ELECTRONIC DESIGN

DECEMBER 24, 1958

CERAMIC-COVERED DIODE—
NEW CAPACITOR ELEMENT

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Design '59—A Challenge

What the design engineer should be working on in 1959 is the subject of a special report in the January 7 issue of ELECTRONIC DESIGN.

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Another year ends, one for the history books. Sputnik demonstrated Soviet scientists' superiority in propulsion techniques; Explorers' microminiaturization testified to sophistication of U.S. design concepts. Long strides were taken in radar, mobile communications, automatic testing and other fields. This review of the year's news replaces the regular Design Behind the News section.

Engineering Passes in Review

by

Ben Patrusky

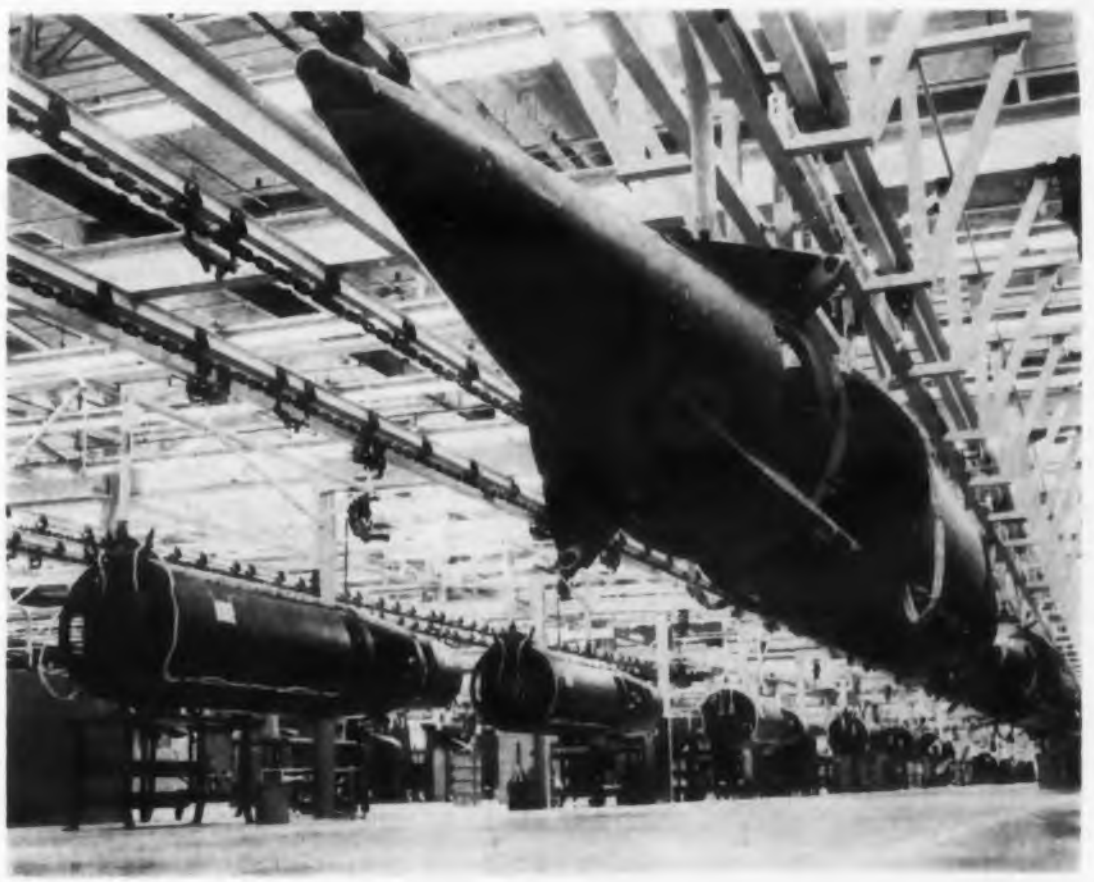
Satellite and Missile Electronics

THE RUSSIANS hurled a ton-and-a-half satellite into orbit this year, while America's heaviest weighed less than 30 pounds. Russia thus demonstrated its superiority in propulsion techniques, but it seemed likely that highly sophisticated U.S. design concepts eclipsed many the Soviets had developed. For lacking advanced propulsion capabilities, American engineers had been obliged to microminiaturize—to get as close as possible to designing instrumentation which occupies no space and is weightless.

Explorer I measured 80 in. and weighed 29.87 lbs. This is what it contained:

- A Geiger-Mueller cosmic ray counting tube and associated circuitry to count primary cosmic radiation. The apparatus was designed and built by the State University of Iowa. It also designed the miniature tape recorder which collected radiation information and played it back.
- Two micrometeorite detectors developed at the Air Force Cambridge Research Center. One was a set of 12 grids mounted as a parallel resistance network on the aft end of the fourth stage rocket motor. Variations in electrical resistance denoted micrometeorites collisions. The second was a microphone to record impacts of micrometeorites upon the exterior.

(Continued on following page)



Army Nike-Hercules is in production (top). Here it goes through final assembly at Douglas Aircraft Co. (Right) Convair's Atlas test fired at Cape Canaveral by Air Force.

Creative Microwave Technology

Vol. 1 No. 1

Published by MICROWAVE and POWER TUBE DIVISION
RAYTHEON MANUFACTURING COMPANY, WALTHAM 54, MASSACHUSETTS

NEW DEVELOPMENTS IN ELECTRONIC TUBES AND CERAMICS

Where abnormal conditions of vibration (25 to 2000 cps at 10G) are encountered, such as in advanced airborne applications, this pulsed-type X-band (9245 ± 40 Mc) air-cooled RK6967A/QK366A magnetron oscillator maintains exceptional frequency stability and operational reliability. Optimum performance is assured by a double-end supported cathode and aluminum-clad integral magnets. Nominal peak

power output is 100 kw at typical pulse conditions of 0.5 μ sec. (.001 duty cycle). The tube operates at a peak anode voltage and current of 15 kv and 13.5 amp. respectively.

CIRCLE 110
Reader Service Card

* * *

Integrally insulated semiconductors can now be produced by using high-alumina ceramic stem assemblies. Heat dissipating ceramic wafer (arrow) in the base insulates up to 2000 volts dc and withstands soldering temperatures as high as

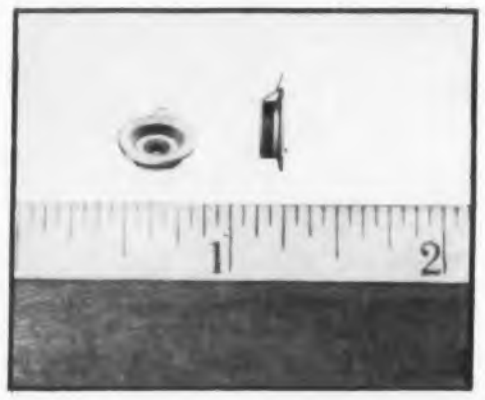
1100C. Bases can be directly mounted to chasses or cold plates. Stems are available to all semi-conductor manufacturers.

CIRCLE 111
Reader Service Card

* * *

Miniature gyro feed-throughs provide take-off points from gas-filled gimbal housings. These high-alumina, vacuum-tight, R-95 ceramic assemblies can be soldered to housings at temperatures up to 1000C. They also assure positive electrical insulation with leakage less than one microampere per 500 volts dc.

CIRCLE 112
Reader Service Card



A Leader in Creative Microwave Technology

RAYTHEON

Designed for voltage tunable CW or pulsed operation over the Government X-band (8500 to 9600 Mc), the QK-684 integral magnet backward wave oscillator delivers 10 to 50 mW over delay-line voltages ranging from 215 to 325 vdc. Regulation of a special control grid facilitates pulsed or amplitude modulation to meet power and frequency requirements. Models available for coupling to standard, type "N" connectors.

CIRCLE 113
Reader Service Card

* * *

Compiled as a Raytheon service to the field, new Consolidated Data Booklet contains comprehensive information about principal unclassified magnetrons, klystrons, backward wave oscillators and special purpose tubes manufactured by Raytheon. Characteristics presented include maximum ratings, typical operating values, band or frequency ranges and other essential data for microwave engineers and purchasing departments.

CIRCLE 114
Reader Service Card

Instrumentation package of Air Force Lunar Probe is joined to terminal rocket engine.

■ Four temperature gages, to read temperature at three different locations on the outer shell and the interior. These were designed by Jet Propulsion Laboratory.

■ Two radio beacons, to transmit data back to ground receiving stations. Two silicon-transistor transmitters used mercury battery power supplies. The higher power transmitter radiated 60 mw continuously at 108.03 mc for about two weeks. It weighed 2 lbs with its four telemetering oscillators.

The lower-power phase-modulated transmitter radiated 10 mw at 108.00 mc. This unit telemetered continuously much the same information as did the high-power unit. It transmitted for two months. The frequency-determining quartz crystal was mounted on a spin axis, transistors next, and power supply batteries were symmetrically arranged outside. The entire package was potted in plastic and tested to withstand 100-g steady acceleration and 15-g rms vibration acceleration.

Explorer II, which did not orbit, also contained the miniature tape recorder. The 1/2 lb 2.25 in.-diam memory device was designed to monitor cosmic particle impacts from all directions in space. Each second of recording time, a ratchet gear advances the 0.16 in.-wide magnetic tape about 0.005. As this 36-in.-long bronze tape is advanced, the return spring is wound. Playback is completed in 5 sec, the speed being damped by an eddy-current brake. The recorder then resets itself.

Transducers installed in Explorer III carried out the experiments intended for Explorer II. However, in the transmitting system, the turnstile antenna wires were eliminated. Instead, the stainless steel instrument case and motor case were wired and tuned to the higher-power transmitter. Thus they served as a dipole radiating antenna.

Similarly the nose cone and instrument case served as dipole radiators for the lower-power transmitter. Telemetered data included satellite external and internal temperatures, micrometeorite impacts, and cosmic ray counts, much the same as its predecessor had been designed to do. Explorer IV contains 18.26 lbs of instrumentation, all devoted to radiation studies.

The security lid is shut tighter than ever on the biggest and costliest earth satellite project to date. Lockheed Aircraft is the prime contractor for this project, the "Pied Piper."

Vanguard II's launching was "scratched" for 1958. But when the program is resumed, the Navy satellite will contain a two-way radio about the size of a loaf of bread. Known as DOVAP (Doppler, Velocity and Position), it was produced by International Telephone and Telegraph Corp. The 10 lb radio will send back data on the trajectory and velocity of the first and second stage of the Vanguard missiles.

Pioneer I, the first lunar probe, fell short of its goal by 66 per cent because of a 3.5 deg error in the gyroscope. Scientifically, however, the rocket was a huge success. The radiation detectors and telemeters worked well. The communications link also seemed to work well. The 400 mw transmitter appeared to be unaffected by distance, shock or environment.

The activity in missiles has been confusing, and it is not always clear which service and which contractor is doing what. Here is a brief listing of the number of missiles now under development or in production.

- Air-to-Air missiles—7
- Air-to-Surface missiles—7
- Anti-Submarine—5
- Surface-to-Surface—18
- Surface-to-Air—10

Labs across the country meanwhile are groping with the instrumentation problems accompanying man's space travel. In addition to medical man-in-space studies, there's been considerable activity in new propulsion techniques.

One of the most promising is magnetohydrodynamics (MHD). GE is busily engaged in R & D work in this area. It recently described a laboratory model of an MHD device, called, the "pulsed plasma accelerator," which can change space vehicle direction in flight. Electric and magnetic fields exert a force upon an ionized fluid much like rotor reaction in a motor. ■ ■

Communications

NARY a week went by during '58 that so "revolutionary" development in communi tions didn't break into print. It was an exciti year with significant progress made in rad mobile communications, and broadcasti

Radar

Perhaps one of the most interesting announc ments was Hughes Aircraft's "3-D" rad Dubbed Frescanar, the radar simultaneou computes distance, bearing and altitude of a borne targets. Scanning is done electronicall The antenna rotates but does not move v tically. By supplying a succession of frequenc to the antenna, Frescanar achieves what is, effect, vertical scan.

All available energy is concentrated in sha pencil beams of energy, flashing on and off fan-shaped array to pinpoint targets with treme accuracy. Data are transmitted electro cally to missile battery processing centers to rect missiles to targets more rapidly. The Ar states the new radar has 25-50 per cent bet range than radars with similar missions. T Navy installed similar radars on test ships.

Early in the year, a highly classified puls radar system was announced which permits tremely fast scanning and faster pulse repetiti rates. Resolution and range losses are minimiz Developed by W. L. Maxson Corp., details s remain secret. FASTAR also scans electronica in elevation or azimuth, or both.

By applying the technique of space or f quency diversity—common in communicatio

RCA's experimental Megacoder for high speed selective calling.

tems—to radar systems the French Air Force ieved marked improvement in signal-to-noise o. At least, those were the beginning-of-the- findings of the Intercontinental Electronics p. Fixed echoes are suppressed by elimina- with memory tubes. Spurious signals are inated by equipment designed to deal with random nature of background noise.

DuMont's 0-4000 mi. radar indicator pinpoints gets of interest by expanding the display in muth and range. Expansion of a range sector ariable from a 50 to 500 nautical mile sector azimuth can be 10 deg min and 350 deg max. uts to the indicator include radar video, sys- trigger, and antenna positioning by means a land 36-speed synchro system. Range and muth calibration markers are generated within indicator.

Westinghouse, last month, demonstrated a radar antenna which is capable of scanning ugh 360 deg without any motion of the an- na structure. Known as the Helisphere, it is er inflated like a balloon or of rigid con- ction like a plastic globe. Embedded on the ide urface are narrow conducting strips nd an endless spiral shape. Polarized radar ves om a rotating source splash against this face These waves are either reflected or sed y portions of the surface, developing a row canning radar beam. Particularly at long ge, igh power radar installations, the Heli- ere will eliminate problems of rotating mas- e a nna structures.

(Continued on following page)

Communications *(continued)*

One significant application of radar [sys]tem was demonstrated by Airborne Instr[u]ment Called Airport Surface Detection Equipm[e]nt. The system makes it possible to control groun[d] traffic in foggy weather. Clear images of all [veh]icles on the airport show up on a scope. Idlewild Airport (New York) has installed the system.

Microwave radiation is being converted into visible light. The Eyetron, as Diamond Antenna and Microwave Corp. calls the conversion device, produces on a screen scenes which are illuminated by or contain sources of microwave energy. A microwave collector separates incoming waves according to their angle of arrival. These waves are channelled into a precise location corresponding to the direction from which they came. An image corresponding to the appearance of the scene to the human eye appears on the screen.

Broadcasting

A compatible TV system which would enable two different programs to be broadcast simultaneously on the same channel was shown by Blonder-Tongue. Standard receivers equipped with special decoding circuit could pick up both signals. The FCC has yet to license multiplex TV.

RCA's experimental transistorized portable color TV uses less power than the sealed beam headlights of an auto. It can be operated from batteries or a fixed power supply. The laboratory system comprises a 20 lb camera using three 1/2 in. Vidicon pickups, and a 45 lb control and monitor unit. The system weighs 65 lbs. It was designed for closed-circuit applications. Over 300 transistors were used. Only the camera tube and a black-and-white viewing tube for monitoring are vacuum tubes.

Way back in January Motorola exhibited an all-transistorized battery-powered black-and-white TV receiver. Thirty-one transistors are used. Two rechargeable batteries provide 4 hours of continuous operation away from commercial power sources. Motorola has no marketing plans until 1960.

A unique TV antenna was designed by RCA. The traveling-wave antenna permits transmitted TV signals to travel the length of the section of antenna as complete waves. This characteristic makes for ideal shaping of vertical patterns, improved circularity, uniform signal distribution and simpler mechanical constructions. Gains from eight to 18 times are available.

Stereophony got big play this year. One stimulating development was announced just last month. It's RCA's experimental system which provides full stereophonic sound through a sin-

...er and dual speakers on a regular a-m ...dcast band. The single side band system, ...ver is still "years" from commercial pack-

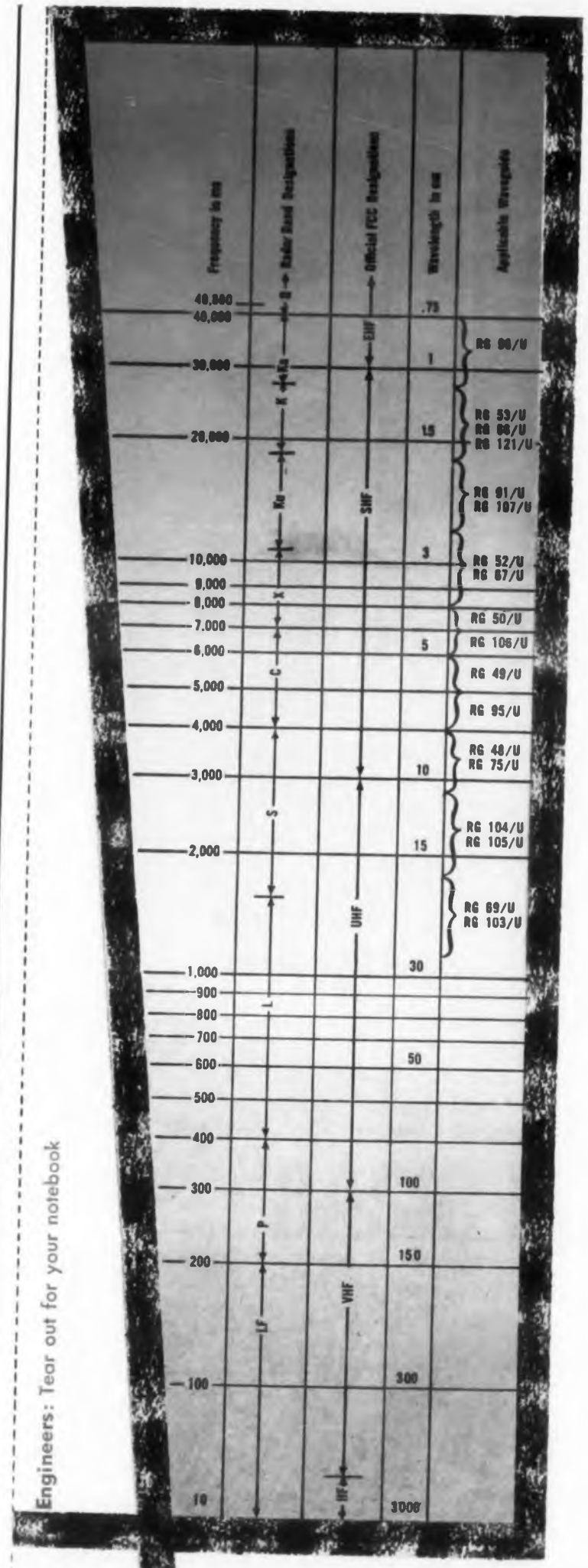
...the same RCA demonstration, a high speed, ...capacity ultracompact miniature decoding ...m was unveiled. The Megacoder permits ...tive coding of any one of more than a mil- ...radio receivers from a common transmitter. ...nsists of a microminiature array of capsule ...its that can be set positively or negatively ...rm a code. The device, only one cu in. in ...me, acts as a gate barring receipt of any but ...ingle correct signal. The system can operate ...eeds of 5000 or more codes per min.

...tivity in single side band has been dynamic, ... the Army announcing that at least half ...ts communications setup will go to SSB ...in five years. The Marine Corps has also ...ped up its study of SSB. Collins Radio Co., ...tern Electric and Federal Electric have sup- ...d equipments for the Army tests being held ...e strategic communications center in Puerto ... Avco Mfg. Co. finalized designs on a fully ...sistorized one-man portable radio with sev- ...hundred watts output for the Marines. The ... has also awarded contracts to Collins, RCA ... Westinghouse for SSB equipment.

...otorola developed and successfully tested a ... type SSB radio for the Army. Called AN/ ...C-66 communications central system, it pro- ...s a military commander with mobile "wire- ...telephone" service to include switching and ...ective calling to distances of 10 miles with ...per cent coverage. Seven kc is used for a ...e channel compared to the 100 kc per chan- ...needed in standard mobile communications ...ipment. The system operates in the 132-165 ...range.

...T&T early this year announced a multi-chan- ...SSB radio system which operates in the 900 ...region. Although designed primarily for line- ...ght transmissions, the SSB equipment is ...ptable to over-the-horizon microwave radio ...ugh the use of bigger antennas and larger ...er amplifiers. Development plans will push ...operating frequency to 2000 or more mc. The ...tem accommodates up to 120 telephone chan- ...s within a 500 kc bandwidth, allotting about ...c per channel. Total power required to oper- ...both transmitter and receiver is about 65 ...tts.

...Another interesting development was Motor- ...'s introduction of a two-way radio with a fully ...transistorized receiver. Dubbed Motrac, it uses ...transistors and weighs 25 lbs. The unit was ...developed for the 25-54 and 144-174 mc bands. ...The power supply is also transistorized. Printed ...circuitry is used. The transmitter requires five ...types. ■



Engineers: Tear out for your notebook

A look at IT & T's portable atomic clock. An atomic gas cell is surounded by magnetic shielding.

Instrumentation

PERHAPS the most pronounced progress in instrumentation came in the way of automatic test equipment. Equipment has been built or is being built for virtually every operation from missile guidance (at audio and ultrasonic ranges) to navigation-doppler radar (at K band). Missile and aircraft checkout equipment was the most publicized. But there was also a wide array of odds-and-ends equipment built covering a multitude of applications.

Sperry Runs RACE

Sperry Microwave Electronics concentrated on RACE (Rapid Automatic Checkout Equipment) for complete checkout of weapon systems. Currently several kinds of RACE systems are under development or in production for a number of weapon systems and associated component systems. Many of the modular components in RACE are being standardized so as to be applicable to several types of weapon systems.

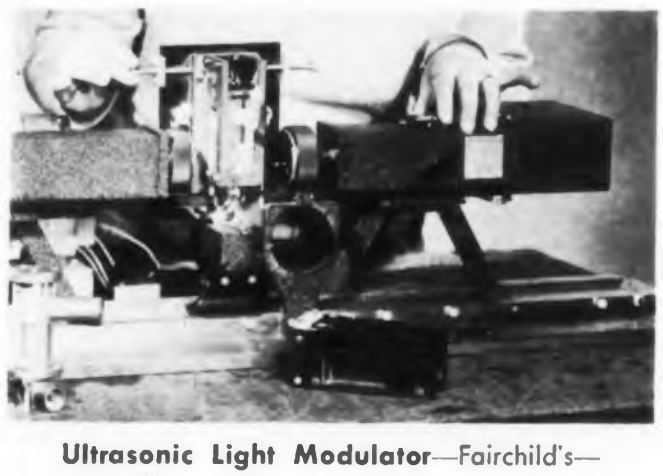
Sperry recently earned praise from Convair for a RACE system to check out the B-58 Hustler navigation and guidance bombing systems. Thirty minutes are required to check out these systems. All testing and fault location is directed by punched tape. Output is of "go, no-go" variety.

Taylor Packages SPAM

All-around checkout of any aircraft or missile package is possible with SPAM (Selective Programmed Automatic Maintenance). Taylor Engineering Co., Baltimore, Md., built it. This too is punch tape controlled. The tape tells voltage check points, and what voltages should be. Lights indicate whether the voltage levels are right, too low or too high. SPAM also includes a 5-in. scope for display. A filmed image of the correct voltage waveforms is superimposed on the scope for pictorial comparison.

Bell Rings with ASCAT

Electrical, hydraulic and pneumatic systems of guided missiles and airplanes can be checked with Bell Aircraft's ASCAT (Analog Self-Checking, Automatic Tester). Only two minutes are required by a single technician to check out a number of operations which previously required 10 men for more than an hour. ASCAT is a device voltage of "go, no-go" measuring unit.



Ultrasonic Light Modulator—Fairchild's—gives high revolution and dynamic range in radar recording.

Missile-laneous

Nike missile-men and other anti-aircraft crews are being trained in enemy interception and destruction, through electronic simulation of an actual attack. IT&T developed the simulator.

Under the direction of a control officer, various combat problems are simulated with the device, exactly as they might occur in actual attack—including the first identification of an enemy plane, "jamming" of signals by the enemy, tracking of the aircraft, "firing" of a missile and "destruction" of the enemy plane. The device can inject six synthetic aircraft targets into the control radars, with each of the simulated targets having the characteristics of extremely fast, maneuverable planes. Target speeds of up to 2300 mph with a maximum target range of more than 100 miles can be simulated. It can also simulate target altitudes up to 80,000 ft.; maneuvers, including climb rates up to 40,000 fpm and dive rates up to 80,000 fpm.

Several atomic clocks hit the scene. IT&T said its clock could be used to guide space travelers. It is not a wall fixture. It is small and light weight. Tests indicate the clock varies one second in 100 years. This error factor is expected to improve as the project continues.

The gas cell device uses optical pumping and optical detection. Atoms in vapor form—cesium and sodium—are acted on in a chamber by light and radio energy. The light comes from a vapor lamp using the same atoms as those in the chamber.

A Time Signal Generator is being used by Army Electronic Proving Ground personnel at Fort Huachuca, Ariz., to provide timing signals with an accuracy of 6-thousandths of a second per day. Timing signals record the time of day on magnetic tape, to provide event markers on special strip chart recorders. Coded time-of-day signals operate neon lamp drivers in remotely located instrumentation equipment. The generator was built by Electronics Engineering Co., Santa Ana, Calif.

A Look Across The Board

Here's a brief across-the-board look at some other developments.

An ultrasonic light modulator has overcome the shortcomings of crt displays—limited resolution and low dynamic range. Operation is based on the diffraction of light at ultrasonic wavefronts. Fairchild Camera and Instruments made it. Though applications remain classified some were suggested. The modulator may be used to obtain extremely high resolution and dynamic range in radar and video recording. It may also

e used as a high speed shutter. Here it would ve a speed of about 1/10 μsec. It might also rve as a correlator or analyzer in computer stems.

Westinghouse designed a "light chopper" to echanically chop light beams into "pieces" only billionth of a second in length. The chopper n be useful in studying "on-off" phenomena. lso under investigation is its use in picture scanng and in high-speed photography.

A new machine is automatically testing transtors to a degree of accuracy previously unown. The Stromberg-Carlson equipment proces any type of transistor through seven ccessive steps, at rates up to 430 transistors per our. Transistors which fail any one of the tests e ejected at the station which they fail. Thus e machine sorts rejected transistors according their defects. Accuracy is said to be within 2 per cent of the range.

Assistance to production line inspection of ansistors is being offered by a traveling wave cilloscope made by Edgerton, Germeshausen Grier, Inc. Boston, Mass. Waveforms of a high eed switching transistor (2N501) made by ansdale Tube Co. are being examined over a osed-circuit TV system with the aid of the cope.

Magnetic forces originating inside the earth d in outer space may now be measured far ore precisely than was before possible. The epartment of Commerce technique uses light bsorption. A beam of light is sent through a be containing a small quantity of vaporized bidium. The manner in which the light is abrbed indicates the strength of magnetic fields. ccording to Commerce Dept. officials, the inruments embodying the principle will be simle, lightly miniaturized and capable of measurg very small magnetic fields—"perhaps one illionth of the force developed by the motor hich runs an apartment elevator."

A unique development in digital voltmeters as a six-digit device developed by Non-Linear stems, Inc. Voltages from 0.0001 v to 100 v ay be measured automatically at approximately readings per min. Numerical readout is on the ont panel. The voltmeter was built for the ation l Bureau of Standards and is not slated r pr duction.

Dur ng this busy year now ending, Tenney Engin ering and Westinghouse were just two of any manufacturers who came up with a huge ray environmental test chambers.

