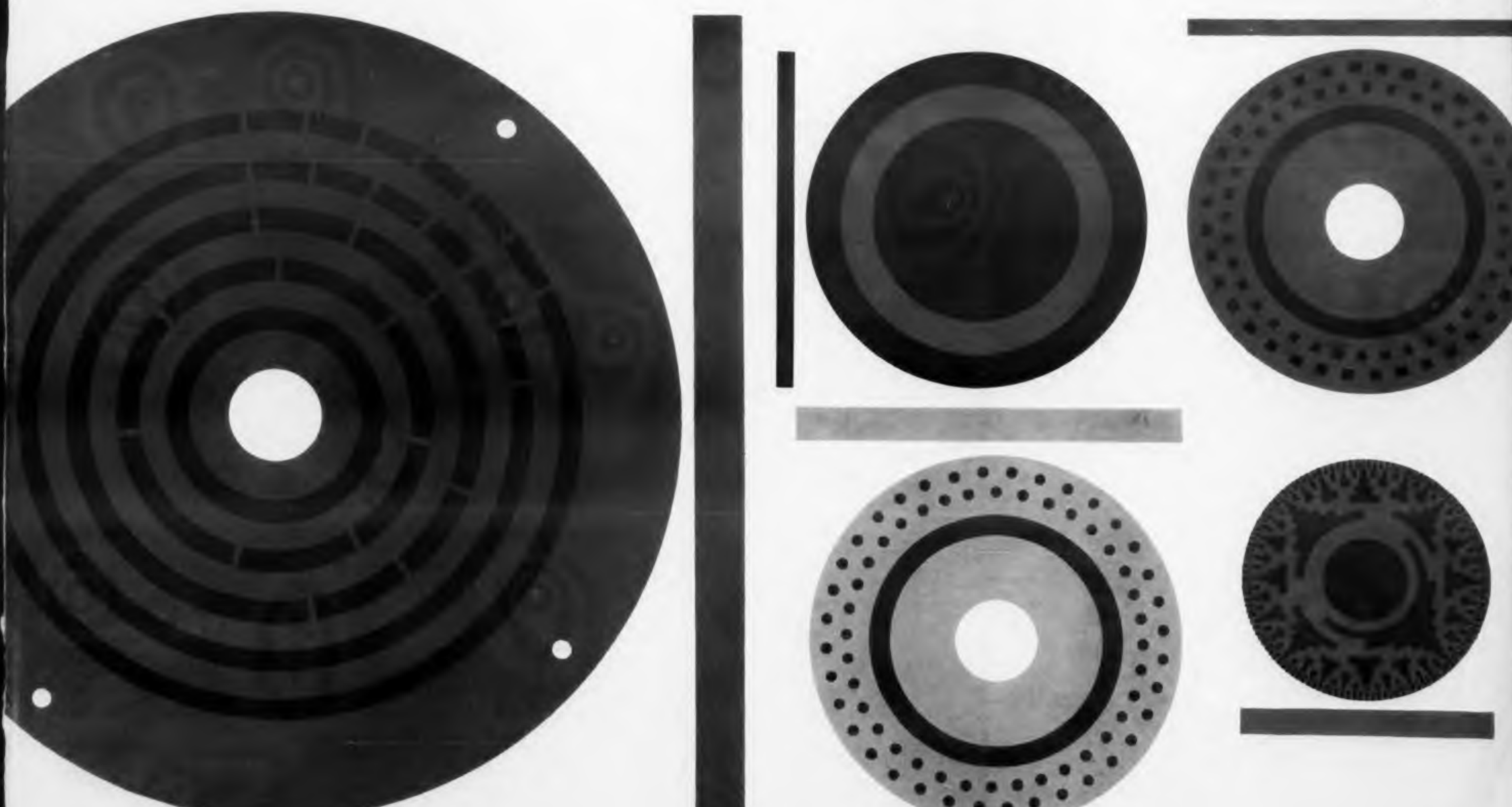
ELECTRONIC DESIGN

Completely Molded and Flush Rotary Switchplates Permit Wide Variety of Configurations...p 66



COVER: It was no design problem to come up with this issue's cover. The almost infinite combinations of conductive plastic segments available in these new switchplates produce a natural design. How do you show that the conductive portion is integrally molded with the switchplate body and that the conductive and insulation surface is flush? The "clean" side views depict flushness —achieved by using ingredients with matched coefficients of friction and thermal expansion.

Coming Next Issue

In some respects electronic reliability is like the weather—a good many people talk about it but few do anything about it.

ELECTRONIC DESIGN'S first major report on reliability was published in 1958. Since then we have spent many patient hours listening to professional views on the subject without hearing anything that was practical enough or significant enough to boil into an informative article. In general, aside from such major programs as Minuteman and Polaris, there has been more talk than concrete action in the realm of reliability in the last three years.

Yet, in view of increasing demands for reliability, is there not some progress afoot? To find out what is being done and what can be done, *ED* assigned Technical Editor Howard Bierman to explore the field. For months he talked and worked with authorities on reliability. What he has come up with is not the last word on an expanding subject, but it is the best available at present.

Don't miss "Meeting the Reliability Challenge," a six-part article, in the next issue.

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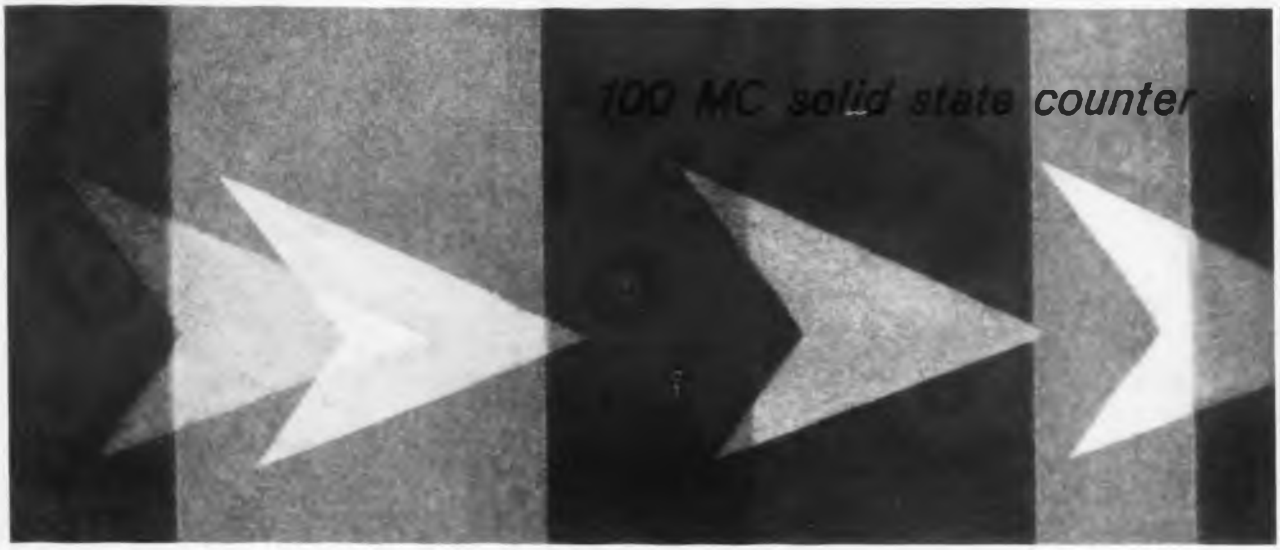

Measure Time Interval, 10 Nanoseconds to 0.1 Second— with 10 Nanosecond Accuracy!

Now you can get 10 nanosecond resolution in wide-range, automatic digital measurement of extremely short time intervals.

Electronic counter accuracy is yours for such measurements as explosive burning rates, speed and acceleration timing of test vehicles in free-flight wind tunnels, and measurements of a broad range of nuclear phenomena.

The new hp 5275A Time Interval Counter, incorporating solid state components, is packaged in the convenient new space-saving hp universal module. It counts 100 megacycles, obtained from an external 1 MC standard by a 100-to-1 multiplying circuit in the counter.

Standard features on the hp 5275A Time Interval Counter include manual front-panel reset, plus automatic and remote reset. A 4-line BCD output permits easy connection for automatic processing and analyzing of data and also may be used to drive the hp 562A Digital Recorder. The unique hp data storage technique provides a non-blinking display which reduces eye fatigue thus reducing reading errors.

Significant to many special measurement problems, as many as 20 hp 5275A Counters may be operated from a single external oscillator (new hp 101A described below). In addition to saving valuable rack space, this multiple counter operation from a single stable precision oscillator provides improved performance over multiple-time-base systems, saves operator time and offers real economy.

New versatility in a stable, accurate, rugged modular 1 megacycle oscillator! Use as a counter time base or moderately priced secondary standard!

hp 101A 1 MC OSCILLATOR Designed specifically as the time base for hp 5275A Time Interval Counter, the new hp 101A provides five parts in 10^{8} per week stability. It also permits increased measurement accuracy as a time base for other electronic counters.

The hp 101A is a solid state version of the time-proved oscillator used in hp 524C/D Counters and in the hp 100E Secondary Frequency Standard. Long-term stability of $5/10^{8}$ per week is achieved by the use of a high quality quartz crystal and by housing critical components in a well regulated oven. Short-term stability, including effects of line, load and ambient temperature variation, is better than $3/10^{8}$. Its rated output of 1 v rms into a 50 ohm load makes it useful for improving the accuracy of counters limited by their own internal time bases. hp 523C/D Counters will operate directly from the 1 MC output of the 101A, and an optional 100 KC output is available for use with counters requiring it.

The 101A also is housed in the new hp modular package, equally suitable for benchtop or rack mount applications.

hp 5275A TIME INTERVAL COUNTER

SPECIFICATIONS

hp 5275A TIME INTERVAL COUNTER

Range:	10 nanoseconds to 0.1 seconds
Resolution:	10 nanoseconds
Accuracy:	± 10 nanoseconds, ± time base accuracy
Time Base:	External 1 MC required. hp 101A recommended
Registration:	7 places, direct digital presentation in neon columns
Reads In:	Microseconds, with decimal point
Input Requirements:	Start and stop trigger pulses through separate channels
Input Impedance:	Approx. 50 ohms
Output:	4-line 1-2-2-4 BCD
Minimum Trigger Pulse Requirement:	3.0 volts peak, 1.0 volt per nanosecond rise time, 5 nanoseconds width at 50% point
Trigger Polarity:	Selectable, positive or negative, for each channel independently
Reset:	Automatic, manual (from front panel), or remote through rear-mounted terminal
Standard Frequency Counted:	100 MC
Operating Temperature Range:	—20° to + 65° C
Dimensions:	16¾" x 3½" x 11½" deep, 15 lbs.
Price:	$3,250.00.

hp 101A 1 MC OSCILLATOR

Stability:	Short-term: 3 parts in 10^8; long-term, 5 parts in 10^8/week
Output Frequency:	1 MC sinusoidal, 100 KC optional. Rear BNC connectors
Output Voltage:	1 v rms minimum into 50 ohm load
Source Impedance:	Approx. 15 ohms
Distortion:	Less than 4% with rated load
Oven Temperature Indicator:	Front panel dial thermometer
Frequency Adjustment:	Front panel screwdriver adjustment with range of approximately 1 part in 10^6 for calibration from primary standard
Dimensions:	16¾" x 3½" x 11½" deep, 10 lbs.
Price:	$500.00.

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DCA-1000A DIVERSITY COMBINER. COMBINING ACTION IS OBTAINED BY SAMPLING NOISE OUTPUT OF EACH RECEIVER BY MEANS OF HIGH-PASS FILTERS.

POSITIVE DATA RETRIEVAL

...telemetry data from up to four sources combined into one improved output. The DCA-1000A Diversity Combiner is designed to handle FM/FM and PDM/FM signals in ground support installations in which up to four receivers with 500 kc and 100 kc bandwidths receive the same RF transmission simultaneously. Signals of the receivers are mixed by combiner into one improved output. The s/n ratio is better than that of any one of equal input, or as good as the best single input. Unit responds instantly to rapid changes in s/n ratio.

Fail-safe circuits assure signal reception at all times. One circuit per input prevents loss of any one of the input signals from causing additional degradation of the output signal. Another circuit guards against complete loss of data should the combiner fail. Each channel has its own plug-in unit, and any one module may be removed for servicing while the others continue to operate. Unit is designed for standard 19-inch relay rack mounting.

Diversity Combiners for non-standard signal reception are available on special order. Where the utmost in exacting communications equipment performance is demanded — Vitro is at work.

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CIRCLE 4 ON READER-SERVICE CARD

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September 13, 1961
Vol. 9 Number 19

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

More On Computer Memories

Last issue contained three excellent articles on computer design: Logic, timing and memories. In this issue we continue the article on *Cyclic Memories—A Comparative Evaluation* by Y. J. Lubkin. If you haven't yet read the series in the Aug. 30 issue, be sure to look them up.

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CIRCLE 5 ON READER-SERVICE CARD

Bionic System Uses Liquid-State Element

Symposium Told of Pattern Recognizer that Uses An Electro-Plate-Varied Neuron-Analog Resistor

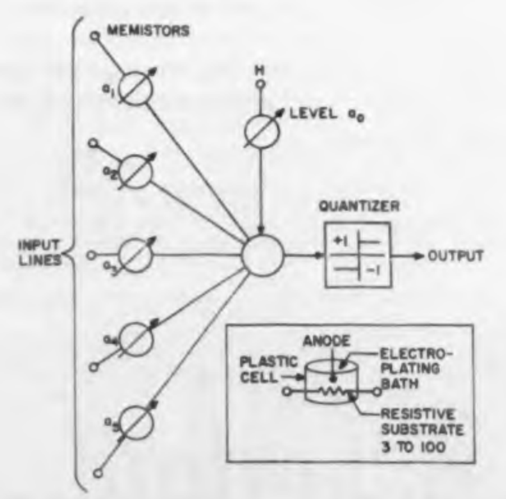
Alan Corneretto
News Editor

A NEURAL-NET pattern recognizer, called Madaline, that uses liquid-state resistive elements, was among significant developments described at the second annual Bionics Symposium at Cornell University. Sessions were held in Ithaca, N. Y., Aug. 28-29 and Sept. 1.

Also described at the symposium were:

- The first quantitative analysis of electronic neural-net behavior.
- Design of a relatively simple conditional-probability computer.
- Models for pulse-interval modulation systems.

The liquid-state resistive elements were developed at Stanford University by M. E. Hoff and Dr. Bernard Widrow, who delivered a symposium paper on the work. Called memistors, the devices are three-terminal cylindrical plastic cells, less than 1/64 of 1 cu in. in volume. They contain a tin-oxide resistive substrate, electro-plating anode, and a bath of copper sulphate and sulphuric acid, which is injected by a hypo-dermic needle. These tiny elements make possible very compact neuron-net machines. When a small dc signal is applied to the anode or the resistive substrate, it increases or decreases the deposit on the substrate. Thus resistance of the unit varies from about 3 to 100 ohms. Though the electroplate in present modules dissolves in two or three weeks, Dr. Widrow says he expects future units to remain stable for years.



Neural element of six memistors is adjusted to provide desired output by adjusting weights or resistances of memistors. The memistor, shown in inset, provides memory for the neuron and is repeated six times in this analog.

Net of Memistors Composes Variable Element in Analog

The memistors, which are resistors with memories, are used as the variable elements in a neuron analog (called Adaline, for adaptive linear neuron). Seventeen memistors are netted in the basic neural element developed at Stanford. Their resistance-varying capability is used in assigning weights to the neural element. The weights represent experience learned by the neurons during training. The neural elements in turn are connected in networks to form a system for doing work adaptively.

Though somewhat resembling a perceptron, the complete Stanford system differs in two important respects: its associations are not random, and stimuli are only paired to responses rather than being linked more strongly through reward and punish signals.

In the largest system built at the university, six neurons comprising 17 memistors each are interconnected to form a powerful classifier. Outputs of the system's neurons are connected to majority, or "OR", elements to provide the actual machine output.

Each neural element of the system is adapted to the pattern characteristic so that logic circuitry can provide a desired response.

Two-Layer Adaptive System Being Constructed at Stanford

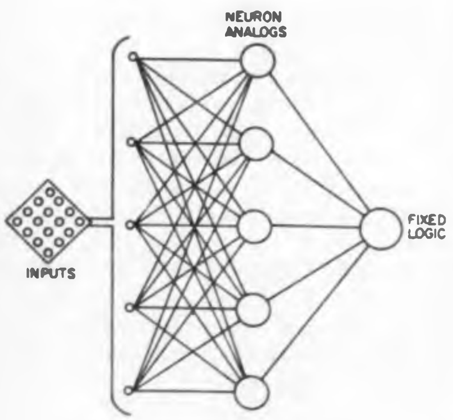
The Stanford neurons, basically Kirchoff adders, have been interconnected to show that in logic-tree form they can control signal flow on the basis of characteristics of the signal. Under construction at Stanford is a two-layer adaptive system in which the output of one set of adaptive neurons is the input, in basically parallel operation to the other set. The first layer derives a set of arbitrary signals, which are characteristic of the pattern and are not sensitive to size, position, rotation, or noise. The second layer would indicate recognition of the input pattern.

The key to all the systems being studied by Dr. Widrow's group is the memistor element, which stores positive and negative-gain values. A different type variable element under development at Stanford—the optimistor—depends on detection by a photo cell of the density of electro-plate film formed by a weighting signal.

A different type of semi-linear network system—a conditional probability computer—also was described at the symposium. The computer is under development at the University of Saskatchewan, Saskatoon, for use in industrial process control. The unit is said to be simpler and requires less storage space than the original CPC proposed by Dr. A. M. Uttley.

Several-Hundred-Input Computers Contemplated

K. H. Reid of the University of Saskatchewan, who delivered a paper on the computer, said it was feasible to build a several-hundred-input machine with a conventional magnetic-tape storage unit. A five-input CPC has been built at the university and is operat-



Six-neural-element pattern recognizer built at Stanford takes patterns from toggle-switch inputs and after training by feedback from operator gives a desired response in accordance with logic circuitry. Only six of 16 interconnections between inputs and neuron analogs are shown. Fixed logic provides output.

ing in an experimental chemical process. It gives dynamic response to changing conditions by filling in missing bits from signals transmitted by process monitors.

At the University of Wisconsin, researchers are quantitatively analyzing behavior of simulated neural nets to provide a basis for intelligent design of neural-net systems. Prof. C. H. Davidson reports that his group would like this information to develop a temporary memory system for storage of time-varying signals. Hopefully, he says oscillation, which can be induced in neural networks, could be used for this temporary storage.

Several systems of pulse-interval modulation (PIM) have been modeled in hardware at the Polytechnic Institute in Brooklyn, according to another symposium speaker, H. J. Hunt, Jr. PIM is believed to be used in many biological systems. The Brooklyn Poly models simulate the encoding characteristics of sensory receptors. They are reported to exhibit refractory periods, varying threshholds, and adaptation. ■ ■

CIRCLE 6 ON READER-SERVICE CARD ➤

NEWS

SIGNIFICANT BITS

Important news items for electronic designers written for fast scanning

High temperature strain gages are being sprayed on at Boeing Co. of Seattle, Wash. A flame spraying gun employs metal in powdered or wire form. A burning mixture of oxygen acetylene melts it and the molten metal is shot out of the gun by air pressure, in an atomized spray, and adheres at contact. Sprayed-on sensors have withstood temperatures to 1,200 F, the company reports. The expected limit is past 2,000 F. According to Boeing researchers, it would be possible to make heat sensors, erosion and ablative gages and other high-temperature measurement devices by the same method.

0001

Chances of false targets being picked up on air defense radars as a result of solar radiation will increase with more widespread utilization of extremely sensitive receivers using parametric amplifiers and masers. Anticipating the problem is a project at the Air Force Cambridge Research Laboratories for analysis of amplitude-modulated solar signals. Basic objectives of the research effort are: (a) To catalog the modulation structure of solar noise bursts to find ways to distinguish solar signals from true radar targets; and (b) To understand better the mechanism of the solar burst and its associated radio signals.

0010

Semiconductor rectifiers saved an estimated $1-million in electrical equipment, according to a report made at the recent Pacific General Meeting of American Institute of Electrical Engineers. Remotely controlled germanium and silicon semiconductor rectifiers were used in place of motor generators in the Baltimore, Md. refinery of the Kennecott Copper Corp. Each rectifier was located adjacent to the electrolytic cell it served, rather than being centrally located. According to the report, the savings were made without compromising either reliability or production capability.

0011

Advanced laser components, for use in optical surveillance systems, will be developed by the Quantum Physics Div. of Electro Optical Systems, Inc., Pasadena, Calif., under a $94,728 Air Force contract. Program goals include investigation of new techniques and materials used in laser amplifiers, oscillators, and coherent detectors. Emphasis will be placed on cw lasers and high-power pulsed lasers where a high degree of spectral purity and high repetition rates are required.

0100

An ocean seismograph, developed for the Vela-Uniform program for improving detection of underground nuclear tests, recently made its first earthquake recording about three miles below the Atlantic Ocean 180 miles off Bermuda. Seismometer, amplifier, fm transmitter and batteries were enclosed in a 14-ft-long underwater device, with a nose cone and spike at one end and tail fins at the other. Signals were transmitted to the surface by acoustic telemetering. An almost complete absence of background noise deep on the ocean floor greatly enhances sensitivity to earth tremors, according to the Air Force Cambridge Research Laboratories, one of many Government agencies participating in the Vela program.

0101

Experimentation with Echo I has led to the following discoveries: a radio bandwidth of at least 1.5 mc and probably greater can be transmitted and received via the balloon-bounce method; atmospheric interference has no effect on the transmission quality of signals bounced from the satellite reflector; transmitting teletypewriter messages, wirephoto facsimile photographs, music and voice over this type of balloon-bounce circuit is feasible; and, in addition, certain theories of radio propagation have been confirmed. These particular experiments, made with the still orbiting satellite, were conducted by Collins Radio Co. of Cedar Rapids, Iowa and its systems division, the Alpha Corp., Dallas, Tex.

Backlog of Searches Besets Patent Office

Agency, Fearing Breakdown, Seeks Funds to Develop Generalized Information-Retrieval System by '71

John J. Christie
News Editor

THE U.S. PATENT Office is the logical proving ground for sophisticated information-retrieval systems, Patent Commissioner David L. Ladd emphasized in an interview with ELECTRONIC DESIGN last week.

Reiterating what he has told Congress, the American Bar Association and the National Association of Manufacturers since taking office in April, the 35-year-old commissioner warned that the patent-examining system is heading for a breakdown unless generalized mechanical searching becomes feasible within a decade.

Commissioner Ladd does not believe the necessary hardware can be made available in less than 10 years because of the problems of reducing patent text and drawings to machine language.

The commissioner hopes that up to $3,000,000 annually will be appropriated over the next few years for basic and applied research on indexing and coding "the most sophisticated classification of technical material available." The $3,000,000 figure was recommended in a recent report by Dr. Allen Astin, director of the Bureau of Standards, and John C. Green, director of the Commerce Department's Office of Technical Services. If voted by Congress, this fiscal '63 sum will be about five times the amount provided for research in the current budget.

Ladd Questions Proposed Allocations of Research

The Astin-Green report represents an endorsement of an earlier study by a group headed by Dr. Gilbert King, director of research for International Business Machines Corp. The report will serve as a policy guide for the information-retrieval research program—with one possible exception.

Commissioner Ladd questions proposals that would put the National Bureau of Standards in charge of a sizable share of the research, all of which would be in the Patent Office budget. He feels that his Office of Research and Planning, for which a director with the rank of assistant commissioner is being sought, should carry the ball, with NBS in an advisory role.

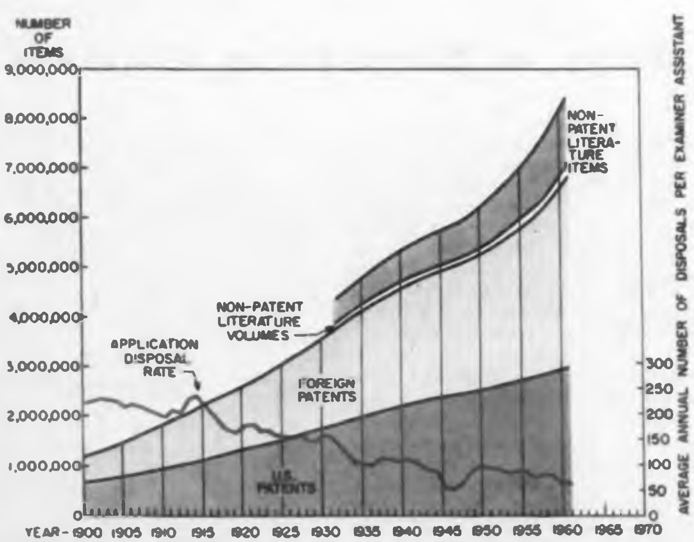
The basic question that this research effort ultimately must answer is whether a universal information-retrieval system, covering all the arts, is economically feasible or whether a series of encapsulated systems, each covering a segregated area of patent search, offers the best solution.

The Patent Office, the commissioner explained, probably will deal with both approaches simultaneously in its program.

A universal system, the commissioner noted, could well prove too costly, in view of the tremendous effort that would be required to convert all data now existing in printed form to whatever form the retrieval machines could accept. A universal system would be out of the question. Mr. Ladd said, without scanning systems capable of extracting and coding automatically all elements in text and drawings.

Transistor-Cir-File Mechanized On Trial Basis

The segmented approach already is underway on a limited scale, Commissioner Ladd said. He called attention to one project that involves preparation of a mechanical file on transistor circuitry. Patent examiners assigned to this project, on a part-time basis, are analyzing and coding these patents in terms of some 1,000 so-called descriptors or features. The coding is done on regular IBM cards, which are fed into a RAMAC 305 computer to check the logic of the coding. The computer punches out "peek-a-boo" cards. A single patent yields several cards, each bearing about 25 coded terms.



The Patent Backlog, as this chart shows, steadily worsens as the number of applications increases year after year while the output per examiner declines as a result of the growing complexity of examining requirements. Manual searching, as portrayed in the photo of a typical Patent Office file room, clearly cannot stem the tide. Unless mechanized searching can take over, the U.S. patent examining system may have to be abandoned.

Thus far, 300 out of 705 patents issued in transistor circuitry have been processed and microfilmed. In addition, this category numbers 940 cross references. By the end of July, there were 1,087 patents pending in transistor circuitry.

The commissioner feels, as do his technical advisors, that such projects will be valuable in testing approaches to file preparation and assist in training personnel in machine methods of handling information. They note that there are several limited areas of technology under consideration for mechanical search.

However, the Astin-Green report notes that such projects "probably cannot be expected to provide more than an interim solution to the search problem in an extremely limited segment of the total active patent art." The report cautions:

"Consequently, plans to introduce mechanized techniques for 'encapsulated' areas into the work of the examining divisions of the Patent Office should be based on sound estimates of expected savings or increased accuracy."

File-Preparation Costs Could Torpedo Program

The report urges that more attention be given to research in "mechanization of the preparation of the file." Noting that cost of file preparation rises in direct relationship to the care and detail employed in analysis and coding, the report warns that unless such costs are controlled, the entire program will be economically unfeasible.

"Therefore," Astin and Green conclude, "we believe that a vigorous research program should be undertaken, aimed at new techniques to permit mechanizing the preparation of the patent files. In addition, it would seem useful to develop cooperative relationships with private industry in order that special patent files set up by companies for their own needs can serve a wider purpose."

The new commissioner has no illusions about the job ahead. He is prepared for several years of effort to formulate the searching and retrieval theory on which the effectiveness of high-speed, mechanized procedures will depend. "None of the information-retrieval programs now under way in industry and the universities," Mr. Ladd pointed out, "approaches the depth of document analysis required in patent examining. Minute bits of data are often vital in establishing patentability."

Commissioner Ladd sees the Patent Office as an ideal laboratory for costing out

(continued on p 10)

Patent Office . . .

(continued from p 9)

machine-searching systems, in comparison with the exhaustive manual searching.

Statistics support the sense of urgency with which the commissioner has taken up the cause of mechanized searching.

A growing search load, together with the increasing complexity of disclosures in applications, has made the Patent Office's notorious backlog clearly unmanageable under current procedures. Moreover, it is becoming increasingly difficult to assure accuracy of search by present methods.

Beyond the solution to these immediate problems, Commissioner Ladd and his technical advisors hope that information-retrieval systems might ultimately revive the Patent Office's historic but long-dormant function as a technical-information clearing house. ■ ■

Grooved Plastic Sheets Eliminate TV Image Lines

A grooved plastic sheet that is laminated to the glass panel of a TV picture tube eliminates the line structure in the picture, according to its German manufacturer.

The sheet, described as a cellulose ester, has been introduced by Saba GmbH, a West German concern, and will become standard equipment on all Saba TV sets. It sells for the equivalent of about $12.50 under the trade name of Sabavision.

Saba says the sheet eliminates picture lines down to a viewing distance of about 30 in. for a 23-in. picture tube. The sheet's many grooves distribute the TV screen's light vertically so that black picture portions between the image's lines are lifted to the light level prevailing above and below them.

Perfection of Sabavision gave rise to a related accessory. The device, called Telelupe, produces electronic magnification of the picture tube image. Telelupe is push-button operated and produces magnification with a factor of about three.

The maximum picture magnification depends on the deflection voltage available. A special circuit protects the picture geometry when the magnifier is turned on. Other special circuits provide for continuous contrast and brightness levels.

One-Head TV-Tape Unit Offered in W. Germany

A one-head video-tape recorder, reportedly the first manufactured in quantity in West Germany, stirred considerable interest at the recent Berlin Radio Show.

Loewe-Opta A.G. says its recorder—the Optacord 500—uses one ferrite head, which rotates within a cylindrical tape guide at 3,000 rpm. The video track is recorded diagonally, rather than vertically.

The Optacord 500 wraps the tape around a cylindrical guide drum forming one turn of a helix. If the tape's speed is zero, the rotating head writes one slanted track from one edge of the tape to the other. A single track contains an entire frame.

The manufacturer notes that this system makes a single recorded frame visible without movement of the tape. The frame is reproduced because of the relative speed between rotating head and tape.

The machine uses 2-in. magnetic tape and one reel gives a recording-reproduction time of 105 min.

The Optacord 500 is relatively compact, measuring about 28 x 28 x 40 in.

Optacord 500 video-tape recorder is said by its West German manufacturer to be as easy to handle as an audio-tape recorder. Size compares favorably with that of professional audio-tape recorders.

System Identifies Radar-TV Blips

Passive Identification Device, Designed For Harbor Control, Proposed for Navy Use

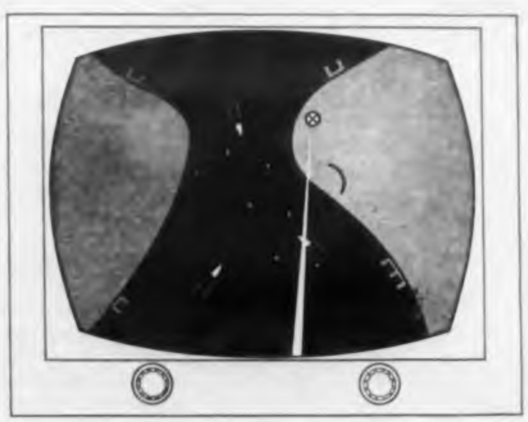
A PASSIVE system for identifying blips on televised displays of radar information has been proposed to the Navy for use by attack landing craft during poor visibility.

The system, called Plan, (Positive Locator Aid to Navigation), is being developed by General Precision, Inc., Tarrytown, N. Y., primarily for harbor control. However, the company hopes the Navy will find it suitable for landing-craft use and harbor defense.

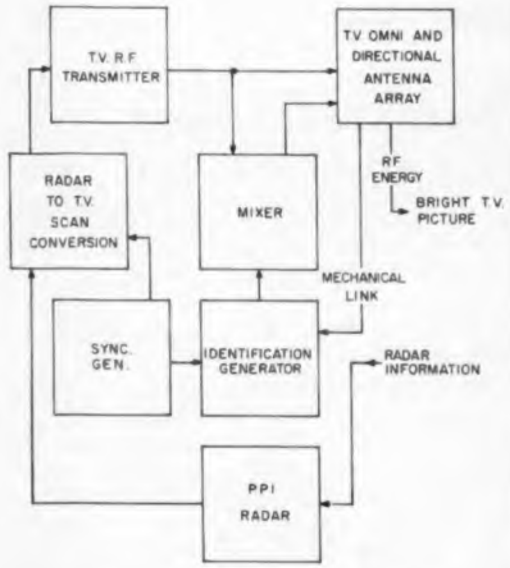
The original use proposed was in a Coast Guard harbor-surveillance system that will shortly be tested in New York Harbor. In this system, data from a harbor-surveillance radar will be relayed to an antenna for transmission to harbor craft equipped with almost-standard uhf television receivers. The picture seen on these screens will be the same as that appearing on the Coast Guard's ppi display. Blips representing ships, buoys and other harbor features will be unidentified on the display.

Rotating Beam Added to TV Picture Permits Ships to Identify Themselves

General Precision says its system could transmit a rotating beam in synchronism with the television transmissions of the radar data, so that a line would appear on the TV screen of each ship in range as the beam reached the blip representing each ship. As the line swept past the blip, it would drop out of the display on that ship until it touched the next blip, when it would appear



How-Plan display would appear on screen of adapted uhf set carried by ship receiving televised radar data and rotating identification beam. Line appears over blip of each ship in turn as beam rotates at about 10 rpm. As soon as it passes through one blip, it drops out of display on that ship's screen.



Plan system works by generating a rotating beam synchronized with scan-converted and televised radar data.

as a line moving through that spot. Though theoretical range would be line-of-sight, a range of about 10 miles would provide best resolution in a practical system.

The identifying line could originate from a mechanical image viewed by a vidicon or could be electronically generated. In either case its image would be used by an identification generator to provide a voltage-time series of video pulses in synchronism with the radar-to-TV scan-conversion system. A sync-pulse generator would drive the scan converter for generation of the identity display. A series of video pulses generated for the identity-generator display would control rf fed to a directional rotating TV antenna used in conjunction with an omnidirectional TV antenna.

Albert Roberts, a General Precision engineer credited with development of Plan, believes that passive identification could be added to a system like the Coast Guard's at relatively small additional cost. Another application he forsees is in lighthouses, where the system would aid in transmitting identifiable converted-radar TV data.

In harbor-surveillance applications, Mr. Roberts says, the system could be modified to include provision for stopping the identification beam on a particular ship to call attention to a dangerous situation or to give advice. It could also be used for tracking.

Although patents on several versions of Plan have been applied for, no equipment has been built. ■ ■

NEWS

Sweep Camera Snaps Light Beam In Motion

Pictures of the flight of light have been achieved by scientists at STL Products Div. of Space Technology Laboratories, Inc.

An electronic STL image converter camera took the pictures by sweeping the image from top to bottom at 168,000 mph.

When adjusted to take individual frame exposures, the image converter camera can record subjects in exposures as brief as 2-1/2 billionths of 1 sec, and can take three frames in succession at a speed equivalent to 20,000,000 exposures per second.

The camera converts optical images to electron images, allowing electronic shuttering, light amplification, and image deflection.

Image Amplified on Screen Before It Is Photographed

Optical images are focused on an image-converter tube. The focused light strikes the photo cathode of the tube. The resulting electrons carrying the picture information move toward the anode, where they cross over and are accelerated to a focus on a fluorescent screen at the end of the tube.

The optical image is thus re-created at an amplified intensity on the screen. The amplified image is then focused on the film through a lens system and photographed by conventional means.

A gating grid, placed in the path of the electrons flowing toward the anode, serves as the electronic shutter. Advanced circuit design provides a fast-rising voltage pulse to the gating grid; thus the shutter speed is limited only by the parameters of the pulse forming the circuitry.

Plug-In Units Permit Variety Of Framing and Writing Speeds

Interchangeable plug-in units provide a choice of high-speed or standard-speed framing pictures and high-speed or extended time-writing rates.

David G. Fladlien, assistant director of STL Products, believes the camera will be useful in astrophysics, atomic spectroscopy, arc discharges, combustion, high-temperature physics, jet velocity and stability, time-resolved spectroscopy, wave propagation, and velocity, shock waves, and propulsion.

STL is a subsidiary of Thompson Ramo Wooldridge, Inc.

Aluminum Space 'Flower' Blooms

When unfolded in space, this flower-like aluminum-coated unit becomes a 16-ft parabolic mirror. The model shown is part of an experimental solar thermionic electrical-power system and is used only in ground tests. The device was developed by General Electric Co., Philadelphia, for the Air Force's Aeronautical Systems Div. It is designed for possible use in space craft to convert concentrated solar energy or heat into electricity. The mirror is folded for compactness during its space flight.

Ultrasonic Doppler Unit Measures Landing Speed

An airborne ultrasonic Doppler system to measure an aircraft's rate of descent at touchdown has been developed by Gulton Industries, Inc., of Metuchen, N. J.

The Gulton system, under test at the Wright Air Development Division in Dayton, Ohio, measures an aircraft's velocity during the last 18 in. of vertical descent. Velocity is recorded on an airborne recorder.

Gulton considered electromagnetic and optical aproaches to the instrument's design, but found ultrasonics the most economical.

More powerful versions of the doppler system, says Gulton, may someday be applied as automatic flare-out devices for aircraft and soft-landing systems for space vehicles.

Russians Like It, Too

According to visitors to Russian technical institutes, the USSR believes that rugged, easily understood and maintained pneumatic-analog controls may be the most practical initial form of industrial automation, particularly for underdeveloped areas.

Pneumatic Computing Units Built for Process Control

Small, Rugged Modules Considered Competitive With Electronic Systems In Automation Uses

AiResearch engineer holds one of the new air-operated analog computing modules. The 1-ft-long, 4-lb units will sell for $500. Computing will be done by balancing forces from pneumatic inputs acting on pivoted rods. Cylinder extending away from box houses piston which is used for moving the input force along the rod during multiplication.

AN AIR-OPERATED analog-computing module, which like electronic units can be packaged into small, rugged industrial analog computers, has been developed for industrial process control.

The pneumatic unit is the work of the AiResearch Manufacturing Div., Garrett Corp., Phoenix, Ariz. It is is priced at $500.

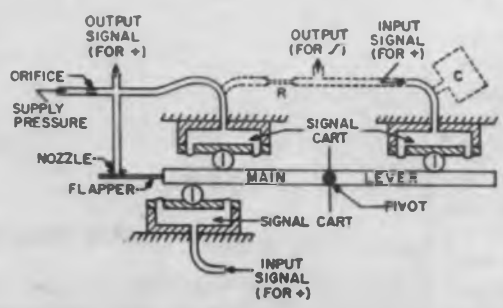
AiResearch engineers developed the unit as a pneumatic, rather than electronic, system because they felt there was a great need for a mechanical device that would be easier for industrial operators to understand and maintain. The pneumatic unit, has provisions for electrical input and output signals.

AiResearch engineers say their unit could achieve an order-of-magnitude better reliability than even solid-state electronic systems. The unit's designers said their model should be competitive with existing pneumatic systems because it has slightly better accuracy and more installation flexibility. The flexibility comes from the way in which AiResearch has adapted modular concepts, familiar in electronic-analog computers, to their pneumatic "building blocks."

Similar Computing Principle Used In Pneumatic-Process Controllers

Actually, the computing principle used in the new units does not differ markedly from that which has been widely used since the 1930's in standard pneumatic-process controllers. The basic computing element in each module is a "see-saw" lever. Force inputs to this lever are via "carts" containing bellows. The carts attempt to rotate the lever around the center pivot, but any rotation is sensed by a nozzle at one end of the lever. Movement of the lever changes the back-pressure in this nozzle and this pressure in turn acts on a rebalance cart. The amount of pressure which must be fed to the rebalance cart also is the output.

Additions and subtractions are performed by the arrangement shown inside the solid lines in the accompanying diagram. The additional circuitry needed for integration is indicated by the dashed lines. A pneumatic re-



Computing principle: Signal carts convert signal pressures into forces acting to rotate lever around its central pivot. Nozzle and flapper sense lever rotation and alter pressure on upper left signal cart to keep lever in balance. Dashed lines show additions to enable unit to integrate.

sistance in the form of a length of capillary tubing would be introduced at R and a pneumatic capacitance in the form of a volume would be added at C. Then, just as in an electronic analog computer, integration is performed by charging a capacitance in the feedback path around an operational amplifier; pneumatic integration is performed by filling the volume.

Piston Servo Used to Move Cart Along Lever In Multiplication

For multiplication, a piston servo is used to move one of the carts along the lever. The cylinder containing this piston can be seen sticking out one side of the unit in the photograph.

The most obvious drawback of the pneumatic units to an electronic engineer is their very limited bandwidth. However, since the time constants of industrial processes are often a matter of hours, or even days, the 1-cps bandwidth of these units probably will not be a disadvantage.

AiResearch has provided means for introducing electrical inputs and outputs through other pivot-nozzle transducers that are voice-coil actuated. Thus these units can be used with increasing numbers of special-purpose electronic instruments, such as gas stream analyzers.

Transducing to electrical signals also may be desirable because pneumatic signals cannot be transmitted over long distances. ■ ■

Delta Airlines Will Install Electronic Reservation System

A computer-based electronic system will make flight and passenger information available to reservation agents of Delta Airlines in 66 cities.

The IBM 9074 Sabre system was tailored to the airline's requirements after a two-year study. Installation of the network will begin in April, 1963.

The system, developed by International Business Machines, White Plains, N. Y., will provide high-speed, two-way transmission of data via leased communications lines. A computer center, planned for Atlanta, will be linked to nearly 300 electronic agent sets throughout the country.

Two solid-state IBM 7074 computers, modified to meet the system's requirements, will be used. Each computer is capable of making 250,000 logical decisions a second, and each can retrieve a character from core storage in 4 μsec.

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a continuing series on technical topics of specific interest to engineers

Folio 15 REFERENCE DATA FILE

Ripple Current in D.C. Filter Capacitor Applications

A.C. ripple current rating of an electrolytic capacitor is one of the important factors in filter applications. Excessive ripple current can cause excessive temperature rise and can shorten life. This is why it is desirable to understand the facts concerning the effect of ripple currents before specifying electrolytic capacitors for filters.

A typical filter-capacitor application is shown in Figure 1 (a), where a singlephase, full wave bridge rectifier is supplied from a 60 cycle, sinusoidal input. If the switch to the resistive load is open, the capacitor will be charged to peak voltage during the first 1/240 second and will hold its charge, maintaining a constant D.C. voltage across its terminals. There will be no significant A.C. voltage ripple under these conditions, as shown in Figure 1 (b).

Figure 1 (a)

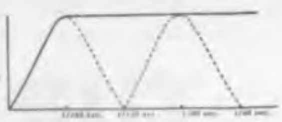

Figure 1 (b)

Figure 1—Typical full wave, singlephase bridge rectifier circuit operating on 60 cycle input is shown in 1 (a). Rectified voltage wave shown in 1 (b) is a constant D.C. voltage so long as load switch remains open.

However, conditions change when the load switch of Figure 1 is closed. The capacitor will be charged to peak voltage during the first 1/240 second as before, but after rectifier voltage reaches peak and begins to decrease, capacitor voltage remains higher than rectifier voltage. The capacitor must now supply load voltage and current until rectifier voltage is again equal to or greater than capacitor voltage. How rapidly capacitor voltage drops during intervals when it is supplying the load is governed by size of load and, hence, rate of discharge of the capacitor. Total drop $\triangle E$, shown in Figure 2, is proportional to load current. These drops are what produce the ripple voltage. Ripple voltage is decreased when the filter capacitor is increased in capacity.

$\triangle E$ is the total peak-to-peak ripple voltage and is a complex wave containing harmonics of the fundamental ripple frequency. Exact heating effect calculations on the capacitor would involve determining the effective voltage for each harmonic, determining the rms current from known total impedance of the capacitor at this frequency, and calculating the watts loss from the known resistive component of the capacitor at this frequency. Total loss would be the sum of these individual harmonic contributions. This is a most complicated procedure since harmonic contents vary with application and complete impedance and resistance data versus frequency is not readily available for each capacitor design.

It is well to keep in mind that suppliers' ripple ratings are most usually based on tests conducted using 120 cps sinusoidal currents. Even though the true rms current in a practical situation is equal to the suppliers' rating, it does not mean that the heating effect will be the same as that obtained on the suppliers' test. This is due to the different wave forms involved and the harmonic current components mentioned above. However, an accurate rms current measurement is a very close approximation and is a practical first approach.

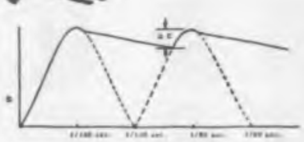

Figure 2

Figure 2—When load switch of Figure 1 is closed, capacitor supplies load voltage and current between successive rectifier input peaks. As capacitor discharges, its terminal voltage drops by amount $\triangle E$, creating ripple voltage.

One method of making this measurement is to insert a low impedance thermal ammeter in series with the negative lead of the capacitor. The impedance of this meter must be small compared to the capacitor impedance or the ripple current will be altered. Large errors can be produced by this method, especially if a large low impedance capacitor is being tested. A thermal type ammeter is recommended for this test since a true rms reading can be obtained from a complex wave and the impedance of this type of meter is very low.

Another approximate measurement can be obtained by inserting a low value resistor or shunt in series with the capacitor and reading the voltage drop with a vacuum tube voltmeter. An additional error is encountered in this method unless the voltmeter used is a special type which reads true rms voltage.

A third method is to estimate, calculate, or measure the ripple voltage and divide by the capacitor impedance. The same errors exist here as mentioned above.

The above methods have been used very satisfactorily; however, when there is doubt or if complicated duty cycles are involved, the most satisfactory answer is obtained by measuring the capacitor case temperature rise by inserting a thermocouple between the insulating sleeve and aluminum can midway between top and bottom. If the ambient temperature is also measured at the same time, temperature rise of the capacitor above ambient can be determined.

Equipment should be operated in this test at maximum load for approximately 2 hours or until two successive measurements, taken 15 minutes apart, show no change in capacitor or ambient temperature. A Sangamo DCM capacitor is safely loaded if temperature rise is not more than 8°C. for 65°C. ambient or 12°C. for 40°C. ambient.

EC61-5

SANGAMO ELECTRIC COMPANY, Springfield, Illinois

— designing toward the promise of tomorrow

NEWS

Message Sorter Feeds 105 Teletype Circuits

Army System Processes Data And Transmits on Priority Basis

AN ELECTRONIC message-distribution system will allow the Army to process and route incoming messages to as many as 105 receiving teletypes.

The system, resembling a large digital computer, rapidly and automatically sorts incoming messages according to priority. The equipment was developed by Minneapolis-Honeywell Regulator Co.

Priority messages automatically interrupt communications of lesser importance. The system "recalls" the interrupted messages and re-sends them later.

The unit is known as a Semi-Automatic Teletypewriter Message Distribution System. It consists of 40 cabinets of electronic circuitry and storage elements, a control console, five record page printers, and 105 terminal teletypewriters.

System's Digital-Logic Controls Housed in 4,000 Circuit Cards

The system's memory consists of a magnetic drum and magnetic-tape units. Four thousand solid-state circuit cards house the digital logic for control of the unit.

This is how the system works:

Messages arriving on several 100-word-per-minute teletype lines are recorded on a magnetic drum and automatically assigned serial numbers. Simultaneously, the message is printed on a monitor teletype.

The magnetic drum provides 1-1/2 min of storage for initial processing. During this time messages are assigned to any of 25 addresses and designated either for action or information by the push of a button for each address.

Priority messages are singled out immediately upon receipt by circuitry, which decodes and recognizes the precedence identifier. An alarm sounds and the operator pushes a button for immediate transmission.

Messages are transferred from the magnetic drum to storage on transmission tape, a continuous loop of magnetic tape. From there they are routed to their addresses as outgoing lines become available.

Messages in transmission storage pass

readout heads five times at intervals of four minutes. If a message completes the transmission-storage cycle without being delivered, it is transferred to intercept storage. From there it can be re-introduced into transmission storage by the operator when volume permits.

Annotation buttons permit addition of notes to messages when they are being addressed. Extended notes can be added, or a message can be edited, by use of a standard teletypewriter keyboard. ■ ■

Developmental Fuel Cells Use Radioisotope Catalysts

A fuel cell with a radioisotope-coated electrode has been operating continuously for more than two months at the laboratories of Yardney Electric Corp.

Oxygen under pressure is diffused through sintered porous silver electrodes into a low-temperature alkaline electrolyte. Radioisotopes on the silver surface serve as catalysts for the oxygen-electrolyte reaction.

The cells under development have current densities of 150 ma per sq cm, or about 150 amp per sq ft, with polarizations of 0.2 to 0.3 v. Current research is to determine how the radioisotopes aid the oxidation and to find the best isotope for the reaction. Alpha and beta emitters like Cu^{14} and Ni^{63} are currently being used.

COMLOGNET Takes Shape

Electronic-communications equipment for the Air Force's Combat Logistics Network (COMLOGNET) is viewed by Air Force Lieut. Col. F. W. Schultz and the project control manager, George Weilenman, of Radio Corp. of America. The RCA equipment, recently delivered to Norton Air Force Base, San Bernardino, Calif., will be used in the first of five control and switching centers for the communications network linking 350 bases, depots, and installations. The system will be able to transmit 100,000,000 words daily. Western Union Telegraph Co. is the prime contractor for the project, to be completed in 1962.

OVERNIGHT
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DELAY LINES
TO FIT YOUR ELECTRICAL SPECIFICATIONS
OVERNIGHT

the
WEE LINE

A NEW MARKETING CONCEPT IN DELAY LINES

Here's the supermarket approach to your delay line problems. It's fast . . . versatile . . . accurate, really something new under the sun! Wee Lines are sectionalized delay lines, mounted on printed circuit boards that conform to MIL-P-13949B. Each section is a discreet value of delay time. The number of sections determines the overall delay time and the delay-to-rise time ratio. A quick computation tells the engineer how many sections are required; the problem is reduced to a simple ordering process, and the Wee Lines are shipped within 24 hours. An innovation designed and manufactured exclusively by Nytronics, Inc.

FEATURES

- Cut motion, time and costs
- Delay lines made from standard sections shipped in 24 hours
- Will fit 80% of requirements
- Uniform performance characteristics
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CIRCLE 19 ON READER-SERVICE CARD

WASHINGTON REPORT

SPACE SHOTS FEATURE NEW SENSORS, DETECTORS

Two imminent satellite launchings by the National Aeronautics and Space Administration, will expose a variety of sensing and detecting devices to space phenomena.

One 83-lb spacecraft, to be orbited from Cape Canaveral, Fla., will study the behavior of energetic particles. This shot has been dubbed S-3. The other satellite, to be launched from Wallops Station, Va., will be a Scout (S-55) whose mission will be to observe micrometeoroids.

The S-55 will carry five micrometeoroid detectors: pressurized cells, foil gages, wire grids, cadmium-sulfide cells, and impact sensors. Each of the sensors can produce a measurable electrical signal that can be stored and subsequently telemetered from orbit.

The pressurized cells are the primary sensors of the experiment. They are beryllium copper detectors composed of 160 half-cylinders from 0.1000 in. to 0.5000 in. thick.

Each of the 60 foil-gage detectors consists of a circuit developed from an electrochemical deposition process. The circuit, about 90 μin. thick, is attached to 1-mil Mylar and mounted on the underside of 304 stainless-steel samples of rocket skin.

There are 46 wire grids, each consisting of a winding of fine copper wire mounted on 1.45 x 7 in. rectangular melamine cards.

The cadmium-sulfide cells are mounted in aluminum flasks. Their exposed surfaces are covered with a sheet of 1/4-mil Mylar, coated with evaporated aluminum on both sides.

The impact detectors—piezoelectric crystal impact-detecting transducers—are acoustically decoupled from the satellite structure and have three levels of impact-detecting sensitivity.

The electronic components in the satellite payload will have two functions. They will be used as a radio beacon during orbital tracking and as experimental telemeters during the approximately one-year lifetime of the scientific package. Two telemeters, working independently to enhance reliability, will be turned on by ground command, and after a minute of data transmission will be turned off by an electronic internal timer.

High-density packaging has been achieved in the energetic-particles satellite. Ten detecting systems and associated electronics have been packed into 1.578 cu in. An octagon-walled platform, of nylon honeycomb and fiber glass, and having an aluminum cover 0.020-in. thick, houses most of the electronics and instruments. A transmitter in the base of the payload allows heat to dissipate through the structure and aluminum cover.

A magnetometer package, containing three orthogonally mounted saturable core magnetometers and calibration coils, reduces the field effects from the electronics and instruments. The vehicle will carry 5,600 solar cells, weighing 11 lb, in paddles that will be spring-extended in flight. The craft also will contain an optical aspect sensor to determine the orientation in space of the satellite as a function of time.

The system has two basic parts: a digital solar aspect sensor, consisting of a light mask and a number of photo-diodes, and a digital computer to determine the time at which a photo-diode sees the sun and to remember which photo-diode had the input.

U.S. TESTS UPPER-ATMOSPHERE BLAST EFFECTS

The Defense Atomic Support Agency is sponsoring several experiments on nuclear and conventional blast effects in the rarified atmosphere.

A contract has gone to Geophysics Corp. of America for a theoretical study of debris motion after high-altitude nuclear explosions. The company will develop an "idealized" problem in hydrodynamics capable of solution either in analytic form or by programing through computers.

The intense ionizing radiation from debris of high-altitude nuclear blasts increases the electron density in the upper atmosphere over wide regions. This may have widespread effects on radio and radar communications.

In a Continuing Study of missile-warhead performances at high altitudes, the General Mills Electronics Group has lofted 500-lb exposive charges into the atmosphere aboard huge balloons. The program has been dubbed Project Banshee. Three of more than a dozen balloon flights have been completed.

The 200-ft instrumentation chain carried by the balloon includes a command-control and recording package, four pressure-sensing transducer stations, and the explosive charge. The instrument package is recovered from altitudes ranging from 38,000 to 115,000 ft.

