grid Surface	Anode Atomic No.	Space Charge Grid Current	Shield
Ionization of Residual Gas		x	x			x				
Ions from Cathode	x									
Thermionic Ions	x									
Ions due to cosmic radiation etc.				x						x
Thermionic Grid emission	x				x					
Cathode light	x				x		x			
External light					x					x
Photoexcitation		x	x		x	x	x			x
Continuous Radiation		x			x	x	x	x	x	x

A Digital Recorder

E. Brenner

RECORDING oscillographs using deflecting pens present a record voltage variation as a function of the distance through which the recording paper moves (time dependence for constant drive speed). Such recorders are limited by the mechanical characteristics of the pen deflection. This results not only in frequency limitations but also in fixed scaling, i.e. a given pen motor may give proportional deflection. In addition, the pen mounts are subject to mechanical shock.

A digital technique which employs several static pens can overcome these defects. It can eliminate the mechanical difficulties caused by movable pens and it can be designed or adjusted to give a record on quadratic, logarithmic or other scales.

In the digital method, the signal is fed to an amplitude discriminator which senses the level of the signal and feeds a pulse to a corresponding fixed electric pen. Consider for example a signal which varies between 0 and 10 v and a ten pen recorder. Two variations are possible. In one case as the signal passes through a given integral voltage value, i.e. 4 v, a sharp pulse is produced which energizes the 4 v pen, producing a dot on the (electric) recording paper. Thus the information on the record consists of a series of dots and no record is obtained for constant voltage. In the second scheme, one pen is activated at all times, so that a line at 4.5 v is produced if the signal voltage is between 4 and 5 v. Each of the schemes is, of course, resolution-limited by the number of pens used and the speed of the paper drive.

Abstracted from an article by W. Auer, Elektronische Rondschau, Vol. 12, No. 7, July 1958, p, 240.

Filter—In Or Out?

Dear Sir:

Reference is made to your recent series of articles in ELECTRONIC DESIGN on "Concentrated Filter Passbands" (*ED*, Part 1, p 22, Aug. 6, Part 2, p 30, Aug. 20, Part 3, p 54, Sept. 3). I have enjoyed them and found them very informative.

However, I am puzzled by one point you make in the introduction to the first article, and reiterate in the third article. That is, that a narrow-band filter should be used at the input to the i-f amplifier for minimum noise. Intuitively, it seems to me that, from the "noise" point of view, the filter should be at the output-end of the amplifier.

Explaining further, Figure 1 is a system such as you describe. The noise into the detector would consist of narrow-band noise from the "front-end," and broad-band noise from the i-f (predominantly the first i-f amplifier). Figure 2 is system with the filter at the output. Here the noise into the detector would be narrow-band from both the "front-end" and the i-f. Barring non-linearities, wouldn't the total noise content be somewhat less for the second system?

I add "barring non-linearities," because I realize the second system can more readily give rise to cross-modulation between noise and signal than the first. Is this why the first system is preferable?

I will certainly appreciate any clarification that you can provide.

Eugene H. Kopp
Project Engineer
Flite Industries, Inc.
Burbank, Calif.

I appreciate your interest in my article, "Concentrated Filter Passbands," which appeared in recent issues of ELECTRONIC DESIGN.

My statements concerning the circuit location of a concentrated filter were based on filter application in a super heterodyne receiver. The fourth paragraph of your letter gives the basis for these statements.

LETTERS

If we had an application where non-linear devices such as mixers and automatically biased tubes were not used, then you have a point well taken, the filter should follow the amplifier.

Frederick A. Schaner

Reliability Curves Clarified

Dear Sir:

As an engineer with primary interests in the field of reliability, I find it gratifying to see emphasis such as was placed on this area of design in your October 29 issue. The electronic designer is one of the most important, and at the same time often one of the least informed, contributors to equipment reliability or its absence.