RC developed a noteworthy testing device. The mpressed Air Loudspeaker generates the orld loudest controlled noise to test sensitive lectr nic gear. Noise levels of 160 db can be gener ed in the plywood box measuring 5 x 5 x 2 3 ■ ■

Pictorial information (below) is ocesse at National Bureau of Standards. BS a Bell Labs also working on TV and S eech search with computers.

Data Processing

IT WOULD take a pretty active computer to process information on developments in data processing this year. There are computers everywhere doing just about everything—and more. A complete machine tool line has been automated. A computer corrects its errors. There's even a machine that thinks.

Perception is the thinker. The Office of Naval Research unveiled plans for this machine, which perceives, recognizes and identifies its surroundings without human control or training. It has demonstrated its ability to perform what no machine previously has done—conceive an original idea. Perceptron generates a spontaneous concept based on its observations of visual forms and attaches meaningful symbols to things which it senses. A pilot model is now being built. The original demonstration used the IBM 704 to simulate the Perceptron concept. The first model will probably use a TV-like device to "see" with. Perceptron was developed at Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y. No practical applications are expected in "the immediate future." However, applications of Perceptron as automatic landing systems, missile and space vehicle guidance systems, library research, and scientific data gathering seem clearly indicated.

The first Semi-Automatic Ground Environment (SAGE) center went into operation at McGuire Air Force Base, N.J. More than 30 SAGE sites will be made operational within th next few years. SAGE will be a vast, interco nected network of air defense direction cente which will receive information from ma sources, process the information rapidly on hig speed digital computers, and generate battle o ders to jet interceptors and other weapons in t air defense system.

Hughes Aircraft revealed its completely aut matic punch tape control of a machine tool li It's the first. Machines can work on a series successive operations and make a variety of pa at the same time with the Digitape syste Changes in operations may be introduced or pr duction may be started on new parts by cha ing tapes without stopping the machines. T system makes available mass-production te niques for small-lot production.

The Datamatic Div. of Minneapolis-Hone well built a system which automatically corre errors being entered into its computer tape fil Orthotronic Control re-creates source data computer speeds the instant it is read into t computer. The system works with the Datama 1000 computer. It uses the 32nd channel on t 3-in. magnetic tape used in the computer me ory system. Thirty-one channels store data.

Special adding circuitry check the tape tra versely. A binary zero is written in the 32 channel if the sum of the other 31 bits is n ev

...mber. ... one signifies the sum is odd. A ...ghted ...inary check count is inserted in each ...nnel ... ter every 48-bit word. If the machine ...rects a... error in a channel, a comparison with ... 32nd ...channel shows which bits are wrong. ...ere a... error is detected, the system inverts the ...ary d...git. Further verification assures that ... corre...tions are authentic.

...Handw...ritten numbers can be read by a device ...veloped at Bell Labs. Numbers are recognized ...they are being written and the device indi...es the numeral by lighting up the correct ...t on a numbered panel. With some modifica...ns the equipment could be used to read hand...itten letters. The size of a typewriter, the ...vice works off a flashlight battery.

...T&T developed an aerial automatic caption ...ter. The Digital Data Recording Device re...ds in code the speed, location, altitude and ...er pertinent data directly on the photographic ...n as the camera plane speeds over its target. ...was made to "meet the demands of jet-age ...otography." The device continuously takes ...ormation from the plane's instruments and ...plays it on a one-in. crt in the camera's field ...vision.

...A lot of work is being done in speech and ...torial research using computers as simulators. ...th Bell Labs and the National Bureau of ...ndards are actively engaged in this area. ...neral-purpose digital computers are being ...d. The object is to understand the nature of ...torial and speech information to make trans...sion of information more efficient.

...From the University of Texas came news of ... impedance computer which provides auto...tic determination of network characteristics. ...measures impedances, admittances and trans... functions of networks rapidly. The computer ...tains an oscillator which provides the driving ...ction, automatically sweeping through the ...ired frequency range. The devised informa...n is obtained on a complex plane plot.

...The British Broadcasting Corp. announced a ...eotape recorder which is said to be consider...y cheaper to operate than comparable Amer...n units. Designated VERA (Vision Electronic ...cording Apparatus), it uses a standard 1/2 in. ...gnetic tape. The comparable American make, ...t out by Ampex, uses 2-in. tape.

...VERA records along the length of the tape as ... nor...nal sound recording. The reproducing ...ad p...rmits pictures to be monitored while re...rdin... is taking place, a facility which is not ...liev...d to exist in other equipment. Video ...que...cies are separated into two bands. Each ...rec...rded on different tracks. Sound is put ... a ...hird. The machine accommodates tape ...els ... 1-1/2 in. in diam. for 15 min. recording. ...pe ...peed is 200 in. per sec. ■ ■

Components

ELECTRONIC components manufacture broke new ground in the past year, working generally in four major areas. They improved existing components. They came up with brand new components. They reduced the size of components. And they designed components for higher operating temperatures.

To list all the companies, and their work, is impossible. The field is too big. Those mentioned have been arbitrarily selected.

Hot Stuff

There are very few components available for 200 C operation and even fewer for 500 C operation. Pressed by military needs, however, the search for components to operate at higher and higher temperatures goes on.

A thermistor which could operate continuously at about 650 C was announced by Fenwal Electronics, Inc. About 300 C was the limit for previous thermistors.

General Electric developed a vacuum tube not much larger than a shirt button which operates at ambient temperatures in the 600 C range. An interesting feature was that the cathode heating was supplied by the high ambient temperature. There was no filament in the tube. The tube is not commercially available at this time.

Using gallium arsenide, the Radio Corporation of America developed a microwave diode that will operate effectively above 572 F. The laboratory unit beats silicon rectifiers which operate at a maximum of about 392 F.

The key to high temperature components is development of materials which can stand heat. And research is essentially a slow process.

It's Little Things That Count

Everyone and his competitors, it seems, is out to make components tinier—and better.

Miniaturization sometimes has confusing results. A tiny silicon rectifier is smaller than its germanium predecessor. But the heat sink required for the silicon unit eats up the space saved.

Never eless, a big need for small components emains.

The Radio Corporation of America is develop- micromodules. These electronic units, de- gned for avionic equipment, are expected to rovide a 90 per cent reduction in the size and eight of components. Modules consist of 3 in. submodules. Each submodule is made from ceramic plate and mounts one or more compo- ents with flat shapes.

Lumped constant delay lines suitable for ansistor and printed circuit applications are vailable in 1 in. x 0.4 in. cases, manufactured by alor Instruments, Inc., Gardena, Calif.

A tantalum capacitor which measures less than 16 in. in diameter and a little longer than 1/8 in length is produced by P. R. Mallory & Co., dianapolis, Ind. They're available in ratings of to 10 μf and 1 to 10 v.

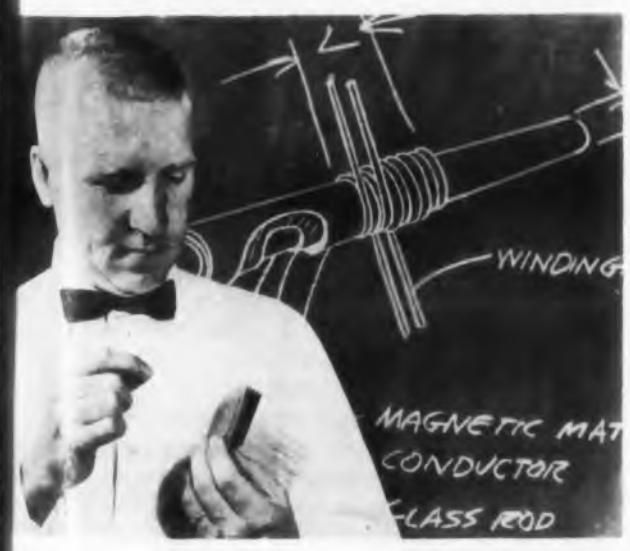
National Cash Register developed a pin-sized emory device, a glass rod with magnetic coat- g, which serves as both switching and data orage element and promises to increase "think- g" speeds of future computers 10 to 20 times. esearch models had switching speeds of 4 illimicrosecs. The rod lends itself to cheap ass production techniques, both in fabrication nd testing.

And so the story goes. If something is small it miniaturized. If it's miniature it's made peanut ze. And if it's peanut size, it's made pea size.

Something New, Something Old

Thousands of new products were announced uring the year. In general, it was a big year for lid state devices. Here are a few products that ade people sit up and take notice.

The maser oscillator was put on the market by e Polytechnic Research and Development Co., rooklyn, N.Y., for the first time. For about $7000



iny M CR **magnetic rod** providing high switching peeds s inserted in a memory assembly to show ease f fab cation.

you could generate a signal at 23.8701924 kmc ±0.0000005 kmc. Stability of the unit was better than one part in a billion.

Then there was the silicon controlled rectifier by General Electric. Sample models created a stir in the industry but they weren't available beyond sample lots until now. The solid state device acts like a thyratron and can handle up to about 60 amp.

A four-layer switch, ten times faster than most switching transistors, was made available by the General Transistor Research Laboratory. It had a switching time of from 0.03 to 0.05 μsec. and was designed for driving memory cores.

Ohio Semiconductor, Inc. and Westinghouse experimented with an 80-year-old principle: The Hall effect. Both companies came out with devices that took advantage of this principle. The devices generated a voltage as a function of the current and a magnetic field passing through the unit. Ohio Semiconductor called theirs the Halltron, and Westinghouse called theirs the Hall Generator. Same thing.

Ohio Semiconductor went one step further. Using the Hall effect, they developed the Magneto-resistor. This unit changes its resistance as a function of the field passing through it.

Westinghouse also developed what they called the silicon Trinistor triode, which is a high power switch. Still in the laboratory stage in the early part of the year, these units were capable of blocking up to 200 v and carrying up to 10 amp. From the on to off time, the unit is ten times faster than that of a comparable transistor.

Another component still in the laboratory stage was the constant-current varistor. Work on it is being done by Bell Telephone Laboratories. This two-terminal passive semiconductor is applicable as a current regulator where load or supply varies from 20 to 120 v. It can be used as a coupling choke or ac switch.

The Wamoscope, developed by Sylvania, has

Transistor-size ceramic vacuum tubes made by GE operate at 600 C.

a traveling wave tube in its neck. Developed for radar applications, the Wamoscope serves several purposes. It amplifies microwave signals, detects them and provides a video display.

The cathode ray tube is an example of an old component which was improved. CBS-Hytron developed a 5 in. unit which had a resolution of 6000 lines. With it radar can be improved to compensate for the rapid transition in aircraft speed.

Work was also done to improve sampling switches. The Roto-Jet, developed by Normal Hardy Assoc., was placed on the market. Operation of the device depended entirely on a jet of air blowing against one movable contact.

Sylvania made available a ceramic-in-glass "stacked" electron tube. The ceramic was used for spacers and in the post for mounting internal elements. Use of ceramic helped the tube stand extreme vibration, shock and fatigue.

And Lockheed Missile Systems announced a "fuel cell" which attains unprecedented efficiencies in electrochemical conversions and "could revolutionize conventional propulsion systems." Almost 100 per cent fuel utilization and 70 per cent energy conversion efficiencies were reported achieved in lab tests. Electrochemical fuel is stored outside the fuel cell so cell components are not consumed in the electrode reactions.

What Interested the Engineer

Meanwhile, back at the office, the engineer pored over his copy of ELECTRONIC DESIGN. When he was finished with each issue he sent back his inquiry card and asked for more information on new products that interested him. We've scanned his inquiries and here are our conclusions.

In general, transistors interested him most. Inquiries for the Transistor issue of ELECTRONIC DESIGN were about the same as in the previous year. Whatever he was building, the design engineer was either using or considering the use of transistors. Interest was also high in other basic components such as resistors, capacitors, inductors, tubes and diodes.

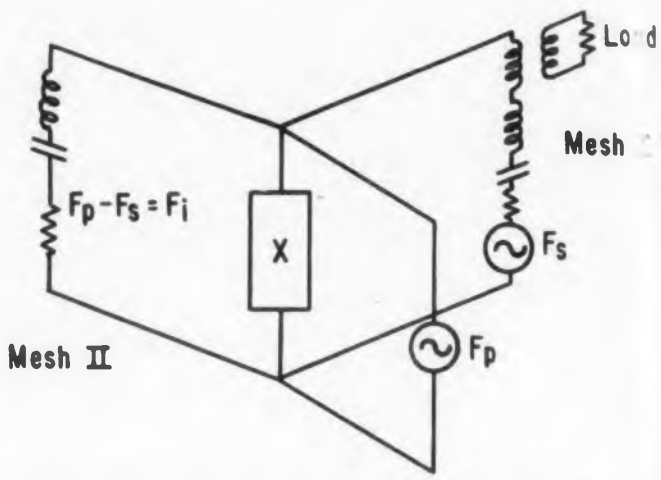
Of course, this interest in basic components could be expected of ELECTRONIC DESIGN readers. As design engineers, they're primarily interested in components with which to build their own equipment.

But they needed other units too. Next in interest were what could be subassemblies and accessories. Units such as amplifiers (all types), filters, power supplies, servo and synchro units, connectors and wire ran a close second.

Naturally, whatever was built had to be tested. Meters, all kinds of meters, and oscilloscopes, and measuring devices ran third insofar as the design engineer was concerned. ■ ■

Engineering Passes in Review

Microwave Amplifiers



Schematic representation of parametric amplifier.

THE LOW NOISE solid-state microwave amplifier field has been one of the most exciting news hatcheries this year. It is estimated that anywhere from 100 to 150 facilities are seriously engaged in R & D activity. And a booming dollar business is expected in three years—perhaps $70 million dollars worth.

Applications, however, remain classified generally but certainly their use in radars, radio astronomy, telemetering, scatter and satellite communication are logical speculations.

Basically, there are two kinds of solid-state amplifiers—masers and parametric amplifiers (mavars).

Masers are low power devices operating under cyrogenic conditions at a 1 db or better noise level. Parametric amplifiers require no cooling. They offer noise levels on the order of 3 db.

To many engineers these microwave devices are still sources of confusion. Some of their general characteristics:

Masers: Masers depend on electron energy within individual atoms or molecules. When these electrons interact with a microwave field they can exist only at a discrete number of energy levels. At various frequencies electrons can absorb energy or emit energy by jumping to higher or lower energy levels. The trick is to put more energy out than is absorbed.

Until recently masers were operating with gases to achieve the molecular energy exchange. A short time ago, Professor N. Bloemgarden of Harvard proposed an effective technique whereby solid-state materials could be used in maser work. These solid-state masers provide much larger gain for a given bandwidth than the gas type. Another useful property is the tunability obtained by using paramagnetic salts as the active material.

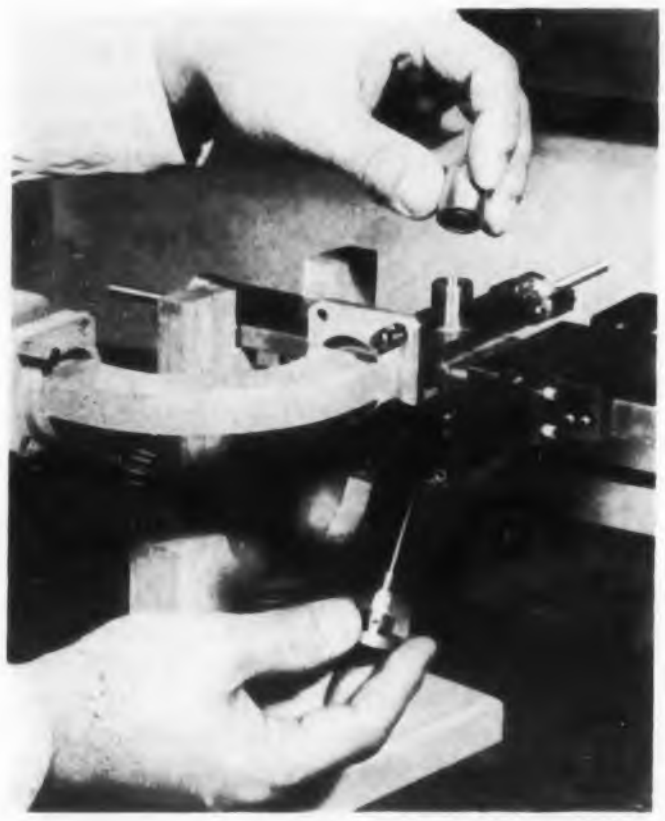
The frequency of these salts can be changed by varying the magnetic field strength. The salt is placed in a high Q cavity. Electrons within the structure assume various energy levels depending upon the salt used. With an increase in energy levels, the electron population of each level decreases. Most cavity-type research is with three-level devices. Westinghouse, Stanford University and the University of California are working on two-level devices. There is also activity in four-level masers by Varian and Ewen Knight.

Here's how a three-level maser works: A pumping signal with a frequency corresponding to the energy difference between the lowest and highest energy level is supplied by an external oscillator (a klystron is often used.) Electrons then jump from the lowest to the highest energy level. Electrons in the highest level jump to the intermediate level because of impurities in the crystal. This middle level then becomes over-populated compared to the lowest level. Application of an input signal corresponding to the energy level between these levels results in amplification.

In a four-level device pumping frequencies correspond to the energy differences between levels one and three and two and four. The output is the difference between levels two and three.

Work with cavity-type masers has been abandoned at Bell Telephone Labs because of development of a traveling wave maser. This slow-wave structure produces wide-amplifying bandwidth by variation of the pumping frequency and the magnetic field. The device also offers gains which are much higher than cavity-type offerings. BTL scientists report that the TWM can be tuned over a 350 mc range centered at 5.9 kmc.

Here's a capsule review of some present maser activity:



IT & T's parametric amplifier (above) extends microwave links 100 miles over present 250-mi. limits. Silicon diode (inset) is heart of amplifier.

Bell Telephone Labs' parametric amplifier (left) uses semiconductor diode (varactor diode) as the non-linear capacitor.

lumbia University—Developing an infrared ser to produce oscillations in infrared range. ecently, one of their solid state masers was talled in the Naval Research Labs' 50-ft tele-pe. This represents one of the first practical s these devices have been put to.

A—Trying to develop new crystals with the of chemists under a Signal Corps contract. building a solid-state maser with K-band mp and X-band amplification.

ian—Working under Government sponsorship. jects include: three-level solid-state maser 88 kmc operation; exploring titanate crystals maser use.

versity of California—Engaged in developing ed two-level solid-state device using mag-ium oxide; further along is a three-level ruby ser (X-band).

lco—Researching three-level solid state TWT ser; has developed molecular beam double ity-type maser, reportedly first cavity maser how one-way gain of molecular energy.

versity of Michigan—Operated three-level ser in the S-band. Working on four-level ma-. Using three-level ruby maser (K-band pump, and output) in noise studies on their radio scope.

stinghouse—Working on two-level and three-el masers in C and X band under a Wright -Development Center contract.

neral Electric—Recently built three-level de-using pink ruby for X- and S-band operation.

Parametric Amplifiers: These devices operate mirably at room temperature and do not re-re the liquid helium coolant temperatures K) to achieve their low noise characteristics. here maser operation is determined by mole-lar or atomic energy interchange, the mavar pends on energy stored in a circuit element h as a capacitor ferrite, or inductor. Perhaps best explanation can be achieved with the of a schematic of a parametric amplifier, ich is shown here.

In the circuit currents from the pumping rce (F_p) and from the signal (F_s) flow in the linear reactance (X). The two currents mix produce sideband currents, F_p and F_s. Mesh is tuned to the lower sideband, i.e. $F_p - F_s \approx$ Only this component of current can flow in sh II. It adds to the current already present the mesh. In turn this current (F_i) mixes with source current and has a lower side band at For positive feedback it has been found that current in both meshes builds up to a level termined by circuit losses and source power. ove the critical source power necessary to com circuit amplification is obtained.

Some of the representative developments in amagnetic amplifiers are depicted in the ac-mpanying picture spread. ■ ■

Production Processes And Materials

A SLEW of new production processes and materials took prominence in the industry during the year.

Three of the newest developments in production processes have come from Bell Telephone Laboratories.

One, a floating zone method for growing single crystals of binary semiconductors, looks superior to other crystal-growing techniques. Basic experimental work was done on gallium arsenide. But the method should be applicable to a variety of compounds which are thermally unstable at their melting points. The compound, however, must have a high enough thermal conductivity to allow heating by rf induction. Also, surface tension and density of the molten material must be such as to support a molten zone during the process.

In the basic floating zone refining technique, a rod is supported vertically. A heat source (an induction coil operated at radio frequencies) is moved relative to the rod. It melts a liquid zone as it moves. Surface tension supports this zone.

Crystal growing equipment used in Bell Labs' floating zone process. Molten zone of a gallium arsenide rod is examined during crystal growing experiment.

Also From Bell

In Bell's second development, downtime of equipment such as that used used in the manufacture of printed circuits is eliminated by a process for continuously regenerating copper etching solutions. The proces does away with the dangers inherent in changing corrosive spent etchants. It also makes it possible to salvage the etched copper.

For its third contribution, Bell conducted research which indicates that cathode metal sputtering may be useful in producing precision printed circuits. Entire circuits, included resistors, capacitors and leads, may be laid down. In this technique ionized gas molecules bombard a cathode, dislodging atoms of metal which then redeposit on nearby surfaces.

Earlier in the year, a machine which winds coils on toroidal cores almost invisible to the naked eye was designed at Stanford Research Institute. The wire forming the coil is made to pull itself through the hole or holes through which the coil is wound.

A process for electroplating copper on aluminum strips and wire was developed at Sylvania. The technique permits plating of strips in widths up to 10 in. and thicknesses of 0.008 to 0.050 in. Thickness of the copper plating ranges from flash coating of 0.002 in. per side.

An ultrasonic continuous seam welder—reportedly the first fully automated—joins any two similar or dissimilar metals. Gulton Industries was the designer. Welding is the result of a plastic flow at the interfaces of the two metals below the melting point of either. There are eight welding heads which can weld at a rate of 200 in. per min.

New Materials, New Products

Development of new materials is important for two broad reasons. First, new materials often lead to unique new products. Second, new materials are needed to meet the severe environmental stresses in military applications.

Indium antimonide is an example of a new material which is used in a unique new product—new at least in terms of the development of suitable indium antimonide. Using this material, Westinghouse and Ohio Semiconductor, Inc., developed a solid state component based on the Hall effect. This effect, though known for 80 years, could not be turned into a commercial product until suitable materials were developed. The device manufactured by the two companies produces a voltage as a function of the current and magnetic field passing through it.

Employing gallium arsenide, a new suitable material, RCA Laboratories developed high-temperature semiconductor devices. The material is used in transistors and experimental microwave diodes and power rectifiers.

For use as a light weight free flowing filler, hollow silicate glass microspheres were produced. They look like ground sand and are manufactured by Emerson & Cuming, Inc. Dissipation factors as low as 0.008 are achieved when the microspheres are used in low-loss material. This material has a low density and low conductivity.

For molding and extrusion purposes, Teflon 100X fills the bill. It is a pefluorocarbon resin. Operating temperature limit of Teflon 100X is approximately 450 F. However, when used in injection or transfer-type molds, it may be preheated at 750 F and cooled at 400 F. It has low-loss properties and can be combined with inorganic fillers to provide rigidity and dimensional control.

Penton, manufactured by Hercules, is not affected by moisture pickup and may be used as a coating material. It is a high molecular weight-chlorinated polyether thermoplastic. Penton has a strong resistance to abrasion, excellent dimensional stability and may be easily fabricated.

In high-humidity electrical applications, Orlon filled diallyl phthalate (DAP) is an important new material. Two manufacturers are the Food Machinery and Chemical Corp. and Mesa Plastics. Among the material's features are its arc resistance, low loss and dimensional stability.

Insulating Under Stress

A silicone resin rubber tape has several good properties for insulation purposes. It can stand ozone, vibration, shock and moisture well enough to be used in big motors and generators. The tape is a product of Moxness Products, Inc.

As brought out at the recent first National Conference on the Application of Electrical Insulation, the greatest advances in recent years have been the development of the silicones and fluorocarbon materials. To meet today's ultra-high temperature requirements these substances, along with the newer plastics, are being combined successfully with the traditional insulating materials. ■ ■

EDITORIAL

Peace on Earth, Good Will To All Men – A Proposal

The marvels of electronics described in preceding columns have been largely designed with the aim of saving Western mankind. If Western man is kept safe, if the deterrent effects of his weapons capability staves off Armageddon, there will be "peace on earth."

History unfortunately records that most weapons developed by man have been called upon to kill. The end objective of weapons –that of maintaining the peace–never has been fully realized.

We can only hope that our arsenals will not lead to destruction, that they will remain a deterrent to all-out war. With the advent of electronic controls, the difference between a deterrent and destruction is the flick of a switch.

The precarious balance can be swung to peace if "good will towards all men" becomes operative, if it becomes more than a seasonal ideal. A great amount of good will could be given the world–given both our enemies and our friends–if we were to share those electronic marvels now saving men here, electronics for medicine.

The limited exchange of scientists and engineers between East and West already has done much to generate understanding and feelings of good will. Where "security" was at stake, however, both sides have held back. In the area of medical electronics, "security" is not a factor and there can be full giving on our part.

Nor need we concern ourselves about receiving as much or more in return. Our good will need not be confined to a few guarded overtures made from time to time by a State Department official. It can be a genuine effort, made with no thought of repayment–an effort to make the marvels of electronics available to all mankind.

International cooperation in the field of medical electronics got a start this year through the efforts of Dr. Vladimir K. Zworykin of the Rockefeller Institute's Medical Electronics Center. But there are vast problems to be surmounted before the program can go into full swing–problems of money, of labor, and, importantly, of planning. National and international committees of doctors and electronic experts, in equal partnerships, must be set up.

The engineer can participate, for example, by joining the IRE Professional Group on Medical Electronics. And to the engineer engaged in weapons development who may be pondering the meaning of his work, an avocation in medical electronics possibly could add the dimensions he seeks.

To the individuals who already have given much of their time to this work, we can appreciatively pay tribute at this season for their acts of good will to all men.

Microwave Test Instruments

Part 2
Signal Generators

David Fidelman
Roslyn Heights, N. Y.

Different types of microwave instruments were described in the first part. It included a complete list of manufacturers of microwave instruments. In this second part, signal generators are taken up. They are classified into different types and discussed both as a source of signal power and as an accessory to supply a calibrated signal for comparison purposes.

IN ALL measurements on passive sections components of a microwave system, a sig generator is required as a source of signal po for the measurement. A signal generator is normally needed when making measurement units which produce microwave signals such oscillators, or in making noise level measu ments. But, it is often used as an access instrument to supply an accurately calibra signal as a reference for comparison purpo Measurements which require the use of a sig generator include: receiver sensitivity; selecti or rejection, signal/noise ratio; gain-bandwi characteristics, conversion gain; antenna g transmission line characteristics, filter netw characteristics; for driving bridges; and slo line measurements.

A signal generator is designed to give output of known frequency and power, wi wide range of power and as wide a range frequency as possible. Up to frequencies of a hundred megacycles, signal generators relatively easy to build; frequency ranges very wide (2:1 or more), power measurem can be made by the use of diodes as g voltmeters, and variable power output is poss by use of resistive ladder-type attenuators u about 100 mc, while above 100 mc the piston used with loop or probe coupling. Microw signal generators are more difficult to make, there are a large number of excellent u commercially available. In all measurements final measurement of power is by bolometer thermistor. But a power monitor is often inclu to avoid the necessity of frequent cal measurement. Tables 1 through 4 list manufa turers of K, X, S, L band signal generators.