The experiments collect data on blast over-pressure vs distance and time; shock-wave velocity, and the duration of the positive phase of the shock wave.

The Atomic Support Agency has for years been sampling radioactive isotopes through high-altitude U-2 flights. Tests over the Western Hemisphere have led the agency to conclude that 95 per cent of the strontium-90 generated by nuclear testing has filtered out of the atmosphere to the earth.

PIECEMEAL ATTRITION BY IMPORTS DISTURBS INDUSTRY

A sector-by-sector invasion of the domestic electronics market by Japan threatens American electronics growth, a Congressional committee has been warned.

Robert C. Sprague, chairman of the imports committee of the Electronic Industries Association, favored trade restrictions, in testimony before the House Subcommittee on the Impact of Imports and Exports on American Employment.

Mr. Sprague, board chairman of Sprague Electric Co., also urged Congress to demand true reciprocity in international trade when it considers renewal of the Trade Act next year.

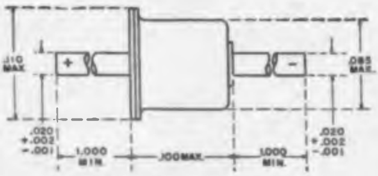
While the bulk of Japanese electronics shipments to the U.S. has been in transistor radios, competition is spreading to several components and other home-entertainment equipment, Mr. Sprague said.

semiconductor products news

Give 'Em the Axe, the Axe, the Axial

It's usually safer to give 'em the axe when the other school has graduated its entire first team, lost its quarterback due to a leg injury, and comes into the game with a line that averages 50 lbs. less than yours. If you want that kind of an edge when you put your tunnel diodes into play, give 'em the axial. G-E's new "back" diodes for ultra high speed computer switching circuits are extremely small, unusually fast and consume very little power in the new axial package shown below. The regular line of general purpose-computer tunnel diodes is also available in this package, in addition to the TO-18 package which has always been popular. We can also supply them in racoon coats, but the cost is rather high.

AXIAL DIODE OUTLINE



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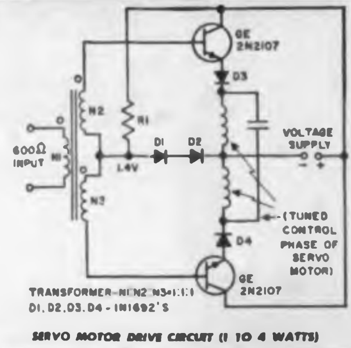
. . . put industrial silicon transistors into your feedback and servo amplifier circuits (or any number of other medium power applications you might have in mind) *at germanium prices.* New low cost industrial silicon Mesas 2N2106, 07, 08 are like a refreshing hint of mint julep on a humid day if you want top performance at prices that will qualify you as an honorary Kentucky Colonel when the purchasing agent looks at the blueprint (not to mention the boss).

The servo motor drive circuit shown is just one example. Chapter 16 of the G-E Transistor Manual (5th edition) gives you many more feedback and servo amplifier circuit suggestions, and complete details. Don't be like Scarlett O'Hara and "think about it tomorrow." Read that chapter today . . . the circuit you save may be your own!



SERVO MOTOR DRIVE CIRCUIT (1 TO 4 WATTS)

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. . . give the car keys to your wife, lock the kid's bicycle in the garage, sink the outboard motor, break the skis, sell the horse and lock yourself in the lab. Frustrated? No need to be. You can satiate that high speed mania by designing a real hot rod switching circuit for industrial and military applications with the G-E 2N705 germanium PNP triode mesa transistor. Gain bandwidth product is 600 mcs, and that's without shaving the head or turning the cam shafts.

For low cost computer applications, and other lower voltage and lower cost circuits, the 2N710, 2N711, 2N725 and 2N1646 types offer all the speed you'll need. For complete details, write to Section 231106. You'll get your answer by return mail in nanoseconds (if the Post Office will cooperate).

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If you have any questions, write us at Section 231106. General Electric Company, Semiconductor Products Department, Electronics Park, Syracuse, New York. In Canada: Canadian General Electric, 189 Dufferin Street, Toronto, Ont. Export: International General Electric, 150 East 42nd Street, New York 17, New York.

GENERAL ELECTRIC

CRICLE 20 ON READER-SERVICE CARD

Industry, Military Use Teaching Devices

Some Designs Sophisticated— Others Simple and Low-Cost

IMMEDIATE markets for well-designed teaching machines for the military or industry are attracting many companies into this young but fast-moving field.

Equipment design in the many machines shown at a conference and exhibit on teaching machines and programed learning in New York, Aug. 28-29, seemed to be taking two directions. Some designers are concentrating on simplicity and low cost. Others are directing efforts toward sophisticated machines capable of dealing with students of widely varying background and learning ability. Several exhibitors commented that military and industrial users had been much quicker than educators to see the advantages of both types of equipment.

The Mentor machine introduced at the show by Thompson Ramo Wooldridge, Inc., is one example of the sophisticated approach. The logic circuitry in the experimental model was said to be capable of controlling some 40 teaching machines. Time-sharing of the logic, by use of circuit branching, would allow each student to proceed at his own pace following individual programs based on questions posed by the machine.

Full-Logic Machines May Run to $25,000

The final configuration of Mentor, and price, are not yet definite, according to a company spokeman. He indicated, however, that an individual machine with full logic probably would be priced in the $25,000 range, and sets of centrally controlled machines in quantities of 200 to 300 might cost about $6,000 to $8,000 each.

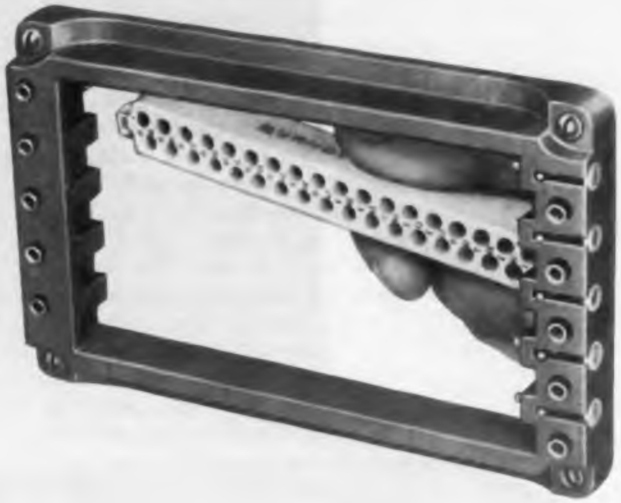
Visual presentations are possible up to a maximum of 17,000 color frames or 25,000 in black-and-white. A magnetic tape synchronized with the visual material gives verbal information or instructions. Responses are made by pushing buttons at the side of the view screen.

Another sophisticated machine is the AutoTutor Mark II shown by Western Design & Electronics Div. of U. S. Industries, Inc. This machine, a scaled-down version of

packaging flexibility...

BURNDY MODULAR HYFEN®

for single conductor, miniature and standard coax cables



All Contacts Crimp-Type and Removable

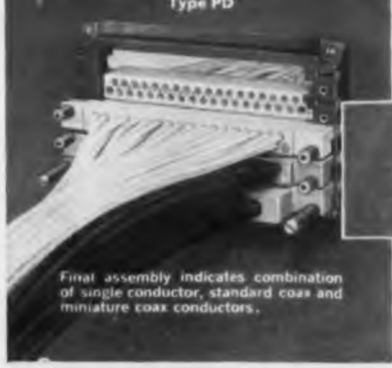
1 SELECT FRAME AND ADD INSERTS

Choice of 3, 5, 8, and 12 insert high strength metal frames. Inserts are high dielectric glass-filled molded material with excellent insulation characteristics. Metal ferrules molded in permit frequent insertion and removal of contacts without loss of contact retention force. Inserts may be mounted from front or rear of mounting panel. Jack screws fasten plug to frame, providing necessary engaging forces.

2 COMPLETE ASSEMBLY

Pins and sockets, interchangeable in plug and receptacle, may be inserted before or after inserts are in place. Inserts accommodate 35 single conductor contacts, 21 miniature coax contacts, or 10 standard coax contacts. All contacts are completely crimp-type assuring high reliability of tool-controlled installations. Contacts are individually removable, providing versatility of gang or individual connect and disconnect.

Type PD



Final assembly indicates combination of single conductor, standard coax and miniature coax conductors.

For complete engineering and specification details on the MODULAR HYFEN and other Burndy connectors for electronic use contact OMATON DIVISION

BURNDY

60-20

NORWALK, CONNECT. BICC—BURNDY Ltd. Prescot, Lancs., England In Continental Europe: Antwerp, Belgium TORONTO, CANADA

CIRCLE 22 ON READER-SERVICE CARD

Industry, Military . . .

the company's original Mark I, is priced at $1,250. Written material is presented on a view screen, and students punch buttons to indicate answers to questions. If incorrect answers are chosen, additional material is presented to clear up the student's misunderstanding; a return button is pushed to get back the original material. If a student's answer indicates a lack of understanding of a concept, a series of additional-information slides can be produced. If correct answers are given each time, however, the student progresses rapidly through the material and skips all supplementary data.

A demonstration of girls learning to make pig-tail connections with the aid of a new teaching machine made by Litton Industries, Inc., Los Angeles, and Prentice Hall, Inc., New York, showed the value of these devices for industrial applications. Color slides showing steps in the process were displayed on a view screen in front of the worker. Verbal instructions over earphones were used to describe each operation. The frames can be pretimed or can be switched by the operator with a foot pedal.

This machine, with 36 color-frame capacity and a magnetic tape that can be started over again by flipping a tape cartridge, is priced at $545.

A similar machine, called Instructron, was shown at the exhibit by American Systems, Inc. Specifications for a Videosonic teaching machine, allowing a variety of slide material and verbal instruction techniques, as well as student responses through pushing buttons, were presented by Hughes Aircraft Co. This machine still is in the research stage, according to Hughes.

A new Management Information Control System was shown by Teleprompter Corp. It permits TV-screen presentations to be received by an executive at the side of his desk, allowing two-way visual, as well as voice, communication between executives in different locations. Data can be stored in a central control area and called for by an executive when necessary.

Transmission of the TV images in this system can be by coaxial cable or microwave link. This is currently expensive, but with the development of more microwave links throughout the country Teleprompter expects these costs to go down.

Price of the Management Information

Control System itself can vary from about $50,000 to about $400,000, depending on complexity. An initial installation has been made at Redstone Arsenal, Huntsville, Ala.

An automatic multiple-choice test called the Teletest Communications System, was shown by Corrigan Communications, Inc., Palo Alto, Calif. An instructor has a master console with five choice buttons. When a question is presented, he pushes the button for the correct answer. Each student then pushes a button at his desk to indicate his answers. If the student's answer is correct a green light goes on. If incorrect, a red light flashes and a new choice is made.

This technique is said to let the student know immediately when he has made a mistake, and allows him to determine the correct answer. His score on the test can be determined before he leaves the testing room. An added feature is a percentage meter on the instructor's console which indicates how many students were able to answer each question correctly.

The two-day conference was sponsored by the American Management Association. ■ ■

Portable Feed Array Built

Feed array for antenna of AN/TPS-27 three-dimensional radar and data-gathering system is designed to be dismantled for convenient transportation. Array is being produced by Gorham Corp., Providence, R. I., for Westinghouse Electric Co.

NEWS

Audio-Visual System Aids In Training, Production

An audio-visual system that serves both as a training aid and as a continuous guide in production-line operations has been introduced by Graflex, Inc., a subsidiary of General Precision Equipment Corp.

Graflex's Audio Graphic System provides a synchronized sound and slide presentation. It features a simplified programing method and a relatively easy means of modifying a tape program to accommodate any change orders.

The playback unit weighs 35 lb and measures 17 in. x 15 in. x 13 in. It contains a 35-mm rear-projection 8 in. x 10 in. screen, amplifier, tape deck, speaker, earphones, volume control, and operator-controlled footswitches.

Recording on the instructor unit is done by means of a programing accessory, which contains microphone, controls for recording levels, stop signals and time-delay pulses. The programing unit plugs into the instructor.

Slides of each step in a job operation are shot with a 35-mm camera. The instructor holds 36 slides. Previously prepared commentary is read onto magnetic tape.

The instructor unit can be programed for continuous operation, demand operation, or timed operation. In demand operation, the tape mechanism stops automatically at the end of each block commentary, leaving the accompanying picture on the screen until the operator re-starts the tape by a footswitch.

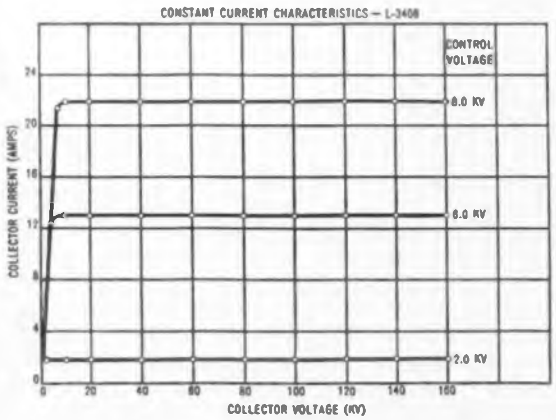
An accessory enables the instructor to re-start itself in timed operations.

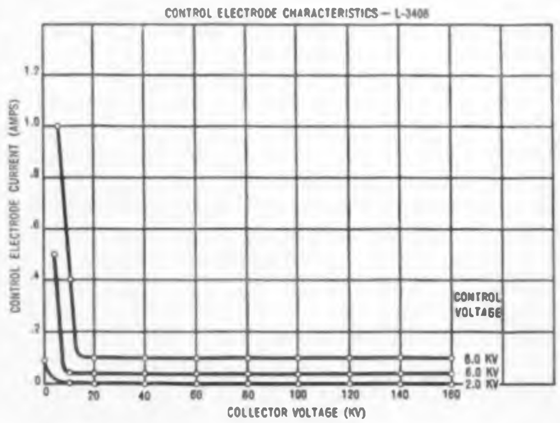
The instructor unit sells for $695, the programing accessory for $195, and the timer for $95.

A worker at the Graflex plant follows an assembly operation on the Audio Graphic System projector. She hears commentary on earphone.

HEIGHT 20 IN. — WEIGHT 45 LBS.

NEW LITTON INJECTRON* HOLDS OFF 150 KV, SWITCHES 20 AMPS





*An advanced concept by Litton for high power beam switching with high efficiency and fast rise time. Requires only low control voltages. Collector current is largely independent of collector voltage, resulting in pentode-like current characteristics. Ideal for floating deck modulators for switching modulating anode klystrons. L-3408 is in field operation now. Other models for cathode switching to 750 amps, 350 KV coming soon. *Contact us at San Carlos, California, for more information.*

LITTON INDUSTRIES
Electron Tube Division

MICROWAVE TUBES AND DISPLAY DEVICES

CIRCLE 26 ON READER-SERVICE CARD

CIRCLE 27 ON READER-SERVICE CARD FOR AMPHENOL-BORG ➤

Help stamp out close-quarter soldering

Miniaturization can be a mixed blessing. It's good when it conserves precious space and weight. It's bad when it creates a new gamut of how-do-you put-it-together problems.

Take miniaturized rack and panel connectors, for example. They must be small, lightweight and reliable. But many of them are tough to put together. Consider the plight of the worker whose job requires soldering 50 molded-in contacts in a space not much larger than an air-mail stamp. The job gets done, but when?

One way to unmix the blessings of miniaturization is, obviously, to stamp out this close-quarter soldering.

The same thought occurred to Amphenol designers. In fact, they asked themselves, "Why solder to contacts after the connector is assembled; why not terminate, then assemble?"

So, they designed the Min-Rac 17 ...the first miniature rack and panel connector with Poke-Home* contacts.

(To those who are not familiar with Poke-Home contacts—a brief exposition. Poke-Home contacts are so named because they are soldered or crimped to wires before the contacts are assembled to the connector. Contacts are then placed in the connector and pushed into the contact hole where they are firmly retained.)

► Although Poke-Home contacts were not new when Amphenol designers began work on the Min-Rac 17, the contacts were new to miniaturized applications. This spawned a few problems for Amphenol design engineers.

For instance: Working at contact spacings of .115 inch meant that extremely rigid molding tolerances had to be established. (Tolerances are held to $\pm.003''$ throughout the insert—some go down to $+.001''$, $-.000''$.)

Materials selection played an important part, too. A long and exhaustive study of over 100 phenolic resins and thermo-plastics conducted by the Amphenol Materials Laboratory convinced Amphenol designers that Zytel 101 offered the optimum combination of strength, insulation-properties, resilience, and weight savings. More testing, more evaluation followed. Strength tests. Insertion and withdrawal tests. Salt spray tests. Finally, the Min-Rac 17 was ready to go.

► How successful was all this effort? We can only judge by what our customers tell us. An equipment manufacturer on Long Island tells us that the Min-Rac 17 made a significant difference in his direct production costs—not to mention the fact that his reject rate took a nose-dive when he switched to the Amphenol Min-Rac 17. Another was most grateful that we had at last provided him with a way to get high-density crimped terminations into his equipment. (Imagine trying to crimp contacts by hand in a connector as small as the Min-Rac 17. Virtually impossible!) Still another customer in the San Francisco area is highly pleased with our float bushings, which allow him the leeway to correct for slight misalignment errors.

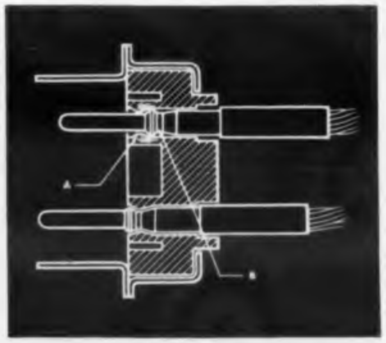
And so it goes.

► To those in our audience who may wish additional information on miniature rack and panel connectors, we make this no-obligation offer. Get in touch with an Amphenol Sales Engineer or Industrial Distributor (if you're in electronics, you're not far from one). He will be most pleased to share his knowledge of the Min-Rac 17, and all Amphenol connectors for that matter, in the hope that a solution to your connection problem may be found. Or, if you prefer, write directly to Dick Hall, Vice President, Marketing, Amphenol Connector Division, 1830 South 54th Avenue, Chicago 5, Illinois.

DIMENSIONS

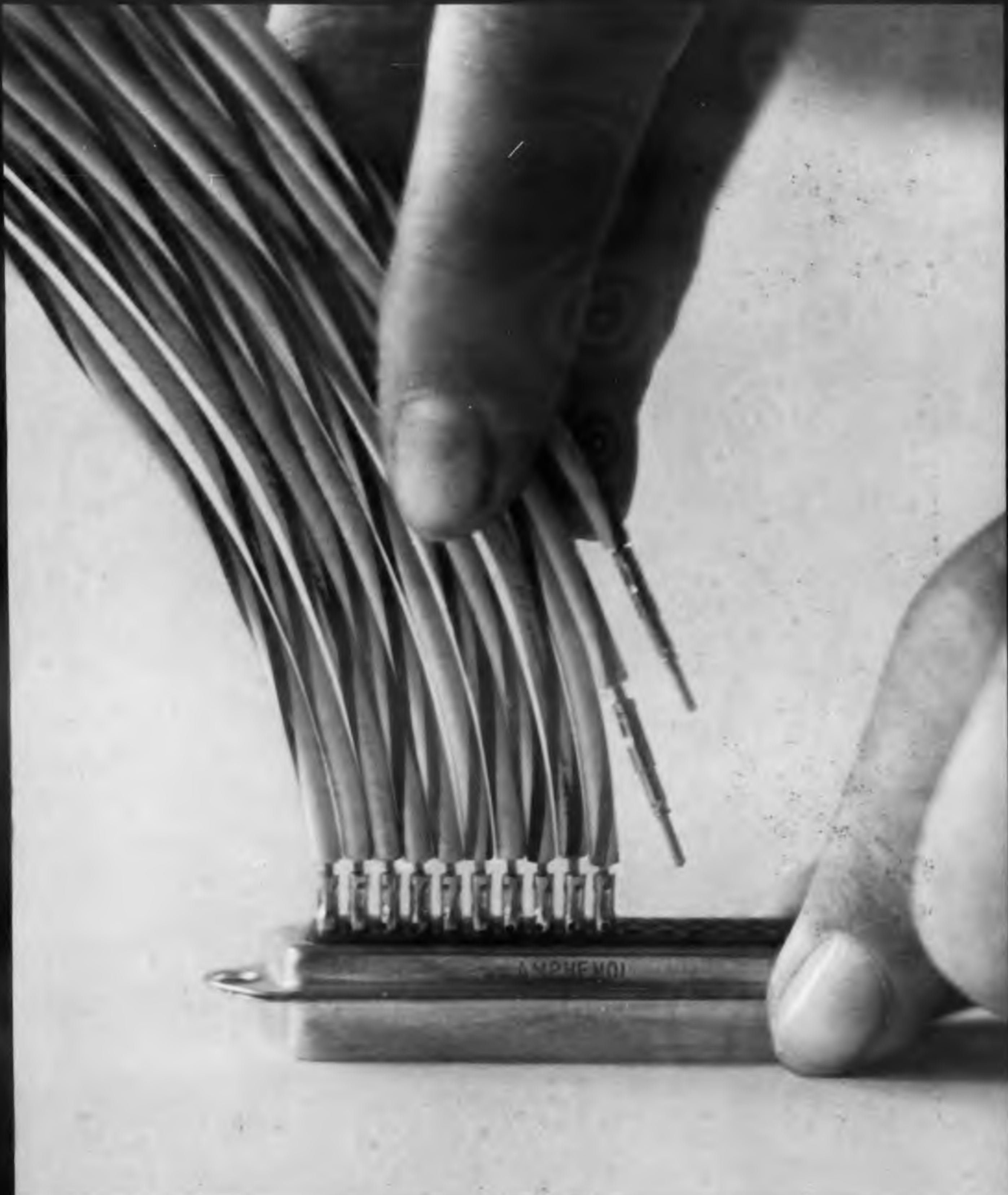
CONTACTS	A	B	C
9	1.239	.984	.515
15	1.567	1.312	.515
25	2.109	1.852	.515
37	2.754	2.500	.515
50	2.661	2.406	.645

The Min-Rac 17 is designed to mate with other popular miniature rack and panel connectors. Therefore you can immediately apply the advantages of Poke-Home contacts to your present equipment without tooling expense.



Poke-Home contacts "stay home" because of the precision-molded shoulder (A) and the groove (B) around the contact barrel. Although Poke-Home contacts are held firmly in place, they can also be easily removed if necessary.

AMPHENOL ***Connector Division*** / Amphenol-Borg Electronics Corporation



Automatic Unit Titles Film At 170 Characters Per Sec

An automatic unit designed for the ground-support data-handling system of the B-58 bomber xerographically prints titling data taken from the aircraft's instruments onto the edges of coded aerial photographs. The system operates at a rate of 15 to 25 ft per min and 170 characters per second.

Designed by Photomechanisms, Inc., Huntington, N. Y., the unit handles film in widths of 9.5 in., 35 mm and 70 mm.

After the film is developed and placed in the titler, data magnetically taped during a reconnaissance flight are searched out, stored briefly, read out on a cathode-ray tube, imaged as letters and numbers onto a xerographic drum, transferred to the film surface, and fixed by chemical vapor.

Automatic film titler for B-58 ground-support system combines data taken during reconnaissance flights with appropriate photographs.

Developmental Fuels Cells Use Porous Metallic Electrode

Several types of fuel cells under development at Electric Storage Battery Co., Philadelphia, use a porous metallic electrode, said to have the following advantages:

- It is unaffected by saturation with electrolyte if oxygen is low or cut off.
- It will operate efficiently at high current loads.
- It is resistant to corrosion caused by high temperatures or pressures.
- It has high electrical conductivity.
- It can be mass-produced in a variety of shapes.

In one fuel cell under development at the company zinc is oxidized in a potassium hydroxide electrolyte as oxygen is admitted under low pressure.

Another uses a gaseous fuel oxidized by oxygen from the air. This cell reportedly operates at room temperature and normal atmospheric pressure.

EDITORIAL

Incidence of Invention Greater If There Is Coincidence of Trial Answers

The demand for large, complex systems brought on the attendant need for team work and cooperation. Much was said a few years back about the need for group or committee engineering.

Then there followed rebuttal disagreeing with the hope of miracles from committees. Individualists pointed out that the final inspiration, insight, or understanding occurred to only one man. They thoroughly debunked engineering by committee and the later frequent necessity to debug the project team's effort, upheld the critique charge.

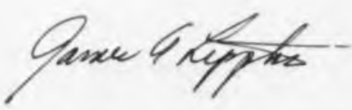
Nevertheless patents continue to be issued to co-inventors and sometimes tri-inventors.

In some cases, one inventor makes one contribution, the other a different contribution. But there are joint efforts in which the contributions are inseparable. The final invention unfolds in the minds of all concerned.

That more than one person should truly have the identical idea is not necessarily surprising. Prolific inventor, Jacob Rabinow, (the proximity fuse, the magnetic clutch, and many others) holds many patents, yet his "re-inventions" are even more numerous. Sometimes his flashes of insight were filed in the patent office 30 years earlier.

If we grant that they can be "invented" jointly, are two heads necessarily better than one? Do better inventions, better solutions result?

This is probably difficult to determine. But ignoring separate contributions and the acceleration of the investigation stages when more than one person is on the problem, it can be said that a joint effort will invent more. When the climate is such that inventions are needed and wanted badly, inventions come forth at greater rates. Similarly, when two or three people look at problems together they stimulate each other. And occasionally both see the answer in the same split-second. The day of the sole inventor is not over, but the joint probing of the uncharted yields many return signals in coincidence. Meaningful synthesis is then more likely. Do not overlook this process.



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- Makes direct resistance measurements of ±0.01% accuracy with clip lead simplicity without calibration or need for zero resistance or lead resistance corrections.
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CIRCLE 32 ON READER-SERVICE CARD

An ELECTRONIC DESIGN Staff Report

Bionics Efforts Center on Learning Machines

Adaptive Systems Predominant as Learn-From-Nature Concept Spreads to Spur Novel Research Designs

Alan Corneretto
News Editor

THE BIONICS concept—the application of biological knowledge to electronics—is spreading. Not only are there more organizations than a year ago supporting work in the specialty, but researchers are developing new types of equipment, such as sensors and variable-network systems. Further evidence of the concept's growth are new learning machines, pattern recognizers and other devices that have appeared beside the first neuron analogs and rudimentary self-organizing systems.

Bearing such names as Cybertron, Auditran and Visilog, the new systems indicate that electronic designers are serious about achieving performance beyond the range of conventional equipment by adapting nature's techniques.

In addition to these systems, bionics investigators are working on reliability schemes, memories and research analogs of biological subsystems. Some electronic companies are conducting basic research in biology, aware that in many areas there is not enough information on living systems to support intelligent exploitation.

Some researchers hold that a detailed knowledge of biological systems is necessary before analogous electronics can be designed. Others believe that the barest inspiration from nature could lead to equipment and that experimental hardware should be built as soon as possible. They reason that nothing is really accomplished until hardware is working. Between these extremes lies the view that equipment design can begin relatively early but that it should be based on complete analysis of its expected operation.

The Autonetics Div. of North American Aviation, Inc., Downey, Calif., for instance, is developing a learning machine that will use a new component, a circulating combiner. This device, essentially a dynamic memory unit that holds large units of digital data in temporary storage while it automatically searches and combines pulses in various patterns, has been proved successful in simulations on a computer, Autonetics reports, but an additional program for more simulation is being written to provide an even firmer basis for eventual hardware models.

At General Dynamics/Electronics, Rochester, N. Y., however, researchers would rush to exploit, if it were possible at this time, an admittedly "far-out" idea for a molecular memory for a learning system, based on doping macromolecules of one material with atomic quantities of bistable elements, like yttrium, whose state may be changed by photoconductivity.

Most bionic development, though, is done on a middle-ground by researchers who have been struck by an idea that appears useful and who do a reasonable amount of analysis before building research models of equipment on a practical scale to test their concepts.

Primary Design Goal Appears To Be Learning Machines

Learning machines, mainly for pattern-recognition, are the current center of attention for bionics investigators. Designers are looking to nature for help with this equipment because the learning function has proved unattainable so far by conventionally organized electronics of practical size. Efficient pattern-recognition machines, especially for visual patterns, have a huge and immediate market awaiting in all sectors of the economy. Hence the great attraction of these systems for designers. The widespread activity in speech recognition is partly explained by the relationship of this specialty to the speech-bandwidth-compression problem, whose solution or even alleviation would also bring great rewards.

Most of the learning machines and adaptive pattern recognizers under development are of the neural-net type, including systems at Aeronutronic, Burroughs, Cornell Aeronautical Laboratories, General Electric-LMED, General Dynamics/Electronics, Philco, Stanford Research Institute and the University of Illinois.

Among the non-neural-net types are systems at Autonetics, Brooks Research, International Telephone and Telegraph Laboratories, Litton Industries, Melpar, Rabinow, Raytheon, and System Development Corp.

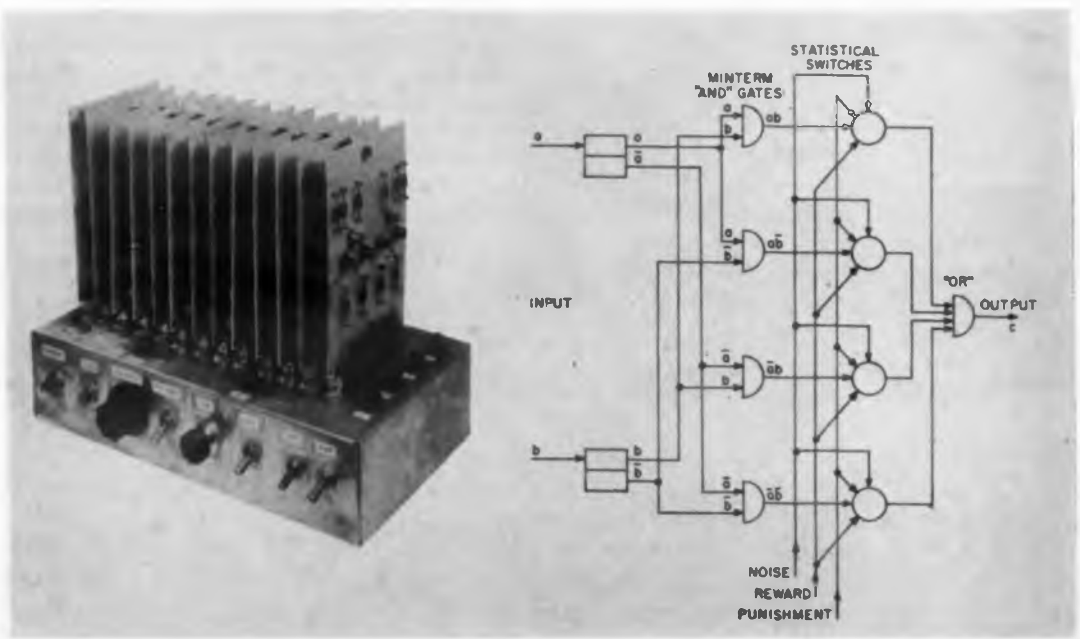
Several bionics programs are devoted to developing r e l i a b l e systems, generally through redundancy of some sort, emulating nature's favorite type of construction. Redundant networks of neural-type logic are under study at Bell Telephone Laboratories, Radio Corp. of America, General Dynamics/Electronics, Wright Air Development Div., Massachusetts Institute of Technology and Air Force Cambridge Research Center.

Other redundancy projects include two programs at General Electric. One involves redundant basic logical function blocks, the other redundant components in power supplies. There is also a program at Magnavox in which redundant-component Quad circuits have been developed for most logical functions. And in the Signal Corps Advent communication satellite program, the satellite payload is being designed to use redundant components for reliability. ■ ■

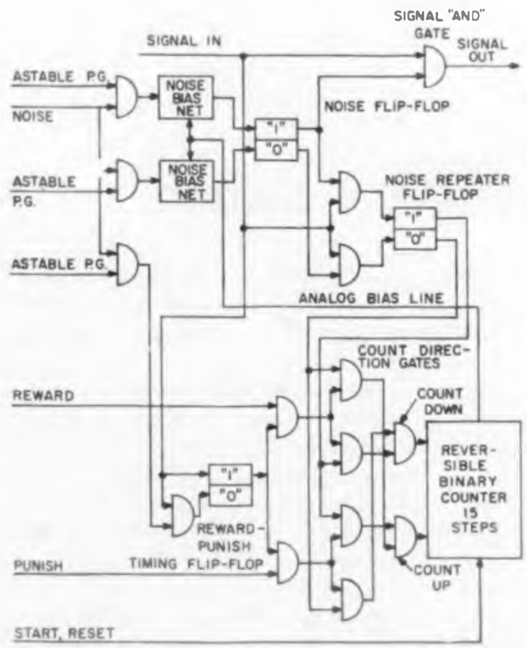
Melpar Learner Uses Statistical Switch

AMONG the non-neural-net learning machines under development is a system of Melpar, Inc., Falls Church, Va., that uses a "statistical switch" technique to achieve self-organization. A simple system that can be trained to provide a "0" or "1" output for any combination of binary inputs has been breadboarded. Melpar reports that under test this decision element achieved its maximum level of learning in about eight attempts for initial learning and 16 tries for complete relearning. The company hopes to apply the "self-organizing binary logical network" to pattern-recognition and adaptive-filter circuits. In other applications, the network's digital output would be converted to analog signals to give solutions to analog control problems.

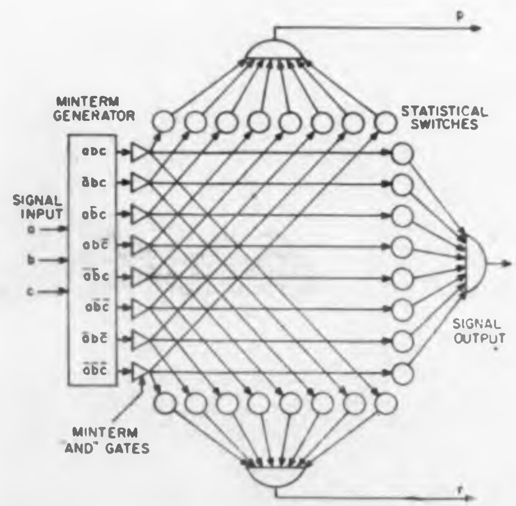
According to Melpar, the statistical switch is the key to the self-organizing characteristics of the network. The average state—or fraction of the total open or closed period—of the switch over any period is modified and controlled by the learning process. In its initial state the switch averages approximately equal time in the open and closed positions. Learning becomes the adjustment of the average state of the switch toward a



Self-organizing binary logical network breadboarded at Melpar can be taught to decide, on the basis of "reward" and "punishment" signals whether a "0" or "1" output is desired for any of the combinations of binary inputs. Key elements in the network are the statistical switches, which change value in accordance with what is learned, until each is completely open or closed for implementation of a logic function.



Typical statistical switch can be connected with other elements to solve all Boolean functions of any number of input variables. PG units are pulse generators.



Self-organizing logical system for three inputs and two outputs is a more general version of the two-input-one-output unit. Because only those switches that connect input to output gates are contributing usefully for any one input, elements can be time-shared, thereby reducing their number and the system's complexity.

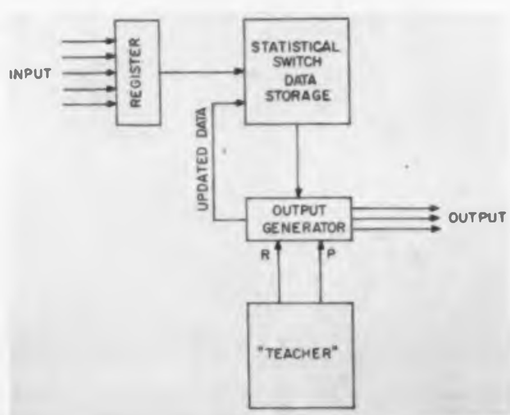
completely closed position, depending on the function to be implemented.

An input signal to the switch passes to the output through the Signal AND Gate, (see diagram), if the noise flip-flop is set to the "1" state. The average time this circuit spends in the "0" or "1" state is controlled by the number of trigger pulses passed by each noise-bias net. These pulses are generated by sampling a relatively low-frequency noise source with astable pulse generators having different pulse-repetition intervals, so that the AND-gate outputs are sharp spikes with a random and essentially independent time of occurrence. The noise-bias nets are resistor-capacitor-diode networks driven in push-pull by an analog bias voltage developed from the setting of the binary counter.

Statistical Switch Uses Counter As Its Memory Element

A 15-step counter constitutes the memory element of the statistical switch. The analog voltage, corresponding to the count used to bias the noise-bias networks, is developed by summing currents in weighted resistors. The noise-repeater and count-direction gates accomplish the conversion to count-up and count-down instructions for the counter. When a signal pulse is received, it is fed through the noise-repeater gates to the noise-repeater flip-flop, setting it to the same condition as the noise flip-flop. This repeater function is said to be necessary because "reward" or "punishment" may occur after the input signal arrives, and during this interval the noise flip-flop may change its state.

If the function to be performed requires the closing of the statistical switch, reward



Practical learning system would have memory to permit time-sharing of basic elements.

will cause the count to decrease, permitting more trigger pulses to pass through the upper bias network and fewer through the lower bias network, thereby increasing the average time for which the Signal AND Gate is operative. Punishment causes the counter to count up, which, in turn, reverses the process described. If the function to be performed had required the statistical switch to be open, the count direction for reward and punishment would be reversed. The reward and punishment pulses are applied to the count-direction gates for a finite time following the signal, as determined by the reward-punish timing flip-flop and gates. These gates ensure that only those switches that received signal inputs are rewarded or punished. The flip-flop is reset after a statistically variable period by sampling the noise generator with an astable pulse generator, as previously described. An AND gate and an inverter are included to inhibit the reset so long as the signal is present. (The signal may remain present for some time; it is not constrained to be a pulse.)

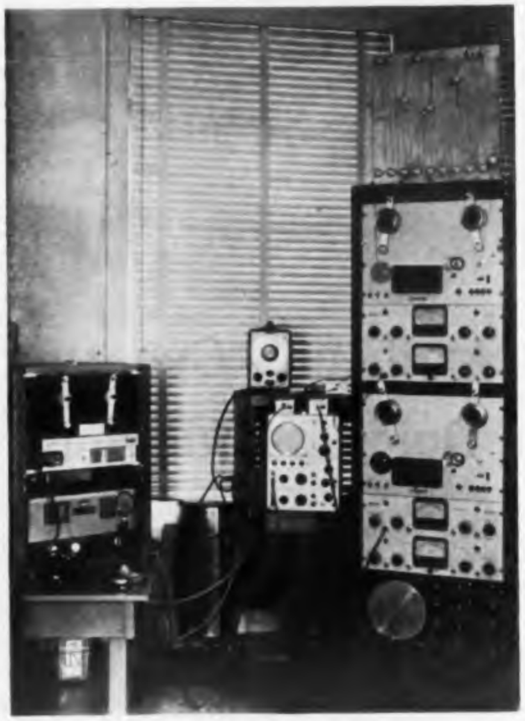
Time-Sharing of Elements Could Hold Down Complexity

Melpar's studies indicate that any n-input-to-k-output function requires 2^n AND gates, $k \times 2^n$ statistical switches, and k OR gates. Fortunately, because size of a learner increases rapidly with the number of input variables, a great number of problems can be specially simplified for solution in the network. In general, says the company, the more *a priori* information at hand, the less complicated the circuit will be.

In addition much of the hardware in a practical system could be used on a time-shared basis, it is believed. In the diagram of the three-input-three-output network, only those statistical switches that connect the input AND gate to the output OR gates are contributing to the performance of the network for a specific input. The other switches are kept idle until a suitable input is received.

Melpar plans to store the statistical state of each of these switches as a four-bit binary number to be read out to the output generator on command. In such a practical system, the output generator would comprise as many statistical switches as there would be required outputs. On generation of the output function, reward or punishment signals would be applied to the statistical switches

Waveform Recognizer Is Analog



Auditran speech recognizer under development at Bulova Research and Development Laboratories (*ED*, Aug. 2, 1961, p 16) uses tape-loop memory of spoken words against which input words are matched by correlation techniques. Actual comparison is of internally generated waveform envelopes based on amplitude or other characteristics. This research model is all-analog and has a 10-word memory. A practical system under development will probably have an optical storage system using a flying-spot scanner and cathode-ray tubes. Auditran concept is said to be suitable for recognition of any patterns or waveforms.

in the output generator. The updated statistical states would then be returned to central storage.

If time were available and the outputs were independent of one another, a further reduction would be possible by implementing only one switch. This could be shared between the output generator stations.

Melpar believes that using time-sharing, a 10-input-four-output learning element, could be built in a standard relay rack. Such a unit would be the equivalent of 1,024 × 10-input AND gates, 4,096 statistical switches, and 4 × 1,024-input OR gates with a capability of organizing to any one of about $10^{1,200}$ connectives. ■ ■

BIONICS

Raytheon's Cybertron Doing Useful Work

A DIFFERENT learning technique, based on a special and reportedly powerful type of correlation, is used in Raytheon's Cybertron, a concept implemented in two different hardware systems. Both are digital, single-level, distributed-memory data processors designed to recognize time-varying signal waveforms. In operation they compare input with stored waveforms.

An operator, by pressing a punish-signal button, trains the Cybertron as it compares input signals with previously learned and stored memory functions. These are distributed throughout the elements of the system. The organization is such that if the input

Cybertron learning machine, Raytheon's K200, is designed to recognize speech through the use of special correlation techniques and stored vocabulary. A Flexowriter output will type phonetic symbols of sounds spoken into a vocoder type of input. Magnetic-drum memory, at far left, for stored sounds is used as an analog store.

Distributed memory in Cybertron is not critically dependent on linearity of system elements.

signal is incorrectly identified, it will be either added to or subtracted from the total of the system's stored experience. Correct recognition indicates that the system is a filter that is equivalent to the difference between the desired and all known interfering signals. Recognition initiates no modifying action.

The input signal is added to the memory when it is of a class whose output response is a signal that should be recognized; it is subtracted when its response should be rejected. As a result of this converging technique, the initial untrained memory is modified so it recognizes, becoming, in effect, a series of complex filters.

In the existing Cybertrons, actual association of new with stored information is made through use of the processing equivalent of a correlation integral. Other association techniques are planned for different situations, where signal-to-noise conditions or other factors would reduce the effectiveness of the correlation-integral method.

Raytheon reports that the basic association procedure and the technique by which the memory is modified are the key features of the system. Identification is said to be not critically dependent on memory errors, local memory failures, or linearity of the multipliers in the association and memory units.

One Cybertron Already Working On Practical Problems

A K100 Cybertron, constructed to test feasibility of the concept, is reported to be

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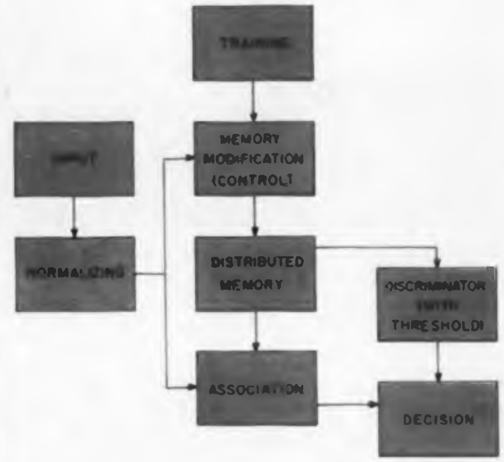


First Cybertron built has paper-tape input and output, can be trained to recognize patterns like this cardiogram curve, or sonar, radar or other waveforms. The system is now working on actual adaptive-recognition problems for a military agency.

working on spectral signature problems for a military agency. It has also been used for the design of a radar correlation filter. This system has a paper-tape input and memory and is not on-line. A much larger, K200 Cybertron is nearing completion. Designed to recognize speech in real time, it is being developed as part of a company-sponsored speech-bandwidth-compression program.

This system has a microphone and vocoder type of input, a Flexowriter output to type phonetic symbols of recognized speech, and a magnetic drum memory used as an analog store. The K200 has 192 learning elements consisting of storage, association and discriminator or control circuitry. It is designed to process 40 phonemes, enough to solve all speech recognition problems in the English language, according to Raytheon.

A visual-pattern-recognizing version is also under study, as are multi-level Cybertrons. Future systems may be analog; digital implementation was chosen for the existing units because of the availability of digital building blocks. The company says an analog

Why Study Nature?

In his book, *"Echoes of Bats and Men,"* D. R. Griffin shows that a case can be made for the bat in a comparison with airborne radar for target and obstacle detection by pulse echolocation. Here is how three echolocation systems compare:

		Big brown bat	Little brown bat
Target detected	Airplane	Insect	Wire
Target diameter, d (cm)	300	1	1.8×10^{-2}
Range of detection, R (cm)	8×10^{6}	200	90
Weight of apparatus, W (grams)	9×10^{4}	0.1	0.05
Emitted power, P (watts)	10^{4}	10^{-5}	10^{-6}
R/PWd	2.9×10^{-5}	2×10^{8}	10^{11}
R^4/PWd^2	5×10^{13}	1.6×10^{15}	3.8×10^{17}
R^4/PWd^4	5.5×10^{8}	1.6×10^{15}	1.2×10^{22}

In this table an allowance of 10 per cent of the bats' weight is made for those portions of a bat used for "radar" purposes. The first "efficiency" index, R/PWd, makes the AN/APS-10 look very bad. But this simple index assumes that range will increase in direct proportion to power; it does not allow for signal attenuation on both the outgoing and return legs. The second index, R^4/PWd^2, makes allowance for this fact and for the reasonable assumption that echo power varies as the square of the target diameter. The final efficiency index is adjusted for Rayleigh scattering, which becomes a factor in the domain of tiny target size.

implementation of the concept would be more natural.

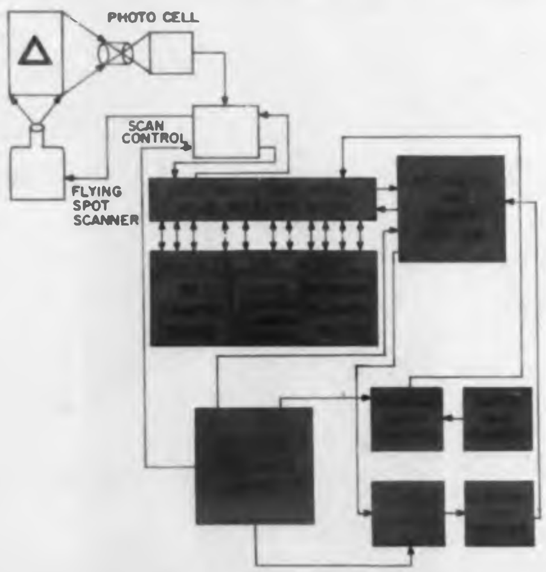
A complementary system, Aide (Adapted Identification Decision Equipment), is also under study at the company's Norwood, Mass., laboratories. Aide would use the results of what a Cybertron learned to solve special recognition or other problems non-adaptively. Being a copy of the trained memory of a Cybertron, it would be much less expensive and complex than a system having a complete learning ability. This concept is being explored at several organizations where learning machines are under development. ■ ■

BIONICS

Variable-Network Perceptron Almost Completed at GD/E

A LEARNING machine specifically based on processes believed to occur in the human brain is being built at General Dynamics/Electronics. This system, called a variable-network distributed-state response model (DSR), is essentially a special-purpose digital computer with unique logic. It will be programed to recognize visual patterns.

Like the perceptron developed by Cornell Aeronautical Laboratories, it consists of a set of multilevel association elements connected to a set of receptor cells and a set of response units. In both systems excitation of the sensory elements by a stimulus pattern causes a distribution of activity in the association elements. This distribution is marked by a change in some characteristic or value of the association elements. If following this change of value, a response element operates —either spontaneously or by being forced— a new permanent distribution of value is created. The new value is such that whenever the original stimulus pattern is again presented, it will correlate with the distribution, so as to favor the spontaneous operation of the previously associated response.



Adaptive pattern recognizer, distributed-state-response model, nearing completion at General Dynamics/Electronics is a special-purpose variable-network digital computer resembling a perceptron. Stimulating inputs from a scanner distribute values through synapse and association elements on track of disk memory and evoke a response, which changes the distribution of values. System can be trained by reinforcement of responses, so that input of a previously learned stimulus will correlate the distribution to evoke desired response.

The digital DRS model is a variable network system, unlike the perceptron of the Cornell Aeronautical Laboratories, which has a fixed analog network through which voltage values are distributed to form memory and which is organized so that sensory units drive association elements directly. Variations in the DSR system's network are developed by synapse units that correspond to the connecting elements between living neurons. The synapse units lie between the sensory and association units of the DSR system. They are the source of signals for the association elements and receive feedback from the system's response elements.

By placing these variable synapses or impedances on the lead of every association unit, General Dynamics researchers believe they have solved the problem of impossible associations. This problem arises when the response of the system to one stimulus is completely incompatible with another association, that may later be desirable.

Hardware Model of DSR System Designed to Recognize Patterns

A hardware version of the digital DSR system is nearing completion at General Dynamics. It has a flying-spot scanner input (equivalent to a 32 × 32 photocell retina), 4,096 synapses, 256 association elements, 32 response units and a magnetic disk memory.

Programing the model consists of writing into each of the synapse words the address of the association element with which that word is associated, and into each of the response words the 16 different association elements with which each response is connected.

During reading, the spot of the flying-spot scanner scans the pattern to be recognized in synchronism with the revolution of the memory and stores a "1" in the activity-bit position of all synapses that are connected to active portions of the pattern. The ambient values of the appropriate active synapses are then summed for each association element, and the resultant association-element values are summed for each response element. The responses may be of either the single (largest value) or multiple (coded) type. Reinforcement is achieved by depressing an appropriate typewriter key.

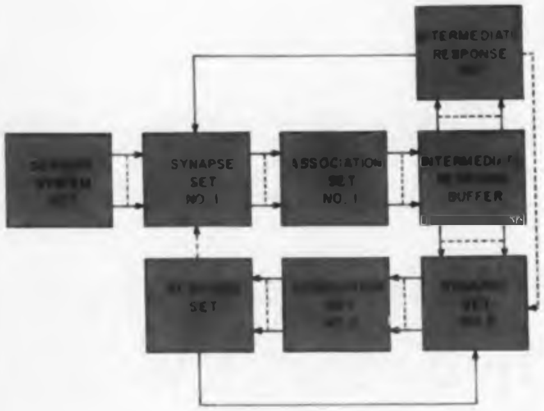
A smaller variable-network DSR model simulated on a computer performed very well, according to the company. The research system being built is expected to recognize patterns in a maximum of about 4 sec each. The company says a system built for practical use would recognize in microseconds. The characteristics of the variable-network DSR system have been summarized by General Dynamics as follows:

- Random organization of the association cells may be used but is not required.
- Memory traces are distributed throughout the system.
- Any cell may simultaneously participate as a member of many different memory traces.
- Increasing failure of elements causes a gradual decrease in performance rather than catastrophic failure.
- Memory is a process of response reinforcement rather than coded or classified lists of experience.
- Recognition is automatic and rapid, without any search and comparison.

The company is also considering multilayer systems in which the responses of one model would be the inputs to another. Learning in such a system would be more spontaneous than the conditioned-reflex type predominant in single-layer models.

Much Bionics Work Based On Organization of Human Brain

The General Dynamics work and that of many other organizations in bionics is based



Multilayer distributed-state-response systems are also under study at General Dynamics. In this two-layer system, the responses of the first are inputs to the second. Independent feedback loops connect each response set to its synapse set. Third feedback loop (dotted line) is in effect a forward reinforcement mechanism by which reinforcement of events in the first layer could directly reinforce synapses in the second without requiring any physical response at the second level. Learning in such a system would be more naturalistic than in any conditioned-reflex-type perceptron systems.

on the belief that much of the human brain is a randomly organized network of neurons with inputs from receptor cells, such as retinal elements.

In one hypothesis, stimulation of particular receptors is said to lead to the formation of closed systems of reverberating association area cells whose activity persists after the stimulation ceases. This activity in turn induces permanent changes in the active cells —changes that increase in depth every time activity occurs. The seat of memory in this model is composed of the synaptic junctions, and the model implies that the memory function is performed by changes in the transfer functions of these junctions. In effect, the brain could be conceived as a variable network in which the variation is achieved through modification of randomly distributed impedances.

Variable-network distributed-state-response models, perceptrons and other systems under development lean heavily on hypotheses such as these. The hope is that the power of neural-net logic can be combined with the advantages of microminiature electronics to achieve some of the performance of living systems—especially such functions as learning, low-power operation, reliability, self-repairability and large memory capacity. These are the incentives for much neuron and neuron analog research. ■ ■

RCA Neuron Analog To Do Speech Work

AT Radio Corp. of America, Camden, N. J., speech investigators have developed a neuron analog said to have a firing rate that can be varied over a 30:1 ratio above threshold. The device is said to be basically a four-transistor, one-shot multivibrator with low-impedance input and output. Its time constants are reportedly about the same as those of human neurons.

A definitely ordered net of 100 of the neurons is being built for inclusion in a speech-research system that will be used to study the invariants of speech, RCA reports. Data acquired through use of the equipment, which will resemble the auditory pre-processing of humans, will be used to design a speech-recognition system that will use a net of neuron analogs and appropriate logic. The company hopes that the networks of its recognizer will have self-healing and self-optimizing capabilities. A visual-pattern recognition system is also under study at RCA.