For this reason, I should like to offer a clarifying comment regarding Mr. W. H. Lesser's interesting article. Following the test reference to Fig. 2, he states that "Here the reliability at any point in life is equal to the number of survivors at that point divided by the number of units originally placed on test." This statement actually defines, not the reliability *at any point*, but the reliability for the *period* from time zero to that point. Frequently, the reliability figure of interest is that for an interval, a number of operations, or a "mission," commencing at a point other than zero time; that reliability figure is then the number surviving at the end of the period of interest divided by the number present at its beginning. It is important to note that, except for the exponential law (constant failure rate) case, the reliability for a stated period varies as a function of the starting point, generally declining as the age of the equipment increases.

As an example, consider Fig. 3 of Mr. Lesser's article. By the definitions stated in the article, the reliability at 50 million operations is read as 0.90; at 60 million operations, 0.60. If we compute the reliability for the 10-million-cycle period intervening, however, we find that is 0.60/0.90 = 0.667: at the 50 million operation

LETTERS

point, the reliability for the 10 million operations following is far less than for the 50 million cycles preceding.

At times, the equipment user—and hence the designer—may be interested primarily in percentage failures accumulating over the lifetime of the equipment. There are many instances, however, where the rate of occurrence of failures is of great interest, particularly in its effects on decisions to overhaul or scrap equipment at predetermined intervals.

Paul Gottfried
Project Director
Reliability Test Section
Inland Testing Laboratories
Morton Grove, Ill.

. . . Mr. Gottfried explains in more detail than my article some of the characteristics of reliability curves. Needless to say, there are many other ways in which reliability data can be utilized to indicate product performance.

We use a hazard curve to show the probability of future failure and an instantaneous failure rate curve to show the probability of instantaneous failure.

W. H. Lesser

Bearing The Standard

Dear Sir:

Congratulations to you on your Editorials which have kept standardizing The Design Approach in the forefront. I wholeheartedly agree that a step in the right direction would be settling on standard circuits and packaging by the industry; however, these should be preceded by the standardization of D-C Power Supply Voltages.

Standardizing D-C Power Supply Voltages is one small step in standardizing the design approach but it is a very vital first step. Such standardization besides enhancing interchangeability, will pave the way for the orderly progress of standardizing circuitry. We at the Light Military Electronics Department of General Electric have standardized nominal supply voltages. It is intended that future designed circuits will be designed to operate on one or more of the preferred series of supply voltages. I have enclosed a Newsletter abstracting the standard as issued to our engineers. You will note I took the liberty of opening the Newsletter with thoughts provoked by your June 25th editorial.

I hope with your stimulation that the industry can begin to take some bold steps toward stand-

ardizing the design approach and such a step would be the wholehearted endorsement of The National Aircraft Standard 716, "Standard Power Supply Voltages."

We cannot afford to wrangle for years or even months over the pros and cons of circuit standardization and circuit packaging and at the same time permit designs to go into such diverse directions that virtually all past designs would be scrapped in order to evolve a compatible standard. By developing now the design standards (elements of design) which synthetically create interchangeability and compatability, we can much more readily standardize those functional circuits which incorporate the best features of reliability, performance and economy.

John T. La Forte
Engineering Standards
General Electric Co.
Utica, N.Y.

The Engineering Standards Newsletter, July 7, 1958 lists the LMEE Engineering Standard 616-1, which states: "Low D.C. Power Supply Voltages should be selected from one of the following series. Insofar as is possible, attempts to use the primary series should be exhausted before resorting to the succeeding series. All voltages are plus or minus.

Primary	Secondary	Tertiary
6	3	1.5
25	12	100
150	50	200
300	125	
	250	

"In June 1958 the Aircraft Industries Association distributed an advance copy of National Aircraft Standard 716, 'Standard Power Supply Voltages.' NAS 716 standardizes the same voltages standardized in the LMEE series with the exception that it does not include 125 volts."

Psychological Word-Fare

Dear Sir:

In your "Letters" section, you say, "The specialist's vocabulary continues to become more esoteric. How should we overcome this paradoxical situation?" (*ED*, Nov. 12, p. 15).

