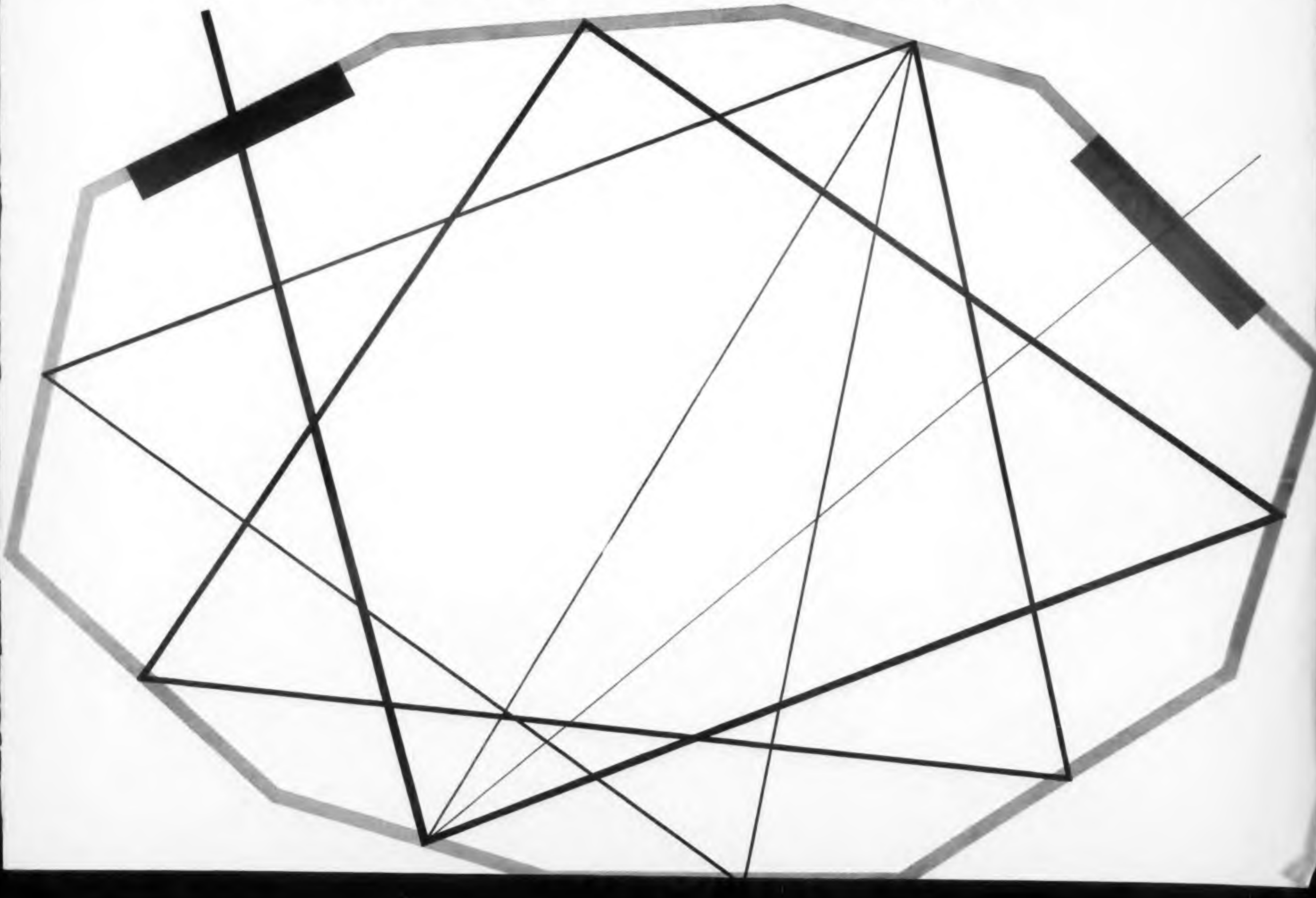
ELECTRONIC DESIGN

Two new acoustic delay lines offer high-speed serial memory... p 56



COVER: Artist's conception of a quartz or glass slab shows how acoustic signal is delayed (and somewhat attenuated) as it bounces from facet to facet before leaving ultrasonic delay line at some finite time after the signal enters. Stories on p 56 tell of two excitingly new developments in this field.

Sidelights Of This Issue

Warming of the Cold War in the last few weeks has cast the spotlight on two areas where design breakthroughs are needed.

One requirement is a simple, inexpensive gadget to warn everyone in the nation of imminent danger on a moment's notice. The other is for many elements of a complex nuclear weapons test-monitoring system.

Civil defense officials, queried by ELECTRONIC DESIGN after President Kennedy's speech on the Berlin crises, say they are looking for a simple, solid-state receiver that can be plugged into any electrical outlet to pick up national warning signals from local power stations. Suitable signal generators have already been designed and are to be used in a statewide test in Michigan.

Details of the planned tests and requirements for receivers to pick up signals on power lines are spelled out in the story on p 12.

Whether signals from electric power stations will be the final choice as a national emergency warning system is, of course, not definite until tests are completed. Also, the Government has not thus far allocated any R & D funds for industry for a new receiving system.

Detection of nuclear explosions—underground, surface or high-altitude—presents much more formidable design problems. Scientists testifying before Congress have painted a rather pessimistic picture of present detection capabilities. A summary of their testimony, outlining progress to date and needs for the future, appears in a story beginning on p 8.

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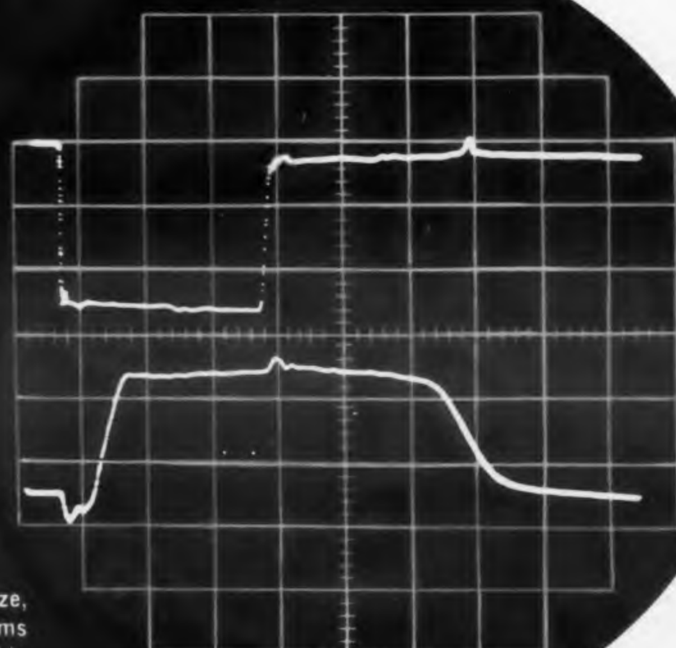

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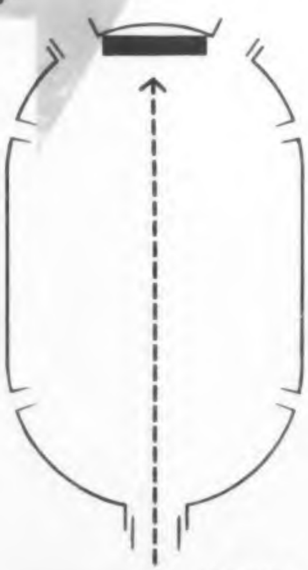

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Never before such versatility in a single oscilloscope! The new 185B gives you the same steady, bright picture and the same simplicity of operation as conventional low-frequency scopes . . . all the way to 1,000 MC!

Its remarkable versatility makes it ideal for measuring switching speeds of transistors, diodes, computer memory elements; analyzing rf carrier signals by viewing rf directly; measuring phase angle on signals to 1,000 MC by dual channel viewing; analyzing coaxial connectors, cables, attenuators and other devices by observing reflections of fast pulses.

The sampling technique used in the 185B overcomes the inherent limitations of "conventional" high-frequency scopes, to make it the first practical, commercially available answer to the need for measuring and viewing nanosecond pulses. Broad sweep speed capability (10 ranges and vernier, 10 μsec/cm to 3 nsec/cm) and extreme sensitivity increase its usefulness.

Sync sensitivity is ± 10 mv, and, using an accessory delay line, you can sync on the signal being viewed, over the entire dynamic range of the scope, and see the leading edge. 60:1 dynamic range and x100 sweep expansion give you an effective screen area of 600,000 square centimeters, with no loss in brightness, even at maximum expansion.

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August 16, 1961
Vol. 9 Number 17

Electronic Design

Hayden Publishing Company, Inc.
850 Third Ave., New York 22, N.Y.

Coming Next Issue

Digital design, one of the fastest moving areas in the electronics technology, will be highlighted in the special feature report in the August 30th issue of ELECTRONIC DESIGN. The report will focus on three of the most dynamic foundation stones of digital, data-processing equipment—Logic and Timing, Matrix Memories, and Cyclic Memories. In the articles making up the report, the authors have stressed important, central themes. They have deliberately avoided extensive dissertations that leave a reader with no feeling of what is important and what is not. They have spotlighted the dominant techniques and devices of today and those which are likely to dominate the field tomorrow.

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 38,800 copies this issue.

Bright Future Seen for Silicon Strain Gages

Gage Factors of Over 100 and High Outputs Without Amplifiers Provided—Need for Compensation Requires Design Ingenuity

Thomas E. Mount
West Coast Editor

PIEZORESISTIVE strain gages using silicon elements appear to have a promising future in the design of many control, monitoring and telemetry systems.

Although few transducers and stress-measuring devices utilizing silicon strain gages are now on the market, most manufacturers of these instruments are actively investigating the potential of these elements. Some of the reasons for high interest in the new gages are:

- Gage factors are well over 100, compared with about 2 for conventional wire types (gage factor is defined as $\Delta R/R \div \Delta L/L$, were R is resistance and L is length).
- Voltage outputs are on the order of volts rather than millivolts, so that amplifiers can be eliminated in many applications.
- High-temperature operation is possible.
- The gages can be made very small.
- High flexibility is provided.
- Hysteresis is negligible, and the gages have almost no zero drift.

Balanced against these significant advantages, the designer finds many difficulties in using the elements in sensing devices. Nonlinearity is a problem, because ΔR is not small in comparison with R. Silicon, both p and n types, has a large positive temperature coefficient of resistance.

Two kinds of semiconductor strain gages are in use today, both made of silicon—the filamentary type and the die type. Best known is the filamentary type, produced by such companies as Micro Systems, Inc., Pasadena, Calif.; Century Electronics Div., Tulsa, Okla., Tang Industries, Inc., Waltham, Mass., and Kulite-Bytrex Corp., Newton, Mass.

P or n- type silicon crystals are cut into thin, flat wires to become the stressed element in the strain gage. Some companies have experimented with growing silicon whiskers, but this technique has fallen into disrepute and is considered impractical.

The best slicing orientation for p-type silicon is in the 111 direction; for n-type it is optimum in the 100 direction. Sensitivity to stress is greatest when the filaments are cut in these planes.

The silicon strips are bonded to a thin, flat "carrier"—an epoxy-glass substrate—and terminals attached to the ends. In use, the strain gage, carrier and all, is bonded with a stiff epoxy to the member under test. As the member bends, the silicon wire is stressed and its resistance changes. With p-type silicon, the resistance increases; with n-type, it decreases.

By plastering a p-type strain gage on one side of a member to be bent and an n-type on the reverse side, one gage would be pulled, the other compressed, and output doubled.

Die-type strain gages consist in a silicon die diffused onto a substrate. At Fairchild Controls Corp., Los Angeles, where bonded strain-gage pressure transducers are manufactured using silicon dice made by Fairchild Semiconductor Div., diffusion of the element is said to give greater control over the impurity levels and resistivity of the silicon.

As for the silicon high-temperature coefficient of resistivity, there are several good techniques for self-compensation, according to Robert E. Talmo, general manager of Micro Systems, Inc.

"The temperature coefficient is positive for both p and n- type strain gages," he says. "By using a Wheatstone bridge circuit with a p-type, 111 strain filament in conjugate bridge arms with an n-type, 100 filament, the bridge remains in balance over a wide temperature range."

Other techniques include using a dummy gage on an unstressed sample of the test material, wired in conjugate bridge arms with the active gage.

A thermistor network used in series or parallel with the active gage, such that the equivalent resistance change of the active

Semiconductor Strain-Gage Applications—Present and Future

Semiconductor strain gages will be used in many types of transducers and strain sensing elements in the near future, according to workers in this field.

The most common use at present is for pressure transducers. However, ELECTRONIC DESIGN learned of plans to use these sensitive elements in accelerometers, force and displacement transducers, load cells, and bending beams for electronic scales. Here are some examples of recently announced or planned units:

- A displacement transducer designed by Micro Systems, Inc., measures up to 2 in. displacement with 2-v readout, or 1 mv per mil. The meter reads to 0.1 mv, giving 0.0001-in. precision.
- A high-frequency pressure cell, with a 100-kc natural frequency, will be described at an Instrument Society of America Show next month in Los Angeles by Dr. Anthony Kurtz, of Kulite-Bytrex Corp.
- A pressure transducer with 5-v output, without using an amplifier, being offered by Dynisco Div., American Brake Shoe Co., Cambridge, Mass., is said to avoid the use of thermistors or semiconductor doping for temperature compensation. Both of these compensation methods reduce sensitivity. Accuracy is said to be 1 per cent

Pressure transducers on the market are of two basic types—bonded and unbonded. Bonded strain gage transducers ordinarily have one or more filaments bonded directly to the pressure-sensing diaphragm. Curvature of the diaphragm causes stress of the filaments. Micro Systems' new subminiature, one-quarter-in.-diam pressure transducer is constructed in this way, as are those made by Tabor Instruments, Century, Dynisco and others.

The type produced by Fairchild Controls has a rod protruding from the center of the diaphragm that exerts a bending moment on a cantilevered beam. The beam has a number of diffused silicon dice bonded to it for strain-sensing.

Subminiature pressure transducer marketed by Micro Systems, Inc., contains four silicon filaments as strain sensors, arranged in a Wheatstone bridge. Output is 2 v with a pressure range of 0-100 psia.

bridge leg as a function of the temperature is minimized, will also help.

The sensitivity coefficient of resistance in silicon strain gages is about ten times that of wire-type gages.

Compensation techniques for this effect include using a single or a half-active bridge as an asymmetric bridge, with two of the bridge arms higher in resistance than the active arms. A thermistor and resistive shunt network may be placed at the bridge location and wired into the legs, such that the supply voltage at the bridge is made to increase at the same rate as gage factor decreases.

Constant current sources also keep temperature effects down over a wide range.

Another problem in the use of semiconductor strain gages is the disparity between the thermal coefficient of expansion of the strain gage and the test material. This also can be compensated for by using thermistors in the bridge circuit.

Hysteresis in semiconductor strain gages is said to be very small. This is a mechanical effect: as the filament is elongated, its resistance changes in one direction; as it is returned to its original state, the resistance change should return along its original path. With silicon strain gages, this is very nearly true. Power dissipation across the strain gage contributes to this effect. For this reason many engineers prefer bonded strain gages to unbonded: heat is dissipated through the member under test. ▪ ▪

Electron Multiplier Uses Semiconductor Dynode

Continuous Strip of Oxide Coating Replaces Multi-Element Structure

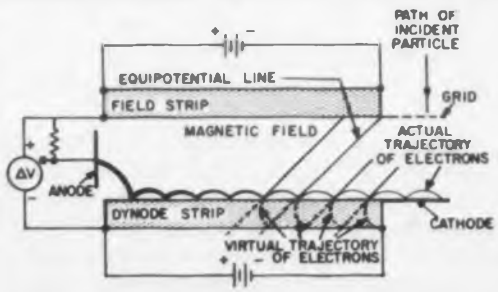
Alan Corneretto
News Editor

A SIMPLE semiconductor strip is used in place of a conventional dynode structure in a magnetic electron multiplier developed by Bendix Corp., Detroit.

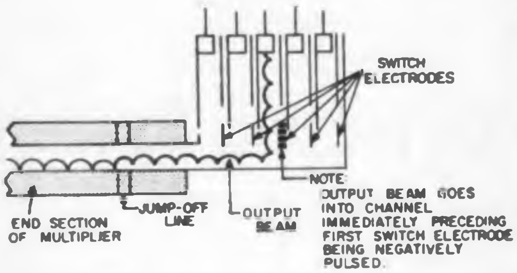
According to Bendix engineers, the advantage of the high-resistance strip over the usual dynode multiple-element structure is its simplicity; it does not have better secondary emission. However, the semiconductor dynode may be exposed to air without harm.

The new dynode resulted from an effort to achieve a better means of ion detection for time-of-flight mass spectrometers. In conventional magnetic electron multipliers used for this type of spectrometer, detected particles hit a cathode and liberate electrons. The electrons strike a succession of dynodes, each of which yields secondary emission greater than unity. The electrons are directed from dynode to dynode by the action of a crossed electric and magnetic field.

The resistance-strip electron multiplier developed by Bendix consists of a field surface and a dynode surface spaced a few millimeters apart. Particles enter at one end, generating electrons that are collected by an anode at the other end. Although the same potential difference is applied across the long dimension of each surface to obtain the same potential gradient, the actual gradient of the



Resistance-strip magnetic electron multiplier with novel dynode structure consists of two surfaces—one coated with a metal-oxide semiconductor—through which electrons are generated in a cycloidal path by a particle striking a cathode at one end. Anode at left collects amplified beam. Diagonal equipotential lines control paths of secondary-emission electrons.



Strip dynode multiplier can be built with crossed-field gates, so that the output beam can be electronically switched to any of several channels.

field strip is maintained more positive than the dynode-strip surface. This provides suitable equipotential lines in the volume between the surfaces. A uniform magnetic field surrounds the entire structure.

Secondary-Emission Electrons Travel Cycloidal Path Along Dynode Strip

An electron released from rest at any point along the dynode travels in a cycloidal path along the equipotential line on which the electron originates. The electron strikes the dynode before completion of the first cycle with an impact energy corresponding to the difference in potential between the points of origin and impact. The multiplier is designed to make this energy large enough for secondary-emission ratios greater than unity. Released secondary electrons travel the same way.

The cathode surface that incoming particles strike may be either a continuation of the semiconductor dynode strip or a surface made from a conductor, Bendix researchers report. The surfaces between which the electrons travel may be made either of an insulating base coated with a semiconductor or of material with proper volume resistivity for convenient operation, the researchers say.

The structure may also be bent to form a cylinder, a right angle or other shape. If desired, the anode may be replaced by a set of crossed-field gates, permitting the output beam from the multiplier to be electronically switched in a few nanoseconds to any one of several channels. Cross-talk would probably be insignificant. And not only could the multiplier be time-shared by use of cross-field gates, but the signal in each channel would pass through the same multiplier and receive equal amplication.

Bendix expects that subnanosecond rise times may be achieved with a resistance-strip magnetic electron multiplier. This would reportedly require use of a grid to shield the anode from displacement current. ■ ■

U.S. to Press Hunt for Better Nuclear Detection System

Three-Pronged R&D Effort, Using Land, Sea and High-Altitude Sensing Equipment, Will Seek to Identify Bomb Detonations

John J. Christie
Washington Editor

PROJECT Vela, the three-part R&D program for improving means of detecting and identifying underground and high altitude nuclear-bomb explosions in the world, will move ahead despite a setback in Geneva test-ban negotiations.

The expected resumption of nuclear blasts by the United States for the purpose of improving detection will enable scientists to evaluate a number of theories, as well as research using chemical and high-explosive detonations, since the moratorium on nuclear-bomb tests.

However, some 20 scientists, in recent testimony before the Congressional Joint Committee on Atomic Energy, have warned that only modest improvements in techniques and instrument capabilities can be expected in the forthcoming tests. They are generally agreed that several more years of costly research in the physical sciences and electronics will be required to come up with optimum detection systems, unless some unexpected breakthroughs occur.

Present Nuclear Control System Is Not Completely Foolproof

Dr. Richard Latter, a member of the Rand Corp.'s research council and a leading technical adviser in the Geneva negotiations, summed up the limited capabilities of the control system under consideration at Geneva in these terms:

"For atmospheric and underwater tests, it has a good capability of detecting and identifying nuclear tests above about one kiloton. For underground tests, large tamped explosions are detectable, but large decoupled explosions are not. For space tests unshielded explosions are detectable, but large shielded explosions are not."

The Vela program, under the supervision of the Defense Dept.'s Advanced Research Projects Agency, now involves 11 separate Government agencies, and there are currently more than 100 R&D contracts which are in effect with universities and private concerns.

Vela Uniform, the program for improving detection and identification of underground nuclear explosions, is by far the biggest part of the undertaking at this stage. It accounts for 80 or more of the current R&D contracts. Construction of a network of prototype seismic stations, with elaborate supporting facilities, and the resumption of nuclear testing will move Vela Uniform into the spotlight in fiscal 1962.

Construction Starts This Year On 4 'Geneva-Type' Stations

Work is already underway on a prototype seismic detection network that will be analogous to the international control system proposed in 1958 by the Geneva conference of experts. Construction will start this year on four "Geneva-type" stations, similar to one in operation at Lawton, Okla., since October, 1960. The new stations will be in California, Oregon, Montana and Utah, spaced at about 600 miles.

The network will also include two larger and more advanced stations, incorporating improvements recommended by the U. S. panel of experts. The panel set higher goals for nuclear test-ban policing following the discovery that initial Western proposals were based on highly inadequate and inconclusive data.

Other facilities will include one capable of conducting "control systems headquarters" studies and tests. There will also be a center for evaluating sub-surface detection systems.

It is planned to equip one Geneva-type station with several "pre-prototype" instruments developed under the Vela Sierra program for ground-based detection of high-altitude atomic explosions.

Vela Hotel, the program for development of a satellite detection system, has led to design of new X-ray, gamma-ray and neutron detectors.

Following are some of the highlights of work underway in each of the three Vela programs:

VELA UNIFORM

Development of identification criteria for distinguishing between natural and man-made seismic events continues as the major objective.

Efforts to solve the identification problem are devoted for the most part to improving the means of measuring and interpreting seismic signals. A number of new techniques and instruments for this purpose will be tested in the forthcoming series of underground nuclear explosions.

Among noteworthy programs is a study by the U. S. Geological Survey of seismic propagation paths and regional travel times in the California-Nevada region. An all-transistorized seismic-refraction system, designed and built by the Southwestern Industrial Electronic Co., covers a range of frequencies from 1 to 300 cps and can record voltages, the largest of which is more than 1,000 times as great as the smallest. The system, reported to have extremely low internal noise, records on both magnetic tape and film.

According to Dr. Charles C. Bates, chief of the Vela Uniform program, the system's magnetic tapes can be played back through a variety of filters to permit extraction of extremely weak signals not detectable by conventional seismic-refraction systems. He expressed belief that the system had "many potential applications in nuclear-test detection and studies of small earthquakes and after-shocks."

New Computer Programs Expected Along with Digitized Seismograms

Once nuclear testing is resumed, it is also believed that a number of new computer programs and digitized seismograms will aid in developing new knowledge about seismic-wave propagation phenomena. Among developments are these listed by Dr. Bates:

"A family of surface response curves generated by typical explosion wavelets with

Three Steps to Nuclear Detection

The United States' effort to develop a foolproof system for detecting all nuclear explosions in the world is composed of three programs. They are:

Vela Uniform—Detection of underground and underwater detonations.

Vela Sierra—Ground-based detection of high-altitude detonations.

Vela Hotel—Satellite detection of high-altitude detonations.

varying depths and geology; the improvement of time resolution of closely spaced or overlapping seismic wave arrivals of direct and surface-reflected waves from various sources by the application of inverse filtering techniques; and the determination of the amount of energy that should be contained in the shear-wave phases of a wave train from various types of seismic sources."

Supplementing efforts to improve identification of seismic signals are new programs to determine if electromagnetic waves generated by underground explosions are detectable at a distance of several hundred miles.

Thus five research projects are underway in sub-surface electromagnetic propagation. Also, plans have been made to have Edgerton, Germeshausen & Grier, under technical direction of the Rome Air Development Center, generate large electromagnetic signals in a tunnel cut into granite and measure the signals at varying distances.

Arrays and Deep-Well Seismographs Offer Hopes of Improved Detection

The problem of achieving better detection lies in improving instrument capability for detecting weaker signals. "Instrument improvement," Rand Corp.'s Dr. Latter told the Congressional committee, "requires more knowledge about microseismic noise which interferes with detection."

"We must," he said, "find out the principal sources of this noise and learn its detailed nature. In this way we hope to design more optimal instruments."

Vela scientists are generally agreed that seismometer arrays and deep-hole seismometers both offer opportunities for further improvement. Although in a preliminary stage, the deep-hole technique may be capable of greater improvement than the arrays.

A panel discussion before the Congressional committee brought out that experience thus

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far has been limited to arrays of 20 detectors and that there was sufficient improvement in signal-to-noise ratio to warrant attempting larger arrays. It was noted that more elaborate filtering processes should also enhance the effectiveness of arrays.

The initial station in the prototype seismic network—the one at Lawton—has an array of 10 short-period vertical seismometers at intervals of about 3,000 ft.

New theoretical array studies have been completed, and Texas Instruments has begun developing new hardware that will be tested in the prototype seismic network. This will include a 30-seismometer array. In testifying on the outlook for the array experiments, Dr. Carl Romney, assistant technical director of the Air Force Technical Applications Center, declared:

"On the basis of reasonable models of signals and noise, it has been concluded that an improvement on the order of $(2N)^{0.5}$, where N is the number of seismometers, or better over a two-to-three-octave pass band can be achieved in a practical system. This means that an array having 30 seismometers could detect signals 7.5 times smaller than could be detected by a single seismometer; similarly an array of 100 seismometers could, in principle, detect a signal 14 times smaller than could be detected by a single seismometer."

One big disadvantage of the arrays is the large amount of space they occupy. An array of 30, for example, will require a 3-sq-mile area.

Three research contracts have been let on the deep-hole approach and three contracts for development of seismometers. An Air Force program last summer proved, on the basis of non-nuclear detonations, that smaller signals could be detected by the deep-hole method. The problem now is to develop instruments that can operate efficiently at great depths for long periods and to determine the optimum geologic environments for installing deep-well detectors.

Three types of ocean-bottom seismographs are under development for exploring the possibility that low seismic background noise levels may prevail on the ocean floor.

As to the nature of signal and background noise level, Dr. Bates testified that "a transition is also underway from complete dependence on photographic recording to supplementary recording on slow-speed magnetic tape for greater dynamic range, ease of digitalization, immediate playback through special filters and suitability for electronic data processing." He also noted that "improvements have been made in long-period seismographs, so that they become stable in the field within a matter of hours, not days."

"Improved long-period galvanometers, filters, timing devices and amplifiers, both photo-tube and solid-state, are also well along in the development stage," Dr. Bates said.

Higher Yield of Seismic Data Requires New Processing Systems

The Vela Uniform program will result in an output of seismic data far in excess of what is produced at present. Thus some 14 contracts have been let for improved data processing, analysis and display techniques. Texas Instruments, for example, has a $1.4-million contract for seismometer array data processing.

Dr. Bates testified that "high-speed" computer techniques are being attempted with good success for spectral analysis, determination of energy spectra through auto-correlation techniques, and objective analysis of the polarity of first motion."

Optical techniques that may be capable of quickly correlating a large number of channels of analog seismic data are under investigation at the University of Michigan. The university and Bell Laboratories are also taking the acoustical approach "to determine whether the human auditory system has the capability to distinguish between time-compressed seismic signals from underground explosions and earthquakes at comparable distances."

VELA SIERRA

The program for ground-based detection of high-altitude nuclear explosions involves investigation of three possible detection and identification media: visible light and air fluorescence; radio frequency signals; and the effects of radiation and nuclear debris on the earth's atmosphere and magnetic field.

Here again, Vela scientists are confronted with the familiar problems of distinguishing between natural and explosion signals and of coping with background noise.

Prototype equipment built for detection of air fluorescence has shown promising results. The fluorescent method is based on the fact that much of the energy of an upper air nuclear blast is released as X-rays. Tests have led to confidence that approximately 1/4 per cent of the X-ray energy that enters the atmosphere is converted to light a 3,914 A in the upper atmosphere.

(continued on p 14)

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Wanted—Civil Defense Receiver

Officials Hope for Solid-State Device For Receiving Signals Over Power Lines

CIVIL Defense officials are looking for a new solid-state receiver for tuning in power line Near (National Emergency Alarm Repeater) signals. No funds for research are available, however, so that any development work will have to be financed by individual companies.

Near utilizes a 240-cps signal generator at power sub-stations to warn civilians in a given area of impending enemy attack. A continuous warning signal of 2 or 3-min duration is intended to be received in homes. Provision for coded signals can be built into the system.

A statewide test of Near is planned in Michigan, and if successful there, the system will be extended to other areas. But needed are home receivers that are cheaper and more reliable than the electromechanical plug-in buzzer alarms now available. No Government funds have been allocated for the receivers, however. R&D and marketing is being left to the initiative of individual companies.

Last Jan. 30 the Office of Civil and Defense Mobilization issued a set of preliminary requirements for prospective manufacturers of receivers, noting that firm specifications would be established after further systems studies have been completed.

Must Have Operating Life Of 5,000 Cycles, or 5 Years

The receiver, which must be designed for an operating life of 5,000 complete cycles, or five years, must be operable on a minimum 240-cycle signal of 1-v rms with a line voltage of 100 to 130-v rms, 60 cps. Ambient noise at 60 cps and its harmonics must be considered in the design.

The range of the 240-cps signal voltage amplitude found at the 155-v power receptacle is between 1-v rms to 6-v rms, depending on network load conditions and proximity of the receiver to the Near inductors. Signal voltages below 1-v rms are not considered adequate for receiver operation in the warning system.

The Near signal of 240 cps can be expected to be held to ± 0.4 cycle. Receivers will operate within specified limits with any 240-cps to 60-cps phase relationship.

The receiver must be designed to operate with a signal of 240 cps, ± 1 cycle, at a minimum of 1 v. Its combined selectivity must be such that it will reject 130-v rms of 60 cps, 10-v of 180 cps, and 10-v of 300 cps.

Reliable operation must be achieved within the range of 1-v to 6-v rms signal frequency. The receiver may not operate on a signal having an amplitude of 0.5-rms or less.

The total audio output of the alarm at 10 ft must be not less than 85 db. The alarm must have a distinctive sound to permit ready identification, and the loudness level may be independent of the 240-cps signaling frequency amplitude.

The receiver must be designed to plug into any energized 115-v ac receptacle normally found in the home.

Midwest Research Institute of Kansas City, Mo., which developed the prototype 240-cps signal generator that was tested successfully a couple of years ago, has undertaken a survey of Michigan's power grid to determine where the generators will be placed for the statewide test.

The generators for the Michigan test will be manufactured by General Electric's Rome, Ga., plant.

The 240-cps fourth harmonic of the 60-cps system frequency was chosen for Near, according to R. I. Kopan of Midwest Research and T. J. Twomey of GE, "because it is readily generated through the use of asymmetrically biased magnetic cores, is transmitted efficiently over power networks, and is not normally found as ambient potential."

Both series-connected and shunt-connected Near generators have been developed. However, the shunt type has been selected on the basis of experiments indicating that it provides greater signal coverage and compatibility with the power system.

The shunt system uses inductors connected between phases of the power system, with full voltage impressed on the line-connected windings, according to Mr. Kopan and Mr. Twomey. Shunt inductors inject harmonic current in all directions from the generator into each phase of the three-phase system and produce a voltage across the system impedances.

The first home receivers have been made by the AC Spark Plug Div. of General Motors Corp.

Funds Allocated to Evaluate And Expand Near System

Of the $10 million earmarked by the United States for Near in fiscal 1962, a total of $1.5 million will be used for signal generators and for testing services to evaluate the Michigan system. The remainder is to go for installation of Near networks elsewhere.

The Administration also seeks $9.3 million for procurement of radiation monitoring instruments for fall-out shelters and communications equipment for the Civil Defense warning network.

Of about $15 million budgeted for R&D in fiscal 1962, a small amount will be devoted to improvement of fall-out monitoring devices and to make them easier to read and interpret. ■ ■

NEWS

(continued from p 11)

As to direct optical systems, Dr. William Ogle of the Los Alamos Scientific Laboratory testified that at this time Los Alamos scientists "feel that about 10^{-4} of the energy of a megaton device will come out as visible light in perhaps 30 μsec and that this is the major signal."

Four Direct Optical Channels Are Being Evaluated by U. S.

Four typical channels of a direct optical system are under evaluation at Los Alamos.

Dr. Ogle explained: "We also propose to study natural backgrounds with one extended range channel; that is, a channel that has larger optics and sees a smaller proportion of the sky and hence has a higher signal-to-noise ratio."

With present photomultipliers, an actual system of this type would be far too complex, requiring something like 20,000 channels. However, it was noted that larger area multipliers were now under development that would allow construction of an extended-range direct optical system with a more reasonable number of channels.

Possibilities for employing radio-detection equipment now hinge on the riometer, the electromagnetic pulse generated by a detonation and the use of back-scatter radar.

As to the riometer, a sensitive receiver for observing continuous radiation from above the earth's atmosphere, analysis of effects expected from a nuclear detonation indicate that the rapidity of onset should be less than 1 sec. The corresponding time for natural events is 30 sec to several minutes. Thus, according to Lt. Comdr. D. E. Chandler, Sierra program chief, "development of instruments capable of resolving the rapid time history of the observed signals is being carried out."

"Prototype riometer instruments capable of adequate resolution time are being operated to determine whether, in fact, signals with rapid variation do occur naturally," Comdr. Chandler added.

The nature of the electromagnetic radio frequency pulse is far from well-understood and is still the subject of a number of theoretical studies. As to backscatter radar, "a fundamental difficulty," Comdr. Chandler pointed out, "is in clearly defining what would be specified as a signal resulting from a nuclear test."

"The second difficulty," he went on, "lies in designing equipment capable of performing the required measurements. The specific effort being carried out in the Vela Sierra program deals with a conceptual design of appropriate instruments."

Analysis of the expected effects on the ionosphere of a high-altitude nuclear detonation indicate that changes in propagation time should result and should enable discrimination to be made between natural and man-made causes.

VELA HOTEL

A comprehensive study of X-ray, gamma-ray and neutron detector designs has been made over the last two years, together with research as to the anticipated effects that radiation backgrounds will have on them. Electronic logics have also been developed for interpreting signals from the detectors. A design freeze is scheduled for no later than Sept. 1.

A series of piggyback flights for instrument packages are planned on various balloons, satellites and probes. The plans, described at the Congressional hearing by Dr. B. P. Leonard of Aerospace Corp., call for a double-decker spacecraft to be launched into an elliptical orbit of from 50,000 to 75,000 nautical miles.

Spaced uniformly over the surface of the satellite will be 10 X-ray detectors, thin dome-like plastic fluors extending out from the vehicle. "This arrangement makes a number of them visible from any direction in space," explained Dr. Harold V. Argo of Los Alamos Scientific Laboratory in his testimony. The plastic fluors absorb the X-rays and convert their energy into visible light. The light pulse is then collected and measured by standard photomultiplier tubes.

"The photomultipliers have to be shielded from the sunlight, and this is done by placing a thin cover of beryllium or aluminum over the dome-shaped plastic fluors," Dr. Argo noted. "This shield has to be thin enough that it doesn't absorb the soft X-rays, yet still be opaque to sunlight."

There will be seven different bias levels, or sensitivity levels, built into the electronics to measure the intensity of the pulses.

Six gamma-ray detectors will be spaced uniformly about the satellite and probably beneath the surface skin.

The neutron detector will consist of two or more adjacent BF_3 neutron counters, surrounded by a common moderator of 10 lb of CH_2. These will be inside the satellite shell. ■ ■

Narrow-Band TV Uses Pseudo-Random Scan

A system of narrow-band telecasting under development at Polytechnic Institute of Brooklyn uses a pseudo-random scan technique and long-persistance phosphors in passing a useful picture through a 45-kc channel.

Resolution of the system, developed by Prof. Sid Deutch, is said to appear equivalent to that of a conventional system, although only one-quarter as many picture elements are used. However, because a slow-scan and long-persistance phosphors are used, frames require 1.6 sec to fade. Because of this, quick-moving images leave a ghost. In demonstrations of a closed-circuit version of the system, the mouth of a person shown speaking appeared blurred.

Scan rate of Professor Deutch's system is 20 cps horizontally and 2.25 kc vertically. A conventional 4-mc TV system in the U.S. uses a 15.75-kc and 60-cps scan.

Fine Scan Is Imposed on Coarse One to Minimize Flicker

To prevent flicker at 45 kc, the spot, while moving in its coarse scanning pattern, moves rapidly within an area of about 1/32 sq in. in a pseudo-random pattern of 32 positions. A complete fine scan takes 1.6 sec.

In the closed-circuit demonstration system, a yellow long-persistance screen is also used to reduce flicker. A modified vidicon of about 300 lines resolution picks up programs from a conventional TV receiver. These are passed through the pseudo-random scan circuitry to a monitor a few feet away.

Four synchronizing signals are required. One of these would be a pulse sent at 1.6-sec intervals to reset five multivibrators in the receiver to zero. These bistable units generate five square waves that produce the random scan.

1	9	3	11		
17	25	19	27		
5	13	7	15		
21	29	23	31		
		2	10	4	12
		18	26	20	28
		6	14	8	16
		22	30	24	32

Pseudo-random scan sequence of proposed narrow-band TV system is shown by numbers. Thirty-two positions of the spot fit in an area of about 1/32 sq in., which moves in regular scanning pattern as pseudo-random scan occurs.

The other sync signals required are: a 2.25-kc vertical sync pulse; a 20-cps horizontal sync pulse; and a 45-kc sine-wave sync signal.

Professor Deutch believes the system may be feasible for transoceanic telecasts. In such an application, multipath problems might require that the signal be sent over several channels. Signals would be received by a master diversity receiver and televised to home receivers. Studies are under way to determine the best modulation method.

The system was originally developed at Polytechnic for recording classroom lectures, where the camera was stationary and the only rapid motion was that of the instructor. The advantage of the system was its saving of recording tape.

'Magnetically Clean' Laboratory To Be Used for Navy Testing

A "magnetically clean" laboratory has been built for the Naval Engineering Experiment Station at Annapolis, Md.

Including virtually nonmagnetic construction materials and the ambient earth's field, the laboratory has a relative permeability of less than 1.02 for a radius of 288 ft.

According to Navy spokesmen, one of the most important problems at the new facility is quick location and accurate identification of major magnetic field sources within a field-producing item, such as various types of shipboard electric equipment.

The Magnaflux Corp. of Chicago, a subsidiary of General Mills, Inc., installed the nondestructive electronic test gear and magnetic field measuring devices. The equipment is based on design and instrumentation by Dr. Friedrich Foerster of Reutlingen, West Germany.

Air-Traffic Control System Uses Prerecorded Voice Command Sign

A semiautomatic air-traffic control system using digitally selected pre-recorded voice commands has been delivered for evaluation by the Federal Aviation Agency.

The system, received at the FAA's National Aviation Facilities Experimental Center in Atlantic City, N. J., handles up to 18 inbound and six outbound aircraft. A computer evaluates the information needed to bring the planes to a safe landing; it issues vector commands, so they will arrive at the airport in properly timed sequence rather than all at once.

Small Optical Pickoff Made for Exotic Gyros

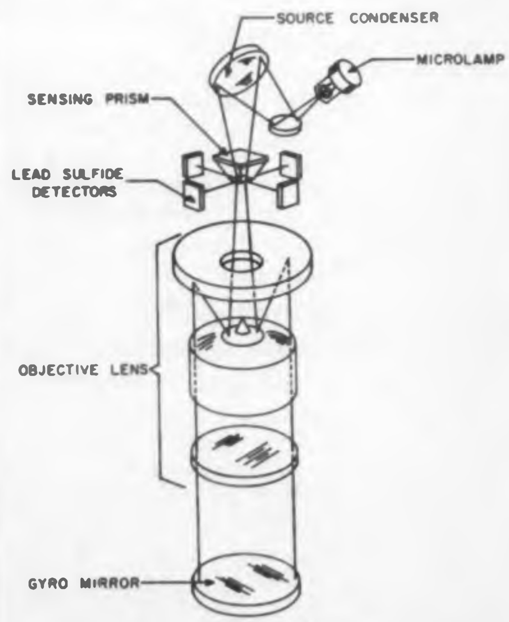
Autocollimator Method Said to Give High Resolution in Two-Axis Unit

A MINIATURE, two-axis autocollimator has been designed to serve as an optical pickoff for air-suspended, spherical rotor gyroscopes.

Resolution of the new device, termed Optag (Optical Pickoff Twin Axis Gyro), is 0.05 arc-sec rms, according to its developer, the Perkin-Elmer Corp., Norwalk, Conn. The complete pickoff, including light source, optics and photodetectors, is contained in a cylinder only 1 in. across and 2 in. long. The cylinder weighs 9 oz.

Optical precession pickoffs, which impose no reaction torque on the gyro rotor have long been favored for air-suspended and other exotic gyros, such as cryogenic, electrostatic and magnetically suspended types. Optag could be employed successfully in all, Perkin-Elmer believes.

Optag includes a microlamp incandescent light source, reflective optics, a truncated sensing prism and four lead sulfide photodetectors. Light is reflected from a small



Operating scheme of Optag pickoff. When gyroscope mirror is centered, light is reflected into sensing prism. When gyro precesses, mirror tilts and reflects light from sides of prism into lead sulfide detectors.

Disassembled Optag pickoff. Arrow indicates nose of sensing prism surrounded by four lead sulfide detectors. A flat-field Schmitt objective lens is housed in metal cylinder at left.

plane mirror on the gyroscope rotor, mounted normally to the spin axis.

When the gyro precession is zero, the reflected light passes entirely through the clear nose of the sensing prism. Any spillover is equally divided between the two photodetectors serving each sensing axis. When precession occurs, the mirror is no longer precisely normal to the optical axis; some light falls on the sides of the sensing prism and is reflected into the photodetectors. The resultant error signals are then amplified and applied to torquing servos that maintain the gyro case in accurate alignment with the rotor.

Light Weight and Reliability Dictate Choice of Design

The selection of one light source for the entire system and two detectors per sensing channel was dictated by the need for light weight and reliability. In general, incandescent lamps are the bulkiest, most power-hungry and least reliable components in such a system. The lamp itself employs a square filament consisting of four rectangular tungsten coils. The filament is 0.030 in. sq, slightly larger than the nose of the sensing prism on which it is imaged to prevent discontinuity of illumination.