Among features cited for the neuron analog are these:

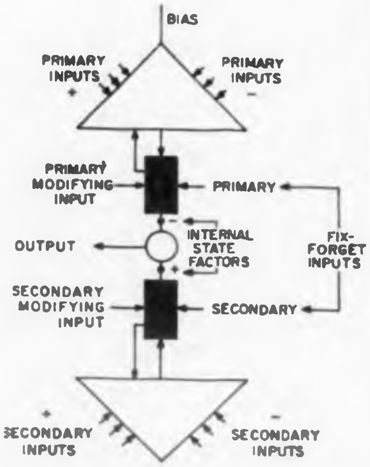
- Low input and output impedances to minimize paths through the logic nets.
- Integration and refractory time constants that are independent of the input connections, because of the wide variance in the *number and weight* of the input connections to different neurons.
- Equal-strength excitation and inhibition connections, independent of transistor gain factors—for repeatability.
- Stable thresholds with a minimum of variation among circuits.

Computer simulations of networks of the neuron analogs combined with a model of the cochlea portion of the ear have duplicated many psycho-acoustic phenomena, such as masking, equal loudness, sensation, amplitude-independent frequency discrimination, and others, RCA reports. ■ ■

GE/WADD Analog Includes EL-PC Cells

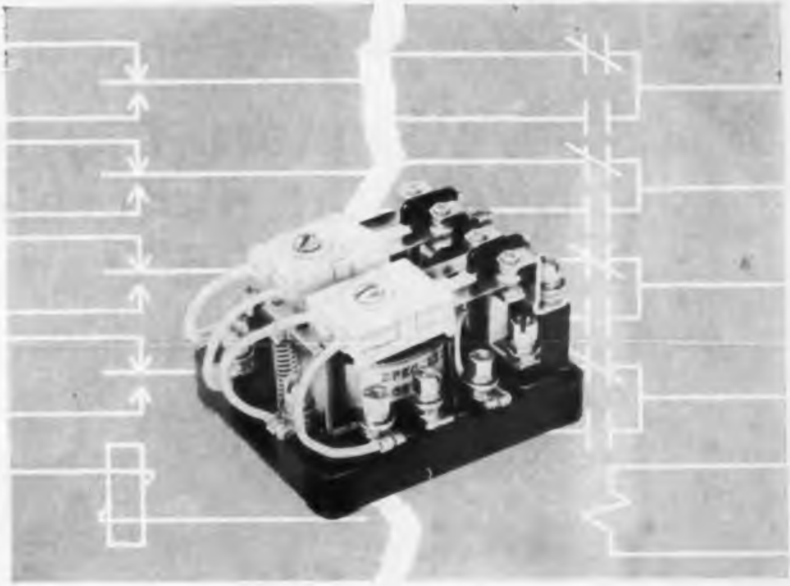
GENERAL Electric, Syracuse, N. Y., has built and is testing a very elaborate neuron analog for the Wright Air Development Div. of the Air Force. This analog is designed to simulate an actual neuron closely and is believed to be the first hardware model that takes into account the action of the chemical environment surrounding an actual neuron. Electroluminescent-photoconductive cells are the basic elements of the simulation. Magnetic aperture cores are also used.

The complete neuron, it is hoped, will exhibit some of the properties of a biological neuron, including excitation, inhibition, threshold, summing and others. The el-pc cells and memory units in the transmission-line portion of the analog are organized in groups, called g-sets, that route signals coming from sensors or other neurons to other components. One 20-cell g-set receives signals from the same logic level; another 20-cell set receives signals from other logic levels. Added to these are automatic bias adjustments, which have a fix-or-forget memory, feedback loops to provide a weight factor, an output expander, and an output comparator. The comparator, actually a difference amplifier, combines the output of the units mentioned with a similar set that corresponds to a chemical environment. In biological systems this environment can affect the action of an individual neuron. ■ ■



Organization of WADD neuron analog requires one group of components that represent line portion of neuron (below of center circle) and another to represent chemical environment surrounding a biological neuron (at right of circle).

Twenty-input array of cells for the neuron analog being built by General Electric for WADD is made up of transfluxor elements mounted on electroluminescent-photoconductive cells.



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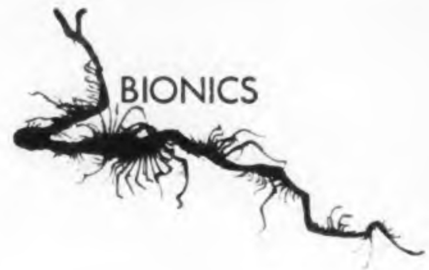


Moth's Sync Pulses Aid Neural-Net Study

AN APPLICATION of neurophysiology to communications is being investigated at the Air Force Cambridge Research Center, Bedford, Mass. The studies which are related to research on moths, established a relationship between synchronizing signals and the operation of the moth's sensory system.

Two of the three fibers that connect a moth's ear with its brain terminate in acoustic sense cells—those affected by acoustic stimulation. One of these cells is much more sensitive than the other. It responds to signals about 20 to 25 db weaker than those required to produce a response in the other. The third fiber comes from a large cell that apparently is not acoustic.

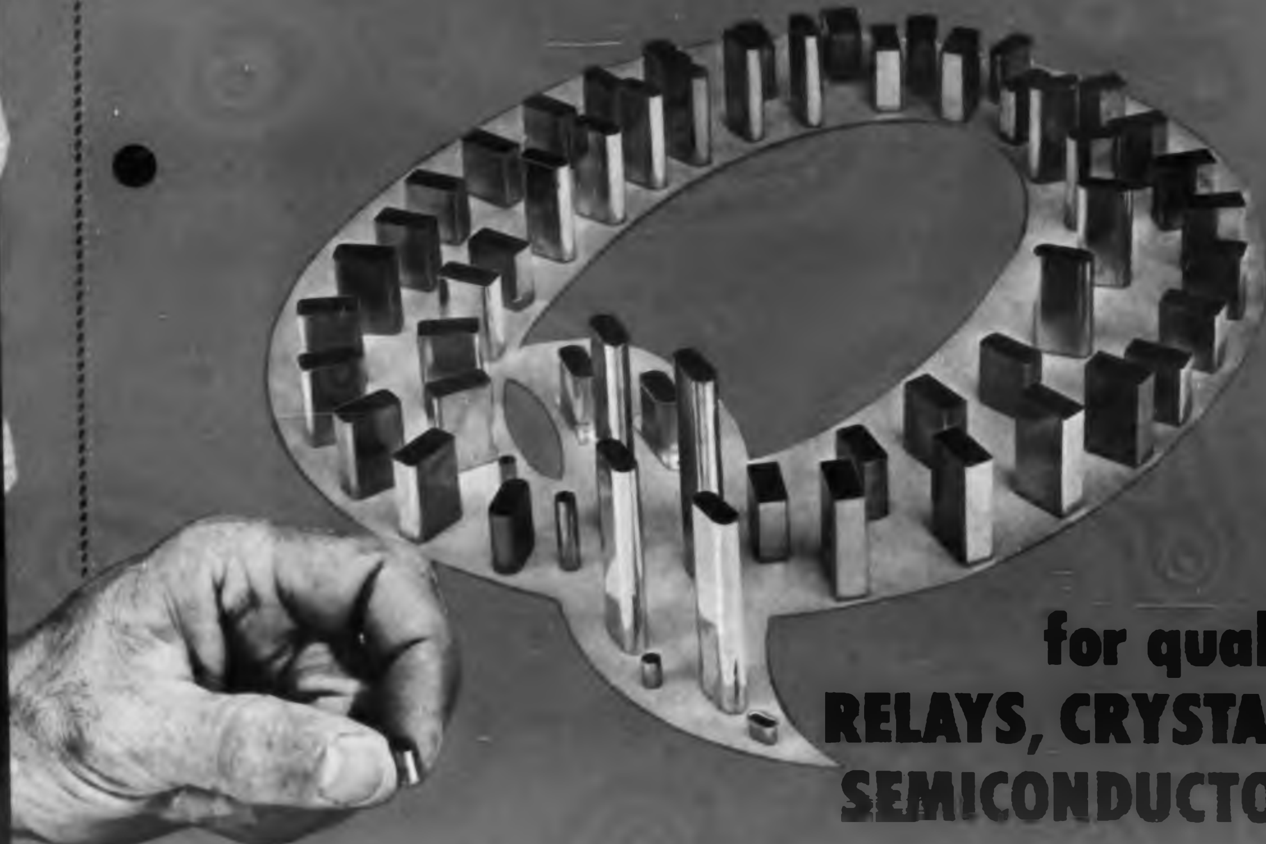
On the basis of two assumptions:

1. the large cells generate synchronizing signals that help the moth's brain decode acoustic signals such as "radar" pulses emitted by a moth-hunting bat; and

2. these sounds are first picked up by the sensitive cells; the Air Force researchers hypothesize that additional pulses from the less sensitive cells could confuse decoding and encoding by interfering with the sync pulses. This apparently happens when loud signals from bats are picked up by the less sensitive cells. The moth flies irregularly, as though taking evasive action, which could be explained as "faulty" operation of its desynchronized control system.

Neural-Net Logic Could Convert Parallel to Serial Data

The Air Force researchers believe that electronic neural-net logic may be able to



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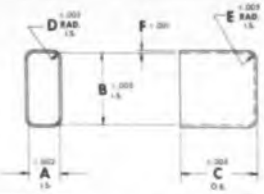

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29-4	.359	.759	1.000	.080	.020	.012
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29-6	.359	.759	.360	.080	.020	.012
29-7	.359	.759	1.375	.080	.020	.012
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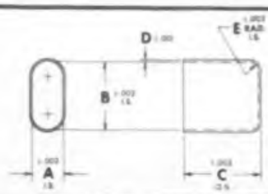
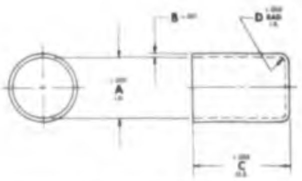
40-2	.359	.759	1.035	.030	.020	.012
40-3	.359	.759	.885	.030	.020	.012
41-1	.356	.756	.485	.080	.032	.005
42-1	.450	.700	.843	.047	.015	.016
42-2	.450	.700	.781	.047	.015	.016
43-1	.387	.787	.865	.093	.032	.010
44-1	.365	.765	.870	.077	.015	.012
44-2	.365	.765	1.141	.077	.015	.012
46-1	.354	.766	.326	.015	.015	.006
47-1	.363	.767	.870	.030	.030	.010
47-2	.363	.767	.977	.030	.030	.010
47-3	.363	.767	1.276	.030	.030	.010
47-4	.363	.767	.880	.030	.030	.010
47-5	.363	.767	1.312	.030	.030	.010
47-6	.363	.767	1.250	.030	.030	.010
48-1	.370	.782	.835	.026	.025	.008
49-1	.366	.770	.867	.035	.015	.012
49-2	.366	.770	1.437	.035	.015	.012
50-1	.344	.534	.383	.088	.025	.005
51-1	.179	.379	.595	.040	.040	.010
51-2	.179	.379	.775	.040	.040	.010
52-1	.550	.983	1.252	.061	.015	.012
53-1	.358	.768	.833	.015	.025	.014
54-1	.362	.767	.875	.032	.015	.012



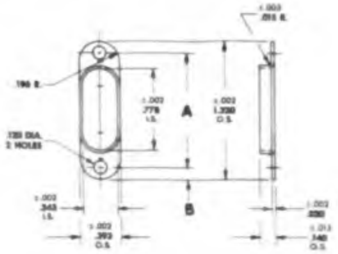
TC NO.	A	B	C	D	E
25-1	.318	.755	.850	.012	1/64
25-2	.318	.755	.870	.012	1/64
25-3	.318	.755	1.162	.012	1/64
25-4	.318	.755	1.175	.012	1/64
25-5	.318	.755	.881	.012	1/64
25-6	.318	.755	1.375	.012	1/64
25-7	.318	.755	1.152	.012	1/64
25-8	.318	.755	.988	.012	1/64
25-9	.318	.755	1.437	.012	1/64
25-10	.318	.755	.865	.012	1/64
26-1	.378	.881	1.175	.012	1/64
26-2	.378	.881	1.230	.012	1/64
30-1	.293	.698	.750	.010	1/64
30-2	.293	.698	1.640	.010	1/64
30-3	.293	.698	2.500	.010	1/64
30-4	.293	.698	3.000	.010	1/64
30-5	.293	.698	1.375	.010	1/64
30-6	.293	.698	1.500	.010	1/64
30-7	.293	.698	.572	.010	1/64
30-8	.293	.698	.969	.010	1/64
30-9	.293	.698	1.984	.010	1/64
30-10	.293	.698	1.750	.010	1/64
30-11	.293	.698	.322	.010	1/64
34-1	.298	.732	.483	.008	1/64
39-1	.350	.842	.785	.010	1/64

Hudson Tool & Die Com

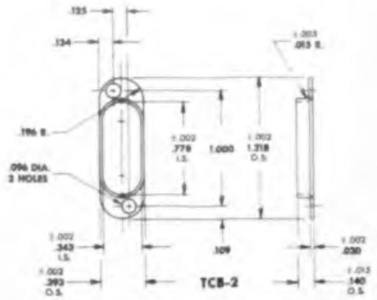
18-38 Malvern Street, Newar

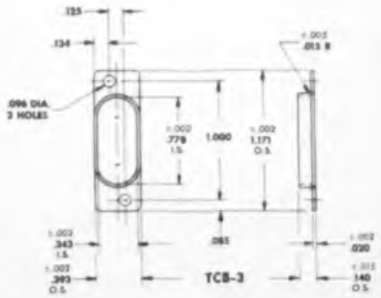


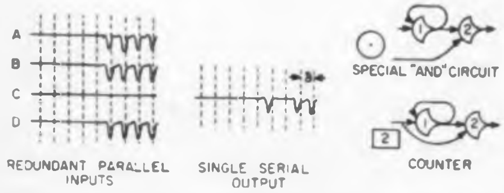
TC NO.	A	B	C	D
TC-3-1	.196	.010	.300	.015
TC-3-2	.196	.010	.340	.015
TC-4-1	.222	.010	1.000	.015
TC-7-1	.217	.008	.375	.015
TC-8-1	.290	.010	.562	.015
TC-9-1	.347	.008	.875	.015
TC-10-1	.109	.012	.235	.015
TC-11-1	.2065	.010	.400	.015
TC-13-1	.229	.006	.375	.005



TCB NO.	A	B
TCB-1	1.078	.121
TCB-7	1.062	.129



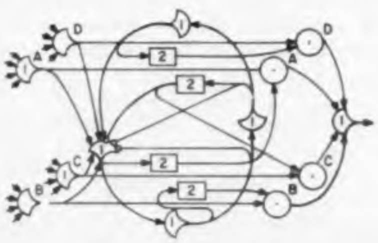




AND and counter neuron-logic circuits could transform four parallel inputs to a serial output. Numbers are threshold levels, and delta is spacing equal to synaptic delay of neurons. The delay could be used to synchronize signals.

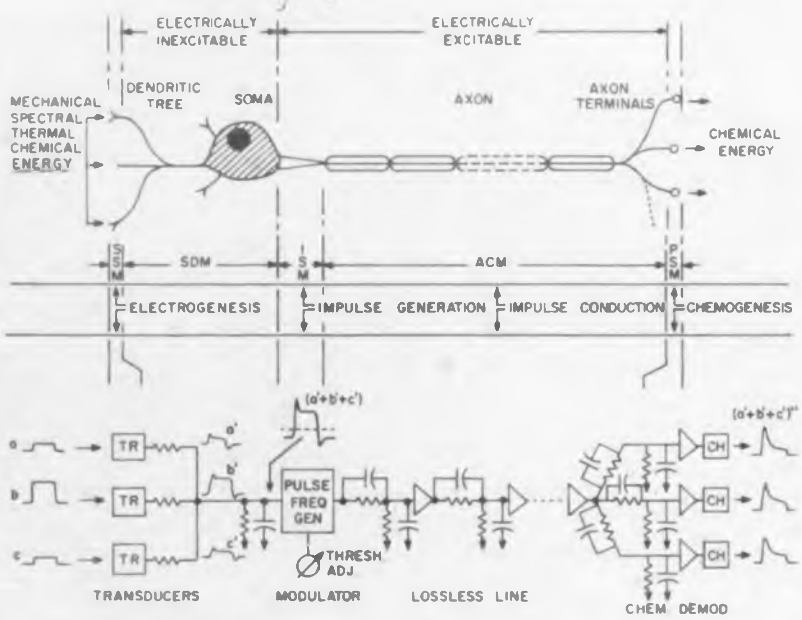
perform the parallel-input-to-serial-output functions necessary to enable synchronizing signals to aid extraction of information from pulsed data. W. B. Bishop of the Cambridge Research Center has shown how a message carried by four parallel channels can be transformed to a single serial binary message on one channel by neural-net logic.

If the message 1101, shown is repeated four times on channels *A, B, C, D,* in the drawing, is processed by a suitable network of neurons that uses the AND and counter circuits shown, the output will be a single serial message. The two typical neuron circuits appear several times in the array. The AND circuit is the same as an electronic AND circuit except that exact coincidence of the two inputs is not required. Instead a pulse appearing on one fiber will keep the



Decoder arrangement of AND and counter circuits in previous drawing (shown here as circles and rectangles) could transform A, B, C, D parallel inputs to serial, one-channel output. First signal to arrive starts pulse around heavy-line loop of self-exciting neurons. Inhibitor connections prevent succeeding impulses from generating more pulses in the loop. After circulating pulse makes its second trip around loop, it causes an output, provided that appropriate AND circuit has been facilitated by a pulse from another of the input channels.

◄ CIRCLE 234 ON READER-SERVICE CARD



A Neuron and Its Electronic Analog

Much bionic research is devoted to exploiting nature's neuron technology. To do this various models of neurons have been postulated as basic elements of proposed and implemented neural-net systems. The model shown here is a suggestion of J. F. Davis, Allen Memorial Institute, Montreal. It is intended as a clarification rather than as a proposal for implementation.

Anatomically the neuron consists of several distinct portions: the dendritic tree, consisting of a system of branching dendrites leading from many input synapses; the body of the neuron or soma; and the axon system, divided into three parts, the initial segment, the axon cylinder, and the axon terminal branches.

Membranes Cover Neuron Cell. The membranes covering various portions of the cell are: the sub-synaptic membrane (SSM) immediately subjacent to any input synapse on a dendrite or on the body, the soma-dendrite membrane (SDM) covering all parts of the dendritic tree and some except for the parts under the synapses, the initial segment membrane (ISM) in the general area of the axon hillock, the axon cylinder membrane (ACM) including a portion of the main axon and the axon terminal branches, and finally the pre-synaptic membrane (PSM) at the endings of axon branches where synapses are formed with other neurons.

How Neurons Work. This model assumes that nerve impulses, as electrical signals, do not cross the synaptic gap. Whatever electrical effect remains at the input synapses from the arrival of a volley of nerve impulses from the previous neurons is ineffective in causing this neuron to fire because of the electrical inexcitability of the sub-synaptic and soma-dendritic membrane. Energy (or information), usually chemical (but of mechanical, thermal or spectral type in the case of specialized sensory neurons) arrives at one or more dendritic inputs. This energy or signal passes through the dendritic structures and the body of the cell to the initial segment of the axon, and it is not until the signal arrives at this point that the decision is made as to whether or not this neuron will fire. All of the neuron's capability for combining information (including some data reduction, summation, integration and other transfer functions), therefore, is built into these parts of the neuron.

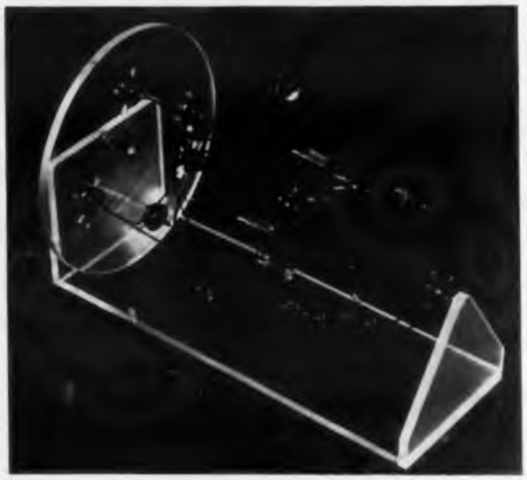
Several Electric Potentials Involved. The energy input is converted into electrical potential signals by the process known as electrogenesis, various types of potentials are involved: generator potentials, excitory post-synaptic potentials and inhibitory post-synaptic potentials. These may correspond perfectly in waveform to the waveform of the input energy or they may be somewhat distorted by partial differentiation. By electrical conduction through the cell and surrounding electrolyte these potentials reach the initial segment of axon where they are summated. At this point the effective summated potential may be altered by a biasing or threshhold effect in which local dc or slowly changing or rhythmic electrical fields in the vicinity of the cell body may play a part.

Impulse generation, then, occurs at the initial segment and the impulses (representing a pulse-frequency-coded version of the summated and modified input information) are conducted along the axon cylinder and out to the end of the axon terminal branches without any further change in amplitude or waveform. At the ends of the output branches the electrical impulses each release a small amount of chemical transmitter substance into the synaptic gap (a process that can be called chemogenesis) so that the output energy or information appears in the form of a release of chemicals, the changing concentration of which represents decoded or demodulated signals resulting from the volley of impulses coming down the axon.

How Electrical Analog Works. In the electrical analog, chemical or other forms of information (a, b, c) are shown entering transducers that convert the chemical information into electrical information of approximately equivalent waveforms, but sometimes slightly modified (as shown in a', b', and c'). These generator potentials are added together in a resistive network, but there is a time constant or capacitive factor in this network, which allows some integration to spread out over the time axis. The initial segment of axon is shown in the analog as a pulse frequency generator into which is fed the summated potentials ($a' + b' + c'$) and upon which operates a bias effect or threshold effect (shown as a horizontal broken line in the wave form).

Transmission Line Is Lossless. The analog of the axon cylinder and branching is shown as a lossless transmission line with virtually perfect phase characteristics such that the impulses from the pulse-frequency generator arrive at the outputs in the same form in which they were generated except for a delay in time. The output electrical impulses pass through another set of transducers that convert them to chemical signals. The time constant of the chemical demodulation process is such that the output chemical signal represents the envelope or integrated version of the arriving volley of impulses. The branching at the axon terminal has a multiplication effect in which each terminal ending releases the same chemical signal. These output signals are, therefore, chemical analogs of the modified and combined chemical inputs to the neuron. They may be used by one or more succeeding neurons in passing the data onto other parts of the central nervous system.

This Neuron Is Analog. The neuron in this model is an essentially analog device, in which several analog signals are combined and modified in some way meaningful to the position in which the neuron functions relative to the central nervous system as a whole, and giving out a somewhat delayed signal, also in analog form, which represents the combined information. The discontinuous signals observed when an electrode is placed on or near the neuron or its axon should not be seen as representing digital or binary nerve-cell activity but as a pulse-frequency-coded version of the analog signal in the course of transmission to nearby or distant parts of the nervous system.

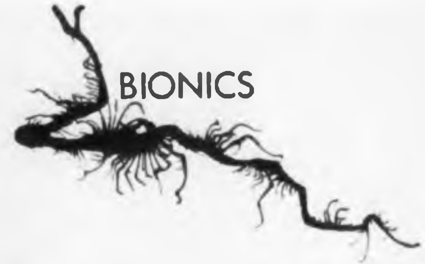


Model of neural net for parallel-to-serial conversion shows vertical loop with self-exciting neurons on it, complete spheres representing AND circuits of other neurons, cylinders representing counter circuits, and input and output neurons.

"2" neuron facilitated, or receptive, long enough to allow a pulse on the other fiber to trigger the neuron and produce an output. The counter circuit performs the same function as an electronic counter. Although the circuit shown counts only to two before producing an output, a cascade of similar circuits could count to any number.

A complete network to produce a serially coded output from repeated parallel inputs is shown below. The chain of self-exciting neurons appears in heavy lines. Circles are AND gates, rectangles are counters with numbers showing how far the circuit counts before giving a single-pulse output. Numbers in fan-shaped neurons show threshold. The first impulse to arrive on *A*, *B*, *C* or *D* fibers will start a pulse on its way around the loop. Inhibitor connections prevent succeeding pulses from starting more pulses in the chain. Outputs will occur as this circulating pulse makes its second trip around the loop, provided that the appropriate AND circuit has been facilitated by a pulse from one of the parallel channels. Inhibiting connections cancel the circulating pulse after two trips around the loop. A three-dimensional, nonworking model of this system has been built.

Studies are underway at the Cambridge Research Center to adapt neural-net probabilistic logic to computational and communication problems, including possible secure communications links. ■ ■



GE's Visilog Sensor Operates Like Eye

THE Visilog, a bionic sensor, is under development at General Electric Co.'s Advanced Electronics Center, Ithaca, N. Y. It is being designed to sense its own orientation, with respect to surfaces in its environment, in the same way believed used by humans—by abstracting information from the presence of texture on surfaces.

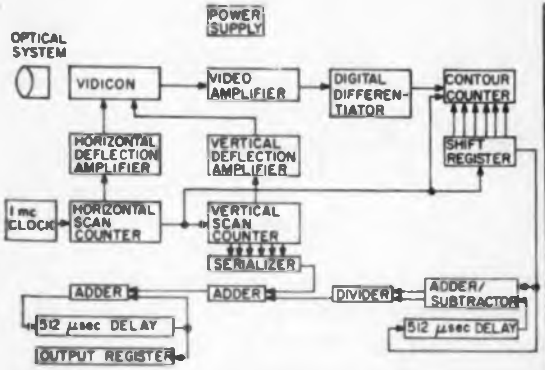
In a stationary Visilog this could be done by measuring the slant angle between the two lines: the line of sight from the device to the surface, and the projected image of the line on the surface. The first step in doing this would be to scan the surface from nadir to horizon. In humans such a scan gives an impression of depth, because the size or spacing of the texture elements decreases with distance.

In a Visilog, if this scanning were done across the retina of the device at a uniform rate and an exact computation were made of the relative change in texture element density per unit retinal distance, the result would be a function of the slant angle that could be used to measure the angle, reports GE. The company says it has established that this is indeed what happens with humans—experimental subjects have extracted slant information from just such stimuli.

According to the company, a stationary machine that extracted this information from the input image would be able to describe partially the environment that surrounded it.

A moving Visilog could give distance—and time—information and would be much more practical. The company is designing a moving-toy-type Visilog to demonstrate some of the concept's capabilities.

By analyzing vectors generated by several lines of sight, the moving Visilog could provide all the information given by a sta-



Rudimentary stationary Visilog, in hypothetical configuration, would be able to determine its orientation with respect to a plane surface. Scanning system and computing circuitry would enable it to measure changes in textural elements of a surface to calculate slant angle to the surface. This implementation is more complex and expensive than others under study at General Electric.

tionary unit and more, the company says. GE researchers have described a Visilog system that would develop time-to-contact information from scans of a surface.

In this example, an optical system moves in a linear path, with no roll angle, above and toward a textured surface. The point where the path of motion intersects the surface appears to remain stationary, while the image of any other fixed point on the surface moves away from the origin on a straight line until it goes off the retina. This can be described as a set of radiating vectors, each of which describes the motion over a short interval of time of any image point at the base of the vector.

Rates of change of the vector lengths change with time. Properly normalized, these derivatives yield the reciprocal of time-to-contact, according to the company.

Because the analysis that a Visilog performs is a geometric one of patterns of radiation reflected from objects to a point in space, and because it depends only on the presence of stable local inhomogeneities (texture), the Visilog need not operate in the visible spectrum, GE researchers speculate. They suggest that such texture differences as reflectance and color might be used and that data could be extracted from a sensor that measured heat in the infrared portion of the spectrum. Texture in this case would be equivalent to local stable inhomogeneities in temperature. Even the stationary Visilog is said to have broader possibilities than that of calculating slant angle. ■ ■

Design Considerations For Low Noise Transistor Input Stages

When designing low-noise transistor input stages, the engineer must make practical compromises among the various parameters of interest. In this article, author Rheinfelder discusses the general design objectives for these circuits. He begins by presenting basic definitions, and specific circuit requirements.

Subsequent articles will deal with low-noise circuit measurements and with design recommendations for practical circuitry.

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Applications Engineer
Motorola Semiconductor Products Inc.
Phoenix, Ariz.

THE random motion of free electrons in a conductor, caused by thermal agitation, generates very small currents. Although the sum of all these currents over a long period of time is zero, at a given instant a net current in one direction may result. These transient currents produce a voltage across a resistor of so-called "white" noise, a voltage which has a constant spectral density independent of frequency.

According to Nyquist the mean square noise voltage is:

$$E_n^2 = 4\,kTRB \qquad (1)$$

where k = Boltzmann's constant

= 1.372×10^{-23} joules per deg K (absolute)

T = temperature of conductor in deg K

R = resistance of conductor in ohms

B = bandwidth of circuits following the resistance in cps

For 75 F (or 24 C) we obtain:

$$E_n^2 = 1.63 \times 10^{-20}\,RB \qquad (2)$$

Eq. 2 is plotted in Fig. 1 for easy reference. The random motion of electrons in a conductor is unaffected by superimposed voltages as long as they do not generate heat.

Practical resistors generally follow Eq. 1 only over a limited operating range. Their spectral distribution is uneven at very low or at high frequencies. Both dc and signal currents increase the noise in practical resistors. This is due to the nonlinear relation between resistance and applied voltage, internal arcing, and other defects which introduce noise modulation, etc.

In noise figure or signal to noise calculations the bandwidth can be considered constant and Eq. 2 can be simplified to

$$E_n^2 = a^2R \qquad (3)$$

where $a^2 = 1.63 \times 10^{-20}\,B = 4\,kTB$

This equation is used to calculate equivalent input noise at the base of a transistor.

We assume for the moment an ideal transistor, not generating any noise except for thermal noise in the input resistance. Fig. 2 show an actual circuit and Fig. 3 its equivalent. Since only the resistive part of an impedance produces noise, the tuned circuit has been replaced by its equivalent parallel resistance at resonance.

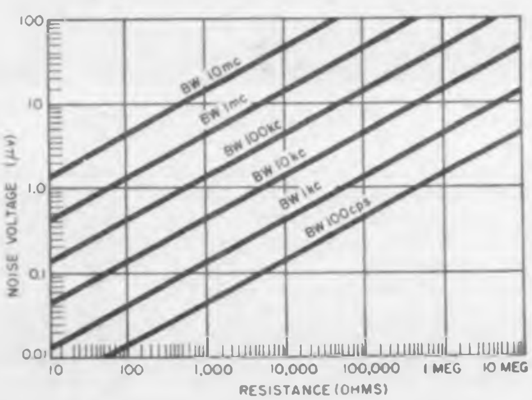


Fig. 1. Noise voltage is plotted for various values of bandwidth and resistance.

$$R_D = Q\omega L \qquad (4)$$

where R_D = equivalent parallel resistance of tuned circuit in ohms

Q = magnification factor of coil

L = inductance of coil in henries

R_i = the input resistance of the transistor.

A noise-free transistor is assumed. A noise generator, according to Eq. 3, is connected in series with each resistance. The various signals at the base must be added by the sum of the squares method because independent ac voltages are involved.

The mean square noise voltage appearing across the input to the assumed noise-free amplifier is

$$E_n^2 = \frac{a^2 R_s R_D R_i}{R_s R_D + R_D R_i + R_i R_s} \qquad (5)$$

This can be obtained from Fig. 3 or from the equivalent circuit of Fig. 4.

Receiver Performance Given by Signal-to-Noise Ratio, Noise Figure

In a receiver the signal-to-noise ratio is simply defined by the ratio of signal power to noise power at a specified point in the circuit. While it is important to have as high a signal-to-noise ratio as possible in the output, a low ratio does not imply that the receiver performs poorly. It is possible the signal is arriving from the antenna with poor signal to noise. And, if the noise is at the same frequency as the signal, the best receiver will not improve on the ratio.

As a figure of performance for a receiver, a term called noise figure, F, has been defined as the ratio of input signal to noise ratio to output signal to noise ratio. Various other definitions may be used, for instance, noise figure F is noise power output to noise power input divided by the power gain of the amplifier.

$$F = \frac{P_{si} P_{no}}{P_{so} P_{ni}} = \frac{P_{no}}{P_{ni}} \cdot \frac{1}{G} \qquad (6)$$

where P_{si} = signal input power
P_{so} = signal output power
P_{ni} = noise input power
P_{no} = noise output power
G = power gain

The input noise power has been standdardized as the thermal noise which is available from the resistance component of the signal source. The maximum available noise power of a generator with source resistance R occurs under matched conditions:

$$P_{ni}\,(max) = \frac{E_n^2}{4R} \qquad (7)$$

Substituting from Eq. 3 we obtain:

$$P_{ni}\,(max) = kTB = \frac{a^2}{4} \qquad (8)$$

With this definition of P_{ni}, the noise figure F is also equal to the ratio of noise power output of a practical amplifier to noise power output of an ideal noiseless amplifier. It is, therefore, a true indication of amplifier performance, and 0 db noise figure represents the best possible value. Pure thermal noise of the source is the limiting factor.

Noise figure can also be expressed simply by the square of the voltage ratios, since the resistances cancel. This yields a form more convenient for calculation.

$$F = \frac{E_{si}^2 E_{no}^2}{E_{ni}^2 E_{so}^2} \qquad (9)$$

where E_{si} = signal input voltage
E_{ni} = noise input voltage
E_{so} = signal output voltage
E_{no} = noise output voltage

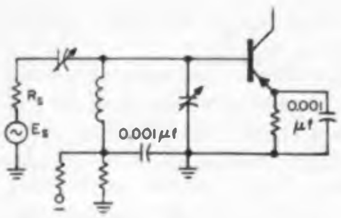


Fig. 2. Typical circuit for which the expression for the equivalent input noise, E_n^2, is calculated in the text.

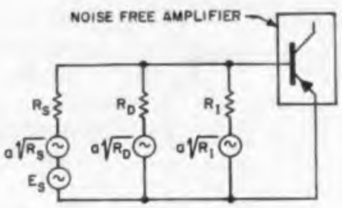


Fig. 3. Circuit equivalent of Fig. 2 has noise generators, given by Eq. 3, connected in series with each equivalent resistance, feeding a noise free amplifier with infinite input impedance.

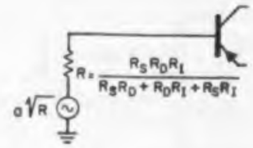


Fig. 4. Equivalent circuit of Fig. 3 is further reduced to a noise voltage source and single resistor feeding an ideal amplifier.

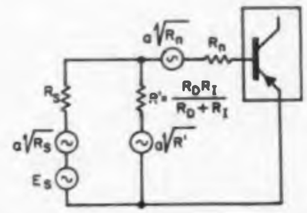
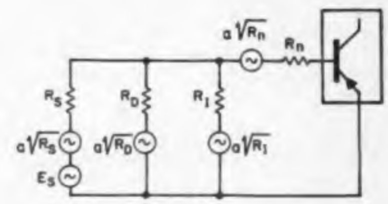


Fig. 5. Noise generated in transistor amplifier of Fig. 3 is represented by the equivalent noise generator $a\sqrt{R_n}$ and the equivalent noise resistance R_n.

Fig. 6. Simplified circuit for calculating noise figure is derived from the circuit of Fig. 5.



The standard input noise is, from Eq. 8:

$$E_{ni}^2 = 4\,kTBR_s = a^2 R_s \qquad (10)$$

If we now calculate the noise figure of the simplified circuit of Fig. 3, we have to evaluate E_{no} and E_{so} at the output of the network into the noise-free amplifier. E_{no}^2 has already been evaluated in Eq. 5:

$$E_{no}^2 = \frac{a^2 R_s R_D R_I}{R_s R_D + R_D R_I + R_I R_s} \qquad (11)$$

To calculate the signal output voltage all the noise generators of Fig. 3 are replaced by short circuits. Thus we obtain:

$$E_{so}^2 = E_{si}^2 \frac{R_D R_I}{R_s R_D + R_D R_I + R_I R_s} \qquad (12)$$

Substituting Eqs. 10, 11 and 12 into Eq. 9 we obtain:

$$F = 1 + \frac{R_s}{R_D} + \frac{R_s}{R_I} = 1 + \frac{R_s}{R'} \qquad (13)$$

where R' = equivalent parallel resistance of R_D and R_I.

For matched conditions where $R_s = R'$, the noise figure equals 2, corresponding to 3 db. Thus, with matching and with an ideal noiseless amplifier following, a noise figure of 3 db is the best which can be obtained. By decreasing the ratio of R_s to R' the noise figure can be made to approach unity, corresponding to 0 db.

Equivalent Noise Resistance Lumps All Noise Sources

In a transistor amplifier, noise is generated in various ways. However, noise in an active element is most commonly considered by introducing the equivalent noise resistance, R_n. All noise is assumed to be generated in this resistance, with a noiseless transistor following it. The equivalent noise generator $a\sqrt{R_n}$ is shown in Fig. 5.

Using the equivalent noise resistances, noise figure and signal-to-noise calculations may be made easily because only resistances are involved. Also an easy comparison may be made between different devices.

A simplified circuit for calculating noise figure is shown in Fig. 6. Here, R_D and R_I are replaced by R'. Evaluating the mean square voltage at output and input of the network both for signal and noise, and using Eq. 9 leads to the following expression for noise figure:

$$F = 1 + \frac{R_s}{R'} + \frac{R_n}{R_s}\left(1 + \frac{R_s}{R'}\right)^2 \qquad (14)$$

(continued on p 50)

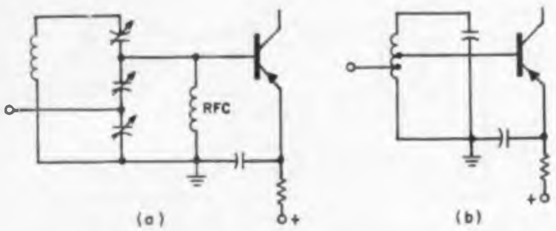


Fig. 7. Calculating the Q and the signal loss of either of these circuits shows that with higher selectivity in front of the first transistor, both the signal input power and signal to noise decrease.

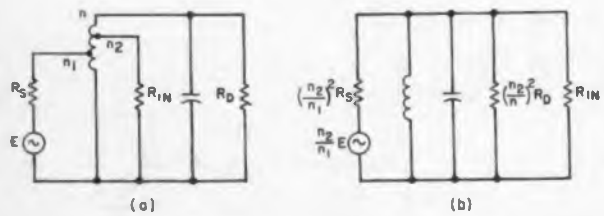


Fig. 8. The circuit of Fig. 7b can be simplified as in (a) and then further reduced as in (b).

Differentiating F with respect to R_s leads to the expression for R_s', giving minimum noise figure F':

$$R_s' = R' \sqrt{\frac{R_n}{R_n + R'}} \qquad (15)$$

$$F' = 1 + \frac{2R_n}{R'} + 2\sqrt{\frac{R_n}{R'}\left(1 + \frac{R_n}{R'}\right)} \qquad (16)$$

The optimum source resistance is obtained at a certain mismatch ratio and hence some sacrifice in gain. Under matched conditions the noise figure is, from Eq. 14, with $R_s = R'$,

$$F_{(matched)} = 2 + 4\frac{R_n}{R_s} \qquad (17)$$

with the minimum being 3 db as before, if $R_n = 0$.

Cross Modulation and Intermodulation Add Important Distortions

Cross modulation is a form of interference occuring in a nonlinear device having third order curvature if two or more modulated signals are present simultaneously. The modulation of an interfering carrier appears as modulation of the carrier to which the receiver is tuned. The frequency of the interfering carrier is important only because the amplitude at the base of the transistor changes with frequency due to the selectivity of the input tuned circuit. For cross modulation to take place, third or higher order nonlinearities must exist.

Intermodulation distortion is interference caused by two or more modulated or unmodulated signals beating together to form a sum or difference frequency to which the receiver is tuned. It is caused by mixing action. Usually, it is considered together with the family of spurious responses inherent in mixer operation. For this interference to take place, the following frequency relationship must exist:

$$nf_1 \pm mf_2 = f_0 \qquad (18)$$

where n, m = integral numbers
f_1, f_2 = carrier frequencies
f_0 = frequency receiver is tuned to.

The frequency f_0 will be produced by second order curvature. Intermodulation interference is caused by modulated and unmodulated carriers as well. For clarity, cross modulation and intermodulation are compared in Table I.

Generally, intermodulation is of a smaller order of magnitude because the receiver is tuned to neither f_1 nor f_2. Therefore these frequencies are attenuated considerably by the selectivity of the input tuned circuit.

Cross modulation, however, is a major form of interference because the receiver is tuned to one of the required carriers (which is the desired signal). Further, the undesired carrier frequency and sidebands can be anywhere since no frequency relationship exists between desired and interfering signal.

After cross modulation has taken place there is no way of removing the interference. Not even the sharpest crystal filter will remove it because it appears in the if channel as true modulation of the desired carrier. A narrow if bandwidth removes both the desired modulation sidebands and the interference modulation in the same amount. Thus, signal to noise remains unchanged.

In general, the signal to noise of the majority of present receivers (including expensive communication units) is determined by cross modulation rather than by if bandwidth. This is because far too little emphasis is put on designing for low cross modulation. Instead, crystal filters are added in the if strip in the mistaken belief that a narrower bandwidth will improve the signal to noise.

The bandwidth of the receiver must be wide enough to accommodate the sidebands of the desired signal. Once cross modulation has taken place, decreasing the bandwidth beyond this point will not improve the signal to noise. The only way to minimize cross modulation is to avoid it. This means that the receiver front end must be designed for low noise and interference. The stages most susceptible to cross modulation are the rf stages, the first and second mixer and the last if stage.

Proper Design Minimizes Effects Of Cross Modulation

Several means can be taken to minimize cross modulation. The gain of the rf stages, that is the stages with low selectivity, must be kept as small as possible. The lower limit is, of course, reached at the point where the over-all noise figure deteriorates due to noise in the second stage. A compromise between noise figure and cross modulation must be made. Generally, a gain of about 10 db is a good value to be used for the rf stages. A tapped tuned circuit for the collector load may be used to reduce the gain and also improve the selectivity.

The selectivity of the early receiver stages should be made as high as possible. This calls for double tuned circuits after the rf stage and high-Q circuits in the whole front end. A double tuned circuit may also be used ahead of the first stage to decrease cross modulation at the expense of noise figure. At frequencies below 50-mc antenna noise is usually much larger than receiver noise. Therefore it is more important to design for low cross modulation in this frequency range rather than for low noise figure. A double-tuned input circuit may be used.

A third way to minimize cross modulation is to properly choose the dc-operating point. Since cross modulation is caused only by third and higher power terms of the transfer characteristic, it is possible to minimize these terms by adjusting the dc conditions. In critical cases, no agc should be applied to the rf stage until a sufficient signal strength is reached. In this way cross modulation becomes unimportant.

A fourth method for decreasing cross modulation is to introduce high frequency negative feedback. Cross modulation is reduced in proportion to the feedback factor as long as the feedback is resistive. An unbypassed emitter resistance may be used.

Low Frequency Noise Can Also Modulate Carrier

Similar interfering conditions exist if, instead of an interfering signal, a noise source is present in the circuit. All transistors

Table 1. Comparison Between Cross and Intermodulation Distortions

	Cross Modulation	Inter-modulation
Receiver tuned to frequency	f_0	f_0
Carrier frequencies necessary for interference to be produced	f_0 (with or without modulation)	f_1 (with or without modulation)
	f_2 with modulation	f_2 (with or without modulation)
Frequency relationship required	no	$nf_1 \pm mf_2 = f_0$ n,m integer numbers
Caused by	Third (or higher) order curvature	Second (or higher) order curvature

have considerable low frequency noise. This noise can act as the interfering signal to modulate the desired carrier (or even the existing high-frequency noise) to produce a poor signal-to-noise ratio or increased high-frequency noise.

This noise modulation effect is by no means small and can be readily measured. In a typical portable receiver the signal to noise (ratio of modulated to unmodulated carrier) increased by only 6 db when the carrier increased 45 db. Without noise modulation the signal to noise should have also increased 45 db.

Noise modulation can be reduced by the same methods used for cross modulation. In addition, it is possible to remove parts of the interfering low frequency noise by bypassing and shorting the proper circuits for audio frequencies. It is therefore very important to design the first stages in a transistorized receiver to produce the least audio noise possible.

'Best' Low Noise Design Must Be a Compromise

After the previous discussions it is obvious that the design for low noise must be a compromise between lowest noise figure and lowest cross modulation, both of which affect the signal to noise. Cross modulation effects are decreased when higher selectivity is used in front of the first transistor,

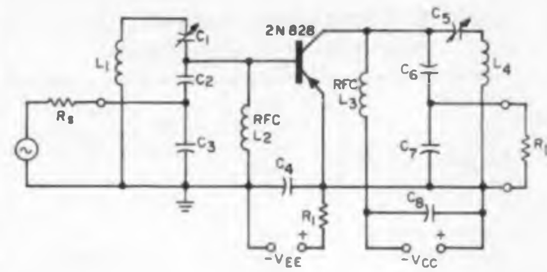


Fig. 9. Recommended low noise circuit. (This circuit will be discussed more fully in a subsequent article.)

unfortunately this also decreases the signal input power and with it the signal to noise. Therefore, according to Eq. 6, the noise figure deteriorates. This is seen by calculating the Q and the signal loss of the circuits of Fig. 7. Equivalents of Fig. 7b are shown in Fig. 8.

From Figs. 7b and 8b we obtain the expression for the maximum available power:

$$P_{AV} = \frac{\left(\frac{n_2}{n_1}\right)^2 E^2}{4\left(\frac{n_2}{n_1}\right)^2 R_s} = \frac{E^2}{4R_s} \qquad (19)$$

This power is applied to both the reflected losses of the coil $(n_2/n)^2 R_D$ and R_{in}. Under matched conditions the power into R_{in} is

$$P_{in} = P_{AV} - P_D = \frac{E^2}{4R_s} - \frac{E^2}{4R_D}\left(\frac{n}{n_2}\right)^2 \qquad (20)$$

To make the second term small, n_2 and R_D must be as large as possible. A large R_D means a high-Q coil and practical limits do exist. The largest n_2 is equal to n. Under this condition we get the lowest circuit Q because the coil is loaded directly by R_s. Therefore the maximum signal input power is reached at the widest bandwidth. At smaller values of n_2, the circuit Q can be raised at a loss in signal input power. The limiting case is the Q of the coil itself.

Factors To Remember In Low Noise Design Are Summarized

It is evident that to decrease the interference, any circuit requires a high quality transistor with a very low noise figure. However, in a practical circuit, some sacrifice in noise figure may be necessary to achieve the required signal to noise.

For a low noise figure we need maximum signal input power (widest bandwidth). For low cross modulation we need smallest bandwidth (small signal input power). The proper compromise must be made with regard to frequency, mode of operation, adjacent channel allocations, atmospheric interference, etc.

In general, below 50 mc, the equivalent noise resistance of antennas is high and noise figure should be sacrificed for lower bandwidth. Above 50 mc, noise figure may be more important but even here a few decibels in noise figure can be sacrificed. For instance, in a typical case with 3.2-db noise figure a bandwidth of 50 mc resulted, which was too great for low cross modulation. However, at a noise figure of 4 db the bandwidth was reduced to 4 mc; at 5 db to 2.5 mc.

Another aspect of the ideal input circuit deals with mismatching and noise figure. As will be explained in a subsequent article, mismatching does not give any improvement if the noise figure under matched conditions is 10 db or more.

However, with a noise-free transistor, the noise figure is 3 db matched and can be asymptotically reduced by mismatching to 0 db (the case of zero source resistance or infinite input resistance). The maximum improvement possible by mismatching is therefore less than 3 db if noise is generated in the transistor.

It is found that in the common emitter configuration a source resistance below the input resistance is optimum. For common base the opposite is true. Therefore, some intermediate configuration could be found where matching and lowest noise figure coincide. A circuit having these properties has been developed in Europe. It is an intermediate between the common base and common emitter circuit.

A mutual inductance-coupled input circuit or a lattice filter must be used. Preliminary measurements indicate that the signal losses in this input network at high frequencies are higher than the improvement possible by mismatching if the mutual inductance coupling is used. This circuit has been called "tap-circuit" by us, because the common base — common emitter configuration is established by a tap across the input coil. Slight detuning of the input circuit also decreases the noise figure. It can be shown that in the tap circuit the minimum noise figure occurs at exact resonance.

Without going into this circuit or feedback, and other more complicated schemes, the recommended low noise circuit is as shown in Fig. 9. It will be discussed fully in a subsequent article. ■ ■

The Design of Large Servos

Servos larger than the familiar instrument types present practical problems to the designer because of the lack of specially tailored components. After briefly describing the components which they have found useful in solving integral-hp servo problems, the authors detail design steps for reducing these components to reasonably high-performance servomechanisms.

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THE STATE of the art in the design and development of low-power (a few watts to fractional-horsepower) servomechanisms has been highly developed. However, there has developed an increasing need for control systems in which the torque is orders of magnitude larger than the torque which can be produced by these precise, relatively low-power "instrument" servos; and, yet, the accuracy, transient response, and stability of the smaller units must be achieved in the larger.

In the development of a servomechanism to position accurately a large steerable radio telescope (see box p 57), it was necessary to develop a torque unit which would produce torques that were orders of magnitude larger than those developed in smaller units. Since the design procedures used in this unit are of general interest to those who have integral horsepower servo design problems, they will be used as the basis of this article. To present these design procedures logically, the hardware solutions for the units comprising the system will be discussed first. Then the complete system design and test will be described.

Torque Units For Large Servos Are First Hurdle

The torque unit for the example had to be reliable and maintenance-free. In addition, it had to have extremely low-level radio-frequency noise characteristics. A torque unit with these characteristics and yet capable of developing the required torque is shown as part of Fig. 1a. This unit employs two induction motors, two eddy-current clutches and a gear train. (Two 7-1/2-hp, 1,800-rpm induction motors were used in the example to develop the required torque). The torque is transmitted to the load by two eddy-current clutches (1-1/2 hp in the example) and a gear train.

The amount of torque transmitted through the clutches is controlled by the current in the clutch field coil which produces a magnetic coupling between the input and output members. The output members of the clutches drive two pinions meshed to a common gear. The pinions develop opposing torques so that if each clutch is developing the same torque, the torque delivered to the load is zero.

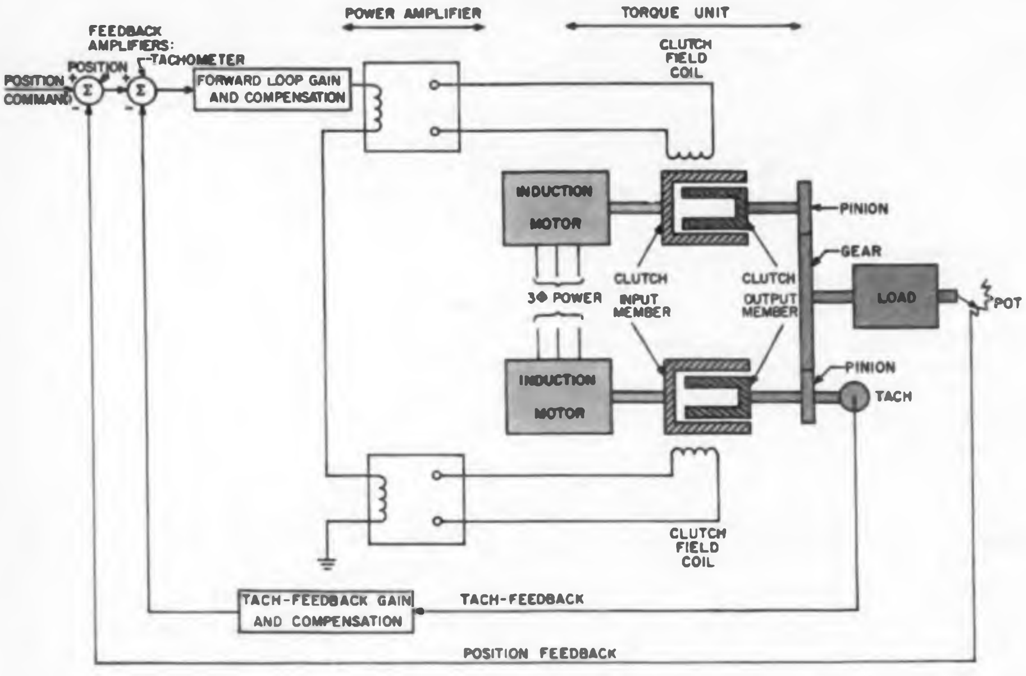
Authors Larry Mackey and John Wetherbee before the breadboard of the large Servo used as the "example." The two 7-1/2-hp, 1,800-rpm induction motors drive the two 1-1/2-hp eddy-current clutches bolted to their inner faces. The output members of the clutches in turn drive the short shaft in the middle. The shaft represents the servo's output and is sized to be the inertial equivalent of the actual load that would be reflected back through the step-down gearing. The motors run in opposition; at null the clutches each transmit enough torque to cancel each other and the shaft doesn't move.

The tachometer and potentiometer for velocity and position feedback are shown belt-driven off the interconnecting shaft. Magnetic power amplifiers and other system electronics are in racks behind the authors.

Power Amplifier Must Be Able To Work Into Inductive Load

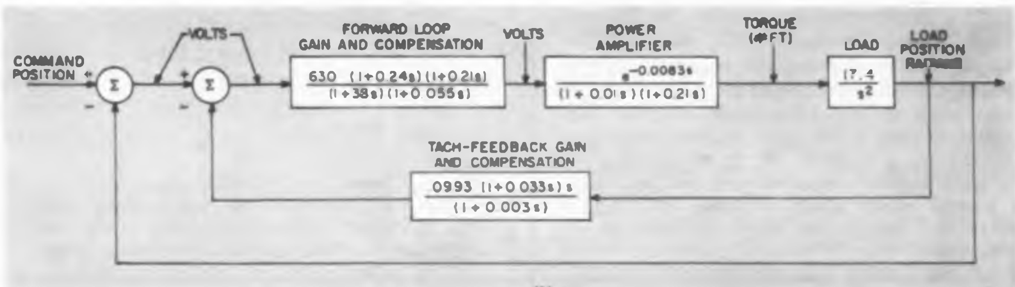
The power amplifier used to excite the control field of the eddy-current clutch must also be reliable and relatively maintenance-free and have low-level radio-frequency noise characteristics. The amplifier in addition must be capable of working into the highly inductive clutch field-coil load.