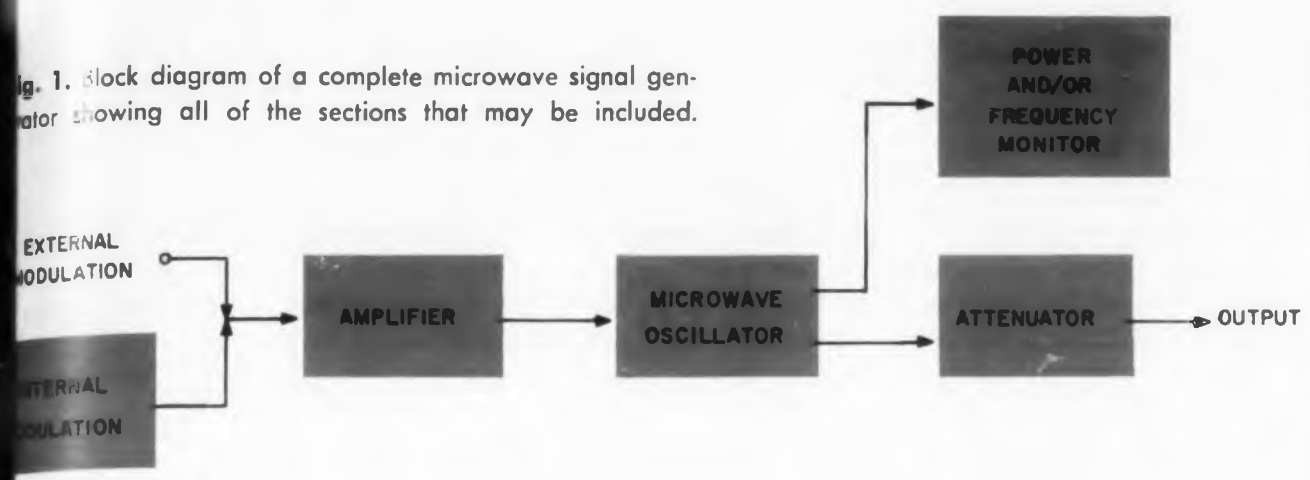


Fig. 1. Block diagram of a complete microwave signal generator showing all of the sections that may be included.

Types of Signal Generators

Signal generators may be divided into a number of different types. The block diagram of a complete signal generator containing all the different sections that may be included in commercial units is shown in Fig. 1. It may include all of the sections shown, or in its simplest form it may consist merely of an oscillator and a tuning mechanism. Another class of signal generators, shown in one form in Fig. 2, includes a frequency meter and a power meter, which may be used for measurements of frequency and power independently of the signal generator operation. This type of unit is generally called a test set.

Low Frequency Measurements

Oscillators for use at the lower microwave frequencies generally consist of an oscillator tube and a resonant cavity, or coaxial line. A typical lower oscillator which is suitable for use up to frequencies of about 2800 mc consists of a disc-seal triode in a grounded-grid oscillator circuit which uses two independently tunable concentric coaxial lines as the resonant circuit elements. The lines are tuned to one-quarter or three-quarters of a wavelength depending upon the operating frequency, and cause the unit to act as a tuned-plate tuned-grid oscillator.

Feedback from plate to grid circuit is obtained through small loops or capacitive probes which couple energy between the two cavities, and the power output is taken from a loop or capacitive probe coupled into the plate cavity. This type of oscillator can produce appreciable power, ranging from 30 watts or more at 1000 mc to 3 watts or more of cw at 2500 mc.

High Frequency Measurements

At higher frequencies the signal generator usually uses a reflex klystron oscillator, with either an external or an internal cavity. The klystron is used because it can be easily tuned over a relatively wide frequency range and can be readily frequency or amplitude modulated. In a typical reflex klystron oscillator with an external tuned cavity, the cavity is connected across the klystron resonator grids, and is tuned at the other end by changing its length by a noncontacting movable short-circuit. A coaxial cavity is preferred for broadband oscillators because its principal mode is the TEM mode, which affords a much wider frequency range than the TE or TM modes of rectangular waveguide sections.

Signal generators may also use cavities which are an integral part of the klystron tube, and can be tuned by mechanically changing the capacitive loading on the cavity; this type is inherently more narrowband than the external cavity oscillator. Output power is coupled by means of a loop extending into the cavity. In many units, the oscillator repeller voltage is

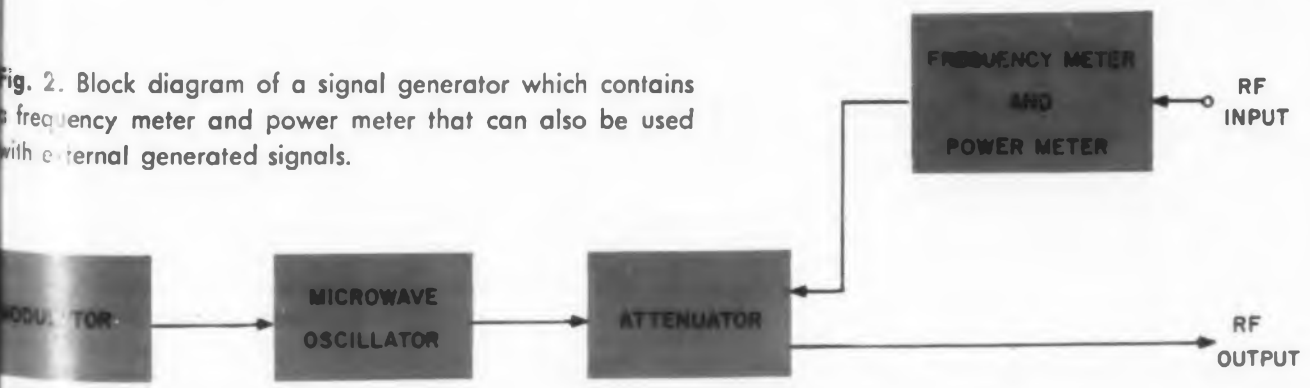


Fig. 2. Block diagram of a signal generator which contains a frequency meter and power meter that can also be used with external generated signals.

made to track frequency changes automatically, thus avoiding the necessity of voltage adjustments during operation.

When extremely good frequency accuracy is required, the output frequency may be compared with the reading of a wavemeter for final settings. Some units may have built-in automatic frequency control, in which the output signal is compared with the frequency of a reference cavity, and automatically tuned by a feedback loop which causes a drift in the klystron frequency to be opposed by a feedback voltage applied to the klystron repeller to correct the frequency.

In such a unit, the klystron output is applied to a tunable reference cavity which has dual mode responses—one just below center frequency, the other just above center frequency. The outputs of these two cavities are connected through a stabilizing amplifier to the klystron repeller in such a manner that drift in the operating frequency will cause a feedback voltage which opposes the change in frequency. The discriminator cavity is made to resonate through a band of frequencies by moving a plunger within it. Tuning of the oscillator is accomplished by tuning the cavity to the desired frequency, and then adjusting the klystron frequency until it automatically follows the cavity resonant frequency.

Modulation

Modulation in microwave signal generators can be accomplished in a number of different ways. Triode oscillators used at the lower microwave frequencies can be modulated by applying the modulation voltage in series with the plate voltage supply to the tube; since considerable power is required, power amplifier is necessary for modulation, and there is a certain amount of incidental frequency modulation. Another method, which can be used for square-wave modulation, is to insert a resistor in the grid circuit to make the oscillator unstable, and it can be triggered in and out of oscillation with relatively low power in the grid circuit.

Amplitude modulation of reflex klystrons may be accomplished by applying the modulating voltage to either the reflector electrode or the control grid. Oscillations will cease if the reflector voltage is driven out of the mode; thus, a square wave or pulse applied to the reflector will alternately turn the oscillations on and off. With control grid modulation, the electron stream is turned off and on. Klystrons may be frequency-modulated by taking advantage of their voltage tuning characteristics, by superimposing a modulation voltage on the reflector and causing the frequency to change; however, this modulating voltage must not drive the reflector from one mode to another. Depending upon the elaborateness of their circuit, microwave signal generators may include modulation generators and amplifiers, or may simply have taps for the application of external modulating voltages.

Other Arrangements

Several different arrangements may be used in the output section of the signal generator. The simplest is to couple the output of the oscillator directly to the load. More elaborate units may include an attenuator (either calibrated or uncalibrated) between the oscillator and the load, to permit setting the output level as desired. Other units include a power monitor as well as a calibrated attenuator, and some include wavemeters for most accurate settings of frequency. Specific types of attenuators, power monitors, and wavemeters will be described in later articles dealing specifically with these devices.

Table 1 — K band signal generators

Manufacturer	Model No.	Frequency Range	Output	Accuracy of Frequency Calibration	Frequency Drift	Modulation	Price	General Comments
Hewlett-Packard	626A	10,000-15,500 mc	+10 to −90 dbm	±1%	—	Int or Ext: Pulse, fm, square wave	$3000	Output power continuously variable; monitored and indicated to accuracy of ±1 db
	628 A	15,000-21,000 mc	+10 to −90 dbm	±1%	—	Int or Ext: Pulse, fm, square wave	$3000	Output power continuously variable; monitored and indicated to accuracy of ±1 db
Polarad Electronics Corp.	EHF	18,000-39,700 mc (using 7 plug-in rf units)	−10 to −90 dbm	±0.1% (using internal wavemeter)	—	Int: 1000 cps square wave Ext: pulse 100-10,000 pps; fm 50-10,000 cps	—	Output power continuously variable; monitored and indicated to accuracy of ±2 db
	SS-1218	12,400-17,500 mc	15 mw	±0.1% (using internal wavemeter)	—	Int: 1000 cps square wave Ext: Pulse, fm	—	Output power continuously variable; not monitored
	EHF Signal Source	18,000-50,000 mc (using 9 plug-in rf units)	3 mw to 10 mw (for different units)	±0.1% (using internal wavemeter)	—	Int: 1000 cps square wave Ext: Pulse, fm	—	Output power continuously variable; not monitored
Laboratory for Electronics, Inc.	814-K-1 to 814-K-21	12,000-13,800 to 15,500-17,500 mc (6 separate instruments)	20 mw to 100 m (for different units)	1 mc per division and vernier	1 part in 10^6	Int: 1000 cps am, fm Ext: am, fm	$3800 to $3950	Ultra stable microwave oscillator, frequency stabilized by comparison with reference cavity and feedback control
Polarad Electronics Corp.	PMK	10,000-21,000 mc (using 2 plug-in rf units)	+10 to −90 dbm	+1%	—	Int: Pulse, square wave, fm Ext: Pulse, square wave, fm	$5220 (complete)	Power unit and each tuning unit may be purchased separately; output power continuously variable and indicated to accuracy of ±2 db

Table 2 — X band signal generators

Manufacturer	Model No.	Frequency Range	Power Output	Accuracy of Frequency Calibration	Frequency Drift	Modulation	Price	General Comments
General Radio Co.	1220-A5 to 1220-A8	4240-7425 mc	80-100 mw	Uncalibrated	—	Int: 1 kc square wave Ext: Sine wave, square wave, pulse or fm	$261.45 to $301.45	Frequency range depends upon klystron tube used; four klystrons required to cover range; see also S-band listing
Hewlett-Packard	618 B	3800-7600 mc	0 to −127 dbm	±1%	0.02%	Int or Ext: Pulse, fm, square wave	$2250	Output power continuously variable; monitored and indicated to accuracy of ±2 db
	620 A	7000-11,000 mc	0 to −127 dbm	±1%	0.02%	Int or Ext: Pulse, fm, square wave	$2250	Output power continuously variable; monitored and indicated to accuracy of ±2 db
Laboratory for Electronics Inc.	814	8500-10,000 mc	80-100 mw	1 mc per division and vernier	1 part in 10^6	Int: 1 kc also ext.	$3600	Ultra-stable microwave oscillator; frequency stabilized by comparison with reference cavity and feedback control
Microwave Development Laboratories, Inc.	10 X	8500-9600 mc	10 mw	—	1 part in 10^5	External	—	Stabilized oscillator using reference cavity and automatic feedback control
Polarad Electronics Corp.	MSG-34	4200-11,000 mc	0 to −127 dbm	±1%	—	Int: Square wave, pulse fm, 10-10,000 cps Ext: Pulse 10-10,000 pps	—	Output continuously variable, monitored and indicated to accuracy of ±2 db; contains internal pulse delay generator
	Model B (Band 3) (Band 4) (See also Tables 1 and 2)	4450-8000 mc 7850-10,750 mc	0 to −127 dbm	±1%	±0.25%	Int: Pulse, square wave PTM, etc. (5 independent pulse channels)	—	(See Table 1)
	SSM-A	4450-8000 mc	15 to 50 mw	±1%	—	Ext: Square wave, fm	$1180	Adjustable coupling probe may be used as uncalibrated attenuator;
	SSX-A	7850-10,750 mc	14 to 40 mw					
	SSX-E	7850-11,500 mc					$1440	requires external power supply
Polytechnic Research & Development Corp.	706	3600-7300 mc	20-100 mw	±1%	—	Ext: cw, pulse, fm	$ 950	Requires external power supply
	705	7000-11,000 mc	10-100 mw	±1%	—	Ext: cw, pulse, fm	$ 950	Requires external power supply
Sivers Lab.	SL-5660	8200-12,400 mc	50 mw max	±0.1% (using internal wavemeter)	—	—	—	Output power continuously variable to maximum attenuation of 25 db; requires external power supply
F-R Machine Works, Inc.	C772A X772A	3950-8200 mc 7000-10,750 mc	50 mw (average)	±1%	—	Int: cw, pulse, square wave	—	Output continuously variable through level-set attenuator (uncalibrated)
Laboratory for Electronics, Inc.	814-C-1 to 814-C-5	5100-5900 mc to 7500-8500 mc	60 mw to 90 mw	1 mc per division and	1 part in 10^6	Int: 1000 cps am, fm Ext: am, fm	$3600 to	Ultra-stable microwave oscillator; frequency stabilized by comparison control
	814-C-11 to 814-C-13	5700-6300 mc to 6800-7400 mc (3 sep. instruments)	200 mw to 300 mw					
	814-X-1 to 814-X-4	8500 to 10,000 mc to 10,500-11,700 mc (4 sep. instruments)	55mw to 80 mw					
	814-X-11	8500-10,000 mc	200 mw					
	814-X-21	8500-10,000 mc	500 mw					
Polarad Electronics Corp.	PMX	4450-11,000 mc (in 2 tuning units)	0 to −120 dbm	±1%	—	Int: cw, pulse, square wave, fm Ext: Pulse	$3710 complete)	Power unit and each tuning unit may be purchased separately; output power monitored and indicated to accuracy of ±2 db, continuously variable

(continued on following page)

Table 3 — S band signal generators

Manufacturer	Model No.	Frequency Range	Output	Accuracy of Frequency Calibration	Frequency Drift	Modulation	Price	General Comments
Amerac, Inc.	192A	400 mc tuning range	200 w peak (pulsed) 10 mw (cw)	(counter for frequency calibration)	—	cw or pulse models (extreme modulation)	$475	Complete series of oscillators available for frequencies in 1000-4000-mc range
B J Electronics	80	2700 - 3000 mc	10 w peak (pulsed, 1.25% max. duty cycle)	±0.03%	—	Pulsed: 200-2500 pps: 0.5-5.0 microsec pw	$3675	Signal generator to supply high-level pulsed signals in 10 cm band
	82	2700 - 3000 mc	2.3 μv to 22.5 v	±0.1%	—	Pulsed: 1000 pps: 2.3 microsec; max duty cycle 0.23%	—	Uses Model 83 r-f oscillator; continuously variable output from −80 to +40 dbm
F-R Machine Works, Inc.	S 771B	1900 - 4000 mc	50 mw (average)	±1%	—	Int: pulse or square wave 350 to 2000 cps; cw Ext: pulse or fm	—	Output continuously variable through level-set attenuator (uncalibrated)
General Radio Co.	1220-A1 to 1220-A4	2700-4460 mc	75-100 mw	Uncalibrated	—	Int: 1 kc square wave Ext. sine wave, square wave, pulse or fm	$254.65 to $312.15	Frequency range depends upon klystran tube used; four klystrans required to cover range; see also x-band listing
Hewlett-Packard	616A	1800-4000 mc	0 to −127 dbm	±1%	0.01%	Int: Pulse, fm Ext: Pulse, square wave	$1950	Output power continuously variable; monitored and indicated to accuracy ±1.5 db
Loral Electronics Corp.	MSS-2	2140-4440 mc	5 to 15 mw max; 100 db attenuator	0.3%	—	Int: 1 kc square wave Ext: 40-4000 pps	—	Output power continuously variable to ± db accuracy
New London Instrument Co.	TS-155c/ue	2700-3400 mc	−20 to −100 dbm calibrated	—	—	Int: 80-2600 pps	—	Also contains power meter for measurement of average power up to 200 mw; frequency band covered in three ranges
Polarad Electronics Corp.	MSG-2	2150-4600 mc	0 to −127 dbm	±1%	—	Int: Square wave, pulse, FM, 40-4000 cps Ext: Pulse 40-4000 pps	—	Output power monitored and continuously variable
	Model B (Band 2)	2150-4600 mc (For other frequency bands see other tables)	0 to −127 dbm	±1%	±0.25%	Int: Pulse, square wave, PTM, etc. (5 independent pulse channels)		
	SSS	2140-4600 mc	—	±1%	—	Ext: Square wave, fm	—	Adjustable coupling probe may be used as uncalibrated attenuator; requires external power supply
Sivers Lab	SL-5640	2500-4000 mc	50 mw	±0.1% (using internal wavemeter)	—	—	—	Requires external power supply
Transitron, Inc.	SG-153	1800-4000 mc	0 to −120 dbm	±1%	—	Int: Pulse, fm Ext: Pulse	—	Output power continuously variable; monitored and indicated to accuracy of ±2 db
Laboratory for Electronics, Inc.	814-S-1 814-S-2 814-S-3	2500-3050 mc 2950-3600 mc 4200-4800 mc	75 mw 80 mw 70 mw	1 mc per division and vernier	1 part in 10^6 per 10 min.	Int: 1000 cps am, fm Ext: am, fm	$3600	Ultra-stable microwave oscillator; frequency stabilized by comparison with reference cavity and feedback control
Marconi Instruments	1058	1700-4000 mc	−30 to −165 dbm; to 50 mw uncalibrated	±1% and vernier	0.001%	Int: 1 kc square wave Ext: Pulse	—	Output power continuously variable; indicated to accuracy of ±2 db

Table 4 — L band signal generators

Manufacturer	Model No.	Frequency Range	Output	Accuracy of Frequency Calibration	Frequency Drift	Modulation	Price	General Comments
Airborne Instruments Lab.	124B	200 - 2500 mc	2.5 - 20 watts (varies with frequency)	(Indicated by 4 - digit counter)	.005%	Int: 400 and 1000 cps sine waves Est: Square wave or sine wave	$2285	Frequency coverage in three ranges; power output varies with frequency; useful for applications requiring appreciable power, such as antenna design, etc.
Amerac, Inc.	192 ab and 192 b series	300 - 500 mc range (950 - 2000 mc in 4 models)	500 - 1000 mw	(Indicated by counter)	—	External	$ 475	Coaxial line cavity using 2C 36 uhf planar triode: requires external power supply
B-J Electronics	82	1050 - 1350 mc	2.3 mv to 22.5 mv	±0.1%	—	Pulsed: 1000 pps: 2.3 μsec; max duty cycle 0.23%	—	Uses Model 84 RF oscillator; continuously variable output from −80 to ±40 dbm
F-R Machine Works, Inc.	L771B	950 - 2000 mc	50 mw (average)	±1%	—	Int: pulse or square wave 350 to 2000 cps; cw Ext: Pulse or fm	—	Output continuously variable through level-set attenuator (uncalibrated)
General Radio Co.	1021-AW	900 - 2000 mc	0.7 v max	±1%	—	Ext: Square wave 100 to 5000 cps	$ 910	Output continuously variable; indicated by meter with ±20% or better accuracy
	1213-A	900 - 2000 mc	200 mw	±1%	0.1%	Ext: Sine wave, square wave, pulse, or fm	$ 465	Requires external power supply; modulator must be able to carry plate current of oscillator
Hewlett-Packard	614A	800 - 2100 mc	0 to −127 dbm	±1%	0.01%	Int: Pulse, fm Ext: Pulse, square wave	$1950	Output power continuously variable; monitored and indicated to accuracy of ±1 db
Maxson Instruments	Power Oscillator	200 - 2500 mc	2.5 to 20 watts (varies with frequency)	(Indicated by 4 - digit counter)	0.005%	Int: 400 or 1000 cps sine wave or square wave Ext: Sine wave or square wave	$2325	Frequency coverage in three ranges; power output varies with frequency; useful for applications requiring appreciable power, such as antenna design, etc.
Northeastern Engineering, Inc.	NE 12-20-SG	900 - 2100 mc	0 to 120 dbm	±1%	0.005%	Int: 40 to 4000 pps Ext: Pulse	—	Output power continuously variable; monitored and indicated to accuracy of ±2 db
Polarad Electronics Corp.	MSG-1	950 - 2400 mc	0 to 127 dbm	±1%	—	Int: Square wave, pulse, fm 40 - 4000 cps Ext: Pulse 40 - 4000 pps	—	Output power monitored and continuously variable
	Model B (Band I)	950 - 2400 mc (For other frequencies using interchangeable r.f. heads, see other tables)	0 to −127 dbm	±1%	±0.25%	Int: Pulse, square wave PTM, etc. (has 5 independent pulse channels)	—	Output power continuously variable, monitored and indicated to accuracy of ±2 db; this unit intended as code modulated microwave signal generator; has built in oscilloscope for pulse calibration
	SSR SSL	650 - 1300 mc 1050 - 2250 mc	—	±1%	—	Ext: Square wave, fm	—	Adjustable coupling probe may be used as uncalibrated attenuator; requires external power supply
Transitron, Inc.	SG-161	900 - 2100 mc	0 to −120 dbm	±1%	—	Int: Pulse Ext: Pulse	—	Output power continuously variable; monitored and indicated to accuracy of ±2 db
Winschel Engineering	MS-3	900 - 2000 mc	50 mw	±1%	0.1%	Int: 1000 cps square wave Ext: Sine or square wave	$2550	When used with directional coupler and power monitor, feedback regulator amplitude stability is ±0.05 db 1 hr; without regulator ±0.1 db 1 hr

Ceramic Capacitors Made SMALLER

THESE CERAMIC capacitors are smaller than those previously available. Their miniaturization was achieved through a new manufacturing process which also makes their cost reasonable. Called Cerafil, the new ceramic capacitor is compared to a paper unit in Fig. 1.

Cerafil capacitors—manufactured by Aerovox Corp., Hi-Q Div., Myrtle Beach, S.C.—were designed primarily for transistor and other subminiature applications. They range in size from 0.09 in. in diameter by 0.320 in. long for the 0.001 μf unit to 0.310 in. in diameter by 0.750 in. long for the 0.1 μf unit. These are maximum dimensions. In some cases diameters are 20 to 25 per cent smaller than guaranteed maximum ameters. These units are rated at 100 v dc w a maximum power factor of 2.5 per cent at 1 Capacity varies with temperature by appr mately +10%/—15% over the range of —5 85 C based on 25 C as the reference temperat They are available in capacities from 10 μμ 100,000 μμf.

These capacitors will meet or surpass all requirements of MIL-C-11015A. Extended tests are being performed on these capaci They are subjected to 200 v dc in an amb temperature of 200 C. After 3000 hours no f ures were reported.

Fig. 1. A paper capacitor (top) vs a Cerafil capacitor (bottom).

Fig. 2. The photo shows 10,000 partially finished Cera- capacitors, three finished ones, and a paper clip.

The Good and Bad of Ceramics

Ceramic dielectrics are good because they have high dielectric constant. Unfortunately, ceram- have a brittle nature. This imposes limitations processing thin sheets of ceramic dielectrics in e conventional manner.

New Manufacturing Techniques

Aerovox Corp. circumvented the problems of n ceramic sheets by employing new manufac- ring techniques. The main principle consists of rming the thin film of dielectric on a substrate. e substrate is used as one of the electrodes and o serves as a support for the fragile film. With s support, extremely thin films can be proc- ed conveniently and resulting high capacities tained. Naturally, the voltage rating is deter- ined by the thickness of the film employed.

The Cerafil construction consists of a single pacitor element, or a multiple of this capacitor ement, depending on the capacity value re- ired. A capacitor element is a rod of approxi- tely 1/32 in. in diameter. Length of the rod is termined by the length of the unit desired. The ndled rods form a cylindrically shaped honey- mb structure. Surface to volume ratio increases th diminishing rod diameter.

This design and construction offers several ad- ntages. Parallel connection to obtain the high pacities is a simple operation. Also, an element positive temperature coefficient may be paral- ed with one of a negative temperature coeffi- ent to give a flat curve.

Ten thousand partially finished Cerafil capaci- rs, three finished Cerafil capacitors and a paper p (for comparison) are shown in Fig. 2.

For more information of these miniature ce- mic capacitors, turn to the Readers-Service rd and circle number 109.

DESIGN FORUM

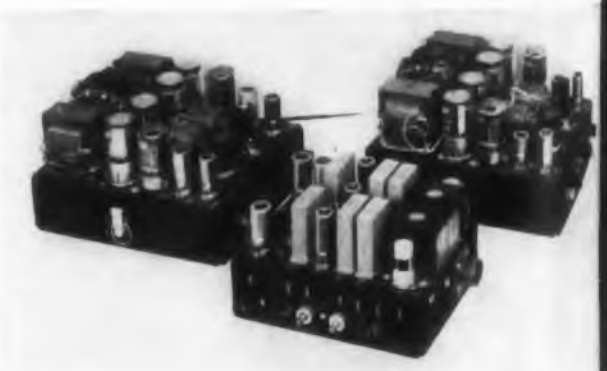
Smaller, Lighte Power Suppl ic

EIGHTY-TWO per cent smaller, seventy-f per cent lighter, and much cheaper. Tha an achievement for an airborne power supp Without sacrificing required performance, We inghouse substituted one chassis for three a maintained reliability and ease of maintenan

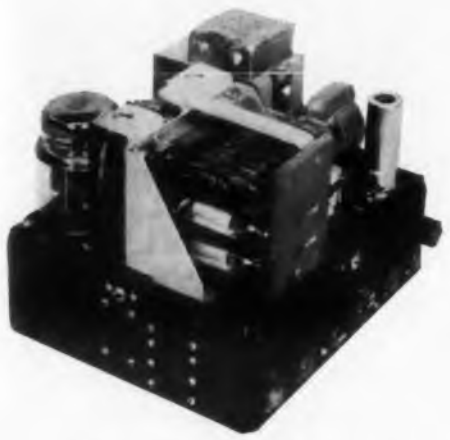
To do this, modern miniaturization techniqu were put to work by M. L. Feistman and R. W Lieske of Westinghouse Electric's Air Arm Di in Baltimore, Md. Here are some of the tec niques they used.

"Cold plate" transformers are used to c size and weight. With their better means of co ducting heat away from the core, and with bett core materials, they can chop volume about per cent without affecting electrical charact istics.

For high voltage rectification, a bridge of eig silicon diodes replaces a two-thyratron full-wa rectifier. This reduces size further and obviat



PREVIOUS UNITS



Subminiature tubes, silicon diodes, and the "cold plate" transformer in the rear helped shrink this airborne power supply.

Cheaper Too

generous filament supply. As a bonus, the silicon diodes take vibration and shock better than the thyratrons.

A 6336A series regulator tube replaces two 6080's.

Further shrinkage results from the use of subminiature tubes and potentiometers and printed circuitry. The diodes and subminiature components lend themselves well to mounting on printed circuit cards. The cards, identical for positive and negative supplies, help trouble shooting.

Perhaps most significant is the introduction of the zener diode as a precision regulator. A small, simple zener circuit with a few components replaces older circuitry with many components.

Simpler circuitry and fewer components throughout enhance the reliability of the power supply. ■ ■

Airborne power supply on the right is 82 per cent smaller, 75 per cent lighter than earlier three-chassis model.