The lamp is operated at a de-rated voltage for greater reliability and thus has a color temperature of only 2,150 K. This, in turn, places its peak spectral output in the 0.5-to-2 micron range and calls for lead sulfide detectors and reflective optics.

Optics are quartz and the housing is Invar to assure low but equal thermal expansion of Optag components. ■ ■

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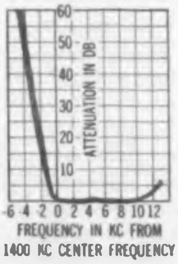

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WASHINGTON REPORT

John J. Christie
Washington Editor

A PROBLEM OF COMPETITION IN SPACE

Earliest possible development of a commercial satellite communications system apparently has been assured by a series of Governmental actions that have resulted in:

(a) the formation of a committee of international carriers to draft proposed plans for a joint venture, and

(b) the assumption of strong technical leadership by the National Aeronautics and Space Administration.

The Federal Communications Commission, in authorizing the carriers to propose a joint charter no later than Oct. 13, reaffirmed an earlier decision not to permit ownership participation by aerospace and electronics manufacturers. Despite a strongly worded directive that acceptable provisions be made for competitive bidding, not only in the procurement of hardware and services but also in the R&D stage, the commission has failed to allay fears that competition cannot be fully safeguarded. Moreover the Justice Dept. has indicated that it shares these misgivings.

NASA has put the competitive outlook in a somewhat better light as a result of the stringent patent provisions in its agreement with AT&T for launching and tracking, on a reimbursable basis, at least two and possibly four experimental satellites for the company in 1962. These unprecedented provisions give NASA royalty-free licenses to any invention conceived of or reduced to practice under the contract, even though no direct Government financing is involved. Moreover NASA may make any of the royalty-free licenses it obtains available to manufacturers. The RCA contract to develop and build NASA's Project Relay experimental satellite will further strengthen the agency's patent position.

NASA's Role as a Catalytic Agent in space technology is by no means confined to patent rights and licensing. Under the AT&T agreement, for example, the space agency also requires that the company report the results of experiments and provide test and evaluation data that might have a bearing on other programs and that NASA can turn this over to other firms.

It is noteworthy how closely the NASA approach resembles the thinking of the Justice Dept., as expressed in testimony by Assistant Atty. Gen. Lee Loveinger before the House Interstate and Foreign Commerce Committee. In reference to an all-carrier joint venture, he said:

"Provision should also be made so that no company could gain control of the system through ownership of patents. . . . The department believes that all inventions developed under Government contracts, or in projects supported in significant part by Government contracts, should belong to the Government. . . . There should be an exchange of licenses under relevant patents among companies participating in the development, ownership or operation of the satellite communications system, and between such companies and the government."

This and other testimony calling attention to risks of monopoly in the operational stage, if not in the developmental period, has aroused growing Congressional dissatisfaction with the proposed all-carrier joint venture. However, it is highly unlikely that any counter proposal for Government participation in the ownership and operation of a U. S. satellite communications system will prevail.

GOVERNMENT DATA-PROCESSING REQUIREMENTS

Federal agencies offer a number of challenging requirements for complex data-processing and data-retrieval systems. Few can equal the problems posed by the Patent Office, which has under consideration a number of ambitious systems proposals to whittle down its notorious backlog of pending applications.

Latest agency to turn to electronic data-processing is the Federal Communications Commission, beset by serious backlogs in some phases of its operations. The FCC has provided systems specifications to 14 computer manufacturers, whose bid proposals are due by Sept. 29. The general-purpose computer and peripheral equipment will be standard. But programing requirements are complex. Electronic data-processing operations are scheduled to begin in mid-1963.

A shortage of engineering manpower has been a chronic problem for the FCC. Thus a prime objective is to eliminate manual computation of radiation patterns, contour predictions, channel studies, etc. A variety of administrative functions will be transferred to electronic data-processing, including the scheduling of pending applications and renewals, the compiling of details about existing and proposed ownership of stations, analysis of data for rate making, and posting, retrieving and assimilating data for the legal staff.

NEW PRESSURE TO BOOST SUBCONTRACTING

The subcontracting practices of prime contractors and their major subcontractors will be subjected soon to scrutiny by examiners of the Small Business Administration.

An industry-Government task force will assist SBA in devising procedures under which contractors' files would be monitored to determine whether they were wholeheartedly complying with regulations designed to give small firms a maximum opportunity to bid for work.

SBA acknowledges that the Defense Dept.—which is committed to a 10 per cent increase in small-business awards in fiscal '62—NASA and other agencies are making a much stronger effort than formerly to increase subcontracting opportunities. But it contends that better enforcement of these good intentions is in order. SBA also believes that its probing may lead to stronger regulations on subcontracting.

Among other measures to be considered by the SBA task force is a proposal for setting up regional data-processing centers that would give procurement officials and prime contractors access to meaningful and up-to-date data on small-firm capabilities.

Sole-source procurement and limited invitations to bid are frequently defended on the ground that qualified small firms are too difficult to locate. Small firms complain that they lack the manpower and means of ferreting out opportunities for subcontracts.

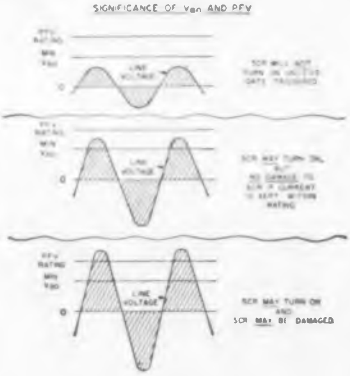
rectifier components news

PFV and We . . .

PFV (repetitive peak forward blocking voltage) and V_{BO} (forward breakover voltage) are terms which have been giving us heartburn of late. This is because some people are confusing the two and not taking advantage of the extra margin of performance offered by G-E Silicon Controlled Rectifiers.

Many manufacturers consider the V_{BO} as a *rating*—that is, if you exceed the V_{BO} spec the SCR may turn on *and* may be damaged. Not so with us, dear friends. V_{BO} is the point at which a G-E SCR may *turn on*, period. It is a *characteristic* of the SCR. The *damage level* of said unit is known as the PFV *rating*. There's quite a margin of difference between the two.

Look at it this way:



In this bottom curve, you can be in real trouble if you exceed the PFV rating.

As fate would have it, you only get this extra margin of protection against forward voltage surges with G-E SCR's . . . at no extra cost, of course!

While we're on the subject of trouble, we're reminded that every semiconductor rectifier user needs protection against that arch-villian "transient voltages." Our new booklet 630.3 is a virtual college course on the subject, gives 10 different causes of transient voltages, tells how to protect against them. Write to Section 20G25 and ask for your free copy.

Well Stacked?

. . . among other things, rectifiers can be too, you know. For instance, the new 1N3289-1N3293 high current rectifier has been officially released, and this is a cell that can handle current up to 70 amps and cyclical PRV's up to 1000 volts. Well, it's also available in a beautifully proportioned (or stacked) 4JA6011 series! And now hear this, if you're interested in frosting on the cake . . . prices have been reduced approximately 35%!

But that ain't the whole story . . . *all* G-E rectifier stacks are pretested and pre-assembled to save you time and money. Germanium, silicon, potted rectifier circuits . . . just take your pick from thousands of combinations. And when you check our new *low* stack prices against your *actual* cost of assembly when you do it yourself, you just might decide to call our local Sales Manager.

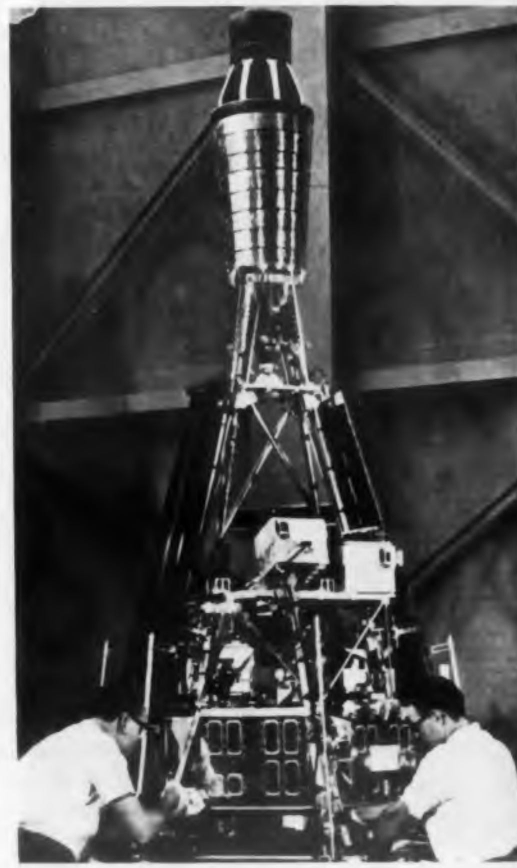
If you're writing to us for the booklet on transient voltage protection (and you should be . . . for your own protection), you might also be interested in the latest application note that we've added to our library of helpful hints to rectifier requirers. Glen Snyder, Application Engineer, has polished off a masterpiece titled "Silicon Controlled Rectifier High Voltage Power Supply." Highlights include RFI suppression, temperature compensation, and transformer design techniques for Morgan chopper circuits. It's not only good, it's also free. Just ask for booklet 610.5 when you write to Section 23H25

Rectifier Components Dept., General Electric Company, Auburn, N.Y. In Canada: Canadian General Electric, 189 Dufferin St., Toronto, Ont. Export: International General Electric, 150 E. 42nd Street, New York 17, New York.

GENERAL ELECTRIC

Moon Vehicle Set For Launch

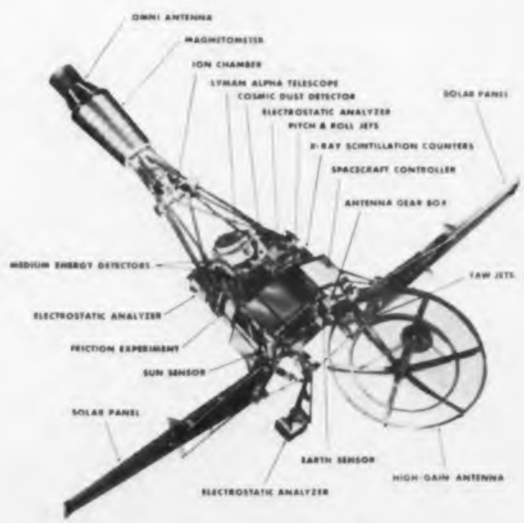
Most complicated space vehicle ever built for the U. S. space program is the Ranger I, designed to test control systems on an initial shot some 500,000 miles into space. Later versions of Ranger will make landings on the surface of the moon or planets. An earth-sun sensor orientation system and new "blue" solar cells are among the specialized electronic units carried on the space vehicle.



Ranger is prepared for packing in the nose of an Agena-B Atlas booster combination. Solar-cell paddles are pulled into an upright position, and the 4-ft parabolic directional antenna is tucked up tightly underneath the vehicle structure.

"Blue" solar cells are used in this Ranger panel built by Hoffman Electronics Corp. The cells are designed to allow a greater percentage of sunlight toward the blue end of the spectrum to contribute to the energy conversion. The shift is rather small—down to 0.62 from 0.67 microns at the 80 per cent point on the response curve and down to 0.48 from 0.53 microns at the 50 per cent point, with about the same red response, according to Hoffman's random sampling. But the added blue response is at the peak energy portion of the solar spectrum. The improvement is attributed to the use of a thinner top layer over the semiconductor junction in the cells. This panel provides about 90 w, using 4,340 silicon cells, and weighs 19 lb, Hoffman reports.

Passive temperature control of the Ranger spacecraft is provided by varying surface finishes. Gold plate, white paint and polished aluminum are used to balance the thermal effects of extreme cold on the space side of the vehicle and intense heat on the side facing the sun. The directional antenna is partially extended below the vehicle, and solar-cell paddles are in position for receiving radiation from the sun.



Complexity of Ranger systems is illustrated by this detailed view of the vehicle's parts. More than 1,500 industrial and educational organizations have contributed to the Ranger program.

(Advertisement)

NEW PRODUCT

Versatile Crimped Connector For Miniature Coax Cable

A highly versatile crimp-type snap-locked modular HYFEN® connector for miniature coaxial cable has been introduced by the Omaton Division of the Burndy Corporation, Norwalk, Connect. This modular HYFEN offers the facility of simple removal of individual snap-locked contacts or gang disconnect.

Both inner and outer contacts are crimped to the conductors, simplifying a previously complicated and difficult process. In addition this process eliminates many of the parts formerly used, and also eliminates any heat in the connection process. The result is a reliable coax connection, easily and quickly installed.

The new plug-and-receptacle unit will presently connect RG195U and #24 shielded miniature coax cable. Connectors for other sizes of miniature coax will be available soon.

Connector frames, of die-cast anodized aluminum, accommodate three, five, or eight inserts, snapped in from either front or back. Inserts for coax cable, of glass-filled diallyl phthalate, accommodate up to 21 contacts. A plug or receptacle insert may hold male or female contacts, or they may be intermixed. Coax cable inserts and standard wire inserts (35 contacts) may be mounted in the same frame.

Contacts can be crimped to cable ends either before or after the harness is in place. Engaging and disengaging forces of low magnitude make it easy to insert, remove, and replace contacts and inserts individually for flexibility and economy in circuit changes and checks.

Burndy Corporation, Norwalk, Connect.

CIRCLE 22 ON READER-SERVICE CARD

Lightweight, easy-operating M10S hand tool takes four-indent die sets conforming to MIL-T-22520 to install many makes, sizes of contacts. Opposing indentors crimp contacts without bending, facilitating their installation in high-density connectors. Die sets can include insulation grip closers. Long tool life—no die adjustment necessary—assures contact installation with consistent dependability.

High-speed, bench-sized Bandomatic machine is engineered for the same solderless crimp-type contacts as the M10S, but for production volume. Takes from 3,000 to 5,000 contacts on a flexible carrying strip... reels, dies easy to change. Three-way mounting: flat (easy for handling harnesses), at 45°, or intermediate angles. Streamlined surface prevents snagging or damage to harness or components.

Either tool installs miniature HYFEN® and many other contacts for multi-conductor connectors. Four-indent crimping disperses pressure over greater area, so that all contacts, can be installed with standard dies. Dispersed crimping pressure permits each barrel size to take a wider range of conductor sizes. Crimp conforms to MIL-T-22520.

for further information contact OMATON DIVISION

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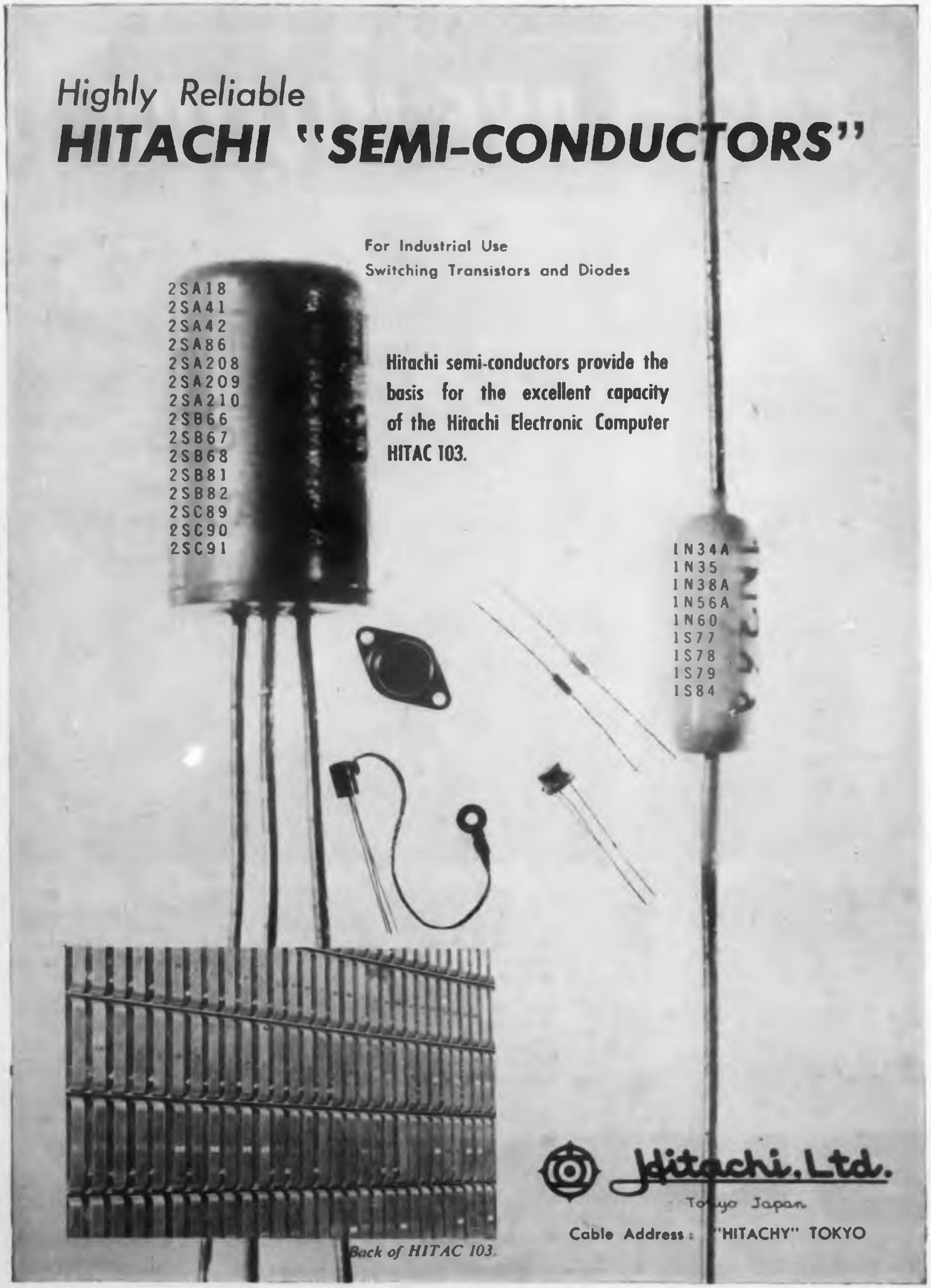


Island Tested as Antenna With Special R-C Bridge

Radiation tests to determine the usefulness of Deception Island, in the Falklands, as an antenna have been made with specially designed R-C bridge. The bridge has a frequency range of 2 to 20 kc and capacitance and resistance ranges of 0 to 10 μf and 0 to 10 kΩ.

As an antenna, the island, off the southern coast of Argentina near the Antarctic, would test the characteristics of interference in the very-low-frequency region. The 10-mile-diam, horseshoe-shaped island would be wired as an insulated slot and the surrounding sea used as the long-wave antenna for the radiation of artificial interference. This is considered easier than building a long-wave antenna in the Antarctic for frequencies around 5 kc. The wavelength at this frequency is 60 km; an efficient antenna for 5 kc would have dimensions in miles.

Project Is Part of RFI Propagation Studies

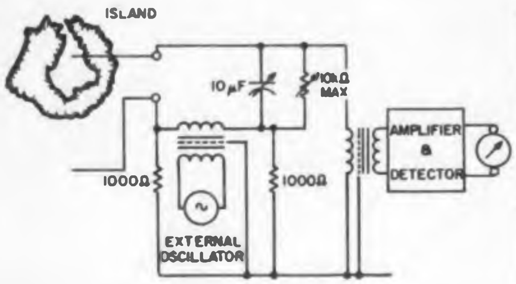
The project is a result of the discovery that lightning generates interference at vlf and the interference propagates along the earth's lines of magnetic force. Tests in which artificial interference was transmitted north to south have already been carried out; Deception Island is to be used for transmissions from south to north.

A 600-ft-high ridge circles the island. For the radiation tests, two sets of five telephone-gage wires were strung from the top of the ridge 20 yd into the sea. Radiation resistance was measured where the two sets of wires met at the summit—the point from which transmissions are to be made.

The R-C bridge was built by Marconi Instruments of Hertfordshire, England, to specifications of Prof. M. G. Morgan of Dartmouth College. Professor Morgan was the originator of the idea to use Deception Island as an antenna.

Bridge Is Straightforward; Has 5 Per Cent Accuracy

The instrument is a straightforward R-C bridge with balanced terminals, independent of ground, and a measurement accuracy of ± 5 per cent. The two ratio arms comprise a variable decade capacitor of 11 μf maxi-



How R-C bridge for 2 to 20 kc was used in measuring radiation resistance of island. Instrument was placed at summit of 600-ft-high ridge. Wires from it were strung 20 yd into sea.

mum, in parallel with a series arrangement of three calibrated variable resistors totaling 11.1 kΩ.

The bridge and transformers to isolate it from an external oscillator and a low-consumption, transistorized amplifier detector were housed in a simple aluminum box. Power was supplied by a 6-v, 20 amp-hr accumulator and two 120-v batteries. ■ ■

Disk Files Designed For Honeywell Computer

Random-access storage equipment, using magnetic disks, has been designed by Minneapolis-Honeywell's Electronic Data Processing Div. for the Honeywell 400 medium-scale computer.

Four models are available, ranging from a minimum capacity of 24 million alphanumeric characters to a maximum of 96 million.

The capacity of the four units is as follows: Model 460-1, six disks, 24 million characters; Model 460-2, with 12 disks, 48 million characters; Model 460-3, with 18 disks, 72 million characters, and Model 460-4, with 24 disks, 96 million characters.

Average access time to any item in the file, regardless of file size, is approximately 100 msec, Minneapolis-Honeywell reports. Maximum access time is given as 170 msec.

The minimum random-access storage and control unit (24 million characters) will rent for $2,900 a month. The sale price will be $140,000. The maximum unit (96 million characters) will rent for $6,200 a month and sells for $260,000.

The company says units will be available for delivery 15 months after receipt of the order.

NEWS

Ultrasonic Blood-Flow Meter Developed at London Hospital

A device for measuring blood flow in a human vessel ultrasonically has been developed at St. Thomas's Hospital, London, England.

The system works by transmitting 3-mc pulses generated by a quartz crystal across a patient's blood vessel. A second crystal transducer is positioned opposite the transmitting unit. The length of time taken for a pulse to traverse the blood vessel is measured by a ramp generator.

A miniature computer compares the difference in velocity between pulses traveling in opposite directions. By using this information, it can determine the blood-flow rate and direction.

Paper on Automatic Controls Wins NEC Award of Merit

A paper that has caused significant changes in automatic controls over the last decade has earned for its author the Award of Merit of the National Electronic Conference. The award has been made only once before in the conference's 17-year history.

Donald C. McDonald, engineering vice-president of Sola Electric Co. of Chicago, a division of Basic Products Corp., has won the award for his paper on "Nonlinear Techniques for Improving Servo Performance." The paper, which was read at the 1950 conference, is regarded as a departure from conventional theory. It opened the field of time-optimal control.

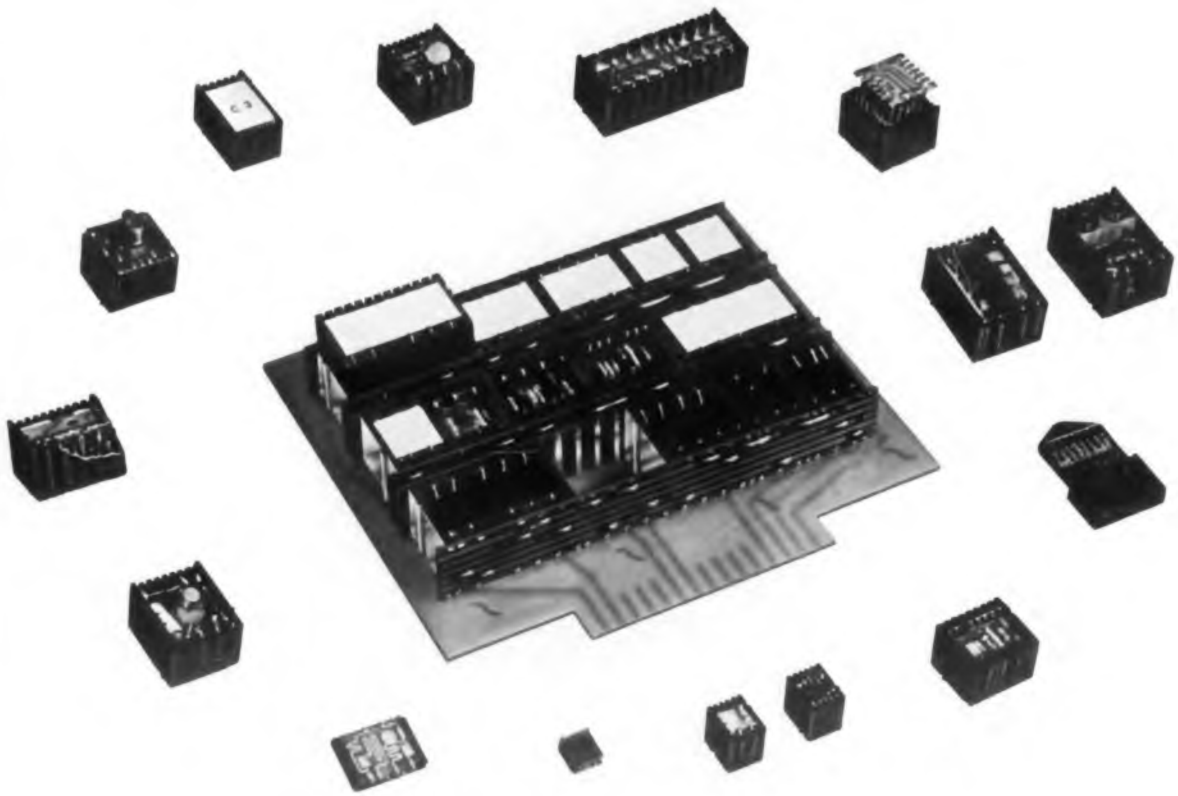
A certificate of award and a check for $750 will be presented to Mr. McDonald Oct. 9 at the National Electronics Conference, International Amphitheatre, Chicago.

High-Frequency Magnetron Developed for Air Force

A backward-wave magnetron with a 10.8-to-15.0-kmc tuning range has been developed for the Air Force to extend the frequency coverage of microwave communication systems. Presently available magnetrons operate at frequencies up to about 11 kmc, Sylvania says.

The units were developed by the Microwave Div. of Sylvania Electric Products, Inc., New York City.

PICK ANY CIRCUIT
(or design a new one . . .)



AMP-MECA®
assemblies can package it!

Name any present or foreseeable future electronic circuit—from conventional to solid state, from molecular to thin film . . . welded or cordwood or micro-module or semi-conducted network—AMP-MECA Maintainable Electronic Component Assemblies can package and interconnect every one of them!

How does the AMP-MECA system achieve this remarkable compatibility?

First of all, the basic AMP-MECA building block—the plug-in cell—is not fixed in physical size. Cell height, width and length can be varied, by increments, through four flexible grid systems, .050 in., .075 in., 0.1 in., and 0.2 in. to adapt to present or future circuits of all shapes and sizes. Circuit designers can choose to package into any AMP-MECA cell **only** those components which constitute an economically expendable function.

Second, AMP-MECA cells can easily interconnect circuits in all of the basic patterns; pure series, pure parallel, and complex series-parallel.

Third, the lay out of interconnections between circuits is greatly simplified through the use of graphs. To date, multi-layer wiring has not been required for even the most complex logic system. The AMP-MECA Circuit Assembly concept is adaptable to specialized military or non-military, simple and complex systems, as well as large volume systems.

Explore the compatibility of the AMP-MECA system with your circuits. To see a specific AMP-MECA application, please turn this page. Write today for literature.

See AMP-MECA Assemblies at the Packaging Symposium in Boulder, Colorado, August 16-18, or, at the Wescon Show, San Francisco, August 22-25 (Booth 517-521).

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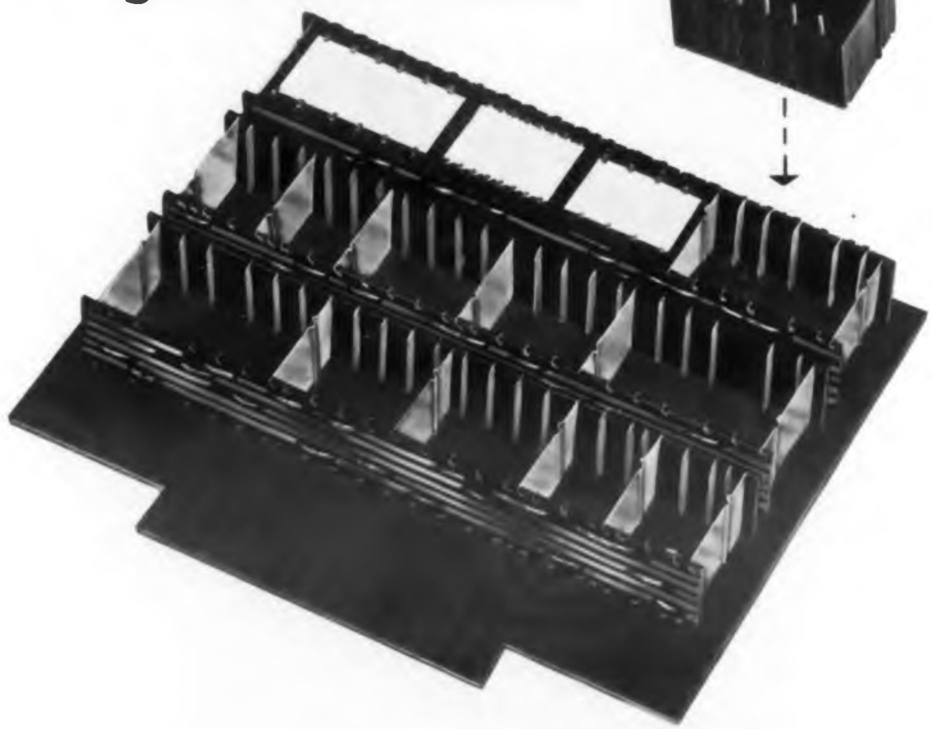
Bendix makes the circuits...

AMP-MECA®
assemblies make
the right interconnections!



Bendix Radio now offers a number of standard or special circuit modules packaged in MECA. Currently in mass production of more than 250,000 digital circuit modules, Bendix has chosen AMP-MECA Maintainable Electronic Component Assemblies as a totally compatible module packaging and interconnection system. So have several other circuit manufacturers whose customers want completely assembled, pre-packaged circuits.

Their selection is a calculated one.

Electrically the AMP-MECA concept provides a sophisticated wiring harness with short path interconnections in three-dimensions for integration of modular systems.

Bendix circuit modules and the AMP-MECA cell connectors vary in size depending upon the circuits to be packaged and make possible optimum packaging densities to meet your most exacting requirements. Contact area redundancy in the AMP-MECA system assures maximum reliability. Overall design elements make the system easy to assemble, test and maintain.

The AMP-MECA system provides the ease and simplicity of laying out interconnections between circuits when using the three-dimensional capabilities of the system. Circuit layout using the AMP-MECA concept can be accomplished without multi-layer wiring.

Write today for complete information on Bendix Circuits in AMP-MECA cells . . . get the facts on how this combination can go to work for you.

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Aerovox Puts 2-Year Warranty On Capacitors and Resistors

A two-year warranty on resistors and capacitors has been announced by Aerovox Corp., New Bedford, Mass.

This is a departure from the usual one-year warranty set by most components manufacturers. Aerovox said the cost of its components would not increase, although manufacturing and production costs have risen with stricter quality control.

Computer Control to Regulate Louisiana-to-N. J. Gas Pipeline

A solid-state control system is planned to regulate the flow of natural gas in a pipeline network from Northwest Louisiana to New Jersey.

The control equipment will be furnished by Control Data Corp., Minneapolis. In the initial installation a master station and three satellite stations will be joined by a common digital-computer language operating over microwave channels. The complete system will comprise 128 satellite stations and a computer at the master station.

The gas pipeline is operated by Texas Eastern Transmission Corp., with numerous lateral lines and loops from the main line.

The master control center will be at Shreveport, La., and the first three satellite stations at West Monroe, La.; Danville, Ky., and Berne, Ohio.

Power Sent by Remote Control

A remote-controlled supervisory system is controlling the transmission of power for the entire Pittsfield, Mass., area. Remote operation of three substations is accomplished with a solid-state master control unit at one substation in Pittsfield. The equipment, developed by General Electric Co.'s Medium Voltage Switchgear Dept. of Philadelphia, provides for station operation, five alarm functions, two position indications, and frequency telemeter readings for voltage and vars.

◄ CIRCLE 28 ON READER-SERVICE CARD

San Francisco: Golden Gate To Electronic Research

WESCON Delegates Will Find Many Laboratories Pursuing Studies In Solid State, Microwaves, Information Handling and Other Areas

Dash process furnace for epitaxy studies of semiconductors is examined by Dr. Richard Ewing of Shockley Laboratories with a filter viewer which provides magnification of the phenomena.

Thomas E. Mount
West Coast Editor

INQUISITIVE engineers attending the forthcoming Western Electronics Show and Convention will find the San Francisco area a thriving center of electronic research.

Intensive studies are under way today in solid state, microwaves, information handling and other branches of the industry. WESCON is scheduling field trips to representative laboratories for those engineers who are interested.

An examination of the problems being probed by researchers will disclose such typical ones as these:

Solid State

Shockley Laboratories, Palo Alto, is growing ultra-pure silicon crystals to study imperfections in silicon p-n junctions. Researchers are using the Dash process originally developed at General Electric to grow the crystals. Diffusion "constants" have been found to be inconstant—or, as the researchers call them, "diffusion coefficients"—and R&D manager Rudolf Biesele points out that "the whole area of semiconductor technology is a peculiar blend of science and art."

"We keep finding areas of art that have heretofore been labeled 'science,' " he says. "These areas that are not really under control are the ones that have been plaguing industry. It is these areas of sorcery we are attacking."

Impurities in Starting Materials Limit Solar-Cell Performance

From some of the work on imperfections in junctions, it now appears that many of the compromises that have been forced on solar-cell manufacturers are caused by the quality of their starting materials—the semiconductor crystals they process into solar cells. Tests on solar cells show efficiency differences due to stray impurities, possibly precipitation materials established during heat treatment.

To check the efficiency over the surface of a given solar cell, Shockley researchers etched several mesas on the surface. Lower efficiencies were found on the periphery of the cell, higher ones in the center, and highest of all under the contacts to the solar cell.

Other research, conducted principally by Dr. Adolph Goetzberger, provided an answer to the last anomaly. Some glasses, formed on the surface of the silicon during processing, and some metals, like the nickel contacts, act as efficient "getters." In this sense the getters act as blotters for impurities.

More imperfections examined by Dr. Goetzberger include "pipes"—shorts through the middle layer in transistors. These are caused by dust settling on the transistor n-layer before the p-layer has been diffused on. Silicon dice left exposed to dust show

'Fertilized' Transistors Grow Annoying 'Pipes'

Puzzled Shockley Laboratories researchers engaged in transistor studies noticed a sudden high incidence of "pipes"—undesirable imperfections—on silicon wafers one day.

The difficulty was traced to a pile of manure dumped near an open window to await spreading on the plant's lawn. The large amount of phosphorus in the fertilizer ruined the batch of silicon transistors.

Processing of materials in closed atmospheres has solved this contamination problem for Shockley.

Light emission in solid state materials is observed by Dr. Adolph Goetzberger of Shockley Laboratories through an avalanche light emission analyzer. Much of the research activity in the San Francisco area is concentrated on solid state phenomena.

pipes, and the greater the duration of exposure, the more pipes. Phosphorus, even in small quantities, is a prodigious pipemaker.

The obvious solution to the problem of pipes is make the semiconductors in a controlled environment. At Shockley the phosphorus-diffusion furnaces are even walled off from the other fabrication furnaces—average content of phosphorus in a pipe is 10^9 atoms, half a micron in size—and air-conditioning filters have 1-micron interstices.

Some results from the study of dislocations indicate that two or more doping materials should be used in the manufacture of solar cells instead of one. Dr. Ham Queisser discovered that a boron atom diffused into a semiconductor causes strain and slippage, since the boron atom is much smaller than the silicon atoms. He theorizes that the use of two doping materials—one larger than the crystal atom, one smaller—would alleviate the strain and prevent dislocations.

Other programs in effect at Shockley include studies of how surface conditions influence silicon diffusion. It turns out that diffusion 1 micron below the surface is quite different from that on the surface. This effect had no importance in earlier days, since relatively thick layers were used in semiconductors, but the trend in modern devices

is toward the use of layers that are themselves only 1 micron thick. The study is aimed at resolving this anomaly.

IBM Laboratory Is Pursuing Variety of Solid-State Studies

Elsewhere in the solid-state field IBM Research Laboratory at San Jose, a division of International Business Machines, is looking into photochemistry, surface studies and films, and resonance physics, such as nuclear magnetic resonance, electron paramagnetic resonance and quantum electronics. Dr. John Michaelson is heading a team investigating photochemistry and other problems originally extracted from the image-storage field. Among the phenomena he is concerned with are the absorption, storage and transfer of energy, photodecomposition of organic solids, energy transfer to various impurity atoms in solution, and the phosphorescent state of solids.

Lockheed Missiles and Space Div. maintains a major research center in the Stanford Industrial Park, Palo Alto. There Dr. Herbert N. Leifer is working with the University of California on magnetic effects, thermoelectric effects, spin waves in thin ferromagnetic films and the magnetic properties of rare earth materials. A spin-echo electron paramagnetic spectrometer shows promise for the study of fast-access (10^{-8} sec) memories. Information is stored in atomic lattices.


2B1A
HI-G INC

Atmospheric breakdown as a function of air density is studied in a microwave transmission project at Stanford Research Institute. Microwave energy directed into evacuated plastic chamber, left, breaks down at a certain power level creating bright spots to appear. Inset shows waveform observed at breakdown. Above, Dr. Tetsu Morita, in charge of the project, operates oscilloscope used in breakdown studies.

Microwaves

At Stanford Research Institute, Palo Alto, a radiation systems group under Dr. Tetsu Morita is working to determine at what power level the atmosphere breaks down as a function of density and therefore of altitude. The group has set up a spherical transparent chamber and pumped it out to a few millimeters of mercury. A parabolic microwave antenna, mounted outside the chamber, focuses pulses of microwave energy through the wall into a small spot near the center of the sphere. If the electric field is above a critical value, the rarified air breaks down, forming a pattern of brightly glowing spots. Information is obtained on the breakdown field strength as a function of altitude; it represents an upper limit to the power that may be transmitted through the atmosphere.

Dr. Morita is also studying a missile re-entry problem. During re-entry antennas are subjected to a partially ionized atmosphere. The presence of free electrons in sufficient number will lower the power-handling capabilities of the antennas. To investigate this effect, Dr. Morita has set up an artificial plasma generator. He puts an antenna into the flame and checks communications.

Radars to Locate and Measure Rainfall in 100-Mile Area Studied

An aid to meteorologists may develop from work on weather radar being con-

Today's big values in instrument bearings are the tiny but extremely precise bearings made by REED. Produced to ABEC-7 tolerances, they are available at no increase in price over ABEC-5. This added value, in bearings up to ⅝" OD, is possible because REED's centerless grinding operations provide exacting control of tolerances and operating characteristics. So, precision and price give you two important reasons for listing REED among your approved sources for instrument bearings. 6110

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The big west coast source for instrument bearings, today, is a highly specialized producer named REED. Each year, REED produces hundreds of thousands of miniature and instrument bearings—in bore sizes between .0469" and .2500". REED also makes these bearings available nationally—through local stocks at REED sales offices and by air directly from Los Angeles. REED specialists are strategically-located in major cities to help you make these tiny bearings do big, important jobs—another reason why REED should be on your list of approved sources for instrument bearings. 6109

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CIRCLE 212 ON READER-SERVICE CARD

ducted by the aerophysics group at Stanford Research Institute. Radars under development indicate the possibility of locating rain on a ppi and simultaneously gaging the amount of rainfall by the density of the echo. Such a weather radar could measure the precipitation with quantizing techniques and record all rainfall in an area of 100 miles' diameter.

Prototypes of broadband (25 per cent) traveling-wave parametric amplifiers have been built by the microwave group under E. M. Theodore Jones. The device could find application as a pre-amplifier on receivers, since it would obviate tuning.

Another development of this group is an up-converter, narrowband parametric amplifier with less than 1-db noise. The group is also concerned with the design of strip lines and electronically tunable filters.

Meanwhile researcher Philip Carter at Stanford Research Institute is studying the use of ferrites in parametric amplifiers. He has designed very-high-frequency parametric amplifiers using garnets.

Information Handling

The Advanced Systems Development Laboratory in San Jose has concentrated considerable effort on data-transmission research. Engineers there have built many modulator-demodulator subsets and have connected computers to telephone lines in seeking to get to the root of problems. A radio link has been set up between the laboratory and IBM in Tucson, Ariz., to experiment with error-detection codes.

The division is also examining the technological and systems implications of data storage and retrieval. Image storage, as exemplified by IBM's recently announced Walnut File designed for the Counter Intelligence Agency, was developed in this division. With an optically demanding system like Walnut, the specification of lens design and measurements becomes important; close understanding between "optickers" at American Optical Co., for example and "electronickers" at IBM is necessary.

In computer research, pattern recognition and threshold switching takes precedence. At Lockheed Missiles and Space Div., Palo Alto, Dr. David G. Willis is studying artificial neurons—multiple-input, single-output devices. Various weighted functions may be input to the neuron, or the weighting factors may be implemented within the neuron. The results of these studies will be used in scheme and pattern recognition, hybrid logic and normal logic.

Energy Sources

With a view toward thermionic energy conversion, researchers at Varian Associates, Palo Alto, are studying plasma synthesis. If a plasma can be generated cheaply—with low expenditure of electrical power—then low temperature (1,000-1,500 C) emitters can be fabricated instead of the 2,500 C presently needed for tungsten or tantalum.

Low density, magnetically confined discharges are under investigation at Varian, with the goal of eventual high-power controlled fusion. Former research in this area resulted in ion gages, ion pumps (the VacIon) and upper-atmosphere instruments.

Communications

In communications, Dr. Joachim Muehlner of Lockheed Missiles and Space Div., Palo Alto, is carrying out research in broad band carrier modulation and demodulation techniques, statistical communications theory and oceanographic instrumentation. The instrumentation laboratories under Dr. Muehlner developed pressure, temperature and voice instrumentation for the deep-diving Trieste bathyscaphe.

The electromagnetic sciences group at Stanford Research Institute, Palo Alto, is designing antennas for specific purposes. Current work concerns vlf antennas for submarine communications, including the design of a large, flat-top, top-loaded stub antenna for 15 kc.