It is my belief that the trouble is psychological. We write, speak and lecture nowadays, not so much to tell about our developments, as to gain recognition—impress others. To impress others of our profession as well as the layman, it does not suffice to tell about what we have done in as simple a way as possible and in such a way that the discovery is of the maximum use to the

LETTERS

recipient. No, by camouflaging it in complex language, higher mathematics, formulas, etc., a relatively trivial development can be made into a "project." The three requirements an article, paper, or lecture must meet in order to have professional standing today is that it must be: 1. incomprehensible 2. useless 3. voluminous.

Anything not meeting these requirements is rejected by our learned societies and journals. Not only is this true in our own engineering profession, but also in others.

Our learned societies must recognize that, in order for communication both within and among the professions not to become impossible, these requirements must be reversed. A disclosure should be brief, understandable, and useful. The ideals toward which we must strive must be diametrically opposed to those now prevailing.

Dr. Henry B. Weisbecker
Director of Research
Manson Laboratories, Inc.
Stamford, Conn.

▶ Dr. Weisbecker's condemnations are harsh but unfortunately too often true. We at ELECTRONIC DESIGN certainly endorse brevity, understandability and utility as goals. We try to edit articles along these lines. We think the effort is necessary and worthwhile as the following letter from an author indicates.

Gentlemen:

In my opinion, the editing job on my article (*ED*, Sept. 3, p. 58) was high level. I was amazed at the condensation achieved with fundamental essence retained. Our company has a keen appreciation of technical writers and editors of this caliber.

The comments received to date on my article have been extremely favorable. We have received inquiries regarding our helix antenna from various parts of the country and some of the correspondence commented on the clarity and presentation of the article.

Our company officials, and our engineers, feel that ELECTRONIC DESIGN fills the gap between technician magazines and the *IRE Proceedings*. The level of ELECTRONIC DESIGN is technical, but not ostentatious. We also feel that your publication is highly readable and is probably more widely read by working engineers than any other magazine or journal.

Milton Nussbaum
Division Head
Antennas and Microwave
American Electronic Laboratories, Inc.
Philadelphia, Pa.

MEETINGS

Calendar of Events

January

12-14 5th National Symposium on Reliability and Quality Control, Philadelphia, Pa.

14 Special Conference, Rockefeller Institute, New York, N.Y.

26-29 27th Annual Meeting Institute of Aeronautical Sciences, New York, N.Y.

27-30 15th Annual Technical Conference (SPE), New York, N.Y.

28-29 1st International Symposium on Nuclear Fuel Elements, New York, N.Y.

29-30 Long Distance Transmission by Waveguides (IRE), London

February

1-6 AIEE Winter General Meeting, New York, N.Y.

2-6 ASTM Committee Week, Pittsburgh, Pa.

3-5 14th Annual Technical and Management Conference, Chicago, Ill.

8-14 National Electrical Week, New York, N.Y.

12-13 Transistor and Solid State Circuits Conference, Philadelphia, Pa.

17-20 6th Annual Western Convention, Audio Engineering Society, Los Angeles, Calif.

March

3-4 Western Joint Computer Conference, San Francisco, Calif.

5-6 Flight Propulsion Meeting, Cleveland, Ohio. (Inst. of Aero. Sciences)

5-7 Second Western Space Age Conference and Exhibit, Los Angeles, Calif.

16-20 National Meeting American Inst. Chemical Engineers, Atlantic City, N.J.

17-21 8th Electrical Engineers' Exhibition, London

23-26 IRE National Convention, New York, N.Y.

26 15th Annual Quality Control Clinic, Rochester, N.Y.

30-

April 1 Electrical Industry Show, Chicago, Ill.

31-

April 2 21st American Power Conference, Chicago, Ill.

31-

April 2 Symposium on Millimeter Waves, New York, N.Y.*

April

5-10 5th Nuclear Congress, Cleveland, Ohio

6-8 3rd Annual Astronautics Symposium, Washington, D.C.

6-9 16th Annual British Radio and Electronic Component Show, London

8-10 AIEE Southern District Meeting, Atlanta, Ga.

14-15 Electric Heating Conference (AIEE), Philadelphia, Pa.