The two single-phase, full-wave-bridge, magnetic-amplifier circuits with dc outputs



(a)

Fig. 1. (a) Schematic of large servo (left) with performance and reliability approaching that of a smaller instrument servo. Magnetic amplifiers replace transistors in the power amplifier and two eddy-current clutches driven by constant-speed induction motors replace the two-phase servo motor. Backlash is eliminated by driving the load gear in opposition with the two clutches. (b) Block diagram of large servo (below) indicates the form of typical time constants found in this type of servo's loop. The numerical values are for the example described in the text.



(b)

shown schematically in Fig. 2 satisfy these requirements. The core and coils of this amplifier have very good reliability and, by derating the solid-state diodes in the circuit, sufficient over-all reliability can be achieved. The only maintenance required of this amplifier is corrective (replacing failed components). The radio-frequency noise generated by this amplifier consists of harmonics of the power-supply frequency; the rf spectrum harmonics are relatively low amplitude.

The two free-wheeling diodes shunted by the 2-K resistors provide a low-impedance path for the inductive currents of the clutch coil while the flux in the core of the magnetic amplifier is being reset. It is this low-impedance path that makes the operation of the magnetic amplifier satisfactory when working into an inductive load.

The control coils of the magnetic amplifier are connected so that the control signal increases the current in the field coil of one clutch while simultaneously decreasing it in the other. In this manner push-pull action is established that will give full continuous control of torque through a positive and negative range of operation.

The clutches should be biased to approximately one-half their rated output torque by exciting the bias coils of the magnetic amplifiers with a dc voltage. Biasing the clutches makes it possible to operate the clutches in the linear portion of their torque-vs-field-coil-current characteristics. This results in linear load-torque-vs-control-signal characteristics over a positive and negative range of torques. The bias torque which cancels at the output shaft also keeps the gears under constant load, thereby eliminating backlash.

Two Time Constants and a Time Lag In Power Section Transfer Function

The dynamic performance of the power amplifier and its load is described by a transfer function having two time constants and a transport lag. One of the time constants is associated with the input circuit to the magnetic amplifier, and the other is associated with the inductive load. The transport lag is inherent in the magnetic-amplifier circuit and is related to the power-supply frequency.

The clutch field coil can be represented by an L-R circuit where the L is the equivalent inductance and the R is the resistance of the clutch field coil. The time constant associated with the load is then given, in seconds, by the ratio of L/R. For the clutch used, the time constant was 0.154 sec.

The time constant associated with the input to the magnetic amplifier is dependent upon the number of turns of the control windings, the resistance in series with the windings, and K factor of the magnetic amplifier. The K factor is usually given in the manufacturer's magnetic amplifier data. The time constant for the circuit of Fig. 2 (the example) is given by the equation:

$$\tau m = K\left[\frac{N_c^2}{R_c} + \frac{N_B^2}{R_B}\right] \text{ sec}$$

where:

N_c = number of turns on control winding.

(continued on p 56)

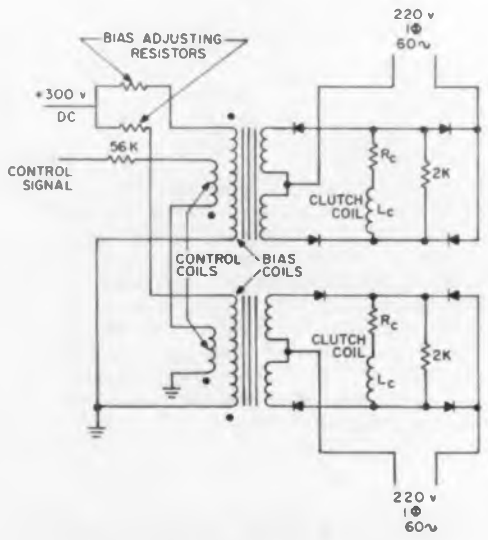


Fig. 2. Power amplifier for large servo: two magnetic amplifiers in series provide the push-pull signals for the eddy-current clutches. The control winding in the upper magnetic amplifier opposes the bias while the control winding in the lower magnetic amplifier aids the bias. Thus a control signal which increases the torque transmitted through one clutch will decrease it in the other.

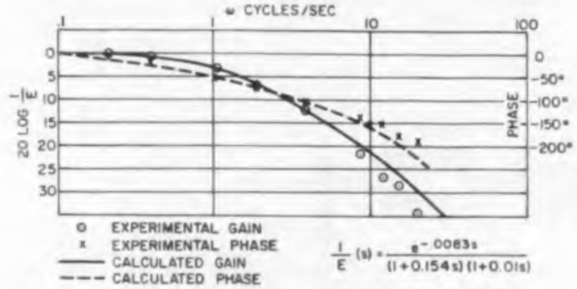


Fig. 3. Bode diagram comparing experimental and calculated results. The differences between the two plots are due to higher order coupling effects within the magnetic amplifier.

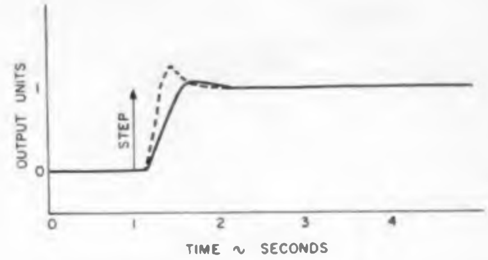


Fig. 5. Response of servo to step input: solid line is response when gains are adjusted for static stiffness of 630 lb-ft per radian and a velocity constant of 10 per sec. Dashed line is for gains adjusted for static stiffness of 1,260 lb-ft per radian and a velocity constant of 15 per sec.

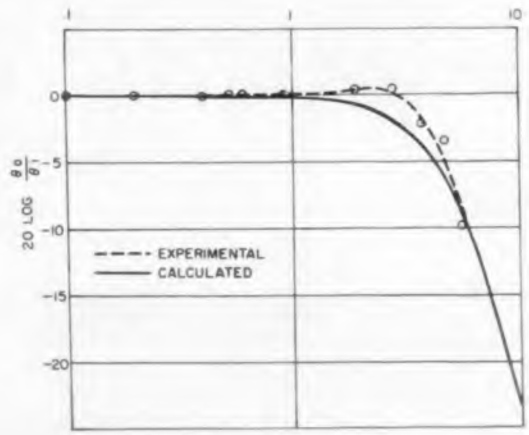


Fig. 4. Closed loop frequency response plot for large servo. The peaking in the experimental response is due to higher order coupling terms in both the magnetic amplifier (see also Fig. 3) and the clutch.

N_B = number of turns on bias winding.

R_C = resistance in series with control winding.

R_B = resistance in series with bias winding.

K = factor for particular magnetic amplifier.

For the magnetic amplifier and circuit used, the time constant τ_m was 0.01 sec.

The transport delay for the circuit of Fig. 2 is approximately one half cycle of the power supply voltage. For a 60-cps supply frequency, this is 0.0083 sec.

The transfer function for the power amplifier and its load can be checked experimentally by the usual frequency response techniques of applying sinusoidal voltages of various frequencies to the control windings of the magnetic amplifier. This voltage and the resulting steady-state sinusoidal current in the load circuit are recorded for each frequency. The ratio, in decibels, of peak load current to peak excitation voltage and phase in degrees between the voltage and current are plotted as a function of frequency. From this "Bode" plot and a similar plot for the transfer function, the accuracy of the transfer function can be graphically judged.

Fig. 3 is the Bode diagram from the experimental data of the example after being normalized to 0 db at zero frequency. An *L-R* circuit was used to simulate the load for this test. Plotted with the experimental data is the Bode diagram of the transfer function. The two are in good agreement in the frequency range of interest.

Loads for Large Servos Can Usually Be Scaled for Laboratory Simulation

The block diagram of the over-all servo system is shown in Fig. 1a. The input to the servo is the desired position for the load. The position feedback amplifier compares the command position with the actual load position, and the resulting error signal in turn is compared with the tachometer feedback signal in the tachometer feedback amplifier. The output of the tachometer amplifier, after being further amplified and compensated, is used to excite the control windings of the magnetic amplifiers which produce the control currents in the clutch field coils. The actual load in the case of the example was a large inertia (in the form of a 600-ft diam antenna) driven by the clutches through a step-down gear box. In the breadboarding of larger servos the actual load can usually be simulated in the laboratory by less cumbersome inertias attached directly to the torque units. To the extent that the step-down gearing is eliminated, progressively smaller physical inertias can represent the actual load.

Adjustment of Compensation To Meet Specifications

The desired performance of the example servomechanism was specified by two parameters, the velocity constant and the static stiffness, along with a well-damped transient response. The velocity constant is a measure of how well the load will follow a constant velocity command, and the static stiffness a measure of how well the load will remain in a fixed position when it is acted upon by a disturbance torque (a wind load on an antenna, for example).

The velocity constant of a servo is defined as the ratio of the command velocity to the constant position error which results from the velocity input. When a constant velocity is commanded at the input, the load, after transients have subsided, will have the same velocity as the command input. Since the tachometer generates a voltage proportional to this velocity, a position error voltage must exist which cancels this amplified tachometer voltage at the tachometer feedback amplifier. The larger the tachometer feedback gain, the larger the position error must be to cancel this voltage.

The gain of the tachometer feedback is directly related to the damping of the servo: the larger the gain, the greater the damping. It is seen that there are two conflicting requirements on the tachometer gain: high gain for good damping, and low gain for a large velocity constant.

The static stiffness is defined as the ratio of disturbance torque to the steady-state position error. When a constant disturbance torque acts on the load, the load position is different from the command position. This produces a position error which is amplified by the forward-loop gain and causes a torque equal to the disturbance torque to be transmitted to the load. The larger the forward-loop gain, the smaller the position error required to produce a torque equal to the disturbance torque.

The effect of increasing the forward-loop gain is to decrease the damping. Again there are two conflicting requirements on the forward loop gain: high gain to produce good static stiffness, and low gain to have good damping.

The compensation, as the name implies, is added to alter the system in a way that the high forward-loop gain and the low tachometer feedback gain can be achieved in a system that has the desired damping.

The values for the transfer functions of the compensation networks used for the example are given in Fig. 1b, along with the other system transfer functions. Experimental work with the breadboard was used to arrive at the compensation values.

Calculated and Experimental Transfer Functions Used in Performance Evaluation

The laboratory performance of the servo's breadboard should be measured and compared with the performance predicted using a block diagram such as Fig. 1b. Several different types of inputs can be used to measure the closed-loop system performance. Sinusoidal command inputs were used for the example in the same manner that they were used to measure the performance of the power amplifier, and a constant disturbance torque was applied at the load end to measure the static stiffness of the system. Step command inputs (nearly instantaneous changes of the command position to another position) were used to measure the settling time and damping.

To obtain the frequency response of the servo, sinusoidal command inputs of various frequencies were used to excite the system. These inputs and the resulting sinusoidal load positions were recorded for each frequency. Fig. 4 is a plot of the ratio, in db, of peak load position to peak command position as a function of frequency. The bandwidth of the servo, as defined by the frequency at which the response is down 3 db, is about 4 cps. The calculated frequency response obtained by using the block diagram of Fig. 1b, is plotted with the experimental data for comparison. The agreement between the experimental data and the predicted frequency response is considered good for a servomechanism as large as the example.

To measure the static stiffness, a constant disturbance torque was applied to the load. The torque was generated by applying a known force to a lever arm of known length attached to the load. The rotation of the load from its command position could then be measured when the disturbance torque was applied. The static stiffness measured for the example in this manner was 630 lb-ft per radian. To calculate the static stiffness from the block diagram, Fig. 1b, assume a disturbance torque acting on the load is of such a magnitude as to cause a position error of one radian. A position error of one radian is equivalent to 1 v in Fig. 1b, and will cause a steady-state torque of 630 lb-ft to be transmitted to the load by the clutches. The torque transmitted to the load by the clutches must equal the disturbance torque for the system to be in a steady-state condition. The static stiffness of the example was 630 lb-ft disturbance torque divided by the one-radian position error or 630 lb-ft per radian, which was the same as the measured static stiffness.

Because of the limited travel available in the potentiometer used to measure the load position in the example's breadboard, it was impractical to measure the velocity constant. In such a case, however, the velocity constant can be calculated with a high degree of confidence, if other calculations have been in good agreement with the experimental data. To calculate the velocity constant from the block diagram of Fig. 1b, assume a command velocity of one radian per second has been applied to the input. The load will then have a velocity of one radian per second. When the load velocity is one radian per second, the tachometer will generate a voltage of such a magnitude that the output of the tachometer feedback gain and compensation network will be 0.0993 v. A position error voltage of 0.0993 must exist to cancel out the tachometer feedback voltage at the tachometer feedback amplifier. The position error which corresponds to this voltage is 0.0993 radian. The velocity constant is then one radian per sec divided by 0.0993 radian or approximately 10 (1/sec).

The transient response of the example to a step input is given by Fig. 5. The transient with the system gains adjusted as in Fig. 1b was well damped, and the settling time (time to settle at the command position) is about 0.4 sec. Fig. 5 also shows the response of the example to a step input with the gains adjusted so that the static stiffness of the system is 1,260 lb-ft per radian and the velocity constant is about 15 (1/sec). With these gains, the transient is no longer over-damped, having about 50 per cent overshoot; however, the transient stabilizes at the new command position in about 0.2 sec. ■ ■

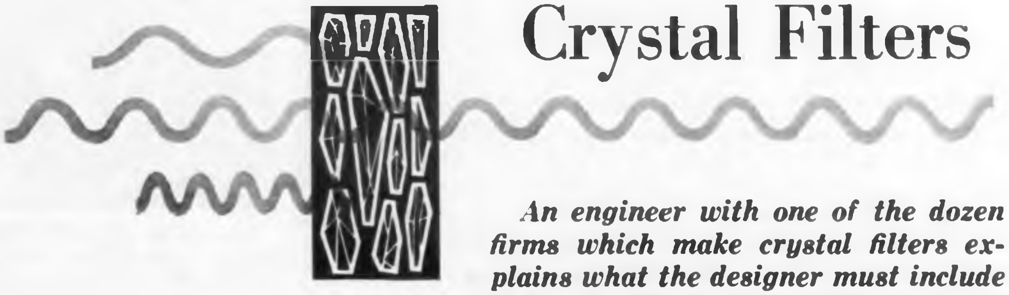
Where a Large Servo is Needed:

Drives for this 600-ft diam radio telescope (shown here in artist's conception) were the project which produced the large-servo "example" used in this article. The 600-ft antenna is being installed by the Office of Naval Research (USN) at Sugar Grove, W. Va. "Hundreds" of the units of the type described (but with 15- to 25-hp motors) will be used in unison to move what is claimed will be "the world's largest movable structure."

While hydraulic or other types of electrical servos are often used for large servo applications, only the all-electric eddy-current clutch system was felt to have the combination of reliability, low-maintenance requirements and performance needed.

The General Electric Co., Erie, Pa., is manufacturing the motors, clutches as well as the magnetic and other amplifiers for the Sugar Grove servos.

How To Specify Crystal Filters



An engineer with one of the dozen firms which make crystal filters explains what the designer must include in his specifications to obtain the right crystal filter for his application.

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Bulova Electronics
Woodside, N. Y.

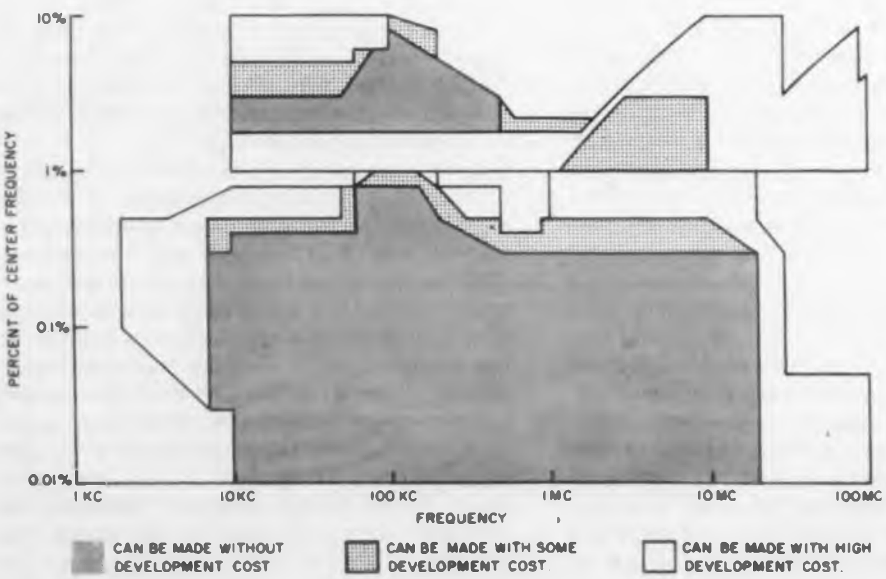
THE attraction of crystal filters for the designer is that they provide high selectivity with excellent stability. From the total circuit standpoint, by using crystal filters, the designer finds that he can simplify his circuit. In the process reliability is increased, not only because of the simplification, but because many of the eliminated components have reliabilities much less than that of quartz.

As an indication of the performance of crystal filters, a quartz element may have a Q in the hundreds of thousands, an inductance in the thousands of henries, and a stability of one part in 10^7 per day. At the same time, there is no electromagnetic coupling to any other coil in the system.

Fortunately, as this piece will attempt to show, crystal filters can be obtained in a fairly wide variety of frequency combinations. To the basic frequency ranges permitted by the quartz elements can be added the additional ranges allowed by the combination of quartz elements with coils.

Fig. 1 shows these ranges in terms of center frequencies and bandwidths for pass-band filters. Bandwidths of 12.0 per cent and operating frequencies of 110 mc are the present limits for crystal filters. Bandwidths less than 0.01 per cent can be obtained with crystal Q's in excess of 200,000 at an additional expense.

Actually the 12 per cent limitation is rather artificial for, by wedding a crystal filter with an LC filter, bandwidths up to 30 per cent are possible. The stabilities for these



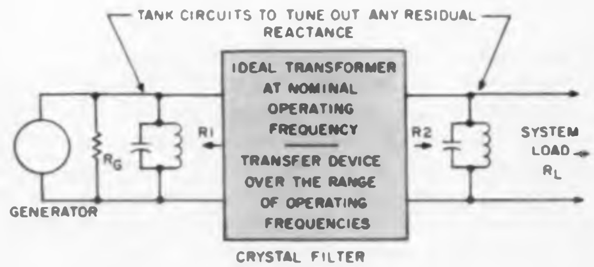


Fig. 2. It is important that the filter, when in the circuit, see pure resistances which match the filter's input and output resistances. Circuit capacitances which alter this matching by more than ±5 per cent must be tuned out by tank circuits.

Fig. 1. Bandwidth vs frequency for crystal filters. Though based on the filters produced by the author's company, the chart is believed to be fairly representative of industry practice. Note the "grey" area between the lower narrow-band areas and the upper "wide-band" areas. The author believes most of the future development efforts in crystal filters will go towards extending the upper frequency limits.

How to Order Crystal Filters

The following is a guide to the type of information that the firms which produce crystal filters like to have from engineers. Note that the electrical and mechanical requirements are listed separately.

A. Electrical Requirements:

1. *Specific Frequency.* In the case of symmetrical band pass, this will be the center frequency, while for a single side band this will be the carrier frequency.
2. *Bandwidth of Filter.* This is usually described at the 3-db level, although it may be at the 1- or 6-db levels.
3. *Shape Factor.* This determines the number of sections of the filter (see Table 2.).
4. *Input, Output Impedance.* See Table 1.
5. *Other Requirements.* As required, such as ripple and variation due to temperature.

B. Mechanical Requirements:

1. *Size of Can.*
2. *Location of Mounting Studs or Inserts.*
3. *Location of Terminals.*
4. *Type of Terminals.*
5. *Other Mechanical Requirements.* Unusual environments such as humidity, excessive humidity, shock, vibration or pressure.

modified crystal filters are still greater than for straight LC filters, though not as great as the stabilities of the all-quartz filters.

Start the Design Right

It is strongly recommended that the systems engineer introduce the crystal filter into his design during the initial phases. Often a complete system is designed and then during the development a crystal filter is introduced almost as an afterthought. By this time much of the advantage of using a crystal filter can be lost.

Because a compromise will probably have to be made between the characteristics of the established system and the crystal filter, full utilization of the crystal filter's ability to control frequency-voltage characteristics will not be achieved in such a system.

How the Filter Fits in the System

To design the filter into his system, the engineer need only regard the filter as an ideal transformer at the nominal operating frequency. If, in Fig. 2, the terminations change the magnitude of the impedances seen by the filter by more than ± 5 per cent from pure resistances, then the corrective tank circuits will have to be added. The filter must "see" the system as the two resistors R_1 and R_2. In many applications, this ± 5 per cent tolerance is such that a tank circuit need not be included and $R_1 = R_g$ and $R_2 = R_L$.

For band rejection filters, the ideal transformer concept is still applicable so long as the nominal operating frequency is taken as any passed frequency two or more bandwidths from the center frequency of the rejected band.

As an ideal transformer, and at the nominal operating frequency, the filter will provide a voltage gain of:

$$\textit{Insertion Gain} = 20 \log \frac{R_1 + R_2}{2\sqrt{R_1 R_2}} \text{ (db)}$$

This is the gain at the load that occurs with the insertion of the filter between R_g and R_L. The system engineer need do little more for by using these nominal conditions as references he can specify the desired voltage or phase characteristics over the full frequency range within the values obtainable with the filter. From these, the engineers of the firm supplying the filter can take over and provide the proper filter.

No matter how ideal a crystal may appear there is always some resistance loss. For crystals alone, this rarely amounts to more than 0.2 db. However, one or more transformers are normally included in a filter. Coil losses in these transformers are inevitable. For most applications these coil losses may be held to less than 3 db and for almost all applications to less than 8 db. Since the coil losses are "flat" losses and constant over the operating range, the system engineer can easily provide for them.

Whenever the system engineer can, he should choose the impedances R_g and R_L alike. Also, he should try to make their level as nearly equal to the values shown in Table 1 as possible. The overlap in Table 1 is due to the variety of crystal cuts used.

If the impedances cannot be kept to these values, an upper limit of

$$\frac{3 \times 10^3}{f}$$

should be used. The "f" in this equation is in kilocycles per second and represents the state of the art.

Temperature stability is normally held to ± 0.01 per cent over a range of 100 C. At frequencies greater than 1 mc, this figure can be improved to 0.004 per cent. To obtain better than this, the filter can be put in an oven and the frequency stability improved to one part in 10^7 per day.

The selectivity as measured by the shape factor may be as high as 1.1 to 1 bandwidth ratio of that at 1 db to the bandwidth at 80 db.

Temperature characteristics of narrow band filters are almost completely dependent on the variation of the crystal parameters with temperature. Coils do not play an important part in shaping narrow-band filters. Therefore, variations in inductance with temperature can usually be compensated for by use of temperature-compensated capacitors. Insertion loss and ripple vary only slightly, usually within the specified requirements imposed on room temperature.

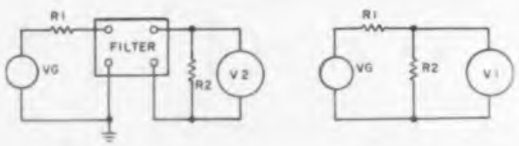
Though coils are not needed for shaping in narrow-band filters, they are sometimes needed to balance out the stray capacitance and provide a required impedance.

"Wide-Band" a Relative Term for Crystal Filters

"Wide-band crystal filters" cover bandwidths from about 1.2 to 12 per cent. They are considered wide-band because they get

Crystal Filter Nomenclature

Insertion Loss: The loss of a filter at the minimum loss of frequency of the filter, usually measured in db.



$$\text{Insertion Loss} = 20 \log \frac{V_1}{V_2} \text{ db}$$

Attenuation: The loss at any frequency relative to the minimum loss of the filter.

Bandwidth: Width measured in frequency between two points at the same db level, typically the 3-db bandwidth. In a symmetrical filter a bandwidth is usually specified for the 3-db level.

Shape Factor: The ratio (usually maximum) between a high attenuation level bandwidth and a low attenuation level bandwidth. For example, the interpretation of "60 db to 3-db shape factor is 3.3 to 1," is that the bandwidth at 60 db is 3.3 times the bandwidth at 3 db.

Pass-Band Ripple: This is the difference of the minimum loss point to the maximum loss point in a specified pass-band bandwidth and is measured in db.

Pass Band Filter: A filter which passes a band of frequency while attenuating above and below this band.

Band Suppression or Band Reject Filter: A filter which suppresses a band of frequency and passes frequencies above and below this band.

Single Side-Band Filter: A term applied to a band pass filter in which the shape factor of the slope one side of the filter is greater than on the other side. The name single side band is derived from the system use of filters to suppress a carrier frequency and transmit one or both side bands. Bandwidths that are available in single side-band filters are the same as for the symmetrical filters.

Comb. Set of Band Pass Filters: A grouping of filters of the same bandwidth and impedance equally spaced where the similarity in shape and insertion loss level are stressed.

Input and Output Impedance: This is the resistive load which the filter must see at its input and output terminals in order that the characteristics called for are met. This impedance must be strictly resistive. Any reactance load which the filter may see must be tuned out, if possible, and if not it must be controlled to a given value in order that it may be incorporated into the filter design.

Table 1. Preferred Impedances for Frequency Ranges

Nominal Operating Frequency, f	Preferred Impedance, Z
2-50 kc	$3 \times 10^6 \times$ (% bandwidth)
4-500 "	$5 \times 10^5 \times$ (% bandwidth)
50-500 "	$2 \times 10^5 \times$ (% bandwidth)
55-550 "	$3 \times 10^5 \times$ (% bandwidth)
80-700 "	$2 \times 10^5 \times$ (% bandwidth)
0.5×10^3 - 30×10^3 kc	$0.2 \times$ (% bandwidth)$/f^2$
15×10^3 - 90×10^3 "	$80 \times$ (% bandwidth)$/f^2$
25×10^3 - 110×10^3 "	$475 \times$ (% bandwidth)$/f^2$

Table 2. Typical Shape Factors for Wide-Band Symmetrical Crystal Filters

Type	Db Ratio	Shape Factor
3WS	40/3	3/1
	60/3	4/1
5WS	60/6	2.5/1
	40/3	1.7/1
6WS	60/6	1.7/1
10WS	60/6	1.5/1

their effective width due to coils which act in the circuit to widen the bandwidth beyond that obtainable with the crystals.

These wide-band crystal filters do not attain the widths obtainable with LC filters and would therefore be considered "narrow-band" in comparison. Therefore, it must be understood that "wide-band" as applied to crystal filters is a relative term. Here again, as Fig. 1 shows, the feasible ranges of crystal filter bandwidths vary across the spectrum.

Coils are an integral part of the design of wide-band filters. The effective resistance of the coil is part of the termination of the filter and is in this sense essential. Variations in coils, however, do not effect the attenuation characteristics of filters as critically as they do in regular LC filters because of the lattice and half-lattice construction which permits these coils to be resonant outside the balance portion of the filter. A typical narrow-band, two-crystal filter has a shape factor at a 40/3 db ratio of approximately 8:1, whereas a two-crystal, wide-band filter has a shape factor of about 3:1.

Table 2 gives typical shape factors for various wide-band symmetrical filters. ■ ■

Cyclic Memories—A Comparative Evaluation

DIGITAL DESIGN

Part 2 (Nonvolatile Memories)

DIGITAL DESIGN

Here is the concluding part of Y. J. Lubkin's critical evaluation of cyclic memories. The first part (ED, Aug. 30, pp 56-63) dealt with volatile memories. Here, Mr. Lubkin treats nonvolatile memories.

Yale Jay Lubkin
Loral Electronics
Bronx, N. Y.

THE ONLY forms of nonvolatile cyclic memory in wide use are devices in which a magnetic surface moves past a magnetic read-write head. These devices take the form of drums, disks, and endless tape loops. They are used when a moderate to large amount of storage is required with a low cost per bit and with moderate access time. The capacity range is quite wide, varying from 5,000 to 16,000,000 bits on drums, and from 5,000 to 30,000,000 bits on single disks. There is no essential limit on the capacity of tape loops.

Cyclic rotation rates for drums, disks, and tape loops vary from about 1 rpm to about 200,000 rpm. Most popular rates are 1,800, 3,600, 12,000, and 24,000 rpm, corresponding to speeds available from four- and two-pole motors for 60 and 400 cps, respectively. Cost per bit varies from a maximum of $100, in one case known to the author, to a minimum of about a mill. Costs exceeding a dollar a bit are rare, the usual price being a few cents.

Magnetic Drums Store Data on Cylinder Surfaces

A magnetic drum is a cylinder upon which a magnetic coating is deposited. The coating is usually either a dispersion of iron oxide or a plating of a nickel alloy like Permalloy. Nearly all modern drums use direct motor drive. Most drums are supported on ball bearings, but high-speed drums use fluid (air or liquid) bearings. Some drums have been built with magnetic bearings.

Data are normally stored on a drum in sequence on each of a number of tracks. The data are stored as a sequence of permanently magnetized spots, impressed on the drum surface by a magnetic head. The same head is generally used for reading as well as writing.

The storage capacity of a drum is the product of the number of tracks and the number of bits per track. The number of tracks per inch of linear drum dimension varies from about 10 to 32, with the total number of tracks varying between five and 500. When an extremely large number of tracks is required, it is frequently better to use several drums or to change the design approach.

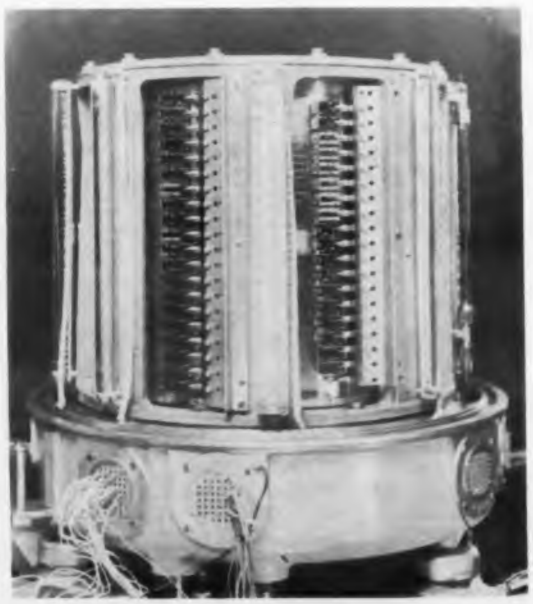


Fig. 5. Magnetic file drum by Laboratory for Electronics, Inc., is only 14 in. high, 15 in. in diameter. It can store 15 million bits with an average access time of 180 msec.

The number of bits per circumferential inch of track varies over a wide range. A survey by the author several years ago revealed that about a dozen manufacturers were designing drums with a packing density of 60 bits per in.; two used a packing density of about 150 bits per in.; two had a density of about 300 per in.; and one had same drum design at 150 bits per in.

Manufacturer's "Know-How" May Determine Drum Capacity

While drum eccentricity, coating, head spacing, and head design are important, the major factor determining the bit-packing density appears to be the manufacturer's understanding of the nature of the recording process. As example, with one manufacturer's drum, the author has recorded at 300 bits per in. with better safety margins and reliability, and with lower drive power, than the manufacturer had obtained from the same drum design at 150 bits per in.

One large-capacity drum, shown in Fig. 5, stores 15,000,000 bits with a density of 1,040 bits per in. With electronics, this drum sells for about $30,000, or about 2 miles per bit. The drum uses a surface of ground Cunife, while most drums use a dispersion of iron oxide. It is completely immersed in kerosene, while most drums run in air. The heads float on a thin film of kerosene to maintain an ef-

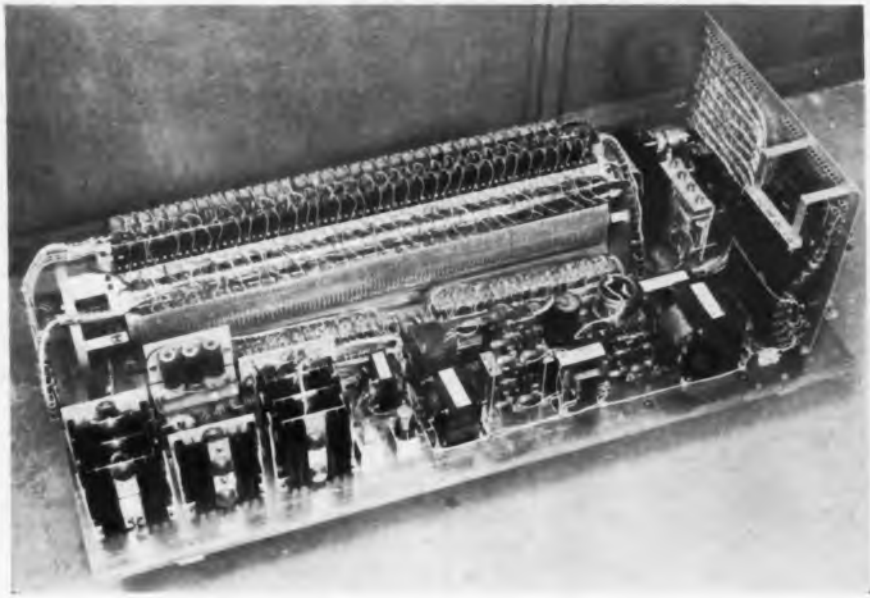


Fig. 6. Flux-sensitive drum can store up to about 15,000 bits. The heads, individual bistable magnetic amplifiers, can write at up to about 200 bits per minute and can read at about 7,500 bits per minute. Made by Consolidated Controls Corp., such drums are intended for program control rather than computer memory.

Fig. 7. The BD-500 Bernoulli Disk memory of Laboratory for Electronics, Inc. can store 500,000 bits. In the drawing, the black section (A) represents the flexible Mylar disk. (B) is the stabilizing backplate, (C) is one of the read/write heads, (D) is the backplate bearing cartridge, (E) is a connector ring, and (F) is the drive motor.

fective drum-to-head air gap of about 0.1 mil, while usual air gaps vary from 0.5 to 3.0 mil with 1.0 mil being most common.

When a drum serves as the main storage of a computer, a clock track on the drum sets the computer timing. Speed variations of the drum will normally have little effect on system performance, since the entire computer is synchronized to the drum. When a drum is used with random-access devices like magnetic cores, little difficulty is encountered, because the random-access circuitry will tolerate small variations in clock rate. If the drum is used with another synchronous device, like another drum or a delay-line register, then one of four conditions must be satisfied:

1. The two synchronous media must be synchronized (as in the Edvac, with its drum and delay line).

2. The computer must operate separately with the two media (as in Elecom 125, which used a drum and quartz delay lines. Signals from one medium were not used by the same portion of the computer at the same time as signals from the other).

3. An asynchronous buffer must be used (as with the multiple drums on many commercial machines).

4. The computer must use one medium to sample another (as with many drum machines where the drum samples punched-card input).

Flux-Sensitive Drum Heads Give Asynchronous Operation

A novel variant of the drum that permits asynchronous operation uses flux-sensitive read heads rather than the common, flux-derivative read heads. Early models used a separate magnet for each bit and recorded at 10 bits per in., two tracks per in. One unit, shown in Fig. 6, stores 15,000 bits in a drum size normally used for several million bits.

Such drums are driven by stepping motors rather than the usual induction or hysteresis motors, and they are intended for industrial control rather than computer memory. Bits can be written or read while the drum is stationary.

Disk Memories Cut Bulk for Large Storage

The volume-to-surface ratio of a drum is quite high, so the physical bulk of large-capacity drums makes their design, use, and transportation difficult. Disks have a much lower ratio of volume to surface, so they allow for comparatively light structures with large storage capacity.

Two approaches to disk memories are current, one using disks of a rigid material such as aluminum or quartz, and one using a flexible material supported by gas pressure. Each type has advantages and disadvantages offsetting those of the other.

In a drum, all tracks have the same peripheral speed, so the packing density in all tracks is the same if the number of bits per track is the same. This is not true in a disk because the track speed is proportional to the distance from the disk track to the center of the disk.

Hence, for a given number of bits per track, the packing density is highest for the inner tracks and lowest for the outer tracks. A disk operated this way, with a fixed number of bits per track (for uniform bit rate), will yield maximum storage when the outer half radius is used for storage and the inner half is left blank.

But the capacity can be increased if more bits are recorded in the outer tracks than in the inner tracks. A favored technique is to record at a given density from the one-third radius point to the two-thirds radius point, and to double the density thereafter. This enables a capacity increase of 33 per cent compared with the uniform-bit-per-track technique. The tracks recorded at higher density are considered to be two interleaved tracks of normal density, separated by computer logic.

A thin, flexible sheet of Mylar, coated with a magnetic dispersion, and rotated at high speed, makes for another type of disk memory called a Bernoulli disk. A typical Bernoulli-disk memory is shown in Fig 7. When the disk is not turning, it hangs limply, but at rotational speeds, the disk flattens out under centrifugal force and assumes a nearly planar form.

Head-to-disk spacing is maintained by mounting the heads in a plate and allowing the disk to move axially. An air film, produced by disk pumping, controls the actual spacing. The disk has holes and slots in the edge to control the pumping action and to regulate the head-to-disk spacing.

Since the head-to-disk spacing of the Bernoulli disk is not constant (near the disk center the spacing is smaller than near the edge), the maximum recording density is approximately constant, in bits per track, over the entire usable portion of the disk. Typical values of bit-packing density lie in the range of 200 to 300 bits per in. Bernoulli disks are available with storage up to two megabits.

Bernoulli Disks Are Rugged, But Can Not Take High Heat

Bernoulli disks have the advantage of an inexpensive recording medium (Mylar film is much cheaper than an aluminum drum, for instance), and the advantage of great ruggedness. Since the forces exerted on the disk by its pumping action and by centrifugal force are much greater than those exerted by acceleration of the disk during shock and vibration, operation of the disk is little affected by shock and vibration. Indeed, a standard demonstration is to pound a running Bernoulli disk with a hammer without any momentary loss of data.

The Bernoulli disk has a number of serious defects which limit its military applications. The power requirements of the disk are appreciably higher than that of a rigid disk or drum of the same capacity, and much of the delivered motor power goes into heating the Mylar film. Because of this, the upper temperature limit of the Bernoulli disk is less than that of other media we have considered.

Lifetime to failure is undoubtedly shorter than that of other media because of the heating effect, though a great many years of life can be expected if temperatures are kept moderate. Lastly, the disk is not suitable for low or very high rotational speeds—the first because the film will not maintain its shape at low speeds (below about 1,800 rpm), and the last because of excessive power consumption, film heating, and centrifugal force.

Rigid Disks Give Fast Access For Bulk Storage

Rigid disks have found use in two widely divergent applications: small disks for airborne and other small computers and large disks for bulk storage. The favored material for large disks is aluminum, while aluminum and quartz are both popular for small military disks.

The small rigid disks frequently run in helium or Freon rather than air to minimize windage power. They can operate at very high rotation rates with little motor power. Multiple-disk assemblies on a common shaft are quite common. They tend to reduce the cost per bit stored, which is higher, in general, for the small rigid disks than for the other forms of disk and drum memory (primarily because of the military environmental specifications).

One approach to small-disk design uses a deposited nickel coating on a quartz disk, with the coating etched so each bit space is magnetically separated from all other bit spaces. This isolates the flux of each bit from that of adjacent bits; it prevents flux fringing; and it produces clean signals with a high signal-to-noise ratio. Packing densities with this technique are limited to about 300 per in. by the state of the art in etching.

The large disks, up to 4 ft in diameter, are generally used in multiple for storing large amounts of data. Smaller media use one or more heads per track, while the large disks frequently use one or more heads per disk face.

One large disk assembly (Telex II), uses 64 disks to store more than 600,000,000 bits. It is almost superfluous to note that the large disk arrays are not intended for mobile or airborne applications. The 600,000,000-bit Telex II weighs 3,000 lb. and requires 7 kw.

A variant of the disk memory, the juke-box memory, has movable disks. The juke-box memories are more flexible than the disk files which use disks fixed in position, but they have a higher mean access time. A juke-box memory is shown in Fig 8.

The large disk memories use a number of interesting techniques to maximize data. The

Fig. 8. Disks can be removed and exchanged quickly in RCA's model 361 file.

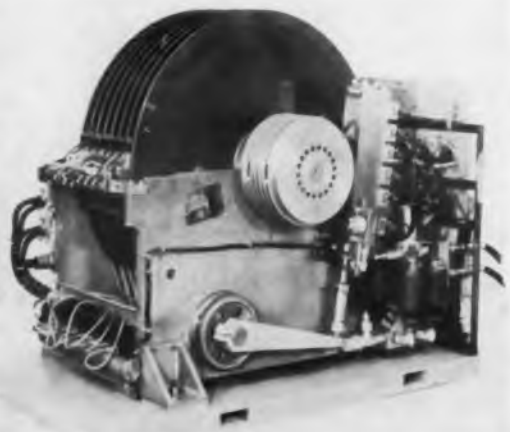


Fig. 9. Multiple disk file made by Bryant Computer Products can have as many as 20 disks.

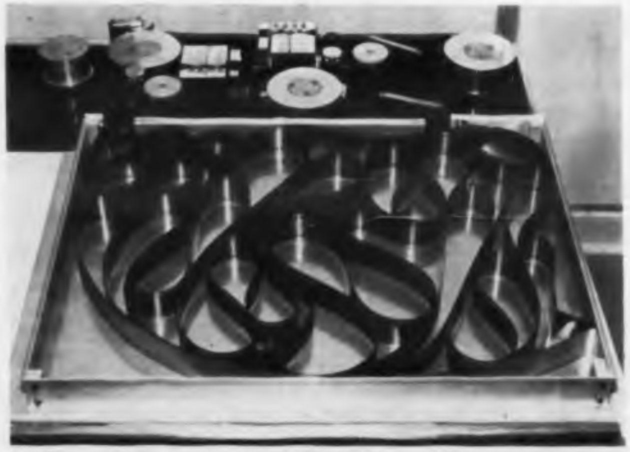


Fig. 10. Royal McBee's RPC-9100 magnetic tape storage unit has an endless loop of tape in a stationary cartridge.

Bryant 4000, (Fig. 9), which stores 30,000,000 bits per disk on a maximum of 20 disks, divides each disk surface into six zones, with a different clock track in each zone. The zones are recorded at an average packing density of 240 bits per in. and at clock rates varying from 165 kc to 420 kc.

Extremely tight track spacing is used to minimize size, and 64 tracks per in. of radius are provided. Disk diameter is 39 in. and disk rotation rate is about 1,000 rpm. Maximum access time is 150 msec. Power requirements are about 3 kw. Air-floating heads maintain a head-to-disk spacing of 0.5 mil.

Endless Tape Loops Have Low Bit Cost, Slow Access

One form of large-capacity memory is the endless tape loop. Early designs, built by the National Bureau of Standards and others, packaged a tape loop in a basket made of parallel glass plates separated by slightly more than the tape width. The tape drapes at random in the basket. Tape is pulled out of the basket, it travels past the read-write heads, and then it is pushed back into the basket. More recent units store the tape in a removable cartridge.

In the Royal McBee device shown in Fig. 10, each cartridge can store 960,000 alphanumeric characters in 10,000 blocks of 96 characters, for a total storage of nearly 6,000,000 bits.

Tape loops of this form are useful when an entire file of data must be referred to in blocks which are arranged in an ordered manner. They appear unsuitable for the pseudo-random access for which a large disk file may be used because of their high access time. But their low cost per bit, indefinitely expandable size (by adding extra cartridges), and light weight make them attractive for many applications where moderately long access time is bearable.

One unsuccessful variant of the tape loop was a tape-drum combination, which used a very wide (18 in.) magnetic tape on which information was recorded in pages. The read-write heads were arrayed on a drum, and a page of the tape was curved to fit around the drum.

In any page position, the memory had the characteristics of a magnetic drum, but pages could be changed by moving the tape. Storage capacity was high and access time to read any bit on the page was low, but construction difficulties and the competition of other media led to the effective abandonment of the idea. ■ ■

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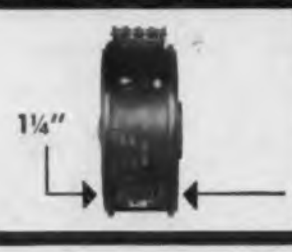

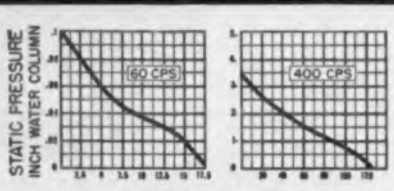

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CIRCLE 52 ON READER-SERVICE CARD

PRODUCT FEATURE

Rotary Switches Have Completely Molded Switchplates

THE VIRTUAL elimination of "slip-stick" phenomena is made possible by the use of completely molded switch plates in the construction of precision rotary switches. Long wear-life capabilities, with good signal-to-noise ratios are possible under conditions of light load.

The new line of conductive plastic precision rotary switches, manufactured by the Markite Corp., 155 Waverly Place, New York, N. Y., is extremely resistant to vibration, shock and acceleration . . . at least 50 g at 5 to 2,000 cps, as well as shock loading and acceleration in excess of 100 g without malfunction.

Each switchplate embodies highly conducting sections of conductive plastic integrally co-molded, together with terminals, to the insulator plastic sections. Conducting and insulator sections are of matched coefficients of friction and thermal expansion which virtually eliminate "slip-stick."

The switch plate yields conducting and nonconducting sections that present a hard, smooth surface to the

Load conditions are 100 v at 50 μa; signal duration is: ON, 12 deg of rotation; OFF, 57 deg of rotation.

precious metal wiper, obviating life limiting galling and wear problems. The ultra-flush switch surface of 2 to 4 μin. eliminates wiper bounce and affords low wiper friction. This permits wiper pressure of 60 to 80 g with low torque.

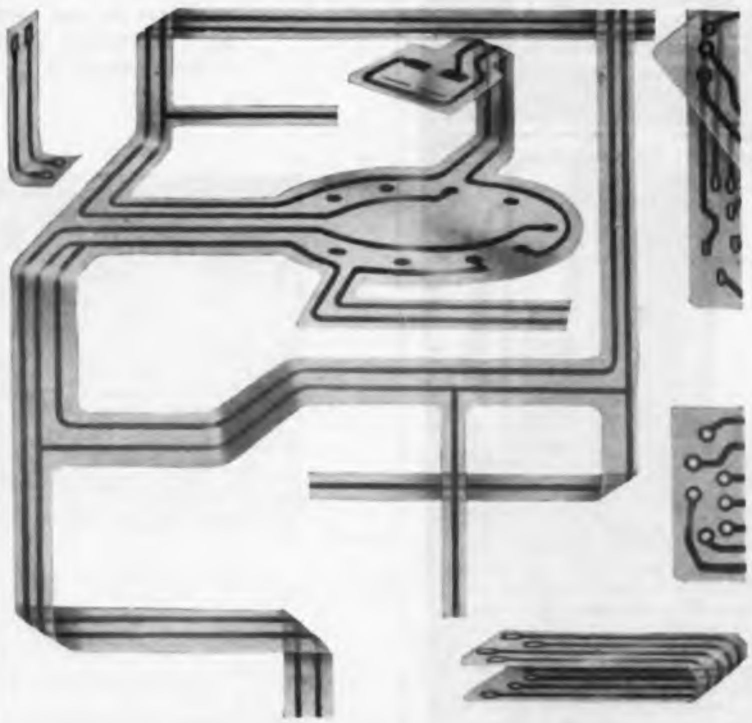
Development of moisture traps and moisture short circuit paths are precluded by the use of dense-molded materials throughout the switchplate. The wear in the conductive and nonconductive areas is essentially equal, therefore extended use does not develop a nonflush surface with consequent wiper bounce.

Conductive plastics possessing resistivities in the range of 10^{-2} to 10^{2} ohms per cm can be utilized in these switchplates.

Spot checks indicate that at light loads a minimum of 3 x 10^{7} revolutions can be expected. Speed can be at least 180 ft per min, surface speed. Signals checked at 18-, 180- and 1,000 ft per min were essentially identical.

Switches have been designed for sampling, telemetering, programing, square wave generators and as mechanical choppers. Prices are expected to run in the range of \$30 to \$1,500, depending on the complexity of the switch and allied components, with deliveries from 4 to 12 weeks.

For more information on this line of conductive plastic precision rotary switches, turn to the Reader-Service Card and circle 251.



CIRCLE 54 ON READER-SERVICE CARD

PRODUCT FEATURES

Rundown of Recent Photoelectric Cells

The need for sturdy, uniform photoelectric devices has been made apparent by the numbers and types of requests recently received by* ELECTRONIC DESIGN. *Presented here are the latest products to be announced.

Cadmium Sulfide Cells For Industrial Controls 252

Rugged and reliable cadmium sulfide photoconductor cells are designed for use as controlling devices in commercial and industrial applications. All units are vacuum sealed to provide complete protection from moisture, dust and dirt. Units are cylindrical, approximately 1/2 in. in height and 1/2 in. in diam. Present types are designed for automatic contrast control in cathode ray tubes and as on-off switches in furnace control.

Sylvania Electric Products Inc., Dept. ED, 1100 Main St., Buffalo 9, N. Y.
***P&A:** price depends upon specifications; immediate.*

Silicon Photosensors Are Designed As Readout Devices 253

Up to 20 v of reverse breakdown voltage with under 10 μa of leakage current can be handled by this line of silicon photosensors. Designed as readout devices for use in conjunction with circuitry to convert light information into usable electrical signals such as pulses and sinusoidal waves, the voltage capabilities of these diodes permit the use of direct coupled circuitry. The units are hermetically sealed in glass envelopes of 0.080 in. in diameter. They have side reading capabilities. Spectral response covers the range from 5,000 to 11,000 A.

Philco Corp., Dept. ED, Tioga and C Sts., Philadelphia 34, Pa.
***P&A:** from $5 to $12; immediate.*

Photoelectric Modulators Offer SPST or DPST Switching 258

Designed to match circuit impedances of 1.5 K, photoelectric modulators M10L and M20L offer either spst or dpst switching action. Being nonmechanical in design they have no contact wear or nonohmic conduction effects and create no vibration in other circuit elements. The devices employ a light-modulated photoconductor as the switching element and are life-rated in excess of 5,000 hr. Specifications are: modulation frequency, dc to 1 kc; dynamic range, 1 μv to 10 v; carrier phase shift, 0 or 180 deg; ambient temperature, −20 to +100 C; weight, 1 oz; dimensions, 2-1/2 in. long x 3/4 in. in diameter.

Cambridge Electronics Corp., Dept. ED, 294 Centre St., Newton 58, Mass.

P&A: *$21 to $50, depending on quantity; from 3 to 10 days.*

Photoconductive Cell Approximates Spectral Perception Of The Human Eye 259

This cadmium sulfide cell is capable of measuring either tungsten or daylight over a wide range of color temperatures through variation in its conductance. The I series as it is called will contain six distinct types designed for normal and low impedance transistor type applications in both side and end view hermetically sealed configurations. The response curves of the I series share a common peak and axis of symmetry with the spectral response of the human eye. Typical applications are: reliable light switches, crt brightness and contrast control and exposure meters without correction filters.

Clairex Corp., Dept. ED, 8 W. 30th St., New York, N. Y.

P&A: *$4 ea; from stock in small quantities.*

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.

Fiber-Optic Tube Prints Computer Readout Data 257

Text a full page wide is reproduced by the fiber-optic Charactron shaped-beam tube. The device permits direct contact-printing of computer readout data on a line-at-a-time basis without conventional lens systems. With 100 to 150 characters per line, typical printing rates of 5,000 characters per sec have been achieved. The fiber-optic faceplate is 8-1/2 in. long and 1/2 in. wide, and uses light-pipes 0.008 in. in diameter and 1/2 in. long.

General Dynamics-Electronics, Dept. ED, 1895 Hancock St., San Diego 12, Calif.

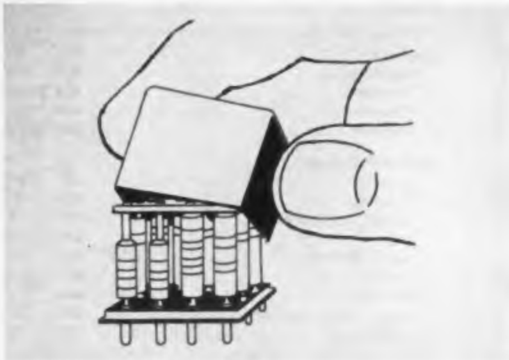
***P&A:** About $5,000; 60 to 90 days.*

Miniature Transistor Chopper Contains Own Drive Transformer 254

The drive transformer is self-contained in this miniature transistorized chopper. Noise level is 1 mv or less. Designated type 6022-3, the chopper is encapsulated for severe environmental operation, and is made for printed-circuit mounting. Input signal level for the single-package device is 30 v, 3 ma max. Sinusoidal or square-wave drive voltage can be 5.7 to 14 v rms, 50 to 5,000 cps. At a drive rating of 6.3 v rms, dwell time is 180 deg, and phase angle is within ±5 deg. Temperature range is −55 to +125 C. Chopper is said to have unlimited life when operated within rated characteristics.

Airpax Electronics, Inc., Dept. ED, Cambridge, Md.

***P&A:** $82.50 each in quantity; 2 to 6 weeks.*



Plug-In Modular Package Provides Automatic Circuit Encapsulation 256

Encapsulate your own circuits with Circupaks. The devices consist of a header with gold-plated pins staked in place and a snap-on case with a hole in the top for epoxy filling. A circuit can be wired onto the header, which is available with pins arranged in either standard tube socket or printed-circuit grid configurations. Circuit is tested, and any adjustments made. When operation is as desired, the case is snapped on, and the unit is filled with epoxy. A solid, environmentally sealed unit results. The operation can be easily automated. Cases in various cubical and cylindrical shapes from 1/2 x 1/2 x 3/8 in. to 1-1/2 x 3/4 x 3/4 in. are available.