A corollary of this work is being carried on in the radio systems group at the institute. Work has been done detecting lightning and direction-finding lightning bursts with 1-cps modulation.

Behavioral Psychology

Representative of the wide range of today's electronic research, techniques in behavioral psychology are being investigated at Varian Associates, Palo Alto. The findings will have application in teaching machines and educational aids.

How do people learn? How is learning modified? These are questions the Varian behavioral psychologists are trying to answer. Some developments have been realized as electronic aids and to some extent have been applied in the Varian organization. ■ ■

Electrostatic Printer Promises Versatility

An electrostatic printer that can print on virtually any material without pressure contact has been developed by the Stanford Research Institute. Paper, cardboard, cloth and wood are among the materials that lend themselves to the new printing method, thus far experimental.

The Electrostatic Printing Corp. of San Francisco has been set up to exploit the machine.

In operation, it charges a 200-mesh stainless-steel screen to about 1,500 v. The paper or other material to be printed on runs in back of the screen, and backing up the paper is an electrode of opposite polarity. Dry-ink-and-resin dust is brushed by a rotating orlon brush into the screen, where the dust particles acquire a charge. Then they are attracted to the rear electrode and are fixed to the paper.

Fixing is accomplished by baking the paper a short time in an oven. This process limits the resin and makes it adhere to the substrate.

The printer is said to show promise of extremely high quality reproduction. The 200-mesh screen, which in operation is masked by the image that is to be reproduced, could result in easy and inexpensive reproduction of 200-screen photographs for newspapers and magazines. Two-hundred-

Detailed electrostatic printing on plywood and corrugated cardboard is examined by Jerome Flax, president of Electrostatic Printing Corp.

screen half tones are twice as fine and detailed as standard magazine photographs.

According to Virgil Barta of the Institute, the electrostatic printer should cost 50 percent less than standard printing presses and weigh only half as much. Greater control of the printing process is possible with the machine: the density of the ink, for example, can be varied by changing the amount or duration of voltage, so relief printing is possible. This capability should provide a new graphic arts dimension.

Another advantage claimed for the electrostatic printer is that both sides of the paper can be printed, since the ink-and-resin dust can be charged to either polarity. Current techniques call for drying one side before printing on the other.

Traveling Technical Exhibit To Cover 7 Areas in East

A traveling technical show, featuring the latest developments of seven instrument manufacturers, will call this fall at seven East Coast points.

All of the booths at this second annual Electronic Instrument Manufacturers Exhibit will be manned by company engineers, who will provide information on calibration and measurement problems.

This year's show will be sponsored by General Radio Co., West Concord, Mass.; Lambda Electronics Corp., Huntington, L. I., N. Y.; Non-Linear Systems, Inc., Del Mar, Calif.; Panoramic Electronics, Inc., Mt. Vernon, N. Y. (formerly Panoramic Radio Products); Sensitive Research Instrument Corp., New Rochelle, N. Y.; Tektronic, Inc., Beaverton, Ore., and Trio Laboratories, Inc., Plainview, L. I., N. Y.

The areas that the Show will visit are:

- Syracuse, N. Y., Sheridan Inn, Sept. 21, noon to 7 pm.
- Norwalk, Conn., Norwalk Motor Inn, Sept. 25, noon to 7 pm.
- Roosevelt Field, L. I., N. Y., Sagamore Room, Sept. 27-28, noon to 8 pm.
- Cedar Grove, N. J., The Towers, Oct. 2, noon to 7 pm.
- Philadelphia, Bellevue-Stratford Hotel, Oct. 3-4, noon to 8 pm.
- Watchung, N. J., Wally's Tavern, Oct. 9, noon to 7 pm.
- Washington, D. C., Marriott Hotel, Oct. 11, 2 to 9 pm.

126,000 Gauss Generated In Small Test Magnet

A continuous magnetic field of more than 126,000 gauss has been reported generated at Massachusetts Institute of Technology in the core a solenoid magnet about the size of a grapefruit.

The achievement is significant for basic studies of semiconductor materials and in investigating the phenomenon of superconductivity. Very high magnetic fields are difficult to achieve because of the problem of getting enough power into a small volume and removing the heat that is produced.

The MIT magnet, designed by Dr. Henry H. Kolm of the institute's National Magnet Laboratory, and built by the High Voltage Engineering Corp. of Burlington, Mass., consists chiefly of a long, thin copper ribbon wound up like a jellyroll. The ribbon, 135 ft long and 6 in. wide (tapering to 1-1/2 in. at one end), is scored with 3,000 square slots.

Magnet Limited by Available Power; Ultimate Capability Still Unknown

The design enabled the laboratory to operate the magnet at a current level of 10,000 amp, and to force 320 gal of water per min through the coil to remove the heat produced. The test of the coil consumed 1.88 million w of electricity. The limit of available power at

Steel Mill to Get Automatic Grinder

Automatic roll grinder, controlled by a punched-tape sequenced program, will be used in milling operations at the Great Lakes Steel Corp. in Detroit. The control console receives pre-programed instructions on a standard 1-in. punched tape. The tape program includes 17 primary directions and four secondary ones. The grinding machine was built by the Farrel-Birmingham Co., Inc., of Ansonia, Conn. Program and control equipment is by the General Electric Specialty Control Dept., Waynesboro, Va.

the laboratory was reached during a test, and the ultimate capability of the magnet is still unknown.

As the electrical current passes through the ribbon, the magnetic field is produced in a 1-in. diam by 2-in.-long aperture at the center of the device. Samples of various materials, such as metals and semiconductors, can be placed in the aperture to determine the effect of the magnetic field on their structure. Radical changes can be made in the characteristics of materials by magnetic realignment of atoms and electrons.

Engineering development of the magnet was carried out with the support of the Air Force Office of Scientific Research.

Tube Filaments Kept Warm When New TV Sets Are Off

Tube filaments are kept warm when television sets are turned off in a new TV line introduced by Westinghouse Electric Corp.

The new feature, called "Instant On" TV, is provided by switching a half-wave rectifier into the filament supply circuit when the set is turned off, according to Westinghouse engineers. This cuts heater voltage to half its normal value. When the set is turned on again, full ac power is supplied to the tube heaters.

Since actual voltages are not critical while the set is off, low-cost semiconductor rectifiers can be used to provide rectification.

Keeping filaments warm while TV sets are off, so that picture and sound are turned on instantly, is also expected to extend tube life by reducing surge currents.

NASA Considers Ion Engines For Propelling Space Vehicles

Electrostatic ion engines are under consideration by the National Aeronautics and Space Administration for use in satellite propulsion units and deep-space probes.

The engines use electro-magnetic fields to expel electrically charged particles from an opening. High exhaust velocities can be produced while still maintaining low engine temperatures.

NASA has selected the Astro-Electronics Division of the Radio Corp. of America for developing and testing experimental engines.

NEWS

Space Chamber to Test Venus Craft and Others

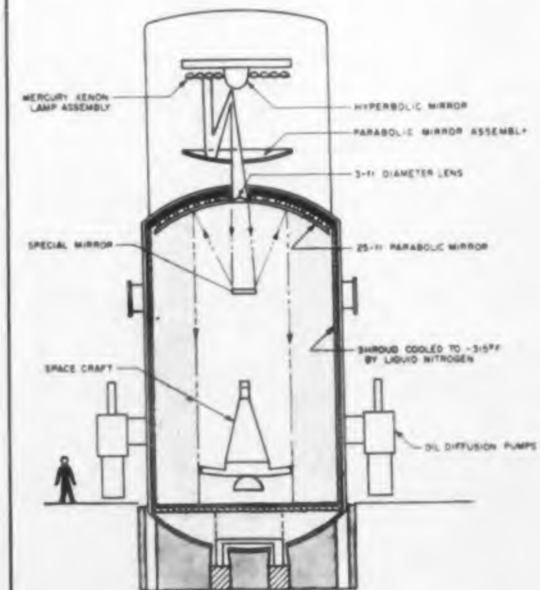
A $4-million space chamber has been ordered for the National Aeronautics and Space Administration to test the design of space craft. The first vehicle to be tested in it will be the Mariner A, designed for a mission to Venus.

The simulator will be a cylindrical, stainless steel tower, 80 ft 4 in. high and 27 ft in diameter. The lower part will house space vehicles for testing; the upper will contain a unit capable of reproducing the sun's rays and concentrating them on the surface of the space vehicle.

A special optical system will be designed for the solar simulator by Bausch & Lomb of Rochester. It will consist of 150 compact arc mercury xenon lamps, each lamp using 2-1/2 kw of power and each with a 16-in. reflector.

Tests will determine among other things the absorptivity and reflectivity of material in the space vehicle to the sun's rays. The test results will help avoid frying or freezing of electrical components and batteries.

A three-stage pumping system will create an atmosphere similar to that of outer space.



Test chamber for space vehicles, as planned by Consolidated Vacuum Corp. Outer space atmosphere will be simulated by a three-stage pumping system. A mirror system (upper chamber) reproduces the sun's energy. Light from mercury lamps shines down on parabolic mirror and reflects upward to hyperbolic mirror.

In the first stage seven large compressors, ordinarily used to run a supersonic wind tunnel, will remove part of the earth's atmosphere in the chamber. Then vacuum blowers and roots vacuum pumps will take over. Finally giant oil-diffusion pumps will complete the evacuation. At this point the chamber will simulate conditions at approximately 250 miles above the earth.

The contract for the space chamber was awarded by Jet Propulsion Laboratory of the California Institute of Technology to Consolidated Vacuum Corp., Rochester, N. Y. Consolidated Vacuum, a subsidiary of Bell & Howell Co., is nearing completion of a similar facility for Lockheed Aircraft Corp.

New Computer Program Evolved For Language Translations

A new computer program for the automatic translation of languages has been developed.

Unlike specialized disk-file and random-access-searching techniques, now under way, the new method is a mathematically developed progression that can be used with any general-purpose computer. It was demonstrated in Washington, D. C., on an IBM 7090 computer.

With the new technique, called Unified Translation System, Russian has been translated into English at 60,000 words an hour. Any languages can be translated from one to another, if one is Indo-European.

Machine Translation, Ltd., developer of the program, says translation speed can be increased by switching to a speedier computer. By the end of the year, the company predicts, translations may be a million words an hour with an IBM Stretch computer.

Video Systems in Production For Air Force Titan ICBM

Sixty closed-circuit TV cameras and 48 monitor screens are being produced for Air Force ICBM Titan program.

The video systems will televise critical in-silo missile functions—including fueling—and relay information to underground control centers.

The systems are being produced by Siegler Corp.'s Hallamore Div., Anaheim, Calif., under contract to the Martin Co., Baltimore, prime contractor on the Titan program.

NEWS

Fuel Cell to Be Orbited 30 Days To Test Efficiency and Reliability

A 50-w fuel-cell battery will be orbited in space for 30 days to test its performance and reliability.

A special test capsule is being developed for the Air Force by General Electric Co.'s Missile and Space Vehicle Dept. of Philadelphia to hold the fuel cell as it orbits 300 miles above the earth.

The fuel-cell battery, to be designed and developed by GE's Aircraft Accessory Turbine Dept. of Lynn, Mass., will have an output of 6 or 28 v. The ion-exchange membrane cells use hydrogen and oxygen as fuel. The chemical action of the two gases produces both electrical power and water.

The fuel cell will be in a zero-g environment and will be operated at varying loads between no-load and full-load.

Data sensors will note the operation of the cell, and telemetry equipment will transmit the information to ground stations. The entire test capsule will have a volume of 6 cu ft and weigh about 100 lb.

One of the major areas of investigation is the effect, if any, of weightlessness on fuel-cell operation. Tests thus far indicate that a fuel cell can operate during relatively short periods of weightlessness. The new test capsule will determine performance under prolonged conditions.

Second Bionics Symposium To Be Held at Cornell

The Second Annual Bionics Symposium, dedicated to applying knowledge of biology to electronic problems, will be held Aug. 30 to Sept. 1, 1961, at Cornell University, Ithaca, N. Y.

The keynote speaker will be Prof. Heinz von Foerster of the University of Illinois. Major addresses are scheduled to be given by Prof. W. S. McCulloch of the Massachusetts Institute of Technology; R. M. Pritchard, McGill University; Prof. James Preston, Syracuse University; Prof. Kenneth Roeder, Tufts University, and Prof. J. J. Gibson of Cornell.

The papers to be presented are expected to fall into three general areas: life sciences, behaviorial science, and mathematical and physical models.

The symposium is sponsored by Cornell

and the Advanced Electronics Center of General Electric Co. Inquiries about accommodations or other information should be addressed to Sylvia W. Switzer, Second Annual Bionics Symposium, General Electric Advanced Electronics Center, Cornell University Industry Research Park, Ithaca, N.Y.

Automatic Atomic Plant Slated For Sea and Remote Land Uses

A portable, self-regulating atomic power plant to generate electricity under the sea or in remote land areas is being developed by General Dynamics Corp. of San Diego.

The small "package" plant is designed for long-term, unattended operation at generating capacities up to 2,000 kw. Dr. Frederic de Hoffmann, president of the company's General Atomic Div., said the plant would be applicable to undersea operation as a power source for naval defense systems. On land it might provide electricity for military, weather or communications stations in polar regions, he said.

The plant will be equipped with homogeneous fuel and moderator elements of uranium-zirconium hydride. In some applications thermoelectric elements might be employed for direct conversion of the reactor's heat into electricity.

Test Unit Checks BMEWS Returns

Digital returns from the Air Force's Ballistic Missile Early Warning System (BMEWS), a 3,000-mile radar system, are checked on a test console, operated here by a Sylvania engineer. The console monitors Detection Radar Data Take-Off computers, which are linked to BMEWS. The computers, developed by Sylvania's Data Systems Operations Div. at Needham, Mass., accept analog inputs from radar receivers, convert them to digital form and determine whether a legitimate target exists. Total time between detection by radar in northern Canada, analysis and display at the North American Air Defense Command in Colorado Springs, Colo., is 8 to 10 sec.

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EDITORIAL

A Quake or a Blast? Challenge for Electronics

Accustomed as we are to expecting the almost impossible from electronic detection—the spotting of flying targets thousands of miles away by radar, the sensing of rocket plumes by IR, the communicating of intelligence via a bounce off Venus—it is a bit disturbing to realize our seismographs can't tell an earthquake from a nuclear blast. Furthermore, an earthquake can effectively shield the detection of a following nuclear blast, according to recent testimony given to the Congressional Joint Committee on Atomic Energy. Clandestine firings could be timed to follow earthquakes thereby violating test banning agreement without fear of being caught (unless inspection of sites causing the seismic disturbance is freely permitted—something the USSR has not been willing to do so far).

The immediate questions are: Are engineers failing to solve this instrumentation problem? Are we doing enough research? There is little hope for disarmament agreement if detection and inspection are not technically feasible.

The answer on the surface seems to be, "yes." Project Vela, under the direction of the Advanced Research Projects Agency, seems to be going along as planned. Scientists reporting on progress at the Congressional hearing claimed information and answers would come faster if nuclear testing were resumed, but did not blame lack of funds or administration policy. Progress, they say, is not startling because so much basic information about the earth's geography and space's properties still has to be gathered. But accustomed to the faster answers we get from fields where emphasis is heavy, we wonder if the progress is adequate.

The broad research challenge before our profession today is no less than the control of the world crisis. Twenty engineers and scientists, several prominent in the control and instrumentation fields believe that a warproof world is not inconceivable.* They feel that if our national strategy is one of prevention of war rather than defense, deterrence, or destruction, our detection, information-gathering and information-processing facilities can be developed so that a worldwide "War Safety Control" organization is politically possible.

Visionary, perhaps beyond imagination such concepts are. More "experts" will say "impossible" than "possible." To make the "possibles" our true prophets, we need heroes of both the Billy Mitchell caliber who can see the new strategy and the unnamed engineer who may improve the seismograph.

James A Lippke

* See *Consulting Report: The Future Research Challenge Control of World Crisis* by Howard G. Kurtz, submitted to Foundation for Instrumentation Education and Research. 355 East 45th Street, New York, N. Y. Copies available at printing cost in quantities or $0.50 per single copy.

Reminder: We'd like to chat with you next week at our WESCON Booth P 1 & 2.

Determining Permissible Dissipation For Silicon Power Transistors

Calculation of the maximum allowable power dissipation of transistors can be time consuming when different types, under different operating conditions and duty cycles are used in a piece of equipment. A handy design guide, complete with tables and nomograms, is provided and a typical example is worked out to illustrate the procedure.

Jerry Eimbinder and Carl R. Turner
Semiconductor and Materials Div.
Radio Corp. of America
Somerville, N. J.

The reliability of equipment using silicon transistors is heavily dependent on the permissible dissipation allowed for each transistor type. Calculations for maximum allowable dissipation can be quite involved since different types may be used in various applications with unequal duty cycles. A straightforward and convenient procedure is outlined, with nomograms to aid the designer; stability factor and signal distortion considerations are included to prevent thermal runaway and reduce nonlinearities.

Determining Permissible Dissipation of Silicon Transistors

Junction-Temperature Limits: Transistor manufacturers usually specify a maximum junction temperature for each type to prevent overheating of the junctions and resultant damage to the transistor. For most commercially available silicon transistors, this temperature limit is either 175 or 200 C.

Because of the difficulty of measuring junction temperatures, it is more convenient for equipment designers to work with maximum allowable transistor dissipation for the maximum ambient temperature expected in a particular application. Such dissipation values can be calculated from the maximum thermal resistance and typical thermal time constant of the transistor, the maximum thermal resistance of the heat-sink arrangement (if one is used), and the specific requirements of the application.

Thermal Resistance: Table 1 shows the various steps involved in the calculation of maximum permissible transistor dissipation (P_{MAX}) for a particular application. The first step is to determine the maximum thermal resistance ($R_{T_{MAX}}$) for the application.

Values of thermal resistance for transistors and heat sinks are obtained from manufacturers' published data (representative data appear in Tables 2, 3, and 4). For applications not involving heat sinks, the maximum thermal resistance is the maxi-

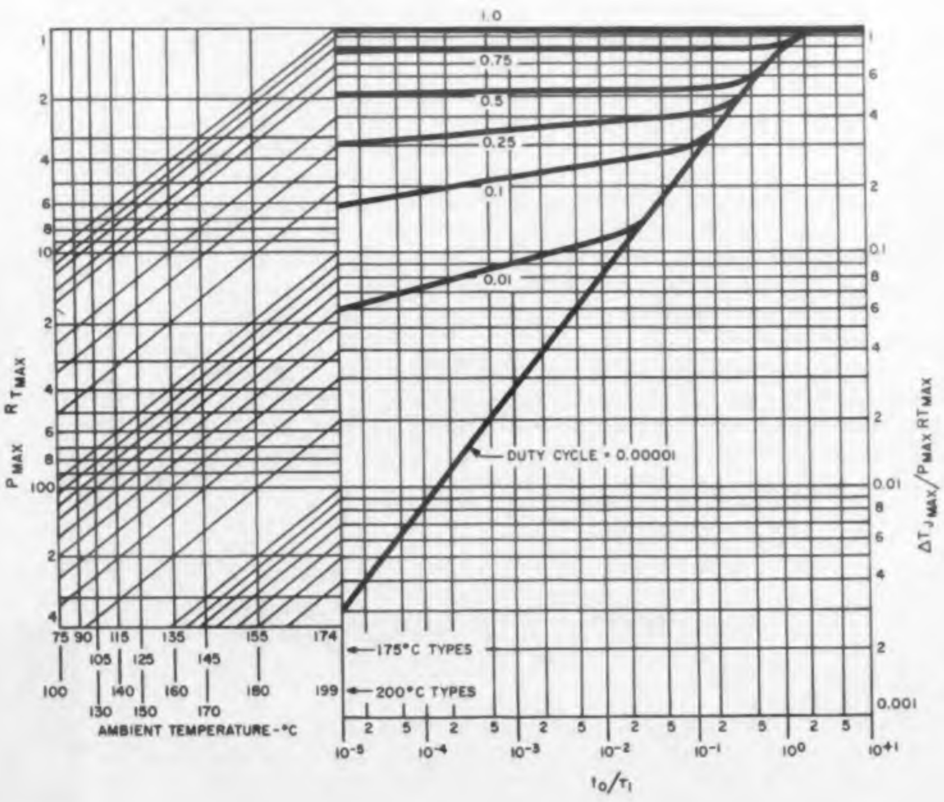


Fig. 1. Nomograph relating pulse duration, duty cycle and ambient operating temperature to maximum dissipation.

mum junction-to-free air thermal resistance ($R_{T'_{MAX}}$). For heat sink applications, the required thermal resistance ($R_{T_{MAX}}$) is the sum of the maximum junction-to-case thermal resistance for the heat sink arrangement.

$$R_{T_{MAX}} = R_{1_{MAX}} + R_{2_{MAX}} + R_{3_{MAX}}$$

where $R_{T_{MAX}}$ = maximum thermal resistance of application,

$R_{1_{MAX}}$ = maximum junction-to-case thermal resistance of transistor,

$R_{2_{MAX}}$ = maximum heat sink thermal resistance,

$R_{3_{MAX}}$ = maximum insulation - and - contact thermal resistance.

Use of the Rating Chart for Pulse and Switching Applications: After the maximum thermal resistance is determined the rating chart (Fig. 1) is used as follows:

1. Locate the point at which the quotient of the pulse duration (t_0) and the typical thermal time constant (τ_1) meets the specified duty cycle.
2. Draw a line horizontally to the left to the dividing line between ambient temperature and t_0/τ_1.
3. From this intersection, next draw a diagonal line parallel to those shown, to the vertical coordinate for the applicable ambient temperature.
4. Finally, read the value of $P_{MAX}R_{T_{MAX}}$ corresponding to the intersection of the diagonal with the coordinate for the ambient temperature.

Using the Rating Chart for Continuous Applications: $P_{MAX}R_{T_{MAX}}$ is obtained by locating the intersection of the top diagonal line (the one for which duty cycle = 1) with the coordinate for the applicable ambient temperature.

The maximum permissible dissipation (P_{MAX}) is obtained by dividing $P_{MAX}R_{T_{MAX}}$ by the maximum thermal resistance.

Determination of the Circuit Stability Factor

For applications in which thermal runaway is a consideration, the maximum permissible dissipation determined may be excessive. To insure that thermal runaway is prevented, the use of an adequate circuit stability factor (S) is required.

(continued on p 49)

Table 1. Sequence of Steps Required to Calculate the Maximum Permissible Transistor Dissipation.

Item to be Calculated Name and Symbol	Data Required				Formula
	Name	Symbol	Units	Source	
Maximum Thermal Resistance ($R_{T_{MAX}}$)	Maximum Junction-To-Case Thermal Resistance	$R_{1_{MAX}}$	C/w	Transistor Data Sheet (Table 2)	Free Air Applications: $R_{T_{MAX}} = R_{T'_{MAX}}$ Heat Sink Applications: $R_{T_{MAX}} = R_{1_{MAX}} + R_{2_{MAX}} + R_{3_{MAX}}$
	Maximum Heat-Sink Thermal Resistance	$R_{2_{MAX}}$	C/w	Material Data Sheet (Table 3)	
	Maximum Insulation-and-Constant Thermal Resistance	$R_{3_{MAX}}$	C/w	Material Data Sheet (Table 4)	
Maximum Permissible Transistor Dissipation (P_{MAX})	Pulse Duration	t_0	sec	Determined by Application	Use Rating Chart (Fig. 5)
	Thermal Time Constant	τ_1	sec	Transistor Data Sheet	
	Ambient Temperature	T_A	C	Determined by Application	
	Maximum Thermal Resistance	$R_{T_{MAX}}$	C/w	Determined Above	
Stability Factor to Prevent Thermal Runaway (S)	Collector-to-Emitter Voltage	V_{CE}	v	Determined by Application	$S = \dfrac{1}{2.3\ K\ V_{CE}R_{T_{MAX}}(I_{CBO_{MAX}})T_J}$
	Maximum Thermal Resistance	$R_{T_{MAX}}$	C/w	Determined Above	
	Maximum Collector Cutoff Current	$(I_{CBO})\ MAX_{T_J}$	amp	Transistor Data Sheet	
	————	K	—	See Reference in Article	
Stability Factor to Limit Distortion (Sd)	Allowable Percentage Change in Collector Current			Determined by Application	$S_d = \dfrac{I_c}{100\ \ I_{CBO}}$
	Collector Current	I_C	amp	Determined by Application	
	Change in Collector Cutoff Current (over the operating temperature range)	I_{CBO}	amp	Determined by Application	

The maximum collector-cutoff current at the highest junction temperature presented by the application must be known or determined before the maximum allowable stability factor may be calculated.

Maximum Junction Temperature: If the maximum junction temperature ($T_{J_{MAX}}$) is not known, it is possible to form the approximation:

$$T_{J_{MAX}} = T_{A_{MAX}} + (R_{T_{MAX}})(V_{CE})(I_E)$$

where $T_{J_{MAX}}$ = maximum junction temperature for application,
$T_{A_{MAX}}$ = maximum ambient temperature for application,
$R_{T_{MAX}}$ = maximum thermal resistance of application,
V_{CE} = collector-to-emitter voltage,
I_E = emitter current.

Maximum Collector-Cutoff Current: If the technical data bulletin issued by the transistor manufacturer contains a curve for maximum collector-cutoff current as a function of junction temperature, no further calculation is necessary. However, a curve for typical collector-cutoff current as a function of junction temperature, often given in published data, will also be of aid to the circuit designer if the following procedure is used:

1. From the technical data for the transistor type, obtain the typical and maximum collector-cutoff current values measured at the specified maximum junction temperature.
2. From the curve, obtain the typical collector-cutoff current at the desired junction temperature.
3. Approximate the maximum collector-cutoff current at the desired junction temperature by use of the formula:

$$(I_{CBO_{MAX}})T_J = \frac{(I_{CBO_{MAX}})T_{J_{MAX}}}{(I_{CBO})T_{J_{MAX}}}(I_{CBO})T_J$$

where $(I_{CBO_{MAX}})T_J$ = maximum collector-cutoff current at the desired junction temperature,
$(I_{CBO_{MAX}})T_{J_{MAX}}$ = maximum collector-cutoff current at maximum junction-temperature rating,
$(I_{CBO})T_{J_{MAX}}$ = typical collector-cutoff current at maximum junction-temperature rating,

Table 2. Values of Thermal Constants for Various Transistors.

Type	Maximum Junction Or Case Temperature (C)	Typical Thermal Time Constant (τ_1) sec	Maximum-Junction-To-Free Air Thermal Resistance ($R_{T'_{MAX}}$) C/w	Maximum-Junction-To-Case Thermal Resistance ($R_{J_{MAX}}$) C/w
2N497	200	0.01	200	35
2N656	200	0.01	200	35
2N1067	175	0.008	100	15
2N1068	175	0.008	100	15
2N1069	175	0.01	—	3
2N1070	175	0.01	—	3
2N1092	175	0.008	225	75
2N1479	200	0.01	200	35
2N1480	200	0.01	200	35
2N1481	200	0.01	200	35
2N1482	200	0.01	200	35
2N1483	200	0.01	100	7
2N1484	200	0.01	100	7
2N1485	200	0.01	100	7
2N1486	200	0.01	100	7
2N1487	200	0.012	—	2.33
2N1488	200	0.012	—	2.33
2N1489	200	0.012	—	2.33
2N1490	200	0.012	—	2.33
2N1511	200	0.012	—	2.33
2N1512	200	0.012	—	2.33
2N1513	200	0.012	—	2.33
2N1514	200	0.012	—	2.33
2N1700	200	0.01	200	35
2N1701	200	0.01	100	7
2N1702	200	0.012	—	2.33
2N1703	200	0.012	—	2.33

$(I_{CBO})T_J$ = typical collector-cutoff current at desired junction temperature.

Stability Factor: The maximum allowable value of the stability factor (S) for prevention of thermal runaway is given by the following expression:

$$S = \frac{1}{2.3\,K\,V_{CE}\,R_{T_{MAX}}\,(I_{CBO_{MAX}})\,T_J}$$

where S = maximum allowable stability factor for prevention of thermal runaway,

V_{CE} = collector-to-emitter volts,

$$K = \frac{\log I_{CBO_1} - \log I_{CBO_2}}{T_{J_1} - T_{J_2}}$$

The constant K is determined from a line drawn tangent to the curve of typical collector-cutoff current at the point representing the maximum expected junction temperature for the application. Then,

T_{J_1} = junction temperature at a point on the tangent line.

T_{J_2} = junction temperature at a second point on the tangent line.

I_{CBO_1} = typical collector-cutoff current corresponding to first point on tangent line.

I_{CBO_2} = typical collector-cutoff current corresponding to second point on tangent line.

Safety Check: For any single transistor circuit using linear circuit elements in the bias network, thermal runaway is prevented by calculating a value of S which is greater than the sum of the dc current transfer ratio or dc current gain (h_{FE}) and unity (i.e., $S > h_{FE} + 1$). In this type of circuit, S can only assume values from 1 to $h_{FE} + 1$.

Distortion: In some cases, a stability factor smaller than that calculated above may be required to reduce signal distortion in the application. This lower stability factor (S_d) is calculated as follows:

$$S_d = \frac{I_c}{100\ \Delta\ I_{CBO}}$$

where S_d = maximum allowable stability factor for limiting allowable percentage change in collector current,

I_c = operating collector current for application,

ΔI_{CBO} = change in collector-cutoff current over the operating temperature range.

(continued on p 48)

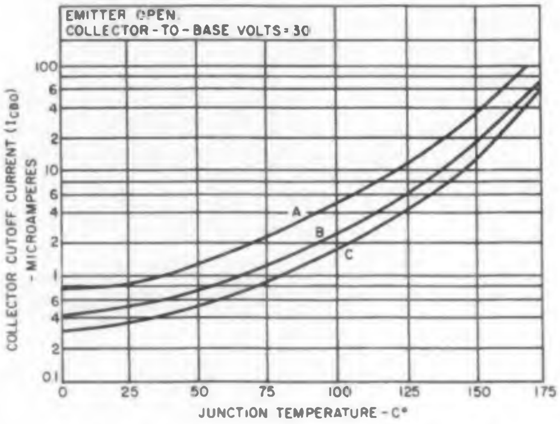
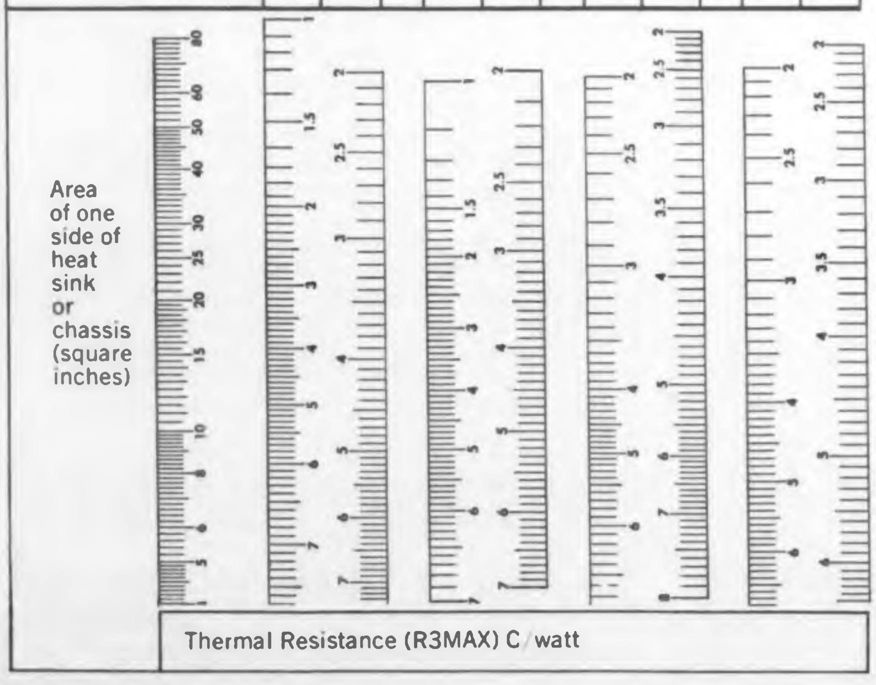


Fig. 2. Typical collector current characteristics of several transistor types. A = 2N1487, 2N1488, 2N1489, 2N1490, 2N1511, 2N1512 and 2N1513. B = 2N1483, 2N1484, 2N1485 and 2N1486. C = 2N1479, 2N1480, 2N1481 and 2N1482.

Table 3. Thermal Resistance As a Function of Heat Sink Dimensions

Material	Copper				Aluminum			
Mounting Position	Horizontal		Vertical		Horizontal		Vertical	
Thickness (Inches)	3/16	3/32	3/16	3/32	3/16	3/32	3/16	3/32



Instructions for use: select the heat sink area at left and draw a horizontal line across the chart from this value. Read the value of Rc max depending on the thickness of the material, type of material and mounting position.

When the stability factor value needed to limit distortion is lower than the stability factor value required to prevent thermal runaway, P_{MAX} must be reduced to assure satisfactory operation.

Example Illustrating Design Procedure

A 2N1482 transistor is to be used in a single-pulse application with a pulse duration (t_0) of 5 x 10^{-4} sec. The dc collector-to-emitter voltage (V_{CE}) is 25 v, the dc emitter current is 45 ma, and the maximum ambient temperature reached is 100 C. The transistor is clamped (making firm contact) to a 0.003-in. thick Teflon-coated glass-cloth insulator which separates the transistor seating surface from a copper heat sink. The heat sink has an area of 9 sq in. and a thickness of 3/16 in., and is horizontally mounted.

1. As shown in Table 1, the first value calculated is $R_{T_{MAX}}$.

$$R_{1_{MAX}} = 35 \text{ C/w (from Table 2)}$$
$$R_{2_{MAX}} = 5.75 \text{ C/w (from Table 3)}$$
$$R_{3_{MAX}} = 1.25 \text{ C/w (from Table 4)}$$
$$R_{T_{MAX}} = R_{1_{MAX}} + R_{2_{MAX}} + R_{3_{MAX}} = 35 + 5.75 + 1.25 = 42 \text{ C/w}$$

2. The next value determined is P_{MAX}.

τ_1 = 1 x 10^{-2} (from Table 2)

$$t_0/\tau_1 = \frac{5 \times 10^{-4}}{1 \times 10^{-2}} = 5 \times 10^{-2}$$

From Fig. 1, at the point t_0/τ_1 = 5 x 10^{-2}, locate the intersection of this point and the duty cycle of 0.0001 (the lowest available duty cycle is used because only a single pulse is to be applied). (P_{MAX}) ($R_{T_{MAX}}$) is approximated as 58 at an ambient temperature of 100 C.

$$P_{MAX} = \frac{P_{MAX}\,R_{T_{MAX}}}{R_{T_{MAX}}} = \frac{58}{42} = 1.38 \text{ w}$$

3. Calculation of stability factor. The maximum junction temperature ($T_{J_{MAX}}$) may be approximated as:

$$T_{J_{MAX}} = T_{A_{MAX}} + R_{T_{MAX}}\,(V_{CE})\,(I_E)$$
$$T_{J_{MAX}} = 100 + (42)\,(25)\,(0.45)$$
$$= 150 \text{ C}$$ (This figure is the maximum junction temperature reached for this application and not the maximum rating for the junction).

Draw a line tangent to curve C, as illustrated in Fig. 2 (2N1482 curve) at 150 C. Select additional points such as 75 C and 125 C and calculate K.

Table 4. Table of Maximum Insulation and Contact Thermal Resistance (R_{3MAX}).

Insulator	Thickness (In.)	R_{3MAX} C/w
No Insulator	—	0.4
Anodized Aluminum	0.016	0.4
Anodized Aluminum	0.125	0.5
Mica	0.002	0.5
Mica	0.004	0.65
Mylar	0.003	1
Glass Cloth (Teflon-coated)	0 003	1.25

Highly conductive silicone lubricant applied between mating surfaces. Note that values may vary among manufacturers.

$$K = \frac{\log I_{CBO_1} - \log I_{CBO_2}}{T_{J_1} - T_{J_2}}$$

$$= \frac{\log 3 - \log 0.15}{125 - 75} = 2.5 \times 10^{-2}$$

$$(I_{CBO_{MAX}})T_J = \frac{(I_{CBO_{MAX}})T_{J_{MAX}}}{(I_{CBO})T_{J_{MAX}}} \cdot (I_{CBO})T_J$$

$$(I_{CBO_{MAX}})T_J = 0.12 \times 10^{-4} \frac{(750)}{60}$$

$$= 1.5 \times 10^{-4} \text{ amp}$$

$$S = \frac{1}{2.3 \cdot K \cdot V_{CE} \cdot R_{T_{MAX}} \cdot (I_{CBO_{MAX}})T_J}$$

$$= \frac{1}{2.3\ (2.6 \times 10^{-2})\ (25)\ (42)\ (1.5 \times 10^{-4})}$$

$$= 100$$

4. Limiting distortion. Since the collector current is 45 ma and the maximum allowable change in collector current is equal to 5 per cent, then:

$$S_d = \frac{I_c}{100\ I_{CBO}}$$

$$= \frac{5\ (45)}{100\ (150 \times 10^{-3} - 20 \times 10^{-3})}$$

$$S_d = 17.3$$

In a case of this type, the stability factor is determined by the distortion limitations rather than by thermal runaway. ■ ■

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Equations Help Determine Operating Points Of Stabilized Transistor Amplifiers

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WHETHER a transistor amplifier circuit, designed from a published schematic, will perform satisfactorily, can be determined by finding the operating points of the transistors. Often, the circuit will not yield the same results as the original designer obtained. This may be due to component variations, or to changes the engineer has had to make in the circuit values.

If the circuit is actually built, the operating points can be easily found. However, if this is not practical, they can be determined, relatively simply, using only the circuit diagram and a set of transistor curves.

Fig. 1a shows a stabilized amplifier circuit that uses both voltage and current feedback. V_{cc}, β, resistance values and transistor characteristics are assumed to be given. From basic circuit theory, the following equations can be written:

$$I_B = I_F - I_A \qquad (1)$$

$$I_E = I_C + I_B \qquad (2)$$

$$I_C = \beta\, I_B \qquad (3)$$

Also:

$$I_F = V_{cb}/R_F \cong V_{ce}/R_F \qquad (4)$$

Since $V_{ce} = V_{cb} + V_{eb}$

and $V_{eb} << V_{ce}$ and V_{cb}

then $V_{ce} \cong V_{cb}$

$$I_A = I_E R_E / R_A \text{ if } V_{eb} \cong 0 \qquad (5)$$

A dc load line is drawn on the characteristic curves, with R_L (dc) $= R_L + R_E$. In an assembled circuit, since the quantity V_{ce} is easiest to measure, the next step is to find equations to solve for V_{ce}. Once V_{ce} and the load line are determined, the values of I_C and I_B can be determined from the characteristics.

The loop equation is written as:

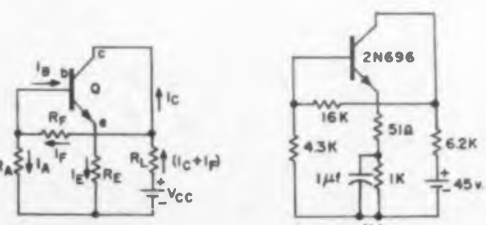
$$V_{cc} = (I_C + I_F)R_L + V_{ce} + I_E R_E \qquad (6)$$

Using Eqs. 2, 3, and 4, Eq. 6 becomes

$$V_{cc}R_F = R_F I_B(\beta R_L + \beta R_E + R_E) + V_{ce}(R_F + R_L) \qquad (7)$$

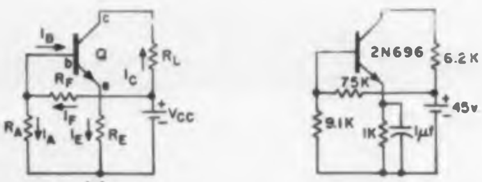
Since $\beta R_L >> \beta R_E + R_E$ and $V_{cc}R_F$ is usually greater than $V_{ce}R_L$, then:

$$V_{cc}R_F \cong I_B(\beta R_L R_F) + V_{ce}R_F \qquad (8)$$



(a) (b)

Fig. 1. *(a)* Equations for determining the operating point are derived for this stabilized amplifier which uses both voltage and current feedback. *(b)* Operating point is determined in text for circuit with the typical values shown.



(a) (b)

Fig. 2. *(a)* Equations are also derived for amplifier which uses current feedback only. *(b)* Operating point is determined for circuit with these typical values.

Substituting Eqs. 4 and 5 into Eq. 1,

$$V_{ce}R_A = I_B\,[R_E R_F(\beta + 1) + R_A R_F] \qquad (9)$$

Equating for I_B, Eqs. 8 and 9 can be solved simultaneously for V_{ce}.

Examples Illustrate Method For Stabilized Amplifier

We will show how the equations are used by applying them to the circuit of Fig. 1b. For this circuit the following information is given:

Q = 2N696 $V_{cc} = 45$ v $\beta = 20$ $R_L = 6.2$ K

$R_E = 1.05$ K $R_A = 4.3$ K $R_F = 16$ K

Substituting these values into Eqs. 8 and 9, yields:

$$45 \times 16 \times 10^3 \cong I_B\,(20 \times 6.2 \times 10^3 \times 16 \times 10^3) + V_{ce} \times 16 \times 10^3 \qquad (8)$$

$$V_{ce}\,4.3 \times 10^3 = I_B\,[1.05 \times 10^3 \times 16 \times 10^3\,(20 + 1) + 4.3 \times 10^3 \times 16 \times 10^3] \qquad (9)$$

$$V_{ce} = 19.9 \text{ v}$$

This circuit was constructed in the laboratory and the measured value of V_{ce} was found to be 18 v.

Fig. 2a shows a circuit that uses current feedback only. The solution here differs from the multiple feedback circuit in that the value of I_B must be found before solving for V_{ce}. Again, from basic circuit theory, the following equation can be written:

$$I_B = I_F - I_A \qquad (10)$$

$$I_E = I_C + I_B \qquad (11)$$

$$I_C = \beta\, I_B \qquad (12)$$

Also:

$$I_F = (V_{cc} - I_E R_E)/R_F \qquad (13)$$

because $I_C R_L = V_{ce} + I_E R_E - V_{cc}$

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and $\quad I_F R_F = V_{bc} - I_c R_L$

if $\quad V_{be} \cong V_{ce}$

then $\quad I_F R_F = V_{cc} - I_E R_E$

$$I_A = I_E R_E / R_A \qquad (14)$$

Again, the first step is to draw a dc load line on the characteristic curves.