(Continued on following page)

MEETINGS

April

16-18 Southwestern IRE Regional Conference and Electronics Show, Dallas, Tex.

20-21 Recording and Controlling Instruments Conference, Philadelphia, Pa.

22-24 AIEE East-Central District Meeting, Akron, Ohio

29-

May 1 AIEE Empire District Meeting, Syracuse, N.Y.

May

3-7 Symposium on Electrode Processes, Philadelphia, Pa.

4-6 National Aeronautical Electronics Conference (IRE), Dayton, Ohio

5-7 URSI Spring Meeting, Washington, D.C.

6-8 Joint Electronics Components Conference, Philadelphia, Pa.*

6-8 IRE 7th Regional Technical Conference and Trade Show, Albuquerque, N.Mex.

11-13 Joint Conference on Automatic Techniques, Chicago, Ill.

11-13 National Power Instrumentation Symposium, Kansas City, Kan.

18-20 Electronic Parts Distributors Show, Chicago, Ill.*

18-20 5th Annual National Symposium on Instrumental Methods of Analysis, Houston, Tex.

19-21 AIEE Middle Eastern District Meeting, Baltimore, Md.

25-27 National Telemetering Conference, Denver, Colo.*

25-29 International Convention on Transistors and Associated Semi-Conductor Devices, London*

*Indicates meetings herewith described.

Symposium on Millimeter Waves, March 31-April 2

Engineering Societies Bldg., New York, N. Y. This is the ninth international symposium of the Polytechnic Institute of Brooklyn, Microwave Research Institute under the co-sponsorship of the Air Force Office of Scientific Research, U. S. Army Signal Research and Development Laboratory, Office of Naval Research, and the IRE. Intended to highlight the present state of research in, and applications of, millimeter wave technology, the program will be devoted to the following topics: Interaction of millimeter waves and materials; Solid state active millimeter circuits; Millimeter electron tubes; Radiating circuits and antennas; Coupled line, multimode, and nonconventional transmission systems; Millimeter components; Millimeter circuit measurement techniques.

Joint Electronic Components Conference, May 6-8

Benjamin Franklin Hotel, Philalephia, Pa. Sponsors: IRE, EIA, AIEE, WCEMA. Theme; New Concepts for Space Age. Papers to be presented on the following general categories: components

and application in space vehicles; microminiaturization; mechanism of failure (operation) of components; new techniques for electronic filtering, tuning, and switching; components for military, industrial, and home appliance applications; and radiation effects, Contact Gen. E. R. Petzing, AGEP Secretariat, Univ. of Pennsylvania, 200 South 33 St., Philadelphia 4, Pa. for more information.

Electronic Parts Distributors Show, May 18-20

Conrad Hilton Hotel, Chicago, Ill. An expanded educational program for distributors designed to bring further benefits to the industry will be a special highlight of the show.