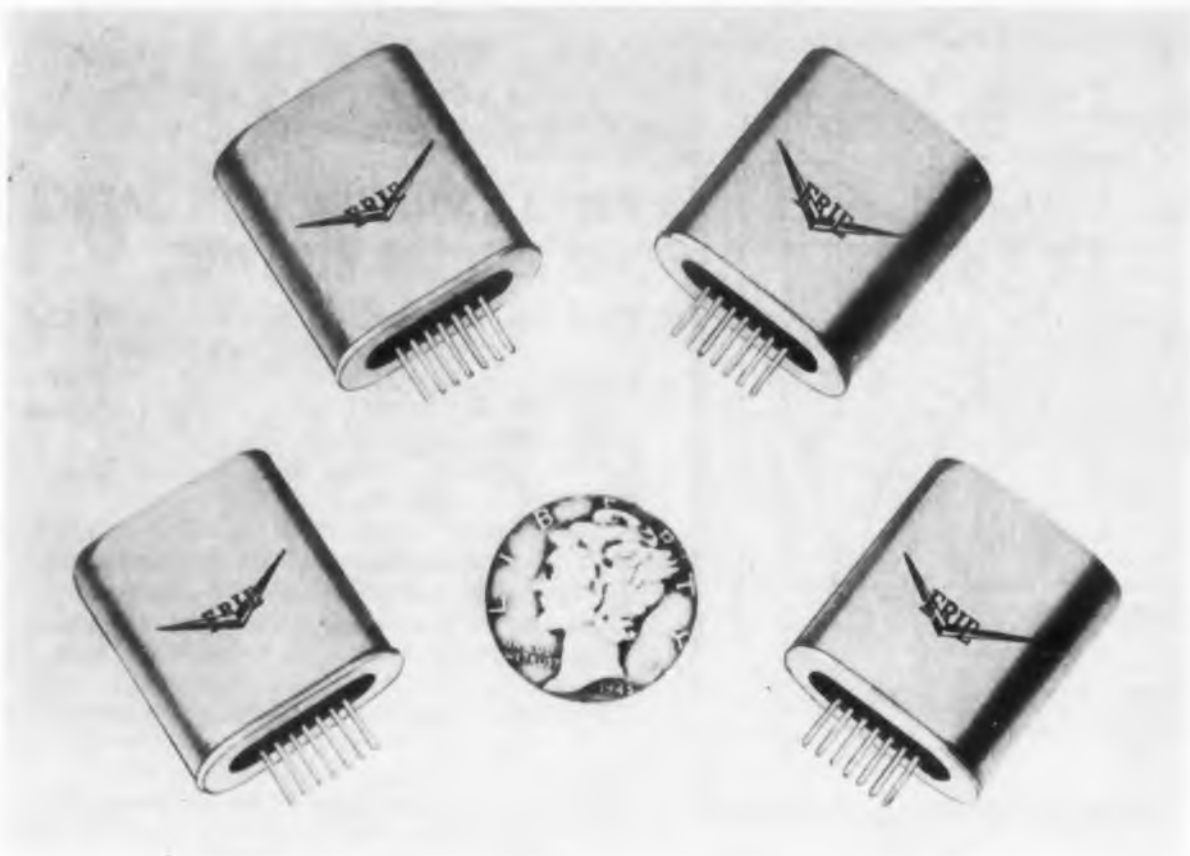
NEW UNIT

NEW PRODUCTS

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

MODULAR UNITS

Small units which plug into a system, or are connected easily, have grown in popularity. They've become popular because they can be easily taken out of a system and quickly replaced if defective. Here are some modular units which have just hit the market.



LOGIC CIRCUITS

These transistorized plug-in modules for digital equipment are based primarily upon the NOR logic. The module is designed to fit a standard 7 pin inline subminiature tube socket. Up to 144 units mount on a 3-1/2 x 19 in. rack panel. Module measurements are 0.75 x 0.687 x 0.297 in. The standard unit contains four inputs.

Erie Resistor Corp., Dept. ED, Erie, Pa.

CIRCLE 24 ON READER-SERVICE CARD

TRANSISTOR AMPLIFIER

Model 2620 transistor amplifier amplifies and converts charge to voltage. This design eliminates high input impedances normally required for low frequency response. Transducer and amplifier may be separated by 300 ft without signal loss. Two continuously variable gain ranges are provided: 0.8 to 12, and 4 to 15 (based on a 500 μμf source). Having a relatively low input impedance, the unit is sealed against dust and humidity. Temperature range is −65 to +185 F.

Endevco Corp., Dept. ED, 161 E. California St., Pasadena, Calif.

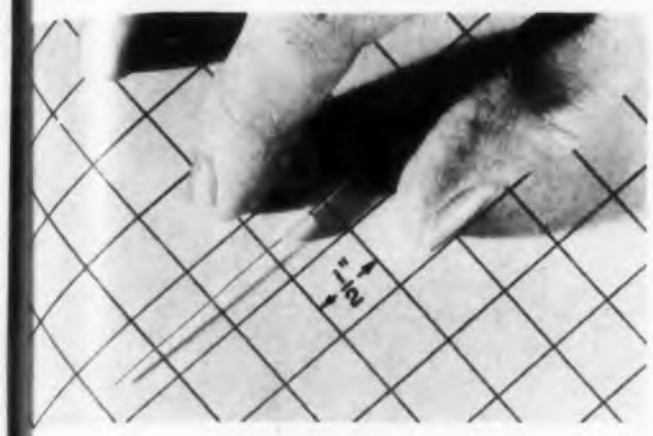
CIRCLE 25 ON READER-SERVICE CARD

TELEMETRY KEYER

Having an input impedance of 5 megohms shunted by 68 μμf, this keyer was designed for use in missile or other telemetry systems. It converts an amplitude modulated pulse sequence to a pulse series of constant amplitude and variable width. Output is suited for modulating a subcarrier oscillator or rf transmitter. Linearity error is less than 1%. Output amplitude is 5 v peak-to-peak max.

Rotary Devices Corp., Dept. ED, 30 Jay St., Englewood, N.J.

CIRCLE 26 ON READER-SERVICE CARD

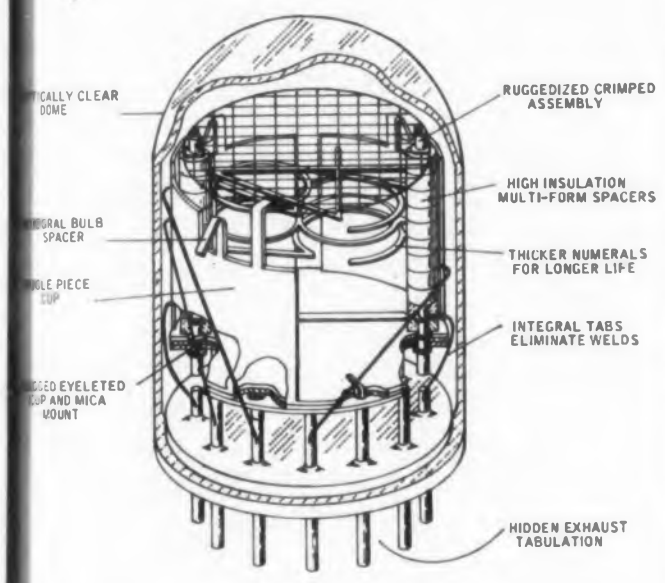


RESISTORS

Engineered to handle 1/10 w, the DCH-1/10 resistors measure 7/64 x 1/4 in. They are hermetically sealed deposited carbon resistors housed in a ceramic shell and come in a resistance range of 100 ohms to 100 K. Their tolerance is ±1%. Operating temperature range is —55 to +150 C. The 1/10 w rating is at 70 C, and they must be rated to 0 w at 150 C.

Dale Products, Inc., Dept. ED, Box 136, Columbus, Nebr.

CIRCLE 27 ON READER-SERVICE CARD



ELECTRONIC INDICATOR TUBES

These Nixie all-electronic indicator tubes have had their life characteristics extended. The regular miniature Type 7009 (BD-200-S) requires a minimum of 170 v and has an average dynamic life of from 3000 to 5000 hr. Type B-4032 has an average dynamic life of more than 10,000 hr and requires a minimum of 170 v. Type B-4021 (BD-214) is designed for transistor operation and requires a 120 v supply. It has provisions for preheating for 45 v operation. All tubes operate with less than 1 ma on approximately 1/8 w of power. Visible up to 20 ft.

Burroughs Corp., Electronic Tube Div., Dept. ED, Plainfield, N.J.

CIRCLE 28 ON READER-SERVICE CARD

NEW FROM JFD Electronics

DELAY LINES

An outstanding new component series in the JFD tradition of uncompromising quality.

Now . . . after extensive laboratory research — JFD distributed constant Delay Lines to meet today's challenging reliability demands!

Designed for applications calling for short delay intervals, the new lines offer a high ratio of delay to pulse rise time, in minimum space. Available for printed circuit assembly or for conventional mounting, JFD Delay Lines meet all military requirements. They can also be modified or custom-designed to meet your most rigid specifications.

Call or write today for Bulletin 213 providing complete electrical and mechanical data. Better yet, tell us *your* delay network problem — distributed or lumped constant. Our engineering staff will promptly recommend the solution with detailed specifications for your particular application.

Characteristics:

- Precise pulse fidelity
- Operating temperature range of –55°C to +125°C
- Excellent temperature stability
- Rugged encapsulated construction resists environmental moisture, humidity, shock and vibration
- Linear phase shift
- 0.1 inch grid spacing for printed board types
- Attenuation of approximately 1 db per μ sec.

PHONE DEWEY 1-1000

Pioneers in electronics since 1929

JFD Electronics CORPORATION

1462 62nd Street, Brooklyn, New York

JFD Canada Ltd.
51 McCormack St.
Toronto, Ontario, Canada

JFD International
15 Moore Street
New York, New York

CIRCLE 29 ON READER-SERVICE CARD

NEW PRODUCTS

Oscilloscope Kit

0 to 4.5 mc vertical response

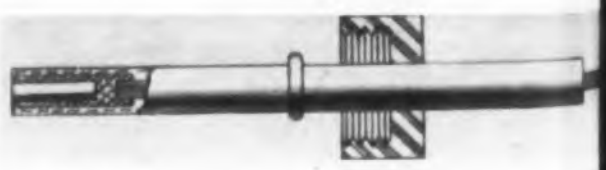
Professional oscilloscope kit OP-1 has dc coupled amplifiers and a dc coupled crt unblanking. The triggered sweep circuit operates on internal or external signals and may be ac or dc coupled. The polarity of the triggering signal may be selected, and a triggering level control can start the sweep at any point on the waveform. The sweep frequencies are provided by switch-selected base rates of 2 and 0.2 msec and 20, 2, and 1 μsec per cm in conjunction with the continuously variable 10 to 1 multiplier. Sweep frequencies are calibrated to within 10% at all control settings. Vertical frequency response is within 1 db from dc to 2.2 mc, and within 6 db from dc to 4.5 mc. Rise time is under 0.1 μsec. Horizontal frequency response is within 1 db from dc to 450 kc, and within 6 db from dc to 900 kc.

Heath Co., Dept. ED, Benton Harbor, Mich.

CIRCLE 31 ON READER-SERVICE CARD

Solderless Terminals

For high voltage



Rated 12, 25, and 35 kv at 5 amp, type LG solderless terminals are designed for high temperature, high altitude use. The leads, made of silicone rubber insulated wire, come in any length which is a multiple of 3 in. The terminals are epoxy and glass fibre or ceramic.

Amp Inc., Capitron Div., Dept. ED, Elizabethtown, Pa.

CIRCLE 32 ON READER-SERVICE CARD

Resistance Welder

Uses stored energy

A precision resistance welder, model DC 30A has a stored energy panel of 80 w-sec capacity. It welds copper, silver, tungsten, molybdenum, and other difficult materials without discoloration or metallurgical change. It also joins dissimilar metals of widely different thickness.

Federal Tool Engineering Co., Dept. ED, Cedar Grove, N.J.

CIRCLE 33 ON READER-SERVICE CARD

Multichannel Sampling Switch

For amplifier drift stabilization

Model 108A is a high-speed sampling switch which stabilizes the sequential drift of 83 high gain dc amplifiers. It has two poles, each with 170 contacts or 85 nonshorting channels. The plug-in unit is 10 x 10.38 x 6.31 in.

General Devices, Inc., Dept. ED, P.O. Box 253, Princeton, N.J.

CIRCLE 34 ON READER-SERVICE CARD

Vacuum Pumping System

For silicon and germanium deposition

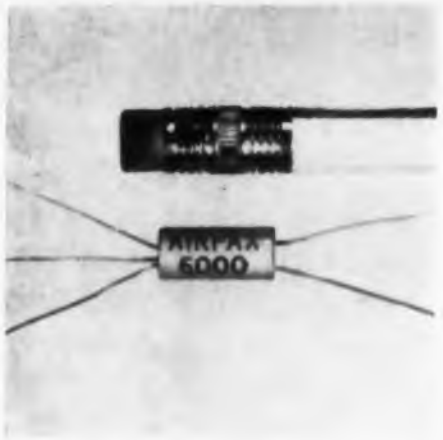
A 3 in. vacuum pumping system, model VD-40V was designed primarily for vacuum metallizing and silicon and germanium deposition. It provides an ultimate pressure of 5×10^{-6} mm Hg and operates during reloading. The chamber is 12.5 in. in diameter and 12 in. high.

Bo-De Electronic Labs, Inc., Dept. ED, Danvers, Mass.

CIRCLE 35 ON READER-SERVICE CARD

Transistorized Choppers

Handle signals from 0 to 100 kc



Shock and vibration resistant, these 1 gram transistoried choppers handle 0 to 100 kc signals. They may be driven by a sine or square wave with 1 to 18 v peak to peak amplitude. Type 6000 operates from —40 to +60 C and handles input signals from less than 1 mv to 5 v. For type 6010, the upper limits are extended to 85 C and 10 v.

Airpax Products Co., Cambridge Div., Dept. ED, Jacktown Rd., Cambridge, Md.

CIRCLE 38 ON READER-SERVICE CARD

Elapsed Time Indicator

2 inches long

Recording up to 10,000 hr, the WT-1 elapsed time indicator keeps track of the time electrically powered equipment is in use. It is 1 in. in diameter, 2 in. long, and weighs 3 oz. Designed to operate from 115 v, 60 or 400 cps, it attains synchronous speed almost as soon as power is applied. In a variety of mountings, the unit is hermetically sealed and meets MIL-E-5272A specifications.

Waltham Precision Instrument Co., Dept. ED, Waltham, Mass.

CIRCLE 39 ON READER-SERVICE CARD

Dry Batteries

High voltage

Dynox dry batteries come in four sizes: 0.14, 1.15, 1.57, and 2.87 cu in. Respectively, the units have 95, 190, 380, and 950 v potential.

Universal Winding Co., Patterson, Moos Div., Dept. ED, 90-28 Van Wyck Expressway, Jamaica, N.Y.

CIRCLE 41 ON READER-SERVICE CARD

Terminal Blocks

Time saving design

RH terminal blocks are delivered open and ready for wire insertion. To save searching time for dropped or lost screws, each terminal has a spring clip to retain backed out screws. Rated at 750 v, 50 amp, the blocks have 1 to 20 terminals. They accept 8 to 18 AWG wire.

Curtis Development & Mfg. Co., Dept. ED, 3250 N. 33rd St., Milwaukee 16, Wis.

CIRCLE 42 ON READER-SERVICE CARD

Missing Ace

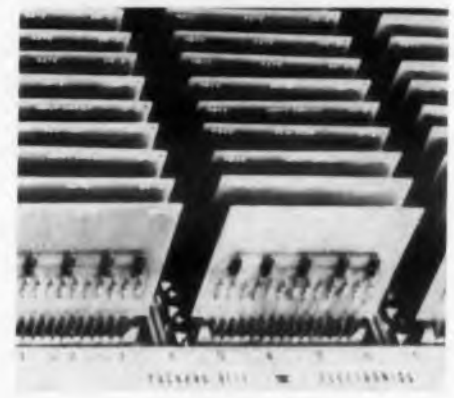
Change-Quick potentiometers, announced on p 85 of ELECTRONIC DESIGN, Nov. 12, are made by Ace Electronics Associates, Inc. Inadvertently, we dropped the Ace and credited them to Electronics Associates, Inc.

CIRCLE 40 ON READER-SERVICE CARD

NEW PRODUCTS

Digital Logic Packages

For data handling equipment



These solid state digital logic packages can b combined to build registers, counters, computer and other data handling equipment. They in clude flip-flops, inverters, gates, drivers, cloc generators, and so forth. Low cost plug-in mod ules, they are easily replaced and can be bui into systems of any size. High reliability i achieved through the elimination of both eyele and printed circuit connectors. Shown are mod ules in an input buffering system.

Packard-Bell Computer Corp., Dept. ED, 190 S. Armacost Ave., Los Angeles 25, Calif.

CIRCLE 45 ON READER-SERVICE CARD

Plastic Rods and Sheets

10^{16} ohm-cm resistance

In rods and sheets of various shapes an sizes, Eccostock HT 0003 is a thermosettin plastic that withstands 500 F and exhibits a most no cold flow. From 10^2 to 10^{10} cps, dielec tric constant is 2.2 and dissipation factor is belo 0.0003. Insulation resistance is 10^{16} ohm-cm. Th material can be used for coaxial insulation, an tenna windows, and sundry dielectric machine parts.

Emerson & Cuming, Inc., Dept. ED, 869 Wash ington St., Canton, Mass.

CIRCLE 46 ON READER-SERVICE CARD

CIRCLE 47 ON READER-SERVICE CARD

NEW DESIGN CONCEPTS WITH ALUMINUM STRIP

by Robert R. Cope, Aluminum Company of America, Pittsburgh, Pa

Light weight, better space factor, better heat dissipation, low voltage between turns, less point-to-point contact . . . these characteristics of aluminum strip have long intrigued designers of electrical windings. Today, this aluminum application is a practical reality.

Intensive research and testing by ALCOA have contributed to important technical breakthroughs. New techniques are solving problems relating to edge effect, joining and insulation.

Recently, ALCOA purchased the transformer division of Automation Instruments, Inc., to perfect winding techniques and to produce prototype coils for customers' evaluation. With this added facility, the electrical windings division of ALCOA Research Laboratories is equipped to wind coils from small solenoids up to distribution transformer sizes for testing by manufacturers—an important, new service for the electrical industry.

ALUMINUM'S NATURAL ADVANTAGES

Aluminum weighs less. In general, an aluminum strip winding weighs only half as much as an equivalent winding of copper. Based on equal current-carrying capacity, 0.48 pounds of aluminum replaces one pound of copper. (Figures are for 61.0 per cent conductivity aluminum, 97 per cent conductivity hard-drawn copper.) ALCOA No. 3 EC alloy has been developed expressly for electrical windings. Space factor of aluminum strip can be 90 per cent and higher; for copper wire, 55 per cent to 65 per cent is typical. Thus, although an aluminum strip requires more conductor volume than a conventional wire winding, the total space occupied by each is about the same. Variations in space factor will depend on the strip-to-insulation thickness ratio.

Aluminum strip windings permit higher current densities because each turn has an outside radiating edge that provides effective heat dissipation. Layer-to-layer temperatures are constant; hot spots are virtually eliminated. The inner turns of a wire-wound coil cannot radiate heat as efficiently as the outer turns.

In most cases, aluminum strip windings can be manufactured at lower cost than equivalent wire windings. Aluminum strip lends itself to automation; new high-speed winding techniques have reduced fabrication costs by eliminating much of the hand labor necessary with wire.

Conventional wire windings require heavier insulations to withstand (1) abrasion during winding, (2) abrasion from point-to-point contact between turns, (3) layer-to-layer voltage, which may be many times the turn-to-turn voltage. Aluminum strip insulation needs to withstand only turn-to-turn voltage because a single turn occupies the entire width of the coil. Thus, thinner and less abrasion-resistant insulations can be used, such as interleaved sheets of Mylar or Kraft paper . . . coatings of varnish, lacquer or epoxy . . . anodized films or vitreous enamel.

ALCOA has tested every known method of joining aluminum. Some techniques proved impractical or costly. But successful joining has been accomplished with ultrasonic welding, high temperature soldering, shielded inert arc welding, cold pressure welding, resistance welding and mechanical joining. Cold pressure welding is quite practical; joints have high strength and conductivity. Ultrasonic welding requires no heat, precleaning or flux; joints are made quickly between parts of different thicknesses, or of multiple thicknesses—and the weld can be made through many types of insulation.

Where is the best application for aluminum strip windings? In power devices or electronic equipment, the economics of aluminum strip windings are indicated when customary wire sizes are 24 gage or larger. However, in many aircraft and missile applications, where weight is a critical factor, aluminum strip is a natural application regardless of size.

Here, at a glance, are the main areas of comparison:

PROPERTY	HARD-DRAWN COPPER WIRE	ALUMINUM STRIP No. 3 EC
Weight (lb/cu in.)	0.321	0.098
Specific gravity	8.89	2.70
Coefficient of linear expansion (/°C)	0.000017	0.000023
Thermal conductivity at 20°C $\left(\frac{\text{watts/sq in.}}{\text{in./°C}}\right)$	9.7	6.0
Electrical conductivity at 20°C, per cent IACS	97	61.0
Electrical resistance at 20°C (microhms/sq in./ft)	8.40	13.14
Temperature coefficient of electrical resistance at 20°C (/°C)	0.00381	0.00409
Modulus of elasticity	17×10^6	10×10^6

ALCOA Aluminum Electrical Windings will reduce your costs and improve your product. We'd like to prove it. Send your specifications to us and we will wind sample coils. Then make your own test.

ALUMINUM COMPANY OF AMERICA, 2263-M Alcoa Building, Pittsburgh 19, Pennsylvania.

Interleaving sheet-type insulation with aluminum strip.

Specially designed equipment for winding smaller coils.

Preliminary testing of foil-wound transformer.

Send for Alcoa's new *Conductor Selector Chart*, a convenient slide rule for converting standard wire sizes to equivalent strip conductor.

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

Production Coil Tester

Checks for shorts, opens, and grounds

At a rate of 600 an hour, this coil tester checks armature windings for shorts, opens, and grounds. It automatically ejects acceptable parts into a support cradle. Rejected parts light a red lamp and stay clamped to the machine until a button is pushed to release them.

Cen-Tec Corp., Dept. ED, 38903 Schoolcraft Rd., Livonia, Mich.

CIRCLE 48 ON READER-SERVICE CARD

Permanent Magnet Motors

Miniature

Diameters of these permanent magnet dc motors are 1-1/2 in. Types BD and BL are respectively 1-1/16 and 2-15/16 in. long and rated at 1/45 and 1/30 hp continuous duty at 10,000 rpm.

Globe Industries, Inc., Dept. ED, 1784 Stanley Ave., Dayton 4, Ohio.

CIRCLE 49 ON READER-SERVICE CARD

Transient Protector

Transistorized

Model N210 transistorized transient protector is for use on a 28 v line. It passes up to 30 amp with input to output voltage drop of 1 v. The clipping level of the input voltage is 35 v. The unit is 2-1/2 x 2-5/8 x 3.5 in.

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

CIRCLE 50 ON READER-SERVICE CARD

CIRCLE 47 ON READER-SERVICE CARD

CIRCLE 51 ON READER-SERVICE CARD

NEW PRODUCTS

Miniature Relay

Has heavy-duty socket

For industrial and instrument use, this sealed electromagnetic relay has a 14 terminal header mated with a heavy-duty socket. The 4pdt unit has a minimum creepage of 1/4 in. At reduced contact loads, it survives up to 100 million operations. In ratings to 5 amp at 28 v dc or 120 v ac, it measures 1.5 x 1.6 x 2 in.

General Electric Co., Specialty Control Dept., Dept. ED, Schenectady 5, N.Y.

CIRCLE 53 ON READER-SERVICE CARD

Magnetic Core Memory System

Modular

Made from transistorized plug-in packages, the 3C-Memory magnetic core memory system is designed to handle core matrix driving and sensing circuits. Its modular construction permits random access memories with capacities to 4096 words and 40-bit word lengths.

Computer Control Co., Inc., Dept. ED, 92 Broad St., Wellesley, Mass.

CIRCLE 54 ON READER-SERVICE CARD

DC Power Supply

Two continuously adjustable outputs

Type D-10-10-100KS4 power supply has two continuously variable outputs: 6 to 10 v, 50 amp and 6 to

◀ CIRCLE 52 ON READER-SERVICE CARD

10 v, 10 amp. Power may be drawn from them separately or simultaneously. Regulation is ±0.5%; ripple is 60 mv peak to peak; recovery time is 0.2 sec. For missile ground support, the unit meets MIL-E-4970 specifications.

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

CIRCLE 55 ON READER-SERVICE CARD

Preamplifiers

Low noise

These miniature broadband preamplifiers give low noise and cover the 50 to 500 mc range. A typical unit accepts everything from 50 to 300 mc and has a noise figure of 5 to 8 db and a dynamic range of 60 db.

The Singer Mfg. Co., Military Products Div., Dept. ED, 149 Broadway, New York 6, N.Y.

CIRCLE 56 ON READER-SERVICE CARD

Strip Chart Recorder

Offers continuous integration

This strip chart recorder measures, records, and continuously totals any linear variable with respect to time. Quantitative integration is read on a 6 digit counter at speeds to 1000 counts per minute. Analog equivalent is recorded on a chart by a dual pipping pen at rates to 500 strokes per minute. The unit is ± 1% accurate.

Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Dept. ED, Wayne and Windrim Aves., Philadelphia 44, Pa.

CIRCLE 57 ON READER-SERVICE CARD

CIRCLE 58 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Miniature Relays

Control one to six circuits

In 1 to 6 pdt arrangements, series DC miniature relays have snap-action, heavy duty contacts rated at 2 or 5 amp. They have 400 cps ac coils or high resistance coils for plate circuit operation. Available in various mounting brackets, the units are provided with potted leads of any specified size or length.

Phillips Control Corp., Dept. ED, 59 W. Washington St., Joliet, Ill.

CIRCLE 59 ON READER-SERVICE CARD

Electro-magnetic Brake

40 oz-in. torque

Industrial Miniature-B-125 brake has a minimum torque of 40 oz-in. and weighs 6 oz. Unit's backlash is 0 deg, and power consumption is 5 w. Designed for operation on 28 v dc, its response is 30 msec.

Autotronics Inc., Dept. ED, Box 208, Florissant, Mo.

CIRCLE 60 ON READER-SERVICE CARD

Power Supply

For strain gage excitation

Designed for strain gage excitation, model SR-1000 solid-state dc power supply provides a floating output. Voltage is adjustable from 5 to 30 v; maximum output current is 1 amp; and ripple is under 1 mv. Line regulation from 95 to 135 v is 0.1%.

Video Instruments Co., Inc., Dept. ED, 3002 Pennsylvania Ave., Santa Monica, Calif.

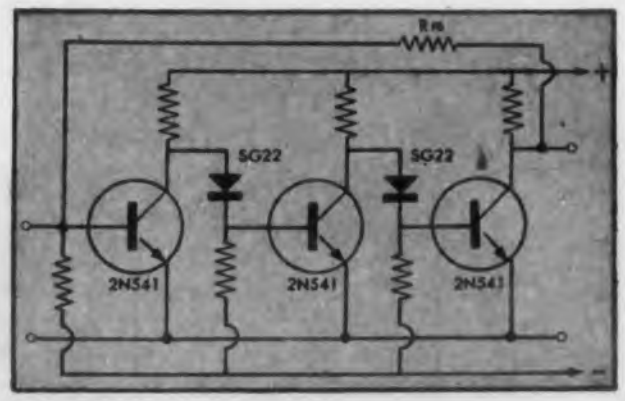
CIRCLE 61 ON READER-SERVICE CARD

HIGH BETA types... *current gain of 80 minimum*

the highest level yet achieved in the industry. A useful end-of-life beta is maintained at temperatures down to −65°C, even at reduced collector current levels. The high gain of these transistors reduces the number of stages required in amplifier applications. A greater degree of degenerative feedback may be used to obtain much greater gain stability and uniformity, resulting in *reliable* amplifier operation.