From Eqs. 10 to 14:

$$I_B = \frac{V_{cc} R_A}{R_A R_F + R_E R_F + R_L R_A + \beta(R_E R_A + R_E R_F)} \qquad (15)$$

Next,

$$V_{cc} = I_c R_L + V_{ce} + T_E R_E \qquad (16)$$

Using Eqs. 11 and 12, Eq. 16 becomes:

$$V_{cc} = I_B[\beta R_L + R_E(\beta + 1)] + V_{ce} \qquad (17)$$

These equations are now applied to the circuit of Fig. 2b. This circuit has the following parameters:

$Q = 2N696 \; V_{cc} = 45 \text{ v} \; \beta = 20 \; R_L = 6.2 \text{ K}$

$R_E = 1 \text{ K} \; R_A = 9.1 \text{ K} \; R_F = 75 \text{ K}$

Substituting in Eq. 15, yields:

$$I_B = 0.167 \times 10^{-3} \text{ amp} = 0.167 \text{ ma.}$$

Using this value of I_B and substituting in Eq. 17 yields:

$$V_{ce} = 20.7 \text{ v}$$

The circuit was constructed in the laboratory and the measured value of V_{ce} was found to be 22 v.

The methods discussed are not limited to the circuits illustrated. These circuits were chosen because they represent the most complex cases. If any of the circuit elements are omitted, it is an easy matter to simplify the current and loop equations and then proceed with this method of solution.

Note that the calculations are based on the typical value of β given by the manufacturer. Checks can be made using both minimum and maximum values to obtain two additional operating points on the load line. If a transistor meets manufacturer's specifications (and in almost all cases it will) all operating points would lie between the two points determined by these β values. ■ ■

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Tunnel Diode Sine-Wave Oscillators

Part 2

Design equations and several typical examples of tunnel diode oscillators were presented in Part 1 (August 2 issue, pg. 40). In Part 2, a complete analysis of the starting and steady-state conditions are discussed and the derivation of the design equations presented. Also included are details on two practical circuits—a wireless fm microphone and a crystal oscillator.

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ALTHOUGH a complete circuit analysis and design equation derivation are not necessary to design tunnel diode oscillator circuits (Part 1, August 2, pg. 40), details concerning frequency limitations and fine points of operation can be gained by such investigation.

Analysis of the "Series-Type" Oscillator Circuit

To really understand the frequency limitation of the tunnel diode oscillator; both the *starting* and the *steady-state* condition of the circuit must be analyzed.

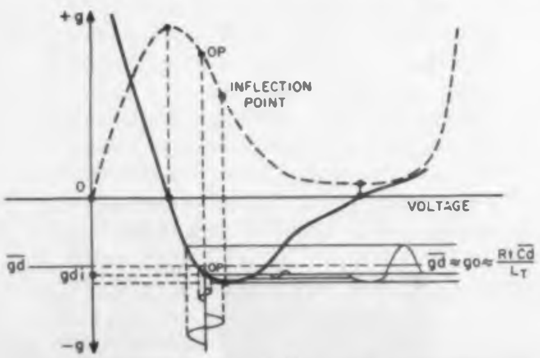


Fig. 1. Variation of g_d (solid curve) superimposed on the controversial $E—I$ tunnel diode characteristic (dotted line). Note that the average value $|\bar{g}_d|$ is smaller than the initial "small signal" value $|g_{di}|$ and decreases further as the signal swing is allowed to increase due to reduction in R_t.

Since the "series" circuit will reach higher frequencies, first consider this circuit. The initial response to a small signal excitation is given by:[3]

$$S^2 L C_{di} + S(R_t C_{di} - L|g_{di}|) + (1 - R_t|g_{di}|) = 0 \qquad (10)$$

where g_{di} and C_{di} are the initial small signal values of g_d and C_D respectively and R_t is the total real part of the circuit impedance. Eq. 10 can be solved for S:

$$S_{1,2} = \sigma_1 \pm j\omega_1$$

$$S_{1,2} = -\frac{1}{2}\left(\frac{R_t}{L_T} - \frac{g_{di}}{C_{di}}\right) \pm \left[\frac{1}{4}\left(\frac{R_t}{L_T} - \frac{g_{di}}{C_{di}}\right)^2 - \frac{1 - R_t|g_{di}|}{L_T C_{di}}\right]^{1/2} \qquad (11)$$

a growing solution can be obtained if $\sigma_1 > 0$. This condition is satisfied if either or both of the following inequalities hold:

$$L_T > \frac{R_t C_{di}}{|g_{di}|} \qquad (12a)$$

$$R_t > |R_{di}| \text{ where } |R_{di}| = \frac{1}{|g_{di}|} \qquad (12b)$$

For sinusoidal growth, condition 12a holds and

$$\frac{1}{L_T C_{di}} > \frac{1}{4}\left(\frac{R_t}{L_T} + \frac{g_{di}}{C_{di}}\right)^2 \qquad (13)$$

The initial frequency of oscillation ω_i is given by:

$$\omega_i = \sqrt{\frac{1}{4}\left(\frac{R_t}{L_T} - \frac{|g_{di}|}{C_{di}}\right)^2 - \left(\frac{1 - R_t|g_{di}|}{L_T C_{di}}\right)} > 0 \qquad (14)$$

or f_i

$$= \frac{1}{2\pi}\sqrt{\frac{1}{4}\left(\frac{R_t}{L_T} - \frac{|g_{di}|}{C_{di}}\right)^2 - \left(\frac{1 - R_t|g_{di}|}{L_T C_{di}}\right)} > 0$$

The steady-state frequency ω_s differs however, from ω_i because of the nonlinearities of the negative conductance characteristics of the diode, where

$$\omega_s = \sqrt{\frac{1}{(L_s + L_x)\,\bar{C}_d} - \frac{\bar{g}_d^2}{\bar{C}_d^2}}$$

$$\omega_s = \sqrt{\frac{1}{L_T\,\bar{C}_d} - \frac{R_t^2}{L_T^2}} \qquad (15)$$

$$f_s = \frac{1}{2\pi}\sqrt{\frac{1}{L_T\,\bar{C}_d} - \frac{R_t^2}{L_T^2}}$$

where $\bar{R}_d$ and $\bar{C}_d$ are average values of R_d and C_d and $R_t = \dfrac{L\,\bar{g}_d}{\bar{C}_d}$ (16)

In other words the starting frequency is dependent on the small signal parameters, while the steady-state frequency differs from the starting frequency and is determined by time average values of g_d and C_d.

It should also be noted that in order to start to oscillate, σ_1 should be positive,

$$\sigma_1 = -\frac{1}{2}\left(\frac{|g_{di}|}{C_{di}} + \frac{R_t}{L_T}\right) > 0 \qquad (17)$$

and the oscillations should build up in the fairly linear negative resistance region until it spreads into the positive resistance regions of the nonlinear characteristic. In the positive resistance regions, g_d is positive and σ_1 becomes negative; hence damping takes place and the amplitude of the oscillation will reach a limiting "steady-state" value.

As the oscillation passes through the nonlinear region, harmonics are generated and relaxation oscillations can take place. However, if σ_1 is a small positive value, the oscillation build up is small and a small decrease in negative conductance can make $\sigma_1 = 0$, thus making the oscillation almost sinusoidal.

For steady state oscillations:

$$\frac{\bar{g}_d}{\bar{C}_d} + \frac{R_t}{L_T} = 0$$

which restates Eq. 16.
Graphically this is shown in Fig. 1.
g vs time is equal to:

$$g_d(t) = g_0 + g_1 \cos \omega t + 2g_2 \cos 2\omega t + \ldots\ldots$$

If we assume (to a first approximation) that $\bar{g}_d = g_0 =$ an average steady-state conductance, this value is determined by:

$$g_0 = \bar{g}_d = \frac{R_t \bar{C}_d}{L_T}$$

As $R_t \bar{C}_d / L_T$ is made smaller, the average negative conductance becomes smaller and the swing of g larger and hence the oscillation becomes nonsinusoidal.

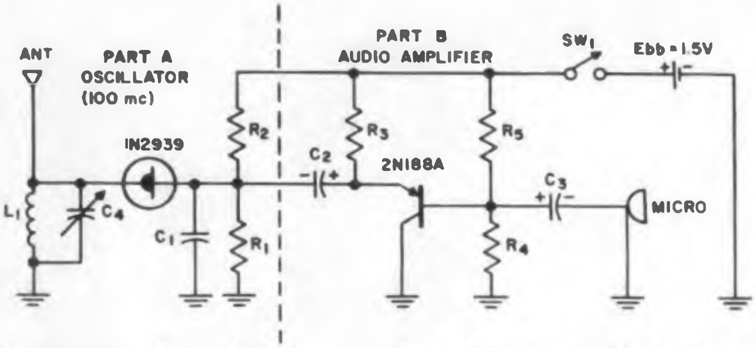
Conversely, to produce sinusoidal oscillations the average value of $g_d(|\bar{g}_d|)$ must be close to the initial value (g_{di}) hence:

R_t should be only slightly smaller than $g_{di} L_T / C_D$.

The highest frequency that can be attained by any tunnel diode oscillator circuit is the resistive cut-off frequency:

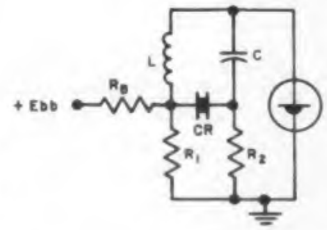
$$f_{ro} = \frac{g_d}{2\pi C}\sqrt{\frac{1}{R_s |g_d|} - 1}$$

since above this frequency there is no real part of the negative resistance left and the device becomes passive (at f_{ro}). However to oscillate, the imaginary part of $|Y|$, must be brought to zero also. The highest frequency



R_1	22Ω - 1/2 WATT	C_1	.001 CERAMIC DISC	L_1	6T NO 16 WIRE - 3/8" DIAM OPEN AIR (L ≈ 2μh)
R_2	270Ω - 1/2 WATT	C_2	50 μfd ELECTROLYTIC	ANT	ANTENNA 4 3/4" LENGTH NO 14 WIRE
R_3	470Ω - 1/2 WATT	C_3	5 μfd ELECTROLYTIC	MICRO	MICROPHONE "SHURE BROTHERS" MODEL NO. 420 OR EQUIV
R_4	10KΩ - 1/2 WATT	C_4	1.5-5.0 μμfd AIR VARIABLE		
R_5	10KΩ - 1/2 WATT				

Fig. 2. A simple micropower 88-108 mc fm transmitter. Part *A* is the oscillator whose frequency is determined by L_1C_4. Part *B* is the audio section which modulates the oscillator by variation of the tunnel diode bias.



CRYSTAL CONTROLLED OSCILLATOR

Fig. 3. A variation in tunnel diode oscillators is this crystal-controlled stage.

at which this can be achieved is the so-called "self resonant frequency".

$$f_{so} = \frac{1}{2\pi}\sqrt{\frac{1}{L_s C} - \frac{g_d^2}{C^2}}$$

where C is the tunnel diode capacity, L_s the inductance of the diode, its package and its leads (if any). For large signal "steady-state" oscillations; however, g_d is not the value given as the small signal parameter (g_{di}) but an average value:

$$g_d = g_0 + g_1 \cos \omega t + 2\, g_2 \cos 2\,\omega t \,\ldots\ldots\ldots$$

determined by $R_t\,\bar{C}_d/L_s$.

To increase the operating frequency to the limit, R_t becomes R_s and $L_T = L_s$ thus the smallest negative conductance becomes:

$$\bar{g}_{d_{min}} = \frac{R_s\,\bar{C}_L}{L_s}$$

The highest frequency of oscillation (without trying to tune out the internal minimum value of L_s) is then given by:

$$f_{osc_{max}} = \frac{1}{2\pi}\sqrt{\frac{1}{L_s\, C_d} - \frac{R_s^2}{L_s^2}}$$

[Note that at this frequency all the power is dissipated in the series resistance R_s and no power is available from the diode.]

and the general expression for the steady state oscillator frequency of the series circuit can be written as:

$$f_{osc} = \frac{1}{2\pi}\sqrt{\frac{1}{L_T\, C_D} - \frac{R_t^2}{L_T}} \qquad (18)$$

For a given inductance this frequency can only be increased by reducing the tunnel diode capacitance for a given conductance (hence increasing g_d/C ratio), or reducing R_t.

Hence for any given diode, operating near the inflection point (point of maximum $-g$) R_t is the only parameter in the circuit that can be used to further increase the oscillating "steady-state" frequency. If we go back to the "steady-state" condition to Eq. 16, where:

$$R_t = \frac{L_T\,\bar{g}_d}{C_d}$$

we note that reducing R_t forces the average negative conductance to decrease. The maximum available sinusoidal power from the diode can be approximated as:

$$P_m = \left(\frac{V_v - V_p}{2\sqrt{2}}\right)^2 \cdot \bar{g}_d$$

Hence as we increase the oscillator frequency, the maximum available power output is reduced, since the voltage swing will be less than $V_v - V_p$, the average value of the negative conductance is decreased and finally R_t is decreased.

Two Practical Tunnel Diode Oscillator Circuits

FM Transmitter: A practical application of the "series-parallel" oscillator circuit is demonstrated in Fig. 2 by a simple micropower fm transmitter.

Operation may be best explained by separating the circuit into two portions. Part *A* is the basic "series-parallel" tunnel diode oscillator whose frequency is primarily determined by the resonant circuit in the cathode. Resistors R_1 and R_2 provide a stable low impedance anode voltage of approximately 150 mv. Capacitor C_1 is the rf bypass for the anode.

(continued on facing page)

Part B is a transistor emitter follower stage to amplify the audio signal from the microphone. The amplified audio is fed through capacitor C_2 to the anode of the tunnel diode. Fm modulation is accomplished by the audio signal instantaneously changing the anode bias. Since di/dv is not linear in the negative resistance region, the negative conductance changes with bias. As can be seen from the self-resonant frequency equation, f_{ro} is a function of $-g_d$ and therefore the resonance of the circuit is affected. Fm deviations of ± 75 kc are readily obtainable with this type of circuit.

The transmitter shown in Fig. 2 has been successfully used as a wireless portable microphone. Its great advantage is that it allows complete mobility on the part of the speaker, and, of course, has no wires or cords. When used with an average fm receiver having a sensitivity of 10 μv, an operating range well in excess of 100 feet can be obtained.

Crystal Controlled Oscillator: The circuit in Fig. 3 works basically as per the previous description with the exception of the criteria for R_t. R_1 and R_2 are identical and are chosen to be about twice the value required for R_t. As a result, oscillations are not possible "off resonance". At resonance however, the crystal becomes a short circuit and R_1 is in parallel with R_2, essentially halving R_t. This new value of R_t permits the circuit to oscillate freely at a frequency accurately governed by the crystal. ■ ■

Acknowledgments

The author is greatful to Chong Wong Lee for his important contribution to this project and to Dr. C. S. Kim and U. S. Davidsohn for many helpful suggestions.

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Equation Derivation

"Series-Parallel" Oscillator Circuit

Looking only at the series combination of the tunnel diode and the source impedance shown in Fig. 2:

$$Z_1 = R + \frac{1}{j\omega C_1 - g_d} = \frac{(1 - R \cdot g_d) + j\omega RC_1}{j\omega C_1 - g_d} \qquad (19)$$

where:

$$R = \frac{R_1 \text{ x } R_2}{R_1 + R_2} + R_s$$

The admittance Y_1 is thus equal to

$$Y_1 = \frac{1}{Z_1} = \frac{j\omega C_1 - g_d}{(1 - R \cdot g_d) + j\omega RC_1}$$

$$= \frac{-g_d(1 - R \cdot g_d) + \omega^2 RC_1^2 + j\omega[C_1 - R \cdot g_d C_1 + R g_d C_1]}{(1 - Rg_d)^2 + \omega^2 R^2 C_1^2}$$

$$Y_1 = \frac{\omega^2 RC_1^2 - g_d(1 - R \cdot g_d)}{(1 - Rg_d)^2 + \omega^2 R^2 C_1^2} + \frac{j\omega C_1}{(1 - R \cdot g_d)^2 + \omega^2 RC_1^2} \qquad (20)$$

The total admittance Y_T is equal to $Y_1 + Y_2$.

$$Y_T = \frac{\omega^2 RC_1^2 - g_d(1 - R \cdot g_d)}{(1 - R \cdot g_d)^2 + \omega^2 R^2 C_1^2} + \frac{j\omega C_1}{(1 - R \cdot g_d)^2 + \omega^2 R^2 C_1^2} - \frac{j(1 - \omega^2 LC)}{\omega L}$$

For sinusoidal oscillations then, the conditions are (21)

1) $R_e\,[Y_T] = 0$ (22a)

2) $I_m\,[Y_T] = 0$ (22b)

For condition 22a, $R_e\,[Y_T] = 0$, $\omega^2 RC_1^2$ must be made equal to $g_d\,(1 - R \cdot g_d)$ in which case

$$\omega^2 = \frac{g_d(1 - R \cdot g_d)}{RC_1^2} \qquad (23)$$

hence $(1 - R \cdot g_d)^2 + \omega^2 R^2 C_1^2 = (1 - R \cdot g_d)^2 + R \cdot g_d - R^2 g_d^2 = 1 - R \cdot g_d$ (24)

Then for condition 22b, $I_m[Y_T] = 0$, rewriting Eq. 23 and adding LC_1 on both sides we obtain:

$$LC_1 g_d = RC_1^2 - LC \cdot g_d(1 - R \cdot g_d)$$

or (25)

$$RC_1^2 = Lg_d[C\,(1 - Rg_d)\,C_1]$$

Rewriting the frequency determining equation (per Eq. 23)

$$\omega^2 = \frac{1 - R \cdot g_d}{L[C(1 - Rg_d) + C_1]} = \frac{1}{L\left[C + \frac{C_1}{1 - R \cdot g_d}\right]} \qquad (26)$$

Eq. 26 shows the relationship of frequency to its determining components as

$$f_o = \frac{1}{2\pi}\sqrt{\frac{1}{L\left(C + \frac{C_1}{1 - R \cdot g_d}\right)}} \qquad (27)$$

To establish the effect of g_d on the frequency,

$$1 - R \cdot g_d = \frac{\omega^2 C_1^2}{\omega^2 C_1^2 + g_d^2}$$

which when substituted into Eq. 26 becomes:

$$\omega^2 = \frac{1}{L\left[C + \frac{(\omega^2 C_1^2 + g_d)^2 C_1}{\omega^2 C_1^2}\right]} = \frac{\omega^2 C_1}{L(\omega^2 CC_1 + \omega^2 C_1^2 + g_d^2}$$

$$\therefore\ \omega^2 LC_1(C + C_1) = C_1 - Lg_d^2$$

or

$$\omega^2 = \frac{1}{L(C + C_1)} - \frac{g_d^2}{C_1(C + C_1)}$$

$$\text{Hence } f = \frac{1}{2\pi}\sqrt{\frac{1}{L(C + C_1)} - \frac{g_d^2}{C_1(C + C_1)}} \qquad (28)$$

Summarizing the above analysis, it follows that for stable, sinusoidal oscillations, R_T must be made equal to (or slightly smaller than)

$$R_T = \frac{g_d}{\omega^2 C_1^2 + g_d^2}$$

and the operating frequency is

$$f_o = \frac{1}{2\pi}\sqrt{\frac{1}{L(C + C_1)} - \frac{g_d^2}{C_1(C + C_1)}}$$

It should be pointed out that the diode inductance l_s and resistance R_s have been neglected in this analysis as they will, in general, be small compared to the external lumped constants. At higher frequencies, these parameters cannot be neglected without introducing serious errors.


RAYTHEON
RCA
STROMBERG-CARLSON
ROYAL McBEE
GENERAL PRECISION
Soroban
IBM
PHILCO
Remington Rand
Univac
The Bendix Corporation
National
General Mills
SANGAMO

PRODUCT FEATURE

Low-TC Glass Delay Lines Offer High-Speed Serial Memory

TEMPERATURE - coefficients - of - delay as low as a remarkable 1 ppm per deg C are featured in a new series of glass ultrasonic delay lines. These lines, available with delays up to 150 μsec, can operate with counting rates from 3 to 20 mc.

The new delay lines, manufactured by the Electronic Components Dept. of Corning Glass Works, in Bradford, Pa., are made of Corning's Code 8875 glass which offers the unusually low temperature coefficient. This "zero TC" glass line can accept bit lengths as short as 20 nsec.

The first delay line in the new series, a 50-μsec line, will have a bandwidth of 20 or 30 mc. With its center frequency of about 25 or 30 mc, the line provides a bandwidth of almost 100 per cent—about the same as that available with magnetostrictive wire lines. Quartz or glass lines formerly available rarely had bandwidths exceeding 50 per cent.

Currently, the chief difficulty with the new glass delay line is that it is restricted to delays of less than 150 μsec, but Corning's engineers are working towards delays as high as

Quartz-Line Memory Offers 10-Mc Counting Rate

NO LARGER than a package of cigarettes, a new, complete delay-line memory offers counting rates as high as 10 mc—almost an order of magnitude higher than previously available with acoustic delay lines. Using a special quartz as the delay medium, the line offers a low temperature-coefficient-of-delay of ±30 ppm per deg C at normal operating temperatures.

Manufactured by Andersen Laboratories, Inc., 501 New Park Ave., West Hartford, Conn., the memory

500 μsec. For the shorter lines, they already have effective compensation for signal corruption.

Ceramic transducers that can operate at up to 15-mc bit rates are available for the new glass lines. Corning's engineers feel that the ceramic transducers offer far less signal attenuation than do quartz transducers.

The engineers are working towards the use of multiple transducers, of either quartz or ceramic. Their intention is to simulate the multi-channel capabilities of magnetic drums and disk files. They are aiming for as many as six or eight channels.

Prototype quantities of the "zero TC" lines will cost \$300 to \$500. Delivery normally starts at six weeks but some lines are available off the shelf. Quantity prices will be lower and, on a per-bit basis, should make the glass lines competitive with magnetostrictive wire lines.

For more information on these glass ultrasonic delay lines, turn to the Reader-Service Card and circle 251.

See at WESCON Booth 1820.

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can store as many as 65 bits. An unusual feature of this memory is that input pulses to the line go directly to quartz piezoelectric transducers; there is no carrier frequency required.

The memories are available with delays ranging from 1 or 2 to about 25 μsec. Bit lengths, which depend, of course, on the counting rate used, can be as small as 50 nsec.

The 10-mc quartz memories are available to meet applicable military specifications. The company is currently working on advanced acoustic lines with counting rates as high as 20 mc.

Prototype units of the 10-mc memories cost roughly \$1,000 each, but production quantities are substantially cheaper. The memories are available within 30 to 60 days.

For more information on these very fast, acoustic memories, turn to the Reader-Service Card and circle 252.

PRODUCT FEATURE

Storage Scope Has Preview Target

A STORAGE scope with a preview target makes it possible to set up a display without cluttering the target storage area prior to freezing the data for comparison. The preview target may also be used for conventional oscilloscope applications. The storage area may be erased in 30 to 45 sec.

Dual-trace storage scope and X-Y recorder, type 1220, is manufactured by the Analab Instrument Corp., 30 Canfield Road, Cedar Grove, N. J. The storage tube incorporated in the scope is rectangular and has a target area of 8 x 10 cm. The tube is electrostatically focused and deflected. This makes it possible to store repetitive signals up to 100 kc and single transients to 10 kc. The resolution of the tube is claimed to be as good as, or better than, that obtained with conventional crt's or "charged-mesh" type storage tubes.

The tube operates at 10 kv and delivers 500 μa peak beam current to the screen. New pulsed-grid techniques used make it possible to deliver these high voltages and currents with an extremely small power supply according to Morton G. Scheraga, president of the firm.

The raster display of either 1, 5 or 10 lines makes it possible to monitor data with slowest sweeps for periods up to 20 min. The raster display operates for either single or dual-trace presentations. It operates line by line, manually or automatically, and uses a beam-switching tube. With continuous erase capabilities the raster display can run automatically and continuously, erasing and storing indefinitely, for long periods of visually monitoring data.

The type 1220 scope with a type 700 plug-in makes possible dual-trace presentations with a maximum sensitivity of 100 μv per cm and a bandwidth of dc to 100 kc. For accurate phase measurement, an extra trigger amplifier is included for external synchronization from a reference signal as low as 100 μv. This same amplifier may be used for increasing the sensitivity of single trace displays to 10 μv per cm with bandwidths from 5 cps to 10 kc. With null readout time dial, the scope can be used as an accurate phasemeter to read phase angle directly in degrees to 2 per cent accuracy. Calibrated sweeps are from 50 sec to 10 μsec, full scale. With balanced amplifiers common mode rejection is better than 20,000 to 1 at 60 cps.

Dual-trace or single-trace plots may be made against the sweep time base, or one channel may be plotted against the other for X-Y stored presentations; or dual-trace X-Y plots against a third external signal may be made.

The type 1220 dual-trace storage scope and X-Y recorder is available in rack-mountable form or for bench and movable cart use. It may be used with all five presently available and future Analab plug-ins. The rack-mountable model is approximately \$1,400; plug-ins range from \$37.50 to \$360 each. Delivery can be made four months after the instrument is shown for the first time at WESCON, Booth 1218.

For further information on this storage scope and X-Y recorder, turn to the Reader-Service Card and circle 253.

NEW PRODUCTS

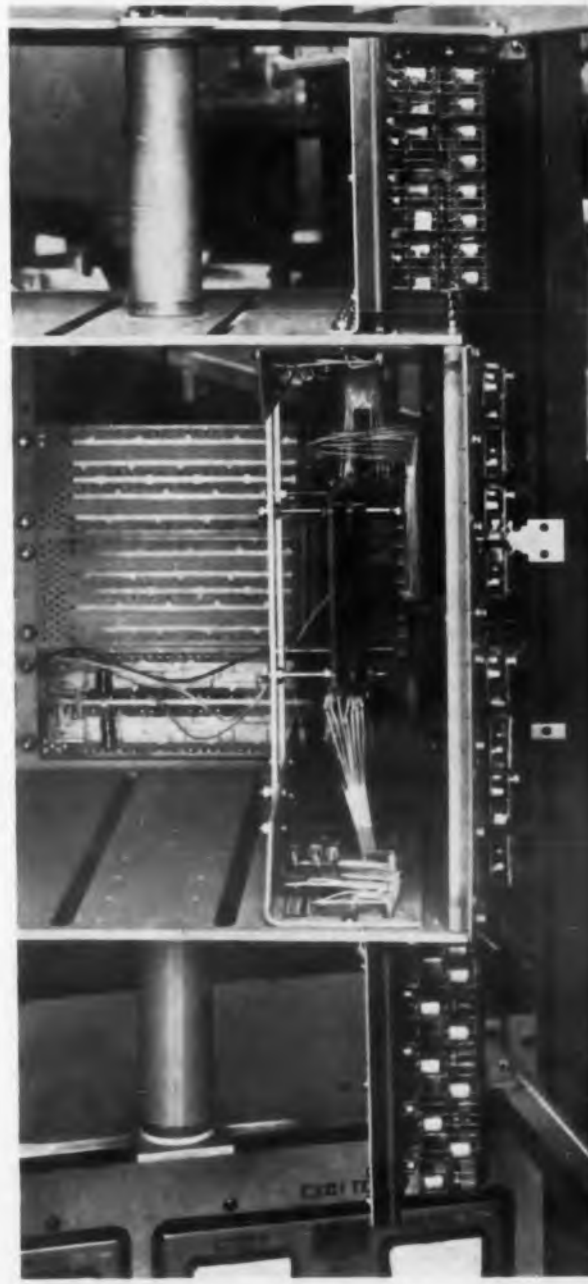
Covering all new products generally specified by engineers designing electronic original equipment. Use the Reader-Service Card for more information on any product. Merely circle number corresponding to that appearing at the top of each description.

Improved Coaxial Connectors Are Compatible With Those In Use **257**

Retaining the hermaphrodite features of the standard, nonlocking type 874 coaxial connector, the improved version is fully compatible with the nonlocking type already in use. A threaded sleeve has been added to the basic design of the connector to permit a rigid and semi-permanent mechanical connection and retain quick connect-disconnect capabilities. Minor revisions in dimensions and a rigorous statistical quality control program have lowered vswr, reduced leakage by some 30 to 40 db, improved repeatability and extended the range of satisfactory performance to 7 Gc.

General Radio Co., Dept. ED, West Concord, Mass.

***P&A:** from $1.60 to $4 ea; immediate.*



Modular Memory Has 1-μsec Access Time **258**

Solid-state magnetic core array system of this modular memory has a full read-write cycle time of 1 μsec, with access time of 0.4 μsec. Standard memory has a capacity of up to 1,024 words, each 50 bits in length. Power supplied need only be regulated to ±5%. Full read driving current of 360 ma ensures low power dissipation. Ambient temperature range is 0 to +55 C.

Daystrom, Inc., Military Electronics Div., Dept. ED, Archibald, Pa.

***Availability:** 120 days.*

Binary-to-Numeric Decoder Drives Electroluminescent Display 256

Switching matrix type SM113 is a neon-photoconductive binary-to-numeric decoder which accepts binary-coded decimal signals and operates a seven-segment e-l numeric display. A pulse input of 5 to 10 μsec will fire the neon lamps; input may then be removed, and the SM113 will continue to provide power to the display so that the number remains until erased.

Picture Tube Operations, Electronic Tube Div., Sylvania Electric Products Inc., Dept. ED, Seneca Falls, N. Y.
***Availability:** after WESCON.*
See at Show Booth 3302-12.

Magnet Material Produces 7.5 x 10[6] Gauss-Oersteds 255

A new magnet material known as Alnicus produces a nominal energy product of 7,500,000 gauss-oersteds. A process which permits 100% grain orientation through the entire cross section of magnet castings facilitates unidirectional orientation of Alnicus' magnetic properties. Two grades are available: USM75 has a nominal energy product (BH) of 7.5 million gauss-oersteds, a residual induction (BR) of 13,900 gauss, a coercive force (HC) of 750 oersteds; USM65 has a BH of 6.5 million, a BR of 13,500, and an HC of 650. The weight of both materials is 0.265 lb per cu in., mechanical properties are hard-brittle.

U.S. Magnet and Alloy Corp., Dept. ED, 266 Glenwood Ave., Bloomfield, N. J.
***Availability:** from stock and made to customer specifications.*

Heat Sink 394

Natural-convection heat sink model 2505 has a wide-space center channel which provides a smooth mounting surface for semiconductors without additional machining. The hole pattern accommodates all common transistor cases. Thermal resistance is 1.9 deg C per w at 30 w.

Astro Dynamics, Inc., Dept. ED, Second Ave., Northwest Industrial Park, Burlington, Mass.
P&A: *$0.75 up; stock.*

Marking Ink 411

For electronic components. Series M Wornowink marking ink adheres to glass, metal and thermosetting plastic surfaces and resists abrasion, solvents, chemicals, acids and alkakis. It is supplied in the ten RETMA colors and will meet MIL specs.

Wornow Process Paint Co., Dept. ED, 1218 Long Beach Ave., Los Angeles 21, Calif.

Portable Cooling Package 392

For factory test and checkout of guidance and similar systems, the model 141 cooling package delivers a coolant flow variable between 0.2 and 1.6 gal per min and maintains a temperature setting from 32 to 80 F within ± 1 degree. Cooling load is variable from 100 to 2,700 w. Unit includes automatic and manual controls and measures 36 x 48 x 48 in.

Advanced Structures Div., Telecomputing Corp., Dept. ED, P. O. Box 150, Monrovia, Calif.

Electron-Beam Welder 398

Complete electron-beam welder system, called Mark VI, includes electron gun, vacuum chamber, mechanical roughing and diffusion pumps, power supply and console. Spot diameter can be controlled from 0.010 to 0.500 in. Focal length is 4 to 12 in.

Alloyd Electronics Corp., Dept. ED, 37 Cambridge Parkway, Cambridge 42, Mass.

Line Amplifier 402

Automatic level control line amplifier, model LRA-40C, has a 54-to 88-mc bandwidth. Gain at channel 6 is 40 db. Recommended input level is +9 dbmv. Noise figure is 7.5 db. Frequency response is ±0.25 db. Input and output impedance are 75 ohms. Tubes are rated at 10,000-hr lifetime.

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

Pulse Counter 388

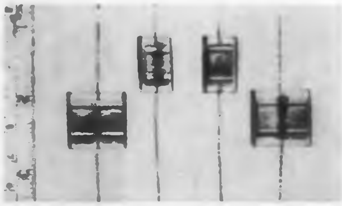
Bi-directional pulse counter, series DZ, operates at 25 pulses per sec. Counter either adds or subtracts, according to instructions, and indicates numbers below zero by a negative sign. A set of electrical contacts closes when counter reaches zero; these may be used for control purposes. Device has six digits, each 3/16 in. high, and push-button zero reset.

Presin Co., Inc., Dept. ED, 2014 Broadway, Santa Monica, Calif.

***P&A:** $62.50; from stock.*

◀ CIRCLE 58 ON READER-SERVICE CARD

Glass Capacitors 541



Moisture-proof, fusion-sealed glass capacitors meet military requirements for life and environmental testing. The CYFM-20 has capacitance range from 560 to 3,300 pf at 500 v and 3,600 to 5,100 pf at 300 v. Capacitance range of the CYFM-30 is from 3,600 to 6,200 pf at 500 v, and from 6,800 to 10,000 pf at 300 v.

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

Price: *CYFM-20, 1,000 pf, ±10%, $0.52 ea, 1,000.*

See at Show Booth 1820-22.

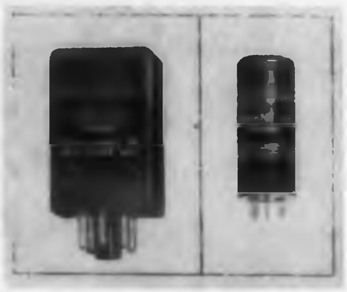
Multiple-Frequency Generator 554

Up to 30 outputs ranging from 5 cps to 100 kc are provided by the model 878 precision multiple-frequency generator. Amplitude is adjustable from 0 to 10 v peak to peak, stable within 1% over 24 hr. Distortion is less than 1% at all frequencies. Modular oscillators are contained in an aluminum case measuring 21 x 17 x 7-1/2 in.

Chalco Engineering Co., Dept. ED, 15126 S. Broadway, Gardena, Calif.

See at Show Booth 2703.

Resonant Relays 535



Tuning-fork resonant relays are made for selective calling or remote control systems. Their vibrating reeds are activated only at their resonant frequency, from 50 to 1,565 cps. Also available are tuning-fork oscillator stabilizers, made to stabilize the oscillators which generate the tones to activate the resonant relays.

Stevens-Arnold, Inc., Dept. ED, 7 Elkins St., South Boston 27, Mass.

Price: *Relays, $15.60; stabilizers, $23.60.*

See at Show Both 2522-24.

Panel Meters 537

These 3-1/2-in. panel meters, model 1931, are available as ammeters, milliammeters, microammeters, and voltmeters. Instruments accurate to 2% have lance-type pointers and conventional scales; models with 1% accuracy have a knife-edge pointer and mirror scale. Units have either shielded or unshielded mechanisms.

Daystrom, Inc., Weston Instrument Div., Dept. ED, 614 Frelinghuysen Ave., Newark 12, N. J.

See at Show Booth 2907-21.

Miniature Integrated Circuits 558

A gate and half-shift register have bodies resembling transistors, with eight leads. Called Micrologic elements, the devices consist of transistors and resistors diffused into a silicon chip. Units dissipate 30 mw and operate from −55 to +125 C.

Fairchild Semiconductor, Dept. ED, 545 Whisman Road, Mountain View, Calif.

Price: *$120 each in small quantities.*

See at Show Booth 814-16.

Function Assembly 538

Potentiometer clutch cluster assembly obtains output information following a prescribed highly nonlinear mathematical function. Four clutch-brake ganged potentiometer assemblies are coupled to a common drive shaft. Full potentiometer rotation is accomplished by 10 turns of the drive shaft. Assembly is shielded against environments.

Technology Instrument Corp., Dept. ED, 531 Main St., Acton, Mass.

See at Show Booth 1506-08.

Power Resistors 546

Noninductive precision power resistors are available rated from 1 to 40,000 ohms with tolerances from 0.05% to 5%. Power ratings are 1/2 w through 10 w. Series N resistors have axial leads, and series NR resistors have radial leads. Units operate to 350 C and meet MIL-R-26 specifications for abrasion, salt-spray, and humidity.

Omtronics Mfg. Co., Dept. ED, P. O. Box 1419, Peony Park Station, Omaha 14, Neb.

P&A: *$0.60 to $1.75; one to three weeks.*

See at Show Booth 4216.

Strain Gage Transducer 559

Available from 0-30 to 0-5,000 psi, this semiconductor strain gage transducer handles overpressures of 300% and has a 4-v dc output. Temperature error is less than 2% per 100 F. Linearity is 0.5%; hysteresis is 0.2%; total error band is 1%. Unit measures 2-1/2 in. in diameter and 1-3/4 in. long, weighs less than 1 lb, and operates from 0 to 250 F.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

See at Show Booth 2307-11.

Transistor Tester 552

Continuous monitoring of applied voltage and leakage current is provided by the model STC-1001-P transistor tester. Emitter current is variable from 1 to 30 ma dc. Applied voltage is up to 230 v dc, and leakage current up to 10 ma is measured. Unit can measure ac gain of transistors, leakage of capacitors, and reverse characteristics of Zener and rectifier diodes.

Plug-In Instruments, Inc., Dept. ED, 1416 Lebanon Road, Nashville 10, Tenn.

Price: *$150.00*

See at Show Booth 4505.

DC Power Supply 539

Energy integrating dc power supplies, series PI-9000, use a switching circuit to take energy from the ac line in discrete pulses. A fast-response time regulator system senses the load requirements and its own internal loses to control input power by varying pulse amplitude. Typical specifications are: output, 2 to 28 v, 0 to 2 amp dc; regulation, 0.5%; ripple, less than 20 mv.

Power Designs, Inc., Dept. ED, 1700 Shames Drive, Westbury, N. Y.

See at Show Booth 2705.

Coaxial Directional Couplers 544

Operating from 0.3 to 11 Gc, the series 430 coaxial directional couplers have 3-to-1 frequency range operation. Providing 10 to 30 db coupling, with minimum directivity of 15 to 20 db, units are rated from 50 to 1,000 w forward power, 10 kw peak.

PRD Electronics, Inc., Dept. ED, 202 Tillary St., Brooklyn 1, N. Y.

See at Show Booth 2109-10.

Transistor Test Sockets 551

With reversible contacts which double the life of the sockets, these transistor test sockets withstand about two million insertions. Type TS-187 is rated at 300 C; type TS-187A is rated at 1,500 C. Sockets have guide holes to direct transistor leads to the contacts.

Atlantis Electronics Corp., Dept. ED, P. O. Box 451, Garland, Tex.

See at Show Booth 4508.

NEW PRODUCTS

Temperature-Humidity Chamber 397

Produces 20% to 95% RH +5% at dry-bulb temperatures of 35 to 200 F, limited by a 35 F dew-point temperature. Model TH-100 temperature-humidity chamber, completely self-contained, requires a 5-gal distilled water bottle and an input of 110 v, single-phase, 60 cps. Sizes are 8, 27 and 64 cu ft.

Wyle Laboratories, Dept. ED, El Segundo, Calif.

Trimmer Potentiometers 403

Subminiature trimmer potentiometer, series 027, resists moisture, vibration, shock, and acceleration. Measuring 0.25 in. in diameter and 1.325 in. long, the device is rated at 1/4 w, and has resistances of 3, 5, 10, 15, or 17 ohms. Unit has 40-turn screwdriver adjustment. Temperature range is −55 to +125 C. MIL specs are met.

Con Elco Div., Edcliff Instruments, Dept. ED, 1711 S. Mountain Ave., Monrovia, Calif.

AC Solenoid 390

No cycle chatter remains with this 400-cps ac solenoid. A relief valve mechanism opens at 21 psig and has zero leakage from 0 to 15 psig. Unit has a force of 1.3 lb, a stroke of 0.025 in., measures about 1.375 x 1.453 in. and weighs 0.34 lb. Device operates continuously at 225 F ambient, and meets MIL-S-4040 specifications.

Rocker Solenoid Co., Dept. ED, 140 N. Marine Ave., Wilmington, Calif.

◄ CIRCLE 61 ON READER-SERVICE CARD

Decommutator 387

For data monitoring at telemetry stations, the model 5500 decommutator is a portable unit with a 90-channel capacity. The instrument selects and reads data from any single channel of standard pam, nrz, or pdm telemetry signals. Unit measures 7 x 14-1/8 x 19 in., and is made for rack or cabinet mounting.

The Ralph M. Parsons Co., Electronics Div., Dept. ED, 151 S. DeLacey Ave., Pasadena, Calif.

Teflon Sheet 412

Extruded Teflon sheet is available in sizes from 1/4 to 1 in. thick by 6 in. wide and up to 10 ft long. The material is also made in continuous lengths. Widths up to 24 in. will be made available.

Tri-Point Industries, Inc., Dept. ED, Albertson, N. Y.

Protective Compounds 409

Motor-stator epoxy compounds provide protection against moisture, dirt, abrasion, impact and chemicals. Type 10-063 motor-casting compound and type 10-062 motor butter are two-component, flexible, and cure at room temperature in 2 to 4 hr.

Hysol Corp., Dept. ED, Olean, N. Y.

Strain Indicator 399

For battery or ac operation, model PS7-LT transistorized strain indicator permits direct reading by means of integral controls. Multipoint and long-term strain measurements are possible. The output is suitable for oscilloscope, oscillograph or pen-type recorder.

Metrix, Inc., Dept. ED, P. O. Box 683, Walnut Creek, Calif.

Polystyrene Capacitors 536

For transistorized circuits and precision low-voltage applications, these capacitors are rated at 30 v. Units rated from 0.001 to 0.68 μf are of tubular, metal-clad design; capacitances to 8 μf have bathtub cases.

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

See at Show Booth 1904-08.

DC Power Supply 561

Rated at 0 to 36 v, 0 to 10 amp, the model 510A power supply operates in either constant-voltage or constant-current modes. Both modes are continuously adjustable. Voltage regulation is 0.5%; current regulation is 5%; efficiency is about 75%. Device uses silicon-controlled rectifiers.

Harrison Laboratories, Inc., Dept. ED, 45 Industrial Road, Berkeley Heights, N. J.

P&A: $450.00; 10 to 30 days.

See at Show Booth 1008-10.

DC Amplifier 545

Solid-state dc amplifier, type 106, is a single-ended unit isolated from the chassis ground. Fixed gain settings of 1, 2, 5, and 10 are offered, with a variable control of +120% of each setting. Output is ±10 v, ±100 ma, from dc to 10 kc. Impedance is 500 K input, 0.25 ohms output. Output through a plug-in damping network for galvanometer matching is provided.