National Telemetering Conference, May 25-27

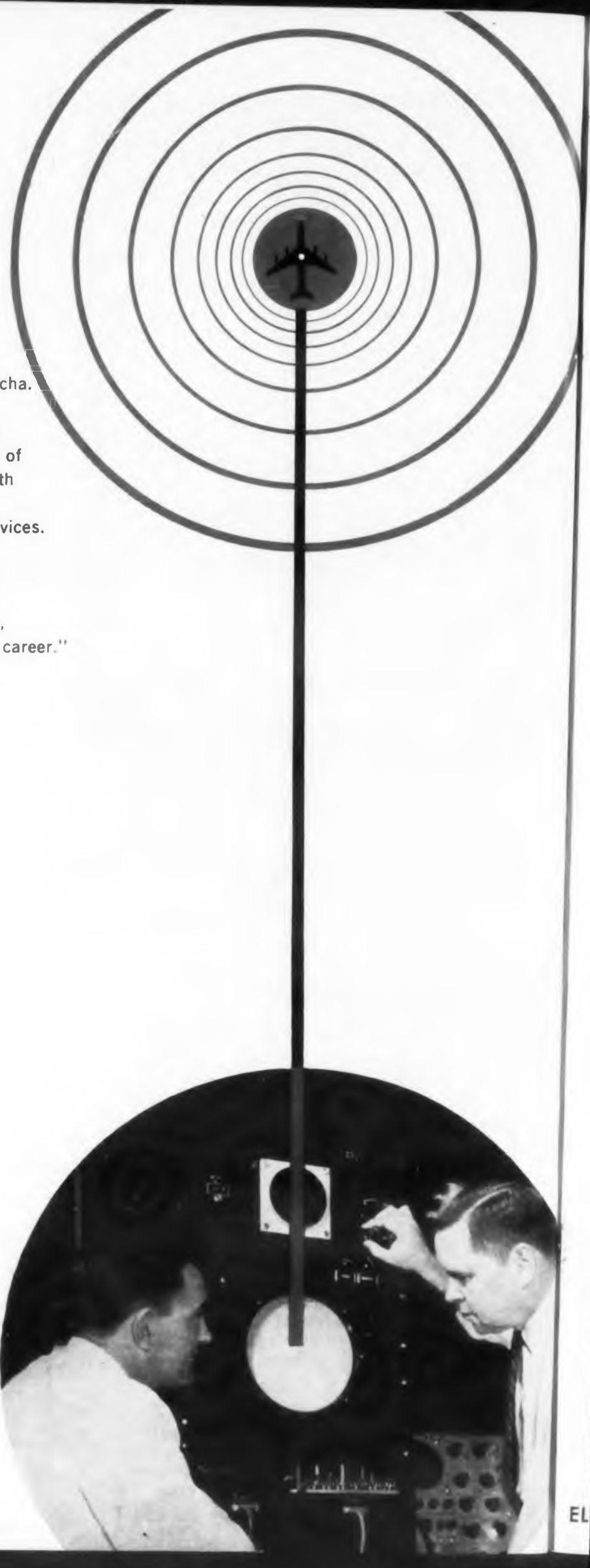
Brown Palace and Cosmopolitan Hotel, Denver, Colo. Sponsored annually by The American Rocket Soc., Inst. of Aeronautical Sciences, AIEE, and ISA. Theme: Investigation of Space. Twelve sessions are tentatively scheduled for the meeting including such subjects as: Special Telemetry Techniques for Satellites and Space Vehicles; Sub-miniaturization; Telemetering of Bio-Medical Information from Man in Space; Transistorization and Data Processing. For information contact Ralph Schmidt, AVCO Mfg. Co., 201 Lowell St., Wilmington, Mass.

International Convention on Transistors and Associated Semi-Conductor Devices, May 25-29

To be held in London, this convention has been organized by the radio and telecommunication section of Britain's Institution of Electrical Engineers to mark the 10th anniversary of the transistor. It will be the most comprehensive ever held on transistors and will cover design, manufacture, basic theory, characteristics, measurements, applications, and equivalent circuits. To provide the widest possible interest, the International Transistor Exhibition will be held at the same time. For details contact Industrial & Trade Fairs Ltd., Drury House, Russell Street, London, W.C. 2.

Seminars

Jan. 13: Clear Technical Writing. Hotel Sheraton-West, Los Angeles, Calif. **Jan. 15:** Hotel Sheraton-Palace, San Francisco, Calif. Conducted by Robert Gunning, authority on writing and readability techniques. Further information and schedules may be obtained by writing *Industrial Education Institute, 25 Huntington Ave., Boston 16, Mass.*



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- **Theoretical design & analysis**
- **Transistor circuits**

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SYSTEMS ENGINEER to design and analyze closed-loop systems of inertial and radar equipment, display materials, and computers.

Qualifications: Bachelor's or advanced degree in E.E. or Aeronautical. At least 2 years' experience in systems analysis. Additional experience desired in development of military devices—servomechanisms, radar or computers.

704 PROGRAMMER ANALYST to study data flow diagrams and write differential equations of a circuit diagram. To investigate analog and digital real-time control systems using digital and/or analog computer.

Qualifications: M.S. in Physics and 2 years' experience in control systems analysis and/or shielding techniques. Must know transforms, numerical analysis, and be able to construct mathematical model of a reactor.