TYPES	2N543	2N542	2N541	
Minimum Common Emitter Current Gain @ 1 Kc	80	80	80	—
Typical Common Emitter Current Gain @ 1 Mc	15	15	15	—
Maximum Collector Voltage	45	30	15	Volts
Maximum Collector Cutoff Current (25°C @ V_c Max.)	.5	.5	.5	μa

Complete data in bulletin TE-1353



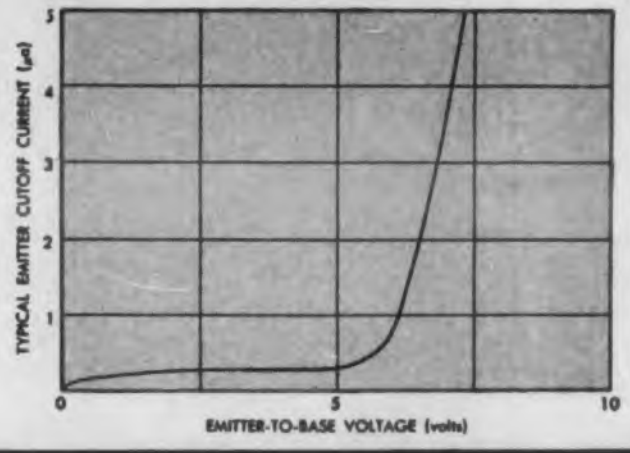
HIGH V_{EB}/SMALL SIGNAL types

... *V_{EB} of 5 Volts minimum*

eliminates the need for series diodes in many applications and protects against transients in pulse and digital circuitry. This improvement in emitter-to-base voltage is available in Transitron's entire line of small signal transistors, at no sacrifice of other characteristics.

TYPES	2N543A	2N480A	2N475A	
Maximum Emitter-to-Base Voltage	5	5	5	Volts
Maximum Collector Voltage	45	45	45	Volts
Minimum Common Emitter Current Gain	80	40	20	—
Maximum Collector Cutoff Current (@ V_c = 45 Volts)	.5	.5	.5	μa

Complete data in bulletin TE-1353



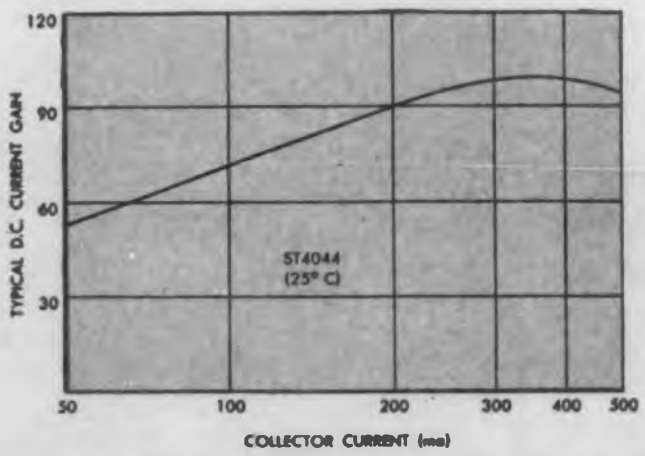
HIGH BETA/MEDIUM POWER types

... *current gain of 40 minimum*

at 500 milliamps. Typical power gain of 1000 into a 100 ohm load significantly reduces drive power requirements. When used in conjunction with small signal high gain types, these transistors reduce the number of components needed in a system and, hence, the overall weight and volume. I_{co} is measured at maximum rated collector voltage at 150°C.

TYPES	ST4044	ST4045	
Minimum DC Beta = 40 at I_c	500	200	ma
Maximum Collector Voltage	60	60	Volts
Power Dissipation (100°C, free air)	6	.6	Watt
Power Dissipation (100°C, stud heat sink mounting)	5	5	Watts
Typical Collector Saturation Voltage (@ specified current)	3	1.5	Volts

Complete data in bulletin TE-1355



HEAT SINK MOUNTINGS... *higher power ratings*

for medium power transistors in Transitron's TO-5 Outline package. These factory-fitted heat sink mountings make possible a realistic 5 watt rating at 100°C case temperature for the first time. The stud type offers the convenience of single-hole mounting, the same as for our JAN rectifiers in the 7/16" hex package. No clip is needed . . . insulation and mounting hardware are supplied. Complete data in bulletin TE-1355.

Transitron

electronic corporation • wakefield, massachusetts

Proximity Pickups

Waterproof

Designed for complete water and oil resistance, these proximity pickups have a 10 ft cable that is potted in place. In model 4913-WPN, the cable ends with a 3-pin connector; in the 4913-WPL, with terminal lugs. The units can detect ferrous and nonferrous metal parts with diameters of less than 0.1 in., and they can be excited by gear teeth of 10 diametral pitch. When connected to a proximity control unit, they can detect moving metal pieces passing at a rate of 60,000 per min. Operating clearances for metal pieces over 3/8 in. in diameter are up to 1/4 in. The units have a 5/16 in. diameter sensing face and are 1-21/32 in. long. They operate from extremely low temperatures to 200 F.

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

CIRCLE 62 ON READER-SERVICE CARD

Counting-Dividing Units

Speed of 100,000 counts per sec

For scaling, computing, and control, Incremag counting and dividing units have a maximum count rate of 100,000 per sec. They accept random or uniform pulses. From a 1 kc input, one form can deliver four outputs from 1 to 1000 cps.

General Time Corp., Dept. ED, 109 Lafayette St., New York 13, N.Y.

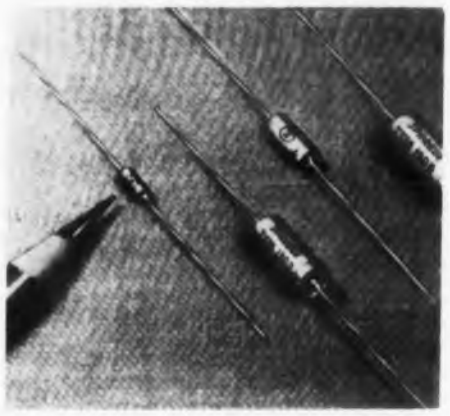
CIRCLE 63 ON READER-SERVICE CARD

◀ CIRCLE 64 ON READER-SERVICE CARD

NEW PRODUCTS

Solid Tantalum Capacitors

Operate to 125 C



Maximum capacitances of type 150D solid-electrolyte tantalum capacitors now range up to 330 μf at 6 v, 220 μf at 10 v, 150 μf at 15 v, 100 μf at 20 v, and 47 μf at 35 v. The units may be operated at 125 C with appropriate voltage derating. They withstand severe shock and high frequency vibration.

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

CIRCLE 65 ON READER-SERVICE CARD

Broadband Load Isolators

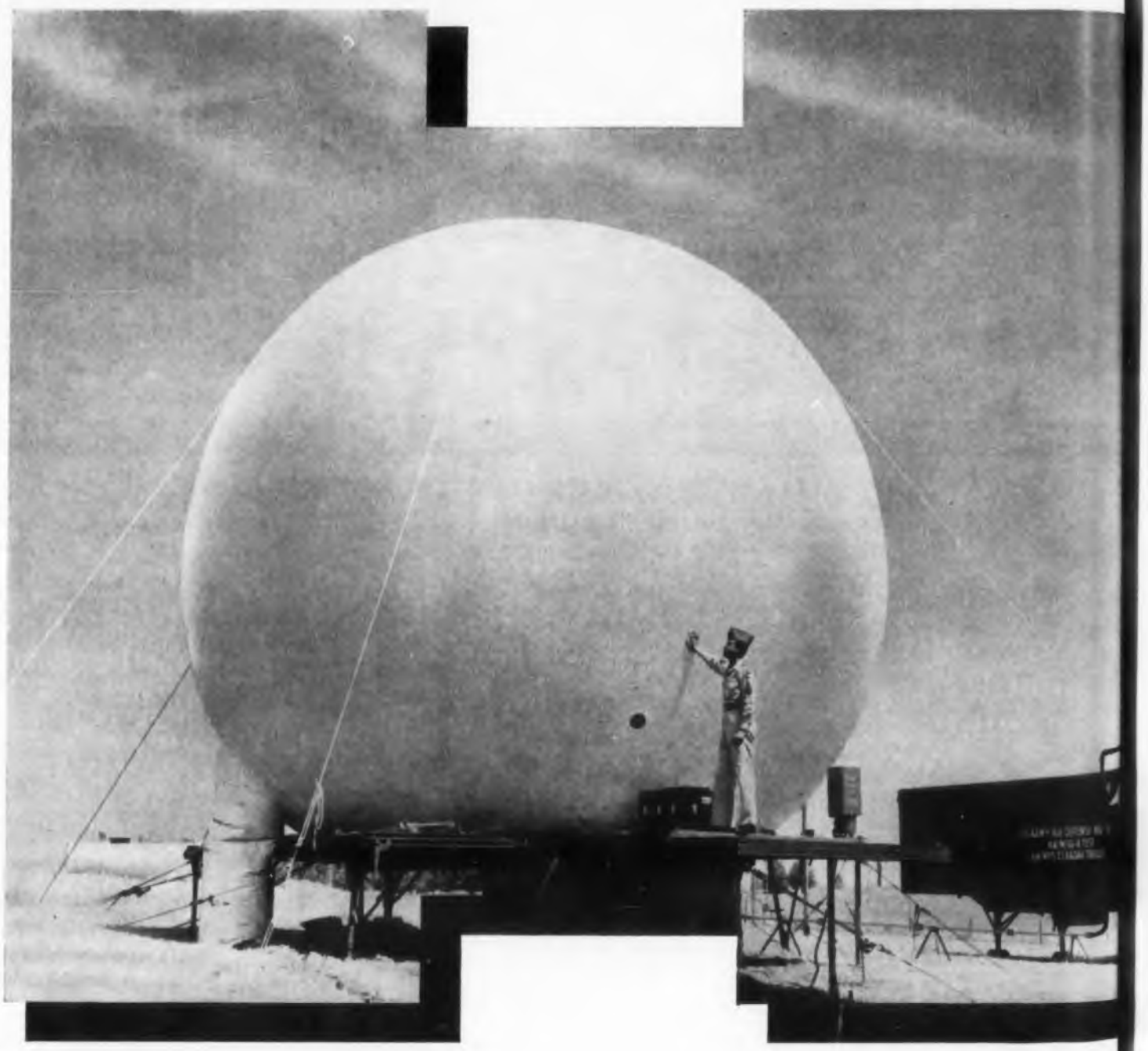
Low power

Handling 10 w in the forward direction and 2 w in the reverse, these broadband ferrite load isolators have 1 db maximum insertion loss. Input vswr into a flat load is 1.15 maximum. Models X-12.29 and X-12.25 cover 8.2 to 12.4 kmc with 30 and 40 db minimum isolation, respectively. With the same respective isolations, models XL-12.10 and XL-12.7 cover 7 to 10 kmc, and models J-12.70 and J-12.65 cover 5.85 to 8.2 kmc.

Cascade Research, Div. of Monogram Precision Industries, Inc., Dept. ED, Los Gatos, Calif.

CIRCLE 66 ON READER-SERVICE CARD

The strange shap



...ap of defense

The Hughes Communications Laboratories have as one objective the development of systems capable of deflecting their signals from meteors, artificial satellites and even the moon.

This photomicrograph of an etched silicon sphere is used in basic studies of semiconductor materials at Hughes Products, the commercial activity of Hughes.

This plastic balloon, resting on a mobile trailer bed like a golf ball on a tee, protects the new Hughes three-dimensional radar antenna.

Frescanar, the exclusive system combining high-speed data processors and a frequency scan radar antenna, has been developed by Hughes engineers in Fullerton, California.

Sensitive to the inadequacies of conventional radar, these Hughes Fullerton engineers have devised a radar antenna whose pointing direction is made sensitive to the frequency of the electromagnetic energy applied to the antenna. This frequency sensitivity results in the radar beam being radiated from the antenna at different angles, depending on the frequency of the energy supplied. With the supply of a succession of frequencies, the antenna beam can be moved through a succession of positions. Utilizing this advanced technique, range, bearing and altitude can be detected . . . on a single antenna.

This Hughes-developed radar system has been combined with compact, high-speed Hughes data processors to provide a completely self-sufficient, mobile radar defense system.

Other Hughes projects provide similarly stimulating outlets for creative engineering talents. Current areas of Research and Development include Advanced Airborne Electronics Systems, Space Vehicles, Nuclear Electronics, Subsurface Electronics, Ballistic Missiles . . . and many more. Hughes Products, the commercial activity of Hughes, has assignments for imaginative engineers for research in semiconductor materials and microwave tubes.

The diversity and advanced nature of Hughes projects provides an ideal environment for the engineer or physicist interested in advancing his professional status.

An immediate need now exists for engineers in the following areas:

Microwave & Storage Tubes	Reliability Engineering
Field Engineering	Systems Analysis
Quality Control	Circuit Design
Semiconductors	Communications
Digital Computer Engineering	Radar

Write in confidence, to Mr. Phil N. Scheid, Hughes General Offices, Bldg. 6-E-2, Culver City, California.

The West's leader in advanced ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY
Culver City, El Segundo, Fullerton and Los Angeles, California
Tucson, Arizona

Conductive Cement

For printed circuit repair

Hysol 6250 is a conductive cement based on epoxy resins. Its volume resistivity is 0.01 ohm-cm at 25 C. For repairing printed circuits or bonding electrical components, it cures in 24 hours at room temperature, or in two hours at 140 F.

Houghton Labs, Inc., Dept. ED, Olean, N.Y.

CIRCLE 67 ON READER-SERVICE CARD

Silicon Transistor Chopper

Operates from −55 to +130C

Encapsulated in epoxy resin, model 70 silicon transistor chopper withstands 500 g shock for 11 msec, 30 g vibration from 0 to 2000 cps, and 700 g acceleration. Operating from −55 to +130 C, it has a chopping frequency of dc to 100 kc. The driving voltage is square wave, 5 to 10 v peak to peak. Both driving source and input resistances are 600 ohms. Input voltage can range from less than 1 mv to over 10 v, and output voltage equals chopped input voltage. The unit may be used as a modulator or demodulator and is suited for low level voltage measurements, dc amplifier stabilization, high speed servomechanisms, thermocouple instrumentation, and low level switching. It is 5/16 in. in diameter and 1-1/8 in. long.

Solid State Electronics Co., Dept. ED, 8158 Orion Ave., Van Nuys, Calif.

CIRCLE 68 ON READER-SERVICE CARD

DC to DC Converter

300 v dc output

Solid state model PP 12/300 converter has an output of 300 v dc at 100 ma for a 12 v dc input. In a commercial case or hermetically sealed, it can serve as a plate supply for all types of communication and telemetering equipment.

Polytron Engineering Inc., Dept. ED, 32 W. Biddle St., Baltimore 1, Md.

CIRCLE 69 ON READER-SERVICE CARD

Power Supply

Has continuously variable output

Transistorized type PS-T-LV12 power supply provides 6 to 18 v at 2 amp, continuously variable. Load regulation is 0.3% no load to full load, and line regulation is 1% for a 105 to 130 v input.

The Reflectone Corp., Dept. ED, Stamford, Conn.

CIRCLE 70 ON READER-SERVICE CARD

Time Sequence Control

Operates on 3 channels

Fully automatic, this time sequence control operates on three channels and handles any time up to 130 sec on the selected channels. Of sturdy construction, the unit is suited for production as well as laboratory testing.

Mid-Eastern Electronics, Inc., Dept. ED, 32G Commerce St., Springfield, N.J.

CIRCLE 71 ON READER-SERVICE CARD

Temperature Control

Noncontacting

A noncontacting monitor and control, the Pyrotrol senses the temperature of objects 6 inches or many feet distant. Insensitive to flame, it reacts only to infrared radiation. Operating range is 950 to 2000 F, and repeat accuracy is within 0.5% of scale.

Mason Instrument Co., Dept. ED, 29 Elm Ave., Mt. Vernon, N.Y.

CIRCLE 72 ON READER-SERVICE CARD

Terminal Block

Snaps together

The Modulok terminal block consists of modules that snap together and fit into a steel track where they are held in place by end locks. Holding up to 30 modules per foot, the tracks come in lengths to 32 in. The modules have either two or four tier spring-loaded plated sockets which may be set for quick-disconnect or made into permanent connections with a screwdriver. The block accommodates wire sizes 22 through 12.

Burndy Corp., Omaton Div., Dept. ED, Norwalk, Conn.

CIRCLE 73 ON READER-SERVICE CARD

Motor Alternators

Provide 420 cps current

PA-40 and SA-40 motor alternators will operate computers, synchros, servo mechanisms, and other control equipment. They can be provided with outputs of 115 or 230 v, single, two, or three phase, at 420 cps. Inputs may be supplied at 230 or 460 v, 50 cps, three phase; 220 or 440 v, 60 cps, three phase; or 220 v, 60 cps, single phase.

Electric Motors and Specialties, Inc., Dept. ED, King and Hamsher Sts., Garrett, Ind.

CIRCLE 74 ON READER-SERVICE CARD

NEW PRODUCTS

Servo Motor
Velocity damped

Servo motor model 8 VM 420 damped by the magnetic coupl of a low inertia drag cup to fixed field of two parallel magn The field intensity can be varied provide added damping up to dyne-cm-sec per radian. The size velocity-damped motor has an dersized rotor with 0.24 gm c inertia. Stall torque is 0.25 oz- and acceleration at stall is 73,0 rad/sec.² The unit is 1.395 in. lo

Beckman Instruments, Inc., Hi pot Div., Dept. ED, Fuller Calif.

CIRCLE 76 ON READER-SERVICE CAR

Microwave Relay Syste
For 120 to 240 channel operati

Operating in the 5925 to 8500 band, model MCR-1000 microw relay system accommodates 12 240 channels. It has linear 1 base-band response and 1 w po output.

Raytheon Mfg. Co., Dept. E Waltham 54, Mass.

CIRCLE 77 ON READER-SERVICE CAR

Emitter Follower
Designed for missiles

For use in aircraft and mis emitter follower model 5000 o ates from —65 to +185 F u high noise and shock condit It permits measurements fro cps to 100 kc and handles si

CIRCLE 75 ON READER-SERVICE CARD

in the low millivolt range. Current gain is 50,000 and voltage gain is 0.99.

Columbia Research Labs, Dept. ED, MacDade Blvd. and Bullens Lane, Woodlyn, Pa.

CIRCLE 78 ON READER-SERVICE CARD

Primary Phase Standard

±0.01 degree accuracy

Self-calibrating type 7000-B audio primary phase standard has an ultimate accuracy of ±0.01 degree. It supplies two sinusoidal voltage signals whose phase relationship, continuously variable from 0 to 360 deg, is known to ±0.05 deg. The two signals have the same frequency set at one selection from 30 cps to 20 kc.

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

CIRCLE 79 ON READER-SERVICE CARD

Differential Transformer

Has large bore

Model 1000XS-N variable differential transformer has a large bore which suits it for flow meter and other applications where a tube must separate core and transformer. With a linear range of 1 in. either way from null, the unit provides a stepless output with less than 1% deviation from a straight line.

Schaevitz Engineering, Dept. ED, Route 130 and Schaevitz Blvd., Pennsauken, N.J.

CIRCLE 80 ON READER-SERVICE CARD

CIRCLE 81 ON READER-SERVICE CARD ➤

NEW PRODUCTS

RF Signal Generators

Permit remote tuning

For the S through K_a bands, these tuneable magnetron rf supplies consist of a modulator, an rf source, and an optional remote control unit. Pulse rates of 1000 pps and pulse widths of 1 μsec are standard. Typical rf sources are the 2J51, tuneable from 8500 to 9600 mc with 35 kw peak power, and the 2J66, tuneable from 2850 to 2905 mc with 15 kw peak power.

California Technical Industries, Div. of Textron, Inc., Dept. ED, 1421 Old County Rd., Belmont, Calif.

CIRCLE 83 ON READER-SERVICE CARD

Low Pass Filters

Sharp cutoff

Compact type 4 low pass filters have sharp cutoff characteristics. They cover a frequency range from 100 to 2000 mc and are supplied with TNC, BNC, and N connectors. Insertion loss is 0.4 to 0.8 db ripple in the pass band, vswr is 1.5 maximum in the pass band. Rejection slope is 40 db minimum at 1.25 x f_c, second harmonic is 60 db minimum; and spurious responses are 40 db minimum greater than 2 x f_c. Nominal impedance is 50 ohms and power handling is 15 or 50 w cw. The units weigh between 0.19 and 0.58 lb.

Maury & Associates, Dept. ED, 10373 Mill Ave., Montclair, Calif.

CIRCLE 84 ON READER-SERVICE CARD

Grid Dip Meter

400 kc to 250 mc range

Supplied complete or as a kit, the 710 grid dip ter covers 400 kc to 250 mc in seven overping ranges. Its meter movement is 500 μa. e unit may be used to align traps and filters, s a signal or marker generator. It comes with ewound plug-in coils calibrated to ±0.5% acracy.

Electronic Instrument Co., Inc., Dept. ED, 00 Northern Blvd., Long Island City, 1, N.Y.

CIRCLE 85 ON READER-SERVICE CARD

Contact Meter and Controller

Work together or apart

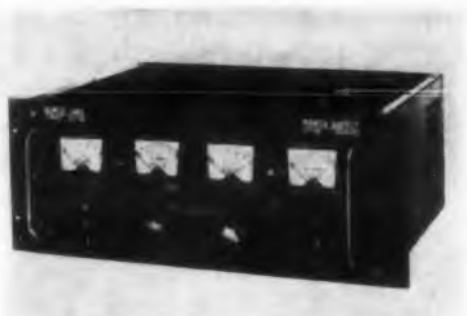
The C'trol combination contact meter and conller continuously limits or controls any elecal variable. The self-contained transistorized vice uses no locking coils or magnetic contacts. set is automatic. The modular panel-mounted ter and chassis-mounted controller may be gged together or separated.

Waters Mfg., Inc., Dept. ED, Wayland, Mass.

CIRCLE 86 ON READER-SERVICE CARD

Regulated Power Supply

Has two outputs



Witl 0.01% regulation and stability, model C-3: 1.5 transistorized power supply delivers o in lependent outputs of 0 to 32 v, 0 to 1.5 p. ipple is under 1 mv rms; recovery time, use output impedance, 0.01 ohm.

Kep Labs, Inc., Dept. ED, 131-38 Sanford ve., ushing 55, N.Y.

CIRCLE 87 ON READER-SERVICE CARD

Barden Precision Z148 bearings specially designed for a gyro rotor

BARDEN *engineers work with you creatively from design to application*

Write for the Barden booklet, "Ball Bearing Yield and System Isoelasticity." An aid to application of precision instrument bearings, it offers background data on axial and radial play, axial take-up, preloading, isoelastic bearings and achievement of system isoelasticity.

To achieve system isoelasticity and minimize moment errors, gyro rotors need bearings that provide rotational accuracy, exact positioning and controlled axial and radial yield rates.

All standard *Barden Precision* bearings have the extreme accuracy required for precise radial and axial positioning. In addition, the special purpose Z148 has these important features:

Closely controlled contact angles—essential for bearing or system isoelasticity

Inner ring raceways ground in shaft—to simplify rotor design . . . reduce mating part errors . . . improve bearing alignment

One of hundreds of Barden "specials," the Z148 is an example of the results that stem from working creatively with Barden engineers from the earliest design stage.

Like all *Barden Precision* bearings, standard or special purpose, the Z148 is planned for *performance* from research and design, through quality controlled production, functional testing and application engineering.

Your product needs *Barden Precision* if it has critical requirements for accuracy, low torque or low vibration . . . if it operates at extreme temperatures or high speed.

THE BARDEN CORPORATION

47 E. Franklin St., Danbury, Connecticut • Western office: 3850 Wilshire Blvd., Los Angeles 5, California

SPECIFY BARDEN PRECISION BALL BEARINGS FOR: INSTRUMENTS • COMPUTERS AND RECORDERS • AIRCRAFT ACCESSORIES • MACHINE TOOL AND TEXTILE SPINDLES • OTHER PRECISION APPLICATIONS

NEW PRODUCTS

Piezoelectric Accelerometers

Ungrounded

Series AXT ungrounded pie electric accelerometers may be directional or tridirectional. T operate from —100 to +525 F w ±5% accuracy and ±1% linea Standard housings are titanium, aluminum can be provided.

Gulton Industries, Inc., D ED, 212 Durham Ave., Metuch N.J.

CIRCLE 90 ON READER-SERVICE CA

Filter Set

Octave band

Model 530P filter set, when tached to the company's GR15 sound level meter, permits measu ments in octave bands between cps and 10 kc. The unit ha built-in transistorized amplifier measuring noise to 36 db below overall noise level. A switch the filter in and out so that set need not be disconnected f the sound level meter at any t

Allison Labs, Dept. ED, 14 Skyline Dr., La Puente, Calif.

CIRCLE 91 ON READER-SERVICE CA

Transistorized Power Supply

±5 mv long term stability

Output of this transistori power supply is 0 to 30 v at

◀ CIRCLE 89 ON READER-SERVICE CARD

amp. Long term stability is ±5 mv; line and load regulation is ±6 mv; and ripple is under 200 μv. At dc output impedance is under 0.002 ohm. At 1 mc, it is 0.1 ohm.

Invar Electronics Co., Dept. ED, 1749 N. Eastern Ave., Los Angeles 32, Calif.

CIRCLE 92 ON READER-SERVICE CARD

Environment Chambers

For military and commercial equipment

For military and commercial testing, TempLine environment chambers feature high and low temperatures, and controlled humidity and altitude ranges. Work space dimensions are 15 x 21 x 15 in.; 24 x 30 x 23 in.; or 35 x 36 x 41 in.

International Test Equipment Mfg. Co., Inc., Dept. ED, 4 Manhasset Ave., Port Washington, N.Y.

CIRCLE 93 ON READER-SERVICE CARD

Static Inverter

±2 cps frequency regulation

Model W-1348 static inverter supplies 800 cps power from nominal 28 v sources. It delivers 150 va of continuous 115 v power, amplitude regulated to 2% under all MIL-E-5272A conditions. Frequency regulation is ±2 cps.

Electrosolids Corp., Dept. ED, 13745 Saticoy St., Panorama City, Calif.

CIRCLE 94 ON READER-SERVICE CARD

RF Filter

Low pass

Designed to protect uhf or vhf communication systems, model 700 low pass rf filter has a 700 mc cutoff and handles 300 w cw. Insertion loss is 0.3 db below 420 mc and 60 db from 750 to 4000 mc. Vswr is 1.3 below 420 mc in a 50 ohm system. The unit is 15 in. long; 2.5 in. in diameter.

Adams-Russell Co., Inc., Dept. ED, 292 Main St., Cambridge, Mass.

CIRCLE 95 ON READER-SERVICE CARD

CIRCLE 96 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Electronic Delay Timer

Plug-in

Complete in a 2 x 2-1/4 x 3-1/8 in. can, this delay timer employs a unique circuit to control the breakdown of gas tubes and provide 0.00 to 300 sec delays. Unaffected by line voltage variations, the timer needs no warmup and consumes under 2 w. It has an octal radio type plug and can be provided with an spdt or 3pdt relay. It can also be supplied to operate an external relay. The unit recycles instantly. Any number of these timers can be connected to provide a sequence of controlled intervals.