Neff Instrument Corp., Dept. ED, 2211 E. Foothill Blvd., Pasadena, Calif.

See at Show Booth 108.

Temperature Control Units 553

Using thermistor probes in a bridge circuit, the Varicycle temperature control units can activate an external relay. Model SCD-1002-P has no meter, while model SCD-1003-P (illustrated) has an indicating meter accurate to 2%. Device is transistorized. Bridge uses 6.3-v ac excitation.

Plug-In Instruments, Inc., Dept. ED, 1416 Lebanon Road, Nashville 10, Tenn.

Price: $65.00 and $125.00.

See at Show Booth 4505.

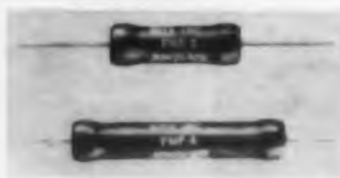
Line Amplifier 555

For telephone intercommunications systems, the model 883 compression line amplifier is of modular, plug-in construction. Inputs handle one dynamic microphone and up to 40 carbon microphones. Second input has a 120-db power gain and agc. Output is 4w, 3.5% maximum distortion. Frequency response is ±3 db from 200 to 3,500 cps.

Chalco Engineering Corp., Dept. ED, 15126 S. Broadway, Gardena, Calif.

See at Show Booth 2703.

Power Film Resistors 549



Noninductive power resistors, type PMF, are said to be available at higher resistance values than wirewound units. Rated at 3 to 4 w, units can handle 10 times rated power for 5 sec, with average change less than 0.25%. Dielectric strength is over 1 kv rms. Resistors have silicone-type coating which withstands solvents and temperatures over 275 C.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

Price: $0.05 each for 1-K units.

See at Show Booth 2307-11.

Automatic Diode Tester 550

Made to test 4,500 diodes per hour, the model T-501A automatic diode tester performs 12 tests on each unit. Test times are variable from 20 to 200 msec. Applied voltage is 1 kv dc max; leakage current has a resolution limit of 10^{-10} amp. Forward currents of 1 amp max are provided; voltage drops as high as 7.5 v can be measured. Accuracy is ±1%.

Atlantis Electronics Corp., Dept. ED, P. O. Box 451, Garland, Tex.

See at Show Booth 4508.

Frequency-Period Counters 540

Operating from dc to 100 mc, the series 700B frequency-period counters are completely transistorized. Sensitivity ranges from 0.25 to 1 v rms. Decimal point is automatically located. Countertimers, frequency-period meters, time interval meters, and counter-controllers are included in the line.

Computer-Measurements Co., Dept. ED. 12970 Bradley Ave., San Fernando, Calif.

See at Show Booth 1524-25.

Turret Attenuators 543

Operating from dc to 300 mc, the type TA-75 turret attenuator has 0 to 50 db settings in 10-db steps, and the type TB-75 provides 0 to 10 db attenuation in 1-db steps. Accuracy of both units is 1% or 0.1 db at 100 mc. Vswr is 1.05 at 100 mc. Insertion loss is 0.1 db max; power rating is 0.25 w. Impedance is 75 ohms. Units weigh 24 oz.

Telonic Industries, Inc., Dept. ED, 60 N. First Ave., Beech Grove, Ind.

Price: $95.00.

See at Show Booth 2813-15.

Semiconductor Insulators 417

Heat-shrinkable sleeving insulates diode and transistor cases. Known as Thermofit, the sleeving is preformed to fit standard cases. It is slipped over the semiconductor case; the bottom is heated, shrinking it to form a skin-tight encapsulation. Sleeving, available in several plastic materials, can encapsulate virtually any shape.

Rayclad Tubes, Inc., Dept. ED, Redwood City, Calif.

Slip Ring and Brush Block 471

Bearing mounted, 24-circuit, slip-ring and brush block-assembly meets environmental and material requirements of MIL-E-5272B and MIL-5400C. Rings are coin gold with 4-μin. finish engaged by spring temper, highly polished round wire Paliney 7 brushes. Diameter over dust cover is 1 in. Life is over 120 million revolutions.

Airflyte Electronics Co., Dept. ED, 535 Ave. A, Bayonne, N. J.

Availability: *stock.*

Tape Punch and Verifier 473

For 5, 6, 7 or 8-channel systems. Model D875 code-tape punch and verifier consists of an alpha-numeric keyboard, a paper-tape punch, a tape reader and interconnecting control circuitry. The keyboard is similar to the IBM card-punch keyboard.

General Instrument Corp., Systematics Div., Dept. ED, Hawthorne, Calif.

Availability: *90 days.*

NEW PRODUCTS AT WESCON

MICROWAVES

Balanced Mixers 383

Miniature balanced mixers, models V-8302A through V-8309B, operate from 3.95 to 10.8 Gc. Called Orthomode mixers, the devices also serve as balanced modulators. Typical noise figure is 9.0; typical maximum input vswr is 2.0. Mixers weigh from 2 to 8 oz.

Varian Associates, Dept. ED, 611 Hansen Way, Palo Alto, Calif.

Price: *$345 to $495.*

See at Show Booth 2009-17.

Traveling-Wave Tube 562

Low-noise traveling-wave tube operates from 2 to 4 Gc. Designated type HA-89, the tube has less than 5 db noise over parts of the band, with a 25-db small-signal gain and over 10-mw saturation power output. Operated broadband, the unit has an 8-db noise figure and 20-db gain. Unit measures 19-7/8 in. long and 1-5/16 in. in diameter. Focusing solenoid weighs 21 lb.

Huggins Laboratories, Dept. ED, 999 E Arques Ave., Sunnyvale, Calif.

Availability: *6 to 8 weeks*

See at Show Booth 2308-10.

Phase Meter 542

Providing 0.1% phase resolution, the model 300X phase meter is a direct-reading device

operating between 8.2 and 12.4 Gc. Frequency coverage is over 10 to 1. Five meter ranges read from 0.6 to over 90 deg separation. Input signals can differ as much as 20 db in amplitude. Servo output for feedback control is provided.

Wiltron Co., Dept. ED, 717 Loma Verde Ave., Palo Alto, Calif.

See at Show Booth 1212.

Reflex Klystron 385

For microwave-relay applications, the model VA-244B reflex klystron is a conduction-cooled unit said to be extremely stable with low distortion and long life. Device tunes from 6.5 to 7.3 Gc and, as a transmitter, produces 1 w average power output. As a local oscillator, the tube will produce 50-mw outputs. Unit weighs 1 lb.

Varian Associates, Dept. ED, 611 Hansen Way, Palo Alto, Calif.

See at Show Booth 2009-17.

Traveling-Wave Tube 382

This low-noise, ppm-focused traveling-wave tube, model HA-60, operates from 7 to 11 Gc. In the 8- to 11-Gc range, noise figure is 17 db max, small-signal gain is 25 db min, and saturation power output is 10 mw min. The tube requires 106 cu in. of mounting space and weighs 4-3/4 lb.

Huggins Laboratories, Inc., Dept. ED, 999 E. Arques Ave., Sunnyvale, Calif.

See at Show Booth 2308-10.

NEW PRODUCTS

Film Resistors 547

Rated at 1/10-w at 125 C, these precision film resistors meet or exceed MIL-R-10509 specifications. Series EM is a molded metal film resistor, available from 50 ohms to 100 K; series DM is a deposited carbon resistor, available from 10 ohms to 300 K. Standard tolerance is 1%. Units are physically interchangeable with type RC07 resistors.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

P&A: *Series DM, \$0.20; EM, \$1.00; 3 weeks.*

Test Set 491

Repeatability of about 0.01% is achieved by the model EC101 test set. The instrument tests such parameters as ac voltage, potentiometer shaft position, and resistance. When device under test reaches a predetermined value, a neon light fires, actuating, if desired, a relay. Instrument can fire at a predetermined deviation from a central value. Unit has four channels.

Elasco, Inc., Dept. ED, 5 Prescott St., Roxbury 19, Mass.

P&A: *about \$250; 6 to 8 weeks.*

Disk Capacitors 436

Rated at 500 wvdc. Power factor is 2% max at 1 kc. Type CE temperature-stable capacitors have ratings of 150 to 1,000 pf. Type CF semistable temperature units range from 1,200 to 10,000 pf. For both types, temperature range is −55 to +85 C and leakage resistance after humidity exposure is over 10,000 meg.

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

P&A: *\$0.18 to \$0.24; stock.*

Reversible Counter 481

Six-decade reversible counter adds and/or subtracts groups of pulses and square waves. Two inputs operate at high speeds from dc to 200 kc with an input amplitude of 1 to 10 v, peak-to-peak, sine or square wave. Readout uses in-line projection indicators; Nixie tubes are also available.

Wang Laboratories, Inc., Dept. ED, Natick, Mass.

P&A: *$1,500; 4 to 5 weeks.*

IF Filter 557

Bandwidths of 100, 200, and 300 cps are available for this line of 455-kc center frequency filters. Case measures 2-23/32 x 3/4 x 1/2 in. Shape factor is 4 to 1.

Communication Accessories Co., Div. Collins Radio Co., Dept. ED, P. O. Box 1891, Dallas 21, Tex.

Automatic-Reset Dial Timer 442

Seven individual load circuits can be controlled by series 305B automatic-reset dial timer. All load connections are internally wired to a 14-point terminal block. Applications are in industrial process control, laboratories and machine automation. The timer is motor driven for control of ac or dc loads.

Automatic Timing & Controls, Inc., Dept. ED, King of Prussia, Pa.

Silicon Micro-Diodes 477

With piv to 100. Silicon micro-diodes MD04, 06, 08, and 10, made for computer and general purpose uses, exceed humidity resistance requirements. The piv ranges from 40 to 100 v; power dissipation at room temperature is 250 mw, average rectified current rating 75 ma. Reverse leakage at 150 C is low. Recovery time is 0.3 μsec.

General Instrument Corp., Semiconductor Div., Dept. ED, 65 Gouverneur St., Newark 4, N. J.

NEW PRODUCTS

Glass-Seal Lead Wires 487

One-piece, necked-down lead wires for glass sealing applications have no welded joint. Wires can be necked down to 50% of their original size. Leads, 3 in. long, have diameters from 0.02 to 0.05 in., and are available in most alloys.

Art Wire and Stamping Co., Dept. ED, 227 High St., Newark 2, N. J.

Trimming Potentiometer 548

Measuring 1/2-in. square, the type 200-20 trimming potentiometer has printed-circuit terminals. Standard resistance range is 10 ohms to 50 K, ±5%. Power rating at 60 C is 1 w; operating temperature is −55 to −150 C. A variety of adjustment screw heads are available, with or without slip clutch protection.

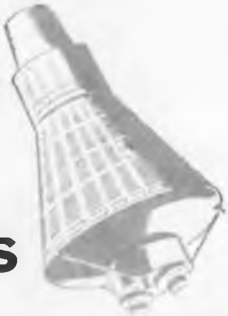
International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

***P&A:** $5.00; four weeks.*

Crystal Filter 490

Miniature 3-kc crystal filter is made for missile, communication, and control applications. Measuring 3 x 2-5/16 x 1-7/16 in., the filter has a 3.5-db insertion loss and attenuation of 3 db in a 2-cps bandwidth. Input and output impedance is 500 K. Filter meets MIL-C-3908B vibration standards and applicable MIL-T-27A specifications.

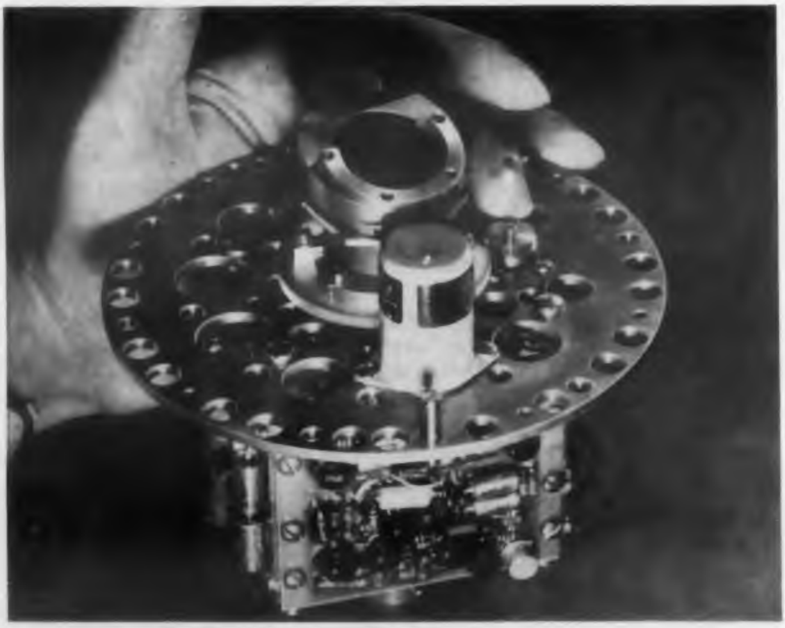
Burnell and Co., Dept. ED, 10 Pelham Parkway, Pelham, N. Y.



Bristol choppers help first U.S. Astronaut maneuver space capsule

Four Bristol Syncroverter* choppers formed a vital part of the infrared horizon sensors manufactured by Barnes Engineering Company, Stamford, Conn., and carried aloft in NASA's MERCURY capsule by the first U.S. astronaut to reach outer space.

The Bristol choppers function as sensitive phase detectors in the sensors as they establish a horizontal reference plane for the vehicle.



Infrared Horizon Sensor undergoes rigorous optical, mechanical, and electrical checks at Barnes Engineering Co. One Bristol chopper is located in foreground, in front of gear.

Bristol Syncroverter* choppers, noted for low noise, long life and high reliability, are finding a vital place in more and more missile guidance systems, as well as in analog computers, d-c amplifiers, and test equipment for industrial applications. More than 200 models available. Write for complete details.

The Bristol Company, Aircraft Equipment Division, 151 Bristol Road, Waterbury 20, Conn.
A Subsidiary of American Chain & Cable Company, Inc.

ACCO

**T.M. Reg. U.S. Pat. Off.* 1.4

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CIRCLE 63 ON READER-SERVICE CARD

Axial Flow Fans 489

Heating unit in the series 1.9 Mini-Spot axial flow fans raises temperature by 30 F. Air flow is 10 cu ft per min. Unit is 1.9 in. in diameter and 1.47 in. long. Fans are made to reduce tube warm-up time. MIL-E-5272C specifications are met.

Pesco Products Div., Borg-Warner Corp., Dept. ED, 24700 N. Miles Blvd., Bedford, Ohio.

Power Resistors 560

With 5% **tolerance,** the series AS power resistors are rated from 2 to 10 w, 125 C ambient, derated to 350 C. Units are of welded construction, have axial leads and a moisture and fungus resistant silicone coating. Devices are made for both military and commercial applications.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

P&A: *$0.25 or less; three weeks.*

Filters 556

Center frequencies of 4 to 20 mc are held by this series of miniature filters. Units have shape factors of 4 to 1. Bandwidths range from 0.1% to 0.3% of center frequency. Cases occupy less than 1 cu in.

Communication Accessories Co., Div. Collins Radio Co., Dept. ED, P. O. Box 1891, Dallas 21, Tex.

Power Supplies 486

For battery charging and equipment operation, this rack-mounted power supply is fully transistorized. The instrument provides 4.5-v 5 amp, 4.5-v 10-amp, 30-v 5-amp, and 4.5-v 10-amp outputs from 115-v ac input. All outputs are dc; one of the 4.5-v 10-amp outputs is for battery charging. Voltage regulation is 0.5% of full load.

Arnoux Corp., Dept. ED, 11924 W. Washington Blvd., Los Angeles 66, Calif.

Counter and Control 404

Photoelectric counter type 1810 and control type 1811 operate in conjunction with model PL photohead exciter. Control or tabulation can be made at areas remote from the readout device. The control can have a time delay of 40 msec to 1 sec. The exciter activates a sensitive relay, eliminating the need for amplification.

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

Program Board Kits 391

Cordless program board kits called Proto-Kits consist of two matrix boards with aligned x and y axes. Pins and diodes for programing functions can be inserted at any point on the matrix boards. Kits, including pins, diodes, boards, and holders, are ideal for breadboarding systems.

Sealectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N. Y. ***P&A:*** *$19.70 to $28.00 for kits; from stock.*

Magnet Wire 405

High - temperature, film-coated magnet wire type ML is for continuous use at up to 250 C and resists heat shock of up to 425 C. Dielectric strength is better than 3,000 v per mil. All sizes of round, square and rectangular wire are available. Film addition conforms to NEMA specs.

Anaconda Wire and Cable Co., Dept. ED, 25 Broadway, New York 4, N. Y.

Pressure Transducer 413

Silicon semiconductor strain gage pressure transducer provides 250 mv output with 10 to 30 v dc excitation. Linearity is 0.25% max in ranges from 0 to 100 through 10,000 psia or psig; hysteresis is 0.3% max. Operating temperature range is −65 to +225 F.

Fairchild Controls Corp., Dept. ED, 219 Park Ave., Hicksville, N. Y.

CIRCLE 72 ON READER-SERVICE CARD ➤

family potrait!

Met the *whole* Ace family yet? Or have your requirements to date in precision pots been only in ½", or wirewound? The famous Ace reliability, quality control and mass production facilities are not just limited to the above, no sir! Just consider Ace's *complete* range of standard sizes for instance — not just ½", ¾", ⅞", 1 1/16", but sizes including A.I.A., up to 6"!

All these, in bushing, servo and universal mounts, in potentiometer and trimmer parameters. And . . . there are specials, multi-gangs, quick-cup-change designs, linear and non-linears and rectilinears — all in standard and special accuracies and conformities, both in wire-wound and conductive plastic. In short, when you can get Ace-quality in your every potentiometer need, get it the easy way: see your ACErep! Write for complete catalog!

This 3" AIA ACEPOT® (shown ⅓-scale) meeting all MIL specs, is available, in a range of accuracies, for prompt delivery.

ACE ELECTRONICS ASSOCIATES, INC.
99 Dover Street, Somerville 44, Mass.
SOmerset 6-5130 TWX SMVL 181 West. Union WUX

Acepot® Acetrim* Aceset® Aceohm® *Reg. Appl. for

CIRCLE 73 ON READER-SERVICE CARD

NEW PRODUCTS

Programable Power Supply 488

Punched cards or tape program the voltage and frequency of the type T236 ac power supply. The instrument is made for production testing and automatic checkout. Unit can be switched to manual operation.

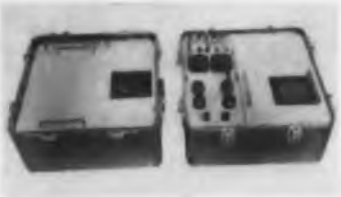
Avtron Manufacturing Co., Dept. ED, 10409 Meech Ave., Cleveland 5, Ohio.

Time Interval Counter 502

With 10-nsec accuracy over its full range, the model 5275A counter gives seven-place digital readout. With a range from 10 nsec to 0.1 sec, the device operates from an external 1-mc frequency standard. A four-line binary decimal output is optional. Manual and remote zero reset are provided.

Hewlett-Packard Co., Dept. ED, 1501 Page Mill Road, Palo Alto, Calif.

Altitude-Airspeed Simulator 485



For instrument testing. Altitude-airspeed pneumatic electronic simulator simulates complete flights from punched cards or magnetic tape. Servo feedback generates static or pivot pressure outputs as functions of voltage inputs. Unit is portable; inputs can be set either manually or remotely. Altitudes of 80,000 ft, hysteresis of 75 ft, and air speed of 600 knots can be simulated.

Parker Aircraft Co., Dept. ED, 5827 W. Century Blvd., Los Angeles 45, Calif.

Magnetic Amplifier 635

Fast-response magnetic amplifier, model 1085, is a dc push-pull unit made for use with recorders. Output is ±20 v; output impedance is 300 ohms. Input is 100 μa dc; sensitivity is 200 mv per μa nominal. Linearity is ±2%. Case measures 3 x 3-1/2 x 3-3/4 in.

Lumen, Inc., Dept. ED, P. O. Box 905, Joliet, Ill.

***P&A:** $376 each fob Joliet; four weeks.*

Adhesives 571

For printed circuits. Four synthetic resin base thermosetting adhesives are for bonding copper foil to phenolic or epoxy-impregnated base stock, phenolic paper, epoxy paper and epoxy glass materials. Designations are EC-1855, EC-1857, EC-2080 and EC-2130.

Minnesota Mining and Manufacturing Co., Adhesives, Coatings and Sealers Div., Dept. ED, 900 Bush Ave., St. Paul, Minn.

Switching Transistor 642

Epitaxial silicon mesa type. Type 2N835 has a storage time of 16 nsec and a typical over-all switching time of 47 nsec. Collector capacitance is 2.8 pf. Saturation voltage is 0.15 v at 10 ma. Maximum junction and storage temperature is ±175 C. It is housed in the TO-18 package and is capable of dissipating 1 w.

Motorola Semiconductor Products Inc., Technical Information Center, Dept. ED, 5005 E. McDowell Road, Phoenix 8, Ariz.

***Price:** $5.10 ea in quantities of 100 or more.*

NEW PRODUCTS

Display Console 604

Electron microprobe analyzer outputs are displayed on the four oscilloscope screens of this display console. Location and concentration of up to four separate X-ray spectra can be displayed simultaneously, or one channel may display back-scattered electrons. Raster drive for both the probe beam and the crt's is provided. Sweep time is 1 to 30 sec.

Elcor, Inc., Dept. ED, 1225 W. Broad St., Falls Church, Va.

P&A: *$10,000; 90 days.*

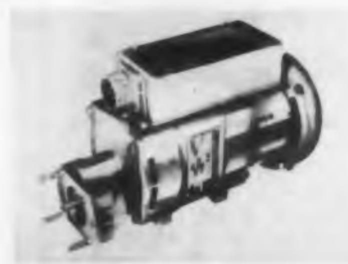
Tantalum Capacitors 386

Axial lead tantalum foil capacitors type HV have single-unit ratings to 300 wvdc from −55 to +85 C, and to 250 wvdc, −55 to +125 C. Capacitances range from 0.13 to 35 μf. Seven case sizes range from 3/16 x 3/4 in. to 17/32 x 2-7/8 in., weigh 1.5 to 35 g.

Tansitor Electronics, Inc., Dept. ED, West Road, Bennington, Vt.

P&A: *$3.12 to $23.39 ea, 1,000 or more; stock to two weeks.*

DC Motor 596



With square frame. Operating from 27 v dc, motor 2510 provides 2.5 hp at 3,050 rpm, continuous duty, and 4.0 hp at 2,700 rpm, intermittent duty. Maximum temperature is 260 F, altitude 150,000 ft. Weight is 14.9 lb with radio noise filter, size 9.75 x 5.0 x 6.4 in.

Hoover Electric Co., Dept. ED, 2100 S. Stoner Ave., Los Angeles 25, Calif.

Limit Switch 597

Snap-acting limit switch is available in double-pole form with two normally open, two normally closed contacts. Operating head types include button, plunger, and roller-lever operated forms.

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

Three-Phase Protector 605

Static, transistorized three-phase protecting device operates from voltage signals and warns of three-phase voltage unbalance, phase failure, or phase reversal. Designated Phaseguard, the device can be used on either delta or wye three- and four-wire systems. Operating time is 30 to 52 msec. Voltage level is adjustable. Device automatically resets when normal conditions return.

Emerson Electric Manufacturing Co., Dept. ED, 8100 Florissant Ave., St. Louis 36, Mo.

Microcircuit Bonder 609

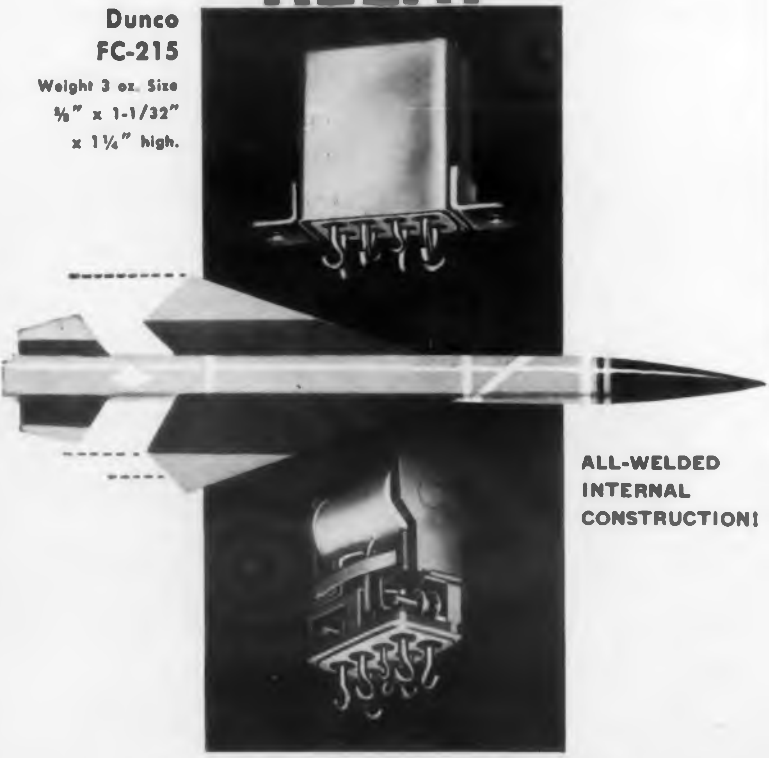
Precise positioning of microcircuit components to tolerances of 10 to 15 millionths of an inch is provided by the model 601M Multi-Dice Bonder. Heat and bonding force are controlled, and oxidation is prevented. Positioning is controlled by one hand. Semiconductor dice, gold foil, and other micromodules are handled continuously.

Kulicke and Soffa Manufacturing Co., Inc., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

NEW! 10-AMPERE RELAY

Dunco FC-215

Weight 3 oz. Size ⅝" x 1-1/32" x 1¼" high.



ALL-WELDED INTERNAL CONSTRUCTION!

for missile and aircraft uses

Conservatively rated for 10 ampere DC operation, these solidly built little DPDT units fill a long standing need for dependable heavy duty power relay service under temperature, vibration and shock extremes.

Constructed throughout to meet or surpass MIL-R-575C and MIL-R-25018 requirements. No internal soldered joints. Withstand 30G vibration to 2000 cycles and 50G shock. Standard coils rated 26.5 Volts DC nominal with 400 ohms coil resistance. Other coils available. Designed for 125° C. operation

Header terminals are 0.2" grid-spaced and can be furnished with hook, long or short wire lead terminals.

WRITE FOR DUNCO BULLETIN FC-215

STRUTHERS-DUNN

S-D

World's largest selection of relay types

STRUTHERS-DUNN, Inc., Pitman, N. J.

Member, National Association of Relay Manufacturers

Sales Engineering offices in: Atlanta • Boston • Buffalo • Charlotte • Chicago • Cincinnati • Cleveland • Dallas • Dayton • Detroit • Kansas City • Los Angeles • Montreal • New Orleans • New York • Pittsburgh • St. Louis • San Francisco • Seattle • Toronto

CIRCLE 78 ON READER-SERVICE CARD

NEW PRODUCTS

Coaxial Cable 603

With integrated messenger. Coaxial cable type IM has a stranded or solid steel support wire as an integral part of the polyethylene cable jacket. Diameter and strength of the steel messenger can be varied to meet stress.

Hickory Brand Electronic Wires and Cables, Dept. ED, Box 480-A, Hickory, N. C.

Vacuum Systems 620

Completely packaged high-vacuum pumping system includes a diffusion pump, liquid nitrogen trap, mechanical pump, pneumatically operating vacuum valves, push button operation, sequence control, and is electrically interlocked. Systems evacuate ovens or bell jars.

Tri Metal Works, Inc., Dept. ED, 1600 Bannard St., Riverton, N. J.

Oscilloscope Cart 619

Any standard scope can be seated in the model ICB-1A mobile scope cart. Deck is 29-1/4 in. long and 18 in. wide, and is tilted 17 deg. A cabinet below the deck provides for storage. Plug-in units for different oscilloscopes are available. Cart has 5-in. swivel casters and a capacity of 500 lb.

Mobil-Tronics, Dept. ED, P. O. Box 47633, Los Angeles 47, Calif.

***Price:** $85.00, fob Whittier, Calif.*

Time Code Generator 631

Projected numerals on control panel indicate time on model EM-1 time code generator. Scan rates are 100 pps available as dc level shifts and with 1 kc carrier, and 2 pps with 100 cps carrier. There are 20 isolated coded outputs on balanced lines. Device is for either field or laboratory operation.

Abacus, Inc., Dept. ED, 1718 21st St., Santa Monica, Calif.

Electronic Timers 627

Transistorized timers called Electro-Time have no motors, clutches, or solenoids. Time interval ranges from 0.5 sec to 5 min are covered, adjustable by control knob or slotted shaft. Contacts are rated at 5 amp, 115 v.

Electro-Seal Corp., Dept. ED, 938 North Ave., Des Plaines, Ill.

Expandable Chassis 630

Sections may be added to the type MPX chassis when the circuit is redesigned or expanded. Single cabinet without inserts measures 21-5/8 x 18-1/2 x 11-1/4 in. Inserts are available in increments of 1-3/4, 3-1/2, and 5-1/2 in. Cabinet accepts standard relay-rack panels.

California Chassis Co., Dept. ED, Lynwood, Calif.

CIRCLE 80 ON READER-SERVICE CARD ➤

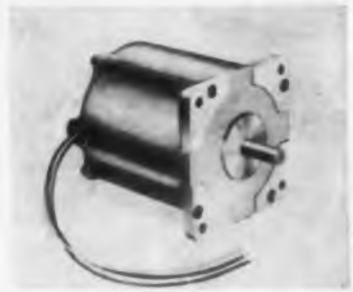
NEW PRODUCTS

Heat Sinks 639

For printed-circuit boards. Three miniature types, HS-1, HS-2, and HS-3 are made of aluminum. Jaw sizes are 5/32 x 1/16 in. wide on all models. Lengths range from 1-1/4 to 1-3/4 in. Weight is 6 oz per 100 packed.

Macdonald & Co., Dept. ED, 714 E. California, Glendale 6, Calif.
***Price:** 1 to 499, $0.29 ea.*

Synchronous Motor 641



For on-off ac servo applications. SLO-SYN type X1000 can be started, stopped or reversed instantly with a single-pole, 3-position switch. Input is 120 v, 60 cps, 1 phase. Max current is 3.0 amp at 60 cps. Output speed is 72 rpm at 60 cps. Torque is 1,000 oz-in. Output shaft can be stepped at 200 precise steps per revolution using dc power.

The Superior Electric Co., Dept. ED, Bristol, Conn.
***Price:** $195.00 ea.*

Console Cabinet 625

Modular cabinet for machine control equipment is said to be functional and very versatile. Enclosure has sloping front panel.

Equipto Electronics Corp., Dept. ED, Naperville, Ill.

◄ CIRCLE 81 ON READER-SERVICE CARD

Detector and Alarm 454

Warning of accidental grounds on power lines is provided by the Brunt ground detector and alarm. Indicator lamps for each of three phases dim or go out when a ground occurs. An alarm sounds and a red light flashes. Instrument is in a steel cabinet measuring 16 x 8 x 8 in. and weighing 14 lb.

Parr Mfg. Corp., Dept. ED, 40 Austin St., Newark, N. J.

Strain Gages 573

Silicon strain gages. For biomedical instrumentation, transducer applications and experimental stress analysis. Line of 29 gages includes lengths from 0.05 to 0.5 in., with resistances from 120 to 1,000 ohms and gage factors from +120 to −100. Temperature range is −320 to +650 F.

Micro Systems Inc., Dept. ED, 319 Agostino Road, San Gabriel, Calif.

Price: *from $80.00 to $98.00 for a package of four.*

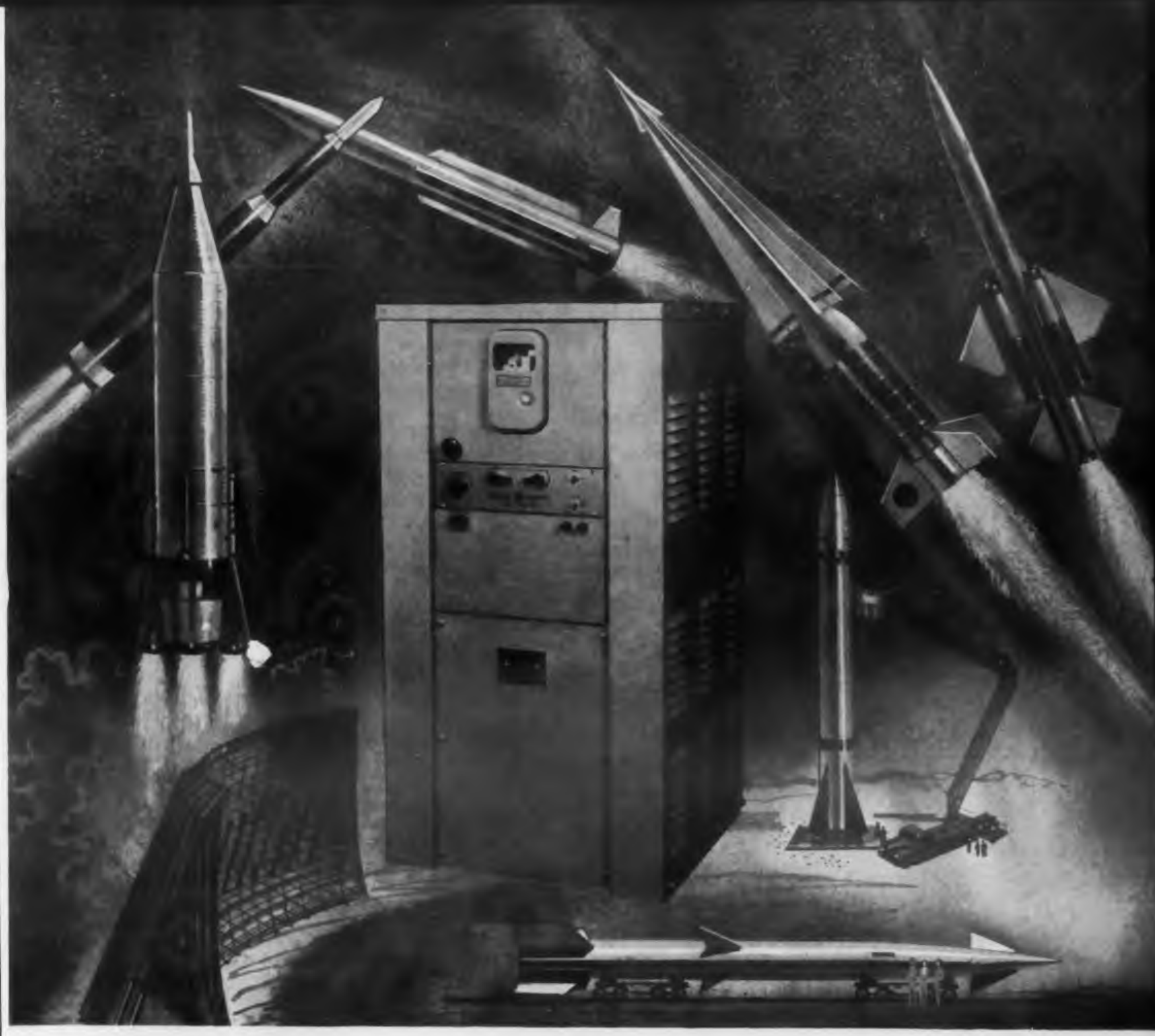
Chopper 633

Low-noise electromechanical chopper, model 43, withstands 100-g shock and temperature range of −65 to +100 C. Noise is at random level. Drive is 6.3 v, 400 cps ±40 cps. Dwell time is 65 deg; signal level, 10 v dc max at 2 ma max. Contacts are spdt. Coil leads, brought out at top of can, have electrostatic and electromagnetic shielding.

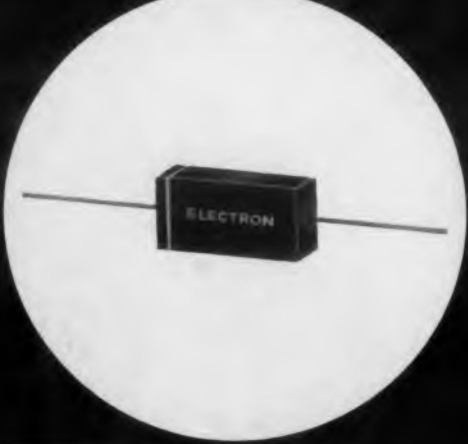
Airpax Electronics, Inc., Dept. ED, Cambridge, Md.

P&A: *$49.00 each, 1 to 6; 2 to 3 weeks.*

CIRCLE 82 ON READER-SERVICE CARD ➤



Electron Products | BW and BWE High Voltage Capacitors



Newest-Smallest High Voltage Capacitors!

Compact configuration, lighter weight and extremely low noise are features deserved by design engineers seeking smaller, more reliable high voltage capacitors.

BWE Series epoxy tube capacitors are designed for applications as AC and DC power supply ripple filter capacitors, voltage doubler circuits and blocking capacitors. Basic construction is similar to the Mil-C-14157 Hi-Rel Spec and meets environmental test conditions of Mil-C-25. Rectangular shaped, non-metallic case eliminates need for large stand-off terminals. The BW wrap and fill version is available for similar applications in less stringent environments.

Up to 30,000 V operation with standard capacity from .001 to .2 mfd. Standard capacity tolerance ±20% (also available to ±1%). Competitively priced against other less sophisticated versions. Technical information and test data available upon request.

Specifications:

Operating Temperature:	−55°C to +125°C
Insulation Resistance:	30,000 MΩ min. @ 25°C
Dissipation Factor:	1.0% max. @ 25°C
Test Voltage:	200% of rated voltage

ELECTRON PRODUCTS

430 North Halstead Street, Pasadena, California

division of Marshall Industries

CIRCLE 83 ON READER-SERVICE CARD

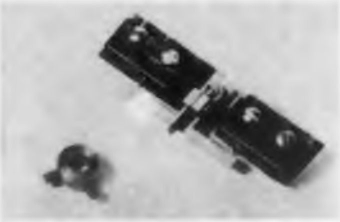
Tuning-Fork Oscillator 602

Accurate to ±0.01%, tuning-fork controlled silicon transistor oscillator model TF-120 provides signals at 240 to 1,200 cps. Output is sine wave greater than 1 v rms with 600-ohm load. Stability is ±50 ppm per day. Temperature range of the encapsulated unit is −55 to +85 C. Input power is 28 v, 8 ma.

Solid State Electronics Co., Dept. ED, 15321 Rayen St., Sepulveda, Calif.

P&A: *$225 to $250; 5 to 6 weeks.*

Limit Stop 594

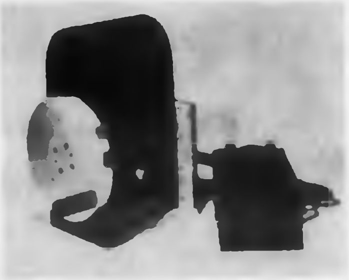


Adjustable electrical limit stop 321A can be set from 20 to 370 deg, and can be overridden without damage. Operating torque is 0.5 oz-in., capacity 5 amp, 250 v ac. Differential angle is minus 4 deg, each end of travel.

Gap Instrument Corp., Dept. ED, S. Main St., Newtown, Conn.

P&A: *$19.85, 25 to 49; one week.*

Gyro Test Fixture 608



Dynamic tests are performed on rate gyros, integrating gyros, and accelerometers by the model FR01 test fixture. A turntable on a precision right-angle mounting base has speeds variable from 1 to over 25 cps. Slip rings provide eight connections. A switch indicates table position, permitting phase measurements.

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

Price: *Less than $3,000.*

Thermocouple Potentiometer 450

Portable thermocouple potentiometer, model 1331 HG, measures temperatures from −450 to +3,200 F, with a minimum temperature span of 250 F. Accuracy is 0.5%. Instrument is held in the hand, and a two-foot thermocouple probe is inserted into the test area. Device is made to test ovens, furnaces, and salt pots. No experience is required to operate.

Pyrometer Service Co., Inc., Dept. ED, 348 River Road, North Arlington, N. J.
Price: *$109.50.*

CRT Accessories 575

For display applications. Cathode-ray tube accessories made to standard and custom designs include deflection yokes, convergence coils, and magnetic shields. All models are available with supports for tubes with 2-in. neck diameter.

General Dynamics/Electronics, Information Technology Div., Dept. ED, P. O. Box 2449, San Diego, Calif.

Shaker Drivers 636

Two systems deliver 3 and 5 kva for driving electrodynamic shakers. Model RP-5/6-C has a power output of 5 kva, and model RP-3/4-C, 3 kva. Frequency range is 5 cps to 10 kc, ±1 db. Console requires 7.7 sq ft of floor space.

Ling Electronics Div., Ling-Tempo Electronics, Inc., Dept. ED, 1515 S. Manchester, Anaheim, Calif.
Availability: *Immediate.*

CIRCLE 85 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Pressure Switch 613

For missile applications, series 4501 pressure switch weighs 0.1 lb and operates at atmospheric pressures from 15 to −1 psia. Life is greater than 10,000 cycles. The switch, spdt, actuates at 7 psia nominal pressure. Contact current is 100 ma at 28 v dc. Elements are enclosed in a sealed case.

Colvin Laboratories, Inc., Dept. ED, 364 Glenwood Ave., East Orange, N. J.

Mercury Arc Lamp 618

High-pressure mercury arc lamp, PEK 200, is a 200-w unit with an average brightness of 25,000 candles per sq cm. Light output is 9,500 lumens.

PEK Labs, Inc., Dept. ED, 4024 Transport St., Palo Alto, Calif.

***P&A:** $49.00 each; from stock.*

Connectors 616

Hermetic-sealed connectors, series PS, are made for missile and nuclear radiation applications. Receptacles have No. 20 contacts with five inserts. Units operate continuously at 80 F, for short terms at 1,200 F. Pressures of 1,200 psi at 1,000 F are withstood. Insulation resistance is 100,000 meg.

Physical Sciences Corp., Dept. ED, 389 N. Fair Oaks Ave., Pasadena, Calif.

AC Voltmeters 610

Panel-mounted voltmeters, models 301-1 and 303-1, have 3-1/2 and 2-1/2 in. meters respectively and extend 6-1/4 in. behind the panel. Units are self-contained, including power supply, and are housed in aluminum cylinders. Meters are transistorized, and are said to have high-frequency response. Temperature range is −55 to +55 C.