U. S. Dielectric Inc., Dept. ED, 181 Greenwood St., Worcester, Mass.

P&A: *$0.50 each, $5 for sample kit; from stock.*

Combined AC/DC Converter-VTVM Operates at 5-Cps Frequencies 255

Resolution of 25 μv with 0.5% ripple is provided by the model HVC-30, which serves as either an ac/dc converter or as an ac vtvm. Operation extends down to 5 cps. Inputs to the vtvm section range from 10 mv to 300 v full scale at 10-meg impedance, accurate to 1%. Calibration voltages of 0.01, 0.1, and 1 v, 0.1% accurate, are provided. On the 20-cps filter setting, output reaches 99% of full value in 1/2 sec, with less than 0.7% ripple at 20 cps and 0.1% ripple at 60 cps. The converter-voltmeter can be mounted in either rack or case.

Houston Instrument Corp., Dept. ED, P. O. Box 22234, Houston 27, Tex.

P&A: *$775; 30 days.*

Choose the exact motor you need from the Barber-Colman family of enclosed, permanent magnet, reversible types for industrial and airborne applications

HYLM—1" dia

FYLM—1-1/4" dia

CYLM—1-1/2" dia

THE MARK OF QUALITY

BARBER COLMAN

d-c small motors

TYPE HYLM, top left, typical specifications (27 V): Horsepower, intermittent duty — .017. Torque — 1.0 oz-in. Speed — 17,000 rpm. Power input — 23 watts. Length — 1.59". Diameter — 1.00".

TYPE FYLM, top right, typical specifications: Horsepower, intermittent duty — up to .055. Speed — 5,000 to 20,000 rpm. Power input — 2 to 70 watts. Length — 1.77" to 2.40". Diameter — 1.25".

TYPE CYLM, lower photo, typical specifications: Horsepower, intermittent duty, up to 0.1. Speed — 5,000 to 20,000 rpm. Power input — 7 to 155 watts. Length — 2.125" to 3.125". Diameter — 1.50".

Radio noise filters, gearheads, governors, blowers, other special features also available on above motors.

WRITE FOR LATEST QUICK REFERENCE FILE on the complete line of Barber-Colman d-c and a-c motors, tach generators, blowers, gearheads, ultrasensitive relays.

TOTALLY CLOSED ALL-METAL HOUSING FOR EXTRA STRENGTH AND COMPACT, CLEAN DESIGN

IMPROVED CONSTANT TENSION BRUSH RIGGINGS

ALNICO VI RING MAGNETS CAST IN PLACE FOR MAXIMUM MAGNET AND PHYSICAL STRENGTH

STRAIGHT-THROUGH SHAFTS

MEET MILITARY SPECIFICATIONS

BARBER-COLMAN COMPANY

Dept. U, 1883 Rock Street, Rockford, Illinois

CIRCLE 57 ON READER-SERVICE CARD

New Products Directory

A complete index of all new products contained in this issue of Electronic Design, *including page and reader-service numbers.*

High-torque, fast-reversing Barber-Colman quality motors for low-cost servo systems utilizing either transistor or vacuum tube control

THE MARK OF QUALITY

BARBER COLMAN

FAST-REVERSING LOW-INERTIA ROTORS

HIGH STARTING TORQUE

ELECTRODYNAMIC BRAKING

ADAPTABLE TO SPLIT-PHASE CAPACITOR OPERATION

AVAILABLE WITH 2-PHASE OR ELECTRONIC CONTROL WINDINGS

AVAILABLE WITH OPEN OR CLOSED GEAR REDUCTIONS

a-c small motors

Barber-Colman shaded pole reversible motors are adaptable to a variety of electronic control circuits to meet the many different requirements of applications demanding a compact, powerful, fast-reversing motor. In many servo systems they satisfactorily replace motors costing twice as much. Ratings are from .00015 to .04 hp. For further information write for literature on use of these motors in servo systems with transistor or vacuum tube amplifiers.

THE WIDE LINE OF BARBER-COLMAN A-C MOTORS includes unidirectional, synchronous, and reversible types . . . with or without reduction gearing . . . open or enclosed. Stator and rotor sets also available. Write for quick reference file.

BARBER-COLMAN COMPANY

Dept. U, 1283 Rock Street, Rockford, Illinois

CIRCLE 58 ON READER-SERVICE CARD

NEW PRODUCTS

Transistor Tester 536

For all npn and pnp types. With small-signal transistors and circuit impedance above 500 ohms, model 990 in-circuit transistor tester has a maximum error of about 5%. Power transistors can be tested with peak collector currents of 700 ma. Five I_{cbo} and three Beta ranges are provided.

Precision Apparatus Co., Inc., Dept. ED, 70-31 84th St., Glendale 27, N. Y.

Clutch-Brake Combination 537

Have in-line construction. Size 100 clutch-brake combination has a torque output of 30 oz-in. at 2-w power input; size 130 is rated at 110 oz-in. at 3.5 w. A special attachment for conversion to continuous-slip operation at infinitely variable torque is used. Standard voltages are from 6 to 100 v dc; various combinations may be specified.

Dial Products Co., Dept. ED, 19 Cottage St., Bayonne, N. J.

***Price:** from $58.20.*

Digital Breadboard 528

Self-contained digital breadboard and training console, called the Digilab, includes from 30 to 40 digital elements. It also contains a manual pulser, a manual reset, an external pulse input, a clock-frequency switch, computer-type indicator lights, a power supply and other equipment needed to construct a wide variety of digital networks.

Tech Serv Inc., Dept. ED, 4911 College Ave., College Park, Md.

***P&A:** $755 to $895; 2 to 4 weeks.*

High-Purity Cesium 535

Purity is 99.9%. Cesium metal, which must be packaged in a vacuum or under argon gas, is available in steel and glass containers and in a multi-ampuled package designed to facilitate the use of small quantities. Its melting point is 83 F; boiling point is 1,238 F. Possible applications include thermionic converters.

Dow Chemical Co., Dept. ED, Midland, Mich.

***Price:** $1.00 per g; $375 per lb for 5 to 9 lb.*

Sonic Gun 512

Generates to 150 db. The sonic gun provides for instantaneous ultrasonic defoaming, degassing, mixing and dispersing in pipe lines or tanks, and can also be used as a noise source for signaling or environmental testing. It can be made to meet specifications for any work requiring 10 to 100 kc.

Ultrasonic Industries Inc., Dept. ED, Ames Court, Engineers Hill, Plainview, L. I., N. Y.

***Price:** $300.*

Racks and Cabinets 486

Sloped-front vertical racks are among the new designs offered in this line of modular racks and cabinets. This cabinet shape provides for easy surveillance of instrumentation in large installations of meters, regulators, scopes and other equipment.

Equipto Electronics Corp., Dept. ED, 319 N Webster St., Naperville, Ill.

RF Switches 488

Relay-type rf switches are designed to meet the requirements of missile applications. Model 2BN18DSR, for example, is a spdt relay for applications to 1,000 mc, with crosstalk of 40 db or more and 0.25-db maximum insertion loss. Vswr is 1.25 with a 50-ohm termination. Operating voltage is 26 to 30 v dc. Life is 1 million cycles, continuous duty.

General Communication Co., Dept. ED, 677 Beacon St., Boston 15, Mass.

Silicon Solar Cell 530

For space-power applications. Solar cells for space vehicles and satellites have conversion efficiencies of 13% and 14%. A photolithography process provides a grid network with extremely uniform positioning and dimensions on the surface of the cell.

Solar Systems, Inc., Dept. ED, 8241 N. Kimball Ave., Skokie, Ill.

***Availability:** some types, stock.*

Servo Gear Boxes 497

Precision servo gear boxes are offered in over 720 variable units, providing even and exact binary ratios from 2:1 to 625:1. Backlash is held to 30 in all models. Maximum rated output torque is 250 oz-in. in the 1/8-in. shaft series to 500 oz-in. in the 1/4-in. shaft series. Designed for all servo, computer and research applications, the units can have slip clutch, anti-backlash gears or both.

PIC Design Corp., Dept. ED, 477 Atlantic Ave., East Rockaway, L. I., N. Y.

***Availability:** $45 to $75; stock.*

Servo Actuator 494

Clutch-type servo actuator series 3170 is designed for computer and missile applications with high precision and low power requirements. Torque range is 1 to 70 lb-in. Speed range is 285 to 4.6 rpm. Frequency response is high. An ac or dc motor and actuator connectors can be supplied as required.

Lear, Inc., Electro-Mechanical Div., Dept. ED, 110 Ionia Ave., N. W., Grand Rapids 2, Mich.

Pulse-Power Calibrator 489

Uses interchangeable rf heads. Series 5000 pulse-power calibrator has a power-level resolution of 0.1 db or better. A precision attenuator provides power-measurement accuracy to ±0.5 db over the frequency range of each rf head for direct power input levels from −5 to +63 dbm.

General Communication Co., Dept. ED, 677 Beacon St., Boston 15, Mass.

Multi-Turn Potentiometers 533

Rated at 0.5 to 30,000 ohms. Potentiometers with up to 40 turns have a temperature coefficient of 20 ppm for most resistances, infinite resolution and linearities to 0.01%. Ratios may be achieved to allow the input shaft to rotate any number of turns from 1/2 to 1,000 for the full resistance range.

Vogue Instrument Corp., Dept. ED, Brooklyn, N. Y.

NEW PRODUCTS

Channel Regulator 495

For multiplexing system type 33A. Type 331A channel regulator is for automatic frequency synchronization and signal-level regulation on channel 1 of the firm's three-stack multiplexing system. Regulation circuitry effects a 5:1 ratio of output improvement over received line signals. Absolute synchronization is produced.

Lenkurt Electric Co., Inc., Dept. ED, San Carlos, Calif.

Discharge Tubes 514

Hollow-cathode discharge tubes for use in atomic absorption spectroscopy are available for analysis of materials containing iron, copper, nickel, zinc, manganese and other elements. They have low starting voltages, low operating voltage and stable current.

Westinghouse Electronic Tube Div., Dept. ED, Box 284, Elmira, N. Y.

***Availability:** samples, stock; quantities, 30 days.*

AC-DC Multimeter 485

Four-digit multimeter type 850 measures dc volts, dc ratios and ac volts over ranges of ±0.0001 to ±999.9. Accuracy is ±1 digit on dc voltages and ratios, ±0.1% or 2 digits on ac voltages. Average dc balance time is 50 msec; average ac balance time is 2 sec below 400 cps and 500 msec above 400 cps.

Electro Instruments, Inc., Dept. ED, 8611 Balboa Ave., San Diego 11, Calif.

Power Amplifier 504

Linear power amplifier model SC-907, rated at 1 kw, is designed for operation with the SC-901 and SC-910 single-sideband radio sets. It consists of two units: power amplifier and power supply. It provides amplification over the range of 2 to 30 mc for SSB, compatible am, cw, FSK and ISB Course tuning is automatic; fine tuning requires adjusting two controls.

General Dynamics/Electronics, Military Products Div., Dept. ED, 1400 N. Goodman St., Rochester 3, N. Y.

Transistor Radiator-Retainers 503

Double-ended radiators and retainers are available for mounting TO-5, 8, 9, 11, 12, 29, 33, 37, 38, 39, 42, 43 and other transistors. They have a tapped base for quick mounting in flip-flop or push-pull circuits. Material is aluminum alloy as per QQ-A-268, finish is black anodize as per MIL-A-8625, type II.

The Birtcher Corp., Industrial Div., Dept. ED, 745 S. Monterey Pass Road, Monterey Park, Calif.

***Availability:** 2 to 3 weeks.*

Vinyl Handle Assemblies 510

Hardware is steel or brass, in any of 12 finishes. The handle assemblies have a Mylar protected insert laminated to the vinyl handle. They can be attached to fans, corrugated boxes, tool chests, small instruments and other devices. They can be supplied in any length, according to customer specifications.

Philadelphia Handle Co., Dept. ED, 1643 Haddon Ave., Camden 3, N. J.

Power Supplies 517

High-voltage, low-current power supplies are for applications that usually require a cathode-ray tube such as oscilloscopes, spectrum analyzers and TV systems. Called H D & K Kilopaks, they are compact, use solid-state circuitry and are hermetically sealed.

Atlee Corp., Wesco Div., Dept. ED, 27 Olive St., Greenfield, Mass.

Volt-Ohmmeter 515

Semi-digital, solid-state volt-ohmmeter type 21A combines analog and digital circuitry. It has four voltage ranges covering from 3.2 to 3,200 v and six resistance ranges covering 320 ohms to 32 meg. Accuracy is ±15% of full scale; input impedance is 10 meg; response time is 1 sec on most ranges.

J-Omega Co., Dept. ED, Los Altos, Calif.

***P&A:** $650; stock.*

Solid-State Control Relay 518

Ultra-sensitive solid-state control relay, designated the Magsense A-82, has a signal output of 0 to 100 μa. Continuously controlling 30 w in the output with 1-μa signal changes, it is capable of operating at 260,000 cycles per day. The output is the solid-state equivalent of spdt, 1 amp. Operation is dc.

Daystrom, Inc., Control Systems Div., Dept. ED, 4455 Miramar Road, La Jolla, Calif.

Printed-Circuit Connector 524

Breakdown voltage is 2,200 v ac at sea level; current rating is 3 amp. This printed-circuit connector has 140 terminations divided into sets of 38 and 32 contacts. Insulator material is diallyl phthalate as per MIL-M-19833, type GDI-30. Over-all length is 8.63 in. with 0.100-in. contact spacing.

Viking Industries Inc., Dept. ED, 21343 Roscoe Blvd., Canoga Park, Calif.

***Availability:** stock.*

Laser Crystals 493

In boules or rods with ends polished optically flat and parallel. Stock crystals include ruby and CaF_2 doped with divalent samarium or trivalent uranium. Reflective surfaces are evaporated metallic coatings or multiple dielectric layers. Custom-grown crystals such as CaF_2, CdF_2, BaF_2 and MgF_2 can be obtained with activators.

Isomet Corp., Dept. ED, 433 Commercial Ave., Palisades Park, N. J.

Laboratory Power Supply 498

Rated at 50 amp dc. Model MTR28-50 power supply is designed to provide the dynamic regulation required by load transistors. Static regulation is $\pm 0.1\%$ for line and load; dynamic regulation is $\pm 0.5\%$ for line and ± 2.0 v for load. Voltage output is 24 to 32 v. No tubes or moving parts are used. Special protective circuitry ensures against overload.

Perkin Electronics Corp., Dept. ED, 345 Kansas St., El Segundo, Calif.

Miniature Controls 505

Composition controls style RV1, are rated at 1/5 w at 70 C, derated to zero at 120 C. They are available in values of 500 ohms to 1 meg, linear taper. Tolerance is $\pm 10\%$ and breakdown point is 900 v ac rms to ground at atmospheric pressure. Model JMP has a standard bushing; model JML, a locking type bushing. Requirements of MIL-R-94B are met.

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

***Price:** $2.27 to $4.50.*

DUAL-BEAM OSCILLOSCOPE

DC-TO-25 MC, 14-NANOSECOND RISETIME WITH FAST-RISE PLUG-IN UNITS

TYPE 551

You can compare waveforms simply, conveniently, reliably with a Tektronix Type 551 Dual-Beam Oscilloscope.

You can display up to four traces at once—with Tektronix dual-trace units in both channels.

Or, you can interchange any combination of 16 other "letter-series" plug-in units for such applications as dual-beam pulse sampling . . . transistor-risetime testing . . . semiconductor-diode-recovery-time studies . . . strain gage and other transducer measurements . . . as well as multiple-trace work in other specialized displays or general-purpose laboratory experiments.

If you need a fast-rise, dual-beam oscilloscope—offering signal-handling ease and dependability in dc-to-25 mc waveform-comparison analyses—consider a Tektronix Type 551.

CHARACTERISTICS

Common X-Independent Y Deflection. Adaptable Vertical System—Accepts interchangeable plug-in preamplifiers. *Versatile Sweep Features*—Wide range from 0.1 μsec/cm to 5 sec/cm in 24 calibrated sweep rates, continuously variable uncalibrated to 12 sec/cm. 5x magnifier increases calibrated sweep time to 20 nsec/cm. Single sweep facilitates recording one-shot phenomena. *Complete Triggering Facilities*—Amplitude-level (manual) selection or fully automatic control. *High Writing Rate*—10-KV accelerating potential provides bright traces at low repetition rates. 4 by 10 centimeter display for each beam, with 2 centimeter overlap. *Precise Amplitude Calibrator*—With 18 square-wave voltages (from 0.2 mv to 100 v peak-to-peak) available at the front panel.

Type 551 (without preamplifiers) $1800

Includes Indicator Unit, Power Unit, 4 Probes, 7 other accessories.

price f.o.b. factory

For a demonstration of the capabilities of a Type 551 in your own waveform-comparison analyses, call your Tektronix Field Engineer.

Tektronix, Inc. *P. O. BOX 500 · BEAVERTON, OREGON / Mitchell 4-0161 · TWX—BEAV 311 · Cable: TEKTRONIX*

TEKTRONIX FIELD OFFICES: Albuquerque, N Mex. • Atlanta, Ga. • Baltimore (Towson) Md. • Boston (Lexington) Mass. • Buffalo, N.Y. • Chicago (Park Ridge) Ill. • Cleveland, Ohio • Dallas, Texas • Dayton, Ohio Denver, Colo. • Detroit (Lathrup Village) Mich. • Endicott (Endwell) N.Y. • Greensboro, N.C • Houston, Texas • Indianapolis, Ind. • Kansas City (Mission) Kan. • Los Angeles, Calif. Area (East Los Angeles, Encino • West Los Angeles) • Minneapolis, Minn. • Montreal, Quebec, Canada • New York City Area (Albertson, L.I., N.Y. • Stamford, Conn. • Union, N.J.) • Orlando, Fla. • Philadelphia, Pa. • Phoenix (Scottsdale) Ariz. Poughkeepsie, N.Y. • San Diego, Calif. • San Francisco, Calif. Area (Lafayette, Palo Alto) • St. Petersburg, Fla. • Syracuse, N.Y. • Toronto (Willowdale) Ont., Canada • Washington, D.C. (Annandale, Va.).

TEKTRONIX ENGINEERING REPRESENTATIVES: Hawthorne Electronics: Portland, Oregon; Seattle, Washington • Kentron Hawaii Ltd., Honolulu, Hawaii. Tektronix is represented in twenty overseas countries by qualified engineering organizations.

In Europe please contact Tektronix International A.G., Terrassenweg 1A, Zug, Switzerland, Phone (042) 4-91-92, for the address of the Tektronix Representative in your country.

CIRCLE 62 ON READER-SERVICE CARD

NEW PRODUCTS

Tantalum Slug Capacitors 496

Meet MIL-C-3965B. Hat-shaped tantalum slug capacitors series TS are available in all three sizes called for by MIL-C-3965B. They can also be furnished in the 125 C rating as commercial units with a K tolerance of ±10% as well as an S tolerance of −15% and +20%.

Ohmite Manufacturing Co., Dept. ED, 3634 Howard St., Skokie, Ill.
Availability: *stock.*

Seal 501

No solders, fluxes, heat or sparking results. The SAC-seal type 110 is designed for sealing by the Koldweld process. Special tools required can be furnished.

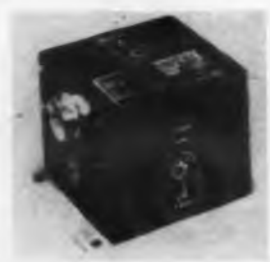
Scully-Anthony Corp., Dept. ED, 4707 Willow Springs Road, La Grange, Ill.

Soldering Iron 516

For microminiature applications. The B-2000 soldering iron weighs 2-3/4 oz and has a tip temperature of 850 F. Soldering iron tips with shank diameters of 1/8 to 3/8 in. in various shapes and working surfaces can also be furnished.

American Electrical Heater Co., Dept. ED, 6110 Cass Ave., Detroit 2, Mich.

Rate Gyro 492



Pitch, yaw and roll rates are monitored by the RGO2-0902-1 rate gyro. Gyro and filter are individually hermetically sealed and mounted on an aluminum base. Rf noise is filtered to meet MIL-1-16910A. Axis alignment can be made within 6 min. Weight is 2.5 lb.

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

NEW PRODUCTS

Paper Capacitors 511

Miniature, metal-clad, hermetically sealed paper capacitors type 231P are offered in ranges from 0.001 to 6 μf at 50 v dc. The dielectric system consists of plastic coated Kraft paper and Vitamin-Q inert oil impregnant. A wide variety of mounting arrangements, including integral side studs, end studs and screw-neck mountings can be furnished.

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

DC-AC Inverters 508

Provide 50 to 2,000 cps. These solid-state dc-ac inverters have a ±1% regulation for input variations or no-load to full-load variations. Distortion is 5% max. Input is 24 to 30 v dc. The inverters are designed for long life and maintenance-free operation.

NJE Corp., Dept. ED, 20 Boright Ave., Kenilworth, N. J.

Tape Perforator 529

Low-speed model SP-2 tape perforator, with a punching rate of up to 120 codes per sec, is similar to the firm's model GP-2. The print station provides 64 symbols. The tape passes horizontally over the punch head directly into the punch and die assembly.

Soroban Engineering, Inc., Dept. ED, Box 1717, Melbourne, Fla.

Data Acquisition System 525

Real-time, fm-fm, multi-channel data acquisition system, called the Midas, is suitable for laboratory or industrial use. Applications include sensing and transmitting pressure, strain and acceleration; measurement of gas-turbine strains and temperatures, forces acting upon rotating helicopter blades and dynamic pressure in steam turbines.

Unilectron Inc., Dept. ED, 129 Binney St., Cambridge 42, Mass.

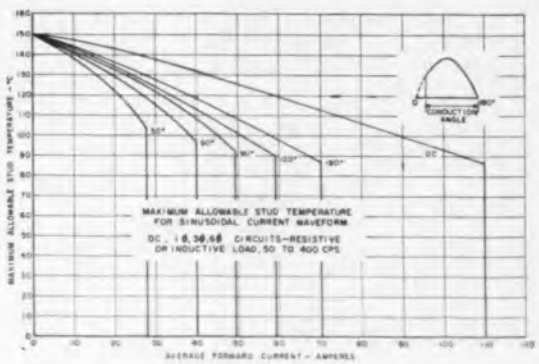
inside story of General Electric

CONTROLLED RECTIFIERS

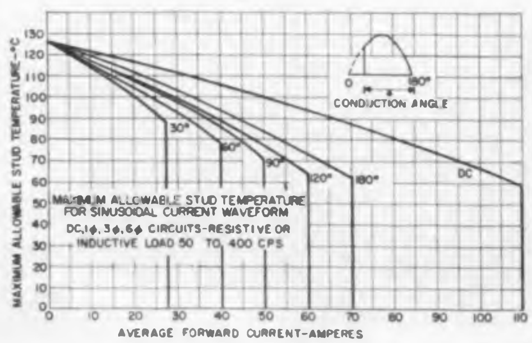
G-E HIGH CURRENT SCR's are three junction semiconductor devices for use in power control and power switching applications requiring blocking voltages up to 600 volts and load currents up to 110 amperes D.C. Series and parallel circuits may be used for higher power applications. Outstanding features of the most completely specified high current SCR's on the market today include:

- Well defined, sensitive firing characteristics over the complete temperature range
- Up to 500 PRV for 2N1909-16 (C50) series
- Transient PRV ratings
- 100% testing of all specified electrical and thermal characteristics
- I^2t ratings permit easy fuse selection
- Operating temperature range available from $-65°C$ to $+150°C$
- Available as inverter types with specified turn-off times

For complete technical data and applications information for your specific circuit requirements, call your G-E Semiconductor Products District Sales Manager. Or write Rectifier Components Department, Section 23134, General Electric Company, Auburn, New York. In Canada: Canadian General Electric, 189 Dufferin Street, Toronto, Ont. Export: International General Electric, 150 East 42nd Street, New York 17, N. Y.



2N2023-30 (C60) and C61 Series



2N1909-16 (C50) Series

For fast delivery of High Current SCR's at factory-low prices, see your authorized G-E distributor

GENERAL ELECTRIC

CIRCLE 66 ON READER-SERVICE CARD

Rotary Switch 534

Exceeds MIL-S-6807A. Series 3-1900 miniature rotary selector switch with 22.5-deg indexing, is designed for ground and airborne electrical systems where execution of tap, transfer and sequence functions is required. Power handling capacity is up to 5 amp at 115 v ac and 3 amp at 28 v dc, resistive, and 2 amp at 28 v dc, inductive.

Janco Corp., Dept. ED, 3111 Winona Ave., Burbank, Calif.

Tap Setting Device 519

For push-in taps in the firm's models C-200 and BC-200 potentiometers. Designed to simplify field setting of potentiometer taps, the tap setting device is furnished complete with tweezers, bonding agent and styrene carrying case.

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

Payload Instrumentation Package 532

Rocket payload instrumentation package type TM 18-Ola incorporates most of the instruments needed for rocket probes including telemetry, commutators, magnetometers, accelerometers, accelerometer pre-amplifiers, calibration and control circuitry. The package measures 5 in. in diameter and 13 in. high; it withstands high shock and vibration.

Washington Technological Associates, Inc., Dept. ED, 979 Rollins Ave., Rockville, Md.

The Tantacon makes possible high capacitance per unit volume, while maintaining low, linear temperature characteristics for capacitance and low dissipation factor over a wide operating temperature range.

Solid electrolyte eliminates leakage problems, and quality Erie construction assures long shelf and operating life.

TANTACON SPECIFICATIONS

Supplied in metal MIL cases sizes A and B (insulated and non-insulated)
Capacitance range: 1.0 mf to 56 mf
Capacitance tolerances: ±5% (on request), ±10%, ±20%
Voltage ratings: 6, 10, 15, 20 and 35 VDCW
Operating temperature range: −80°C to +85°C at full rated voltage

Specify the polar tantalum capacitor with the ultimate in reliability, stability and compactness—specify TANTACONS by Erie.

Write for Bulletin 511 for complete specifications.

ELECTRONICS DIVISION
ERIE RESISTOR CORPORATION
644 West 12th Street • Erie 6, Pennsylvania

Sales Offices in principal cities of U. S. A., Canada, Europe

CIRCLE 67 ON READER-SERVICE CARD

Signal Conditioner 479

Strain-gage signal conditioner type SSC-1 offers any configuration of bridge circuitry, up to four calibration points, single and double shunt, plus-or-minus and plus-and-minus calibration. Long-term stability is 0.1%; short-term stability is 0.01%. Each of the eight channels is contained on three printed-circuit, plug-in cards.

Astra Technical Instrument Corp., Dept. ED, 12930 Panama St., Los Angeles 66, Calif.

Silicon Transistor 418

Switching transistor type 2N-957 is for use in vhf and if amplifiers. Voltage rating is 40 v, power rating 800 mw. Minimum dc beta is 45. Minimum ac beta is 40 at 1 mc, and 2 at 100 mc. It is packaged in a TO-18 configuration.

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

Price: *$6.50 for 1 to 99, $4.50 for 100 to 999.*

Temperature Test Stands 483

Movable temperature test stands with a working surface of 24 x 30 in. centralize tests made with the firm's portable temperature chambers. Storage space is provided on a shelf beneath the unit.

Delta Design, Inc., Dept. ED, 3163 Adams Ave., San Diego 16, Calif.

Delay Line 593

Fixed magnetostrictive delay line L30 provides delays from 250 to 850 μsec. Adjustment range is 8 μsec. Pulse width is 0.5 to 5 μsec, center frequency range 100 kc to 1 mc, bandwidth 1 mc max. Signal-to-noise ratio is at least 20:1. Temperature coefficient is 5 to 10 ppm per degree C, or 0 ±1 ppm if required.

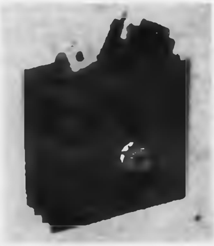
Ferranti Electric Inc., Electronics Div., Dept. ED, Industrial Park No. 1, Plainview, N. Y.

Cables and Cable Assemblies 480

Miniature coaxial and triaxial cables and cable assemblies are furnished with connectors in 50, 75 and 95-ohm sizes. Standard line includes braided or solid conductor, Teflon insulation, silver-plated shield, and Teflon, nylon or composition jackets.

Boston Insulated Wire & Cable Co., Dept. ED, Bay St.. Boston 25, Mass.

Selenium Rectifier 448



Ratings from 0.46 to 379.2 amp at an ambient temperature of 40 C and up to 948 amp in force-cooled applications are available. Selenium rectifier Mark 5 ranges from 1 x 1 in. to 12 x 16 in. in size, in both 26 v and 33 v rms types.

Syntron Co., Semiconductor Div., Dept. ED, Homer City, Pa.

Availability: *from stock.*

Electron-Beam Evaporator 477

A complete system, the Mark V evaporator includes electron gun, vacuum chamber, mechanical roughing and diffusion pumps, power supply and console. It is designed for the evaporation of ultra-high-purity metallic and ceramic films. Spot diameter can be controlled from 0.01 to over 0.5 in. and focal length, from 4 to 12 in.

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

Ferrite Core Memory 478

Has a 5-μsec memory cycle. Access time is 2 μsec and buffer cycle is 2.5 μsec. The type RQA ferrite core memory has word capacities of 1,024 up to 32,768, available in lengths of 8 to 60 bits. A wide range of reference levels and signal amplitudes can be furnished for compatibility with tube and transistor circuits. Temperature range is 0 to 50 C at humidity conditions to 95%.

Ampex Computer Products Co., Dept. ED, P. O. Box 329, Culver City, Calif.

Reverse Feedthrough 451

Provides 90-deg turn. Subminiature reverse feedthrough Type RFT-SM-18 TUR-L2 has a Teflon body and brass studs. Height is 0.378 in. and body diameter is 0.148 in. Studs are terminated in turrets at both ends, measuring 0.040 in. in diameter, may be finished in solder or gold plated.

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

NEW PRODUCTS

Decade Counter 499

Frequency response is 200 kc, with less than 5-μsec pulse resolution, electrical reset to zero and an output to drive similar decades. Model F1601 miniature decade counter operates on 12 v at 100 ma and has a flexible cable with printed-circuit or amphenol connector. Dimensions are 1-7/8 x 2-1/8 x 4-1/4 in. Weight is 6 oz.

Robotomics Enterprises, Inc., Dept. ED, 4624 E. Garfield, Phoenix 8, Ariz.
***P&A:** $98; 3 to 4 weeks.*

Dynamic Analyzer 520

Frequency range is 5 to 2,500 cps; response is flat within 1 db. The dynamic analyzer is a frequency-tuned band-pass filter for such uses as vibration analysis in rotating devices, harmonic and random wave analysis, bearing analysis and transmissibility studies. A recorder output is provided.

General Dynamics/Electronics, Information Technology Div., Dept. ED, P. O. Box 2449, San Diego 12, Calif.

Cooler Kit 502

Semiconductor cooler kit contains representative types of semiconductor coolers including natural-convection units and forced-convection modular packages. Included is a handbook which outlines the theory as well as practical techniques for temperature, power and air-flow measurement.

Wakefield Engineering, Inc., Dept. ED, Wakefield, Mass.
***Price:** $38.50.*

Temperature Chamber 482

Range is −100 to 500 F. Model 1060B temperature chamber is for testing of large assemblies where gradient, control variation and drift cannot exceed ±1 C. Volume is about 6 cu ft. Fixtures are available for testing large quantities of small components for quality-control test runs. Mil specs are met.

Delta Design, Inc., Dept. ED, 3163 Adams Ave., San Diego 16, Calif.

Power Transistors 372

Germanium power transistors with junction temperature ratings of 110 C and maximum power dissipation ratings of 170 w are made in eight types. Housed in TO-36 packages, types 2N2075-2N2082 are capable of 30 w dissipation at 95-C case temperature. Range of BV_{CES} is 40 to 80; h_{FE} at I_c=5 amp is 20 to 70.

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

***Price:** $1.95 to $8.75 ea, 100 up.*

Cryogenic Thermometer 622

Operates at 1.5 K. Miniature cryogenic thermometer CG-1 measures from 1.5 to 5.0 K with accuracy and repeatability better than ±0.050 K. Length is 0.350 in., diameter 0.130 in. Weight is less than 0.5 g.

Radiation Research Corp., Dept ED, Westbury, N. Y.

CIRCLE 71 ON READER-SERVICE CARD ➤

Motor Speed Control 506

Provides 2% regulation with input voltage variations of ±10% over the temperature range of −55 to +100 C. Designed for controlling a 28-v dc input, the speed control can be furnished as a separate module measuring 2-1/4 x 2-1/4 x 3/4 in. or it may be attached to any dc-driven commutator with a 1/2-in. extension of the case.

Instrument Development Laboratories, Inc., Dept. ED, 67 Mechanic St., Attleboro, Mass.

Disk File 500

With 22 to 88 million characters. The 301 disk file system is offered in four standard models. Two files can be connected to provide a total capacity of 176 million characters. Average accessibility time is 100 msec. Each file holds 1 to 24 magnetic disks, 39 in. in diameter, in a vertical position. Data is recorded on both sides.

Radio Corp. of America, Dept. ED, 30 Rockefeller Plaza, New York 20, N. Y.

***P&A:** $3,000 up, monthly lease rate.*

Voltage-to-Frequency Converter 507

Linearity is 0.1% or better. The Volcon voltage-to-frequency converter can be used in control and instrumentation applications, including fm signal generators, frequency-control systems and digital voltmeters. Nominal center frequency is 600 kc. Stability approaches that of a good crystal oscillator.

Neshaminy Electronic Corp., Dept. ED, Neshaminy, Pa.

***Price:** $75.*

TURN PAGE

Printed-Circuit Connector 481

Designed for space applications, the Digi-Klip printed-circuit board connector withstands temperatures of over 200 C without fatigue or contact failure. It has a beryllium-copper, heat-treated wire mounting in two 0.21-in. holes spaced at 0.25 in.

Components Corp., Dept. ED, Denville, N. J.

***Price:** $25 per 1,000.*

Coaxial Cables 416

For high temperatures. New versions of miniature high-temperature coaxial cables included in MIL-C-17C have made possible seven new constructions. Types RG-178B/U to RG-180B/U are available with Teflon FEP jackets, usable to 200 C. Types RG-187A/U, RG-188A/U, RG-195A/U and RG-196A/U are available with annealed center conductors and TFE jackets, usable to 250 C.

Times Wire and Cable Co., Inc., Dept. ED, Wallingford, Conn.

RF Attenuators 484

High-power rf attenuators models AX-100 and AX-500 are rated at 100 and 500 w, respectively. Accuracy is ±0.3 db. Frequency ranges are dc to 700 mc and dc to 1,000 mc with reduced accuracy. Standard attenuation values are 10, 20 and 30 db; others can be furnished.

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

Germanium Mesa Transistors 490

High-speed germanium mesa transistors are available in four types, designated 2N705, 2N710, 2N711 and 2N725. Typical switching speed is 96 nsec. Gain-bandwidth product is about 600 mc. Housing is standard JEDEC TO-18. Units have high mechanical strength and low failure rates on operating and storage-life tests.

General Electric Co., Dept. ED, Kelley Bldg., Liverpool, N. Y.

Price: $1.60 to $2.80 to OEM.

Communications Antennas 526

Range is 150 to 170 mc. These communications antennas, known as Gibson antennas, include single element dipole and stacked colinear dipole types. They have solid dipole elements, gamma match to 50-ohm coaxial line, element length and tuning to exact operating frequency and better than 1.2 vswr. They withstand severe icing and winds up to 100 mph.

Brad Thompson Industries, Inc., Dept. ED, 83-810 Tamarisk St., Indio, Calif.

Circuit Breaker 527

For aircraft use. The Klixon 6752-12 circuit breaker meets MS24571 aircraft requirements and exceeds MIL-C-5809C. It has a rupture capacity of 6,000 amp, 120 v ac, 400 cps; 4,200 amp, 205 v ac, 400 cps; 6,000 amp, 30 v dc. Vibration limit is 10 g at 1,500 cps; ambient temperature range is −65 to +250 F.

Texas Instruments, Inc., Metals & Controls Inc., Dept. ED, 34 Forest St., Attleboro, Mass.

Wirewound Potentiometers 523

Linearity is 0.01%. Model 20-A infinite-resolution wirewound potentiometers can be supplied for continuous rotation applications or with solid-end stops, rated at 800 oz-in. Resistances are from 0.5 to 1,000 ohms.

Vogue Instrument Corp., Dept. ED, 2350 Linden Blvd., Brooklyn 8, N. Y.

***P&A:** $35; 2 to 3 weeks.*

Impulse Counter 521

Life is 500 million counts. Driven by an electromagnetic stepping motor, the impulse counter can count 100 per sec. It can be used to measure time and distance directly in decimals and is particularly suitable for data processing and automation equipment. It can be furnished with five or six-figure drums.

Ringsdorff Carbon Corp., Dept. ED, East McKeesport, Pa.

Compact Timer 491

For complex programing. The timer combines a 115-v ac, 400-cps, synchronous motor with a 28-v dc magnetic clutch to provide two or more fixed or adjustable timing sequences with automatic reset. It is designed to withstand 15-g shock and is sealed for environmental protection. Weight is 2.75 lb; dimensions are 3-21/32 x 3-13/32 x 3-1/2 in.

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

Power Resistors 509

With ±10 ppm per deg C temperature coefficient from −55 to +350 C. Code C-10 power resistors have inductive or non-inductive windings, power ratings of 1/2 to 10 w, resistances of 25 ohms to 275 K and tolerances to ±0.05%.

Omtronics Manufacturing, Inc., Dept. ED, P. O. Box 1419, Peony Park Station, Omaha 14, Nebr.

***P&A:** $0.70 to $3; 1 to 3 weeks.*

Printed-Circuit Chassis 513

Holds up to 30 cards. Rack mounting combination printed-circuit card file and chassis consists of one to three files with chassis plate for power supply or up to four files without chassis plate. It can be furnished in steel or aluminum, 9 to 24 in. deep in 1-in. increments. Panel height is 5-1/4 to 19-1/4 in. in 1-3/4 in. increments.

Western Devices, Inc., Dept. ED, 600 W. Florence Ave., Inglewood 1, Calif.

***P&A:** $50 to $250; 14 days.*

Clock Pulse Generator 531

For 5-mc operation. type 2011 CL Logix Block clock pulse generator is a variable frequency oscillator. Repetition rate is 0.2 to 250 μsec with frequency variations of 5 mc to 4 kc. Continuous frequency variation is by means of three capacitors located on the module and an external potentiometer.

Rese Engineering, Inc., Dept. ED, A and Courtland Streets, Philadelphia 20, Pa.

DC Power Supplies 487

Rated at 10 and 200 amp. Designed for electrolytic plating, these power supplies have 2% voltage accuracy and Powerstat voltage control. Voltage outputs are from 6 to 15 v. Components are rated for long life.

Gates Electronics Co., Dept. ED, 2243 White Plains Road, New York, N. Y.

***P&A:** $75 to $210; stock.*

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Mylar Capacitors 611

Rated from 1 to 50 kv, these dc mylar capacitors exceed MIL-C-25A-E specifications. Designed for 10,000-hr life at 65 C, they operate between −60 and +105 C. Units are said to be small and lightweight, and have footed brackets. Three-layer dielectric is employed.

Corson Electric Manufacturing Co., Dept. ED, 540 39th St., Union City, N. J.

Electrostatic Printing Tube 441

A 250,000 element per sq. in. mosaic is provided on the face of the type B3C2 Printapix electrostatic printing tube. The direct-writing cathode-ray tube prints alpha-numeric characters on nonsensitized paper at rates of 100,000 per sec. Precharged pigment powder adheres to electrostatic charges on paper.

Litton Industries, Electron Tube Div., Dept. ED, 960 Industrial Road, San Carlos, Calif.

Magnetostrictive Delay Lines 440

A 5-msec delay with a bit rate of 500 kc is offered by the type FM 200-5000 Magline series magnetostrictive delay lines. Unit includes transistorized circuitry providing zero insertion loss and output pulse identical to input. Limiting action in apmlifier removes noise from the signal. Device measures 10-1/2 x 11-1/2 x 1 in.

Control Electronics, Inc., Dept. ED, 10 Stepar Place, Huntington Station, L.I., N.Y.

RF Connectors 685

Subminiature 50-ohm coaxial rf connectors of the 1000 series have no flashover at 70,000 ft at 1 kv, and operate at 200 C for long periods. Cable pull-out resistance of the small, lightweight devices is 30 lb min.

Micon, Inc., Dept. ED, Roosevelt Field, Garden City, N. Y.

***Availability:** stock to 30 days.*

NEW PRODUCTS

Printed-Circuit Connectors 684

Bifurcated, bellows-type printed circuit connectors provide constant contact under extremes of shock and vibration. Single- and double-row connectors in various multiples up to 130 contacts are standard.

Masterite Industries, Dept. ED, 851 W. Olive St., Inglewood, Calif.

Availability: *stock.*

Digital Voltmeter 691

Solid-state switching logic in voltmeter/ratiometer 848 eliminates contact maintenance problems. Three-position tilting readout shows four decimal digits, polarity sign, and decimal point. Average balance time is 50 msec.

Electro Instruments, Inc., Dept. ED, 8611 Balboa Ave., San Diego 11, Calif.

Rate Gyro 686

Self-checking rate gyro JRS incorporates a spin motor running detector which indicates wheel speed, and a gimbal torquer which checks gimbal operation and pick-off sensitivity. Checking circuits are completely isolated from operational circuits. The 2.2-lb gyro measures 2.1 in. OD, 4.6 in. long. Linearity is 0.25% of full-scale max. Gyro withstands 100-g shock and 40-g vibration.

Minneapolis-Honeywell, Boston Div., Dept. ED, 1400 Soldiers Field Road, Boston, Mass.

Availability: *120 days.*

NEW PRODUCTS

Ratiometer 687

Complex voltage ratiometer model 551 makes ac measurements of magnitude and phase angle, as well as in-phase and quadrature components. Ratio reference for in-phase measurements is provided by an inductive divider having an accuracy of one ppm. An attenuating network of dual scale mechanism allows direct reading of phase angles of all input voltages and ratios.

North Atlantic Industries, Inc., Dept. ED, Plainview, N. Y.

Photoconductors 678

Cadmium sulfide photoconductors are made for commercial and industrial applications. Units are vacuum-sealed for protection against environmental contamination. Applications include automatic TV contrast control, and on-off control of oil burners.

Sylvania Electric Products Inc., Dept. ED, 1100 Main St., Buffalo 9, N. Y.

Silicon Rectifiers 679

Compact line of silicon rectifiers provides cabinet size reduction of 45%. Units are available in capacities of 1,000, 1,500, 2,000, 2,500 and 3,000 amp with a wide choice of control regulation.

Allied Research Products, Inc., Dept. ED, 4004-06 E. Monument St., Baltimore 5, Md.

Voltage Reference 690

Diffused-junction silicon voltage regulator DEC 5651 directly replaces the 5651 voltage reference vacuum tube. Housed in a molded epoxy package, the device provides an output of 87 v ±2%. Operating current is 1.5 to 3.5 ma.

Dickson Electronics Corp., Dept. ED, 248 Wells Fargo Ave., Scottsdale, Ariz.

Ampere-Hour Meter 689

Mercury microcoulombmeter provides direct reading of ampere hours on dc or pulsed dc with any waveform. Model 150E is housed in a plastic case with a 10-division scale; model 150, element alone, measures 1-1/2 in. long by 0.050 in. OD.

Curtis Instruments, Inc., Dept. ED, 45 Kisco Ave., Mount Kisco, N. Y.

***P&A:** model 150, $5; 150E, $8; stock.*

Remote Terminating Amplifier 439

Low and high vhf remote terminating amplifier has adjustable tilt. With a gain of 15 db in the 54- to 88-mc band, and 22 db in the 174- to 216-mc band, the model LHT-6204 amplifier has input and output impedances of 75 ohms. Gain can be controlled over 10 db. Unit has a regulated power supply which operates from 40 to 60 v ac.

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

AC/DC Digital Voltmeter 677

Accurate within 0.1%. Digital voltmeter model 502B measures dc from $\pm 100\ \mu v$ to ± 1 kv, ac from 30 cps to 10 kc between 1 mv and 1 kv. Measurements are accurate within 0.01% of reading ± 1 digit on dc, 0.1% of reading or ± 3 digits on ac. Voltmeter is controllable by remote contact closures.

Kin Tel Div., Cohu Electronics, Inc., Dept. ED, 5725 Kearny Villa Road, San Diego 11, Calif.

***P&A:** $4,245; delivery from stock.*

Telemetering Filters 693

Low-distortion telemetering filters are available for all standard frequencies from 400 cps to 70 kc. The Perma-D series uses standard mechanical packages. Delay distortion is less than 6%. Filters are made for vacuum-tube and transistor equipment.

Hisonic, Inc., Dept. ED, P. O. Box 534, Shawnee, Kan.

NEW PRODUCTS

Film Trimmer 695

Operates to 150 C. Trimmer potentiometers use element of fused oxide deposited on a glass substrate. Temperature coefficient is 50 ppm per deg C. The stepless devices operate from −65 to +150 C, and withstand 30-g shock and 20-g vibration from 20 to 2,000 cps.

Intellux, Inc., Dept. ED, 30 Salsipuedes St., Santa Barbara, Calif.

Pulse Amplifier 692

Capacity driver T-165, a 250-kc pulse amplifier, will drive up to 75 shift register elements or up to 150 flip-flops at temperatures below +45 C. Container measures 7/8 in. OD by 2-3/16 in. seated height and plugs into a standard 9-pin miniature tube socket.

Engineered Electronics Co., Dept. ED, 1441 E. Chestnut Ave., Santa Ana, Calif.

P&A: *$45.85; stock.*

Ratio Analyzer 694

Output-to-input ratio analyzer RA01-0101-1 is useful in checking calibration of accelerometers, rate gyros, and other devices with potentiometer pickoff. With two operating ranges of 1 K to 10 K and 5 K up, the device has an overall accuracy of 0.10%.

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

Wideband Amplifier 651

Flat from 1 to 100 mc within 1 db, the model WB-100 wideband amplifier is completely transistorized. Gain is 20 db min. Input and output impedances are 50 ohms at 30 mc. Output voltage is 70.5 mv peak. Noise figure is 8 db. The device, said to be lightweight and rugged, measures 6 x 2 x 1-5/8 in. Power requirements are +3 and −15 v dc.

Teltronics, Inc., Dept. ED, 23-27 Main St., Nashua, N. H.

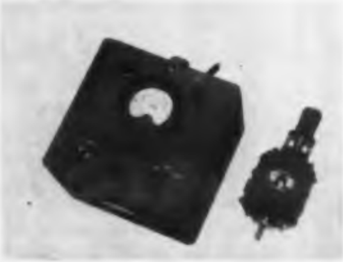
P&A: *$200.00; two weeks.*

Miniature Transformers 698

Military and industrial specifications are met by this line of transformers for pulse and other applications. Included are balanced, four-winding designs for differential input parallel circuit isolation. Custom types are also made.

James Electronics, Inc., Dept. ED, 4050 N. Rockwell St., Chicago 18, Ill.

Motor Control 652

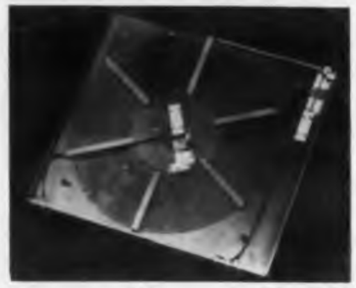


For driving a 1/20 hp motor directly from a 60-cps line, the model 309-A motor control is a solid-state device. Shaft speed range is from 100 to 5,000 rpm, with a maximum load torque of 10 oz at any speed. Speed remains constant within 2% over load range. Power drain is 150 w max.

Industrial Control Co., Dept. ED, Central Ave. at Pinelawn, Farmingdale, L. I., N. Y.

NEW PRODUCTS

Delay Line 589



Suitable for commercial and less severe military environments, fixed magnetostrictive delay line L40 provides delays from 2,500 to 3,500 or 5,000 μsec. Delay adjustment range is ±4 μsec from specified delay. Measuring 12-7/8 x 11-5/8 x 13/32 in., package weighs 1-3/4 lb. Digit rate in nrz recording can reach 2 mc.

Ferranti Electric Inc., Electronics Div., Dept. ED, Industrial Park No. 1, Plainview, N. Y.

Digital Voltmeter 604

Automatic ranging and polarity, 500-msec balance time, and silent reed relays have been combined in digital voltmeter model V-71. Range is 1 mv to 999.9 v, accuracy 0.01%, ±1 digit. Weight is 28 lb, panel height 5-1/4 in.

Cubic Corp., Dept. ED, 5575 Kearny Villa Road, San Diego 11, Calif.

AC Standby Supply 581

Static standby ac power supply provides 60-cps power when the line supply fails. Response is instantaneous. Input is 115/220/-440 v, 3-phase, 60 cps; battery voltage is 43 to 56 v dc. Output is 2.5 kva, 1 phase, 115 ±0.5 v, 60 cps ±1%. Efficiency is 80% at full load.

Tapco Div., Thompson Ramo Wooldridge Inc., Dept. ED, 23555 Euclid Ave., Cleveland 17, Ohio.

◄ CIRCLE 86 ON READER-SERVICE CARD

Interlock Relays 590

Mechanical interlock relay SIL holds an armature operated indefinitely after the coil is deenergized. The shock- and vibration-resistant relay is available with coils for a number of dc voltages up to 110 v plus dioderectified 110 v ac. Electrical interlock relay SEL is wired so that both coils are controlled by pulsing over a single lead. Free of mechanical wear, life expectancy is 30 million operations. The SEL is available with coil ratings up to 60 v dc.

Automatic Electric Sales Corp., Dept. ED, Northlake, Ill.

Molding Compound 603

Polyurethane-based molding and encapsulating compound 783 operates from −65 to +300 F. The material has Shore hardness of 65 ±5, tensile strength of 2,500 to 3,500 psi, and 600% elongation.

Coast Pro-Seal & Manufacturing Co., Dept. ED, 2235 Beverly Blvd., Los Angeles 57, Calif.

Temperature Chamber 576

Vacuum-pressure temperature chamber model ASU-40-3-HC provides a pressure range of 20 to 32 in. mercury, absolute, over temperatures from −40 to +200 F. It is designed for testing and calibrating pressure-indicating instruments. The stainless-steel chamber contains a working area of 3 cu ft.

Cincinnati Sub Zero Products, Dept. ED, 3932 Reading Road, Cincinnati 29, Ohio.

CIRCLE 241, 242 ON READER-SERVICE CARD ➤

Feedthrough Terminals 616

Teflon-insulated feedthrough terminals, type FT-SM-75L2, are made for equipment encountering vibration and high temperature. Units are of press-fit design. Height is 0.343 in.; over-all diameter is 0.172 in., and mounting bushing is 0.15 in. in diameter. Stud is of hole-through type with a turret. Temperatures from −65 to +200 C are withstood.

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

Coaxial Relay 697

High-power vacuum enclosed relays RC30 (spst) and RC31 (spdt) will handle 300 kw cw at 30 mc. Designed for remote switching of 6-in. coaxial lines, the T-configuration relays operate on 24 v dc and have a characteristic impedance of 50 ohms at 2 to 30 mc. Crosstalk is below 60 db at 30 mc.

Jennings Radio Manufacturing Corp., Dept. ED, P. O. Box 1278, San Jose, Calif.

Mylar Capacitors 688

High-voltage dc capacitors use mylar, kraft paper, and polybutene oil dielectrics. Fifteen ranges are made from 1 to 50 kv. Usable from −60 to +105 C, units surpass requirements of MIL-C-25A.

Corson Electric Manufacturing Corp., Dept. ED, 540 39th St., Union City, N. J.

Heat Sinks 696

Transistor heat dissipators stock-mount on insulators and allow direct heat-contact with the transistor. Three-inch lengths with four of the common hole patterns are available from stock. Model HS 201 will accommodate 85% of power transistors in use.

Invar Electronics Corp., Dept. ED, 1723 Cloverfield Blvd., Santa Monica, Calif.
***Price:** $0.70 to $1.60.*

Information Logger 683

Multi-channel information logger model 1043 accepts bipolar analog signal inputs, which are converted to digital words. Data from 30 channels are sampled sequentially with an over-all multiplexing and conversion accuracy of 0.1%. Output is recorded on paper or magnetic tape.

Lockheed Electronics Co., Dept. ED, Plainfield, N. J.

Carrier Failure Alarm 606

For frequency-shift communications equipment, the type 256 carrier failure alarm lights a panel lamp and actuates a relay upon any signal failure. Gradual deterioration is also detected; threshold level can be preset to desired level. Unit, transistorized, measures 7/8 x 5-1/4 x 11-3/4 in.

Northern Radio Co., Dept. ED, 147 W. 22 St., New York, N. Y.

NEW PRODUCTS

Protective Network 644

Rated at 125-v, 2-amp dc, this solid-state protective network protects against inductive spikes and transients up to 1,500 v peak. Temperature range is −65 to +150 C. Device is a miniature single-phase, full-wave bridge using diffused silicon rectifiers.

Solitron Devices, Inc., Dept. ED, 500 Livingston St., Norwood, N. J.

Availability: *from stock.*

Cable Clamps 377

For cord, cables and tubing. Type NE clamp is made of aluminum with a flame- and oil-resistant neoprene cushion to prevent cutting and scraping of cable insulation. Clamps are available in sizes for 1/8-in. to 2-in. cable in 1/16-in. increments.

Richco Plastic Co., Dept. ED, 3722 W. North Ave., Chicago 47, Ill.

Solid-State Switch 643

Handling 20 amp at 125 v ac, the model LJ-1105-AC solid-state switch measures 1 x 2-1/4 x 3/4 in. and weighs 2.5 oz. Unit requires no external power, does not arc or spark, and is said to have noise-free operation.