G. C. Wilson & Co., Dept. ED, Huntington, W. Va.

CIRCLE 98 ON READER-SERVICE CARD

Volt-Ohm-Milliammeter

Highly sensitive

Volt-ohm-milliammeter model 980 is an analyzer with 20 K per v dc and 1 K per v ac sensitivity. Its accuracy is 2% full scale dc, 3% ac. The unit has seven dc ranges to 4000 v, six ac ranges to 1600 v; six db ranges from −15 to +54 db; and six dc ranges to 8 amp.

Weston Instruments, Div. of Daystrom, Inc., Dept. ED, Newark 12, N.J.

CIRCLE 99 ON READER-SERVICE CARD

Transistorized Power Supply

2 amp output

This power supply has a 2 amp output over a voltage range of 0.5 to 36 v dc. Designated model 62-124, it operates continuously in temperatures up to 50 C. Regulation is 0.05% for line voltage change from 105 to 125 v, and 0.05% from no load to full load. Unit is short circuit proof and free from line transients in its output.

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

CIRCLE 115 ON READER-SERVICE CARD

Power Converter

Output of 200 amp, 28 v

From a three phase, 400 cps, 115 or 200 v source, the W-1328 transistorized converter delivers 200 amp of 28 v rectified power. It weighs 7 lb, has a 50,000 hr life expectancy, and meets MIL-E-5272A specifications.

Electrosolids Corp., Dept. ED, 13745 Saticoy St., Panorama City, Calif.

CIRCLE 116 ON READER-SERVICE CARD

Multitester

Pocket size

Furnished semiassembled, the TK-10 pocket size multitester has five dc and five ac voltage ranges from 0 to 1000; three resistance ranges from 10 K to 1 meg; three dc current ranges from 0.5 to 250 ma; and two db ranges. Sensitivity is 20 K per v on dc and 10 K per v on ac.

Lafayette Radio, Dept. ED, 165-08 Liberty Ave., Jamaica 33, N.Y.

CIRCLE 117 ON READER-SERVICE CARD

NEW PRODUCTS

Photoheads

For electronic counters

These photoheads permit Count-Pak electronic counters to operate up to 30 in. away from a light source. They can be assembled so that jarring will not knock them out of focus.

Veeder-Root Inc., Dept. ED, 70 Sargeant St., Hartford 2, Conn.

CIRCLE 119 ON READER-SERVICE CARD

Transistorized Power Supplies

±0.25% regulation

This transistorized power supply line includes plug-in units for ac to dc power supplies, dc to dc converters, dc to ac inverters, and rack-mounted and bench top dc supplies. Standard regulation is up to ±0.25% with a 0.05% ripple content.

Consolidated Avionics Corp., Dept. ED, Westbury, N.Y.

CIRCLE 120 ON READER-SERVICE CARD

Potentiometers

In 25 to 500 K values

Internal redesign has raised the rating of model 3 Radiohm variable resistors from 1/4 to 1/2 w. The miniature units come in values from 25 to 500 K and meet MIL-R-94B requirements.

Centralab, Div. of Globe-Union, Inc., Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.

CIRCLE 121 ON READER-SERVICE CARD

Input Transformers

Plug-in

Designed to match the impedance of a microphone, pickup, or line to a high impedance amplifier, these input transformers have a frequency response of 20 cps to 20 kc ±2 db. The plug-in units have double mu metal shielding.

Microtran Co., Inc., Dept. ED, 145 E. Mineola Ave., Valley Stream, N.Y.

CIRCLE 122 ON READER-SERVICE CARD

...S- GENERAL ELECTRIC 5-STAR TUBES!

ELECTRONIC TUBES are, and will remain, superior in these areas of performance:

- **Proved reliability.**
- **VHF and UHF capability, and flexibility at these frequencies.**
- **One third the number of devices.**
- **Economy.**
- **Stable under ambient-temperature variations. Tolerate high temperatures.**
- **Low noise in wide-band RF circuits.**
- **High-voltage capability.**
- **Uniform product, with predictable performance to ratings.**

This margin of superiority grows as General Electric's active program of improvement makes 5-Star Tubes still more efficient and reliable. Design; manufacture; test; application—every product stage from development to final use in circuits shows progress in materials, methods, or both, as illustrated and described below.

14,000 tubes, using various cathodes and cathode coatings, make up one of many tests by General Electric to help determine the specifications for future 5-Star Tubes having even better performance. Equipment designers can be sure that General Electric leadership in high-reliability tubes is being maintained and strengthened; that 5-Star types will continue to meet the challenges of advanced electronic circuitry.

PROGRESS IN DESIGN. New cathodes for G-E 5-Star Tubes reduce interface and degradation of characteristics throughout life, mean built-in reliability. 100% tube stabilizing—used only by General Electric—adds to cathode and tube dependability and long life. New glass technology gives G-E tubes greater resistance to heat.

PROGRESS IN MANUFACTURE. Ultrasonic cleaning now is used for critical tube parts. This further extends General Electric's famed SNOW WHITE technique for excluding impurities of all kinds—notably dust and lint—during 5-Star Tube manufacture... A new direct-flow coating method for tube heaters accurately centers the wire, and provides an even coating, for more uniform insulating properties.

PROGRESS IN TESTING. General Electric's new impulse test, with vibrational output measured both in peak and integrated values, promotes lower-noise tubes where shock and vibration occur. Interface life tests; 100% DC testing for shorts and opens: these are among the many checks that make 5-Star tubes constantly more reliable.

For further information, phone nearest office of the G-E Receiving Tube Department below:

EASTERN REGION
200 Main Avenue, Clifton, New Jersey
Phones: (Clifton) GRegory 3-6387
(N.Y.C.) WIsconsin 7-4065, 6, 7, 8

CENTRAL REGION
3800 North Milwaukee Avenue
Chicago 41, Illinois
Phone: SPring 7-1600

WESTERN REGION
11840 West Olympic Boulevard
Los Angeles 64, California
Phones: GRanite 9-7765; BRadshaw 2-8566

Progress Is Our Most Important Product

GENERAL ELECTRIC

12-11-207

Beam Power Tubes

250 w plate dissipation

Capable of dissipating 250 w in the plate, these small beam power tubes are forced air cooled and designed with ceramic-metal seals. They can be operated with full ratings to 500 mc. Model 7203/4CX250B has a 6 v, 2.6 amp heater; model 7204/4X250F has a 26.5 v, 0.58 amp heater.

Radio Corporation of America, Electron Tube Div., Dept. ED, Harrison, N.J.

CIRCLE 470 ON READER-SERVICE CARD

Power Supplies

Provide B+, B—, bias voltages

Operating from a 400 cps power line, these miniature power supplies provide various B+, B— or bias voltages. They are sealed in an octal plug-in base.

Magnetico, Inc., Dept. ED, 6 Richter Court, East Northport, N.Y.

CIRCLE 124 ON READER-SERVICE CARD

Impact Switch

Works in 90 μsec

For missile and kindred speed measurement requirements, this single action impact switch has a controllable time limit range of 90 to 200 μsec. It may be supplied in 95% nonmetallic materials. Vibration and shock resistant, it operates from —80 to +185 F.

Servonics Engineering Services Co., Inc., Dept. ED, 4645 Van Nuys Blvd., Sherman Oaks, Calif.

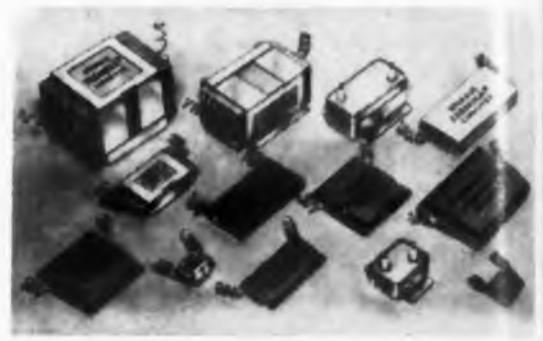
CIRCLE 125 ON READER-SERVICE CARD

◀ CIRCLE 123 ON READER-SERVICE CARD

NEW PRODUCTS

Stacked-Foil Capacitors

Standard ratings to 260 C



Stacked-foil Fabmika capacitors can be us in jet ignition systems, missile controls, ato reactors, and high voltage dc power suppl A dielectric of silicone-bonded mica paper p mits them to function effectively at high te peratures. Standard units have ranges from − to +125, +165, +200, or +260 C. Special un can operate at 310 C. Radiation resistant, th capacitors are available uncased, uncased a clamped, in cast epoxy housings, or in dra metal cases.

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

CIRCLE 127 ON READER-SERVICE CARD

Reference Resistors

Accurate within 1%

Certified accurate within 1% at a given roo temperature and humidity, these improved refe ence resistors are available in values of 100 10,000, 100,000, 1 million, and 10 million me Designed to plug directly into any of the com pany's megatrometers, the instruments are su plied in a Faraday box, utilizing Teflon insulato which are encompassed by grounded guar rings. Surface leakage is virtually eliminated b silicone treatment.

Mid-Eastern Electronics, Inc., Dept. ED. Commerce St., Springfield, N.J.

CIRCLE 128 ON READER-SERVICE CARD

Size 8 Servo Motor

Velocity damped

esigned to replace motor generators in servo ems, model 8 VM 460 is a size 8 velocity- ped servo motor for 115 v operation. It per- damping up to 85 dyne-cm-sec per radian. 0.34 gm cm² rotor inertia and 0.33 oz-in. torque produce an acceleration of 68,000 per sec². The unit has a no load speed of rpm and a 3.3 w power input. It passes L-E-5272A tests and stands 100 g shock and vibration at 2000 cps in all major axes. Its ient range is −55 to +130 C.
eckman Instruments, Inc., Helipot Div., Dept. Fullerton, Calif.

CIRCLE 129 ON READER-SERVICE CARD

Snap Action Switch

Has safety lock

This snap action switch has a safeguard to p it from being moved by accident. It will move from neutral unless the toggle handle aised or pulled out. Particularly suited for raft instrument panels, the dpdt unit comes four switching combinations: momentary, tral, maintained; maintained, neutral, mo- ntary; momentary, neutral, momentary; and intained, neutral, maintained. Any or all parts these combinations can be supplied with the k-out feature.
Milli-Switch Corp., Dept. ED, Frankfort, Ind.

CIRCLE 130 ON READER-SERVICE CARD

Power Supply

Protected against spikes

Mode 6073 transistorized power supply has lt-in protection against spikes and transients. r com munication and navigation applications, s 3.5 in. in diameter and 6.25 in. long. It pro- ces 0 and 100 v from 27 v dc input and erate from −40 to +80 C with 87% efficiency.
Univ rsal Transistor Products Corp., Dept. D, 17 Brooklyn Ave., Westbury, N.Y.

CIRCLE 131 ON READER-SERVICE CARD

NEW PRODUCTS

ROTARY DIAZO PRINTERS.—Blu-Ray 1959 models have improved paper feed. Cases can be quickly removed with snap fasteners.

Reproduction Engineering Corp., Dept. ED, Ivoryton, Conn.

CIRCLE 136 ON READER-SERVICE CARD

UNIVERSAL TRANSISTOR TESTER.—Model TT-1 tests npn and pnp low, medium, and high power types. Has both socket and external leads. Needs no external power connection.

The Reflectone Corp., Dept. ED, Post Rd. and Myano Lane, Stamford, Conn.

CIRCLE 137 ON READER-SERVICE CARD

WIRING DUCT CORNER STRIP.—In 5 ft lengths easily cut to any height. Makes corners for any of the company's plastic ducts.

Panduit Corp., Dept. ED, 14461 Waverly Ave., Midlothian, Ill.

CIRCLE 138 ON READER-SERVICE CARD

TELEMETERING PRESSURE GAGE.—Single coil variable inductance gages 7/8 in. diam. and 1.3 or 1.6 in. long. Absolute, gage, and differential units in ranges from 5 to 5000 psi for use from 1.3 to 70 kc and −85 to +250 F.

Travis Instruments, Inc., Dept. ED, 1901 E. Walnut St., Pasadena, Calif.

CIRCLE 139 ON READER-SERVICE CARD

INDUSTRIAL SERVO MOTOR.—Model A Selsyn transmitter-receiver features rugged, waterproof construction. Operates from 115 v, 50 to 60 cps. Maximum torque is 2.75 oz-in.; maximum speed, 500 rpm.

Rotron Controls Corp., Dept. ED, Woodstock, N.Y.

CIRCLE 140 ON READER-SERVICE CARD

HEAVY-DUTY INDUSTRIAL THERMOCOUPLE.—PermaKouple consists of heavy protecting tube with two no. 8 B & S gage wires completely embedded in solid ceramic. Remains rigid indefinitely in temperatures to 2200 F. In standard pipe diameters of 1/2, 3/4, and 1 in.

E. C. Smith Mfg. Co., Dept. ED, Forrest and Hector Sts., Conshohocken, Pa.

CIRCLE 141 ON READER-SERVICE CARD

12 INCH CATHODE RAY TUBE.—Type SC-2558 uses electrostatic deflection, post deflection acceleration, and an aluminized P7 screen. For medical, radar, and other oscilloscope equipment.

Sylvania Electric Products Inc., Dept. ED, Seneca Falls, N.Y.

CIRCLE 142 ON READER-SERVICE CARD

RIGID VINYL WIRING DUCT.—Type O has slots instead of holes to speed installation of large lugged wires on control panels. Eliminates harness lacing or lug attachment after assembly. Snap-on cover holds all wires in place.

Taylor Electric, Inc., Dept. ED, 15400 Dale, Detroit 23, Mich.

CIRCLE 143 ON READER-SERVICE CARD

ELECTRICAL CONTACTS.—Type 710, cold-headed directly from sintered silver-cadmium oxide wire. Conductivity of the material is 84 to 88% IACS, 6 to 12% above that of oxidized type and 15% above that of pressed and sintered type.

Judson L. Thomson Mfg. Co., Electrical Contacts Div., Dept. ED, Waltham, Mass.

CIRCLE 147 ON READER-SERVICE CARD

DUAL VOICE COIL WOOFER.—Model C-12SW, a 12 in. unit for monophonic or stereophonic use, has 1.5 lb Alnico 5 Gold Dot magnet and built-in response limiter adjustable for 700, 2500, and 5000 cps cutoff. Response: 40 to 6000 cps.

University Loudspeakers, Inc., Dept. ED, 80 S. Kensico Ave., White Plains, N.Y.

CIRCLE 148 ON READER-SERVICE CARD

AIR DRYER AND RECEIVER.—Purifies and dries air to zero dewpoint quality, then stores and delivers it. Prevents fouling, corroding, and freezing of instruments. Capacities to 8000 scfm and 6000 psig.

Van Products Co., Dept. ED, 5825 Swanville Rd., Erie, Pa.

CIRCLE 149 ON READER-SERVICE CARD

REFRIGERATED BLOWERS.—Model BR-6 holds cabinet temperature at 70 F or any preset value between 60 and 100 F. Panel-mounted unit fits standard 19 in. rack. Capacity of 6000 BTU.

Western Devices, Inc., Dept. ED, 600 W. Florence Ave., Inglewood, Calif.

CIRCLE 150 ON READER-SERVICE CARD

SEALED METERS.—Ruggedized, 1.5 in. square metal-cased units for electronic and aircraft equipment.

WacLine, Inc., Dept. ED, 35 S. Clair St., Dayton 2, Ohio.

CIRCLE 151 ON READER-SERVICE CARD

AUTOMATIC BATTERY CHARGERS.—Check batteries every hour; charge those that need it, disconnecting them when fully charged. For inputs to 600 v, 60 cps and 6 to 32 v batteries. Charging rate of 6 amp.

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

CIRCLE 152 ON READER-SERVICE CARD

POTENTIOMETER TESTER.—Model PC-15 uses 10-turn master potentiometer to check 1, 3, 10, and 15-turn units with respective accuracies of 0.01, 0.005, 0.002, and 0.003%.

Analogue Controls, Inc., Dept. ED, 39 Roselle St., Mineola, N.Y.

CIRCLE 153 ON READER-SERVICE CARD

BROADBAND VHF ANTENNA.—CV-3 system has eight vertically polarized corner reflector elements placed two wide and four high. Uses tropo scatter propagation; covers 90 to 160 mc range without adjustment. Gain of 19 to 21 db.

All Products Co., Dept. ED, Box 110, Mineral Wells, Tex.

CIRCLE 154 ON READER-SERVICE CARD

NEW PRODUCTS

INERTIA DAMPED SERVO MOTOR.—Size model 8 IM 460 permits use of a rotor with as as 0.34 gm cm² inertia. Flywheel damping f 52 dyne-cm-sec/rad. Power input. 3.3 w per p No load speed: 6000 rpm.

Beckman Instruments, Inc., Helipot Div., ED, Fullerton, Calif.

CIRCLE 157 ON READER-SERVICE CARD

POTENTIOMETER.—Improved model 21 Res carbon Trimpot is rated 0.25 w at 70 C, stands 1 and meets MIL-STD-202 specifications. Mea 1/4 x 5/16 x 1-1/4 in.

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

CIRCLE 158 ON READER-SERVICE CARD

TV I-F PENTODES.—Sharp cut-off units with μmho transconductance. Types 3DK6 and 4DK 3 and 4 v versions heater warmup controlled series-string operation. Type 6DK6 is for parallel eration.

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

CIRCLE 159 ON READER-SERVICE CARD

INDUSTRIAL HANDLES.—Round wire type ad able to any electronic chassis, relay rack, or cab Series 600 have female thread and bushing; s 700 have male thread.

Grant Pulley & Hardware Corp., Dept. ED, St., West Nyack, N.Y.

CIRCLE 160 ON READER-SERVICE CARD

PLUG AND JACK.—Combination 2317 allows pi backing of patch work panels and additional pl Mates with the company's 2201-2 plug. For term boards from 0.087 to 0.214 in. thick.

Cambridge Thermionic Corp., Dept. ED, 445 C cord Ave., Cambridge 38, Mass.

CIRCLE 161 ON READER-SERVICE CARD

LIGHT SOURCES AND PHOTOUNITS.—Mi ture electric eyes designed for use with the c pany's IRC-5 control relay.

ESS Instrument Co., Dept. ED, 96 S. Washin Ave., Bergenfield, N.J.

CIRCLE 162 ON READER-SERVICE CARD

TIME DELAY RELAY.—Type TDS provides del to 0.2 sec. Coil resistance for 26.5 v dc operat 425 ohms. Dpdt contacts rated 5 amp at 26.5 v or 115 v ac. Weighs 5 oz.

E. V. Naybor Labs, Inc., Dept. ED, 26 Ma haven Blvd., Port Washington, N.Y.

CIRCLE 163 ON READER-SERVICE CARD

PRESSURE-SENSITIVE TAPES AND SYMBO —For printed circuit master layouts. Tapes are 1 to 2 in. wide ±0.002 in. Symbols are precision cut.

Chart-Pak, Inc., Dept. ED, 1 River Rd., Le Mass.

CIRCLE 164 ON READER-SERVICE CARD

PRESSURE CONTROL.—Model PE-103 for wind tunnel applications. Acts like 30pst switch: cuts off 30 pressure lines in one position; connects 30 input lines to 30 output lines in the other. For any pressure to 125 psig.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

CIRCLE 165 ON READER-SERVICE CARD

STEPPING SWITCHES.—Plug-in base with removable cover has been added to type 11 spring driven switches. Bases have three 16 or 36-pin Amphenol plugs, or two 54-pin Elco plugs.

C. P. Clare & Co., Dept. ED, 3101 Pratt Blvd., Chicago 45, Ill.

CIRCLE 166 ON READER-SERVICE CARD

PRESS-ON NAMEPLATES.—Furnished in any commercial metal from 0.003 to 0.006 in. thick. Suited for panel and dial facings. Wide choice of colors, sizes, and shapes.

The Dickey-Grabler Co., Dept. ED, 10302 Madison Ave., Cleveland 2, Ohio.

CIRCLE 167 ON READER-SERVICE CARD

RECTANGULAR CATHODE RAY TUBE.—Improved 3 in. type 3XP has 20% more distortion free usable screen area. Available with P1, P2, P5, P7, and P11 phosphors.

Allen B. Du Mont Labs, Inc., Dept. ED, 750 Bloomfield Ave., Clifton, N.J.

CIRCLE 168 ON READER-SERVICE CARD

PHENOLIC INSULATOR.—Impact-resistant type MI-1000 has Bakelite insulator body and steel cadmium plated base which may be obtained separately. Meets MIL-P-14B-Type CFG requirements.

Electric Machinery Mfg. Co., Mullenbach Div., Dept. ED, 2100 E. 27th St., Los Angeles 58, Calif.

CIRCLE 169 ON READER-SERVICE CARD

JACK.—Model 2515 for tight patch work. Compression spring used with floating key provides permanent gripping power. For plugs with 0.062 in. pin diameter and panels from 1/32 to 3/16 in. Has solder terminal.

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

CIRCLE 170 ON READER-SERVICE CARD

PULSE DELAY UNIT.—Step variable delays of 5, 10, 15, 25, 50, and 100 μsec. For matched use in pulse systems using RG 63/U cable. Characteristic impedance of 125 ohms.

Electrical and Physical Instrument Corp., Dept. ED, 42-19 27th St., Long Island City 1, N.Y.

CIRCLE 171 ON READER-SERVICE CARD

AUTOMATIC IMPEDANCE PLOTTER.—Portable or rack-mounted units present continuous data on unknown rf impedance. Trace 60 points per sec on a Smith chart. Frequency ranges: 2.5 to 250 mc, 30 to 400 mc, 180 to 1100 mc.

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

CIRCLE 172 ON READER-SERVICE CARD

NEW PRODUCTS

SPECIALIZED AIR CONDITIONER. – Model BOMO controls temperature and humidity in mobile vans that house electronic systems used to compute aircraft flight paths. Suspends beneath van floor.

Ellis and Watts Products, Inc., Dept. ED, Cincinnati 36, Ohio.

CIRCLE 175 ON READER-SERVICE CARD

PRECISION GEAR HEADS.—Size 11 units for use with standard BuOrd MK 14 Mod. 2 servo motors. Can be provided with adapters for use with other than size 11 motors and systems. Pass MIL-E-5272A tests.

Fae Instrument Corp., Dept. ED, 42-61 Hunter St., Long Island City 1, N.Y.

CIRCLE 176 ON READER-SERVICE CARD

ELECTRIC COUNTER.—Model CE-800 for dc or any standard voltage to 230 v ac, 25, 40, or 60 cps. Available with six digits, knob or key reset. Rated at 1000 counts per minute.

General Controls Co., Dept. ED, McCormick Blvd., Skokie, Ill.

CIRCLE 177 ON READER-SERVICE CARD

FOOT, KNEE, OR ELBOW SWITCH.—Actuates electric counters, production equipment, and other electrically operated mechanisms. Switches 3/4 hp loads at 115 v ac.

General Controls Co., Dept. ED, McCormick Blvd., Skokie, Ill.

CIRCLE 178 ON READER-SERVICE CARD

CERAMIC COIL FORM.—Type 2500, for printed circuitry, has independently tunable primary and secondary windings. Threaded to accept tuning cores supplied for four ranges between 1 and 150 mc.

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

CIRCLE 179 ON READER-SERVICE CARD

BATTERY CHARGER POWER UNITS.—Provide economical power; can deliver current peaks up to 10 times rated capacity of the batteries. Built-in charger keeps batteries fully charged at all times.

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

CIRCLE 180 ON READER-SERVICE CARD

VARIABLE SPEED DRIVE.—Servotran drive for automatic control systems now has accurately calibrated dial for precision manual speed adjustment. Calibrations may be for 180 deg rotation forward and reverse, or for 360 deg in one direction.

Humphrey, Inc., Humphrey Products Div., Dept. ED, 3794 Rosecrans St., San Diego 10, Calif.

CIRCLE 181 ON READER-SERVICE CARD

NEON PILOT LIGHT.—Extends less than 7/8 in. behind panel, mounts in single 1/2 in. hole. U/L and CSA approved.

Industrial Devices, Inc., Dept. ED, 982 River Rd., Edgewater, N.J.

CIRCLE 182 ON READER-SERVICE CARD

FORCED CONVECTION CABINET OVENS.—Cyclo-Flow series OH horizontal flow and OV vertical flow units with ranges to 500, 650, 850, and 1000 F.

L & L Mfg. Co., Dept. ED, 136 Eighth St., Upland, Delaware Co., Pa.

CIRCLE 183 ON READER-SERVICE CARD

KLYSTRON TRANSMITTER.—Model 50T operates over 225 to 400 mc band, produces 18 kw of cw power and 50 kw of peak power at maximum duty cycle of 0.4 Uses Eimac X590 klystron with 40 db power gain.

Levinthal Electronic Products, Inc., Dept. ED, Stanford Industrial Park, Palo Alto, Calif.

CIRCLE 184 ON READER-SERVICE CARD

PNEUMATIC PRESSURE SWITCH.—Miniature model 610 for gage pressure, 617 for differential. Operate from 0 to 30 psi, —55 to +160 F. Units are 1.5 in. in diameter, 2 in. long.

Meletron Corp., Dept. ED, 950 N. Highland Ave., Los Angeles 38, Calif.

CIRCLE 185 ON READER-SERVICE CARD

PRECISION PRESSURE SWITCH.—Consists of a contactor manometer and a relay-power supply package. Has make or break control sensitivity of 0.005 in. of water. Senses pressure increments of 0.003 oz per sq in.

Meriam Instrument Co., Dept. ED, 10768 Madison Ave., Cleveland 2, Ohio.

CIRCLE 186 ON READER-SERVICE CARD

PRECISION THERMOSTATS.—Klixon M201 fixed setting, snap acting temperature controls in several ac and dc ratings. Units are 5/8 in. diam, weigh 4 g. Shock and vibration resistant.

Metals & Controls Corp., Spencer Thermostat Div., Dept. ED, Attleboro, Mass.

CIRCLE 187 ON READER-SERVICE CARD

HIGH TEMPERATURE RESISTOR RIBBON—26A Thermal-Ribbon for temperature measurement and control applications to 260 C. Measures 0.02 x 0.5 x 4 in. Sticks to irregular surfaces.

Minco Products, Inc., Dept. ED, 740 Washington Ave. N., Minneapolis 1, Minn.

CIRCLE 188 ON READER-SERVICE CARD

POWER RELAY.—Type R310 for switching high currents. Rated 10 amp, 125 or 250 v ac, 30 v dc, inductive. Nominal coil resistance for 26.5 v dc; 300 ohms. Weight: 3 oz.

E. V. Naybor Labs, Inc., Dept. ED, 26 Manorhaven Blvd., Port Washington, N.Y.

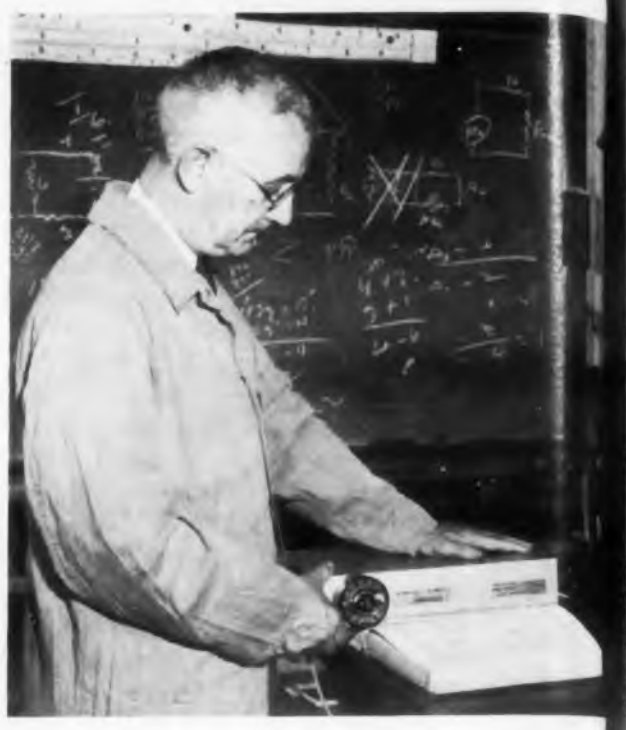
CIRCLE 189 ON READER-SERVICE CARD

MAGNETIC TAPE HEAD.—Stereophonic model TLD-1, records and reproduces frequencies from 30 cps to 15 kc at tape speed of 3.75 in. per sec. Has laminated pole pieces. In four impedances from 0.08 to 1 h.