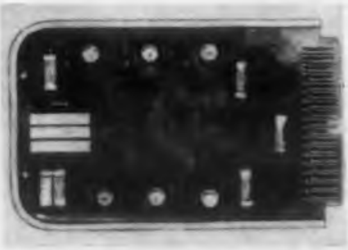
Trio Laboratories, Inc., Dept. ED, Plainview, L. I., N. Y.

Transfer Switches 598

Mechanically held automatic transfer switches are made in 1,200, 1,600, and 2,000 amp sizes. The two- and three-pole switches are rated to 600 v ac, 250 v dc. Relay provides transfer to emergency source when voltage on any phase drops to 70%, retransfer to normal source at 90%.

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

Digital Modules 599



Delay multivibrator and pulse shaper DM-30 contains three independent monostable multivibrators. Pulse duration can range from 0.7 to 200 μsec, or up to several seconds with external capacitors. Model DM-30A also provides a means of continuously varying or trimming pulse width. The 1-mc, plug-in devices use NOT-AND logic.

Computer Control Co., Inc., Dept. ED, 983 Concord St., Framingham, Mass.

***P&A:** DM-30, $97; DM-30A, $127; stock.*

NEW PRODUCTS

Ovens 624

For precision instrumentation. Resistors, capacitors, networks, crystals, and similar precision components can be maintained at constant temperatures by these ovens. Controlled temperatures up to 500 F are available with power requirements from 1/5 to 3 w per sq in. of exposed surface. Solid-state proportioning and thermostatic controls are available.

Spec-Tronics, Inc., Dept. ED, 13901 Saticoy St., Van Nuys, Calif.

Memory System 572

For general purpose digital computers. The 8,000 character, 56-bits per character memory has a cycle time of 6 μsec; access time of 2.5 μsec. The system contains 448,000 GC MC-140 (50 mil) memory cores. Temperature range is 15 to 40 C, with no temperature compensation required. The unit is completely self-contained.

Indiana General Corp., General Ceramics Div., Dept. ED, Keasbey, N. J.

Connector Cap 456

Printed circuit connectors are protected from dirt, dust, debris, and moisture by this environmental cap. The cap is permanently bound to the connector, and forms a tight seal about the printed circuit board, which can be inserted and removed repeatedly. Cap is made of silicone and type E neoprene.

Modular Electronics, Dept. ED, 6211 S. La Brea Ave., Los Angeles 56, Calif.

◄ CIRCLE 87 ON READER-SERVICE CARD

Neutron Generator 453

Provides 14 mev neutrons. Powered by a stabilized 125 kv source, the generator produces a continuous mono-energetic 14-mev neutron flux of 10^8 neutrons per sec, and a pulsed 14 mev flux of 10^9 to 10^{10} neutrons per sec by a deuterium-tritium reaction. Requires 110 v ac power.

Philips Electronic Instruments, Dept. ED, 750 S. Fulton Ave., Mount Vernon, N. Y.

Shift Registers 464

Thin magnetic film shift registers consist of nickel and iron deposited on 1 x 3 in. substrates. Magnetic fields applied to the film in the proper sequence cause dipoles within the film to orient in a manner so as to process the information. Information is read out at the far end of the film, without involving intermediate amplifiers. Units available have 23-bit capacity and yield a 2-mv output signal.

Servomechanisms, Inc., Dept. ED, Santa Barbara, Calif.

Reperforator Comparators 626

Error tape is eliminated with this reperforator comparator, model HPC. Tapes generated for check-out systems and devices are compared with original tapes. Machine can produce 5, 6, 7, or 8 level tape at 60 codes per sec. Military specifications are met.

Soroban Engineering, Inc., Dept. ED, Melbourne, Fla.

CIRCLE 88 ON READER-SERVICE CARD

NEW PRODUCTS

Punch-Verifier 595

Universal code punch and verifier model D875 handles 5, 6, 7, or 8-channel tape, any code structure. The system consists of a standard alpha-numeric keyboard, a paper tape punch, tape reader, and interconnecting control circuitry. It will operate at any speed up to 20 characters per sec.

General Instrument Corp., Systematics Div., Dept. ED, Hawthorne, Calif.

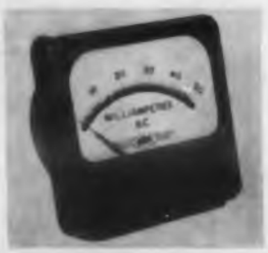
Availability: *90 days.*

Connectors 607

From 15 to 30 amp currents are handled by these terminal blocks. Connectors have from 2 to 20 stations and accommodate from 10 to 30 gage wire. Breakdown voltage is 4,000 v between terminals and 5,000 between terminals and base. Units are molded of Lexan polycarbonate resin.

Camblock Corp., Dept. ED, Natick, Mass.

Panel Meters 612



Precision 0- to 50-ma dc panel meters have an anti-parallax mirrored scale and accuracies of 1%. Sensitivities of 10,000 to 20,000 ohms per volt are available. Special scales can be produced to customer specifications.

Airpax Electronics, Inc., Seminole Div., Dept. ED, Fort Lauderdale, Fla.

Availability: *One week.*

Television Camera 606

A closed-circuit television camera, the Minicamera, is 9 in. long and 3 in. in diameter. It operates without special protection despite noise and vibration. Camera is sealed against dust, and ventilation is not required. Picture quality is said to equal that of standard-sized cameras.

Fairbanks, Morse and Co., Electronics Div., Dept. ED, 100 Electra Lane, East Station, Yonkers, N. Y.

Time-Delay Relay 611

A 5- to 10-sec memory circuit prevents this time-delay relay from recycling in a power failure. Standard time delay is 180 sec, adjustable. Contacts are rated at 2.5 amp resistive, with spdt standard and other arrangements available. Military environmental and rf-interference specifications are met.

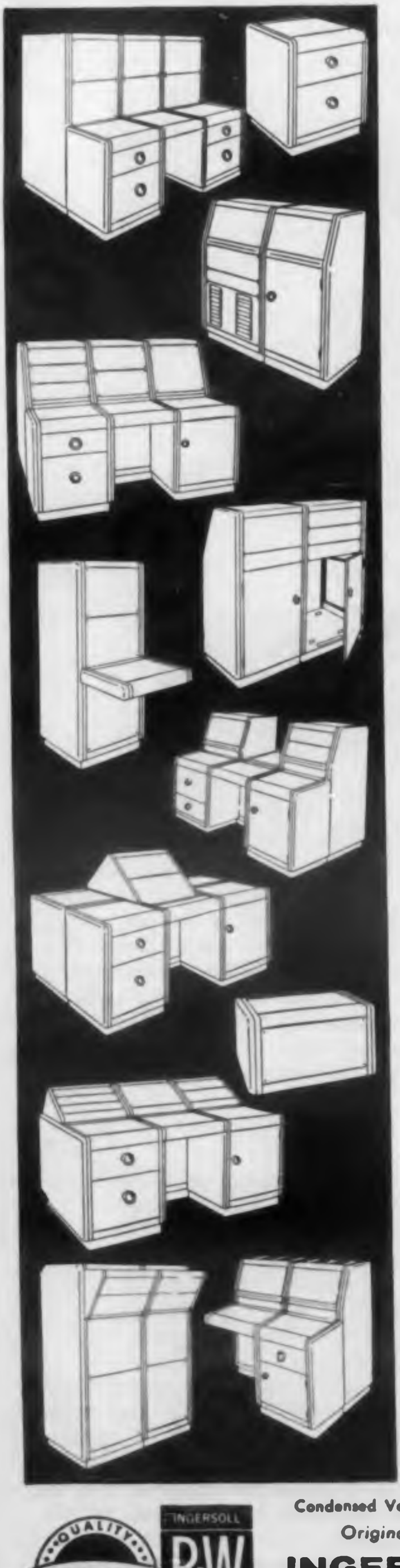
Accutronics, Inc., Dept. ED, 403 N. Foothill Road, Beverly Hills, Calif.

***Availability:** 2 to 3 weeks.*

Capacitors 615

Stability of capacitance during lifetime and temperature change is said to be high with these Oxsil capacitors. Increase in capacitance at 125 C is 0.35% over the 25 C measurement. Operating temperature range is −65 to +150 C. Capacitance ratings are 100 to 330 pf, 50 to 150 wvdc, 5% to 20% tolerance. Axial-lead and radial-lead styles are available.

Sprague Electric Co., Dept. ED, N. Adams, Mass.



HUNDREDS OF Widths, Depths & Heights TO MEET YOUR ENCLOSURE REQUIREMENTS WITH EMCOR® STANDARD CABINETS

- Cut costly enclosure design time. Select your packaging needs from a complete line of standard and heavy duty EMCOR Cabinets.
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- Engineered simplicity of basic frames and components affords quickest and easiest erection of control center assembly.
- EMCOR Cabinetry Engineers backed by the research and development "know-how" of the Roy C. Ingersoll Research Center set the pace for the packaging needs of electronics, instrumentation and electro-mechanical engineers from coast to coast.
- Rugged frame construction surpasses all standard requirements for increased load carrying capacities.
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- EMCOR Cabinet manufacturing meets rigid quality-controlled craftsmanship standards.
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Condensed Version of Catalog 106 Available Upon Request.

Originators of the Modular Enclosure System

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CIRCLE 90 ON READER-SERVICE CARD

Reversible Gearmotor 614

Constant-torque gearmotors are instantly reversible, compact, have a low sound level and provide output speeds from 0.3 to 550 rpm. Torques up to 250 in.-lb are developed. Input is 115 v, single-phase or 220 v, three-phase. Units can be mounted in any position.

New England Gear Works, Inc., Dept. ED, South End Road, Southington, Conn.

Flame-Resistant Laminate 590

Self-extinguishing epoxy-glass laminate is available in standard and printed-circuit copperclad varieties. Designated No. 11587, the new FR-4 laminate has good machining properties and good electrical properties under humid conditions. Sheets are 36-in wide with lengths of 36, 48, and 72 in. Thicknesses range from 0.010 to 1.000 in.

General Electric Co., Laminated Products Dept., Dept. ED, Coshocton, Ohio.

Isolators 592

Power rating is 75 kw cw. In WR-975 waveguide size, two isolators provide 15 db minimum isolation over a total bandwidth of 240 mc, each isolator covering approximately half the band. Insertion loss is 0.8 db max; vswr is 1.10 max. Coolant is water and coolant temperature is 140 to 150 F.

Airtron, Div. of Litton Industries, Dept. ED, 200 E. Hanover Ave., Morris Plains, N. J.

Handles 600

Instrument, equipment, and cabinet handles are available in standard and custom specifications. Materials include brass and aluminum. A choice of plating is offered.

Galaxy Manufacturing Co., Dept. ED, 5458 E. Century Blvd., Lynwood, Calif.

***P&A:** $0.26 up; stock.*

Silicon Rectifiers 637

Surge currents of 5 amp are handled by these microminiature silicon rectifiers. Units measure 0.075 in. long and 0.03 in. in diameter. Average current is 250 ma, piv is 600 v. Rectifiers operate in over 200 C ambient. MIL-STD-19500B specifications are met. Leads are gold-plated silver.

MicroSemiconductor Corp., Dept. ED, 11250 Playa Court, Culver City, Calif.

Sample and Hold Unit 455

For data multiplexing. Sample and hold unit, model SH4, samples a 1-μsec segment of an incoming signal and holds the result for conversion to digital representation. Input frequency is dc to 100 kc. Input impedance is 10 K per v. Output voltage range is ±10 v.

Packard Bell Computer Corp., Dept. ED, 1905 Armacost Ave., Los Angeles 25, Calif.

***P&A:** $1,250; 45 days.*

Pressure Transducer 629

Overpressure stop on this model of the series 4-326 strain-gage pressure transducers permits twice the rated pressure to be applied for three minutes with shift in zero set of 0.5% of rated output, or 10 times rated pressure for shift of 1%. Ranges from 0 to 100 psi to 0 to 5,000 psi are available.

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

CIRCLE 92 ON READER-SERVICE CARD ➤

may we help you?

The design and manufacture of *custom* electrical connectors to perform to highly critical requirements is our specialty. We are equipped to manufacture to any volume for quick delivery. Our application engineers will work directly with you in developing exactly the right connector for your needs. Call or write for details, or further information.

CIRCLE 93 ON READER-SERVICE CARD

Breadboard Kit 601

With circuit card adaptor. Connecting adaptors available with breadboard kits 100, 200, and 300 permit use of printed basic circuit cards. A front panel with 30 standard holes is provided. Tube and transistor sockets may be positioned anywhere, with connections carried above the board. The micarta kit is made in three sizes.

Pacific Coast Electronics, Marketing Dept., Dept. ED, 2457 Chico Blvd., S. El Monte, Calif.

Price: $15.90 to $35.00.

Power Supply 617

Magnetic amplifier, transistor regulated laboratory power supply model MTR 28-100 has an output of 24 to 32 v dc at 100 amp. Dynamic regulation is ±0.5% line and ±2 v load. Static regulation for line and load is ±0.1%. Ripple is 20 mv rms. Overloads and short circuits can be sustained indefinitely.

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

Magnetic Pickup 360

Slow-moving metal objects breaking the magnetic field of the model 3045 pickup generate a signal capable of operating readout devices directly. Gear teeth of 20-pitch or greater will activate the device, generating a voltage and frequency proportional to speed. Unit weighs 1.73 oz.

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

Price: $48.50.

Salt-Spray Chamber 634

Self-contained salt-spray chamber, model S-102, has water reservoir, plumbing, and components in the cabinet. Test compartment is of fiber-glass resin construction. A water seal prevents salt fog from leaking out of chamber. Chamber dimensions are 32 x 21 x 24 in. MIL specs are met.

Wyle Laboratories, Dept. ED, El Segundo, Calif.

Silicon Diodes 574

High-reliability silicon diodes of general-purpose alloy types PS4559 and PS4560 have a failure rate less than 0.008% per 1,000 hr. Type PS4725 is a silicon diffused computer fast-logic switch having a failure rate of less than 0.004% per 1,000 hr.

Pacific Semiconductors, Inc., Dept. ED, 12955 Chadron Ave., Hawthorne, Calif.

P&A: *\$3.15 to \$3.60, 100 to 999; stock.*

Film Reader 638

Converts photographic data to digital form. Accuracy is ±3 microns or ±0.01% for static measurements, ±6 microns or ±0.02% for dynamic measurements. Digital error rate is less than one error of 2 microns per 2,000 readings. Magnification is 12x; screen area is 24 x 24 in.; resolving power is 100 lines per mm.

Itek Laboratories, Dept. ED, 10 Maguire Road, Lexington 73, Mass.

NEW PRODUCTS

Signal Generator 621

From below 100 mc to 3,000 mc are provided by the model 190 signal generator. Long-term stability is better than 1 part in 10^6; short-term phase stability is better than ±0.5 deg. Tuning range is about ±0.005% of center frequency. Rf output is controlled between −30 and −130 dbm. Leakage is less than −145 dbm at 2 ft from generator. Unit is capable of remote operation.

Tridea Electronics, Inc., Dept. ED, 1020 Mission St., S. Pasadena, Calif.

Silicon Rectifiers 449

Multi-cell silicon rectifiers series CR101 through CR110 cover a piv range of 1,200 to 10,000 v. The rms supply voltage ranges from 840 to 7,000 v; average dc forward current at 60 G, 825 to 550 v; maximum forward-voltage drop, 1.2 to 9.6 v. Uses include atomic accelerators, radio and TV transmitters, oscilloscopes and other equipment.

Radio Corp. of America, Dept. ED, 30 Rockefeller Plaza, New York 20, N.Y.

***Price:** $8 to $40.*

Vibration Measuring System 358

Continuous, automatic recording of complete data from accelerometer signals, including phase, distortion, and amplitude, is provided by the model VMS vibration measuring system. Accelerometer signals from 10 cps to 10 kc are slowed to 1/3 to 3 cps for oscillograph recording. Full scale output is either 5 ma or 5 v. Units with either 5 or 10 channels are available.

Chadwick-Helmuth Co., Dept. ED, 472 E. Duarte Road, Monrovia, Calif.

***P&A:** $4,500, 5-channel; $6,000, 10-channel; 8 weeks.*

Linear-Motion Potentiometer 356

High-level output linear-motion potentiometer, model 150, has a resolution of 0.00006 in. The transducer has a power rating of 0.1 w continuous at 400 F. Total travel ranges from 0.015 to 0.07 in. Static error band is ±2%. Unit measures 1-1/2 in. long by 9/16 in. in diameter, weighs 1.3 oz, and operates under extreme shock, vibration, and temperature conditions.

Bourns, Inc., Dept. ED, 6135 Magnolia Ave., Riverside, Calif.

Availability: *from stock.*

Fuel Trace Detector 353

Portable unit called the model 4060 Olfactron detects traces of toxic rocket fuel and oxidizer in the atmosphere. Device occupies about half the volume of a portable typewriter. Sensitivity is one part in four million for fuel vapor and one part in two million for oxidizer.

American Systems, Inc., Dept. ED, 1625 E. 126th St., Hawthorne, Calif.

P&A: *$1,985; from stock.*

Constant Voltage Supply 622

Regulation of 0.0008% per v ac variation between 90 and 130 v ac input is achieved by the model CVS constant voltage supply. Output is 1.5 ±0.0037 v dc, 1.4 ma at 20 C. Operating temperature is 0 to 60 C. Device measures 2.9 x 2.7 x 2.3 in. and weighs 14 oz. Three Zener regulator stages are provided. Unit is suitable for voltage reference and bridge circuits.

Thermo Electric Co., Dept. ED, Saddle Brook, N. J.

NEW PRODUCTS

TV Transmission Accessories 363

Closed-circuit transmission of TV signals is accomplished with these three wide-band accessories. Model AVM-3 video modulator converts the video carrier to a modulated rf signal at one of four vhf crystal-controlled carrier frequencies. Model AVD-3 demodulator converts the signal back into video form, flat within ±1 db to 8 mc. Model AVA-1 amplifier compensates for line losses, providing 30-db gain.

Cohu Electronics, Inc., Kin Tel Div., Dept. ED, P. O. Box 623, San Diego 12, Calif.

***P&A:** $525, $700, and $425; 45 days.*

Diode-Recovery Test Set 443

Automatic diode-recovery test set model 410 measures reverse recovery times down to 1 nsec. Test result may be a front-panel meter reading or an analog voltage proportional to recovery time. The instrument consists of a built-in 0.3-nsec risetime pulse generator and two built-in bias supplies.

Lumatron Electronics, Inc., Dept. ED, 116 County Courthouse Road, New Hyde Park, L.I., N.Y.

***Availability:** after September.*

Static Inverters 354

Regulated power supplies, type MC, provide dc outputs of 0.5 to 10 kv from a 28-v dc input. Efficiency at 3-w output is 50% min. Miniaturized and oil-filled units measure 1-1/2 x 3-1/4 x 3-3/16 in. Circuitry, all solid-state, is not damaged by short-circuit or reversed-polarity input. Devices meet MIL-E-5272B missile requirements up to 100,000 ft, and operate at 80 C.

Arnold Magnetics Corp., Dept. ED, 6050 W. Jefferson Blvd., Los Angeles 16, Calif.

***P&A:** $175 to $250; four weeks.*

Binary Counter 361

Transistorized binary counter, model FF-1001, is settable from 1 to 16 counts. All significant points are available for external injection or detection of signals. Plug-in circuit board is potted in epoxy-glass and contained in a 4-1/2 x 5-1/2 x 3/4 in. aluminum shield.

Digital Design Corp., Dept. ED, P. O. Box 21, Clay, N. Y.

***P&A:** $135.00; stock to 6 weeks.*

Electric Cord Reel 362

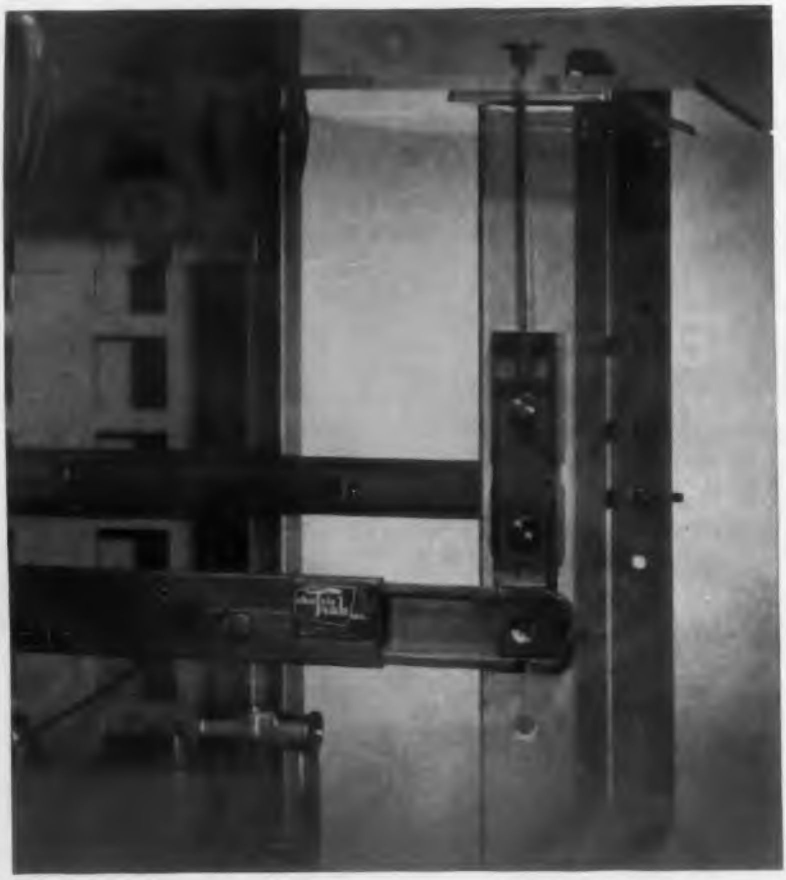
For portable equipment, these electric cord take-up reels hold 4 to 10 ft of No. 18/2 SP2 electric cord. Called Cord-on-Cord reels, the devices measure 3-1/4 to 5 in. in diameter and 1-1/2 in. wide. Reels for internal and external mounting are available.

Cordomatic Reels, Dept. ED, 1724 W. Indiana Ave., Philadelphia 32, Pa.

Inclinometer 357

Made for oceanographic research, the model 109 inclinometer measures tilt angles from 5 to 35 deg. Tolerance is 1 deg max. Device operates under turbulent conditions, and in temperatures from 0 to 110 F.

Braincon Corp., Dept. ED, P. O. Box 312, Marion, Mass.



From CHASSIS-TRAK NEW FEATHER-LIGHT DETENT SLIDE!

Model C-300 Detent locks in three service positions — 90° up, horizontal, 90° down

Chassis-Trak continues to set the pace in slide design with the new Model C-300 Detent. Never before has a tilt-lock slide come in such a small package, yet despite its space-saving size — $1\frac{3}{4}$" high, $\frac{5}{16}$" wide — the Model C-300 Detent will support chassis loads up to 50 lbs. Not the least of the new slide's attractive features is its low price — lowest of any detent slide on the market.

Made of hard, cold-rolled steel, each slide is cadmium plated and then coated with Poxylube 75, a bonded film formulation of molybdenum disulfide, which provides permanent dry lubrication. Solid bearings on all surfaces afford high resistance to shock and vibration.

Model C-300 Detent Slides are available in seven lengths — 12 to 24 in. — and are designed for mounting electronic equipment in any standard rack or cabinet. Like all Chassis-Trak Slides, they are easy to install and smooth and trouble-free in operation.

Model C-300 Detent slide shown locked in horizontal position.

chassis Trak inc.

For further information contact:

525 South Webster, Indianapolis 19, Indiana

CIRCLE 105 ON READER-SERVICE CARD

NEW PRODUCTS

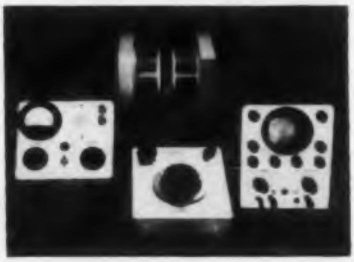
AC Ratio Standards 366

Accuracy to 0.0001% is offered by the series 1000 ac ratio standards. Basic ratio sections include high-frequency ac, low frequency ac, and dc. Ratios in ac sections range from 1.111111 to −0.11111. Units provide switching transient suppression, 6- or 7-place resolution, and terminal linearity of 0.0001%. Dc sections use resistive dividers with 6-place resolution and 0.001% terminal linearity.

Gertsch Products, Inc., Dept. ED, 3211 S. La Cienega Blvd., Los Angeles 16, Calif.

P&A: *$450; 30 days.*

ESR Spectrometer 352



Paramagnetic resonance studies can be conducted with the model AL-55 electron spin resonance spectrometer. Free radicals in either solution or solid form can be studied. Transistorized unit exhibits strong resonance signals. The equipment is made for educational laboratory experiments.

Alpha Scientific Laboratories, Inc., Dept. ED, P. O. Box 333, Berkeley 1, Calif.

P&A: *$1,875; from stock.*

Cabinets 365

The Shadow Cabinet, illustrated, has removable front, rear, and bottom panels. Four sizes are available. The Contour Utility Cabinet, not illustrated, has a one-piece steel body with curved lines. Available in six sizes.

Bud Radio, Inc., Dept. ED, 2118 E. 55th St., Cleveland 3, Ohio.

Coded Transmitter Panel 376

For automatic fire-detection and alarm systems, the series MCN coded transmitter can be connected to most standard coded systems. Alarm, trouble, and restore signals are provided. Local alarm is operated immediately, without waiting for transmission of signals. Relay equipment is sealed in metal plug-in units.

Notifier Corp., Dept. ED, 3700 N. 56th St., Lincoln 4, Neb.

Hydrocarbon Analyzers 355

Trace concentrations of hydrocarbons in gases, vapors, or the atmosphere are detected by models 108 and 109 analyzers. Sensitivity is four parts per million full scale. Model 108 is for panel mounting, and model 109 is for field or laboratory use.

Technical Information Dept., Beckman Scientific and Process Instruments Div., Dept. ED, Fullerton, Calif.

VHF Amplifier 467

Bandwidth is 30 to 300 mc. Model LPD01 distributed-type miniature vhf amplifier has a power output of about 0.1 w cw and an output impedance of 50 ohms. It meets MIL-3-5400. Size is 5 x 1-1/4 x 2-1/8 in.

Motorola Military Electronics Div., Dept. ED, 8330 Indiana Ave., Riverside, Calif.

P&A: *$595; 30 days.*

Patchboard 419

Pre-programing patchboard provides from 200 to 600 contacts. Pre-programed panel is engaged with rear frame assembly by a lever which is operated with one hand. Patchboard may be mounted vertically or horizontally.

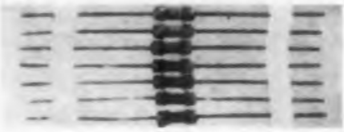
Vector Electronic Co., Dept. ED, 1100 Flower St., Glendale 1, Calif.

Availability: *one week.*

Tubular Capacitors 430

Axial-lead tubular capacitors types 7301 and 7302 are designed for automatic insertion machines. The units have real packaging to meet the high-volume production requirements of radio, TV, and computer manufacturing.

Aerovox Corp., HI-Q Div., Dept. ED, Myrtle Beach, S. C.



Synchro 367

A 2,000-hour lifetime is expected of the Harosyn synchros, available in sizes 5, 8, 10, and 11. Unit, resembling an induction motor, has no rings or brushes. Synchros are explosion-proof, may be immersed in fluid, and meet MIL-S-20708 specifications.

Harowe Servo Controls Inc., Dept. ED, Mount Road, Lenni Mills, Pa.

Availability: *from stock.*

Bandpass Filter 370

Crystal filter provides 10.7 mc bandpass with a spurious free bandwidth of 250 kc and bandwidth-to-center-frequency ratio greater than 2.3%. Device has a passband ripple of 2 db max. Filter, hermetically sealed, occupies 2-1/4 cu in.

Hughes Aircraft Co., Dept. 92-10 Dept. ED, P. O. Box 90904, Airport Station, Los Angeles 45, Calif.

Infrared Source 433

Miniature infrared source is for use in ground, airborne and space applications. It weighs 3 oz, and measures 0.75 in. in diameter and 1.5 in. long. Radiation emitted approaches 99.9% of a true blackbody source. Thermal energy generated is nearly 2,000 K.

Special Devices, Inc., Dept. ED, 16830 W. Placerita Canyon Road, Newhall, Calif.

precise 5 VOLT POWER SUPPLY for instrumentation and telemetry

This compact, reliable DC to DC converter provides conversion of 28 ± 4 volts DC to a precision 5 volts DC @ 100 ma. or 1 amp. Measuring only 4¾" x 3½" x 1¼", weighing only 20 ounces, it gives a completely accurate power supply and maintains it, with no change, within the temperature range. Designed, developed and produced by Temco Electronics, the converter is a solid state, off-the-shelf package that meets or exceeds mil specs. It will meet your airborne or ground telemetry and instrumentation power supply specifications with no necessity for change in configuration. We invite your inquiries on this unit. It is also available in other voltages to meet specific applications.

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CIRCLE 107 ON READER-SERVICE CARD

Precision Chain and Sprockets 378

Miniature precision chain and sprockets are available from 5.9 to 57.525 in. long. Pitch is 0.1475. Pin-type hub sprockets are available in 1/8, 3/16, and 1/4 in. shaft sizes, with hubless sprockets available in a 3/8 in. bore size. Chain is of nonmagnetic type 18-8 stainless steel; sprockets are available in stainless steel, aluminum, linen phenolic or nylon.

PIC Design Corp., Dept. ED, 477 Atlantic Ave., East Rockaway, L. I., N. Y.

***P&A:** $45 to $75; 10 days.*

Rack and Panel Connector 381

With 2 to 78 contacts. The IPD series rack and panel connector is offered in over 20 basic contact arrangements. Contact rating is 10 to 80 amp. The connector is rectangular with a shell of die-cast aluminum alloy. Insert insulation is phenolic.

SPEC Electronics, Dept. ED, P. O. Box 64314, Los Angeles 64, Calif.

***P&A:** $3 to $20; 5 days.*

Decommutation Station 379

Standard telemetry signals and nonstandard outputs of telemetry receivers, subcarrier discriminators, tape, or signal simulators are accepted, processed, and demodulated by the model 5400 decommutation station. A phase-lock-loop synchronizing system is included.

The Ralph M. Parsons Co., Electronics Div., Dept. ED, 151 S. DeLacey Ave., Pasadena, Calif.

Bridge Control Readout 623

Power source and amplification are self-contained in this bridge control readout instrument, model BCR1-0. No additional resistors are needed to test strain-gage devices. Exciter voltage is 2.5 to 10 v dc; calibration point, 40 K; gain stability, ±0.5% over 8 hr; nonlinearity and hysteresis, less than ±0.5% of full scale.

Statham Instruments, Inc., Dept. ED, 12401 W. Olympic Blvd., Los Angeles 64, Calif.

Static Inverter 401

Convection-cooled static inverter, model F-773-A, operates from a 28-v dc source and provides a three-phase, 115-v, 400-cps output with 1% voltage regulation. Harmonic distortion is less than 1%, and frequency is stable to within 0.05% of 400 cps. Power output is 250 va. Unit operates at 65,000 ft and meets MIL-E-5272-C specifications.

ITT Corp., Industrial Products Div., Dept. ED, 15191 Bledsoe St., San Fernando, Calif.

Lead Cutter 628

No scars or marks are left by this axial-lead cutter and bender. Designated model U, the device handles any stackable axial-lead component either automatically or semi-automatically, at 5,400 components per hour. Lead length tolerance is 0.005 in. Bender does not remove oxide from leads.

Develop-Amatic Engineering, Dept. ED, 923 Industrial Ave., Palo Alto, Calif.

NEW PRODUCTS

Medical Telemetry System 372

Three channel multi-pack, about the size of a box of matches, amplifies, multiplexes, and transmits biomedical signals over an fm band. They are received up to 100 yd away by an fm tuner, and the model B-30D discriminator restores the signal to recording or display form. One channel is suitable for electrocardiograph signals; others are designed for slower varying signals.

Medical Electronics and Bionics Dept., Litton Systems, Inc., Dept. ED, Woodland Hills, Calif. ***Availability:*** *60 days.*

Telemetering Link 380

With 7, 14, 30 to 60 channels. Type 104 multiplexer and demultiplexer, designed to meet IRIG standards, are for use in telemetering between air and ground. The multiplexer has an input impedance of 50 K, a sampling rate of 125 per sec and an accuracy of $\pm 0.25\%$.

Sierra Research Corp., Dept. ED, P. O. Box 22-240 Cayuga Road, Cheektowaga, N. Y.

Pressure Switch 351

Subminiature pressure switch, model 6289, withstands 50-g shock, 15-g vibration, and 200% overpressure. Device is 3/4 in. in diameter by 3/4 in. long, and weighs 1.5 oz. Switch is field-settable within 10 psig of set point. Accuracy is ± 2 psig; repeatability is 0.5 psig. Operating temperature range is -65 to $+200$ F. Contacts are spst, 0.2 amp resistive at 28 v dc or 115 v ac.

Aero Mechanism, Inc., Dept. ED, 13866 Saticoy St., Van Nuys, Calif.

Memory Drum 369

Compact stainless-steel memory drum stores 286,000 bits. Drum has a 4-in. diam and a packing density of 160 bits per in. Device has a high strength-to-weight ratio and resists corrosion.

Hughes Aircraft Co., Dept. ED, Florence Ave. and Teale St., Culver City, Calif.

Dynamic Tester 373

Brush-type, V-scan shaft encoders are evaluated by the Mark I dynamic tester. Testing is done at variable shaft speeds up to 100 rpm. Logic elements in the tester compare consecutive interrogations with each other, rather than with a standard. Encoders in digital servos can be tested without disassembly. Autocorrelation rate is 6.25 kc. Sampling time is 120 nsec.

Guidance and Control Systems Div., Litton Systems, Inc., Dept. ED, Woodland Hills, Calif.

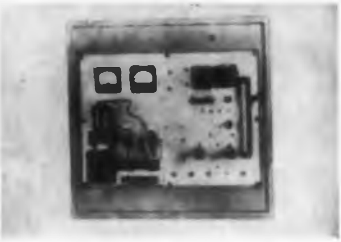
Radio Antenna 368

Retractable whip-type antenna, type WRA-2, is made for submarines. A helix loading coil at the antenna base can be remotely tuned to any frequency from 2 to 32 mc. Peak power is 5 kw. Antenna can be withdrawn in 40 sec.

Hoffman Electronics Corp., Dept. ED, 3761 S. Hill St., Los Angeles, Calif.

NEW PRODUCTS

Variable-Speed Drives 483



Regulation is 0.5% to 2% of set speed on standard line of variable-speed drives; custom drives can have a regulation of 0.1%. Standard units have drift of 0.05% to 0.5%; custom units have drift of 0.025%. Remote controls are available.

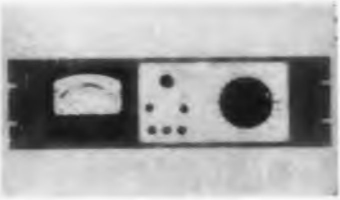
Tenney Engineering, Inc., Dept. ED, 1090 Springfield Road, Union, N. J.

Epoxy-Encased Capacitors 426

Range is 0.005 to 3 μf in ratings of 200, 300, 400 and 600 v dc. Designed for missile use, type GAA epoxy-encased paper capacitors are rectangular, fitting flat against printed-circuit boards and permitting close stacking. A 0.01-μf unit measures 0.17 x 0.29 x 0.5 in.

Hopkins Engineering Co., Dept. ED, 12900 Foothill Blvd., San Fernando, Calif.

Volt-Ohm-Milliammeter 482



Mirror-scaled volt-ohm-milliammeter has a total of 68 ranges and has frequency compensation from 35 cps to 20 kc. Other features are: meter protection against overloads, high accuracy on ac and dc ranges, wide range of ambient temperatures, dc reversing switch.

Triplett Electrical Instrument Co., Dept. ED, Bluffton, Ohio.

Thermocouples 375

For in-wall temperature measurements, these thermocouples can be fabricated in the same material as the wall, whether plastic, nonmetallic, or metallic, thereby maintaining constant heat conduction. Flat ribbon wires comprise the thermal elements. Temperature range is −320 to +5,000 F.

Nanmac Corp., Dept. 11, Dept. ED, P. O. Box 8, Indian Head, Md.

Subminiature Resistors 418

Glass-encapsulated resistors, type CG-1/8. are rated at 1/8 w and are 1/4 in. long. Sealed in a hard glass envelope, the resistors are said to have unusual mechanical strength and stability. MIL specs are met. Resistances range from 10 ohms to 100 K, at 1% tolerances.

Texas Instruments, Inc., Dept. ED, P. O. Box 5012, Dallas 22, Tex.

Availability: *from distributors.*

Indicator Lights 374

Miniature light assemblies are made for airborne and ground support equipment. Designated series R2600, the indicator lights have either permanently installed miniature lamps, or replaceable size T-1-3/4 lamps. Resistors in series allow operation at any of the usual line voltages. Colored legends can be accommodated.

Radar Relay, Inc., Dept. V, Dept. ED, 2322 Michigan Ave., Santa Monica, Calif.

NEW PRODUCTS

Modular Air-Conditioner 393

Electronic-cabinet air-conditioner circulates cooling air through equipment. Designated model 143, the unit requires 115-v, 17.5-amp ac power. Outlet air temperature is maintained below 65 F with an 8,200-BTU-per-hr load at an ambient temperature of 105 F. Unit delivers 300 cfm against an external static pressure of 1 in. of water.

Advanced Structures Div., Telecomputing Corp., Dept. ED, P. O. Box 150, Monrovia, Calif.

Pressure Transducer 570

Corrosion-resistant material, stainless steel type 17-4, is used in case and diaphragm of this model of the series 4-326 strain-gage pressure transducers. Pressure ranges from 0 to 100 psi to 0 to 10,000 psi absolute and gage are available.

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

All-Purpose VTVM 400

For radio, TV and experimental work. Model 48 all-purpose vtvm provides: seven dc voltage ranges, with 7-1/3 meg per v sensitivity of the 1.5-v range; seven ac voltage ranges, peak-to-peak and rms, with a frequency response of ±1 db from 40 cps to 4 mc; seven db ranges from −6 to ±66 db; seven resistances ranges, with 10 ohms, center scale, on initial range.

Precision Apparatus Co., Inc., Dept. ED, 70-31 84th St., Glendale 27, L. I.

Price: $55.95.

Motors 640

For memory drums and similar applications. Motors are synchronous and have good damping. Full load efficiency at 80% assures cool operation. Angular velocity is constant to less than 1 part in a million drift over 5 days working time.

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

Punched-Card Reader 468

From 400 to 3,000 cards per min can be read by the Speedreader 2000 punched-card reader. Cards can be read asynchronously on demand from the computer or system.

Uptime Corp., Dept. ED, 620 Gould Lane, Hermosa Beach, Calif.

Transistorized Relay 465

Less than 4 μw will operate this transistorized relay. Contacts, 4pdt, are rated at 5 amp inductive, 120 v ac. Temperature range is −50 to +80 C. Devices are potted in a metal can meeting MIL-R-6106 Class O specifications.

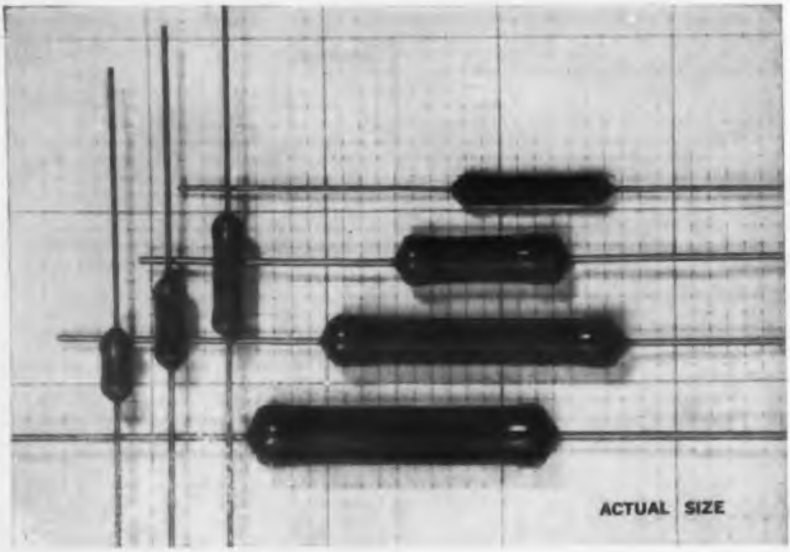
Med-Tronics Mfg. Co., Dept. ED, 2019 Westchester Ave., New York 62, N. Y.

Price: *$115.00 in single units.*

Plugs and Jacks 395

Miniature, Teflon-insulated plugs and jacks are for high-density test panels. Type SKT-10 probe has 0.8-in. diameter. Insulation is stripped back enough to slip the wire conductor through the hollow probe. The end is dip-soldered. Type SKT-10 jack is easily mounted directly on a metal chassis.

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



THESE "WIRE-WOUNDS" ARE CIRCUIT SHRINKERS . . . . . *newly*

expanded line lets AXIOHM® power resistors go into smaller circuits!

Ward Leonard AXIOHM power resistors are now available in *seven* sizes—down to 2 watts, up to 12.5.

They're ideal for miniaturization in printed-circuits, industrial instrumentation and automation circuitry. But they're recommended for *any* electrical or electronic application where the highest stability and maximum overload capacity are required.

The seven AXIOHM sizes come in a complete range of resistance values (see table) from 0.1 to as high as 75,000 ohms. Naturally, they feature the qualities Ward Leonard has made famous in power resistors:

Vitrohm vitreous enamel; Ward Leonard's specially made ceramic core; specially selected and matched resistance wire; and strong, permanent, low-resistance, spot-welded, lead-to-end-cap junctions. 0.9

SIZES AND RATINGS

Rating (in watts)	Type	Resistances (ohms)		Dimensions (inches)	
		Min.	Max.	Length*	Diam.
2	2X	0.1	5,000	3/8	3/16
3	3X	0.1	10,000	1/2	3/16
4	4X	0.1	15,000	11/16	3/16
5	5XM	0.1	20,000	15/16	3/16
7	7X	0.1	25,000	1	3/16
10	10XM	0.1	50,000	1 3/4	5/16
12.5	12.5X	0.1	75,000	1 3/4	3/8

*Less leads.