L J Products, Dept. ED, 7464 Girard Ave., La Jolla, Calif.

Availability: *stock to two weeks.*

Servo Amplifier 650

Less than 0.1 μ**a input** is required per volt output with the model 1160-4 servo amplifier. The device, transistorized, is made for use with size 11 servo motors, and has a low input impedance. The amplifier, with power output stage and gain control, is mounted on a printed circuit card measuring 4-5/8 x 3-7/8 in.

Magnetic Instruments Co., Inc., Dept. ED, Thornwood, N. Y.
P&A: *$75.00; from stock in small quantities.*

Static Converter 639

Provides up to 10 kv. Small, efficient static converter model MC provides outputs from 0.5 to 10 kv dc in 12 standard models. Input is 24 to 30 v dc, 250 ma. Output power is 3 w, ripple 0.3% rms. Efficiency is 50% at 3 w, 30% at 1.5 w. The 12-oz unit measures 1-1/2 x 3-1/4 x 2-1/4 in.

Arnold Magnetics Corp., Dept. ED, 6050 W. Jefferson Blvd., Los Angeles 16, Calif.

Multiple Diode 628

Twin and triple diodes, housed in TO-33 packages, simplify logic network construction. Types 2DG-001 and 3DG001 combine germanium diodes having these characteristics: forward voltage drop at 5 ma, 0.4 v max; reverse breakdown voltage of 20 v; reverse current of 15 μa max at -2 v, junction temperature; recovery time, 0.25 μsec; temperature range, -65 to $+85$ C.

Radio Corp. of America, Semiconductor & Materials Div., Dept. ED, Somerville, N. J.

CIRCLE 91 ON READER-SERVICE CARD ➤

PAKTRON MASTERPIECE MINIATURE CAPACITOR!

1—**TEMPERATURE RANGE:** −55°C to 125°C derating above 85°C to 50% at 125°C.

2—**TEMPERATURE STABILITY:** Capacitance change less than 2.5%, 25°C–85°C.

3—**INSULATION RESISTANCE:** Exceeds 5 x 10^{10} at 25°C.

4—**DISSIPATION FACTOR:** Less than .003 at 1000 cycles, 25°C.

5—**DIELECTRIC STRENGTH:** Pretested at 250% of rated voltage.

6—**MOISTURE RESISTANCE:** I.R. exceeds 10^{10} ohms after 24 hours exposure to 15 PSI steam pressure.

7—**LIFE TEST:** 150% rated voltage at 125°C for 250 hours.

PAKTRON

PACKAGED ELECTRONICS

itw DIVISION OF ILLINOIS TOOL WORKS

1321 LESLIE AVENUE ALEXANDRIA, VA.

CIRCLE 92 ON READER-SERVICE CARD

NEW PRODUCTS

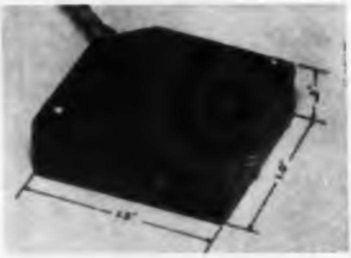
Pulser 642

Balance-wheel regulated transistorized pulser, model E-59, has a 2.5-sec accuracy per 24 hr. Pulse rate is from 4 to 10 pps, with typical output square wave form, +6 v, 5 msec on, 95 msec off. Unit requires 1.5 to 12 v, 0.3 ma power. Device measures 2-1/16 x 1-21/32 x 1-1/32 in. Other models with flip-flop circuits have longer pulse rates.

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

***P&A:** $10 to $12; stock to four weeks.*

Temperature-Sensitive Resistor 610

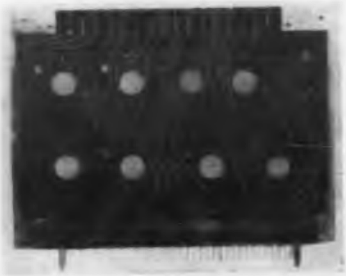


Temperature coefficient is adjustable on the model 7610 Temp-A-Just resistor. Standard resistance values from 100 ohms to 5 K have temperature coefficient variable between 10 and 4,500 ppm per C. Units, hermetically sealed, measure 1 x 1 x 0.3 in. and weigh 11 g. Temperature range is −55 to +150 C. Units compensate for temperature-sensitive components.

Conrad-Carson Electronics, Inc., Dept. ED, 1347 Broadway, El Cajon, Calif.

***Price:** $8.75.*

Logic Inverter Package 647



Transistorized logic inverter package contains eight inverters in a volume less than 5 x 4 x 1 in. Designated model I-141-DC, the device has a frequency range to 1 mc. Logic levels are 0 to −5 v.

Digital Design Corp., Dept. ED, P. O. Box 21, Clay, N. Y.

***P&A:** $94.00; stock to six weeks.*

Feedthrough Capacitor 387

Shielding from uhf and vhf radiation is provided by the type 1107 ceramic disk feedthrough capacitor. Resonant frequency is higher than 1 Gc. Capacities from 5 to 1,000 pf at 500 wvdc are available.

Hi-Q Div., Aerovox Corp., Dept. ED, Myrtle Beach, S. C.

Axial Blower 646

Measuring 3.44 in. sq, this axial blower delivers 15 cu ft per min against 0.2 in. water pressure. Device operates at 3,600 rpm from 117-v, 60-cps, single-phase power. Unit meets MIL specs, and has a continuous-operation life of over 2,500 hr. Housing is cast aluminum. Device is 3.25 in. long and weighs 12 oz.

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

Ruggedized Image Orthicon Tubes 641

A 600-line resolution is achieved by this line of ruggedized image orthicon tubes, despite 1,000-cycle vibration and 44-g acceleration. Construction unites target and mesh, eliminating microphonic bars and related interference. Electron gun and multiplier unit are ruggedized. Type ZL-7805 tube has infared sensitivity; type ZL-7806 tube has sensitivity down to 10^{-6} ft-c; type ZL-7807 tube has high sensitivity and ultraviolet response. Military specs are met or exceeded.

General Electric Co., Cathode Ray Tube Dept., Dept. ED, Syracuse, N. Y.

***Availability:** In sample quantity.*

Load Cells 636

Up to 500,000-lb loads are measured by these load cells. Devices have resistance-wire strain gages which can be 50% overloaded without damage. Bridge impedance is 120 ohms. Typical input voltage is 10 v; output is 25 mv full scale. Linearity and hysteresis are within 0.2%. Temperatures from −300 to +750 F are withstood.

Microdot Inc., Dept. ED, 220 Calif.

Logic Modules 634

Transistorized logic modules are mounted on 4-1/2 x 6-1/2 in. plug-in cards. The series includes a basic active element, a clock oscillator and pulse amplifier, gates, flip-flops, delay lines, Nixie drivers, and blocking oscillators. Gates operate at 200-kc standard, 1-mc high speed. Power requirements are 1.5, ±15, and 45 v dc.

General Applied Science Laboratories, Inc., Dept. ED, Merrick and Stewart Ave., Westbury, N. Y.

Gas Detector 638

Sulfur hexafluoride in concentrations of one part per 10 million are detected and measured by this electronegative gas detector. Air samples are pumped to the instrument from a probe. Unit is transistorized.

Westinghouse Electric Co., Dept. ED, P. O. Box 2278, Pittsburgh 30, Pa.

CIRCLE 93 ON READER-SERVICE CARD ➤

NEARLY PERFECT SWITCH

(And we don't mean a shell game)

HERE ARE THE FACTS IN A NUTSHELL . . .

- High breakdown ratings — 50 to 80 volts
- Two point control of current/voltage offset parameters
- Matched pairs to standard tolerance of 100 μv
- 10 million-to-1 minimum "off" to "on" resistance ratio
- Typically 30,000 megohms reverse resistance
- Typically 50 ohms forward resistance
- High temperature stability
- Unlimited quantities available
- Available from local Sperry Authorized Distributors

Don't gamble — you put your experience on the line when specifying for analog computers, D.C. amplifiers, electronic commutators and multiplex equipment.

Sperry now offers you a complete series of silicon transistors for single use or matched pairs that have the best combination of chopper characteristics — plus an extra margin of safety which provides true design flexibility.

Type Number	BV_{CEO} (Volts)	BV_{CES} (Volts)	BV_{EBO} (Volts)	V_{EC} (max) Offset Voltage (mV)	I_{EC} (max) Offset Current (mμA)	Price 1 — 99	PRICE 100 — 999
2N1917	—8	—25	—25	1.0	1.0	$ 9.75	**$7.50**
2N1918	—8	—25	—25	3.0	3.0	7.80	**6.00**
2N1919	—18	—40	—40	2.0	1.0	12.35	**9.50**
2N1920	—18	—40	—40	3.0	1.5	8.77	**6.75**
2N1921	—50	—50	—50	4.0	2.0	5.20	**4.00**
2N1922	—80	—80	—80	4.0	2.0	6.50	**5.00**

Write for 16 page Technical Application Bulletin #2107 and new Chopper transistor data sheets on types 2N1917 through 2N1922.

SEMICONDUCTOR IS OUR MIDDLE NAME . . . SEMICONDUCTOR INTEGRATED NETWORKS (SEMI-NETS*). TUNNEL DIODES. MESA AND ALLOY SILICON TRANSISTORS AND DIODES

SALES OFFICES: CHICAGO, ILLINOIS; EL SEGUNDO, CALIFORNIA; WESTWOOD, NEW JERSEY; TEWKSBURY, MASSACHUSETTS; STAMFORD, CONNECTICUT; TOWSON, MARYLAND; MASSAPEQUA PARK, NEW YORK.

SEMICONDUCTOR OPPORTUNITIES AVAILABLE TO QUALIFIED ENGINEERS

*Trade Mark, Sperry Rand Corporation

ELECTRONIC
BUTT WELDER

DELIVERS ACCURATE, REPEATABLE END TO END WELDS OF WIRE RANGING FROM .008" TO .040"

Built to handle continuous production line runs, this unit is equally at home on any number of special butt weld situations. For example, use the 1040 to lengthen leads for circuit convenience; salvage short lead components; switch component lead materials; weld different materials for circuit design and convenience. Force setting of up to 10 lbs. and power range of up to 80 watt-seconds allows wide latitude in materials. Easy to operate. Full compliance raceways assure consistent in-line abutment of the workpieces while automatic wire length stops facilitate rapid loading and positioning of parts. Immediate delivery. Ask your local Weldmatic representative for details, or write to us for Bulletin 1040 at 950 Royal Oaks Drive, Monrovia, California.

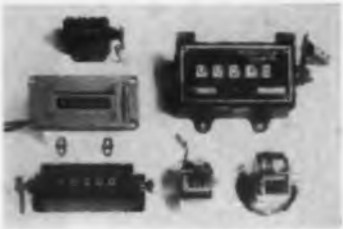
W61-6

WELDMATIC DIVISION / UNITEK

CIRCLE 94 ON READER-SERVICE CARD

NEW PRODUCTS

Counters 645



Rated at 700 strokes per min, these counters are for light and medium duty. Model HL-5 is for light applications. Model HE-6 is an electric counter for either base or panel mounting. Model HM-5 is a medium-duty counter for machine use. Model HT-4 is a hand tally, and model HD-4 is a desk tally. Model 5A is a heavy-duty industrial counter for machine applications.

Hart Manufacturing Co., Dept. ED, Ann Arbor, Mich.

Color-Striped Insulation 385

Silicone-rubber insulation is color striped for single and multiconductor hook-up wire and cable. Many color combinations are available. Ink will not rub off; insulation will not fray. Insulated wire in AWG sizes 24 through 10 are available.

Boston Insulated Wire and Cable Co., Dept. ED, 65 Bay St., Boston 25, Mass.

Power Supply 396

For semiconductor testing. Power supply model 511 supplies 0 to 50 v at up to 100 ma. Programing time is less than 50 msec. Drift is 0.015% per day at 50 v; load and line regulation are about 1 mv at 50 v. There are no voltage transients.

Walden Electronics Co., Dept. ED, 1 Park Ave., Arlington 74, Mass.

***P&A:** $400; 6 weeks.*

Miniature Flip-Flop 600

Passivated components, mounted on a ceramic substrate measuring 0.310 x 0.310 in., form a flip-flop operating at speeds in the nanosecond range. The components are unaffected by environmental extremes and have low failure rates. Circuits are produced on custom order.

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

Xenon Lamp 594

Point-source xenon lamp X-75 has an arc size of 0.015 x 0.015 in. White light has an average brightness of 80,000 candles per cm^2, color temperature of 6,200 K. Spectral output is 2,200 to beyond 14,000 angstroms. The 75-w lamp is 3 in. long, 1/2 in. in diameter.

PEK Labs, Inc., Dept. ED, 4024 Transport St., Palo Alto, Calif.

Rate Meter 591

Transistorized count rate meter CRM-593 operates with any detector. Aural and visual displays are presented. Meter has 1-mv input sensitivity and provides 3-kv supply. There are five count rate ranges to 100,000 cpm, and four probable error settings of 2, 5, 10 and 15% for each range. Recorder drive output is provided.

Technical Services Dept., Instrument and Control Div., Nuclear Corp. of America, Danville, Ill.

CIRCLE 96 ON READER-SERVICE CARD ➤

Multiplex Generator 378

Self-calibrating multiplex stereo signal generator, model SG-292, has control switches, output level control and meter, inputs for A and B signals, and SCA on the front panel.

Crosby-Teletronics, Inc., Dept. ED, Westbury, N. Y.

P&A: *$1,000; six to eight weeks.*

Signal Conditioner 394

Analog sensor module SAM-1 takes low-level signal inputs from strain-gage transducers and produces a proportional output voltage. Over-all stability is 0.02%, noise less than 5 μv, output up to 100 ma. Units are 4-1/4 in. wide, 7 in. high.

Allegany Instrument Co. Div. of Textron Electronics, Inc., 1091 Wills Mountain, Cumberland, Md.

P&A: *$1,750; 60 days.*

Antenna Standards 400

Operating from 10 kc to 300 mc, standard antenna set Model SA-301 permits laboratory standardization of field strength meters. Components furnished include all necessary loop and dipole antennas, baluns, tripods, precision meters, cables and other accessory items. When used with an rf signal source the set is complete with all items needed to perform calibration.

Empire Devices, Inc., Dept. ED, Amsterdam, N.Y.

...Specify Silicones

Flexible from -100 to 300F

Silastic®, the Dow Corning silicone rubber, is specified by Airtron, a division of Litton Industries, for the jacket of their silver-plated brass, and all-aluminum flexible wave-guide designed to resist operating temperatures from −100 to 300 F. With its Silastic jacket, Airtron's Flexaguide is particularly suited for applications in the missile field where environmental operating conditions are severe. In addition, the jacket supports the waveguide during flexure, insures airtightness for pressurized applications. Silastic resists a long list of environments including: cold, heat, ozone, oxygen, voltage stress, thermal cycling, corona, corrosive atmospheres, and weathering.

CIRCLE 773 ON READER SERVICE CARD

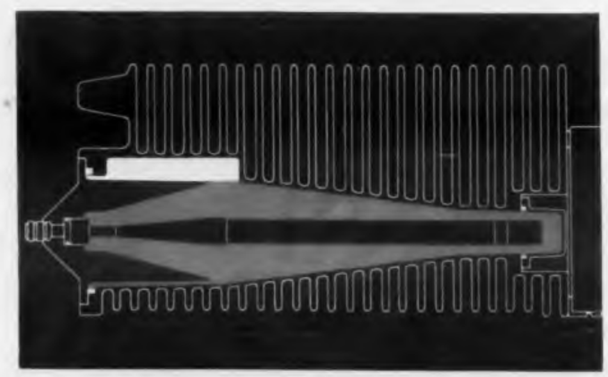
Rigid, Void-Free Protection

This induction heating coil is used to keep metal molten. Metal splatter caused frequent insulation and coil failure until the decision was made to encapsulate the unit in Dow Corning solventless silicone resin. The resin — with zirconium orthosilicate filler — forms a tough, rigid armor that withstands temperatures as high as 300 C indefinitely . . . much higher for short time periods. With no solvents to evaporate, the resin cures without voids. Note the excellent fill between plates of an encapsulated test capacitor.

CIRCLE 772 ON READER SERVICE CARD

For Rapid Heat Dissipation

Dow Corning silicone fluids are used as dielectric coolants for rapid heat dissipation because of their thermal stability and relatively flat viscosity-temperature curves. They can be pumped at high speeds without breakdown due to shear; maintain consistency from −65 to 250 C; and they will not oxidize or act as corrosives to metals even at high temperature. For these reasons and because of low vapor pressure, Sierra Electronics, Menlo Park, California specifies Dow Corning 200 Fluid as the heat transfer medium in their 100 and 500 watt, 60 ohm coaxial RF loads.



CIRCLE 771 ON READER SERVICE CARD

CORPORATION MIDLAND, MICHIGAN

branches: ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.

CIRCLE 770, 771, 772, 773 ON READER SERVICE CARD

Dual-Range Welder 395

Resistance welding power supply has two capacity ranges. Discharge time is about 1 msec. Repetition rate is 100 to 160 welds per min. Standard model 1039 and voltage-regulated model 1049 are bench-mounted. Watt-second meter, stepless heat selector, and watt-second range selector are provided.

Unitek Corp., Weldmatic Div., Dept. ED, 950 Royal Oaks Drive, Monrovia, Calif.

Cathode-Ray Tube 401

Has reduced spot size. Model M-1014P16 tube uses a bundle of 0.001 in. fibers set into a 5-in. aluminized screen in a panel measuring 5/8 x 3-1/2 in., providing 625 vertical light dots by 3,500 horizontal light dots or lines. It uses electrostatic focus and magnetic deflection with a 40-deg deflection angle to minimize deflection defocusing and provide high corner resolution.

Electronic Tube Corp., Dept. ED, 1200 E. Mermaid Lane, Philadelphia 18, Pa.

Tantalum Capacitor 399

Wet-anode capacitor exceeds the requirements of MIL-C-3965-B. Type-Q units are available in standard capacitance tolerances of ±10, ±20, and +50, −15%. Devices are supplied in three case sizes with capacitance values ranging from 1.7 to 330 μf. Standard life expectancy is 3,000 hr. Special types offer 10,000-hr service.

ITT Components Div. of International Telephone and Telegraph Corp., Dept. ED, Palo Alto, Calif.

NEW PRODUCTS

AC Power Recorder 575

For aircraft applications. Dual-channel, ac power recorder has a standard rating of 120 v at 60 cps; other ratings can be furnished. Channel 1 has a scale of 0 to 5 amp; channel 2, 100 to 140 v, 200 to 280 v or 400 to 560 v. Frequency response is 25 to 500 cps.

Rustrak Instrument Co., Dept. ED, 130 Silver St., Manchester, N. H.

***Price:** $149.50.*

Data Gathering System 637

Portable data gathering system, model S-3100, weighs 130 lb. Instrument is packaged in two aluminum carrying cases. Up to 100 analog voltage inputs are accepted and recorded in digital format without intermediate transcription. Unit, transistorized, is available with a variety of sampling rates and digital outputs.

Epsco, Inc., Dept. ED, 275 Massachusetts Ave., Cambridge, Mass.

Delay Line 599

Magnetostrictive delay line 6106 is made for space applications. A storage capacity of up to 10,000 bits at a 2-mc digit rate is provided in a volume of 62 cu in., weight of 14 oz. Up to 5,000 μsec delay is possible. Signal-to-noise ratio is 20:1.

Ferranti Electric Inc., Electronics Div., Dept. ED, Industrial Park No. 1, Plainview, N. Y.

◄ CIRCLE 97 ON READER-SERVICE CARD

Power Supply 586

For solid-state computers. Operating from ac line, 100 to 125 v, solid-state power supply provides four channels of dc power: +15 v dc, −15 v dc, +6 v dc, and −6 v dc. Regulation on all outputs is held to ±2% under maximum line, load, and temperature change. Ripple is 5 mv peak-to-peak; efficiency is 50% min.

Magnetic Research Corp., Dept. ED, 3160 W. El Segundo Blvd., Hawthorne, Calif.

Computer Tape 635

For photoelectric and electromechanical readers, this opaque computer tape is mylar-reinforced. Thickness from 0.002 to 0.0045 in. provides up to 2,700 ft on a 10-in. reel. Made for high-speed readers, tape is able to withstand thousands of readings without elongation of holes.

Arvey Corp., Dept. ED, 3500 N. Kimball Ave., Chicago 18, Ill.
Price: *$9.00 to $15.00 per 500-ft reel.*

Temperature Transducers 595

One-piece stainless steel temperature transducers are made for use in almost any environment in ranges covering from −452 to +1,750 F. Accuracy is 0.1% of range, 0.01% on special order. Response is fast, linearity high, hysteresis low. Units withstand shock of 100 g for 11 msec, pressure from 0 to 5,000 psi, vibration of 20 g to 2 kc.

Temtro, Inc., Dept. ED, 3016-C S. Halladay, Santa Ana, Calif.

NEW PRODUCTS

Power Supply 402

Current-regulated power supply model 254 provides 65 to 105 v dc from 1.5 to 7.5 amp, or 65 to 110 v dc from 1.5 to 6.0 amp. Ripple is 0.5% peak-to-peak, current regulation ±1% line or load. Space is provided for internal mounting of a traveling-wave tube and its focusing solenoid.

Alfred Electronics, Dept. ED, 897 Commercial St., Palo Alto, Calif.

P&A: *$490; from stock.*

Silicon Rectifiers 420

High-voltage rectifiers CR-101 through CR-110 have piv ratings from 1,200 to 10,000 v, average current ratings from 550 to 825 ma at 60 C. Ambient temperature range is −65 to +125 C. Maximum forward voltage drop is 1.2 to 9.6 v.

Radio Corp. of America, Semiconductor and Materials Div., Dept. ED, Somerville, N. J.

Nickel Sulphate Hexadrate 422

Single crystals of nickel sulphate hexadrate are suitable for application as windows in the infrared region. The solution-grown crystals range in size from 25 to 200 g and up.

Semi-Elements, Inc., Dept. ED, Saxonburg Blvd., Saxonburg, Pa.

P&A: *$0.50 to $1.25 per g; immediate.*

Strain-Gage Plotter 403

With computer entry capability. Strain-gage recording and plotting system, with digital output, uses 10 input conditioning modules of 10 channels each. Fixed data may be entered via a parameter board. Output is both a typewritten log sheet and punched paper tape for computer entry.

B & F Instruments, Inc., Dept. ED, 3644 N. Lawrence St., Philadelphia 40, Pa.

FOR THE HOTTEST JOBS

P.R. MALLORY & CO. Inc.

MALLORY

CIRCLE 99 ON READER-SERVICE CARD

Resistance Box 397

Substitution box model 1702 permits rapid direct substitution of 36 different resistance values from 15 ohms to 10 meg. The power dissipation of all resistors is 1 w.

Precision Apparatus Co., Inc., Dept. ED, Glendale 27, N.Y.
Price: $15.95.

Line Extender Amplifier 438

For both low and high band vhf operation the model ABX-40R line extender has a gain of 38 db. Operating from 54 to 88 mc, and from 174 to 216 mc, the instrument is flat within 0.75 db and has an 8.5-db noise figure. Bands have separate gain controls. Device has a regulated power supply, and is stable within 0.2 db for 20% line variation.

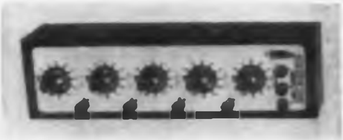
Entron, Inc., Dept. ED, P. O. Box 287, Bladensburg, Md.

Two-Pen Recorder 681

Accurate to ±0.20%. Two-pen strip chart recorder model 83 provides six chart speeds from 2 to 60 in. per min, 15 voltage ranges from 0.5 mv to 20 v per in. with vernier control, chart roll actuator and pen lowering switch. Over-all accuracy is ±0.20% of full scale, and resettability is better than 0.1% of full scale. Paper transport takes 9-1/2-in. by 120-ft chart rolls.

F. L. Moseley Co., Dept. ED, 409 N. Fair Oaks Ave., Pasadena, Calif.

Decade Resistor/Divider 398



For use with bridges and in the determination of resistance values, model 1601 resistor/divider has five decades providing 0 to 111,110 ohms in steps of 1 ohm. Tolerance is ±5%. Four voltage divider posts permit use as a general purpose wide-range voltage divider and permit practical voltage ratios between 0.0001 and 1.0 (10,000 to 1).

Precision Apparatus Co., Inc., Dept. ED, Glendale 27, N.Y.
Price: $29.95.

NEW PRODUCTS

Gating Device 368

For silicon controlled rectifiers. The Siligate functions effectively with a single scr, two in full-wave, or two back-to-back for ac. It may be controlled by dc current, variable resistance, or directly by transistors. Capacity is 3 amp to 100 amp.

Dresser Electronics, HST Div., Dept. ED, 555 N. Fifth St., Garland, Tex.

Price: *$85 to $110.*

Ionization Equipment 522

Research ionizer model RG-3, with continuously variable output of either positive or negative ions, will provide up to one million ions per cc. Research ion counter model ICF-6 is a companion instrument for measuring positive or negative air ion concentrations. Recorder permits a continuous record of ion count.

Philco Corp., Industrial Products, Dept. ED 4700 Wissahickon Ave., Philadelphia 44, Pa

Slip Rings 423

Low-noise slip rings are made for space environments. The rings have low torque; light materials are used for minimum weight. Assemblies are available with up to several hundred circuits.

Slip Ring Co. of America, Dept. ED, 3612 W. Jefferson Blvd., Los Angeles 16, Calif.

Resistance Wire 369

Improved Neutroloy resistance wire, composed of 55/45 Cu/Ni, offers high resistivity in fine wire with a low temperature coefficient. It is suitable for precision wound and vitreous enamelled resistors. Wire withstands corrosion at operating temperatures under 1,000 F.

Molecu Wire Corp., Dept. ED, Eatontown-Freehold Pike, Scobeyville, N. J.

MICRO SWITCH Precision Switches

Save 50% on space. Indicator and switching unit are combined in one device to save panel space.

Start your panel design with the

Reliability, Styling and Flexibility of

MICRO SWITCH lighted push-button switches

The flexibility of MICRO SWITCH "Series 2" lighted push-button switches enables you to precisely tailor your control panel to your requirements. Hundreds of switch and indicator combinations can be assembled by simply snapping together the correct modular parts. Their clean, modern styling complements your panel design without dominating it. Most important, any of the 18 switch units you select has MICRO SWITCH reliability. That's why these "Series 2" switches serve on some of the most crucially important control panels in the world. Write for the colorful Catalog 67, or see the Yellow Pages for the nearby MICRO SWITCH Branch Office.

It's a snap! Modular parts snap together and then snap into panel slots without tools.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls, Limited, Toronto 17, Ontario

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MICRO SWITCH Precision Switches

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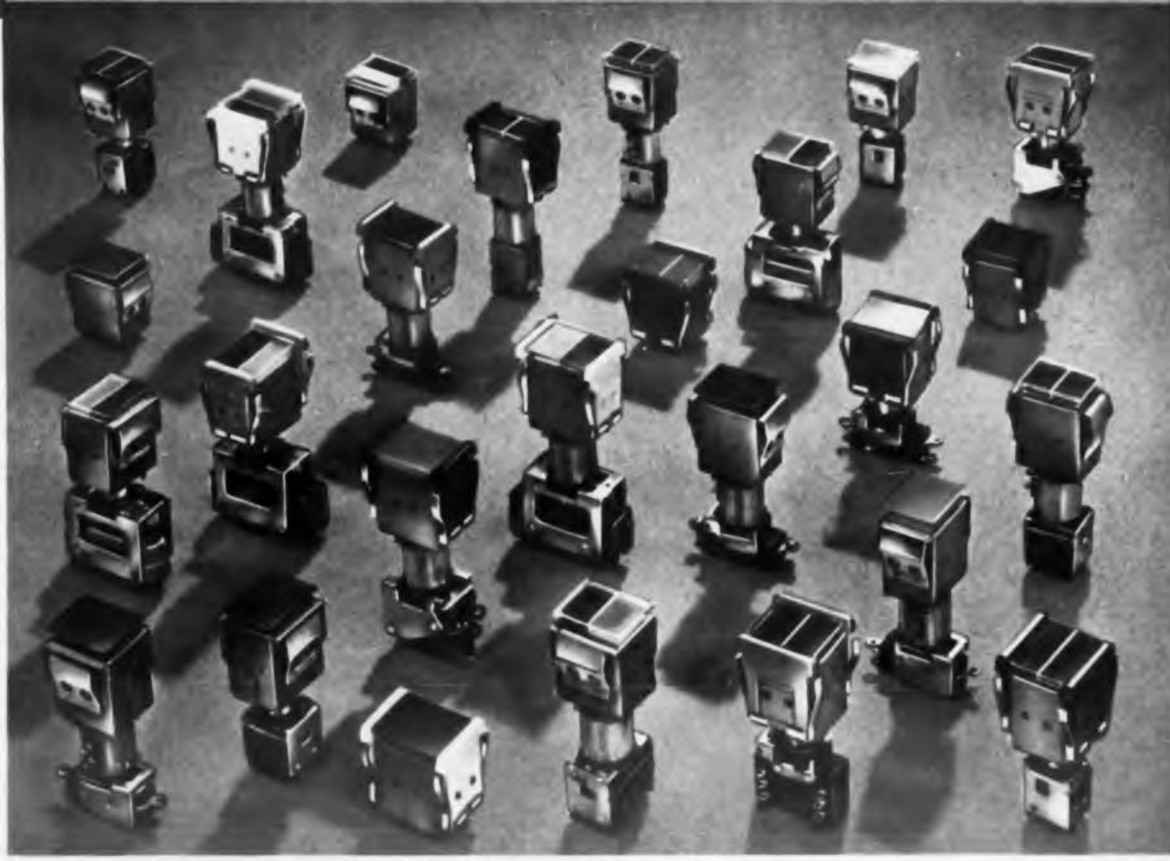
MICRO SWITCH Precision Switches



Eighteen different switching units are available to match virtually all circuitry requirements.

Hundreds of switch and indicator combinations ...with MICRO SWITCH reliability

The functional color combinations on "Series 2" switches can be split laterally or longitudinally. Up to four colors can be used behind each display screen. Projected color makes it possible for the display screen to change color to indicate a change in the circuit.

Available switching units include hermetically sealed units, small but rugged long-life types and space-saving subminiature assemblies. Momentary-contact or alternate-action units are available in a choice of circuitry to exactly match requirements. Insist on MICRO SWITCH reliability by specifying "Series 2" push-button switches for your panel. You may obtain prompt engineering help by simply checking the Yellow Pages for the MICRO SWITCH Branch Office. Send for Catalog 67.

MICRO SWITCH . . . FREEPORT, ILLINOIS
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HONEYWELL INTERNATIONAL
Sales and service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

Honeywell
MICRO SWITCH Precision Switches

Axial Fan 445

For spot cooling or chassis cooling in missile avionics and ground-support equipment, model F234-1 provides 100 cfm at 0.25 in. static pressure at 55,000 ft altitude; or 58 cfm at 1.0 in. static pressure at sea level. Weight is 0.72 lb. Size is 2-1/4 in. long by 3 in. in diameter at mounting rings.

Western Gear Corp., Dept. ED, 132 W. Colorado St., Pasadena, Calif.

Lighted Switch 682

Rated at 10 amp. Illuminated pushbutton switch provides momentary- or alternate-action control of two circuits. Rating is 10 amp at 125 or 250 v ac, 30 v dc; bulbs operate on 6, 12, or 28 v. Colored buttons are made in four sizes and shapes.

Micro Switch Div., Minneapolis-Honeywell Regulator Co., Dept. ED, Freeport, Ill.

Ferrite Cores 421

Toroidal ferrite cores 229M1 and 230M1 are made for use in coincident-current magnetic memory devices. Size is 0.050 x 0.030 x 0.015 in. The 229M1 has a switching time of 0.55 μsec at a driving current of 800 ma; the 230M1 switches in 1 μsec at a driving current of 440 ma.

Radio Corp. of America, Semiconductor and Materials Div., Dept. ED, Somerville, N. J.

Frequency Counter 444

Range is 0 to 220,000 pps, 1 to 220,000 cps. Frequency counter and preset translator model 740 offers direct conversion from frequency to physical units. Nixie readout is provided in 4, 5 or 6 decades. Accuracy is ±0.001% ±1 count. It is especially useful in flow rate measurement, linear velocity measurement, production monitoring and engine-turbine test and calibration.

Erie-Pacific, Div. of Erie Resistor Corp., Dept. ED, 12932 S. Weber Way, Hawthorne, Calif.

◄ CIRCLE 101 ON READER-SERVICE CARD

NEW PRODUCTS

Card Racks 360

Printed circuit card files, mounted in relay racks, hold 38, 30 or 23 cards. All hardware is provided. Height is 3-1/2 to 10-1/2 in., depth 4-5/8 to 14-7/8 in., in 1-3/4-in. increments. Material is 0.062-in. cadmium-plated steel.

Western Devices, Inc., Dept. ED, 600 W. Florence Ave., Inglewood 1, Calif.

***P&A:** $31 to $35; 10 to 14 days.*

Alumina Powder 370

Semiconductor-grade alumina powder is made for production polishing of Si and Ge wafers. Particle sizes of 1.0, 0.3, and 0.05 microns are made. Hardness is 8 or 9 mh.

Crystal Products Dept., Linde Co., Dept. ED, 4120 Kennedy Ave., East Chicago, Ind.

Audio Amplifier 365

Rated at 70 w. Power amplifier model 9 provides over 70 w at less than 0.1% distortion in most of the audio range, less than 0.5% at 20 kc. Intermodulation distortion is less than 0.5%, hum and noise 90 db down. A switch selects 40-w triode operation. Damping factor is 17, output impedance 1, 4, 8 and 16 ohms. Balance and bias adjustment is provided. Panel height is 8 3-4 in.

Marantz Co., Inc., Industrial Dept., Dept. ED, 25-14 Broadway, Long Island City 6, N. Y.

***Price:** $324 to $354.*

Pulse Tube 351

Warranted for 2,500 hr, pulse tube 7899 is a forced-air cooled triode designed for use as a hard tube modulator or pulsed rf amplifier. Plate dissipation is 7.5 kw, duty factor 0.025. Peak plate current is 85 amp max, dc plate voltage 20 kv max.

Amperex Electronic Corp., Power Tube Div., Dept. ED, 230 Duffy Ave., Hicksville, N. Y.

Temperature Control 472

Thermistor/thermocouple system A+540 combines continuous multipoint process temperature control with indication at a central point. Probes contain a thermistor and a thermocouple; thermistor connects to a transistorized controller, thermocouple to a potentiometric indicator.

Atkins Technical Inc., Dept. ED, 1276 W. Third St., Cleveland 13, Ohio.

VHF Preamplifier 366

Low-noise, broad-band vhf preamplifier VHA-2 has a pass band from 55 to 260 mc, a noise figure of 6 db max, and average gain of 16 db with ±1.5 db maximum ripple. Impedance is 50 ohms, input and output. Ambient temperature range is −25 F to +140 F. Unit is suitable for remote operation.

Applied Technology, Inc., Dept. ED, 930 Industrial Ave., Palo Alto, Calif.

***P&A:** $875; 60 days.*

Chart Recorder 627

Operates 50 days. Inkless event recorder 620, made with 10 and 20 channels, can operate more than 50 days without a change in charts. Available chart speeds range from 3/4 in. per hr to 6 in. per sec. Heated styli record on waxless chart paper.

Esterline Angus Instrument Co., Inc., Dept. ED, P. O. Box 596, Indianapolis 6, Ind.

***P&A:** $500 to $600; immediate.*

Elapsed Time Meter 640

Up to 10,000 hr in steps of 0.1 hr can be registered on the model H21M elapsed time meter. Power input is 110, 225, or 420 v, 50 or 60 cps. Meter is available either flushmounting with internally mounted motor, or panelmounting with external motor.

English Electric Co., Ltd., Dept. ED, English Electric House, Strand, London WC 2, England.

Miniature Photosensor 580

For displacement measurement. Photosensor MPS100 is useful in applications prohibiting mechanical loading and where a controlled-intensity spot may be used. It consists of a pair of silicon photodiodes; output is a differential voltage. With a tungsten source, light sensitivity is 250 mv at 50 mw per sq cm; light displacement sensitivity is 35 mv per mw per 0.001 in. with a 0.020-in. diam light spot.

Micro Systems, Inc., Dept. ED, 319 Agostino Road, San Gabriel, Calif.

***P&A:** $75 to $20; immediate.*

NEW PRODUCTS

Synchro Amplifier 425

Buffer amplifier 802-A will allow a small snychro transmitter to drive many synchro control transformers without loss of accuracy or excessive loading. Unit is transistorized and sealed. Three units are necessary for each buffer system. Unit is for synchro stators rated at 90 v per line.

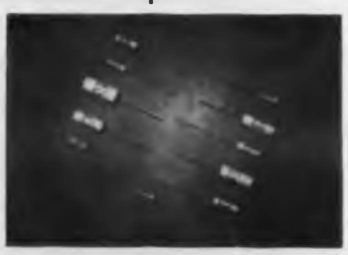
Industrial Control Co., Dept. ED, Central Ave. at Pinelawn, Farmingdale, Long Island, N. Y.

Amplifier-Ohmmeter 432

For industrial applications, this device has pre-amplifier capabilities and can convert a voltmeter to an ohmmeter. The instrument, designated Ampli-Ohm AO-45, can give a 1-mv instrument a sensitivity of 10 or 100 μv with a gain stability of 0.01% and a gain accuracy of $\pm$0.01% of full scale. It permits reading resistances with the Cubic V-45 voltmeter from 0.1 ohm to 10.999 meg.

Cubic Corp., Dept. ED, San Diego, Calif. ***Price:** $980.*

Film Dielectric Capacitors 384



For commercial applications, the series 64F Lectrofilm capacitors are said to be smaller, lighter, and more reliable than similar metal-clad units. Capacitances from 0.001 μf, 100 v, to 0.68 μf, 600 v, are available in 20% decades. Units operate at 85 C and are derated to 125 C.

General Electric Co., Capacitor Dept., Dept. ED, Hudson Falls, N. Y.
***Price:** $0.11 to $0.46 each.*

CIRCLE 105 ON READER-SERVICE CARD

Voltage Sensing Relay 426

Accuracy is within 2% on both high-and low-voltage limits for this solid state relay. It monitors high and low voltage on a go-no-go basis. Temperature range is 55 to 100 C. Size is 1-3/8 x 1 x 2 in. The meter relay will perform a safety function in the ground checkout of a ground-to-air missile system.

Guide Manufacturing Co., Dept. ED, 7602 San Fernando Road, Sun Valley, Calif.

Digital-to-Angle Converters 386

Relay-programed synchro standards, series A-203S-RC, serve as digital-to-angle converters and can be controlled from tape. Handling 50 signals per sec, devices have a response time of 10 msec. Settings are at increments of 5, 10 or 15 deg, accurate within 2 sec. Applications include radar, guidance and servo testing and checkout.

Astrosystems, Inc., Dept. ED, 220 E. 23rd St., New York 10, N. Y.
***P&A:** $850 to $3,600; 3 to 8 weeks.*

FM Demodulator 429

Dual co-channel reception with improved signal-to-noise ratio is possible with fm Demodulator type 310. This fm receiver modification unit can separate and demodulate interfering co-channel signals even if they have the same average frequency and peak deviation. Levels may differ by as much as 20 db.

General Electronic Laboratories, Inc., Dept. ED, 18 Ames St., Cambridge 39, Mass.
***P&A:** $3,500; six weeks.*

"nae" the mark of reliability

These two fingerprints may look alike but an expert can prove them to be as different as night and day.

Silicon rectifiers and regulators look alike on the surface, too, but their internal structure often differs. Those who *know* choose "nae" because this symbol on a semiconductor assures the utmost in performance and reliability

ZENER 1-WATT REGULATORS AVAILABLE IN EXTREMELY LOW VOLTAGES — 200°C STORAGE TESTED.

The "nae" mark on these constant voltage elements in the new compact flangless case means reliability in control and similar circuits. These quality semiconductors give excellent stability and regulation over a wide operating range, and can carry up to 500 ma. Hermetically sealed encapsulation, axial lead design and small size gives them long-term reliability under extreme environmental conditions. Try them and let us prove it.

SPECIFICATIONS

At 25°C and Test Current Listed

NAE & JETEC TYPE NO.	ZENER VOLTAGE Volts	TEST CURRENT Milliamperes	DYNAMIC IMPEDANCE OHMS
PRS3011	2.8	150	25
PRS3012	3.1	150	20
PRS3013	3.4	150	20
PRS3014	3.8	150	15
PRS3015	4.2	150	10
PRS3016	4.6	100	10
PRS3017	5.0	100	4
1N1765 thru 1N1802	5.6 to 200	100 to 5	1.2 to 1100

Write on your letterhead for specific information and sample of Zener type desired.

NAE makes Industry's most complete range of 1-watt Zener regulators.

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NORTH AMERICAN ELECTRONICS, INC.

71 Linden Street, West Lynn, Mass.

TWX Lynn, Mass 805U LYnn 8-4800 AFFILIATE OF IRC

CIRCLE 107 ON READER-SERVICE CARD

DETAIL OF METALIZED AREAS ON TERMINAL

NEW PRODUCTS

Reference Junction Compensator 648

Having all-welded components, the model CJ-1A reference junction compensator meets MIL-E-5272 environmental specifications. Long-term stability is $\pm 5\ \mu v$. Individual channels can be stacked for multiple-channel operation. Power consumption is 50 μw per channel. Units, epoxy-encapsulated, measure 1/2 x 1/4 x 3/4 in. and weigh less than 5 g. Standard units compensate for the chromel-alumel thermocouple curve.

G. B. S. Labs., Inc., Dept. ED, 18-06 126th St., College Point 56, N. Y.

Insulated Terminals 598

Teflon terminal types include miniature and subminiature standoffs and feed-throughs, receptacles, plugs, jacks, and probes. Terminals withstand temperatures from −100 to +250 C, and are made in a variety of colors.

Microdot Inc., Dept. ED, 200 Pasadena Ave., South Pasadena, Calif.

Ceramic-Metal Housings 629

Withstand 1,700 F. Made for packaging power and controlled rectifiers, ceramic-to-metal housings are capable of withstanding temperatures to 1,700 F. Shear strength is around 15,000 psi. Made of metallized alumina ceramic brazed to metal hardware, the devices offer a true hermetic seal.

Advanced Vacuum Products, Inc., Dept. ED, 430 Fairfield Ave., Stamford, Conn.

Transfer Voltmeter 632

Operates to 30 mc. Transfer voltmeter model 393 measures ac voltages up to 50 v, from 25 cps to 30 mc, in terms of a dc voltage. Accuracy of transfer is 0.1% from 25 cps to 10 mc, and 0.5% to 30 mc.

Ballantine Laboratories, Inc., Dept. ED, Boonton, N. J.

***P&A:** $950; August, 1961.*

Transistor Sockets 373

Teflon socket No. 69012-0623 accepts TO-8 rf power transistors. The three tubular contacts are beryllium copper, silver-plated and gold-flashed. Socket 69012-0528 is made for Fairchild micrologic elements. Material is Teflon TFE; there are eight tubular contacts. Sockets are mounted by compression. Other types are available.

Garlock Electronic Products, Dept. ED, Camden, N. J.

Two-Pin Connectors 353

Miniature connectors of series TM are made for cables with a common shield over a twisted pair, or for dual power leads. Saddle clamps are used for nonshielded wires; for shielded plugs, a collet clamp prevents rotation and increases retention by about 30 lb.

Cannon Electric Co., Dept. ED, 1943 Placenta Ave., Costa Mesa, Calif.

CIRCLE 109 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Electronic Timer 428

General purpose electronic timer is transistorized. Full-scale time ranges are 0.1, 1, 10 and 100 sec, with three models for choice of use as an interval timer, time delay relay or cycling timer. Repeat accuracy is 1% of full scale on all units. Load contacts are double-make double-break, rated at 25 amp, 120 v ac resistive or inductive. Designation is type 940.

Giannini Controls Corp., Cramer Div., Dept. ED, Centerbrook, Conn.

Frequency Detectors 467

Expanded scale and linear versions are available in the Statitak line of frequency detectors. Units provide frequency or speed indication with an accuracy of ±0.25% and a linearity of ±0.10%. Filtered outputs of 0 to 5 v correspond to frequency ranges of 0 to 600, 0 to 2,000 and 0 to 6,000 cps in the linear version, and ±1 v corresponds to ±20% deviation in the 60- and 400-cps expanded-scale version.

Crydom Laboratories, Inc., Dept. ED, 12850 Western Ave., Garden Grove, Calif.

***P&A:** $60 to $108 for prototypes; 14 days.*

Data Conversion System 431

10,000 conversions per sec can be achieved with the 7320 system which is for digitizing analog information for direct entry into computers. It can also be used to prepare digital magnetic tape in computer format. Conversion accuracy is ±0.05% or 1 mv, whichever is greater (±1/2 the least significant digit).

Monitor Systems Inc., Dept. ED, Fort Washington Industrial Park, Fort Washington, Pa.

NEW PRODUCTS

Fluorescent Lampholders 433

Rated at 75 w, 250 v, the bi-pin lampholder is made for T-5 fluorescent lamps. Designed for 4-, 6-, 8-, and 13-w lamps, it measures 23/32 x 19/32 x 3/8 in. in depth. Lampholders are furnished with 6-in. No. 18 AWG 105 C AWM plastic wire leads. Other lengths and wire types are available on request.

Circle F Manufacturing Co., Dept. ED, 720 Monmouth St., Trenton, N. J.

Copper Clad Laminate 471

Punching grade laminate has good flame retardancy and low water absorption. Identified as CuClad N-6009, this laminate combines the high electrical properties of regular XXXP copper-clad laminates with excellent punching and machining qualities. Designed for use in 105C Class applications.

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

***Price:** $0.84 per sq ft, for 500 sq ft or more; 1/16 in. thick with 1 oz copper on one side.*

DC Corona Tester 434

Voltage supply is 20 kv dc, corona-free. Model 5435 has a corona pickup filter network and detector. Voltage pattern of corona discharge is displayed on a built-in oscilloscope. A vacuum bell jar allows simulated high altitude testing of insulating materials, cables, components and assemblies. Output is metered in ranges of 0 to 5,000 and 0 to 20,000 v, and 0 to 50 to 500 and 0 to 5,000 ma leakage current.

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

AC Potentiometer 389

Ten-turn ac potentiometer, called size-9 Vernistat, has a 30,000-ohm input impedance, a 160-ohm output impedance, and a 0.2-mv per v quadrature at 400 cps. A tapped autotransformer is said to provide precise voltage ratios, linear to 0.05%. A precision potentiometer permits interpolation between tapped voltages. Unit is made for servo, computer, guidance, and fire-control systems.

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

Electron Beam Welder 470

Operating with 15,000 w, a wide range of spot sizes is available, from 0.020 to 2 in. Unit welds wafer-thin materials such as tungsten and molybdenum and their alloys, as well as ingots or compactions. Gun pressure of 0.05 microns can be sustained with chamber pressures as high as 10 to 25 microns. Chamber system can be evacuated to a pressure of 10^{-4} mm Hg for continuous welding.

Electro-Glass Laboratories, Inc., Dept. ED, Beaverton, Ore.

Millivolt Discriminators 424

For automatic testing, process control and other applications, models 710 and 711 are stable, light-modulator dc amplifiers operating a thyratron tube and relay. They are identical except for the means of adjusting the trip level from 0.2 to 10 mv. Uses also include go, no-go automatic control applications.

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

***P&A:** model 710 $450, model 711 $470; 60 days.*

WRAP-AROUND MAGNETIC SHIELDS

...APPLIED IN SECONDS

Economical CO-NETIC & NETIC Magnetic Shielding Foils

For Any Size or Shape Components

Netic and Co-Netic foils are universally used as an evaluation tool; ultimately, as a production solution. Available in continuous lengths on rolls up to 15" wide . . . for human production line or to fit automated existing reels of your tape serving machinery. Furnished in final annealed state ready for your operation.

HOW YOU SAVE SPACE, WEIGHT, TIME, MONEY

Minimum weight and displacement shielding designs are possible due to the magnetic shielding effectiveness of Co-Netic and Netic foils . . . foils can be supplied FROM .002", even thinner if you desire. Ordinary scissors cut foil easily to exact contour and size required. Foil can be wrapped quickly around hard-to-get-at components, saving valuable time, minimizing tooling costs.

HOW TO INCREASE RELIABILITY

Guard against performance degradation from unpredictable magnetic field conditions to which your equipment may be exposed. Eliminate such failure or erratic performance possibilities with dependable Co-Netic and Netic protection . . . assuring *performance repeatability* for your device over a *wider range* of magnetic field conditions.

Co-Netic and Netic alloys are not affected significantly by dropping, vibration or shock. They are characterized by low magnetic retention and do not require periodic annealing. When grounded, they effectively shield electrostatic as well as magnetic fields over a wide range of intensities.

Every satellite and virtually all guidance devices increase reliability with Netic and Co-Netic magnetic shielding alloys. Use these highly adaptable foils for saving valuable space, weight, time and money . . . in solving your magnetic shielding problems for military, commercial and laboratory applications.

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MAGNETIC SHIELD DIVISION

Perfection Mica Company

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ORIGINATORS OF PERMANENTLY EFFECTIVE NETIC CO-NETIC MAGNETIC SHIELDING

CIRCLE 115 ON READER-SERVICE CARD

NEW PRODUCTS

Power Supplies 354

Automatic overvoltage protection feature of 7500 series power supplies operates within 50 μsec, for internal or external malfunctions. Regulation is 0.01%, ripple 1 mv. Standard transistor models provide 0 to 36 v dc at up to 50 amp.

Systems Research Corp., Dept. ED, 7635 Tobias Ave., Van Nuys, Calif.

P&A: *$400 up; 4 to 6 weeks.*

Crimping Tool 357

Portable pneumatic crimping tool handles No. 20 through No. 12 contacts, producing a crimp equivalent to Class I, MIL-T-22520. The four-indent crimp assures positive mechanical and electrical connections. Magazine holds up to 102 contacts. Weight is 5 lb.

Corp., Dept. ED, Hillside, N.J.
Buchanan Electrical Products

Heading Indicator 355

Variation control indicator C-3335/AJN is a navigation aid made for military aircraft. Calibrated in degrees, the indicator converts magnetic heading to true heading. Size is 3-1/2 x 3-1/2 x 7-1/2 in. long. Unit conforms to MIL-T-5422C.

Temec, Inc., Dept. ED, 7833 Haskell Ave., Van Nuys, Calif.

High-Low Chamber 633

Cascade refrigeration system and resistance heating units provide temperature ranges from −100 to +350 and +500 F. Freon coolant is used. Test space sizes are 2, 3, 8, 27 and 64 cu ft. Interior sleeves and walls are of welded stainless steel.

Bemco Inc., Dept. ED, 9908 San Fernando Road, Pacoima, Calif.

P&A: *$1,925; 4 to 6 weeks.*

Encoder Readout Systems 371

Used with comparators, encoder readout systems have resolution of 1 part in 3 million. Encoder package measures 3-1/2 in. OD by 5-3/4 in. long. Storage and translation unit is rack-mounted. Outputs can be provided to operate an in-line readout, tape punch, data-logging typewriter, or other device.

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

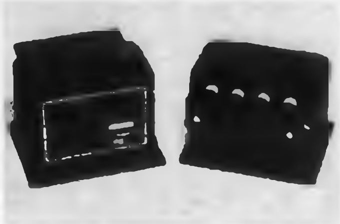
Crystal Oscillator 367

Transistorized, packaged crystal oscillator provides 1 v (into 1.5 K) at 1 mc for reference and time-base applications. Stability over 0 to 60 C is 1 in 10 million. Unit requires 27 v dc; ac or dc heater voltage is 115 v, model CCO-72SA, or 27 v, model CCO-72SD.

Bliley Electric Co., Dept. ED, Union Station Bldg., Erie, Pa.

Availability: *Immediate.*

Frequency Sensor 623



Static frequency sensing controller PA 2143 provides relay actuation at 310 $\pm$10 cps on increasing frequency, drop-out at 305 $\pm$5 cps on decreasing frequency. Input is 102 to 124 v rms line-to-neutral, three phase, four wire, 0 to 550 cps. Qualification testing includes operation to 125 C.

Power Instruments Corp., Dept. ED, 235 Oregon St., El Segundo, Calif.

***P&A:** $225; 3 weeks.*

Solid-State Generator 474

Weighing 1 g in size 2 (type 201) and 7 g in size 5 (type 501), solid-state generator produces a sine wave output as a function of shaft angle. Supply current is 10 to 200 ma continuous, ac or dc; output is 0.01 mv per ma. Operating temperature range is -55 to $+200$ C. Maximum speed is over 10,000 rpm.

The Omnite Co., Dept. ED, P. O. Box 491, Westminster, Calif.

Servo Potentiometers 592

Rated at 1 to 4.5 w, precision servo potentiometers can be ganged to at least five sections. All have anodized aluminum cases and servo mountings or standard bushings. Model 9, with ranges to 50 K, has linearity of $\pm$0.25%, rating of 1 w. The 2-w model 15 provides linearity of $\pm$0.1% in ranges to 250 K. Model 20, rated at 4.5 w, has ranges to 400 K, linearity tolerance of $\pm$0.1%.

Hoffman Electronics Corp., Dept. ED, 3761 S. Hill St., Los Angeles, Calif.

CIRCLE 116 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Linear Transducers 437

Designed for 400-cps operation, this line of universal linear displacement transducers can be used from 60 to 6,000 cps. Six models offer input voltages from 12 to 115 v with input impedances from 150 to 5,500 ohms. Outputs range from 10 to 35 v. Weight is 2-1/4 oz.

Dynamic Measurements Co., Dept. ED, Ter wood Road, Willow Grove, Pa.