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

CIRCLE 190 ON READER-SERVICE CARD

IDEAS FOR DESIGN



Engineer-teacher E. W. Berry uses the Contour Portable photocopier to make copies directly from bound volume.

Contour Following Photocopier Rides On Air

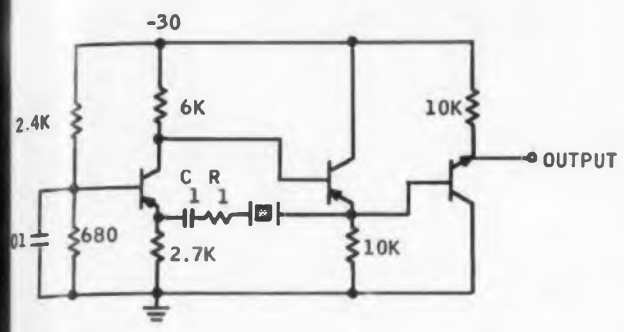
This portable photocopier can make dir copies of pages from books or magazines ri to the margin– and without harming the bi ing. It follows the contour of a page in a volu by virtue of its inflatable plastic air cushion. T copier, placed face down on a page, makes copy in 30 seconds.

Manufactured by F. G. Ludwig, Inc., 2 Coulter St., Old Saybrook, Conn., the Contou Portable copies anything written, printed, drawn in any color. It makes crisp black a white copies.

Good, clean copies can even be made of ov lays and paste-up jobs without showing Sco tape marks.

Transistorized Driver for Medium and High Impedance Crystals

We needed a single oscillator to drive crys in the 300 to 500 kc range and in the 1000 1600 kc range. Crystal characteristics dictat the use of CT or DT cut crystals for the lo frequency operation and AT cut crystals for t higher frequencies. Series-resonance crys were chosen for the desired high frequen stability. With oven control, our final circ



ransistorized crystal driver works with medium high pedance crystals.

rovided a stability of 0.0005 per cent over a deg C temperature variation.

We found the best circuit for the job was a ransistorized Butler oscillator. It has a common ollector amplifier driving the series-resonance rystals, and a common base amplifier to pro- ide the voltage gain necessary for the unity op gain required for oscillation.

Since there is no Miller effect in either stage, ne can operate in the megacycle region with- ut high frequency transistors. Since the com- non collector stage has a low output impe- ance and the common base stage has low input mpedance, a constant current drive results, nce the crystal impedance is much higher than he common base input impedance.

A resistor in series with the crystal keeps in- ernal heating down and increases stability. Its alue is determined experimentally as different rystal impedances are used in the circuit.

The output frequency can be trimmed by hanging the value of C_1. In the case of AT cut rystals, a variation of several hundred cycles an be achieved.

Max Liang, Electronics Engineer, Consoli- ated Electrodynamics Corp., Pasadena, Calif.

Battery Saver

Some people drive to work early in the morn- ng, then leave their lights on in the parking lot. Not a technical problem, but a very practical ne.)

The solution to this problem is a simple one. Put a small warning light in series with a diode betwe en the taillight contact and the ignition wire in such a way that the bulb will light when ights are on and the key off, but not vice versa. The small current through the bulb does not nterfere with normal operation of either cir- uit. The same circuit without the diode would lso warn you to turn lights on at nightfall.

Ro ert W. Blanchard, Sr. Engineer, Federal Telec mmunication Labs., Nutley, N. J.

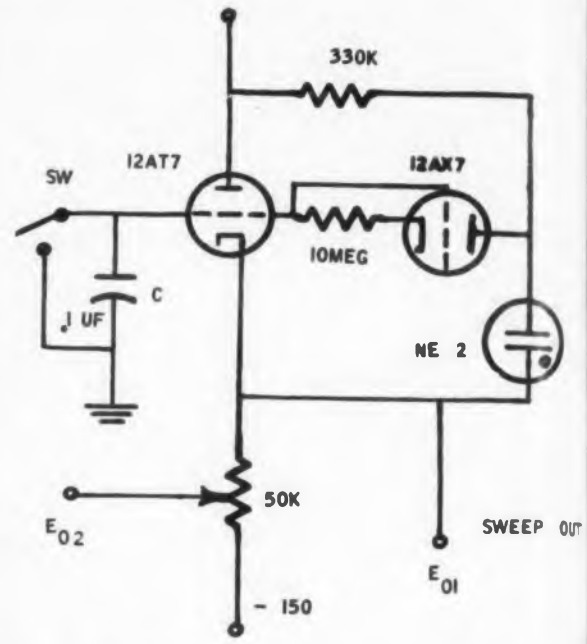


Fig. 1. The neon lamp (or a zener diode) helps t bootstrap sweep from zero to 200 v in 3 sec with bet than 10 per cent linearity.

Long Linear Sweeps

Here's a way to get very long duration swee with good linearity.

A neon lamp, or zener diode, is used in bootstrap circuit to make the bootstrapping a tion effective all the way down to dc. The l earity of the sweep depends on the change grid bias of the cathode follower as the swe runs from zero to a maximum of 200 volts more.

Linearities of better than 10 per cent can b achieved with the circuit of Fig. 1. Linearity defined as per cent change of charging curr from the beginning to the end of the swe

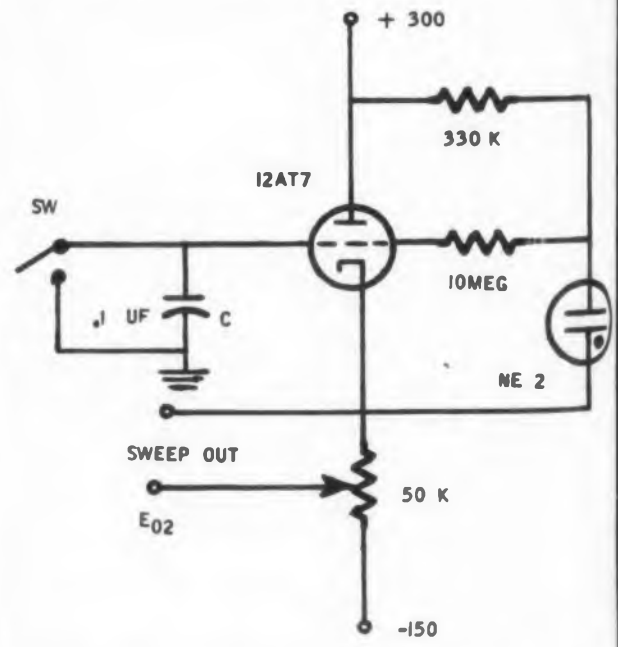
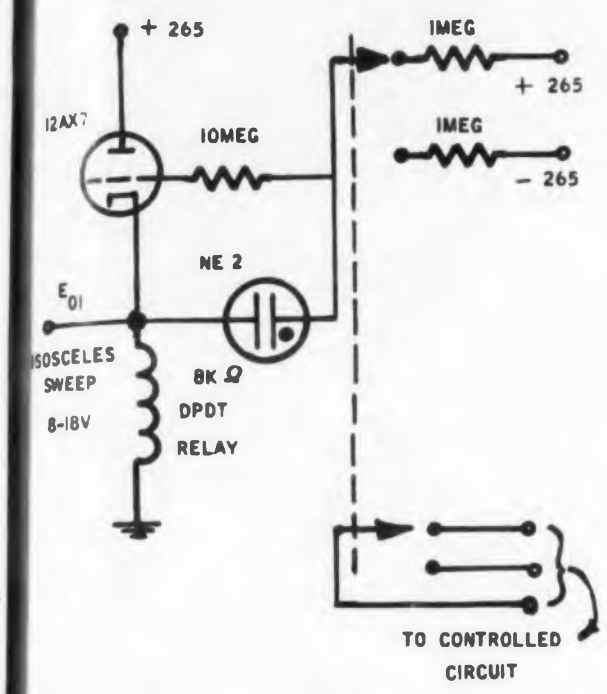


Fig. 2. This bootstrap includes a constant current ge erator. It sweeps 60 times slower than that in Fig.



g. 3. This circuit can provide an isosceles sweep, 10 conds long.

ubes with a large "μ" should be used for best nearity.

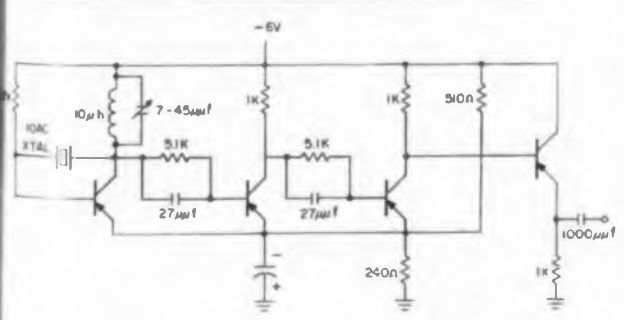
To achieve a 100-fold improvement in both nearity and duration of sweep-time we can use "constant current" generator instead of a re- stor, as shown in Fig. 2. Using $R = 10$ meg and $= 0.1$ μf, sweep times of 3 seconds/200 volts e obtained with the circuit in Fig. 1, and 3 inutes/200 volts with the circuit in Fig. 2. An provement of only 60 times is obtained in- ead of "μ" times ($\mu = 100$) because μ decreases very low plate currents.

The center tap of the filaments of both tubes ould be tied to the cathode follower output to educe hum pick-up and leakage currents.

The sweep can be made repetitive by using a yratron or other discharge device indicated by SW." The firing point can be controlled by E_{02}.

Fig. 3 shows a circuit used to provide a 10- econd isosceles sweep voltage for on-off cycling f certain equipment.

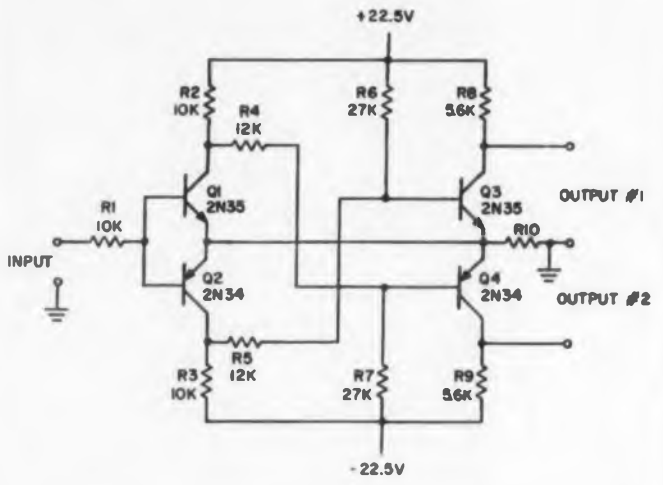
S. Bernstein-Bervery, Tarrytown, N. Y.



Time calibrator for oscilloscopes. It's small and port- ble, nd it checks the most popular oscilloscope time ase—0.1 μs/cm.

Do ald A. Purland, Design Engineer, Philco Corp., Govt. and Ind. Div., Philadelphia, Pa.

IDEAS FOR DESIGN



A Polarity Sensitive Trigger Circuit

In designing a Schmitt trigger to change states when the input goes through zero, two approaches can be used. These are (1) use of an input stage to change the level of the input signal, (2) use of both positive and negative supply voltages to bring the firing level of the Schmitt to zero volts. Because the firing level and hysteresis are subject to changes with age and supply voltage variations, use of the standard Schmitt circuit dictates that for accurate sensing of polarity, caution be taken to insure stability.

The circuit shown here was developed primarily to detect polarity changes. Because of the balanced design and use of complementary symmetry the circuit is stable with temperature and aging. The transistors are operated at either cutoff or saturation and the loop gain is quite high. As a result, the firing points remain relatively drift free. The amount of hysteresis is varied by changing the common emitter resistor *R10* and remains balanced about zero. Typical values of hysteresis are ±0.1 v for *R10* set at 100 ohms, to ±0.5 v for *R10* equal to 500 ohms.

Circuit constants are selected so the transistors operate in either the cutoff or saturation regions. When the input pnp and output npn units are at cutoff the input npn and output pnp units are in saturation. Because the collector current in the output stage is approximately twice that in the input stage, the polarity of the voltage across *R10* is determined by the conducting output transistor. This polarity is opposite the input signal and its magnitude determines the hysteresis of the circuit.

Transition from one state to the other occurs when the input approaches the emitter voltage sufficiently to reduce the collector current in the conducting input transistor. The change in collector voltage resulting from the reduction of collector current is transferred to the conducting

output transistor. The signal appearing at the output transistor is transferred to the input transistor through the common emitter resistor, reappearing at the collector of the input transistor with the same polarity as the original change.

When the loop gain exceeds unity regeneration takes place, causing the circuit to switch states. The action is identical with the operation of the Schmitt trigger and the relationship between loop gain and hysteresis hold for both circuits. This is discussed more fully in Millman and Taub's "Pulse and Digital Circuits."

The circuit can be used as a Schmitt trigger, a squaring circuit or a flip-flop. It has proven quite useful in detecting the polarity of random pulses. It operates over wide temperature ranges and its stability at high temperature can be improved by shunting *R4* and *R5* with back biased germanium diodes to supply I_{co} to the output transistors.

As a sine wave phase comparator it can provide 1 degree accuracy with 3 v rms input. It requires no amplification for most input waveforms.

James E. Curry, Tasker Instruments Corp., Hollywood, Calif.

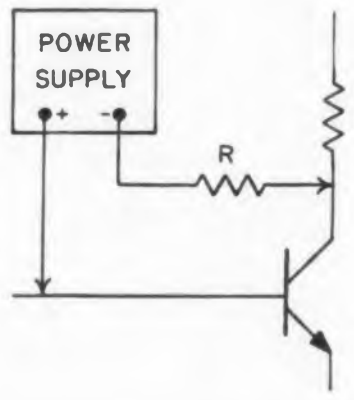
Simple Test For Temperature Effects On Transistors

With germanium transistors, the effect of changes in collector cutoff current (I_{co}) with temperature is very important. Here is a simple and rapid means of evaluating this effect.

The diagram shows how additional I_{co} is injected into the transistor. The series resistor *R* must be very large compared with the collector and base circuit impedances. The amount of current used is determined by the proposed rise in I_{co} over the temperature range.

Typical values are 150 v through 1 meg. This simulates an I_{co} change of 150 μa. Voltage polarity must be reversed for pnp transistors.

J. R. Siconolfi, Engineer, I. T. & T. Labs., Fort Wayne, Ind.



I_{co} ***injector*** simulates temperature changes.

INDEX OF ARTICLES

July 9th through December 24th, 1958

Reference Keys

ABS	**Abstract**
DF	Design Forum
ED	Engineering Data
GA	German Abstract
ID	Ideas for Design
PF	Product Feature
RT	Russian Translation

Bold face type indicates exact title of article.

D

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F

INDEX OF ARTICLES cont.

INDEX OF ARTICLES cont.

INDEX OF ARTICLES cont.

Nonlinear and Phenomena Radio

Part 8

A. A. Kharkevich

(Translated by J. George Adashko)

Chapter 1

Nonlinear Circuits

10. FM and PM Detection

In this section we discuss the general principles of detection, used for modulation other than a-m, particularly frequency modulation (f-m) and certain forms of pulse modulation (p-m).

FM Detection

The usual manner of detecting frequency modulated oscillations consists of first converting the f-m oscillations into a-m oscillations, then detecting them as described in Sec. 9. The f-m is converted into a-m with a so-called frequency detector.

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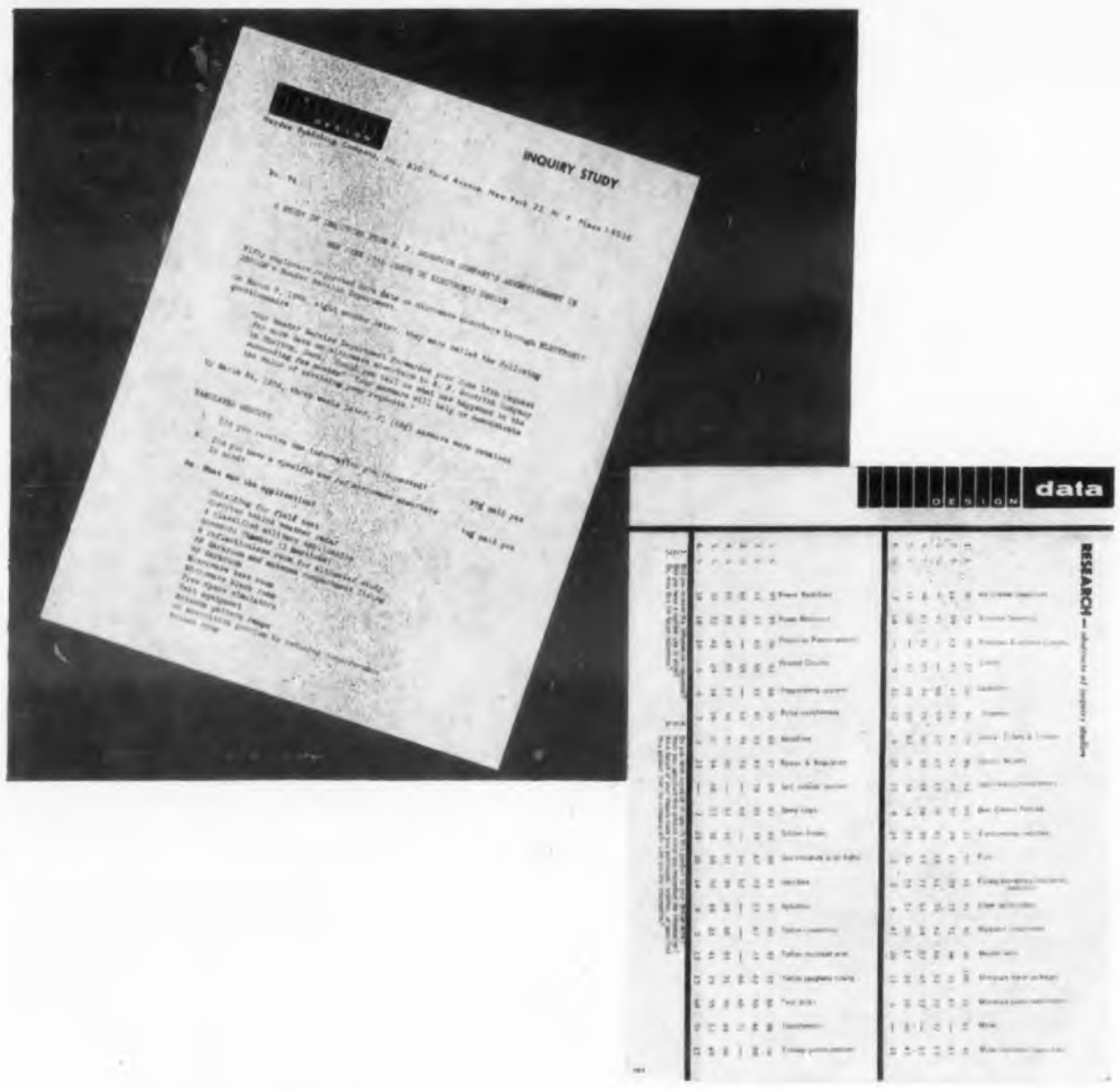
art 8 of Professor Kharkevich's book
udes his Sections 10 and 11, wherein he
usses F-M and P-M Detection, and
dulation.
his continues ELECTRONIC DESIGN's bi-
kly serial translation which began on
tember 17th.

Circuit Fundamental

nlines cesses

ral pri he simplest frequency detector is a resonant
on oth hit that is detuned relative to the carrier. In
odulati absence of modulation, i.e., when $\omega = \omega_0$, the
odulati rating point is on the decreasing branch of
reso ance curve of the tank circuit, as shown
Fig. 32. The lower portion of this diagram
ws the time variation of the frequency. As the
quency quency varies, so does the amplitude I_m of the
nverti h-fr quency current in the tuned circuit, as
then de wn the right half of the diagram.
ne f-m i ut change in amplitude is nothing but
equency plitude modulation. Thus, once the voltage is
ked off the resonant circuit, all that remains is



Thanks For Your Help

One of the questions most often raised by advertisers concerns the conversion of inquiry to sale. Over a period of years, *Electronic Design* has contacted inquirers to find out (1) if the inquiry was prompted by a specific use in mind, (2) needed for future reference, or (3), needed for work in progress. The questionnaire also asked the inquirer if he had specified the product or intended to in the near future.

The results of these polls have been most helpful to potential advertisers, offering proof of the important communication function provided by this magazine.

Those subscribers who have cooperated in filling out their inquiry questionnaire deserve our thanks. By helping us to prepare more accurate information about the market we serve, *Electronic Design* becomes an even more basic media choice in this industry.

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RUSSIAN TRANSLATIONS

to detect and filter it in the usual m nner. basis circuit for f-m detection is shown in F

Modern practice calls for better fre uenc tectors. The point is that to avoid nor linear tortion, the characteristic of the frequency tector must be linear. In other words, the of the characteristic, given by the deriv $dI_m/d\omega$ must be constant within the oper range. For broadband f-m, it is difficult to s this requirement with a simple circuit. therefore employs symmetrical circuits, w have more favorable characteristics.

An example of such a circuit is shown in 34. Here the two tank circuits are usually t to the extreme values of the frequency, i.e $\omega_0 + \Delta\omega$ and $\omega_0 - \Delta\omega$. Each of these tanks verts f-m into a-m. The a-m oscillations ar tected by the respective halves of the do diode.

The *RC* combinations serve as filters. The frequency voltages of U_1 and U_2 across R_1 a are proportional to the ordinates of the reson curves of circuit *1* and *2* respectively. But these voltages across R_1 and R_2 are opposit sign (see arrow showing the directions of the rents on the diagram), the output of the ci is the difference between the voltages U_1 and

The characteristic of the frequency dete i.e., the dependence of the output voltage on f-m frequency at the input, is obtained by tracting the two resonance curves, as shown Fig. 35. Frequency detectors of this type called discriminators.

PM Detection

Let us turn now to pulse modulation. principal forms of pulse modulation are modulation of pulses by amplitude—(PAM) modulation of pulses by repetition frequ (PFM), (3) modulation of pulses by dura (PDM), and (4) modulation of pulses by p (PPM).

Detection of a PAM signal does not differ sentially from detection of an ordinary am tude-modulated oscillation. The difference only in the contents of the high frequency tion of the spectrum, which must be filte out anyway.

The same pertains to PDM, although it is obvious at first glance. It must be taken account, however, that the low-frequency c ponent, after the usual detection of the p modulated signal, is proportional to the area the pulse. Consequently, it makes no differe what changes in the envelope of the pulse du modulation, the amplitude or the duration. T

usual detector circuit is suitable for the de-
ion of PAM and PFM.

atters are different with pulse-phase modu-
n. In the case of PPM, as is known, the area
he pulse remains constant. The modulation
ists merely of shifting the pulse relative to
reference point. It is therefore necessary, in
detection of PPM, first to convert the PPM
PAM or PDM, or in general to a form in
h the pulse area changes. To convert PPM

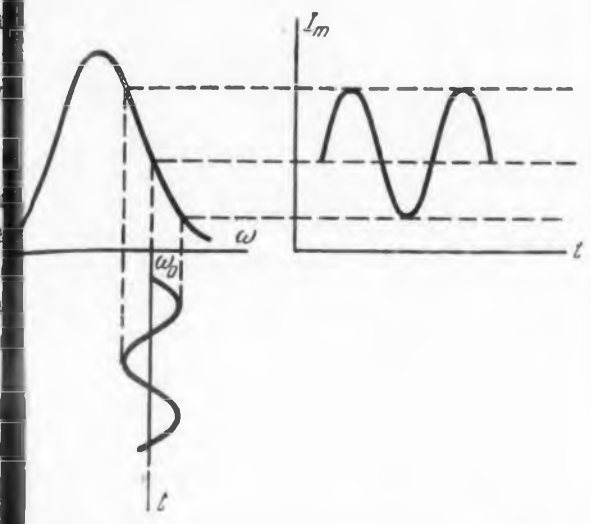

Fig. 32. The simplest frequency detector is tuned to a lower-than-carrier frequency.

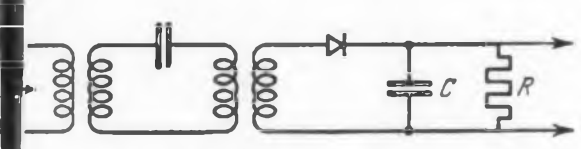

Fig. 33. The simplest type of f-m detector.

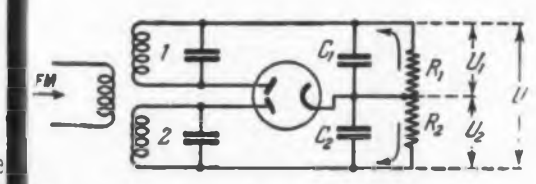

Fig. 34. The discriminator gives more linear f-m detection than the simple circuit of Fig. 33.

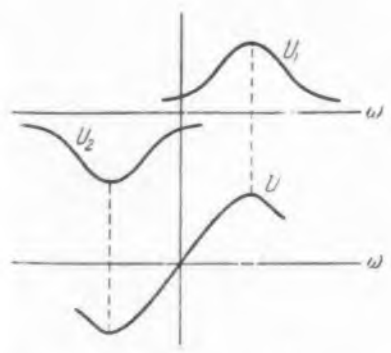

Fig. 35. The discriminator provides more linear outp over a broader frequency range by takir the difference between the two input reso nce curves.

RUSSIAN TRANSLATIONS

into PDM one can employ, for example, a circuit containing an electronic relay energized by the in-phase pulses (or vice versa), as shown in Fig. 36.

Topics connected with detection of pulse-code modulation, being more specialized will not be considered here.

11. Modulation

The purpose of modulation is to shift the spectrum of the transmitted (low-frequency) signal into the high-frequency region. This makes the signal suitable for transmission by radio. Such a shift is necessary because effective radiation can be obtained only at high radio frequencies.

Modulation is produced when the signal modifies the high-frequency oscillations yet remains "imprinted" in the variations of one of the parameters. The high frequency, so to speak, carries the signal with it, retaining all the signal properties. The signal can thus be again separated on the receiving end.

Modulation is essentially a linear process realized in a linear system with variable parameters.

We shall first explain the mechanism of amplitude modulation, using as an example an extremely simple circuit, used at one time in low power telephone transmitters. The circuit is shown in Fig. 37. The high-frequency oscillator is coupled inductively to the antenna. Connected in series with the antenna is an ordinary carbon microphone. The sound causes the membrane of the microphone to vibrate and compress the carbon powder contained in the microphone, thus changing its admittance.

Let us assume that the microphone is strictly linear, i.e., that its admittance is a linear function of the sound pressure. We then obtain for the admittance of the antenna circuit

$$Y = Y_0 + kP$$

Let the sound pressure be sinusoidal

$$P = P_m \sin \Omega t.$$

We can then write for the admittance

$$Y = Y_0 + kP_m \sin \Omega t = Y_0 + Y_1 \sin \Omega t$$
$$= Y_0 (1 + m \sin \Omega t),$$

where $m = Y_1/Y_0$ as the coefficient of modulation of the admittance. Furthermore, let the electromotive force induced by the oscillator in the antenna be

$$E = E_m \sin \omega_0 t,$$

where ω_0 is the high (carrier) frequency. The antenna current is the product of this emf and the admittance.

$$I = EY = E_m Y_0 (1 + m \sin \Omega t) \sin \omega_0 t.$$

We have derived the usual expression for an oscillation, amplitude modulated sinusoidally at a frequency Ω.