Get complete details in Supplement C to Catalog 15. Write for your copy and a list of stocking distributors today. Ward Leonard Electric Co., 77 South Street, Mount Vernon, New York. (In Canada: Ward Leonard of Canada, Ltd., Toronto.)

RESULT-ENGINEERED CONTROLS SINCE 1892

WARD LEONARD ELECTRIC CO. MOUNT VERNON NEW YORK

RESISTORS • RHEOSTATS • RELAYS • CONTROLS • DIMMERS

See us at Booth 509 at the Wescon Show

CIRCLE 119 ON READER-SERVICE CARD

NEW PRODUCTS

Flash Source 414

Point-source light pulses with durations from 0.3 to 1 μsec are provided by this flash source. Four models have energy levels from 2 to 20 joules. Point source sizes range from 0.015 to 0.060 in. diameter.

Unilectron, Inc., Dept. ED, 129 Binney St., Cambridge 42, Mass.

***P&A:** $900; 15 to 30 days.*

Modular Racks 415

Square-cornered modular racks, series PRX, are 18 and 24 in. deep, and accommodate 19-, 24-, and 30-in. panels. Door can be mounted on front or rear of frame. Frame is made of 14-gage steel, and has 3/16-in. thick adjustable panel mounts. Holes punched in the bottom accommodate casters.

Premier Metal Products Co., Dept. ED, 337 Manida St., New York 59, N. Y.

Insulation Tester 425

For transformer testing in accordance with MIL-T-27A, Amendment 3, Paragraph 4.7.5, Item B. Model 4075 hypot test set is a combination of two instruments with a phase-shift network.

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

Mercury-Arc Lamp 484

High-pressure mercury-arc lamp type 200 is for applications such as fluorescence microscopy, projection systems and printed-circuit resist exposure. Rated at 200 w, it has an average brightness of 25,000 cd per cm^2.

PEK Labs Inc., Dept. ED, 4024 Transport St., Palo Alto, Calif.

P&A: *$49; stock.*

FM Signal Generator 466

For checkout of command receivers operating in the range of 400 to 550 mc, model 412 fm signal generator has six-place digital readout, accurate to within 1 kc. It can be frequency modulated to ± 300 kc by an external modulating signal, varying from 300 cps to 100 kc. Frequency stability is 0.0005% per hr.

Microdot Inc., Dept. ED, 220 Pasadena Ave., South Pasadena, Calif.

Latching Relay 435

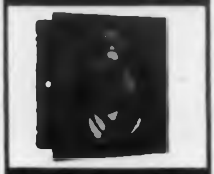
For use as a guard relay, series EML latching relay has manual reset. It is available for dc or ac coils of up to 220 v and has a life of 100 to 200 million operations. It has a contact capacity of 13 springs on one pile-up and 12 on the other.

General Telephone & Electronics, Automatic Electric Co., Dept. ED, Northlake, Ill.

P&A: *$5; 45 to 60 days.*

Gold Seal Muffin
"SKELETON FAN"

Gold Seal Muffin
"VENTURI FAN"



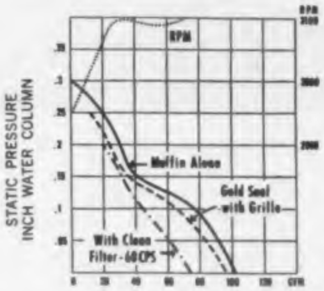
Gold Seal Muffin
"GRILLED FAN"

Gold Seal Muffin
"FILTER FAN"

Minimize component derating—increase life expectancy — assure top performance — KEEP IT COOL with a new Gold Seal Muffin Fan by Rotron.

The Gold Seal Muffin Fan offers "expensive" cooling performance at commercial-equipment prices. No longer is it necessary to settle for haphazard phono motor/blade assemblies. The Gold Seal Muffin Fan provides a completely integrated design of motor, blades, optional venturi, grille and filter in performance-matched assemblies.

100 CFM free delivery—quiet, quiet performance—1½" deep x 4-11/16" square small—version choice to fit every requirement — long, long life motor — looks like the quality it is!



***VERSATILE**...If 100 CFM will cool it, the Gold Seal Muffin Fan will do it best! Reversible air-flow, filtered, grilled, or plain!*

STILL LESS THAN $8.00 IN QUANTITY!

Write For Complete Details Today . . .

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ROTRON mfg. co., inc.

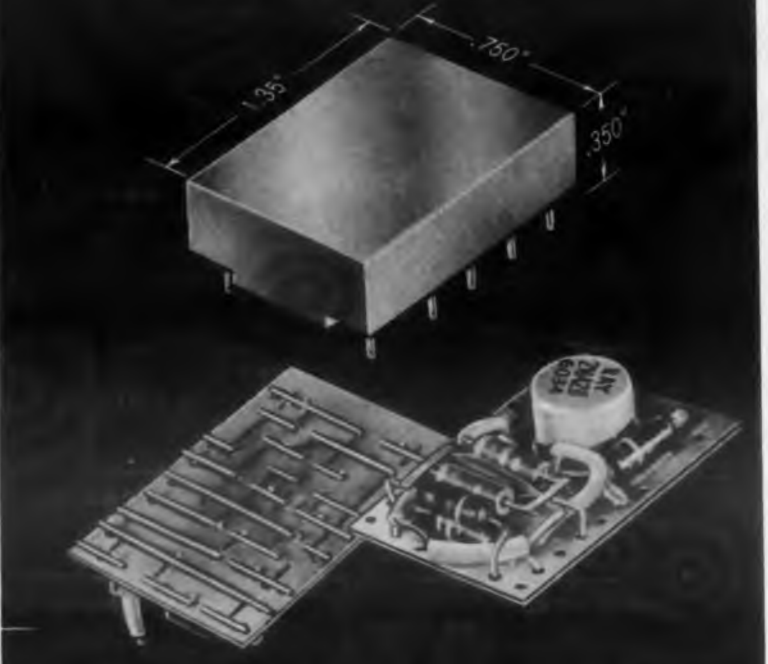
WOODSTOCK, NEW YORK • ORiole 9-2401

In Canada: The Hoover Co., Ltd., Hamilton, Ont.

CIRCLE 122 ON READER-SERVICE CARD

9 NEW

RAYTHEON WELD-PAK STANDARD DIGITAL MODULES



feature welded connections for maximum reliability

New Weld-Pak standard digital circuit modules provide extreme compactness and unequalled mechanical ruggedness. Nine standard modules featuring Raytheon-developed welding techniques and three-dimensional packaging are now available.

NOR Gate, NOR Gate and Emitter Follower, Flip-Flop, Self-gated Binary, Emitter Follower, Diode AND, Diode OR, Clock-Variable, and Inverter circuits are offered in this new group of color-coded Weld-Pak modules. Standard components, conservatively operated, are used throughout. Accurately programmed welding, with short weld cycles and very low heat, is used to insure reliable connections. Thorough quality control measures and Raytheon-engineered reliability assure long and trouble-free operation.

For full details and technical data on Weld-Pak standard digital circuit modules please write: Raytheon, Industrial Components Division, 55 Chapel Street, Newton 58, Massachusetts.

For Small Order or Prototype Requirements See Your Local Franchised Raytheon Distributor.

RAYTHEON

RAYTHEON COMPANY

INDUSTRIAL COMPONENTS DIVISION

CIRCLE 123 ON READER-SERVICE CARD

NEW PRODUCTS

Capacitor Standards 364

Tolerance of 0.25% and stability of 0.1% are specified for the models 83516-1 and 83516-2 precision capacitor standards, having capacitances of 0.5 and 1μf respectively. Operating temperature range is −55 to +85 C. Power factor at 1 kc is 0.02%. Temperature coefficient of resistance is −100 ppm per C. Dc working voltage is 400 v.

Central Scientific Co., Dept. ED, 1700 Irving Pk., Chicago 13, Ill.

***Price:** $22.50 and $35.00*

Sideband Crystal Filters 437

Miniature upper and lower sideband crystal filter has a 3- to 45-db carrier rejection in 200 cps. Unit occupies 11 cu in. Filter has a carrier of 5 mc with a passband width of 3.2 kc on each side.

Hughes Aircraft Co., Dept. 92-10, Dept. ED, P. O. Box 90904, Airport Station, Los Angeles 45, Calif.

Plug-In Attenuators 359

Made for the firm's dc amplifier model 112A, these four plug-in attenuators provide amplification and phase-inversion. Model 112A-A provides phase-inversion and gain steps of 0 to 1,000 with accuracy of 0.5% to 2 kc. Model 112A-B, non-inverting, provides gain, dc accuracy of ±0.001%, 0.1% at 2 kc. Model 112A-AO is the same as model 112A-A, but with an operational switch for connecting an external network. Model 112A-O is an empty plug-in chassis with circuit boards.

Kin Tel Div., Cohu Electronics, Inc., Dept. ED, P. O. Box 623, San Diego 12, Calif.

***P&A:** $45 to $530; one week.*

Wafer Capacitor 632

Shock, vibration, temperature, and altitude extremes are handled by this wafer capacitor molded in silicone rubber. Ratings from 100 pf to 0.1 mf ±10%, 2 kv to 12 kv pulse, 4 kv to 15 kv dc are available. Size is as small as 1-1/8 x 1-1/8 x 1/4.

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

Thermocouple Material 408

Flexible thermocouple material, Tempak, is ceramic-insulated and metal-sheathed. The material is manufactured with its own electrical leads and ceramic insulation, and can be coiled or bent on a radius as small as its own diameter. The material is made for use in corrosive media, high pressure, severe vibration and temperature environments. Material is available either in thermocouple assemblies or in continuous lengths up to 100 ft.

Temptron, Inc., Dept. ED, 7030 Darby Ave., Reseda, Calif.

Console Frame 389

Sloped-front console frame, model FS-1002, is made of 14-gage steel, and accommodates 19 and 24 in. panels. Sloped front is 19 deg from vertical. Holes in bottom accommodate casters, and a cutout is provided for leads.

Premier Metal Products Co., Dept. ED, 337 Manida St., New York 59, N. Y.

CIRCLE 125 ON READER-SERVICE CARD ➤

Multi-Pin Connectors 377

Microminiature connectors have 7, 19, and 47 contacts, and measure 3/8, 1/2, and 5/8 in. in diameter respectively. Having resilient inserts and potted back ends, units resist vibration, shock and moisture. Sockets are multiple-spring, closed-entry type, and are self-aligning. Sockets can be dip-soldered.

Omega Precision, Inc., Dept. ED, 757 N. Coney Ave., Azusa, Calif.

Precision Resistors 371

For high-frequency applications, the type 261-P precision wirewound resistors are rated up to 2 w, 5 meg. Units have low rise and low phase-shift, with 1-pf capacitance up to 800 K, and 1.5 pf max up to 1.25 meg. Windings are noninductive, operate from −65 to +125 C. Units measure 0.75 x 0.25 in. Tolerances of 0.01% are available.

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

Microanalyzer 478

Electron probe microanalyzer is made for identification and measurement of elements in specimen areas of less than 1 micron, weight down to 1 microgram. All elements above atomic number 11 can be identified; limit of detectability is about 0.1 to 0.1%.

Philips Electronic Instruments, Dept. ED, 750 S. Fulton Ave., Mount Vernon, N. Y.

Environmental Chamber 423

Reaches —250 F. Model WT-8-250 environmental chamber, with a mechanically refrigerated closed system, is for research, processing and production applications. It may be used in processing dies and tools, component testing for space vehicles, instrument calibration and nuclear-radiation testing.

Webber Manufacturing Co., Inc., Dept. ED, P. O. Box 217, Indianapolis 6, Ind.

Electronic Counter 429

For liquid-measuring systems, series 181709 nine-decade electronic counter can operate at speeds to 300,000 counts per min. A built-in gating device, operating over a temperature range of —30 to +130 F, calibrates flow meters under test. The counter consists of three decade-counter tubes and a six-digit magnetic counter.

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

Gear Reducers 428

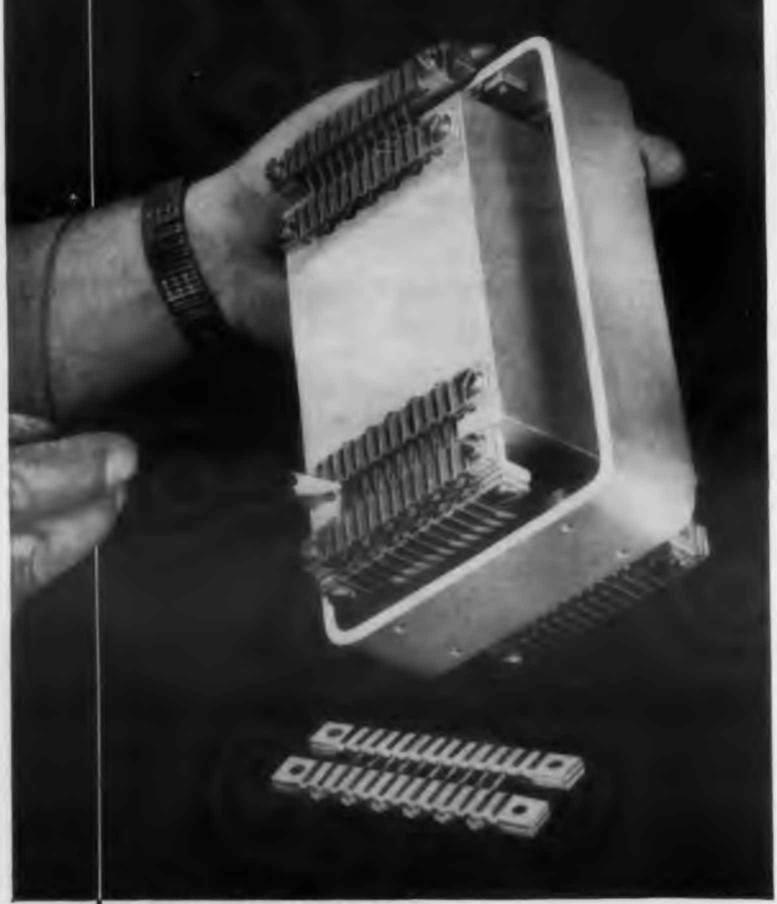
Two-speed gear reducers have reduction ratios of up to 282,475,249:1, energized, and 16,807:1, de-energized. Model 2SG-20, shown, is for applications in computer, control, guidance and automation fields where it is necessary to have reliable changing of reduction ratios in milliseconds.

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

***Availability:** 4 to 6 weeks.*

DETUNE VIBRATION ISOLATE SHOCK

From Aeroflex Laboratories—a major development in the control of vibration and shock—the all new field-proven Cable Isolation System.



NOW YOU CAN:

- Isolate your equipment against shock, vibration and noise, or any combination thereof—even in the presence of constant or long term "G" loading.
- Have three dimensional, all attitude isolation.
- Tune your isolation system in the field.
- Have a vibration control system that does not bottom out under heavy "G" loading and functions in a wide variety of environmental conditions including a temperature range of −100°F to +1000°F.

For information on how an Aeroflex Cable Isolation System can be used to solve your vibration and shock problems, write today to Dept. BR-5.

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AEROFLEX LABORATORIES

INCORPORATED

48-25 36th STREET • LONG ISLAND CITY 1, N. Y.

CIRCLE 127 ON READER-SERVICE CARD

NEW PRODUCTS

Digital Modules — 431

Range is 0 to 25 kc for the U series digital circuit modules. Four types are available: a dual three-input NOR unit, a power driver, a unit to convert a dual NOR to a flip-flop one-shot, or free-running multivibrator; and a pulse-gate unit. All meet MIL-STD-202B. Rectangular modules are 0.95 x 0.95 x 0.5 in.

Engineered Electronics Co., Dept. ED, 1441 E. Chestnut Ave., Santa Ana, Calif.

Silicon Rectifiers — 427

Tube-replacement silicon rectifiers series 1N1237, 1N2630, 1N570, 1N1150, 1N2389 and 1N2490 cover 1,500 to 10,400 piv. Designed for replacement of mercury and vacuum tubes, they have 4-, 5- and 7-pin and octal tube bases. All types have all-welded component connections.

General Instrument Semiconductor Div., Dept. ED, 65 Gouverneur St., Newark 4, N. J.
Availability: *stock.*

Capacitor Tester — 432

In-circuit capacitor tester type IC-60 is designed for radio and TV servicing. The open test can be made on capacitors rated as low as 5 μf and the test for shorted capacitors can be made with circuit shunting resistances of 10 ohms. Electrolytic values from 2 to 400 μf are indicated in two ranges.

Precision Apparatus Co., Inc., Dept. ED, Glendale 27, L. I., N. Y.
Price: *$32.95.*

Liquid-Level Control Unit 424

Ultrasonic liquid-level control unit operates under shock and vibration conditions aboard silo-launched missiles. A solid-state switch replaces the conventional relay. Output current is less than 10 μa, with sensor loaded, and 1 amp with sensor unloaded. Response time is 2 to 20 msec.

Acoustica Associates Inc., Dept. ED, 10400 Aviation Blvd., Los Angeles 45, Calif.

Tape System 444

Photoelectric tape preparation system consists of a standard typewriter, photoelectric encoder and a paper tape punch. Called the Tapemaker, it can be used to prepare any code in 5, 6, 7, or 8-level tape. Circuitry is all solid-state.

Invac Corp., Dept. ED, Natick, Mass.

Price: $1,600.

Power Supply 446

Computer power supply, model 40-160-0, provides positive and negative 6- and 15-v dc outputs, each with 2% regulation under maximum line, load and temperature change. Input is 100 to 125 v rms, 47 to 1,000 cps. Series, shunt, and magnetic-amplifier regulation is included.

Magnetic Research Corp., Dept. ED, 3160 W. El Segundo Blvd., Hawthorne, Calif.

Circuit Analyzer 470

Continuity and hipot tests of computer backboards, cables, and wiring assemblies are made by this automatic circuit analyzer. The equipment accepts instructions from punched cards or tape, or is self-programming. Ten thousand points are checked in less than one hour, with detailed error analysis, print-out and display on control console.

Contronics, Inc., Dept. ED, 43 Leon St., Boston 15, Mass.

fingerprint reliability

Because it never varies from birth to death, a fingerprint is the most reliable method of personal identification.

NAE silicon devices have fingerprint reliability because they never vary in performance, even under extreme conditions of temperature, shock or humidity. Test our semi-conductor devices. You can count on them to perform with reliability. These hermetically sealed, corrosion resistant units perform at full capacity for the life of the equipment. Wherever reliability is important specify NAE.

Here, at North American Electronics, Inc., we manufacture Silicon Rectifiers, Controlled Rectifiers and Voltage Regulators to exclusive specifications. These give them the finest characteristics available. In process, reliability is further assured by 100% testing to all specified parameters.

Get acquainted with NAE devices. Write for specifications, data and details.

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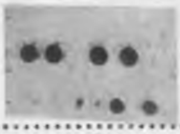
CIRCLE 130 ON READER-SERVICE CARD

ACCURATE RESEARCH STARTS WITH Rutherford PULSE INSTRUMENTATION



Model B-11 REMOTELY PROGRAMMABLE PULSE GENERATOR

Designed specifically for automated check out systems, this all-purpose Pulse Generator may be programmed to fill a broad range of requirements.

Model B-10 TRANSISTORIZED PORTABLE HIGH-SPEED PULSE GENERATOR

A versatile, general purpose portable unit for field and laboratory use featuring a self-contained, rechargeable battery pack which allows independent operation "in the field" as well as from standard line voltage.

Model B-9 HIGH QUALITY PULSE AND TIME DELAY INSTRUMENTATION

Designed on the modular building block concept and featuring accurate transistorized circuitry in a wide range of specifications. It provides special purpose generators to meet any pulse requirement.

Model B-7B HIGH REPETITION RATE PULSE GENERATOR

High performance and wide versatility—50v into 50 ohms @ 30% duty factor, rep. rate to 2 mc, widths .05 us to 10,000 us, delays to 10,000 us. Rack mountable new single unit construction.

Model B-5A 10 MEGACYCLE PULSE GENERATOR

Built to the most exacting standards of precision engineering, offers an unparalleled combination of good clean pulses and high repetition rate with no greater than 8 mus rise and fall time.

Model B5-2 HIGH SPEED 10 MEGACYCLE DOUBLE...PULSE GENERATOR

Producing 2 pulse trains derived from a single oscillator—featuring output pulse adjustable in width from 20 mus to 12.5 us, rise and fall time no greater than 8 mus.

Model B-2A A GENERAL PURPOSE PULSE INSTRUMENT

Produces pulses of accurately controlled widths, amplitude and time delay at low impedance. Internal oscillator gives rep. rates from 10 cycles to 100 kc. Pulse widths from .08 us to 1,000 us.

Model A-2 and Model A-4 TWO TIME DELAY GENERATORS

Feature low jitter, linear scales, small repetition rate effects, external connector provided for delay voltage so that unit may be externally time modulated, easily read dial controls.

Model A9 PULSE AND TIME DELAY SYSTEMS

A highly accurate, jitter free time delay generator featuring time delays from 0.8 to 100,000 usec. Multiple outputs including gates and ramp available at front panel connectors.

See our complete line at the Wescon Show—Booth Nos. 1501 and 1502, or for complete bulletin write to Dept. 8G.

Rutherford ELECTRONICS CO.

8944 Lindblade Street · Culver City, California · TWK-CVR-CY 4133

CIRCLE 131 ON READER-SERVICE CARD

NEW PRODUCTS

Postformable Tubing 420

Cloth and paper based Micarta tubing, types HY-370 and HY-371 respectively, can be postformed. After heating at 135 to 150 C for five min, the tubing softens and can be bent into desired configuration, which will become permanent at room temperature. Internal diameters range from 1/8 through 1 in., and wall thicknesses range from 1/32 through 3/16 in. Maximum length is 46 in.

Westinghouse Electric Corp., Micarta Div., Dept. ED, Hampton, S. C.

Silicon Diode 445

Switches at 0.5 nsec. Silicon point contact computer diode MA-4121 combines fast recovery characteristics with junction capacitance of 0.50 pf max. Forward characteristics are 10.0 ma at 0.55 v max and 30.0 ma at 1.0 v max. The maximum reverse current is 200 μa at -4 v. The diode is suitable for coincident circuits, pulse circuits, and all types of logic functions.

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

Pulse Height Analyzer 416

Multi-channel pulse height analyzer operates at 5 mc. Instrument has 256 channels with a dead time from 13 to 65 μsec, depending on channel. Channel capacity is 65,535 counts; rise and fall times are 0.6 μsec max; differential linearity is better than $\pm 2\%$, and integral linearity, $\pm 0.5\%$. Circuitry is transistorized on plug-in boards. Cabinet or rack mounting is available.

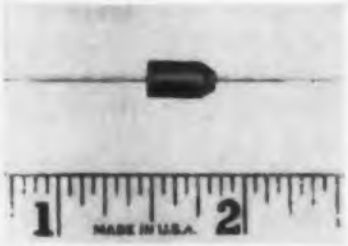
Radiation Counter Laboratories, Inc., Dept. ED, 5121 W. Grove St., Skokie, Ill.

Ruby Rods 410

For optical maser applications. These ruby boules are 0.04% chrome-doped, have had a growing cycle of 42 hr and an annealing cycle of 120 hr, and are 90-deg oriented with the C-axis perpendicular to the cylinder axis. The boules yield cylinders 1/2 in. in diameter and 8 in. long or 3/8 in. in diameter and 12 in. long.

Adolf Meller Co., Dept. ED, Box 6001, Providence, R. I.

Noise Diode 396



Produces up to 15-mc random noise. Features of type SD2-L noise diode include: theoretical Gaussian distribution of frequency, precise control output voltage, uniform variation of energy output per octave. From an input of 50 v dc, the output at 10 mc is about 100 μv.

Solitron Devices, Inc., Dept. ED, 500 Livingston St., Norwood, N. J.

***P&A:** $25; stock.*

Image Orthicons 406

Two types. Model ZL-7802 TV camera tube, a version of the G1-7629, has a field mesh to improve picture quality. Type ZL-7803 is recommended for critical recording applications in field network and tape production centers. It is interchangeable with the 7531 and 5820.

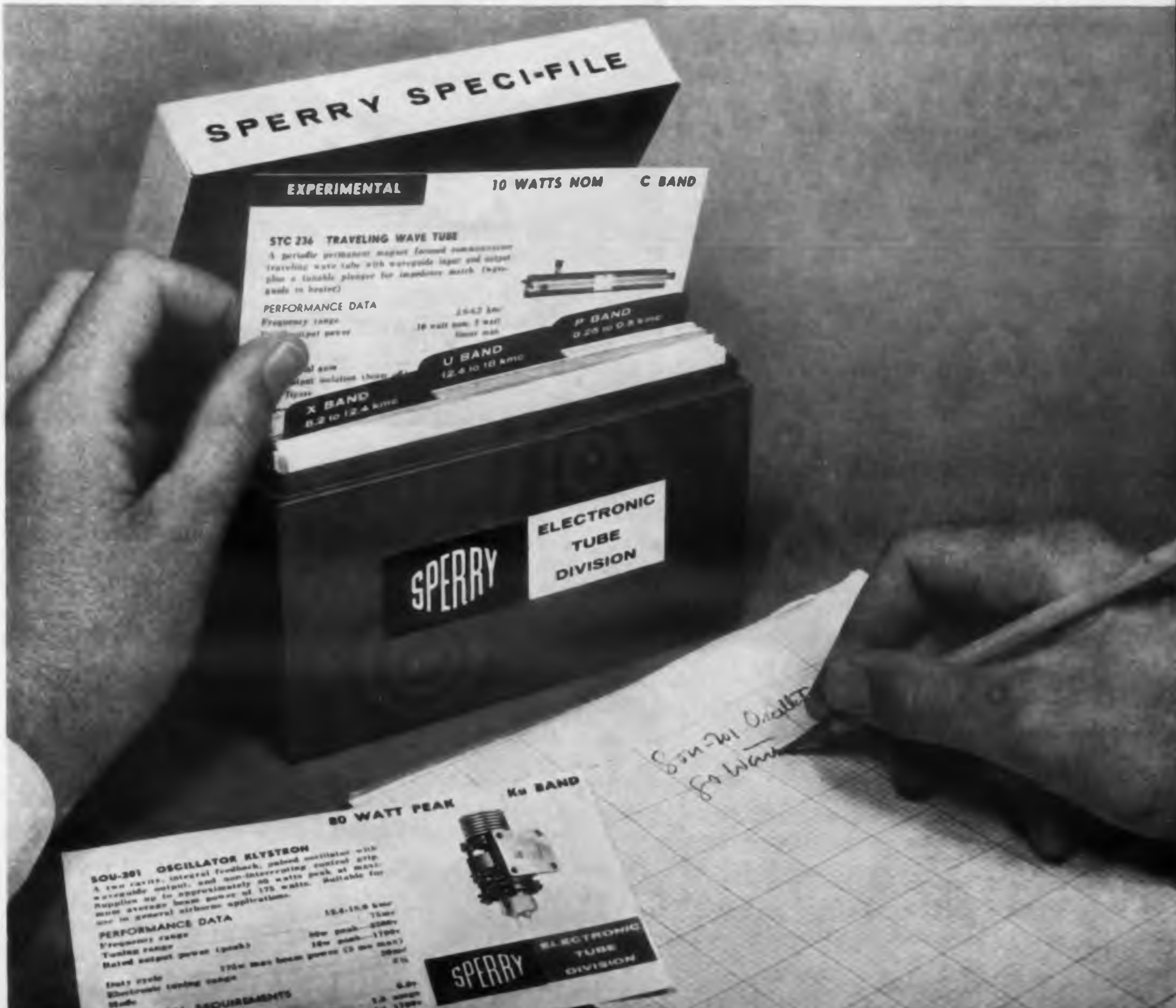
General Electric Co., Dept. ED, 3325 Wilshire Blvd., Los Angeles 5, Calif.

Interference Filters 407

For 0.38 to 0.8 microns. Optical interference filters have band-pass and spike characteristics in the spectral region of 0.38 to 0.8 microns. Spike filters feature bandwidths of 1% or peak wavelength with 60% or better transmission at center wavelength. Standard size is 1 sq in.

Infrared Industries, Inc., Dept. ED, Waltham, Mass.

***Price:** $55.*



NEW PRODUCTS

Teflon-Insulated Terminals 479

Withstand −100 to ±250 C. Teflon-insulated terminals can be furnished in a wide variety of types and sizes. Included are miniature stand-offs and feedthroughs, receptacles, plugs, jacks and probes. All withstand vibration, are corrosion-resistant and are unaffected by solvents, acids or bases.

Microdot Inc., Dept. ED, 200 Pasadena Ave., South Pasadena, Calif.
Availability: *stock.*

Variable Delay Line 469

With seven steps ranging from 1 to 20 nsec of coaxial delay. Model 1202 variable-step delay line has a bandpass of about 500 mc. Steps can be added to provide a total delay of 60 nsec. For laboratory applications, it can be used as a delay calibration tool and in measuring high-frequency phase and pulse delays.

Lumatron Electronics, Inc., Dept. ED, 116 County Courthouse Road, New Hyde Park, L. I., N. Y.
P&A: *$500; 30 to 60 days.*

Signal Simulator 472

Telemetry signal simulator model 2545 generates pam/nrz/pdm pulse trains which simulate the output of fm or pm telemetry equipment. Two tap switches provide all possible combinations of IRIG standard rates, plus a matrix of non-standard frame rates. Panel height is 7 in.

The Ralph M. Parsons Co., Electronics Div., Dept. ED, 151 S. DeLacey Ave., Pasadena, Calif.

Regulated Power Supply 421

Continuously variable dc voltage from 0 to 400 v at 0 to 150 ma; bias voltage variable from 0 to −150 v, 2 ma; 6.3-and 12.6-v ac, 3-amp heater supplies are provided by the model RS-24 regulated power supply. Regulation is 0.3% or 0.3 v load, and 0.4% or 0.5 v line. Ripple is less than 3 mv rms.

Precision Apparatus Inc., Dept. ED, 70-31 84th St., Glendale 27, L. I., N. Y.
***Price:** $99.95.*

Communications System 474

Digital data from all types of equipment are adapted by this modular communication system for simultaneous transmission over telephone lines. Interchangeable plug-in building blocks enable operation with a minimum of equipment, and easy adaptation to system changes. Capacity is 4,800 bits per sec.

ACF Electronics Div., ACF Industries, Inc., Dept. ED, Riverdale, Md.

Capacitor Standards 463

Rated at 1 and 0.5 μf, models 83516-1 and 83516-2 capacitor standards are for laboratory use or applications as circuit elements in tuned circuits, measurement circuits and filter networks. Capacitance stability is ±0.1%; tolerance is ±0.25%; power factor at 1 kc is ±0.02%; wvdc is 400.

Central Scientific Co., Dept. ED, 1700 Irving Park, Chicago 13, Ill.
***Price:** $35 and $22.50.*

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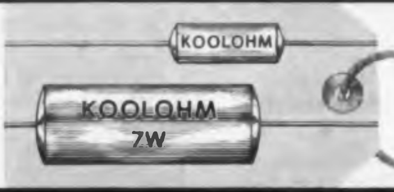

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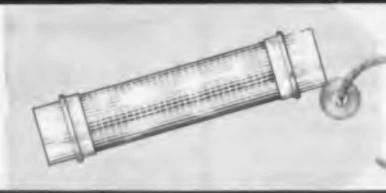
7000 (Molded shell), 7010-B (Ceramic shell)



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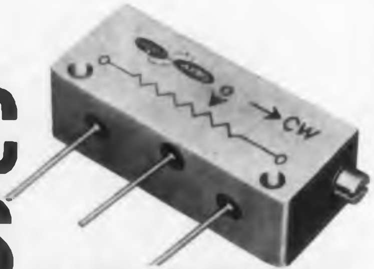


NEW PRODUCTS

Signal Conditioning Unit 475

Transducer signal conditioning unit type PS-290 consists of a power supply with excellent regulation and complete isolation from the line for outputs from millivolts to 16 v. Warm-up time is a few minutes. Output ripple is less than 500 mv peak-to-peak, or 200 mv rms; line regulation is less than 0.02%; output impedance is less than 0.05 ohms.

Microdot Inc., Dept. ED, 220 Pasadena Ave., South Pasadena, Calif.

Tachometer Generators 447

Completely shielded units can be furnished with temperature stabilizing system. Typical of this line of tachometer generators, type T10.0 has a sensitivity of 48 v per radian per sec, linear from 0.1 earth rate to 20 rpm, with a maximum instantaneous error of 0.25%. A wide variety of units is available.

Kollmorgen Corp., Inland Motor Corp. of Virginia, Dept. ED, Northampton, Mass.

Pellets and Washers 448

Made in semiconductor materials such as indium, gold, lead, tin, aluminum and a wide range of alloys. A new stamping process, designed especially to meet the requirements of mesa and epitaxial semiconductors, permits pellet and washers as thin as 0.000250 in.

Semi-Alloys, Inc., Dept. ED, 20 N. MacQuesten Parkway, Mt. Vernon, N.Y.

Thin-Film Resistor 476

Microminiature thin-film resistor network has 12 tinned terminals which allow for resistances ranging from 130 ohms to 51 K. The resistors are thin metal films placed on a glass substrate by vacuum deposition. They have been used in the firm's model 1000 DT microminiature amplifier.

Halex, Inc., Dept. ED, 310 E. Imperial Ave., El Segundo, Calif.

***Price:** $50.*

Nomogram Converts Signal-Level Terms

W. J. Connor
Engineering Leader
Defense Electronic Products
Radio Corporation of America
Camden, N. J.

ENGINEERS working on communications systems often must compare performance data that have been specified in different terms, or have been based on different references. Here is a straight-line nomogram which reduces considerably the time for converting between the terms currently in use. The terms are defined below.

dbm —An expression of power in decibels with respect to a reference of 1 mw. Thus, 1 w corresponds to a level of +30 dbm.

db_{RN} —This term, "db above reference noise", is used to express noise levels with respect to the United States standard reference noise power level of 90 db below 1 mw at 1 kc.

dba —The unit of measurement obtained from the Western Electric 2B noise set, in widespread use in the United States. This meter contains a weighting function known as FIA, a filter network designed to yield measurements which are representative of the actual disturbing effect of noise upon the listener. Therefore, it is limited to speech use only. One thousand cycles is the reference frequency of the FIA network. This corresponds to the 1,000-cycle test tone normally used in the United States. When measuring random noise in a standard voice channel, a reading obtained from this weighted instrument will be 3 db less than one obtained from an identical unweighted instrument. Identical readings will be obtained, however, for the single frequency, 1,000-cycle test tone.

Psophometric EMF—Noise is commonly measured in Europe by means of a psophometer which gives a reading of the psophometric voltage, V, when connected across 600 ohms. This reading is one half of the psophometric electromotive force, E, because by definition, the source has a 600-ohm internal resistance. An FIA-type weighting network is incorporated in the instrument. However, since it is customary in Europe to use an 800-cycle tone at zero level as a reference, the weighting curve is shifted to an 800-cycle reference frequency.

The use of the nomogram, next page, is illustrated by the following examples:

A. Test Tone Measurements:

This measurement involves a single frequency only and the weighting function of the noise meter (if used) will have no effect. This assumes that the test frequency is compatible with the unit's reference frequency.

1. A 1-mw, 1,000-cps, test tone signal developed across 600 ohms is equivalent to 0 dbm or 85 dba.
2. A 1-mw, 800-cps tone across 600 ohms is equivalent to 0 dbm or 1,600 mv of psophometric electromotive force E. The psophometric voltage $V = E/2 = 800$ mv.

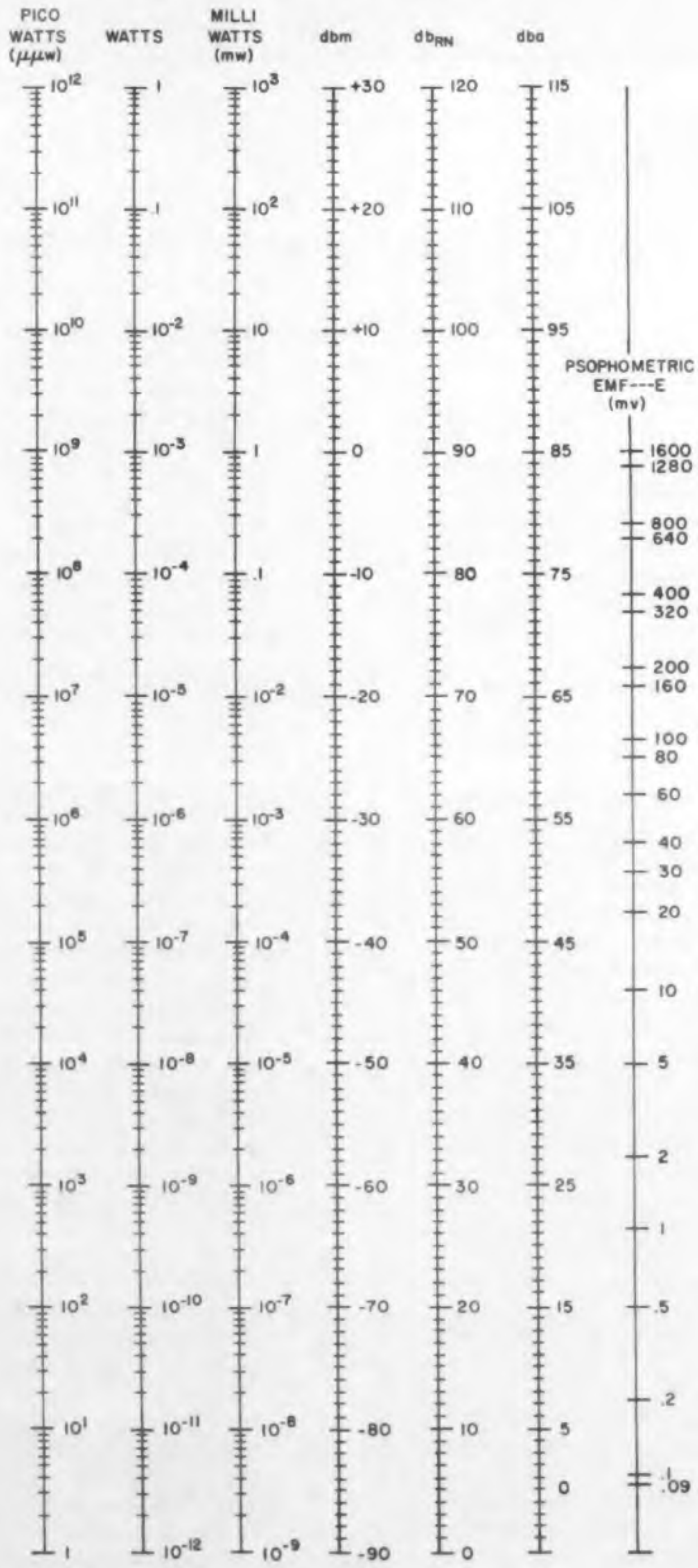
B. Noise Measurements:

1. 1 mw of white (random) noise in a voice channel developed across a 600-ohm load is equal to 82 dba.
2. 38 dba of random noise in a voice channel at a 0 dbm reference signal level point is equivalent to a signal to noise ratio of $85 - 38 = 47$ db weighted. Or, 38 dba is equal to 47 dbm and $0 - (-47) = 47$ db signal to noise ratio. ■ ■

(Nomogram on following page)

Nomogram Converts Signal-Level Terms

(continued from preceding page)



NEW LITERATURE

High-Voltage Insulation 260

Butyl-base high-voltage insulation is described in this 48-page brochure, No. 1131. General physical and electrical characteristics of the insulation are given. A removable booklet gives data on the firm's line of cables. The Okonite Co., Passaic, N. J.

Microwave Tubes 261

Traveling-wave tubes and backward-wave oscillators are described in this eight-page short-form catalog. Illustrations, brief descriptions, and typical operating characteristics are included. Hughes Aircraft Co., Microwave Tube Div., 11105 Anza Ave., Los Angeles 45, Calif.

Plugs and Jacks 262

A line of plugs, jacks, patch cords, and receptacles are described in 16-page catalog No. 70. Physical specifications and dimensional drawings are included. Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass.

Oscilloscopes 263

An oscilloscope, a waveform monitor, and a color-television vectorscope are described in this 16-page booklet. Specifications, performance characteristics, and waveform displays are included. Tektronix, Inc., P. O. Box 500, Beaverton, Ore.

Transformers 264

A line of single-phase, three-phase, and phase-changer dry-type transformers are described in this 36-page catalog. Photographs, wiring diagrams, specifications and prices are included. Atlantic Transformer Co., 8330 Hegerman St., Philadelphia 36, Pa.

Switches 265

Standard push-button, lever, and turn switches are described and illustrated in this four-page catalog, No. 200-61. Electrical ratings and dimensions are given. Donald P. Mossman, Inc., Brewster, N. Y.

Component Cases 266

Square, round, and rectangular metal cases for component packaging are described in this 32-page catalog No. 5. Dimensions, specifications and prices are included. Olympic Products Co., Inc., Alpha, N. J.

NEW LITERATURE

Silicones 267

Eight-page catalog No. CDS-129C discusses the firm's line of silicones. Fluids, coatings, insulations, and silicone rubbers are covered, with general properties and applications described and illustrated. General Electric Co., Silicone Products Dept., Waterford, N. Y.

Graph Plotting Scale

Plastic chart measuring 4 x 8 in. converts plain paper into a custom plot with linear or logarithmic scales of any length, number of cycles, scale modulus, or configuration. Called Alsrule, the scale provides twelve log scales, ranging from 3/4 to 4 in., and three linear scales for direct plotting, plus triangular scales to vary the modulus. Scale is of Vinylite, and inserts into a three-ring notebook. *Send $2.00 to Technical Marketing Associates, Inc., Dept. ED, 33 Sudbury Road, Concord, Mass.*

Microwave Devices 268

Three short-form catalogs cover the firm's line of microwave devices. Catalog 61-MS covers semiconductor products, including silicon diodes, varactors, and computer diodes. Catalog 61-WS describes waveguide components, test equipment, and custom-engineered assemblies. Catalog 61-TD discusses microwave tubes, ferrites, switches, duplexers, and related devices. Microwave Associates, Dept. HE, South Ave., Burlington, Mass.

Potentiometer Construction 269

Termination of windings in wirewound potentiometers is discussed on this two-page bulletin, "Wirewound Termination Characteristics." Several methods of termination are described briefly, including soldering, riveting, welding, use of pressure tabs, and the firm's own technique. Bourns, Inc., 6135 Magnolia Ave., Riverside, Calif.

Flange Hole Patterns 270

Over 60 different flange hole patterns are listed in this four-page bulletin. Patterns are said to simplify mounting of instrument panels in the firm's cases. Zero Manufacturing Co., 1121 Chestnut St., Burbank, Calif.