Circuit Modules 376

Solid-state encapsulated circuits include flip-flops, gates, inverters, amplifiers, emitter followers and pulse generators. Switching speed is 500 kc. The nine-pin plug-in package measures 0.75 in. high.

Peninsular Electronics Corp., Dept. ED, 3510 S. Orange Ave., Orlando, Fla.

Insulated Wire 375

Teflon insulated wire is available in long lengths, in all standard colors, with or without stripes, solid and stranded conductors, in gages 20 through 26. Temperature rating is 200 C.

Philadelphia Insulated Wire Co., Dept. ED, Moorestown, N. J.

High-Temperature Resistors 435

Coefficients of 25, 50 or 100 ppm/C are available. Resistors are encapsulated in a high temperature, nonflammable black epoxy shell. Line meets MIL-R-10519C RN60 to RN80. Designation is Noble-Met.

American Components, Inc., Dept. ED, 8th Ave. and Harry St., Conshohocken, Pa.

***P&A:** $1.55 to $0.55; two weeks.*

◄ CIRCLE 117 ON READER-SERVICE CARD

Germanium Transistors 362

Diffused-junction mesa switching transistors 2N968-2N975 permit simplified logic circuit design through a wide selection of parameters. Turn-off time (in transistor-resistor logic) is 150 to 275 nsec; BV_{CBO}, 7, 12 and 15 v; h_{FE}, 20 and 40.

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

***Price:** $0.80 to $3.05 ea, 100 to 999.*

Polyurethane Resin 475

High-dielectric polyurethane resin Poly U is suitable for potting and encapsulation. Cure time at room temperature is 4 hr; material cures without excessive voids or shrinkage, and may be used in foam formulations.

Isochem Resins Corp., Dept. ED, 221 Oak St., Providence 9, R. I.

***Price:** $7.50, sample kit.*

Epitaxial Transistors 361

Germanium epitaxial mesa transistors 2N960-2N962 and 2N964-2N966 are suitable for virtually all high-speed switching applications. Maximum turn-off time is 85 to 100 nsec; BV_{CBO} is 15 and 12 v; h_{FE} at 10, 50, and 100 ma is 20 or 40. Housed in TO-18 packages, the devices operate in both high- and low-current circuits.

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

***Price:** $2.95 to $4.25 ea, 100 up.*

CIRCLE 119 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Nuclear Delay Timer 382

Uniaxial acceleration of 2 to 2.8 g applied over a specified time period from 15 to 35 sec will actuate the model D5307 nuclear delay timer. Should the acceleration fall below the specified level before the time period expires, the timer resets itself. Unit is small, light weight, and sealed. Shelf life is 10 years.

Leesona Corp., Dept. ED, 90-28 Van Wyck Expressway, Jamaica 18, N. Y.

Damping Device Kit 469

Over 15 damping effects can be set up and observed with this kit. Designated Airpot, the kit offers two-way, one-way pull and one-way push damping modes. Each Airpot is constructed of a low-expansion glass cylinder fitted with a carbon piston to tolerances closer than 0.0002 in. A choice of five different coupling springs to link damping action to a device is offered.

Electric Regulator Corp., Dept. ED, Pearl St., Norwalk, Conn.

***Price:** $19.95.*

Recording Wave Analyzer 390

Waveforms from 20 to 20,000 cps are analyzed in three decades by the model 800 recording wave analyzer. The amplitude of all frequency components in any waveform is measured and recorded. Full-scale sensitivity ranges from 15 mv to 6 v. Frequency accuracy is within 3%; amplitude accuracy, 5%. Chart is precalibrated for electrical, acoustic, and displacement inputs.

Optron Corp., Dept. ED, 335 S. Salinas St., Santa Barbara, Calif.

Forced-Air Heat Dissipator 388

Ten semiconductors are handled by the model FA-71 forced-air heat dissipator. The unit, 12 in. long, dissipates 780 w. Blower and thermostat-controlled air switches are built in. Made of aluminum, dissipators have a thermal resistance of about 0.25 C per w. Lengths of 6 to 24 in. are available.

Vemaline Products Co., Dept. ED, Franklin Lakes, N. J.

P&A: *$75.00; two to four weeks.*

Transistor Heat Dissipator 383

Press-fit transistor heat dissipator, type TXBP-050-037, fits on TO-8 transistor cases from 0.48 to 0.51 in. in diameter. Unit is suitable for printed-circuit board, chassis, or heat-sink mounting. Made of beryllium copper, the device has an insulube or black cadmium finish.

International Electronic Research Corp., Dept. ED, 135 W. Magnolia Blvd., Burbank, Calif.

P&A: *$0.80 to $1.65; from stock.*

Process Monitor 447

Ten points of any process variable measurable by transducers generating dc millivolt outputs or changes in resistance are monitored. Scanning speeds available are from 1 to 10 sec per point. Ten red lights indicate scanning position. Calibration accuracy is 0.25% of full scale span. Sensitivity is 1 μv, independent of scale span.

Thermo Electric Co., Inc., Dept. ED, Saddle Brook, N. J.

NEW PRODUCTS

Plug-In DC Amplifier 379

Drift is limited to 3 mv for temperature variations up to 120 F by the model 205 plug-in solid-state dc amplifier. At constant ambient temperature, drift is ±0.25 mv. Amplifier has a gain of 10 ±2%, a frequency response from dc to 100 kc, 5% down. Distortion is less than 1% at rated output; peak-to-peak output voltage is 5 v. Unit has an octal base with mounting holes, and measures 2 x 2-7/8 x 1-3/8 in.

Quan-Tech Laboratories, Inc., Dept. ED, Boonton, N. J.

P&A: *$105.00; in production quantities.*

Two-Channel Recorder 393

Chart speeds of 3/4 in. per hr to 3 in. per sec are available on the model 602 two-channel recorder. Full-scale sensitivities of 50 μa to 10 amp are provided. The upper 25% of the range can be expanded over 80% of the scale. Center-zero operation is available. Accuracy is 1% to 2%. An electromagnet-operated event pen is mounted in the margin.

Esterline Angus Instrument Co., Inc., Dept. ED, P. O. Box 596, Indianapolis 6, Ind.

RC Ratio Bridge 380

For testing resistors, capacitors, and transformers, the model CB-26 resistance-capacitance-ratio bridge measures capacitance over four ranges from 10 pf to 2,000 μf, resistance from 0.5 ohm to 200 meg, capacitor leakage at 3 to 500 v dc, and ratio of turns, reactance, or resistance of transformers from 0.5:1 to 20:1. A low-voltage bridge analyzes small electrolytic capacitors.

Precision Apparatus Co., Inc., Dept. ED, 70-31 84th St., Glendale 27, N. Y.

Price: *$79.95.*

Power Supply 430

Regulated high-voltage power supply model 15-W-004 can be used as a multiplier phototube bleeder supply and in other applications. Input is 18 to 30 v dc. Units are available in seven output voltages ranging from 800 v (−10 v) to 2,000 v (−50 v). Output current is 100 μa and output ripple is less than 250 mv. Drift is less than 2% over the temperature range of −10 to +130 F.

Franklin Systems, Inc., Dept. ED, 2734 Hillsboro Road, West Palm Beach, Fla.

Servo Amplifier 359

Two-phase servo motors from size 11 up to 1/4 hp can be driven by servo amplifier model A439. Amplifier controls power to both phases of the motor so that at null the power to the motor is zero. Several wattage ranges are made for industrial and military use.

Westamp, Inc., Dept. ED, 11277 Massachusetts Ave., Los Angeles 25, Calif.

Miniature Gearmotors 427

Up to 35 oz-in. torque continuous duty is provided by dc gearmotors type VS. End-mounted reducer provides 62 ratios from 7.88:1 to 25,573.65:1, and the side-mounted reducer provides a choice of 27 ratios from 26.93:1 to 2,511.84:1. End-mounted reducer and VS motor is 7/16 x 7/8 x 3-3/4 in. long maximum. Side-mounted reducer and VS motor is 7/8 x 7/8 x 2-1/4 in. long.

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

NEW PRODUCTS

Isolation Transformer 446

Designed for critical circuits requiring good isolation for power line equipment, isolation transformer HIT-15 is rated at 150 w. Input is 115 v 50/60 cps. Effective capacity coupling between primary and secondary windings is less than 0.1 pf.

United Transformer Corp., Dept. ED, 150 Varick St., New York 13, N. Y.

Tube-Axial Blower 615

Air-conditioned service in missile-ground support equipment is provided by the model STA-1000-11278 tube-axial blower. The unit has a cast aluminum housing, a 10-in. tapered-blade fan, and a 416-v, 400-cps aircraft-type motor. Motors for other voltages can be furnished. The blower delivers about 1,800 cu ft per min at a static pressure of 1 in. of water. MIL specs are met.

Torrington Manufacturing Co., Dept. ED, Torrington, Conn.

Battery Eliminator-Charger 381

Built-in LC filter is provided with the model P-28 battery eliminator-charger. Output is continuously variable from 0 to 6 or 12 v, 6 and 10 amp max respectively for continuous current on standard output. Intermittent currents of 12 and 20 amp respectively are handled. Filtered output provides 5 amp max. Voltage and current are monitored.

Precision Apparatus Co., Inc., Dept. ED, 70-31 84th St., Glendale 27, N. Y.
Price: $64.95.

Precision Dials 436

Tolerance is 6 min for the range of 0 to 360 deg. Precision dials and verniers have engraved divisions and numbers. Standard diameters range from 2 to 6 in. in 1/2 in. increments. Other diameters are available. Dials are available in clear aluminum and in white or black military paint. Graduations and numbers are filled with a contrasting color paint.

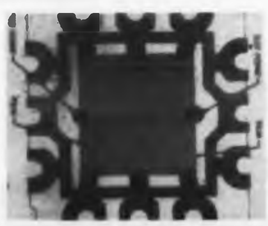
Ackerman Engravers, Inc., Dept. ED, 43-22 36th St., Long Island City 1, N. Y.

Cable Coating 374

Polyethylene resin Alathon 3530 gives wire and cable smooth insulation coatings at production speeds up to 4,000 ft per min. Physical and electrical properties are good. Melt index is 0.3. Ten standard colors are available; resin may be colored with concentrates to meet government requirements.

E. I. Du Pont De Nemours & Co., Dept. ED, Wilmington, Del.

Resistor Element 626



Micromodule film-resistor elements are mounted on a ceramic wafer measuring 0.310 in. sq by 0.010 in. thick. Resistance between terminals can be tailored by scoring or cutting. Basic films have values of 100, 500, or 1,000 ohms; films on each side can differ in value.

Ohmite Manufacturing Co., Dept. ED, 3677 Howard St., Skokie, Ill.,

NEW PRODUCTS

Concealed Latch 392

Slight pressure at any point on an access panel will release this concealed latch, called the Touch Latch. Similar pressure closes and locks the latch and panel. Single-hold mounting with a common nut does not require riveting, welding, or special tooling. Unit may also be mounted in castings with tapped holes.

Camloc Fastener Corp., Dept. ED, 1 Spring Valley Road, Paramus, N. J.

Vacuum Thermocouples 443

Low-frequency af and uhf vacuum thermocouples are available. Heater ratings are from 1.25 ma for the low and audio frequency types to 5 ma for the uhf type. Unmounted, open-wire thermocouples are available for meter manufacturers. Custom made types are also available.

Barker Sales Co., Dept. ED, 339 Broad Ave., Ridgefield, N. J.

Availability: *3 to 4 weeks, from stock.*

Static Switch 608

For vibration, shock, and acceleration environments, this solid-state static switch replaces multipole relays. Unit switches 10 v max through 50 ohms on, 5 meg off. Power requirement is 10 ma at 28 v. Temperatures from −55 to +100 C, shock of 1,500 g, acceleration of 10,000 g, and vibration of 30 g peak from 20 to 2,000 cps are withstood.

Applied Electronics Corp. of N. J., Dept. ED, P. O. Box 43, Metuchen, N. J.

Logic Modules 468

Flip flops, multivibrators, amplifiers, gates and other units are included in the 1200 series of digital logic modules. Applications include shift registers, accumulators and counters. Modules are applicable to airborne and space use.

Computer Techniques, Inc., Dept. ED, 3300 Northern Boulevard, Long Island City 1, N. Y. ***P&A:*** *$3.74 to $13.76 in production quantities; from stock.*

Capacitors 404

Capacitors from 10 to 1,000 pf. Special 1/4-in. long Cerafil capacitors are made in lacquer coated, durez-coated or epoxy-molded cases. Units can be made with ratings up to 100 v dc. Capacity tolerance as low as ±7-1/2% can be supplied.

Aerovox Corp., Hi-Q Div., Dept. ED, Olean, N. Y.

Magnetic Sensing Devices 442

Transverse and axial field types operate from −40 to +100 C, with continuous operation at 85 C. The transverse Hall-effect magnetic sensing device measures 0.500 x 0.130 x 0.19 in. thick. Designation is model BH200. The axial field type, model BH203, is 0.195 in. in diameter and 3/16 in. long. Both units are non-inductive.

F. W. Bell, Inc., Semi-Conductor Div., Dept. ED, 1356 Norton Ave., Columbus 12, Ohio. ***Price:*** *$32.00 each.*

NEW PRODUCTS

Chassis Slide 391

Available in eight sizes from 10 to 24 in., the Universal Chassis Slide is arranged for detent, tilt, or nontilt assembly, and front, back, or side mounting. Slide is permanently lubricated. Detent locks in any of seven positions. Chassis can be easily removed from cabinet, but cannot be removed accidentally.

Metal-Craft, Inc., Dept. ED, 34 Burgess Place, Wayne, N. J.

Servo Amplifier 680

Stable and uniform response is provided by 5-w servo amplifier SA 5601. Gain is 54 ±1 db from −55 to +125 C with all signal levels below saturation, and supply voltage of 56 ±3 v. Size is 1.390 x 1.035 x 1.005 in. Amplifier will drive any size 8, 10 or 11 servo motor with a 26-v control-phase rating.

Clifton Precision Products Co., Inc., Dept. ED, 5050 State Road, Drexel Hill, Pa.

Availability: *stock.*

Vidicon Tube 473

With resolution of 1,200 lines, vidicon type RCA-8051 is made for use with 35-mm film camera optics. Nonmagnetic materials are used in the front end. Flat face-plate is free of distortion.

Radio Corp. of America, Electron Tube Div., Industrial Tube Products Dept. Dept. ED, Harrison, N. J.

Decade Condenser 406

For design and experimental work. Model 1904 has a capacitance range of 0.0001 to 0.111 μf in steps of 0.0001 μf. Accuracy is ±1%. Ratings are 350 wvdc, 500 v intermittent, 1,000 v test. Power factor is 0.001% or better.

Precision Apparatus Co., Inc., Dept. ED, Glendale 27, N. Y.

Price: *$29.95.*

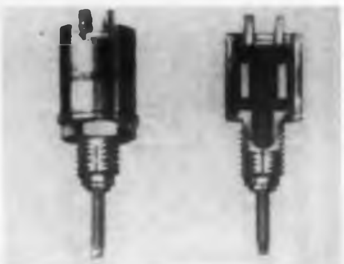
Two-Trace Scope 624

Operating to 5 mc, this dual-gun oscilloscope is designed for easy maintenance and repair. Identical vertical amplifiers give identical traces over the full screen face with no phase shift. Vertical sensitivity is 1 mv per cm; sweep range is 1 μsec to 1 sec per cm.

Packard Bell Electronics, Dept. ED, 12333 W. Olympic Blvd., Los Angeles 64, Calif.

***Price:** $495.*

Coil Form 459



Shielded coil form PLS-9 measures 7/16 in. in diameter and 1/2 in. high, has high shock resistance and enclosed windings. Locking device permits tuning while core is locked. Forms are made for ranges from 0.2 mc up, with two to six terminals.

Cambridge Thermionic Corp., Dept. ED, Cambridge, Mass.

***P&A:** $0.65 ea, 250 to 499; stock.*

High Volume Fan 454

Delivering 550 cfm at a low decibel rating, propeller fan model 1PB95W is powered by a continuous-duty 115-v, 60-cps, single-phase shaded pole motor that is totally enclosed. All hardware is stainless steel or cadmium plated. Lubrication temperature range is −68 to +93 C.

McLean Engineering Laboratories, Dept. ED, Princeton, N. J.

NEW PRODUCTS

Relay 455

Sensitive relay type 3000 has pull-in power rating of 20 to 350 mw, and operating time of 3 to 5 msec. A remanent magnetic core can be fitted to hold contact after power is removed. Relay can be supplied with up to 10 sets of double-throw contacts, will operate at 650 v, and interrupt 10-amp loads.

Ellis & Freed, Dept. R, Dept. ED, P. O. Box 549, Times Square Station, New York 36, N. Y. ***Price:*** *typical 6pdt, $5.20 ea, 100 units.*

Inductance-Controlled 625

Solid-state oscillator model LSE can be used with all types of variable inductor transducers. Device tunes to any IRIG channel. Output voltage is 3 v rms, impedance 100 ohms, harmonic distortion 3%. Unit operates on 24 to 32 v dc with less than ±1% bandwidth change. Built to meet military specifications, the oscillator withstands shock, vibration and acceleration of 100 g; temperature range is −65 to +165 F.

Pace Engineering Co., Dept. ED, 13035 Saticoy St., North Hollywood, Calif.

AC Converter 461

Accurate within ±0.1%. Used with a five-digit voltmeter, solid-state converter 882 provides ac measurement from 0.00001 to 999.9 v. Frequency range is 30 cps to 10 kc. Average ac balance time is 1 sec; accuracy is ±0.1% of reading, or two digits.

Electro Instruments, Inc., Dept. ED, 8611 Balboa Ave., San Diego 11, Calif.

Condenser Box 405

Substitution box model 1803 provides 18 values to EIA specifications. Capacity range is 0.0001 to 0.22 μf. Capacitors in the 100-to 470-μf range are silvered mica, ±5% accuracy, rated at 500 wvdc. Capacitors in the 0.001- to 0.22-μf range are molded, have a ±10% accuracy, and are rated at 600 wvdc.

Precision Apparatus Co., Inc., Dept. ED, Glendale 27, N. Y.

***Price:** $12.95.*

Transient Detector 452

Battery-operated transient detector model TD 661 is useful in semiconductor applications. It uses a dial to establish the set point and an indicating lamp for readout. Range is 0 to 2,000 v, accuracy is ±2% of reading. Transient duration time is a minimum of 1 μsec.

Regent Controls, Inc., Dept. ED, Harvard Ave., Stamford, Conn.

***P&A:** $195; from stock.*

Synchronous Generator 649

This 16-mc synchronous generator, model SG-46, is a plug-in digital module. The device converts a randomly timed, arbitrarily shaped input pulse into a standard pulse for use in the firm's H-PAC series modules. The assertion and negation outputs can drive six unit loads at 16 mc. One dc-coupled and two ac-coupled inputs are provided. Unit measures 3-3/8 x 5 in.

Computer Control Co., Dept. ED, 983 Concord St., Framingham, Mass.

***Availability:** from stock.*

IN STOCK FOR IMMEDIATE QUANTITY DELIVERY...

11 High performance servomotors — precision built by Helipot!

Beckman INSTRUMENTS, INC.

HELIPOT DIVISION
Fullerton, California
Mountainside, New Jersey

For immediate delivery – write, wire, or phone Mr. Ray Forbes at Helipot, Fullerton, California. Phone: TRojan 1-4848. Teletype: FULLERTON CAL 5210. Or contact your local Helipot rep.

		Size 5 Servomotor Model 9005-1502-0	Size 5 Servomotor Damping Generator Model 9005-1102-0	Size 8 Servomotor Model 9008-1501-0	Size 8 Servomotor Model 9008-1502-0	Size 8 Velocity Damp Servomotor Model 9008-1301-0	Size 8 Servomotor Damping Generator Model 9008-1101-0	Size 8 Servomotor Damping Generator Model 9008-1106-0	Size 11 Servomotor Model 9011-1501-0	Size 11 Velocity Damp Servomotor Model 9011-1301-0	Size 11 Servomotor Damping Generator Model 9011-1101-0	Size 11 Servomotor Damping Generator Model 9011-1102-0
Excitation	Fixed Phase	26v	26v	26v	115v	26v	26v	115v	115v	115v	115v	115v
400 cycles	Control Phase	33v	33v	33/16.5v	33/16.5v	33/16.5v	33/16.5v	33/16.5v	40/20v	40/20v	40/20v	40/20v
Length, inches		0.865	1.565	0.840	1.165	1.332	1.350	1.850	1.340	1.915	2.049	2.552
No-load speed, RPM		10,000	10,000	6,000	6,000	5,000	6,000	6,000	6,000	5,300	6,000	5,900
Torque at stall oz. in. (nominal)		0.1	0.1	0.22	0.33	0.22	0.22	0.33	0.6	0.6	0.6	0.6
Acceleration at stall, rad/sec^2		50,000	37,000	86,500	86,500	33,800	67,800	70,700	41,500	26,500	38,500	34,200
Price, single unit		$200.00	$300.00	$75.00	$80.00	$120.00	$125.00	$130.00	$75.00	$125.00	$130.00	$135.00

CIRCLE 151 ON READER-SERVICE CARD

Gertsch announces:

the CRB line of complex ratio bridges

Ideal for voltage and phase comparison.
Measures complex voltage ratios—both in-phase and quadrature—with high accuracy.

Available in small, transistorized units to completely automatic, self-nulling types.

These Gertsch CRB instruments are designed for testing 3- or 4-terminal networks, including transformers, synchros, resolvers, gyros, and transducers. The Gertsch line includes:

SOLID STATE BRIDGE—Model CRB-4. Instrument is fully transistorized . . . highly accurate. A self-contained, phase-sensitive null indicator permits rapid measurements. $R_i + R_j$, voltage ratios are read from concentric switch dials. *Battery or line* operation . . . case or rack mounting. Operating frequency range: 380-420 cps. Weight 20 pounds.

COMPLEX RATIO BRIDGE—Models CRB-1B and CRB-2B. In these units, quadrature component reading is indicated either as rectangular coordinate, tan θ, or θ directly in degrees. Useful for measuring angles as small as .001°. Six-place resolution, with high accuracy. Cabinet or rack mounting.

CRB-1B	30-1,000 cps	2.5 f or 200 V max.
CRB-2B	50-3,000 cps	.35 f or 200 V max.

AUTOMATIC COMPLEX RATIO BRIDGE—Model CRB-3. A self-nulling AC bridge with digital readout of both in-phase and quadrature voltage ratios. Excellent for production testing.

Accuracy of bridge is .002% max. Five-place resolution, with automatic quadrant indication. Unit is self-contained, requiring no external calibration sources, and is equipped for external printer readout.

Complete literature on all units sent on request. Bulletin CRB.

Gertsch

GERTSCH PRODUCTS, INC.

3211 S. La Cienega Blvd., Los Angeles 16, Calif. • UPton 0-2761 • VErmont 9-2201

CIRCLE 152 ON READER-SERVICE CARD

Phase Angle Meter 579

Direct reading of phase angle in tenths of degrees is provided by phase unit model 526D for frequencies from 396 to 404 cps. At other frequencies readings are presented in time units; range is 1 cps to 20 kc. The plug-in unit equips an electronic counter to measure any lead or lag phase angle, with accuracy approaching ±0.1%.

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

***P&A:** $750; 12 weeks.*

Switches 415

Speed-sensitive switches are available with 4, 5 and 6 elements. Each switch has independent, adjustable, normally open and normally closed contacts rated for 10 amp at 115 v ac. Normal speed of the governor shaft can be as high as 7,000 rpm. Low speeu setting can be as low as 200 rpm if the top speed does not exceed 2,500 rpm.

Synchro-Start Products, Inc., Dept. ED, 8151 N. Ridgeway Ave., Skokie, Ill.

Telemeter Recorder 457

With 4-in. chart. Used with Metameter telemetry systems, recorder 670 has one or two pens. Each pen may have one or two retransmitting slidewires, and a maximum of four adjustable alarm contacts. Chart width is 4 in.

The Bristol Co., Dept. ED, Waterbury 20, Conn.

Hipot Testers 577

Nondestructive hipot testers are offered in 22 models with outputs of 0 to 1,500 v to 0 to 10 kv ac, all suitable for testing to ASTM, NEMA and UL spec. They have a 5-ft input cord, 5-ft high-voltage output leads, continuously variable voltage control and breakdown indicator.

Duncan Electric Co., Davenport Manufacturing Div., Dept. ED, 2530 N. Elston Ave., Chicago 47, Ill.

Cable and Harness Tester 409

Tests 17 conductors. Series 701 cable and harness tester provides rapid simultaneous continuity and breakdown testing. Continuity tests are made at a maximum current of 500 ma. Acceptance limit is adjustable between 1 and 5 ohms. Breakdown test voltages of 500 to 2,500 are available in 5 steps.

Slaughter Co., Dept. ED, Piqua, Ohio.

Threaded Terminal 450

Made of Teflon, threaded feed-through Type FT-500 TI permits high torque installation techniques. Unit has a screw-driver slot milled across the threaded stud to facilitate holding the mounted terminal while high torque may be applied to the terminal nut. Length is 0.743 in. Threaded stud is 4-40 2A x 0.234 in.

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

Helitrim® 1/2" square trimming pots give you...

•UNIQUE SLIP CLUTCH STOP •SEALED ALL-METAL HOUSING

as standard features!

Where small size and high operating temperature are important considerations, choose between two ½" square Helitrim trimming potentiometers. The Model 70 has Teflon leads. The Model 71 has gold-plated pins. Both are precision-built by Helipot to give you *special* features as *standard!*

These Helitrim extras include a slip-clutch stop that prevents open circuits – positively keeps the wiper from going off the end of the coil and into dead space. And rugged all-metal housings that provide humidity-resistant operation under the most severe environmental conditions.

Just as important is ease and accuracy of adjustment. There's no guesswork with Helitrim potentiometers – the adjustment screw makes 42 complete turns. This gives extra meaning to the pot's outstanding resolution – as fine as 0.083% in the upper resistance values.

Performance? Take a look at these specs. You'll see why top performance, too, is standard with Helipot.

STANDARD SPECIFICATIONS

Resistance range, ohms	10 to 50,000
Resistance tolerance	±5%
Resolution in percent	1.01 to 0.083 (depending upon total resistance)
Adjustment screw rotation	42 turns, ±1 turn
Power rating, watts	1 at 50°C
Torque, max. oz. in.	10
Life expectance, adjusting screw revolutions	10,000
Temperature range	–55°C to +150°C

Price? These pots are competitively priced at $5.35 for the Model 70 and $5.95 for the Model 71. Considerably less in quantity!

Availability? Your nearest Helipot representative has both models in stock – ready for immediate delivery. Call him today.

Beckman INSTRUMENTS, INC.

HELIPOT DIVISION

Fullerton, California

POTS : MOTORS : METERS

CIRCLE 155 ON READER-SERVICE CARD

NEW PRODUCTS

Signal Tracer 407

For rf and af signals. Model ST-22 is capable of handling all receiver or amplifier signal levels, including the high gain needed for direct tracing of signal at receiver antenna input terminals. It provides a wattmeter circuit for checking power drain of equipment under test over the range of 36 to 500 w.

Precision Apparatus Co., Inc., Dept. ED, Glendale 27, N. Y.

Price: *$59.95.*

Stabilization Networks 411

Line stabilization networks are used in radio-frequency interference measurement. Type JN17-852 meets the requirements of MIL-1-6181. Type JN17-586 meets MIL-1-16910 and type JN17-853 meets MIL-1-26600.

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

Header Machine 408

Produces 6,000 units per hour. Completely automatic transistor header machine may be adapted to many different precision operations including welding, punching and threading. It can assemble as many as 40 different kinds of parts at the same time.

Rhebo Corp., Dept. ED, 1108 W. Evelyn Ave., Sunnydale, Calif.

Static Relay 631

With no moving parts, static relay model 514 latches in either position, and holds on position when contact load is lost. Switching time can be as low as 22 μsec. Both ac and dc types are available is spst and dpdt arrangements. Operating temperature range is −65 to +160 F, operating life one million cycles at full load.

Autronics Corp., Dept. ED, 180 N. Vinedo Ave., Pasadena, Calif.

***P&A:** $78.50; 3 weeks.*

Temperature Potentiometers 578

Accuracy is ±0.3% of range. Type 8694 single-range and type 8695 double-range temperature potentiometers indicate temperature in deg F on 15 ranges. Type 8696 double-range millivolt potentiometer is calibrated for emf measurements from 0 to 22 and 20 to 64.

Leeds & Northrup Co., Dept. ED, 4934 Stenton Ave., Philadelphia 44, Pa.

Diode Dice 466

Silicon mesa diode dice meet or exceed MIL-S-19500B without additional sealing. Ultra-fast computer diode type MSC-1 has less than 2 nsec recovery, less than 2 pf capacitance, more than 75 v piv. General purpose type MSC-2 has piv greater than 300 v, less than 10 na leakage. Size is about 0.020 x 0.020 x 0.007 in. thick.

Microsemiconductor Corp., Dept. ED, 11250 Playa Court, Culver City, Calif.

***P&A:** $2.50 ea, 100 units; stock.*

The Raytron Catalog of Precision Potentiometers describes, illustrates and provides electrical, mechanical and general specifications on most of our standard units. Drawings, temperature rating curves and general engineering data are also included to enable rapid, accurate selection of potentiometers which will meet all requirements, normal or special.

Whatever your specifications in single-turn, linear and non-linear units, the name Raytron guarantees high-precision, exact performance and environmental compliance...at minimum cost.

WRITE FOR YOUR PERSONAL CATALOG OF RAYTRON PRECISION POTENTIOMETERS.

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a subsidiary of
INSTRUMENTS FOR INDUSTRY, INC.
101 NEW SOUTH ROAD, HICKSVILLE, L. I., N. Y.

CIRCLE 160 ON READER-SERVICE CARD

NEW PRODUCTS

Power Resistors 413

Rated at 10 and 20. Types 260E and 261E have integral mounting brackets that make them particularly useful for printed wiring boards and in applications where severe vibration is present. Suitable for stack mounting, these units are smaller in physical size than cylindrical-core power resistors.

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

Voltage Regulators 414

Heavy-duty automatic regulators are for 50/60 cycles, 3-phase applications that require a constant output voltage with zero waveform distortion. Output is adjustable from 440 to 480 v; input range is 380 to 520 v. Both 240 and 480 kva types are available. Units with higher capacities and other input ranges are also made.

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

Logic Cards 463

Digital logic cards operate from dc to 1 mc; flip-flops can be used as counters to 2 mc. Circuits include Schmitt trigger, a four-flip-flop card, and a two-input NOR gate card.

General Applied Science Laboratories, Inc., Dept. ED, Merrick & Stewart Aves., Westbury, N. Y.

Availability: *stock to 30 days.*

Solid-State Relay 410

Has no moving parts. Model SSR-2828-3504 is an ac switching relay rated at over 100 million operations. Actuation time is 2 μsec, dropout time 5 μsec. Actuation or drive frequency can be as high as 5 kc. Operating temperature range is from −55 to +100 C. Maximum contact rating is 150 v, 4 amp rms, resistive or inductive.

Solid State Electronics Co., Dept. ED, 15321 Rayen St., Sepulveda, Calif.

Ohmmeter 363

Direct-reading ohmmeter MV-279B provides measurement accurate within 0.25% of full scale. Total range is 0.1 ohm to 2.5 meg, in 14 overlapping ranges. Constant-current energy source allows use of a linear scale. Meter operates from 117 v, 50 to 60 cps, and an internal 1.4-v mercury battery.

Millivac Instruments, Inc., Dept. ED, Box 997, Schenectady, N. Y.

Time Delay 464

Accurate to 0.01%, time delay relay 31800 has a delay range of 50 msec to infinity. Contact arrangements range from spst to 4pdt, with ratings at 28 v dc or 115 v ac of up to 10 amp resistive, 5 amp inductive.

A. W. Haydon Co., Dept. ED, 4060 Ince Blvd., Culver City, Calif.

NEW PRODUCTS

Test Instruments 364

Ultra-sensitive dc picoammeter MV-111A-L provides full-scale ranges from 100 pa to 250 ma, with 1% accuracy. Model MV-127-A-L is a dc microvoltmeter with ranges from 100 μv through 1 kv. Basic accuracy is 1%. The dc microvoltammeter MV-07B has ranges from 10 μv through 1 kv, and 10 pa through 1 ma. Accuracy is 1% voltage, 2% amperes. All instruments have individual calibration controls.

Millivac Instruments, Inc., Dept. ED, Box 997, Schenectady, N. Y.

Transient Detector 453

Transistorized and battery operated, transient detector model TD 761M is useful in semiconductor applications. Range is 0 to 2,000 v. Transient duration is a minimum of 1 μsec. Measurement from 0 to 1,000 v is in increments of 50 v; 1,000 to 2,000 v, increments of 100 v. Readout device is a 3-1/2 in. dc meter.

Regent Controls, Inc., Dept. ED, Harvard Ave., Stamford, Conn.

P&A: *$325; from stock.*

Power Supply 630

Relay-type switching power supply model 293B is made for diode life testing. Unit supplies a maximum of 50 amp average forward current at 12 v and piv up to 1,400 v. Forward and reverse outputs are metered and may be adjusted by powerstats.

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

P&A: *$650.*

Thermoelectric Coolers 352

Reach −90 C. Designed for infrared detector cooling, thermoelectric elements are capable of achieving −78 to −90 C. The elements are also useful for cooling electronic devices which may be widely separated in physical location.

Pesco Products Div., Borg-Warner Corp., Dept. ED, Bedford, Ohio.

Multiplexing System 417

Up to 18 channels from a single 3-kc voice channel are provided by the C-8102 FSK voice band modem. Maximum transmission rate is 75 bits per sec, equivalent to 100 words per min in teletype operation, on each channel. The data channels consist of tone signals separated by 170 cycles in a frequency range of 425 to 3,315 cps.

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

DC-to-DC Converter 476

Handles 80 w. Separate outputs of converter model 46-129-0 are +200 v dc, +28 v dc, −28 v dc and 6.3 v ac. Regulation is ±1% on 28 v and ±5% on the 200 v dc and 6.3 v ac outputs. Power input is 28 v dc. Temperature range is 0 to 65 C. Weight is 4.5 lb. Converter is for satellite applications.

Magnetic Research Corp., Dept. ED, 3160 W. El Segundo Blvd., Hawthorne, Calif.

Resistor Networks 465

Thin film tin oxide resistor networks are made to military specifications. Range of resistance values is 50 ohms to 4 meg. Temperature coefficient of ±50 ppm per degree C is standard; tolerances to ±1% are available.

Intellux, Inc., Dept. ED, 30 S. Salsipuedes St., Santa Barbara, Calif.

Price: *$10, four-resistor network sample.*

Reduce static circuit costs... install Westinghouse Voltrap* surge suppressors

PROBLEM
411B Bridge; #302 cell, 3x3 Fins
a-c RMS Input-115 volts; d-c output-98 volts
a-c switching surges

SOLUTION

Without Voltrap	With Voltrap
411B Bridge	302g 350PRV @ $56.60
#302K 500PRV @ $87.80	Add Voltrap @ 5.27
	$61.87

Actual savings with Westinghouse Voltrap - **$25.93** or **29.5%**

Substantial savings in static circuits are now possible with VOLTRAP surge suppressors, because they provide reliable, guaranteed surge clamping permitting use of less expensive lower PRV rated silicon devices.

How does it work? — A static device with Zener characteristics, VOLTRAP surge suppressor provides a shunt discharge path for surge currents and clamps dangerous surge voltages to safe levels. VOLTRAP devices clamp the surge voltage peak to 250% or 280% of its rms voltage rating permitting use of silicon devices with PRV ratings *only* 10% above VOLTRAP clamping voltage.

Westinghouse VOLTRAP units have these additional exclusive advantages:

- Open construction allows free air circulation resulting in cooler and more reliable operation.
- VOLTRAP bridge designs permit simplified installation and wiring.
- Clamping voltage ratings guaranteed because each individual unit is oscilloscope tested.

*Trademark

Ratings available:

- Eight discharge currents: 2, 3, 5, 10, 20, 40, 65, 80 amps.
- Sixteen a-c rms voltages in 30 volt steps: 30 to 480 volts.
- Clamping voltage range: 250% or 280% nominal rms voltage rating.
- Units either polarized or non-polarized.
- Finishes available for various environmental conditions.

Call your local Westinghouse sales engineer now for complete information on the savings you can make by installing VOLTRAP surge suppressors in your static circuits. Or, if you prefer, send in the coupon below.

You can be sure . . . if it's Westinghouse.

J-25007

To: Westinghouse Electric Corporation
General Purpose Control Dept.
P.O. Box 2025, Buffalo, N.Y.

☐ Please send me your Technical Data 19-163 on Voltrap Surge Suppressors.

☐ Please have a Westinghouse electronics engineer call for an appointment.

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Company ______________________

City ______________ State ______________

Westinghouse

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ETC

CRT OF THE MONTH

New! Fiber Optics Faceplate, High Resolution Electron Guns—*minimize spot size . . . increase light output 40-80 times over conventional CRTs designed for data display, radar, or other exacting uses.*

Faceplates using fiber optics eliminate halation, refraction and light transmission problems common to conventional CR tubes. ETC **model M-1014** *illustrated, uses 0.001" dia fibers in a 5/8" x 3½" panel insert gaining 625 vertical dots by 3,500 horizontal dots or lines.*

Electro-static focus, 40° magnetic deflection for minimum defocusing, maximum corner resolution.

Larger ETC fiber optics CRTs available from 1" to 6" dia, resolutions of 2,000 by 2,000 dots/inch.

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electronic tube corporation

1200 E MERMAID LANE, PHILADELPHIA 18, PENNA

CIRCLE 168 ON READER-SERVICE CARD

NEW PRODUCTS

Angle Counter 356

Remote angle counter RAC-1 provides an in-line digital display of angle from 0 to 360 deg at a remote location. Housing is size 25, length is 3 in. Accuracy and resolution are 0.1 deg. Power requirement is 28 v, ac or dc.

Theta Instrument Corp., Dept. ED, 520 Victor St., Saddle Brook, N. J.

***P&A:** $500; 8 weeks.*

Transformer 449

Delivers 60 mw at 400 cps. Used for three-phase to two-phase or four-phase transformation, the unit has an output of 11.6 v rms, two-phase, with an input of 11.6 v rms, three phase. It is encased in a hermetically sealed metal container. Lead termination is a 7-pin hermetically sealed glass header.

Supreme Transformer Co., Dept. ED, Chicago, Ill.

Light-Dependent Resistor 456

Compact light-dependent resistor type B8.731-.04 has a resistance ratio in excess of 25,000:1 for light intensity change from darkness to 1,400 foot candles. Operating temperature range is −40 to +85 C. Size is 0.42 x 0.06 in.

Ferroxcube Corp. of America, Dept. ED, Saugerties, N. Y.

***Price:** $10, kit of four.*

Magnetic-Tape Certifier 460

Automatic magnetic-tape certifier model C can be used with any transport at normal speed and packing density. All channels are inspected simultaneously; tape stops when a drop-out occurs.

Cybetronics, Inc., Dept. ED, 235 High St., Waltham 54, Mass.

Digital Voltmeter 462

Solid-state digital voltmeter uses a floating input circuit, providing constant high input impedance. Range and polarity selection are automatic on four ranges, up to ±1,199.9 v. In-line, in-plane projection readout is visible up to 50 ft. Panel height is 6-1/4 in.

Electronic Associates, Inc., Dept. ED, Long Branch, N. J.

Silicon Transistors 419

For switching applications. Silicon npn switching transistors have collector current rating of 500 ma, typical h_{FE} of 40, type 2N696, and 75, type 2N697. Collector-to-base breakdown voltage is 75 v, collector cut-off current 1 μa at 25 C, 100 μa at 150 C. Housed in a TO-5 package, devices meet MIL-S-19500B.

Radio Corp. of America, Semiconductor and Materials Div., Dept. ED, Somerville, N. J.

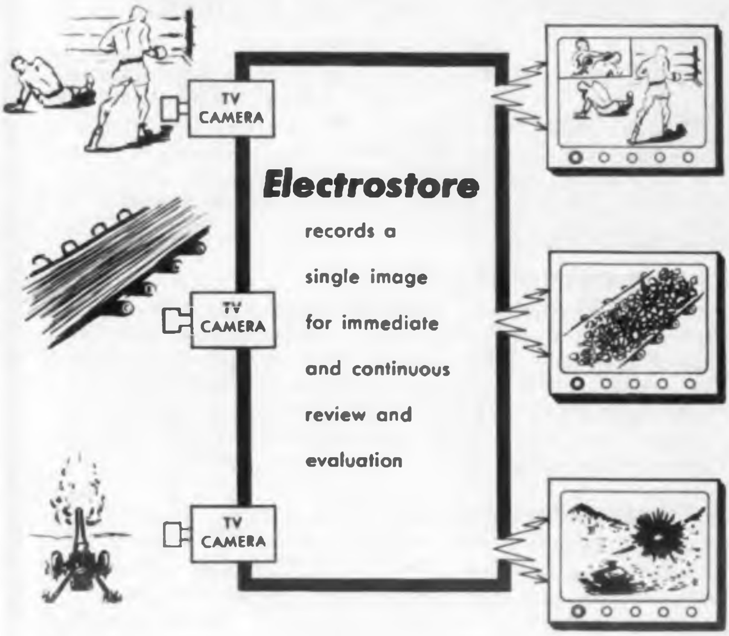
Availability: *Stock.*

Recorder 458

Four-pen chart recorder will handle any set of variables that can be transduced into an electrical quantity. Ample torque is available for auxiliary functions such as slidewires and alarm contacts.

The Bristol Co., Dept. ED, Waterbury 20, Conn.

Actions → STOP → for Review



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PRODUCTION PRODUCTS

Tubing Marker 261

Coding and identification tubing of flexible plastic is fed, cut, and marked by the model ETMA automatic tube marking machine. Tubing from 1/8 to 1 in. in diameter is processed and cut into 3/8 to 2 in. lengths. Production rate is 60 to 190 pieces per min. Dry heat bond process is used, with temperatures adjustable from 200 to 600 F.

The Acromark Co., Dept. ED, 410 Morrell St., Elizabeth 4, N. J.

Batch Ovens 262

Provide to 400 and 600 F. The Power-O-Matic 60 batch ovens provide straight-line control of temperature without cycling. Four sizes providing 16 to 36 cu ft are available. Construction is of heavy steel with Fiberglas wool insulated triple side walls.

Blue M Electric Co., Dept. ED, 138th and Chatham St., Blue Island, Ill.

Toroid Winding Head 263

Rapid, easy insertion and removal of cores is provided by the type 601 toroidal coil winding head assembly. Head replaced 6-in. shuttle head equipment in the firm's line of winders. Coils ranging from 5/8 in. ID to over 5 in. OD can be wound.

Boesch Manufacturing Div., Waltham Precision Instrument Co., Inc., Dept. ED, 45 River St., Danbury, Conn.

Wire Stripper 264

Thermal wire stripper combines the type WS30 stripper and model H101CD power supply. Oxidation and heat build-up are resisted. Operation is by straight-pull action; it can be used on any insulation, including Teflon. Power supply is also suitable to power a soldering iron.

Contact, Inc., Dept. ED, P. O. Box 6, Hudson, N. H.

Parts Handling System 265

Small, delicate parts and components are handled with this system called a Vacuum Tweezer. An aluminum pencil connected to a vacuum generator by rubber tubing is used with various sizes of pick-up needles. Finger operation controls vacuum.

Anco Products, Dept. 118, Dept. ED, 276 Park Ave., Collingswood, N. J.
Price: *$39.95 fob Collingswood.*

Diode Sealer 266

Ohmic contact glass diodes receive final sealing in an inert atmosphere. Unit seals seven diodes per cycle, with 50 cycles per hour. Ohmic contact pressure is predetermined.

Research Instrument Co., Inc., Dept. ED, 558 Main St., Westbury, N. Y.
P&A: *$4,200; 2 months.*

do you tremble

at the sign of a sine?

Does a sine-cosine pot in your pet project mean special prices and annoying delay? No need to pay more . . . no need to wait. Ace has a *full* line of sine-cosine function pots — in sizes, conformities and driving resistances to meet all your requirements — and delivery is prompt. Our *standard* line — which meets 95% of your needs — we can ship promptly . . . AND a special one goes off to you with minimum delay! Ace offers, as standards, conformities in a 7/8" or 1-1/16" size that you'd pay for as a *special* in a 2" size elsewhere! Consider the space, weight and money you save!

Ace's standard sine-cosine line includes sizes from 3/4" to 3", driving resistances from 1K to 1 megohm, in comparable conformities from 0.5%, peak to peak. So if you think you have a special requirement — talk to us! Chances are it's an Ace *standard* sine-cosine pot!

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CIRCLE 176 ON READER-SERVICE CARD

NEW LITERATURE

Servo Units 267

Servo system components available in kit form are listed in 12-page catalog No. 2. Physical specifications and dimensional drawings are included for components, which can be assembled into prototype systems. Gap Instrument Co., 116 E. Merrick Road, Freeport, L. I., N. Y.

Tape Recorders

A bibliography of articles on tape recorders is collected in this eight-page bulletin. Over 400 articles from journals and conferences from 1954 to 1960 are listed. *Send $1.00 to Kinelogic Corp., Dept. ED, 1256 N. Fair Oaks Ave., Pasadena, Calif.*

Coaxial Transmission Lines 268

Straight sections, connectors, elbows, and hardware and accessories associated with rigid coaxial transmission lines are cataloged in this 12-page brochure. Electrical and physical characteristics are given, with tables, graphs, nomograms, and dimensional drawings. Technical Appliance Corp., Sherburne, N. Y.

Metallic Standoffs 269

Metallic spacers and posts are described in four-page data-sheet No. SPPM-1. Physical specifications and prices are given for over 100 items. Angler Industries, Inc., 75 Winthrop St., Newark, N. J.

Components and Equipment 270

The firm's line of electronic components and equipment is described in this 400-page illustrated catalog. Chemicals, tools, hardware, plugs and jacks, resistors, test equipment, communications, sound, and high-fidelity apparatus, antennas, and related components are included. GC Electronics Co., Dept. FR-62, 400 S. Wyman St., Rockford, Ill.

Ceramic Capacitors 271

Plastic-molded and dip-plastic-coated ceramic capacitors are described in this 16-page booklet. General specifications are given, with curves of temperature characteristics. Dimensional drawings of the cases are included. Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J.

Beam Switching Tube 272

Switching tubes, the firm's Beam-X line, are covered by this 24-page brochure. Theory of operation, circuit design, and applications are discussed; illustrations and characteristics curves are included. Burroughs Corp., Electronic Components Div., P. O. Box 1226, Plainfield, N. J.

Tape Heads 273

Tape heads which record seven tracks in line or thirteen tracks interlaced are described in this illustrated brochure. Physical and electrical specifications are given in chart and tabular form. Test data on each unit is included. Norton Associates, Inc., 240 Old Country Road, Hicksville, L. I., N. Y.

Waveguide Flanges 274

Mechanical specifications for waveguide flanges, including single and dual choke and cover for both pressure and nonpressure applications, are listed in 14-page catalog No. FA61-1. Microwave Development Laboratories, Inc., Natick, Mass.

Sidewall Hybrids 275

Over 100 sidewall short-slot hybrids are described in this 12-page catalog, No. HS61. Various styles and terminations are illustrated. Electrical and mechanical data are tabulated with waveguide sizes. Microwave Development Laboratories, Inc., Natick, Mass.

Traveling-Wave Tubes 276

Low-noise traveling-wave tubes are described in this 16-page bulletin. It includes a basic description of low-noise traveling-wave tube design, application information and technical specifications on 7 tube types now available in production or sample quantities. For copies of PT-53 write to General Electric Co., Schenectady 5, N. Y.

Waveguide Filters 277

Electrical data on waveguide filters, including band-pass and insertion loss ratings, are given in 12-page catalog No. FP61. An engineering section permits approximation of filter lengths and number of cavities required for desired slope of filter envelope. Microwave Development Laboratories, Inc., Natick, Mass.

Tungsten Alloy 278

A heavy tungsten alloy, Kennertium W-10, is described in eight-page bulletin No. B-500. Physical properties, machining recommendations, joining and engineering suggestions are included. Applications, particularly for radioactive shielding and rotational balancing, are considered. Kennametal, Inc., Latrobe, Pa.

Telemetry Antennas 279

Over 30 antennas for missile guidance, tracking, and telemetry operations are described in eight-page catalog T. Illustrations and specifications are included. Rotators, patch panels, and other accessories are listed. Andrew Corp., P. O. Box 807, Chicago 42, Ill.

Silicone Fluids 280

Use of silicone fluids as hydraulic and damping fluids, dielectrics and lubricants, antifoam agents, coatings for ceramics and glass, and as additives in urethane foams is outlined in bulletin S-9. Tables and graphs indicate properties of various grades of the fluids. General Electric Co., Silicon Products Dept., Waterford, N. Y.

Magnetic Contactors 281

A line of NEMA size 3 and 4 magnetic contactors and starters is covered by eight-page bulletin GEA-7326. Illustrations and diagrams outline installation of the units. Characteristics are tabulated. Modification kits are listed and discussed. General Electric Co., Schnectady 5, N. Y.

Vibratory Equipment and Power Tools 282

Vibratory materials and parts handling equipment, mechanical shaft seals, paper joggers, portable power tools and power rectification equipment are described in catalog No. 616. Specifications and over 200 illustrations are included. Syntron Co., 283 Lexington Ave., Homer City, Pa.

Printed Circuits 283

Flexible, flush, and multi-layer printed circuits are described in this technical bulletin entitled "Depth in Circuitry". Applications, specifications, and electrical data are outlined. U. S. Engineering Co., 13536 Saticoy St., Van Nuys, Calif.

Circuit Breakers 284

This selector wheel is made to simplify selection of the most suitable circuit-breaker from among the firm's line. Wheel can be rotated until the most favorable electrical and physical parameters are found, at which point the model number can be read off. Westinghouse Electric Co., Standard Control Div., Beaver, Pa.

Antenna Instrumentation 285

Antenna pattern recording equipment, receivers, transmitters, control devices, antenna positioners, microwave components, recorder supplies, and auxiliary equipment are described and illustrated in this 16-page catalog. Specifications and prices are included. Scientific-Atlanta, Inc., 2162 Piedmont Road, N. E., Atlanta, Ga.

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VARIABLE WIDTH PULSE GENERATOR

Continuously Variable Pulse Width and Delay

The 6500 Series includes the features of Texas Instruments 6100 Series plus additional outputs with continuously variable delay from 0-1000 nanosec. All outputs provide controls for continuously variable pulse width from 20-1000 nanosec up to 90% duty cycle. Output amplitude is 0-5 V; rise times of 5 nanosec; repetition rates up to 25 MC.

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TURBO

CIRCLE 178 ON READER-SERVICE CARD

NEW LITERATURE

Test Instruments **297**

A direct-reading LC meter, an indicator unit, a waveform generator, two pulse generators, and two power supplies are described in this 12-page booklet. Specifications, performance characteristics, and illustrations are included. Tektronix, Inc., P. O. Box 500, Beaverton, Ore.

Ovens **298**

Laboratory heating equipment and apparatus are described in 24-page Catalog 92. Included are high-temperature box and tube furnaces and combustion tubes. Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.

Silicone Molds **299**

Silicone release and parting agents are described in this 12-page brochure, S-13. Reliability of release, stability at high temperatures, spreading, and chemical inertness are discussed. Silicone Products Dept., General Electric, Waterford, N. Y.

Industrial Tubes

"Industrial Tubes by National" is a 23-page booklet giving hints for equipment using ignitrons, thyratrons, and gas-filled rectifiers. Maintenance problems are discussed. *Send twenty-five cents to National Electronics, Inc., Dept. ED, Geneva, Ill.*

Magnetic Preamplifiers **300**

Six-page technical bulletin, No. 10-C, describes the use of magnetic amplifiers for thermocouples, strain gages, photocells and other low-level dc signals. Design of low-level and common-mode isolation instrumentation and controls with magnetic amplifiers is outlined. Acromag, Inc., 22515 Telegraph Road, Southfield, Mich.

Zener Diodes

This 185-page manual covers silicon Zener diodes and rectifiers. Use of Zeners in regulated power supplies is discussed, with reference to schematic drawings, tables and curves. Properties of silicon rectifiers are also considered. *Send $2.00 to Motorola Semiconductor Products, Inc., Dept. ED, 5005 E. McDowell Road, Phoenix, Ariz.*

Assembly Tools 301

Equipment for staking, swaging, riveting, punching, marking, and terminal setting, including automatic and semi-automatic instruments, is described in the 16-page catalog, "Electric Assembly Tools." Operation and application of the various tools is discussed. Black and Webster, Inc., 570 Pleasant St., Watertown 72, Mass.

Potentiometers

Information on precision poentiometers is given in this 42-page catalog. The construction and operation of different types of potentiometers are explained. The firm's line of potentiometers is cataloged, with electrical and mechanical specifications. *Write on company letterhead to: The Gamewell Co., Dept. ED, Newton Upper Falls 64, Mass.*

Silicones

Booklet No. CDS-288, eight pages describes silicones for electrical and electronic applications. Included are sections on silicone varnishes, potting and encapsulating materials, adhesives, dielectric fluids and greases, and insulation. *Write to: General Electric Co., Silicone Products Dept., Dept. ED, Waterford, N. Y.*

Copper-Clad Laminates 302

Physical and electrical properties of Micarta copper-clad laminates for printed circuits are given in this eight-page brochure, B8215. Recommended applications are included for each laminate. Westinghouse Electric Corp., Micarta Div., Hampton, S. C.

V-Band Coupling 303

"How, When and Why to Use a V-Band Coupling", an eight-page booklet, No. WB-1, explains the advantages of V-band coupling in design and product appearance, and in consideration of assembly time and manufacturing costs. Available coupling and flange configurations are illustrated. Marman Div., Eeroquip Corp., 11214 Exposition Blvd., Los Angeles, Calif.