STATISTICIANS to handle analysis-of-variance and multiple-regression problems. Design experiments for engineering applications and select the optimum form of statistical analysis. Assist engineering in areas such as reliability analysis and human factors engineering by developing statistical programs for the IBM 704.

Qualifications: M.S. in Statistics, with major work in math statistics. Minimum experience, 2 years, preferably with engineering applications.

SENIOR OPERATIONS RESEARCH ANALYST to apply advanced math techniques to weapons systems analysis and evaluation. Entails simulating tactics involving advanced weapons systems then deriving methods for evaluating operational effectiveness of alternate design concepts. Will work extensively with IBM 704 and other digital and analog computers.

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Senior Electronic Design Engineers—Experienced in development of logical design using standard computer elements, must also evaluate and design transistorized circuits including voltage regulated power supplies and circuitry related to decimal to binary coding. This data processing system is concerned with bank automation.

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Professional Personnel Section C,
The National Cash Register Co.
Dayton 9, Ohio

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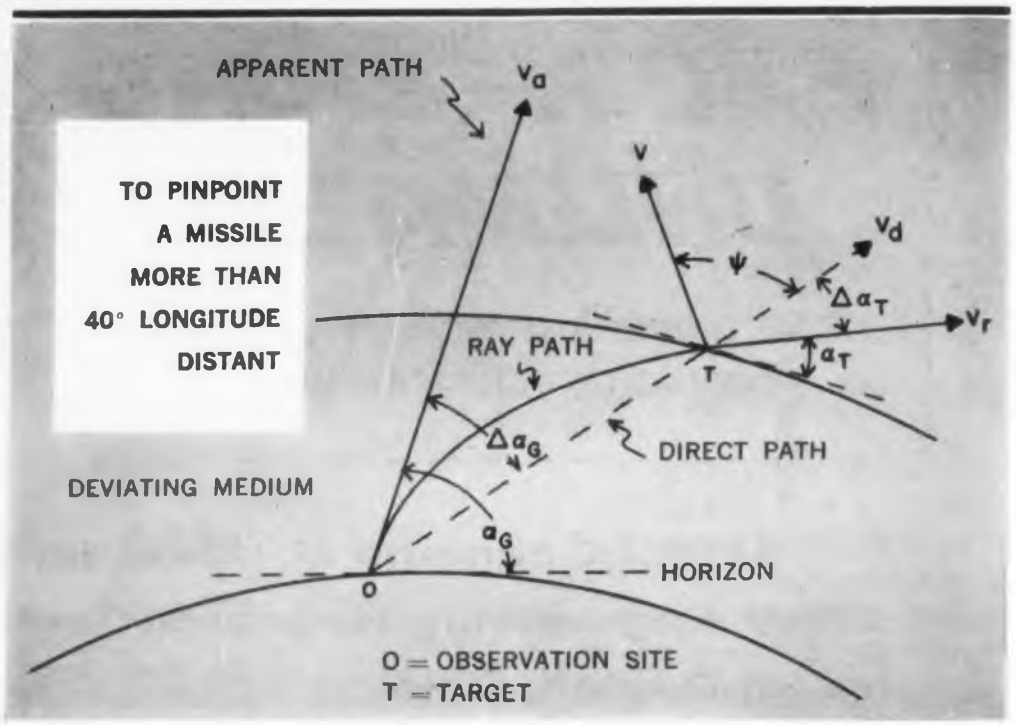

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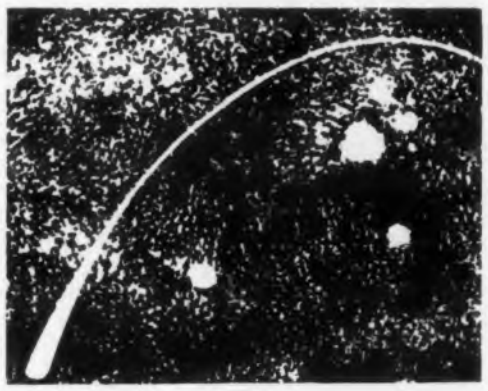

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