High Voltage Components 271

Anti-corona terminations, high-voltage dc power supplies, encapsulated power packs, and high-voltage meters are described in this 16-page catalog. Technical data on the applications of the products are included. Voltronics Corp., 17 S. Lexington Ave., White Plains, N. Y.

Conversion Factors 272

A reference table of conversions is presented in wall-chart form. Included are common conversions and many of the hard-to-find conversion factors. Precision Equipment Co., 4411 Ravenswood Ave., Chicago 40, Ill.

Test Instruments

This 220-page catalog contains complete listings, descriptions and specifications for over 400 test instruments offered by the firm. It also includes a 16-page description of special systems and instrumentation. *Write on company letterhead to Harry J. Lewenstein, Hewlett-Packard Co., Dept. ED, 1501 Page Mill Road, Palo Alto, Calif.*

Neutron Tube Data 273

Design data on tubes which provide neutrons in quantities intermediate to those available from isotopic sources and reactors are found in this 4-page folder titled "Neutrons from Small Tubes." Text describes main features, ion source, accelerating system, replenisher, target assembly, neutron yield and general performance of the neutron generator tube. Philips Electronic Instruments, 750 South Fulton Ave., Mount Vernon, N. Y.

Feed-Through Filter Elements Suppress VHF Resonances

H. M. Schlicke, Dr.-Ing.
Manager High Frequency Laboratories
Allen-Bradley Co.
Milwaukee, Wis.

Recently published, Essentials of Dielectromagnetic Engineering *by H. M. Schlicke (John Wiley & Sons, $9.50) is written for the electronic engineer interested in applying magnetically soft ferrites and high-ε dielectrics, such as barium titanate. These materials are classed as dielectromagnetics.*

Following a systematic theoretical investigation (Chapter I) of the effects of high permeability and permittivity, the text discusses the properties of real dielectromagnetics (Chapter II). Applications are divided into lumped circuit elements (Chapter III), distributed circuit elements (Chapter IV), and (in Chapter V) some classes of unique applications such as non linearity, nonreciprocity, and utilization of losses.

The material presented here is taken from Chapter IV, Section 9 which describes techniques for suppressing electromagnetic resonances in high-ε dielectric bodies.

FEED-THROUGH filter elements are extremely useful for eliminating interference, feedback and radiation in the very high-frequency ranges (vhf, uhf, up to microwaves). They replace the conventional capacitor which cannot be used to shunt or filter out frequencies in these ranges.

The very high dielectric constant of barium titanates, stannates, etc., reduces the wavelength in these electrically very dense materials to between 1 and 10 per cent of its value in air. Thus, at very high and ultra-high frequencies, even small dimensions, say in the order of magnitude of 1 cm, constitute half a wavelength for electromagnetic waves. This can very easily cause resonance phenomena in the dielectric bodies.

For a 0.005 μf ceramic disk capacitor (leads parallel to each other, length measured from rim of capacitor), the following series resonances occur because of the lead inductance:

Lead length (mm)	2	5	10	20	30
f_r	31	19.5	16	12.7	10.5

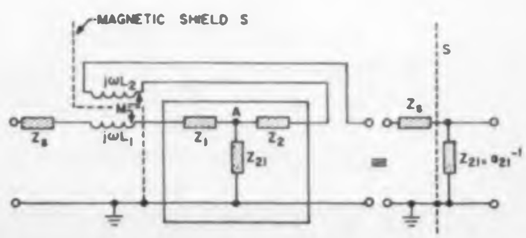
At frequencies above f_r the reactance of the capacitor becomes inductive and consequently increases with further increase in frequency.

Hence, special "feed-through capacitors" are necessary to bar inductances in the shunt branch. An equivalent circuit of such a capacitor is shown in the figure. The unit should be designed so that:

1. (Z_{21}) is small at high frequencies. Ideally Z_{21} should be infinite at low frequencies and zero at high frequencies.
2. Magnetic coupling between the input and output circuits is eliminated, or the high-frequency, short-circuiting effect of Z_{21} is lost.

The second condition is met by mounting the feed-through capacitor—via its outer electrode—in a metallic shield so that the input and output terminals protrude on opposite sides. This shield forms part of the enclosure containing the high-frequency source. The shielded enclosure of the oscillator must be free of leaks to prevent radiation coupling at very high frequencies. Hence, joints of the metallic enclosure must be soldered or folded. Holes or slots in the shield may be required for ventilation or adjustment.

The better the feed-through filter, the more it is necessary to eliminate radiation through these slots or holes. If this is not done the filter element is bypassed by radiation cou-



Impedance representation of a feed-through filter capacitor.

pling and hence is superfluous. These ventilation openings can be made impenetrable up to microwave frequencies by extending them into metallic tubes acting as waveguides below cutoff. Neglect of these precautionary measures may—particularly above 100 mc—falsify the measurement and operation of the feed-through elements.

Apparently misled by the smallest of the dimensions involved, quite a number of engineers try to establish performance criteria for feed-through capacitors by measuring the input impedance, that is, by measuring $Z_1 + Z_{21}$. However, two-pole measurements of these elements are wholly irrelevant. Only four-pole measurements are significant. $Z_1 + Z_{21}$ does not define Z_{21}, the shunting element of interest, any more than the sum of two numbers gives information about one of the summands.

In calculating high-ϵ ceramic filters, transmission line theory is indispensable. Since the phase measure is increased by $\sqrt{\epsilon}$, the characteristic impedance is reduced by $1/\sqrt{\epsilon}$. (For example, if a coaxial structure of a characteristic impedance of $Z_c^* = 50$ ohms is filled with a dielectric of $\epsilon = 4{,}900$, the characteristic impedance Z_c becomes $50/70$ ohms $= 0.719$ ohm).

High-ϵ dielectrics have rather low Q_e (electrical quality factor) values at very high frequencies. Consequently, the low Z_c in conjunction with a low Q_e will condition rather low impedance values, even under resonance conditions. Hence, a simplified approach is permissible, as will be shown now.

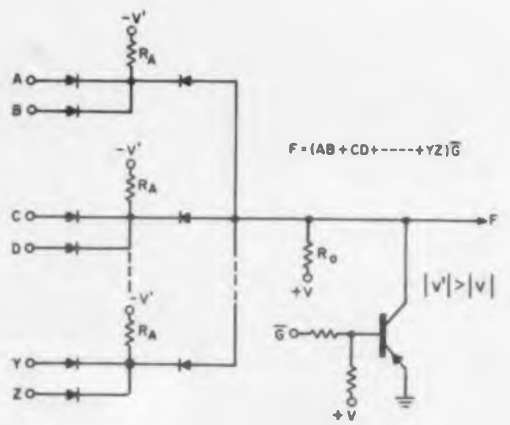
In contrast to conventional filter theory (where impedance matching is important), in high-ϵ ceramic feed-through filter elements, only Z_{21}, the transfer or coupling impedance, is significant. This is because the load impedance is normally larger than Z_c.

Furthermore, because of the low impedance levels of Z_1, Z_2, and Z_{21}, constituting the equivalent T-network (the black box in the figure) of the filter element, the series impedance Z_s, purposely placed in front of the filter element is also much larger than Z_1 and Z_2. Z_s' is the sum of Z_s and $j\omega L$, the inductive lead reactance. Z_1 is nearly always negligible compared to Z_s'. It would only have to be considered for the first maximum of Z_{21}, where it is $2|Z_{21}|$, and then would be of consequence only if Z_s were small. In the investigation of feed-through filter elements, then, only the term (Z_{21}) need be investigated. The filtering performance (attenuation) is defined by the voltage division proportional to $(Z_s)/(Z_{21})$. ■ ■

IDEAS FOR DESIGN

Hybrid Three-Level Logic Requires Fewer Components 732

In general, when standard digital modules are used, an active element will follow every two levels of logic.



Transistor stage helps to simplify three-level logic circuitry.

However, the number of components necessary to produce three-level logic, where one function modifies many, can be minimized with the circuit shown in the figure. This circuit performs the function:

$$F = (AB + CD + \ldots . YZ)\overline{G}$$

Negative logic is assumed, that is, $-V$ is a logical "1" and ground is a logical "zero."

Herb Seidman, Systems Engineer, Daystrom Control Systems, La Jolla, Calif.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 732.

Vote for Ideas Valuable to You

Vote for the Ideas which are valuable to you. Other engineers will vote for the Ideas which are most valuable to them. The Idea which receives the most "Valuable" votes will be judged "Most Valuable of Issue." Its author will receive a $50 award.

Choose the Ideas which suggest a solution to a problem of your own or stimulate your thinking or which you think are clever.

The Ideas chosen as the most valuable in each issue will be eligible for the $1,000 Idea of the Year award.

So vote for the Ideas you find most valuable. And, after you've voted, why not send in an Idea of your own?

Added Stage Protects Regulator From High Voltage 737

The fairly-common voltage regulator shown can be protected from excessive power supply voltages by adding the circuitry indicated in brackets. This extra transistor stage protects the regulator in the event that a short occurs and the supply voltage exceeds the $V_{CE\ (max)}$ of the transistors.

Without the additional stage, when a short occurs R_2 and $CR2$ shunt the emitters of transistors Q_2 and Q_3. These transistors have the full supply voltage across. If this voltage is too great, they can be destroyed.

$50 "Most Valuable of Issue" Award for Capacitor Trimming Idea

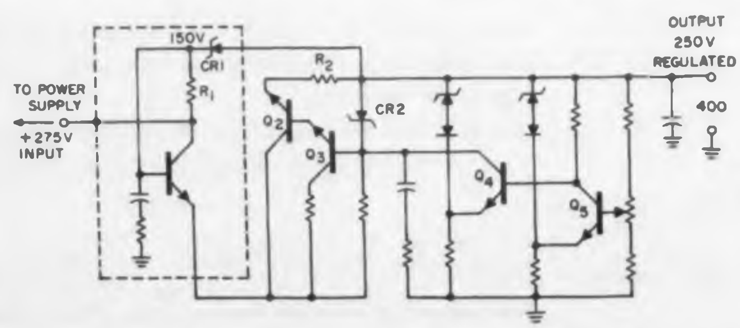
A. de la Lastia, project engineer with Universal Transistor Products Corp., Westbury, New York has won ELECTRONIC DESIGN's seventh $50 Most Valuable of Issue Award.

Mr. de la Lastia receives the award for his Idea for Design in the May 24 issue which described how the value of a ceramic disk capacitor could be trimmed up by filing it down on a grinding wheel.

With the additional stage, R_1, C_1 and Q_1 act as a filter and current regulator under normal conditions. If a short occurs in the load the supply voltage is split between Q_1 and Q_3 by diode $CR1$. This allows R_2 and $CR2$ to provide short circuit protection while guarding the components against damage.

Hugh L. Bain, Engineer, Raytheon Co., Bedford, Mass.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 737.



Voltage regulator is protected from excessive power supply voltage in the event of load short, by adding an extra input stage (in brackets).

How You Can Participate

Rules For Awards

Here's how you can participate in Ideas for Design's Seventh Anniversary Awards:

All engineer readers of ELECTRONIC DESIGN are eligible.

Entries must be accompanied by filled-out Official Entry Blank or facsimile. Ideas submitted must be original with the author, and must not have been previously published (publication in internal company magazines and literature excepted).

Ideas suitable for publication should deal with:

1. new circuits or circuit modifications
2. new design techniques
3. designs for new production methods
4. clever use of new materials or new components in design
5. design or drafting aids
6. new methods of packaging
7. design short cuts
8. cost saving tips

Awards:

1. Each Idea published will receive an honorarium of $20.
2. The Idea selected as the most valuable in the issue in which it appears will receive $50.
3. The Idea selected as the Idea of the Year will receive a Grand Prize of $1,000 in cash.

The Idea of the Year will be selected from those entries chosen Most Valuable of the Issue.

Most Valuable of the Issue and Idea of the Year selections will be made by the readers of ELECTRONIC DESIGN. The readers will select the outstanding Ideas by circling keyed numbers on the Reader-Service cards. Payment will be made eight weeks after Ideas are published.

Exclusive publishing rights for all Ideas will remain with the Hayden Publishing Co.

SEVENTH ANNIVERSARY AWARDS

IDEAS-FOR-DESIGN ***Entry Blank***

Ideas-for-Design Editor
ELECTRONIC DESIGN
850 Third Ave.
New York 22, N. Y.

Idea (State the problem and then give your solution. Include sketches or photos that will help get the idea across.)

(Use separate sheet if necessary)

I submit my Idea for Design for publication in ELECTRONIC DESIGN. I understand it will be eligible for the Seventh Anniversary Awards—$20 if published, $50 if chosen Most Valuable of Issue, $1,000 if chosen Idea of the Year.

I have not submitted my Idea for Design for publication elsewhere. It is entirely original with me and does not violate or infringe any copyrights, patents or trademarks or the property rights of any other person, firm or corporation.

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For Additional Entry Blanks, circle **750** on Reader-Service Card.

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CIRCLE 153 ON READER-SERVICE CARD

Emitter-Follower Stabilizes Two-Transistor Regulator 735

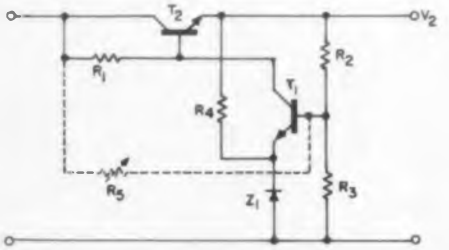
A conventional two-transistor voltage regulator, Fig. 1a, can be made more stable if an emitter-follower is added as shown in Fig. 1b.

In the conventional unit, a decrease of the input voltage, V_1 will decrease the voltage drop across R_1. Consequently, both the collector and base current of T_1 will drop. This means that output voltage V_2 will also decrease slightly.

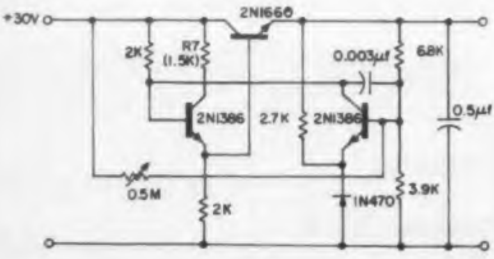
An increasing load current will lower the output voltage because the base current of T_2 requires a decrease of the collector current of T_1. If the base current of T_1 is derived partly from V_1 a decrease of the collector current can be obtained without a drop of V_2. This is accomplished with resistor R_5. The adjustment of R_5 can be made to compensate for the effect of V_1 (minimum dc variation and ripple) or to compensate for the total decrease of V_2 (zero output impedance).

The circuit of Fig. 1b allows these to be made more nearly equal because the emitter-follower reduces the loading of T_1 by the base current of T_2. In many cases, this emitter follower will be required to increase the output current range.

Since R_5 is not a part of a feedback loop, it does not affect the stability of the circuit.



(a)



(b)

Conventional two-transistor voltage regulator, *a*, can be made more stable by adding emitter-follower as shown in *b*.

The output can therefore be shunted with capacitors of any size to obtain further ripple reduction.

Resistor R_7 limits the collector current of T_3 and provides overload protection. Hence, a low-power transistor can be used. If the no-load voltage of V_1 is about $2V_2$, the regulator can be made short-circuit proof by properly choosing R_7 in combination with the output resistance of the power supply.

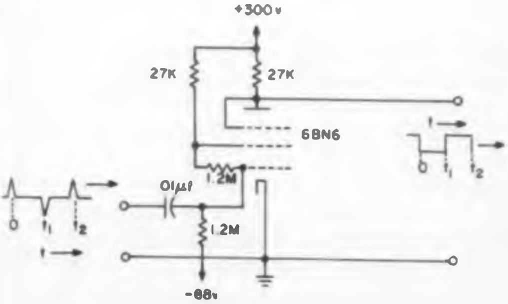
Robrecht Bosselaers, Senior Engineer, Raytheon Co., Needham Heights, Mass.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 735.

Pentode "Multi" Standardizes 741 Long Period Square Waves

In one of our circuit designs we had to amplitude-standardize square waves having relatively long periods (1 sec to 5 mins). This was done by using a circuit, shown in the figure, which differentiated, amplified and then reconstructed the input square wave.

Since the accelerator grid of the 6BN6 is in phase with the limiter-grid voltage, regeneration can be accomplished by connecting the accelerator to the limiter via a suitable bleeder (two 1.2-meg resistors).



Long-period square waves are amplitude-standardized by circuit which differentiates, amplifies and reconstructs the input.

The circuit operates essentially as a bistable multivibrator. Plate current is turned on when a positive pulse is applied to the limiter grid. This state will remain until a negative pulse is applied. The plate current then returns to zero.

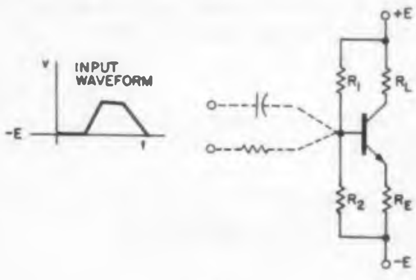
Alfred W. Zinn, Project Engineer, Farrand Optical Co., New York, N. Y.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 741.

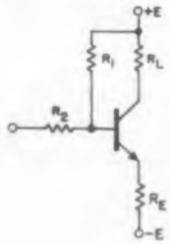
Biased-On AC Amplifier Boosts Low-Level Pulses 740

Amplifying small signal unipolar pulses with transistors is difficult, particularly if the voltage swing is less than 0.2 v. At such low voltages, the normally biased-off, pulse amplifier may not be used. Rather, a biased-on ac amplifier is required.

In the usual ac amplifier, Fig. 1a, the



(a)



(b)

Low-level unipolar pulses can be amplified by circuit *a*, through either resistance or capacitance input. However, attenuation and rise-time problems are eliminated if R_2 is returned to the $-E$ supply through the pulse source as in circuit *b*.

resistors R_1, R_2, R_e, and R_L, are chosen to yield the desired gain, operating point, and stability. The signal is usually introduced through a capacitor or a resistor. If a resistor is used, an appreciable amount of signal attenuation can occur because R_2 must be made small for reasons of temperature stability. If a capacitor is chosen, the amplifier becomes sensitive to pulse duration as well as to input rise time.

Both of these difficulties can be overcome if the circuit of Fig. 1b is used instead. Again R_1, R_2, R_e and R_L, are chosen consistent with good design procedure, as if R_2 were to be returned directly to the $-E$ supply. However, it is returned to the $-E$ supply through the pulse source. This yields the following advantages:

1. There is practically no signal attenua-

tion because R_1 is normally much greater than R_2.

2. Circuit response is extended to dc because no capacitors are used.
3. The amplifier has a high input impedance (essentially $R_2 + \beta R_e$).
4. The circuit requires no more parts than the other configuration.

The design of Fig. 1b assumes a reasonably low source impedance (necessary in any case). It finds application in circuits such as those which amplify the output of differential voltage amplifiers (pickoffs) where a great deal of sensitivity is required.

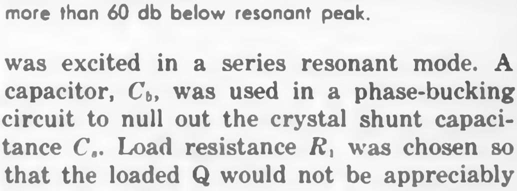
Joseph Albert Pecar, Design Engineer, Department of Defense, Washington, D. C.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 740.

High Q, Selective Filter Has 60-Db Attenuation 739

A high-Q, frequency-selective filter was required for passing a 100-kc sinusoid. Narrow bandwidth and good frequency stability were needed. It was desired to have the filter skirts at least 60 db below the resonant peak.

In the circuit we designed, a 100-kc crystal



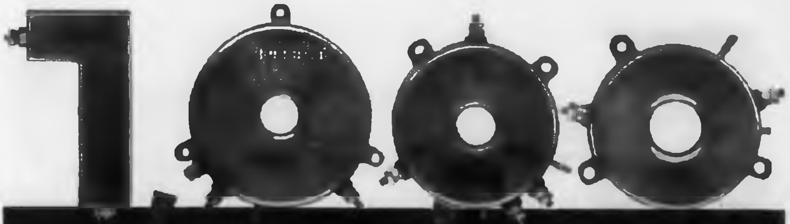
High-Q filter uses a 100-kc crystal excited in a series resonant mode. Filter skirts and spurious modes are more than 60 db below resonant peak.

was excited in a series resonant mode. A capacitor, C_b, was used in a phase-bucking circuit to null out the crystal shunt capacitance C_s. Load resistance R_l was chosen so that the loaded Q would not be appreciably lower than the crystal open-circuit Q. Crystal modes were rejected by placing a conventional LC resonant circuit of appreciably lower Q in series with the crystal filter.

In the final circuit, the filter skirts and spurious crystal modes were kept more than 60 db below the resonant peak. Loaded crystal Q was 10,000, and the insertion loss, 6 db.

J. A. Webb, Electronic Systems Engineer, Lockheed Aircraft Corp., Marietta, Ga.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 739.



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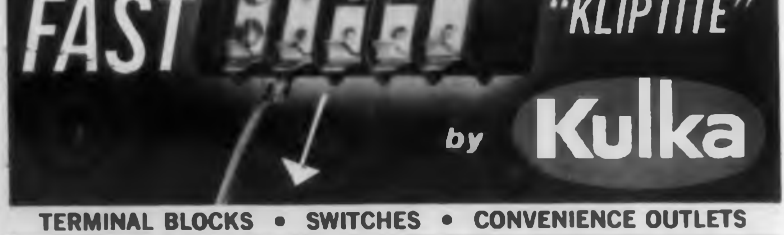

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Sine-Wave Modulator Uses Complementary Transistor Pair 742

When a sine-wave modulator is required, one satisfactory technique is to use a chopper modulator followed by a band-pass filter. But, where only moderate linearity is required, and small size and low phase shift is necessary, a complementary modulator can perform quite adequately.

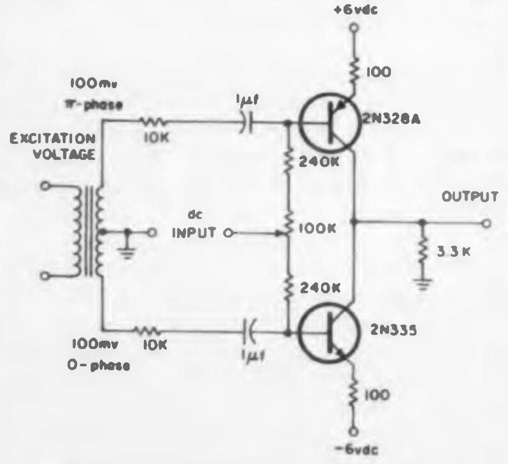
A complementary modulator is shown in the figure. Used with a demodulator that supplies the dc signal, the circuit can replace bulky electromechanical devices in providing quadrature rejection for multi-input servo amplifiers.

The circuit makes use of the ac current gain, h_{fe}, versus emitter current variation of a complementary pair of silicon transistors. The linear modulation characteristic is constructed from the individual h_{fe} vs I_e plots of the transistors. A common bias point, selected midway between the points of greatest average slope, determines the composite characteristic of greatest gain. This characteristic is proportional to the over-all transfer characteristic.

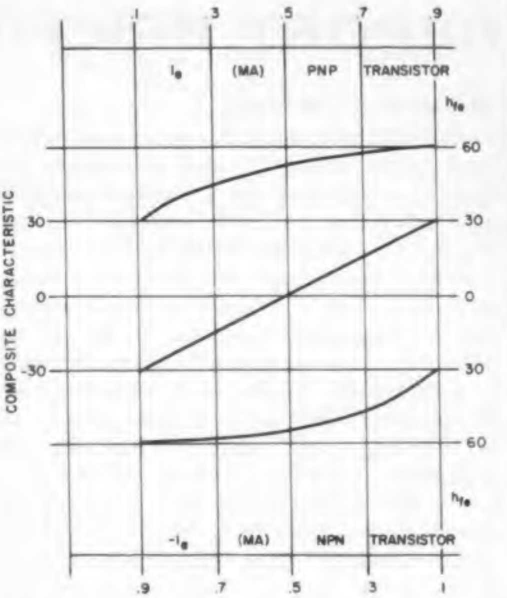
The transistors are connected with push-pull base excitation current and parallel-cancelling ac collector current. The dc input terminal is at the virtual-ground point on the dc base bias resistor network.

With 0 v dc input, equal ac currents flow in the transistor collector circuits and cancel at the output. With a positive dc input, the npn transistor is biased harder.

Thus, because of its larger h_{fe}, it provides the greater contribution of ac current to the



(a) Sine-wave modulator uses complementary transistors to yield moderate linearity, small size and low phase shift.



(b) Linear modulation characteristic is constructed from h_{fe} vs I_e plots of the transistors.

load. The pnp transistor, with reduced dc base current, contributes less ac load current. With the instantaneous base excitation polarities as shown, the output voltage is zero-phase ac. With a negative dc input, the pnp transistor provides the greater gain and the output is π-phase.

For the circuit shown, a 4-v dc input into the 200-K input impedance provides 0.4 v rms output into the 3.3-K load. By selecting transistors, nulls of 1 mv can be obtained.

Lincoln S. Ferriss, Project Engineer, AC Spark Plug, Division of General Motors, Milwaukee, Wis.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 742.

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REPORT BRIEFS

Microwaves Research

Research was continued on a study on surface waves, antennas, and microwave circuits. A paraboloid was fabricated and used in a diffraction loss measurement for a low-loss beam waveguide. Major effort was devoted to a measurement of the reflection loss at the end plate of a beam waveguide resonator. A right angle resonator, that is, a resonator in which the beam from one end plate is deflected 90 deg to the second end plate by a central flat plate, was used for the reflection loss study. *Surface Wave, Antenna and Microwave Filter Engineering Research Study, Elmer H. Scheibe, Wisconsin University, Madison, Wis., May, 1961, 11 pp, $1.60. Order AD-255861 from OTS, Washington 25, D. C.*

Tropospheric Propagation

The results of studies performed on the short-term variability of tropospheric signals received over within-the-horizon paths are presented in this report. The data given were obtained from measurements over propagation paths in the Pacific Coast region of Southern California, and the continental region of Eastern Colorado. Fadeouts are analyzed as a function of carrier frequency, path characteristics, and meteorological parameters. Also included in the report is an evaluation of fadeouts observed over a path using a mountain peak as a diffracting knife-edge-like obstacle between transmitter and receiver. *Prolonged Space-Wave Fadeouts in Tropospheric Propagation, A. P. Barsis and M. E. Johnson, National Bureau of Standards, Feb., 1961, 72 pp, $2. Order PB 161589 from OTS, Washington 25, D. C.*

Unfurlable Antennas

An unfurlable antenna is broadly described as a device which can be unfolded to form a large antenna. Research was concerned with the design of unfurlable antennas for satellites and other space vehicles. A number of relatively large antennas were shown to be suitable. A series of demonstration models was built to show the feasibility of construction techniques and types of radiators suggested by the theoretical studies. *Study and Design of Unfurlable Antennas, J. R. Barewald, A. T. Cole and others, Lockheed Aircraft Corp., Sunnyvale, Calif., May, 1961, 138 pp $10.50. Order AD-255287 from OTS, Washington 25, D. C.*

Recording RF Signals

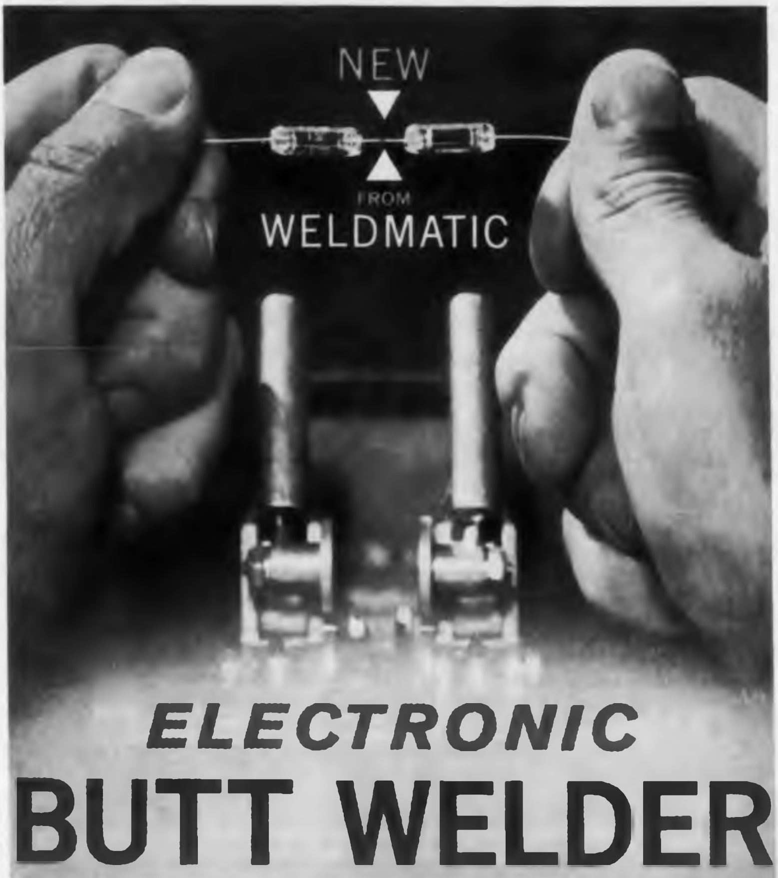
A large number of Doppler frequency shift measurements for radio location were made with 20-mc radio signals from satellites at Breisach, Germany. Special hf receivers of very high sensitivity and high frequency stability were developed for these measurements. The purpose of the measurements was to study the ionospheric influence on the propagation of the 20-mc signals. This causes errors at the radio location of satellites. This influence becomes especially important when the maximum usable frequency of the ionospheric F sub-2 layer is higher than 20 mc. The ion clouds within the E-region, called "sporadic E", may also be considered as source of errors at radio location. *Research on and Recording of RF-Signals From Satellites, Hanns A. Hess and K. Rawer, Ionospharen-Institut Breisach, Germany, May, 1961, $7.60. Order AD-255826 from OTS, Washington 25, D. C.*

HF Antenna Research

Investigations were continued on vehicular antennas in the hf region from 1.5 mc to 20 mc. An experimental, 15-ft antenna was designed that compared favorably with the existing standard whip of the same height. This antenna, of a conical design simulated with four whips, provided an increased impedance bandwidth, a greater power handling capability, and an increase in radiation efficiency by comparison with the standard whip. *Vehicular Antenna Research in the HF Region, Roger R. Trapp, Ramo-Wooldridge Div., Thompson Ramo Wooldridge Inc., Canoga Park, Calif., Sept., 1960, $4.60. Order AD-255071 from OTS, Washington 25, D. C.*

Polarization Modulation Techniques

Several methods are described for generating a multipolarized wave for ECM jamming purposes. These methods generally involve the excitation of two orthogonally oriented linear antennas with a varying phase and amplitude. Discussions and mathematical analyses of the performances of these systems are presented and some experimental data is included. Curves of theoretical relationships are plotted to illustrate performance characteristics. *Study of Polarization Modulation Techniques, Joseph E. Ferris, Melpar, Inc., Falls Church, Va., May, 1961, 80 pp, $8.10. Order AD-255838 from OTS, Washington 25, D. C.*



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REPORT BRIEFS

Broadband Antennas

Research was concerned with the development of a broadband omnidirectional antenna with as many frequency-independent electrical characteristics as possible. A summary is presented of all the usable measures that decrease the frequency dependence of the radiation pattern of broadband radiators. Two technically important antenna shapes are described in detail: (1) a 50-ohm radiator, with good broadband matching, having a broadband diffused radiation pattern which resembles that of a short dipole over a large frequency range, and (2) a 60-ohm radiator that has a constant horizontal direction for the main lobe and a good broadband matching. *Research on Broadband Antenna Design, Hans Meinke, Technische Hochschule, Munich, Germany, May, 1961, $5.60. Order AD-255858 from OTS, Washington 25, D. C.*

Ferrite Duplexers

An experimental switch was constructed using tapered transitions instead of quarter-wave transformers in coupling from rectangular guide to the circular guide of the switch at parts *1* and *2*. Some improvement in vswr was noted, but improvement was also obtained by a reworking of the quarter wave transformers. Recent improvements in Y-circulator bandwidth led to a reconsideration of the possibility of switching a Y-circulator. Characteristics of a recent Y-circulator are given. Broadbanding of a high power isolator by cascading ferrite sections having different demagnetizing factors was also investigated. Some bandwidth improvement was obtained. *Ferrite Duplexing Devices, R. A. Henschke, Melabs, Palo Alto, Calif., May 1961, 15 pp, $2.60. Order AD-255700 from OTS, Washingotn 25, D. C.*

Bandpass Amplifiers

Formulas are derived which give the output waveforms of multi-circuit amplifiers, having an arbitrary number of stages, for an input consisting of carrier frequency modulated by a unit step function. Many numerical results which make clear the transient characteristics of multi-stage amplifiers are also presented. *A Contribution of the Transient Characteristics of a Frequency Bandpass Amplifier, Yoshiro Moriwaki, Microwave Research Institute, Polytechnic Institute of Brooklyn, N. Y., May, 1961, $3.60. Order AD-255546 from OTS, Washington 25, D. C.*

Microwave Filters and Coupling Structures

Research was concerned, both theoretically and experimentally, with new types of microwave filters and coupling structures. More precise methods were also developed for the design of various previously known structures. Among the structures discussed are a wide-band, strip-line, Magic-T; a ferrite-loaded, nonreciprocal TEM-mode structure for wide-band gyrator and isolator applications; and two types of forward-coupling hybrid junction, one in strip-line and one in trough guide. Design data are presented for broadside-coupled strip transmission lines, and for an interleaving, printed-circuit, parallel-coupled, strip-transmission-line construction. *Design Criteria for Microwave Filters and Coupling Structures, G. L. Matthaei, P. S. Carter, Jr. and others, Electromagnetics Lab, Stanford Research Inst., Menlo Park, Calif., May, 1961. 577 pp $26.00. Order AD-255509 from OTS, Washington 25, D. C.*

Phase Shifters

Two general phase-shifting techniques were investigated, both of which employ semiconductor elements. The first approach is the step or incremental phase-shifting device which provides for discrete changes in phase. The second phase-shifting approach is a continuously variable one which provides for a greater flexibility in phase control. Both the semiconductor material and the circuit problems involved in each of these two approaches were explored in some detail. *Phase Shifter Study Program, Kenneth E. Mortenson and Charles Howell, Microwave Associates, Inc., Burlington, Mass., May, 1961, 22 pp, $4.60. Order AD-255990 from OTS, Washington 25, D. C.*

Negative Resistance Circuits

The characteristics of the pnpn triode and the pnpn thyristor, and the capacity of the devices as a function of dc bias were investigated. Negative resistance devices were simulated using transistor pairs of opposite polarity types. Circuits using the properties of the triode and the thyristor were designed, built, analyzed, and evaluated. These circuits include a free-running pulse generator, a triggered pulse generator, a saw-tooth generator, a two thyristor flip-flop, and one thyristor flip-flop. *Circuit Applications for Negative Resistance Semiconductor Devices, R. C. Ricci, Massachusetts Inst. of Tech., Cambridge, Mass., May, 1961, 38 pp, $8.10. Order AD-255840 from OTS, Washington 25, D. C.*

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‘Engineering’ Your Sales Talk

Technical sales are often made best by engineers. But when an engineer is “dragged” in to make the presentation to the customer, the result can be more damaging than enlightening. Here are tips to help you sell your company—and yourself. The author, a speech instructor, has coached engineers in effective presentation.

Roy S. Azarnoff
Consultant to Raytheon Co.
Boston University
Boston, Mass.

HAVE you seen this happen? Monday morning a request comes in for a technical sales presentation to a customer on Tuesday. Twenty engineers throughout the plant are phoned in desperation. Finally three willing “bodies” are found. Whether they are qualified or prepared is another matter.

Later, aboard an airliner flying to the customer, the three hastily draw up plans. For want of a better approach, the three-hour presentation is divided into three parts, with the bravest man taking the first hour.

About what? To whom? For what purpose? There is no time for these details.

The next day, at the presentation, the three discover they have neglected one thing: what the customer is interested in. The customer discovers this, too, even before the first hour is up. The next Monday morning that three men from engineering must be produced for a Tuesday presentation you can be sure it won’t be the same three!

On the other hand, a situation like this can be a happy affair when the members of the team know enough to first take these preparatory steps:

- Analyze the customer.
- Isolate the basic message.
- Prepare verbal aids.
- Prepare visual aids.
- Plan the staging and question-and-answer period.

Know Your Audience and Why It Is Interested in the Product

Analysis of the customer’s wants is the first step. To determine what should be said, you must first know your audience. Technicians, engineers and scientists already familiar with the subject do not want to be insulted or bored with too many generalities. Managers primarily interested in what a product will do, how much it will cost and when it can be delivered, do not want too many technical details. Often both these groups will be in your audience.

Whether the sales presentation is small and intimate or large and formal, you will be glad you took the trouble to prepare for it. In a small presentation, D. Carroll (left) and K. Morrison (standing) explain a point about marine equipment to Raytheon’s Norma E. LaFleur..........

..........**In a large presentation,** Raytheon’s William A. Hands makes a “systems” type presentation to a more formal group.

Questions you should be able to answer about your listeners in advance include:

- How much do they already know about your topic?
- What professional skills do they represent?
- How much authority do they have in their company?
- With what organizations are they affiliated?
- What sources of product information do they have?

Your basic message will fall into three categories: an idea, a product or an image.

An Idea: You might be called upon to explain the concept of a new weapons system proposed by your company. You might be asked to outline an industrial-control system concept. You will have to show the audience what the problem is and how the idea leads to a solution.

A Product: You may be called upon to explain a product made by your concern. The listeners want to know what the product is, how it works, how it is put together, its important properties, the limits of its use, and, finally, why they need it.

An Image: Suppose you want to demonstrate your company's leadership in technology. You could describe the research being done at your plant for future products, the current market position of your company's products, or you could point out the "firsts" your company has introduced in the past.

Working out several basic messages in advance will allow you to select (on your feet) the best approach for the audience you find yourself facing.

Even 'Obvious' Sales Situations May Call for Flexible Approach

To organize the basic message, decide first on your primary purpose. Is it to inform, to inspire, or to persuade?

Suppose that the purpose of the talk is to convince a high-fidelity equipment manufacturer that your company's transistors should be used in place of the tubes he has been using so successfully for some time. Your purpose is to educate this firm to the fact that your company's transistors will perform in such a way as to update the high-fidelity product line.

That is the bare technical situation for your proposal. You may think: "Any engineer can plainly see that this firm would be foolish not to switch over to transistors at this time!" But before you rush off to put these "obvious" facts before this company, fortu-

DESIGNING YOUR FUTURE

nately you stop and go through the steps previously outlined for analyzing the customer.

Your analysis of the customer shows you your job will not be so simple; for there are two non-technical factors inside this firm that will work against an "obvious" presentation of the engineering facts.

First, the older engineers in the company, who make the technical recommendations to management, feel that the present tube equipment is near perfect. After all, they designed it. Second, the management is in the midst of a cost-savings program in an attempt to correct sliding earnings; additional engineering costs are the last thing wanted at this time.

Based on this information, the basic technical message and the attitudes of the individuals in the company you will be addressing, you formulate your basic message. You take into account that although the younger engineers (who prepared the way for your being asked to make this presentation) know all about transistors, your real message must be directed to the older engineers and management.

If your message were only for the older engineers, you could probably concentrate on explaining recent developments in transistors and the new types of circuitry for hi-fi sets. However, since you have learned that management will be in your audience and your survey has shown further that the management is non-technical, you must start at a rather elementary level. (At the same time you must politely let the engineers in the audience know that you are not trying to insult their knowledge.)

The basic outline should guide you in developing your basic sales-education message. For example, explaining the steps in transistor production gives you the opportunity to convince the customer's "old-line" management types that transistors are by now well out of the laboratory stages and that they are being produced by mature production techniques that will assure this company of a reliable, economical, continuing supply. ■ ■

This is the first part of a two-part series on how engineers can make effective sales presentations. The second article will discuss oral and visual aids to enliven the sales message and such "staging" techniques as room arrangements and how to conduct question-and-answer sessions.

Advancement Your Goal?

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ELECTRONIC DESIGN'S Confidential Career Inquiry Service helps engineers "sell" themselves to employers—as confidentially and discreetly as they would do in person. The service is fast. It is the first of its kind in the electronics field and is receiving high praise from personnel managers.

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Study the employment opportunity ads in this section. Then circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

ELECTRONIC DESIGN will act as your secretary, type neat duplicates of your application and send them to all companies you select—the same day the resume is received.

The standardized form permits personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you.

Painstaking procedures have been set up to ensure that your application receives complete, confidential protection. We take the following precautions:

- All forms are delivered unopened to one reliable specialist at ELECTRONIC DESIGN.
- Your form is kept confidential and is processed only by this specialist.
- The "circle number" portion of the form is detached before the application is sent to an employer, so that no company will know how many numbers you have circled.
- All original applications are placed in confidential files at ELECTRONIC DESIGN, and after a reasonable lapse of time, they are destroyed.

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(Please print with a soft pencil or type.)

Name ______________________ *Telephone* ____________

Home Address ______________ *City* ____________ *Zone* ______ *State* __________

Date of Birth ______________ *Place of Birth* ______________ *Citizenship* __________

Position Desired ______________________________________

Educational History

College	*Dates*	*Degree*	*Major*	*Honors*

Recent Special Training ______________________________________

Employment History

Company	*City and State*	*Dates*	*Title*	*Engineering Specialty*

Outstanding Engineering and Administrative Experience ______________________________________

Professional Societies ______________________________________

Published Articles ______________________________________

Minimum Salary Requirements (Optional) ______________________________________

Use section below instead of Reader Service Card. Do not write personal data below this line. This section will be detached before processing.

Circle Career Inquiry numbers of companies that interest you

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ADVERTISERS' INDEX

August 16, 1961

Manufacturers' catalog appears in 1960-1961 ELECTRONIC DESIGNERS' CATALOG

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Electronic engineers make good editors. ELECTRONIC DESIGN's editors have all "converted" from engineering duties to editing duties. You may be interested.

We have new assistant editor openings. EE's with 2-3 years circuit design experience have the ideal background.

If you get satisfaction out of communicating with others, if you enjoy pulling out the important, if you enjoy using words to convey ideas, you will like editorial work.

Write

Edward E. Grazda, Editor

ELECTRONIC DESIGN
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Advertiser *Page*

**Manufacturers' catalog appears in 1960-1961 Electronic Designers' Catalog*

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