This is a linear circuit with variable parameter. The variable parameter is the admittance.

Returning to the expression for the amplitude-modulated oscillation, let us rewrite it in a more general form.

$$I = I_m [1 + m f(t)] \sin \omega_0 t.$$

where $f(t)$ is an arbitrary transmitted signal and it is assumed here that $| f(t) | < 1$.

We see that the modulation process consists of multiplying two functions of time, $1 + mf(t)$ and $I_m \sin \omega_0 t$. Consequently, the modulator should act in principle as a multiplying device, i.e., a device with two inputs and one output.

If the inputs are, say $x(t)$ and $X_0(t)$, the output is

$$y(t) = x(t)\, X_0(t)$$

Multiplication by a given function $X_0(t)$ is a linear operation, as can be seen from the following relationship

$$y(t) = [x_1(t) + x_2(t)]\, X_0(t)$$
$$= x_1(t)\, X_0(t) + x_2(t)\, X_0(t) = y_1(t) + y_2(t)$$

Devices that multiply two functions of time

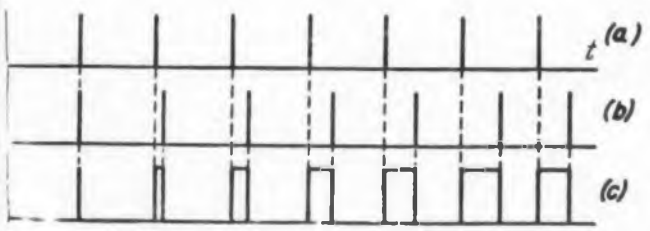

Fig. 36. An electronic relay can convert PPM to PDM. The in phase "on" pulse are shown at (a), the PPM "off" pulses at (b), and the pulses at the output of the electronic relay at (c).

are used for modulation and frequency conversion are usually called mixers. This is a poor term, for it does not describe the nature of the process. We shall call a device that multiplies two functions a multiplier.

Thus, to obtain ordinary amplitude modulation it is necessary to take a multiplier with inputs $x(t) = 1 + m\, f(t)$ and $X_0(t) = I_m \sin \omega_0 t$. The multiplication will yield the modulated oscillation.

(Continued on following page)

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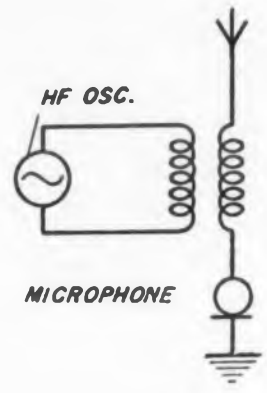

Fig. 37. A simple modulation scheme, once used in low power telephone transmitters.

Let us note that this expression can be written

$$I = I_m \sin \omega_0 t + m\, I_m f(t) \sin \omega_0 t.$$

The first term is the carrier-frequency current. Expansion of the second terms gives the sideband frequencies of the modulation spectrum. Along with ordinary a-m, one also employs transmission without the carrier frequency, obtained with the aid of so-called balanced modulation.

To obtain amplitude modulation without a carrier frequency, using a multiplier, it is merely necessary to eliminate the dc component of the modulating function, i.e., use only $x(t) = f(t)$. This results in a multiplier output

$$y(t) = x(t)\, X_0(t) = I_m f(t) \sin \omega_0 t.$$

The spectrum of this oscillation does not contain the carrier frequency; the spectrum consists of only the two sideband frequencies.

Any two-port network with adjustable transfer function can be used as a linear multiplier. Thus, if we have, in general,

$$y(t) = k\, x(t)$$

and if we can vary the transfer function k in accordance with an arbitrary law $k = k(t)$, we indeed obtain a multiplier, whose operation is described by

$$y(t) = k(t)\, x(t)$$

By way of an example, let us examine how a multigrid tube (specifically, a heptode) operates as a multiplier. In such a tube, as is known, the transconductance with respect to the third (so-called "signal") grid depends on the voltage on the first ("heterodyne") grid. In the ideal case, the dependence of the transconductance on the

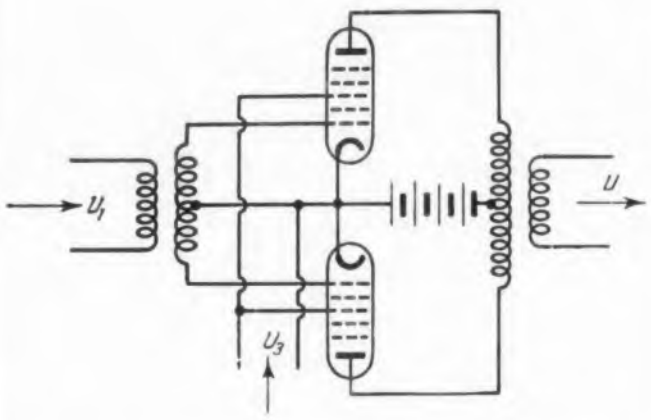

Fig. 38. This balanced multiplier gives U, the product of U_1 and U_3.

potential of the first grid would be linear, i.e.,

$$S_3 = b_0 + b_1 U_1.$$

Applying the two multiplicand voltages $U_1(t)$ and $U_3(t)$ to the first and third grids, we would obtain in the plate circuit the following current

$$I_a = U_3 U_3 = U_3 (b_0 + b_1 U_1)$$
$$= b_0 U_3 + b_1 U_1 U_3.$$

We see that we would not obtain pure multiplication, owing to the presence of a dc component in the transconductance as given by

$$S_3 = b_0 + b_1 U_1.$$

But the effect of this component can be eliminated by using a symmetrical (balanced) circuit with two tubes, as shown in Fig. 38 (for simplicity the connections to the auxiliary grids are not shown). The voltage U_3 is applied to the third grids of both tubes with like polarity (i.e., in phase), while the voltage U_1 is applied to the first grids with opposite polarity (i.e., out of phase). The output voltage U, by virtue of the bucking connection of the coils in the plate circuits, is proportional to the difference in the plate currents, i.e., to the quantity

$$(b_0 U_3 + b_1 U_1 U_3) - (b_0 U_3 - b_1 U_1 U_3) = 2 b_1 U_1 U_3.$$

Thus, if the transconductance varies linearly with the voltage, the circuit of Fig. 38 operates as an ideal linear multiplier. Actually, the expression $S_3 = b_0 + b_1 U_1$, is satisfied only approximately, and over a small voltage range at that. Nevertheless, under these conditions, the balanced circuit of Fig. 38 gives a better result than the simpler (one-tube) circuit.

(To be continued)

RUSSIAN TRANSLATIONS

What the Russians Are Writing

J. George Adashko

CIRCUITS

Low Frequency Power Amplifier with Distortion Compensation by G. Ya. Gurovich. RE, 8/58, pp 50-53, 1 fig.

Analysis of the new circuit described here (patented by the author in 1951) shows that it is possible in principle to cancel out completely frequency, nonlinear, amplitude, phase, background, and all other distortions in a low-frequency power amplifier without reducing its gain.

Use of Phase Frequency Synchronization by A. D. Artym. RE, 8/58, pp 37-46.

The use of phase synchronized frequency control in band pass filters was treated by J. Jelonek et al (*Proceedings IEE*, Part 4, February 1945). The author discusses the use of such a system in frequency modulators or phase detectors and determines the response of such a system to frequency modulated signals. See Fig. 1.

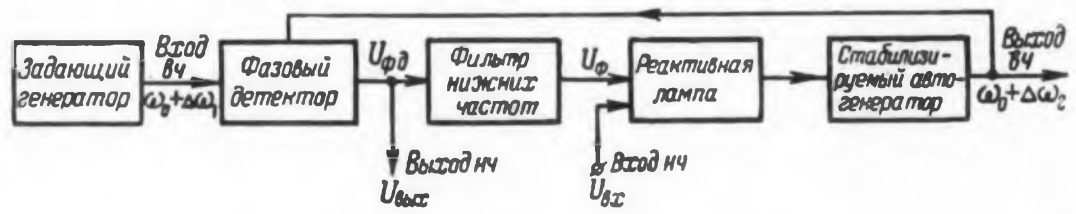

Fig. 1. The circuit consists of two stages: the first includes tube $T1$, output transformer Tr_1 and resistance R_1. The second comprises elements $T2$, Tr_2, and R_2. Both stages are fed from a common plate voltage and have a common self-bias and deliver power to a common load R_H. The input is applied to grid of T_1. The voltage applied to T_2 is obtained from potentiometer R_1. It is the same value as the input voltage. If distortion is produced in the circuit, the two grid voltages become unequal. This difference, amplified in the tubes, is used as the feedback voltage.

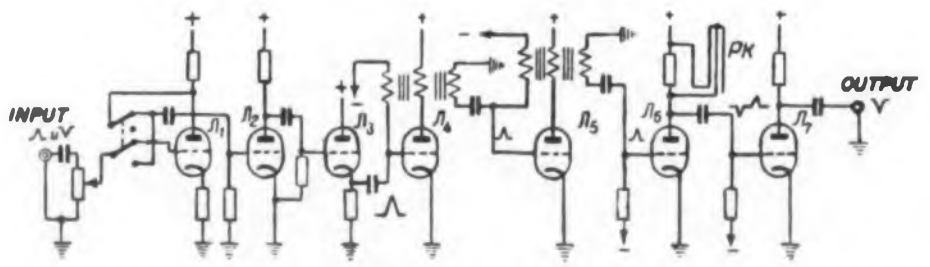

Fig. 2. Basic circuit.

Generator for Triangular Video Pulses by Yu. N. Prozorovskiy. RE, 8/58, pp 47-49.

Triangular video pulses are generated with the aid of a shaping two-terminal network, such as line segment, having a signal time delay that is shorter than the duration of the front of the voltage or current applied to the generator. See Figs. 2 and 3.

TELEMETRY

New Principles for Synthesis of Telemetering Systems with Pulse-Time and Pulse-Width Modulation by V. A. Il'in and A. I. Novikov. AT, 8/58, pp 757-761, 5 figs.

In most telemetering systems, the measurement error depends on the stability of the transfer functions of the system as a whole and of its individual elements. This is why precision of the various converters and transducers used (modulators, demodulators, etc.) in such systems is of primary importance.

This article shows that the use of new type high-stability time-pulse and width-pulse converters or transducers (which the authors call "exponential") makes the telemetering system less sensitive to changes in such external influences as ambient temperature or line voltage. See Figs. 4, 5 and 6.

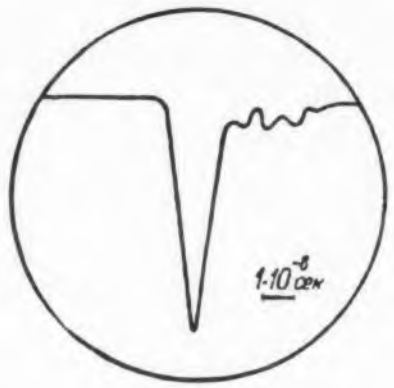

Fig. 3. Pulse produced along with a 1 x 10⁻⁶ second time marker.

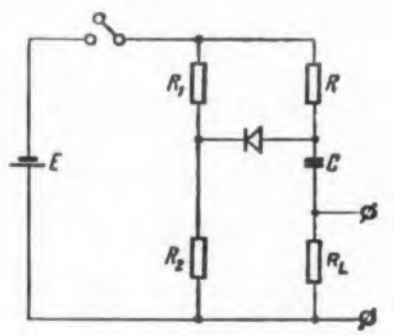

Fig. 4. Prototype of exponential pulse-width converter.

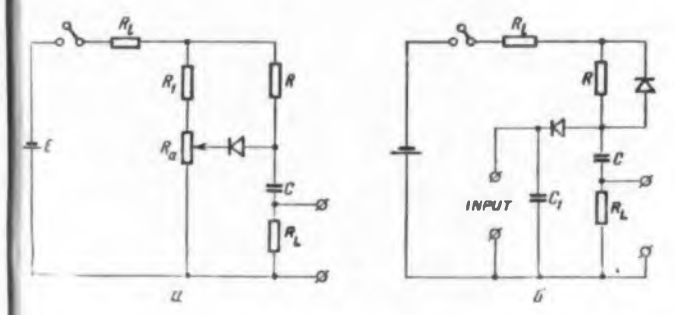

Fig. 5. Two exponential converters modified to accommodate pickups with low resistance.

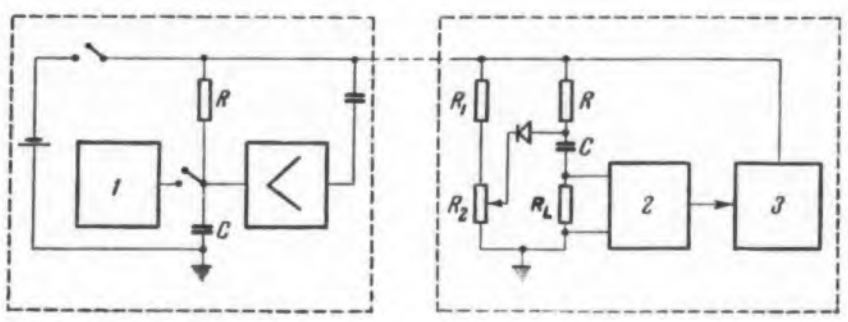

Fig. 6. Telemetering system with exponential converter. **1**—indicator; **2**—electronic relay; **3**—audio generator. The electronic relay operates at the instant t_c and turns on the audio generator until the primary pulse is complete. The receiver is tuned to the audio frequency. The amplified signal causes the relay to operate at the instant t_c. The transmitter and receiver *RC* cells have equal time constants, thus ensuring a linear relation between the measured parameters and the reading of the output meter. The error is less than 1 per cent for ambient variation from −50 to +50° and for supply line variations of ±15 per cent.

RUSSIAN TRANSLATIONS

TELEVISION

Investigation of a Television Synchronization Flywheel System by Yu. N. Bakayev. REE 2/58, pp 227-236, 9 figs.

Generalized equations are derived for synchronization by pulse signals. A detailed investigation is made of a sawtooth and sinusoidal generator. The author also considers synchronization of a sinusoidal generator by discrete signals, and proposes a procedure for its design. Reference is made to work by W. G. Gruen, Theory of AFC Synchronization, *Proceedings IRE*, 1953, 8, 1043-1047, and T. S. George Synchronizing Systems for Dot-Interlaced Color Television, *Proceedings IRE*, 1951, 2, 124-131.

Operation of Television Sets in 1957 by A. Kanayeva. R 2/58, pp 32-35, 1 fig, 2 tables.

Lists all the television sets produced in the USSR and gives some statistical data on operating failures and repairs necessitated in three most popular sets, as well the causes of these failures.

ANTENNA

Disk and Cone Antenna by V. Batayev. R, 8/58, pp 34, 4 figs.

Description of an umbrella type antenna for 144-146 Mc, having a circular pattern in the horizontal plane and a vertical pattern. The disk is made of 1.5 mm duraluminum 370 mm in diameter. Eight ribs are used, each made of aluminum tubing 8 mm in diameter and 74 cm long. A coaxial cable (*11*) is used to feed the antenna.

PROPAGATION

General Formulas for the Field Produced by a Dipole with Arbitrary Orientation, Located over Plane Homogeneous Earth by L. S. Tartakovskiy. RE 4/58, pp 36-44, 1 fig.

The author gives and analyzes general field formulas in the radiation zone produced by the vertical and horizontal electrical dipoles located over a plane homogeneous earth. The features of the propagation of radio waves over a region with a surface deposit of iron ore are indicated.

Stability of the Field Intensity over Sections of Radio Relay Lines by A. I. Kalinin. RE 1/58, pp 22-28, 8 figs.

The author plots curves for the stability of the field intensity on sections of radio relay lines. He uses the known dependence between the attenuation factor on the vertical gradient of the dielectric constant of air and on the statistical

distribution of the values of this gradient in the region where the given section of the line is located. Equations are derived for the curves of optimum stability of field intensity. Numerical results are given for the climatic conditions of the middle zone of European portion of the USSR.

Secondary Diffraction Electromagnetic Waves by a Disc by P. Ya. Ufimtsev. JTP 3/58, pp 583-597, 6 figs.

The diffraction produced by a disc is analyzed with account of the interaction of the edge currents. Expressions are obtained for the fields scattered by the disc in the form of spherical waves from two points on the rim of the disc. The way each wave is rediffracted on the disc is examined.

Radiation of a Hertz Dipole on the Urge of an Ideally-Conducting Wedge by A. I. Potekhin and L. B. Tartakovskii. REE 5/58, pp 592-602, 8 figs.

The method proposed in the preceding article in the same issue is used to find a closed-form solution for the components of the field vectors and current density on the phases of an ideally-conducting wedge excited by a Hertz dipole located on the edge of the wedge. It is shown that if the wedge has a sharp angle, an "edge wave" propagates along the edge of the wedge. This wave is pronounced most clearly in the case of a half plane.

Calculation of the Equivalent Parameters of an Inhomogeneous Ground with Allowance for the Surface Effect by P. G. Gorodetskiy. EC 4/58, pp 59-62, 2 figs.

Formulas are derived for the calculation of the equivalent resistance and inductance of the earth as the return lead for an axially-symmetrical system for the transmission of electromagnetic signals, with allowance for the surface effect. The irregularities of the ground are taken into account conditionally by assuming it to contain two inhomogeneous coaxial layers. The calculation formulas are simplified for the cases of low and high frequencies.

Contribution to the Theory of a Double Block of Slot Resonators by M. F. Stel'makh. RE, 8/58, pp 30-36, 4 figs.

The propagation of waves in a double block of slot resonators was treated by Pierce "Traveling Wave Tubes" and Brillouin's "Waveguides for Slow Waves," (*Journal of Applied Physics*, Vol. 19, No. 4, 1948). It was found that both symmetric and anti-symmetric waves can propagate in such a system. In the former case the frequency band in which slow waves exist is

RUSSIAN TRANSLATIONS

broader than in the latter case, but the longitudinal electric field vanishes in the space between the blocks in the case of anti-symmetric waves for all spatial harmonics, while for the harmonics of the symmetrical waves this field is nonvanishing.

A longitudinal shift of one block relative to the other produces a field structure that is more suitable for the odd harmonics of the anti-symmetric waves, from the point of view of interaction with the electron beam. The results can be used for the design of traveling wave tubes and backward wave tubes in which the interaction between the electric electron beam and the odd-harmonic field is used.

Contribution to the Determination of Losses of Magneto-Dielectric Materials at Microwave Frequencies by V. N. Aksenov. REE 1/58, pp 156-157.

The author derives approximate formulas for the total losses of magneto-dielectric materials when these losses are small, using the results of only one short-circuit measurement (or only one open-circuit measurement). This makes it possible to select a specimen thickness to insure sufficient accurate measurement of the SWVR in the slotted line.

MISCELLANEOUS

List of References on Magnetic Amplifiers and Contactless Magnetic Elements by G. V. Subbotina. AT 4/58, pp 379-388.

Extensive survey of the literature, published mostly in 1956-1957, on magnetic materials, design of nonlinear magnetic circuits, magnetic amplifiers, magnetic contactless elements, and descriptions of commercial devices.

Radio Receiver "Voskhod" (east) by Ye. Dryzgo and Ya. Leven. R, 5/58, pp 23-24, 3 figs.

This all-transistor radio is designed for unelectrified rural communities and apparently no portability or miniaturization was intended. It measures 222 x 282 x 158 mm and weighs 3.5 kg. It is supplied by four 1 1/2-volt dry batteries.

Two-band operation is provided (720 to 2000 and 187 to 577 m). Using a rod antenna, the sensitivity is not less than 70 μv/m at medium waves and 100 μv/m at long waves. The corresponding figures for the built-in ferrite antenna are 500 and 1000 μv/m. The output power is 350 mw, the distortion does not exceed 10 per cent below 400 cycles and 5 per cent above 400 cycles. The current drain is 20 ma at minimum

power and 110 ma at maximum power. The service life of the batteries is about 80 hours. Provision is made also for a phonograph pickup with a sensitivity of approximately 100 mv.

Aerial Defense Radar Techniques by K. Trofimov. R 2/58, pp 27-31, 11 figs.

Popular articles showing various types of radar equipment for the detection of incoming enemy planes and various techniques for tracking and destroying the incoming targets.

Certain Properties of Optical Converters in Radio Engineering by S. I. Borovitskiy. REE 2/58, pp 237-243, 3 figs.

Although the use of optical devices in radio engineering is quite common (recording of electric oscillations, generation of oscillations of specified waveform with light modulated in some manner, etc.), such devices seldom offer outstanding advantages. In many cases they can be replaced by mechanical or magnetic devices. Recent efforts, however, in the direction of employing optical devices for statistical and communication analysis (Kretzmer, *Bell System Technical Journal*, 1952, 31, 7, 751; Schreiber, *Convention Record IRE*, 1953, 4, 35; Oliver, *Bell System Technical Journal*, 1952, 31, 7, 724) use of optical converters for simultaneous analysis of signals using various features (such as the aggregate of spectral components of the signal, the aggregate of the delays of a signal of specific form, or the aggregate of signals of different forms). The author discusses several optical devices from this point of view.

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*
RE	*Tekhnika)* Radio
R	Radio Engineering *(Radiotekhnika)*
REE	Radio Engineering and Electronics *(Radiotekhnika i Elektronika)*

MEETINGS

Calendar of Events

December

26-31 Annual Meeting American Assoc. for Advancement of Science, Washington, D.C.

January

12-14 5th National Symposium on Reliability and Quality Control, Philadelphia, Pa.*

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.

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.

16-18 Southwestern IRE Regional Conference and Electronics Show, Dallas, Tex.

*Indicates meetings herewith described.

5th National Symposium on Reliability and Quality Control, Jan. 12-14

Bellevue-Stratford Hotel, Philadelphia, Pa.

The program this year attempts to show the transition of experience in the reliability art. Highlighted are new design techniques and the greater use of transistors; cost considerations, and management's part in a reliability program; quality control techniques, measurement of reliability; quantitative treatment with progress in the mathematical theory of reliability; and field reliability and maintainability. The program is listed here.

Mon. a.m., Jan. 12

Reliability of Transistorized Equipment

Transac S-2000—A Case History
R. J. Segal, Philco Corporation
Reliability Evaluation of Silicon Transistors
K. W. Davidson, Texas Instruments, Incorporated
An Approach to Transistorized Equipment Design
O. Golubjatnikov, General Electric Company

Cost of Reliability

Support Costs vs Reliability and Maintainability
H. D. Voegtlen, RCA Service Company
A Reliability-Cost Optimization Procedure
P. R. Gyllenhaal, Radio Corporation of America
Experiments to Expose Marginal Reliability Designs
W. R. Kuzmin, Minneapolis-Honeywell Regulator Co.

Mon. p.m., Jan. 12

Military/Industry Reports

Putting the R & D Reliability Dollar to Work
G. N. Beaton, Hughes Aircraft Company
Minuteman Missile Reliability Requirements
S. C. Morrison, Ramo-Wooldridge Corporation
Reliability Program for an Analog Computer
H. M. Davis, Sperry Gyroscope Company
AN/ARC-58 Reliability Program Case History
R. L. Vander Hamm, Collins Radio Company

Mathematical Theory

Methods for Evaluating Reliability Growth
M. H. Saltz, Hughes Aircraft Company
Reliability Starts with the Design
Dr. I. R. Whiteman, General Analysis Corporation
Significance Tests of Effects of Wearout Failures
Dr. J. H. Smith, Vitro Laboratories
Acceptance Sampling with New Life Test Objectives
Dr. M. Sobel, Bell Telephone Laboratories

(Continued on following page)

MEETINGS

Reliability Definitions Panel

C. M. Ryerson, Radio Corporation of America, Moderator

Tues. a.m., Jan. 13

Reliability Training and Education

System Operational Effectiveness
H. G. Friddell, Boeing Airplane Company
Reliability Education in Academic Curricula
G. A. Henderson, Army Rocket & Guided Missile Agency
The ASQC-IRE Reliability Course
F. M. Gryna, Jr., ASQC-IRE (The Martin Company)
Reliability Design Tools for Engineers
J. J. Kaufman, Boeing Airplane Company

Quality Control Techniques

A Critique of the Defect Classification Technique
C. J. Brzezinsky, Ofc. Ass't. Sec. of Def., (S & L)
Determining AQL by Linear Programming
G. H. Sandler, Raytheon Manufacturing Company
Experimental Design for a System Error Analysis
L. H. Chapin, Minneapolis-Honeywell Regulator Company
Economically Optimum Receiving Inspection
M. Goetz, Westinghouse Electric Corporation

Tues. p.m., Jan. 13

Techniques for Reliable Design

Mechanical Design Review—A Tool for Reliability
H. I. Dwyer, Bendix Aviation Corporation
Radio Frequency Compatibility Affects Reliability
L. W. Thomas, BuShips, U. S. Navy
Reliability Through Adequate Specification
A. R. Park, Westinghouse Electric Corporation
Reliable Valves & Performance in Service Equipment
K. Hopkinson, British Ministry of Supply

Field Reliability and Maintainability

Predicting Electronic Equipment Availability
J. W. Thomas, Vitro Laboratories
Cost, Reliability, and Replacement Analysis
Dr. E. L. Welker, ARINC Research Corporation
Selection of Spare Parts Using Part Failure Date
Dr. G. Black, Sylvania Electric Products Inc.
An Analysis of the Operator-Equipment Relationship
R. C. Horne, Jr., ARINC Research Corporation

Symposium Reception

Capt. David R. Hull (USN, Ret.)
"Is Your Customer Satisfied?"

Wed. a.m., Jan. 14

Reliability Tests & Measurements

Accelerated Life Test for Composition Resistors
B. C. Spradlin, Battelle Memorial Institute
Economical Methods for Life Testing Parts
L. Knight, British Tabulating Machine Co., Ltd.
Designing Combined Environmental Tests-to-Failure
V. L. Grose, Boeing Airplane Company
Prediction, Test, & Field vs Lab Reliability
R. G. Stokes, Vitro Laboratories

Reliability Management

Bullpup Reliability & The Project Team Concept
G. R. Eagle, The Martin Company
Organizing Dynamically for Reliability
W. R. Kuzmin, Minneapolis-Honeywell Regulator Company
Measurements Engineering—A Key Reliability Tool
J. A. Connor, Hughes Aircraft Co.
Time Phasing of a Reliability Program
G. Ashendorf, Radio Corporation of America

Mon. p.m., Jan. 12

Tutorial Session on the Fundamentals of Reliability

Basic Reliability Considerations
M. P. Feyerherm, Radio Corporation of America
Statistics for Prediction and Analysis
Dr. G. R. Herd, Booz Allen Applied Research, Inc.
Effective Reliability Management
M. M. Tall, Radio Corporation of America
Data Collection and Evaluation
D. W. Sharp, ARINC Research Corporation
Panel Discussion—A review of the session by the Moderator and Speakers, with audience participation.

Solid State Circuits Conference, Feb. 12-13

Hotel Sheraton, Philadelphia, Pa. Sponsored by IRE, AIEE, and Univ. of Pennsylvania. Devoted to transistor circuit technology, applications, and circuit techniques of a variety of solid state devices.

Paper Deadlines

Jan. 15: Deadline date for submission of titles to be presented at the **1959 National Telemetering Conference,** May 25-27, in Denver, Colo. Final manuscript deadline is **March 19.** Further information from *L. Scott Bailey, American Rocket Society, Inc., 500 Fifth Ave., New York 36, N.Y.*

ADVERTISERS' INDEX

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