Power Supplies

A line of dc power supplies and test instruments is described in this 16-page catalog. Specifications furnished include ratings, dimensions and weights of the equipment. *Write on company letterhead to Opad Electric Co., Dept. ED, 43 Walker St., New York 13, N. Y.*

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PROGRAMMED PULSE GENERATOR

Highest Repetition Rates
(UP TO 25 MEGACYCLES)

Texas Instruments 6200 Series provides signals at higher repetition rates than previously available, for applications in high speed logic circuit and memory system development. Ten pulse times are selectable in any combination for each of the two outputs by front panel controls. Other performance specifications similar to the 6500 Series. All TI Pulse Generators use solid state circuitry and modular construction for reliability and versatility.

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CIRCLE 183 ON READER-SERVICE CARD

NEW LITERATURE

Resistors 286

Physical and electrical characteristics for a line of wire-wound and carbon-film resistors are given in this 24-page catalog. Precision power resistors, epoxy-encased carbon-film resistors, printed-circuit resistors for military and commercial applications are described. Mepco, Inc., Morristown, N. J.

Capacitor Reliability 287

Reliability tests which were conducted over a period of thirty years are described in this manual, No. 60121. Information useful in the design of high-reliability circuits, such as the effects of voltage, temperature, frequency, insulating materials, and area of windings, is included. Life, capacitance and leakage current as affected by extended temperatures are discussed. John E. Fast & Co., 3598 N. Elston Ave., Chicago 18, Ill.

Mechanical Filters 288

This four-piece package on mechanical filters contains a general catalog with filter specifications and performance curves, a short-form catalog, a specification sheet on ferrite filters for mobile and missile applications, and a sheet on filter installation. Collins Radio Co., Western Div., 2700 W. Olive Ave., Burbank, Calif.

Potentiometers 289

A line of precision potentiometers is described in this 28-page technical catalog. Detailed specifications, outline drawings, and general information on miniature and full size units are included. DeJur-Amsco Corp., Electronic Sales Div., 45-01 Northern Blvd., Long Island City 1, N. Y.

DC Power Supplies 290

Semiconductor dc power supplies rated to 100 amp are listed in this 12-page catalog. Performance characteristics are given for more than 80 models. Electronic Measurements Co., Red Bank, Eatontown, N. J.

Accelerometers 291

Operation and application of the firm's line of accelerometers is outlined in this eight-page brochure, "Donner 4310." Circuit diagrams, operating curves, and specifications are included. Donner Scientific Co., Concord, Calif.

Transistor Specifications

Specifications for preferred transistors, including those on the Military Preferred List, are given in this reference book. Both U. S. and United Kingdom military specifications are reproduced. The manual, entitled "Transistor Specification Manual," contains 609 pages bound, loose-leaf, in a hard cover. Supplements will be issued periodically. *Send $10.00 to ARINC Research Corp., Dept. ED, 1700 K St., N.W., Washington 6, D. C.*

Industrial Capacitors 292

Solid electrolyte tantalum capacitors, molded plastic tubulars, subminiature tubulars, paper, mylar, electrolytic, and ceramic capacitors for industrial applications are listed in this 20-page catalog. Astron Sales Corp., 255 Grant Ave., East Newark, N. J.

Radio Telescope Antennas 293

Data on radio telescopes and their antennas is given in report No. WDL-TR-1500 entitled "Reflector Antennas for Radio and Radar Astronomy." Telescopes throughout the world are listed by country. All known antennas of area greater than 10 sq m are included. Philco Corp., Government and Industrial Div., Western Development Laboratories, 3875 Fabian Way, Palo Alto, Calif.

Relays 294

Power, general and special purpose, plate circuit, sensitive, and telephone type relays are listed in this eight-page catalog. Over 40 models are included. Descriptions, dimensions, technical specifications and prices are given for more than 450 variations of the basic relays. Potter and Brumfield, Technical Information Section, Princeton, Ind.

Component Holders 295

Over 400 component holders said to be shock-resistant and vibration-free are described in this 64-page catalog. Masterite Industries, 851 W. Olive St., Inglewood, Calif.

Data System 296

A 3,600-point high-speed automatic monitor system for military or industrial applications is described in this four-page bulletin, No. 101. Bulletin gives standard design specifications and discusses use of the system for control of nuclear reactors. Monitor Systems, Inc., Dept. 17, Ft. Washington Industrial Park, Ft. Washington, Pa.

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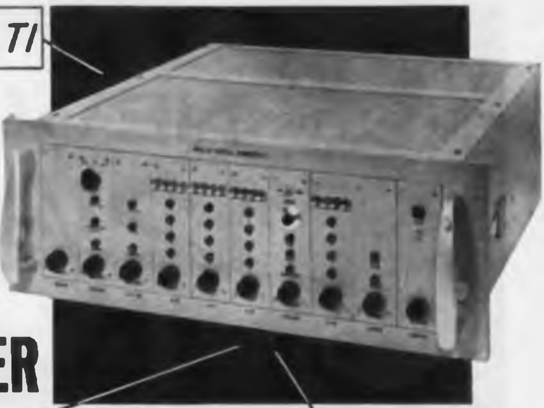

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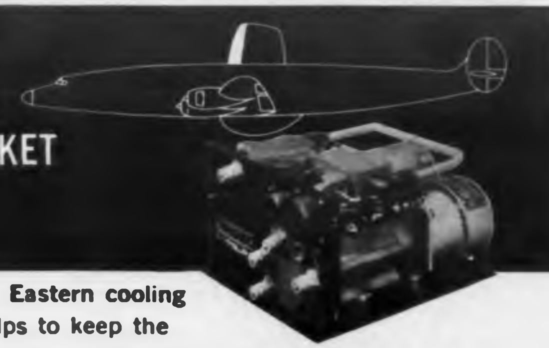
ABOARD A RADAR PICKET PLANE



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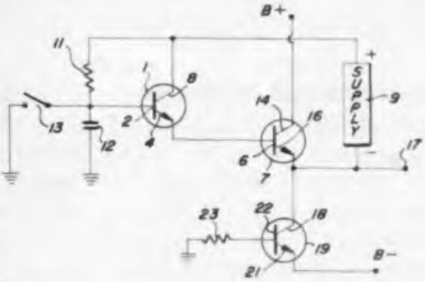
PATENTS

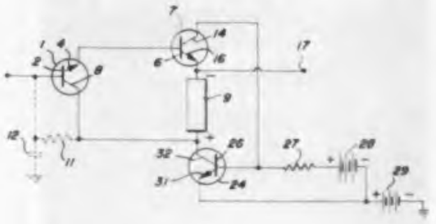
Benjamin Bernstein

Bootstrap Circuits

Patent No. 2,983,831. J. F. Walton (Assigned to Elcor, Inc.)

Two cascaded, emitter-follower circuits, having feedback through a very low capacitance power supply, comprise a very high-input-impedance linear amplifier. To drive a capacitive load, a third transistor may be placed in parallel with the load and operated near cut-off during capacitor charging. When the control signal reverses, the transistor short-circuits to rapidly discharge the load.





In Fig. 1, the bootstrap connection of transistors *1* and *7* couples a linear waveform, generated across capacitor *12*, to a load at terminal *17*. When the capacitor charges, the voltage on emitter *16* follows to raise supply *9* and increase the voltage of collector *8*. This increases the capacitor voltage linearly, especially when transistor *7* is operated as a constant-current device controlled by transistor *19*.

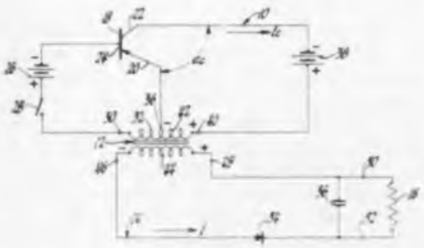
Fig. 2 presents a circuit for driving a capacitive load. A positive pulse applied to terminal *2* raises the voltage at terminal *17* and increases the current of collector *14*. The volt drop coupled to base *26* decreases the current through transistor *24*. This increases the output voltage further. In a similar manner, when the applied voltage is negative, transistor *24* conducts hard and discharges the load.

Transistor Inverter and Half-Wave Rectifier Circuit

Patent No. 2,958,032. K. S. Vogt

A transistor oscillator converts battery voltage to high dc voltage. The transistor is protected against high voltage surges by a diode which conducts during the off time of the amplifier.

Transistor *18* is connected as a feedback oscillator through coupling windings *32* and *42*, while the high-voltage load connects across the secondary winding *44*. Diode *54* conducts when the transistor is nonconducting so that the high inverse voltage does not appear across the transistor.

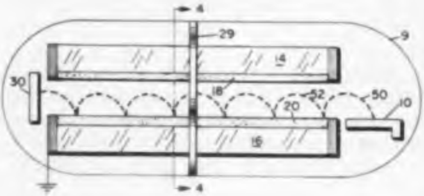


Electron Multiplier, Spurious Noise Baffle

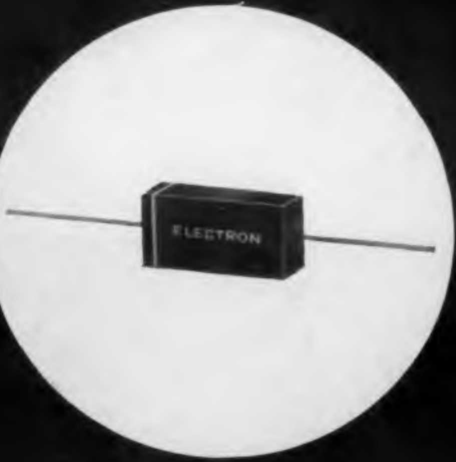
Patent No. 2,983,845. D. C. Damoth (Assigned to North American Aviation, Inc.)

Spurious noise in electron multipliers due to stray electrons, gas molecules and photons is reduced by an apertured baffle placed normal to the path of the electron beam.

In the presence of crossed electric and magnetic fields, the beam path is cycloidal from cathode *10* to anode *30*. The density of electrons increases after each impact against the tin oxide secondary emissive plate *20*. Baffle *29* contacts envelope *9* to block the stray particles.



Electron Products | BW and BWE High Voltage Capacitors



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Up to 30,000V 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.

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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

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BOOKS

Dictionary of Mechanical Engineering

Alfred Del Vecchio, Philosophical Library, Inc., 150 E. 40 St., New York 16, N. Y., 346 pp, $6.00

Lists definitions of terms in fields which include architecture, automatic controls, engineering mechanics, power plants, basic electricity and mathematics, and welding.

Introduction To The Theory Of Linear Differential Equations

E. G. Poole, Dover Publications, Inc., 180 Varick St., New York 14, N. Y., 217 pp, $1.65

Advanced treatment of ordinary linear differential equations including conformal representation, Lamés equation, Mathieu's equation, regular singularities and the hypergeometric equation.

A Treatise On the Calculus of Finite Differences

George Poole, Dover Publications, Inc., 180 Varick St., New York 14, N. Y., 350 pp, $1.85

Field Theory For Engineers

Parry Moon and Domina Eberle Spencer, D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J., 530 pp, $12.75

The separation of variables method is applied to unify the branches of field theory—including electromagnetic, acoustical, thermal, and gravitational. Presents the eleven coordinate systems of Eisenhart as well as bicylindrical, bispherical, and toroidal systems. A background in differential equations, vector analysis and elementary physics is assumed.

Applied Optics and Optical Design, Part 2

A. E. Conrady, Dover Publications, Inc., 180 Varick St., New York 14, N. Y., 842 pp, $2.95 (paperbound).

Sets forth the concepts of geometrical and physical optics and applies them to the design of the simpler optical instruments.

Electronics

Paul M. Chirlian and Armen H. Zemanian, McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y., 335 pp, $8.75

Intended for a first course in electronics, this text emphasizes physical electronics, rather than circuitry.

An Engineering Approach to Gyroscopic Instruments

Elliott J. Siff and Claude L. Emmerich, Robert Speller & Sons, Publishers Inc., 33 W. 42 St., New York 36, N. Y., 120 pp, $7.50

Quantitative relations are derived which can be applied to the solution of gyroscopic problems. Special designs are also presented, including air bearings, electrostatic and electromagnetically supported gyros, vibrating and particle gyros.

Sequential Decoding

John M. Wozencraft and Barney Reiffen, The Technology Press of MIT and John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 75 pp.

Considers the problem of coding and decoding from a probabilistic point of view. Sequential decoding is applied to the binary symmetric channel, with some extension to more general channels. Convolutional encoding is also discussed.

An Introduction To Electrotechnology

S. J. Kowalski, John F. Rider Publisher Inc., 116 W. 14 St., New York 11, N. Y., 316 pp, $7.00

Undergraduate text dealing with ac and dc circuits.

Basics of Analog Computers

Thos. D. Truitt and A. E. Rogers, John F. Rider Publishers, Inc., 116 W. 14 St., New York 11, N. Y., 394 pp, $12.50

Simplified presentation of the design concepts, devices and applications of the analog computer. Written as an introduction to the subject for maintenance technicians and programers.

IDEAS FOR DESIGN

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?

RC-"Blocking Oscillator" Produces Complementary Pulses — 737

In designing a pulse circuit for one of our systems we developed an interesting configuration which, for want of a better name, we call an RC-coupled blocking oscillator. The circuit, shown in the figure, produces two sharp, opposite-polarity pulses. Their periods can range from the low frequencies to the frequency limit of the transistors.

Transistor T_1 and T_2 are a complementary pair connected in a symmetrical circuit where $R_2 = R_4$, $R_1 = R_3$ and $C_1 = C_2$. The interval t_2 is determined primarily by the parallel combination of resistors R_5 and R_1 and capacitor C_1. Thus:

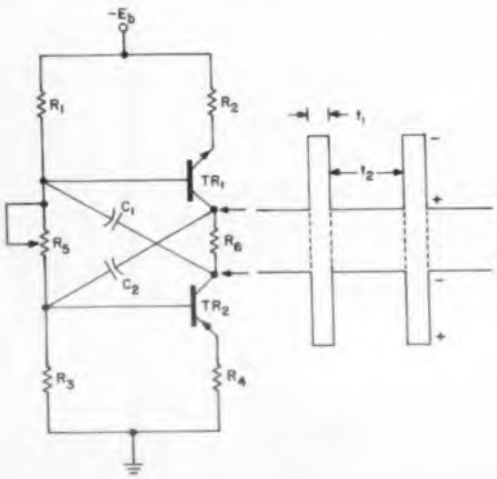
$$t_2 \cong 1/2\ R_5 /\!/ R_1 \cdot C_2$$

Interval t_1 is determined by the input impedance of either transistor and C_1 (or C_2). That is:

$$t_1 \cong \beta R_2 \cdot C_1 \approx \beta R_4 \cdot C_2$$

If the interval t_1 is not critical, both R_2 and R_4 can be removed. With resistance R_6 set by potentiometer, t_2 can be easily varied.

Note that another of the reasons that we refer to the circuit as a "blocking oscillator" is that both transistors are on during t_1 and off during t_2. However, any further



Opposite polarity pulses are produced by this variable-frequency, complementary-transistor-pair circuit.

analysis of this circuit by the readers of ELECTRONIC DESIGN would be appreciated.

J. André Bourget, Design Specialist, The Martin Co., Baltimore, Md.

If this idea is valuable to you, give it a vote by circling Reader-Service number 737.

Steering Diodes Prevent Spurious Multi Triggering — 743

Spurious triggering of multivibrators by stray noise pulses can be prevented by connecting a common steering-diode net as shown in the figure. With this addition the multi can only be triggered when input pulses exceed a minimum threshold level.

Referring to the circuit, if transistor Q_1 is conducting, Q_2 is off and resistor R_2 reverse-biases diode D_2, hence a positive pulse cannot pass to the base of Q_2.

However, Q_1, has a very low collector voltage and because of this, R_1 does not reverse-

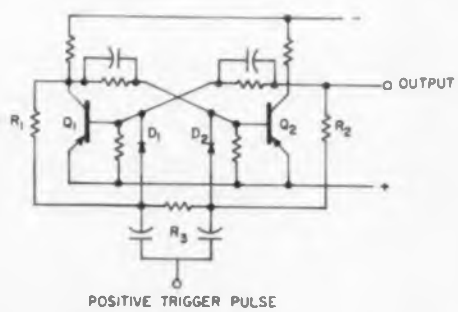
$50 "Most Valuable of Issue" Award for Reduced Capacitor Idea

W. E. Zrubek, design engineer with Westinghouse Electric Corp., Baltimore, Md., has won ELECTRONIC DESIGN's eighth $50 Most Valuable of Issue Award.

Mr. Zrubek receives the award for his Idea for Design, "Long Period Multivibrator Reduces Timing Capacitor Size," which appeared in the July 5 issue. The idea described a method for building a transistorized monostable multivibrator with a small capacitor.

bias D_1. A positive-going trigger pulse of any amplitude can pass through D_1 to turn Q_1 off.

By including resistor R_3 between the steering diodes, a minimum reverse-bias is established which inhibits the passage of



Steering-diode net and resistor R_3 establish threshhold trigger level to safeguard against spurious triggering by stray noise pulses.

signals below the bias level. Thus, the signal threshold level, below which noise cannot trigger the circuit, is set.

J. Eugene Harrison, Manager Communications Laboratory, General Dynamics Electronics, Rochester, N. Y.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 743.

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

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IDEAS FOR DESIGN

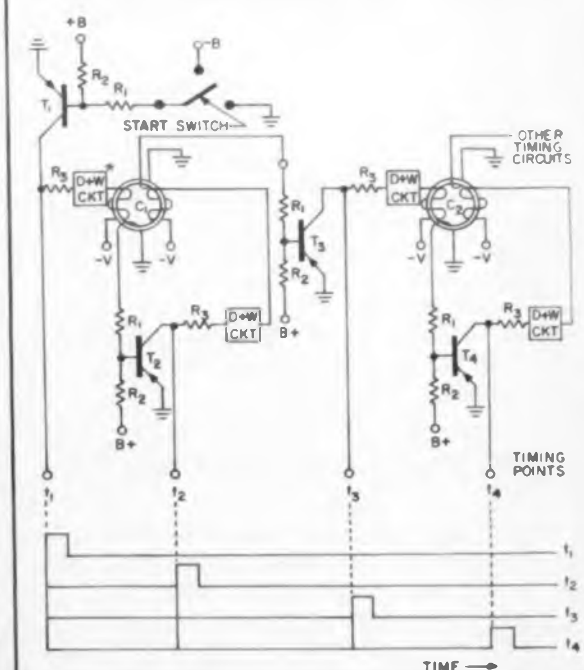
Clock Pulses Generated By Magnetic Core Timer — 744

Clock pulses at frequencies as high as one megacycle can be generated with the magnetic core circuit shown in the figure. Two pulses are obtained from each core and the circuit can be designed for a variety of pulse shapes and time bases.

The circuit is "started" by a momentary closing of the START switch. Transistor T_1 then drives core C_1 into positive saturation. This flux change is sensed by the winding in series with the base of T_2. Transistor T_2 now conducts and drives C_1 back into negative saturation.

This second flux change is sensed by the winding in series with the base of T_3 and the progression continues. The result is that as each transistor conducts, it supplies a voltage pulse at its timing point.

Waveform shape and frequency may be varied through the design of the delay and wave shape (D and W) circuits, and through selecting the cores to be used.



*D+W = DELAY AND WAVEFORM

Magnetic-core clock pulse generator provides two pulses per core. Stages can be added as desired.

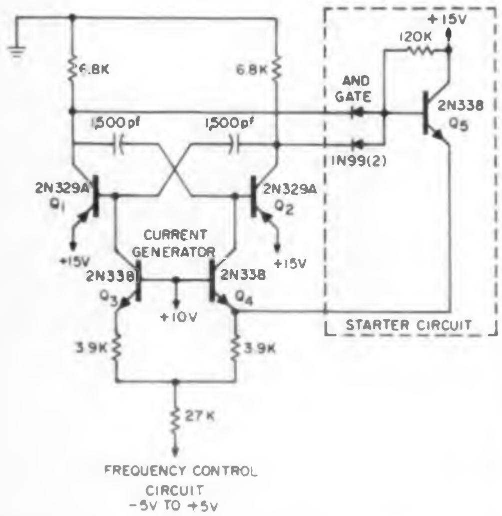
Philip I. Hershberg, Project Engineer, Air Force Cambridge Research Laboratories, Waltham, Mass.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 744.

Starter Circuit Prevents Stall of Free-Running Multi 734

A symmetrical, free-running multivibrator can be protected from stalling at turn-on by adding the AND-gate starter shown. The gate prevents stalling, while in no way interfering with normal, balanced operation after the unit starts oscillating.

In an ordinary multi, stalling can occur when there is insufficient unbalance in the initial rate of change of current in the two halves of the circuit. Purposely introducing an unbalance may be undesirable because of side effects.



AND gate added to symmetrical, free-running multivibrator guards against turn-on stall without interfering with normal, balanced operation.

When power is supplied, the two-input AND-gate connected to the collectors of transistors Q_1 and Q_2 provides a source of signal which turns off, or begins turn-off, in Q_4 and in Q_2. This causes the multi to start oscillating. Since during normal operation, the signals at the collectors of Q_1 and Q_2 are a complementary pair, the output of the AND gate is false and Q_5 is nonconducting.

If the multivibrator stalls, it does so with both Q_1 and Q_2 in a saturated condition, because both sides are driven with voltage-controlled current generators. In a stalled condition, the output of the AND circuit is approximately 15 v and Q_5 is conducting. It draws current from current generator Q_4 which in turn reduces current in Q_2, promoting the start of oscillations.

Martin T. Pett, Space Technology Laboratories, Canoga Park, Calif.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 734.

RUSSIAN TRANSLATIONS

J. George Adashko

A Sine and Cosine Memory Store

SINE and cosine functions for use in computers are usually either stored in tabular form or are generated by successive approximations. This article describes a tabular storing device designed for analog and digital harmonic analyzers and synthesizers. It is used in the relay-type "Sintez" computer at the Leningrad Electrotechnical Institute of Communications. However, the mathematical principles are applicable to other types of computers, including electronic ones.

Harmonic analyzers and synthesizers have to calculate the polynomials

$$(A_n \cos nx + B_n \sin nx)$$

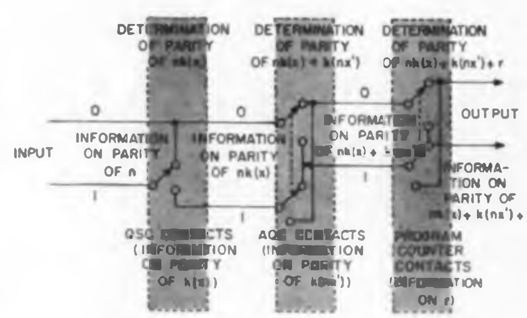
for a series of nodal values of x, namely x_0, $x_0 + \Delta x$, $x_0 + 2\Delta x$, etc. Any device for the generation of sines and cosines should, therefore, be able to deliver the values of sin nx and cos nx for the running values of x and the harmonic number, n.

Argument Nx Is Reduced To Acute Angle

A special scheme is used in the Sintez computer which reduces nx to an acute angle. The running values of x are given in "grads" (the 90° quadrant is divided into 100 parts; 1 grad $= 0.9°$) with a spacing Δx equal to 1 grad. The number of harmonics is also 100. Thus, the sine table consists of 101 values of sin x in the first quadrant. These values are stored in the computer in a diode matrix table.

The table has 101 address buses and an output bus for each stored significant figure (6 decimal places in the Sintez computer). Information is delivered when the address buses of the table receive the address—the value of nx reduced to an acute angle and expressed either in direct code (for the sine function) or in complementary code (to determine the cosine, $\cos x = \sin (100 - x)$).

The access unit yields the values of the argument nx, reduced to an acute angle, to determine the code in which the reduced argument is to be sent to the address buses of the table. It also determines the sign of the products:



Relay-contact version of code-forming network.

$$A_n \cos nx, B_n \sin nx \quad (1)$$

We denote by $k(z)$ the quotient of the division of some angle z by 100 (that is, the integral part of the quotient), and by z', the remainder. Then $k(z) + 1$ denotes the quadrant in which z is located and

$$z = z' + 100\,k(z) \quad (2)$$

We have in mind here the value of z measured from the start of the period. It is sufficient to count $k(z)$ to the nearest multiple of 4.

Decimal Step Adder Generates the Argument x

To generate the argument x, the access unit has a two-column, decimal step adder, *SA*. On proceeding to the next node, the *SA* performs the operation of addition, $x + \Delta x$. The overflow of the *SA* is counted in the quadrant-step counter, QSC. Therefore, if we write:

$$x = x' + 100\,k(x) \qquad (3)$$

then x' is stored in the SA and $k(x)$ is stored in the QSC.

The device also contains an arc adder, AA, which generates the values of nx'. On proceeding to a new value of n, this adder receives the value of x' from the SA and performs the operation $nx' + x'$. This adder also has two decimal columns. Its overflow is stored in the arc quadrant counter, AQC. Analogous to Eq. 3,

$$nx' = (nx')' + 100\,k(nx') \qquad (4)$$

with $(nx')'$ stored in the AA, and $k(nx')$ in the AQC. From Eqs. 3 and 4:

$$nx = (nx')' + 100[k(nx') + nk(x)] \quad (5)$$

Thus, $(nx')'$ is the value of nx, reduced to an acute angle, and is the address sent to the table. The contacts of the QSC and the AQC help the circuitry determine the code of the address $(nx')'$, Fig. 1, and sign of the products, (1).

From Eq. 5 we have:

$$\left.\begin{array}{l}\sin nx \\ \cos nx\end{array}\right\} = \sin\,[(nx')' + 100m_1], \qquad (6)$$

where

$$m_1 = nk(x) + k(nx') + r$$

and

$$r = \begin{cases} 0 \text{ if } \sin nx \text{ is computed} \\ 1 \text{ if } \cos nx \text{ is computed} \end{cases}$$

Thus, the code in which $(nx')'$ is sent to the table depends on whether m_1 is even (direct code) or odd (complementary code).

Actually, if m_1 is even, the argument of Eq. 6 falls in the first and third quadrants, and the table should yield the values of sin

RUSSIAN TRANSLATIONS

$(nx')'$. If m_1 is odd, the argument falls in the second and fourth quadrants, and the table should deliver cos $(nx')'$.

Whether m_1 is even or odd is determined by a step-by-step logic network. This network determines successively the parities of $nk(x)$, $nk(x) + nk(nx')$, and $nk(x) + k(nx') + r$ from the parities of n, $k(x)$, $k(nx')$, and r. The buses over which these quantities are transmitted consists of two wires, "0" and "1". If the corresponding quantity is even, a pulse is produced in the 0 wire; if odd, in the 1 wire.

Russian Logic Network Uses Relays

Because all the input and intermediate quantities assume only two values (0 and 1) in this logic network, the network is very easy to construct. Fig. 1 shows the relay-contact representation of the network used in the Sintez computer. The positions of the contacts in the figure correspond to even values of $k(x)$, $k(nx')$, and r.

Let us consider the formation of the signs of the products, (1). Taking these products into account:

$$\left.\begin{matrix}\text{sign}\,(B_n\sin\ nx)\\ \text{sign}\,(A_n\cos\ nx)\end{matrix}\right\} = \left\{\begin{matrix}\text{sign}\ B_n\\ \text{sign}\ A_n\end{matrix}\right\} \text{sign}\left\{(nx')' + 100\,[nk(x') + k(nx') + r]\right\}$$

Introducing:

$$s = \begin{cases}0, \text{ if the coefficient is positive}\\ 1, \text{ if the coefficient is negative}\end{cases}$$

(we shall show presently that this choice is not accidental), we have:

$$\left.\begin{matrix}\text{sign}(B_n\sin nx)\\ \text{sign}(A_n\cos nx)\end{matrix}\right\} = \text{sign}\ \sin\left\{(nx')' + 100\,[nk(x) + k(n'x) + r + s]\right\}.$$

From this we see that the sign of interest to us is determined by the value of

$$m_2 = nk(x) + k(nx') + r + s.$$

Namely, if $m_2 = 0, 1; 4, 5; \ldots .$, then the sign of the product is plus; if $m_2 = 2, 3; 6, 7; \ldots .$, then the sign is minus. It is assumed that the values of m_2 and $nk(x)$ are reduced to the modulus 4 (this is true for $k\ (nx')$, r, and s).

It is possible to construct a logical network for m_2 made up of a series of successive

How Does the Russian Approach Compare with Ours?

The sine-cosine memory the Russians have described in this article certainly has its equivalent in American equipment. But how does their technique compare with ours?

We'd like to know what you, the reader, thinks. From your own professional experience, would you say that the Russians' memory store is equal to what we have? Is their technique better, or not as good? Is it "old-hat", or an interesting new approach?

We'd appreciate hearing your opinions. Send them to J. George Adashko, ELECTRONIC DESIGN, 850 Third Ave., New York 22, N. Y.

steps. In this network, the quantities n, $nk(x)$, $k(nx')$, as well as the quantities generated in the individual steps, $nk(x)$ and $nk(x) + k(nx')$, assume the four values 0, 1, 2, and 3. Here, the wires 0, 1 and 2, 3 are paired.

Since $s = 0$ and 1, the outputs, 0, 1, of the stage where $nk(x) + k(nx') + r$ is generated are also connected with the outputs 2 and 3, thus simplifying the network.

This procedure can also be used in analog computers. The diode matrix is replaced by voltage dividers (potentiometers) from which the sine and cosine functions are picked off and multiplied by A_n and B_n. The products $A_n \cos nx$ and $B_n \cos nx$ (for one value of x) are obtained successively for different values of n. They can be stored and summed by means of capacitors, as proposed in reference 4.

Translated from "Design of Memory for the Storage of Sines and Cosines," G. G. Men'shikov and L. M. Rakhovich, Leningrad Electrotechnical Institute of Communications, (News of the Higher Institutions of Learning—Instrument Building), *No. 2, 1961, March-April 1961, pp 67-71.*

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E. Brenner

A Simple Analog Multiplier

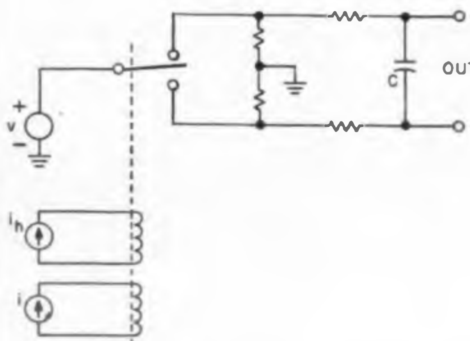

Fig. 1. Analog multiplier uses polarized relay for the multiplication of $v \times i$.

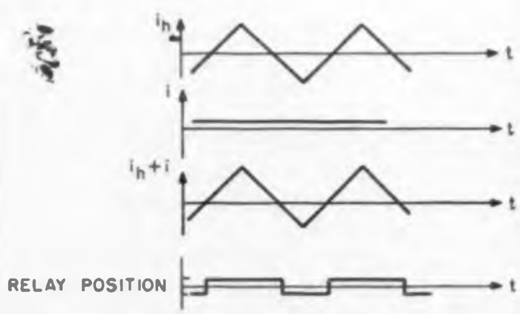

Fig. 2. Waveforms of analog multiplier assuming i = const.

ANALOG multipliers generally fall into one of three classes, depending on their application. For slowly varying signals, servomultipliers are suitable; for faster operation, time-division multipliers are used. Other systems depend on square law devices, together with the relationship

$$4xy = (x + y)^2 - (x - y)^2$$

A simple time-division multiplier which uses so few components that it can be used as a wattmeter is shown in Fig. 1. Its principle of operation can be described with the aid of the waveforms shown in Fig. 2.

The two functions to be multiplied are represented by the voltage v and the current i. For purposes of explanation these are assumed to be constants. However, the circuit works quite well as long as both v and i have no significant spectral components at frequencies near or above the switching frequency.

The function i, supplied by a current source, is applied, together with the switching current i_h, to the control winding of a relay. (It is necessary that the peak value of i_h exceed the peak value of i). The switching current is most conveniently made triangular as shown.

When the current i is zero, the switching occurs symmetrically and the average value of the output voltage is zero. As i increases, the switching occurs unsymmetrically and the average value of the output voltage is proportional to the quotient of vi and i_{hmax}:

$$v_{out} = K\, vi/i_{hmax}$$

In principle the circuit can also be used as a divider.

Abstracted from an article by A. Schief, Elektronische Rundschau, *Vol. 15, No. 4, April 1961, pp 153-154.*

Formulas For Characteristic Impedance

FORMULAS for conductor arrangements of cylindrical conductor and plane shielding are not generally available. Moreover, many of the formulas apply only to conductors far from the plane boundaries. The formulas below are deduced, by conformal mapping methods from inductance and capacitance values, for a cylinder over an infinite plane.

Cylindrical Conductor in a Right Angle Corner, Fig. 1. Various approximations for the characteristic impedance for this arrangement as a function of the ratio of spacing to wire radius are given in Fig. 1. Defining:

$$A = \frac{4x^2 - 2 - 1/(4x^2)}{[8x^2 - 2 - 1/(8x^2)]^{1/2}} \qquad (1)$$

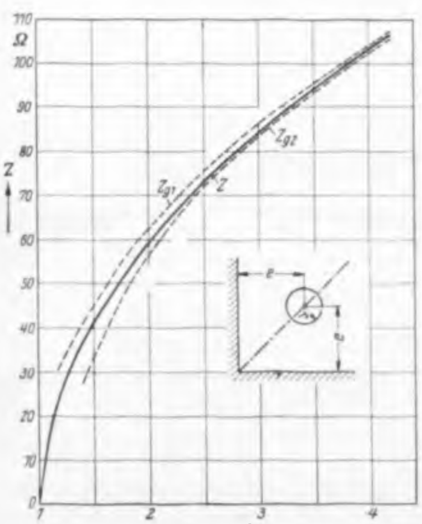

Fig. 1. Characteristic impedance of cylindrical conductor in square corner.

represents the formula:

$$Z = 30 \ln (\sqrt{2}\, xA) \qquad x \geqslant 1.5$$

The upper dotted line is given by:

$$Z_{g1} = 60 \ln (\sqrt{2}\, x) \qquad x \geqslant 4$$

and the lower line is given by:

$$Z_{g2} = 60 \ln (A) \qquad x \geqslant 2.5$$

Cylindrical Conductor in a Square Pipe, Fig. 2. The characteristic impedance as a function of s/d is shown by the solid line. Letting $x = s/d$ and with A defined as in Eq. 1, two relevant approximations are:

$$Z_{g1} = 23.8 \ln (\sqrt{2}\, xA) \qquad 1.5 < x < 2.6$$

and:

$$Z_{g2} = 60 \ln x \qquad x > 4.5$$

Additional Geometries, Fig. 3. Results for cylindrical conductor in a deep rectangular slot, between two parallel planes and within a slit are shown in Fig. 3. The relevant formulas follow.

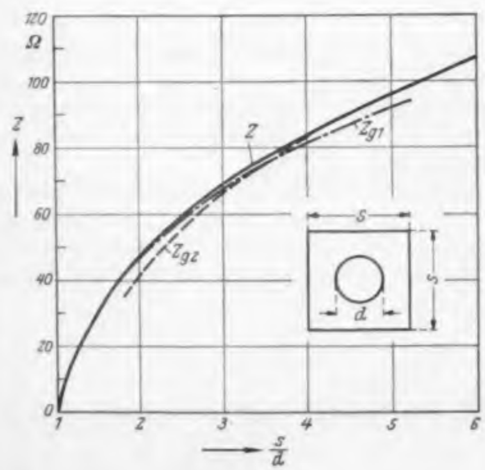

Fig. 2. Characteristic impedance of cylindrical conductor in square pipe.

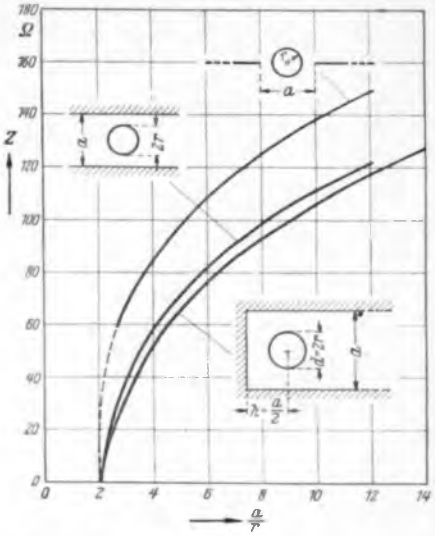

Fig. 3. Characteristic impedance for the three structures shown.

For the slit arrangement:

$$Z = 60 \ln (a/r) \qquad a/r > 2.5$$

For the conductor between parallel planes, let:

$$B = \left[\frac{2}{\tan (\pi r/a)}\right]^2$$

then:

$$Z = 30 \ln (B - 2 - 1/B) \qquad a/r > 5$$

or:

$$Z = 60 \ln (2a/\pi r) \qquad a/r > 8$$

For the slot geometry, let

$$D = \left[\frac{2 \tan (\pi h/a)}{\tan (\pi r/a)}\right]^2$$

and

$$Z = 30 \ln (D - 2 - 1/D) \quad a/r > 4;\ h/r > 2$$

In the special case shown, $a = 2h$ and

$$D = \left[\frac{1.834}{\tan (\pi r/a)}\right]^2$$

and for $a/r > 6$,

$$Z = 60 \ln (0.584\, a/r)$$

Abstracted from an article by W. Buschbeck, Telefunken Zeitung, *Vol. 34, No. 131, March 1961, pp 69-76.*

BREAKTHROUGH!

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LETTERS

Kudos to ED's Transistor Data Chart

Dear Sir:

Just a note of "thanks" and appreciation for the July 1961 issue of ELECTRONIC DESIGN. In particular, the Transistor Data Chart is the handiest and most valuable thing of its kind I have ever seen. I think the outstanding feature of this chart is its division into specific areas of application. We will use this chart frequently in the months to come.

I also appreciate the new binding as DESIGN gets hard usage in this office.

John H. Garley
Chief, Research and Development
Datatronic Systems, Inc.
San Diego, Calif.

► *Many readers apparently agree with Mr. Garley. During the first fifteen days after the Transistor Data Chart appeared, individual requests for reprints poured in at the rate of over 260 a day rapidly using up our supply.*

More on Molecular Computers

Your June 21 edition of ELECTRONIC DESIGN, p 14, carried a story of our Mol-E-Com molecular computer.

You might be interested in knowing that a good number of inquiries have been received on this article which indicate a pretty thorough readership of these news "briefs".

Apparently through a typographical error, a few technical aspects of our efforts on this machine have been reduced in significance. In discussing the memory, the article states that it is "planned to have an expandable random-access memory of 1,600 bits." This figure should actually read 16,000 bits.

In discussing its planned potential of about 50,000 operations per sec, you concluded with the term "hopefully". I mention this only to point out that our design data indicate that we will achieve this capability and that such results will be based on engineering design rather than fond hope.

Finally, in the fourth paragraph, a mention is made of our planned use of functional blocks of etched germanium, about 3/4 in. square and 1/64 in. thick. In this respect, our current plans do not call for the use of germanium but rather silicon for functional blocks. These blocks, each providing separate electronic functions, would be mounted and interconnected in standard units about 3/4 in. square and 1/64 in. thick but each containing four or more functional blocks.

L. M. Dowling, Manager
Computer Development
Westinghouse Electric Corp.
Baltimore, Md.

► *We're pleased to learn that news of the molecular computer, the information about which came from Westinghouse sources, drew many inquiries, even though marred by one typographical error—the memory capacity.*

Diallyl Phthalates As Good as Epoxies

In line with your "Accuracy Policy," allow us to clear up two points contained in the boxed insert appearing on p 55 of your Aug. 2, 1961 issue pertaining to the article "How to Choose Modifiers for Epoxy." You quoted Mr. Paul S. Byrd, "in some cases epoxy molding powders can compete with diallyl phthalate. (He said) that epoxies have shorter molding cycles than DAP and that they can be machined without destroying their surface properties."

Please be advised that the molding cycles of diallyl phthalate compounds under equal conditions are as short as the molding cycles of epoxy compounds. As far as maintenance of surface properties is concerned, daily tests show that both materials suffer to the same extent if the surface of a molded part is disturbed or altered by machining, grinding, drilling, or other similar operations.

We feel qualified to make the above statements because we are compounding both types of compounds, i.e., epoxy molding compounds and diallyl phthalate molding compounds.

Felix C. Karas
Vice President
Mesa Plastics Co.
Los Angeles, Calif.

► *One molder, John L. Hull, vice president, Hull Corp., Hatboro, Pa., told* Electronic Design *that what may have caused confusion here is that Mr. Byrd's company, American-Marietta, Newark, Ohio, happens to have an epoxy molding powder which is (for the present at least) faster than other epoxy molding powders.*

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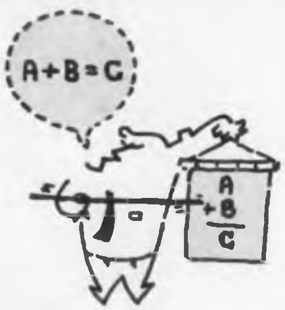

Verbal and Visual Aids Spur Engineer Sales Victories

Roy S. Azarnoff
Consultant to Raytheon Co.
Boston University
Boston, Mass.

This is the second part of a two-part series on how engineers can make effective sales presentations. The first article (ED, Aug. 16, p 144) gave hints on how to analyze the customer and organize the basic sales message.

YOU ARE an engineer, and your company has asked you to lead a team in making a sales presentation to a customer. You have analyzed the customer's wants and have formulated your basic message to meet these wants. Don't rest there. What you have is not yet enough to "sell" the customer. You must have words and pictures that will bridge the gap between your basic message (which probably only makes sense to you) and the customer's mind.

Verbal aids are the primary tool for transplanting your basic message from your mind to the customer's. To get yourself started on the task of finding words that will aid your message, consider that they can be broken down into *definitions, comparisons, statistics* and *examples.* Thinking up a few in each category will start you toward rounding out your complete verbal presentation.

Definitions come in many forms. Describe a transistor as part of a family of semiconductor devices, in terms of its mechanical and thermal properties. Define it in terms of its function and end use. Explain its component parts.

To define a high-frequency transistor as a "device used above 1 or 2 mc" makes little sense when the listeners do not yet know what a transistor is. (In a mixed technical-and-nontechnical audience the technique is to work in definitions in such a way as to educate the nontechnical people but not offend the technical people.)

Comparisons provide one of the most useful tools the engineer has in translating technical information into layman's terms. Here is a statement that needs a comparison:

"The Palomar Observatory is equipped with a 48-in. telescope."

This is not impressive as such. However, this comment makes it so:

"The 48-in. telescope could photograph a candle flame 10,000 miles away."

Here is another illustration:

"The reliability required by a million-hour test is roughly equivalent to printing the Encyclopaedia Britannica without a typographical error."

Reliability is a good example of a subject that calls for easily grasped comparisons. Use them side by side with the point to be illustrated when possible:

"The National Bureau of Standards has developed a high-resolution camera capable of projecting a parallel line pattern with a spacing of 50,000 lines per in. This can be compared to writing out the Bible four times on a postage stamp."

But don't overuse comparisons. Comparisons and analogies will be accepted favorably by your audience only to the extent that they appear naturally. If you "strain" an analogy by endeavoring to use it as "proof" of an idea your audience will lose respect for you.

Statistics are used to support statements or to generalize from specific examples. Use them to demonstrate the importance of an idea. For example:

"Our company produces 83 per cent of the electronic components in this field. Most people consider us the leader in the field."

Unless exactness is required, use round numbers. "About 200,000" can be understood and retained more easily than "198,673." Use statistics sparingly.

Examples add clarity and concreteness to ideas. People prefer the specific to the general. Use examples as a basis for drawing the conclusions:

Example A + Example B + Example C = Conclusion. Or, working deductively: Conclusion = Example A + Example B + Example C.

Three rules govern use of examples.

(1) Select those that your analysis of the audience indicates will be understood.

(2) Keep them reasonably short.

(3) Identify them as real or hypothetical.

Visual Aids Supplement Your Verbal Presentation

Use such visual aids as graphs, tables and diagrams to present concepts that cannot be transmitted solely by verbal means. One picture is worth a thousand words only when the picture is relevant to the audience and to the subject.

And if the presentation is being held in your own plant, don't overlook the possibility of a short, interesting tour of the very facilities or equipment you are talking about.

Determine the type and size of visual aids you will use by the number of listeners and the size of the room, as well as by what you want to show in the aids. For up to about 75 people, 30-by-40-in. charts are effective. For more than 100 persons, a projector and screen will probably be necessary. But films should not be overdone, because when the lights are out, the speaker is no longer the focus of attention.

Prepare visual aids in advance rather than trust that you will be able to draw something on a blackboard while you talk. Make them neat, large enough to see, simple and dramatic. Show them only when needed and remove them as soon as you are finished using them.

Position them so that everyone can see them easily. If you pass around handouts, wait until all eyes are again centered on you. Visual aids should supplement, not supplant, verbal aids.

And while on the subject of mechanical aids, don't overlook audio aids, such as tape recorders, if they will tell part of your story (e.g. to illustrate the difference between noise levels in various kinds of equipment).

Plan the Staging to Eliminate Awkward Moments

The presentation itself will consist of four elements: the audience, the team leader, the speakers and the stage arrangements. The audience is not under the control of the team, but the other elements are, and the part that they play should be rehearsed in advance.

As team leader, you coordinate the entire presentation. You may give a portion of the presentation, but your primary function is to serve as the chairman. You introduce the speakers, indicating their qualifications. After each speaker, you summarize the talk and relate it to the basic message.

After all the speakers have given their talks, you start off the general question-and-answer period by summarizing the entire presentation to renew interest in each speaker's talk. This usually elicits questions for each speaker. The skilled leader receives each question and calls upon the person he thinks best suited to answer it. He may also choose to answer all or part of any question himself.

If no leader has been designated, the unfortunate tendency is for the last speaker to linger at the lectern and to attempt to reply to all of the questions. Most of the questions are for the last speaker anyway, as the audience tends to forget items it wanted to ask previous speakers. But this situation is poor, because the last speaker may not be the best qualified to answer each question.

As a speaker, you must remember that you are in view of the audience even when you are seated. You can help to focus attention on the speaker by looking at him and showing interest in his remarks.

Wear a name plate (or place a card before

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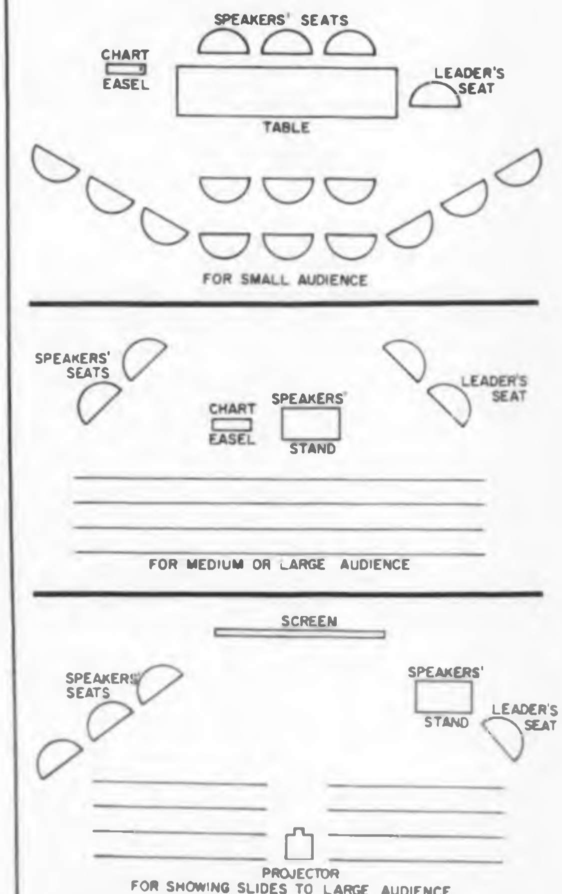

Room arrangements for presentations to small, medium and large audiences should be planned. Visual aids (and audio, including a public-address system, if needed) should suit the size of the audience.

you with your name printed large enough for the audience to see) to help the audience when it wants to address you during the question-and-answer period. Courtesy requires that you stand to answer questions or to deliver a talk. To add to the "team-ness" of the presentation, you can hold one another's visual aids, run projectors, etc. Audiences are influenced by a speaker's appearance; make the most favorable impression possible in this respect.

As for staging arrangements, the primary requisites are easy access from the speaker's chair to the lectern, seating that permits the audience to view each participant and the team leader, and a prominent position for displaying the visual aids. A little forethought in planning the stage arrangements

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will make the rest of the presentation go more smoothly.

Plan Question-Answer Period With Several Categories in Mind

Because the question-and-answer period can't be prepared for as specifically as a talk can be, it is often a cause for concern. You will not be overwhelmed by questions if you remember that replies generally fall in just a few categories:

Report—The most common form of reply is a straightforward factual account of what was done, who did it, how it was done, when, where, and why.

Remind—If your questioner asks for information previously given during the presentation, tactfully remind him that the topic was already covered and summarize the content briefly.

Recommend—Often specific information is called for that you may not have. If this is the case, do not make up answers that might later discredit you and your company. Tell the person you do not know *the* answer but will give him *an* answer. Recommend several possible approaches.

Redirect—If you can't answer a question in any way, there are two suitable options. First, you can pass the question on to someone who might be better able to answer it. Second, you can write it down and promise to send the answer by mail. Of course, this promise must be kept promptly.

Rehearsed—If you can anticipate what some questions will be, you can rehearse answers in advance to ensure a ready, accurate, thought-out reply. (A side benefit from this is that if the audience is slow in starting to ask questions, the team leader can ask one of these previously prepared questions to start the question-and-answer session off.)

Restate—When questions are asked that don't make sense as worded or that you are not immediately prepared to answer, you can gain time by restating the question in your own words and asking the questioner to verify the meaning and intent.

Your success in making effective sales presentations may very well have a bearing on your advancement in the concern. Even if your main interest is not in selling electronic products, sooner or later, as an engineer, you will have to present and "sell" your own ideas. The techniques you learn in making "enforced" sales presentations will stand you in good stead then. ■ ■

ADVERTISERS' INDEX

September 13, 1961

Advertiser — *Page*

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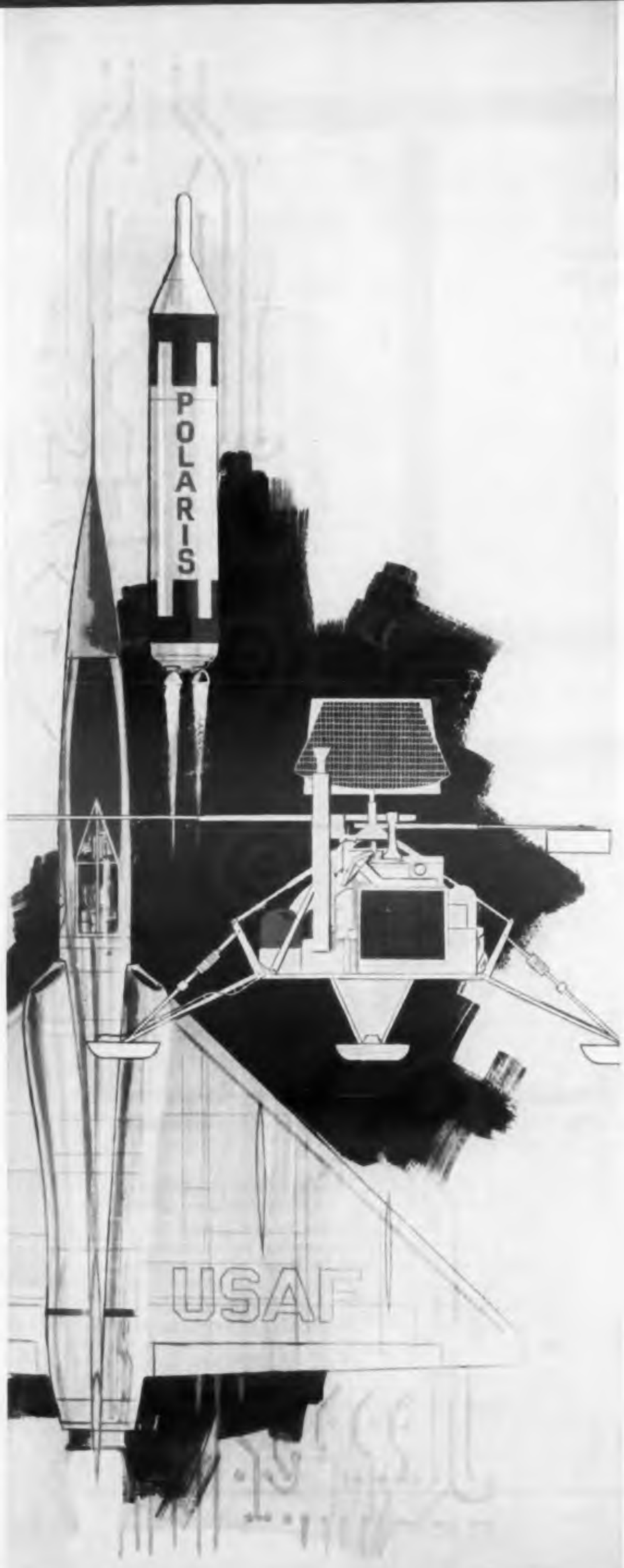

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Name ______________________ Title ______________________

Company ______________________

Company Address ______________________ City ______________________ Zone ______ State ______

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290
1	11	21	31	41	51	61	71	81	91	101	111	121	131	141	151	161	171	181	191	201	211	221	231	241	251	261	271	281	291
2	12	22	32	42	52	62	72	82	92	102	112	122	132	142	152	162	172	182	192	202	212	222	232	242	252	262	272	282	292
3	13	23	33	43	53	63	73	83	93	103	113	123	133	143	153	163	173	183	193	203	213	223	233	243	253	263	273	283	293
4	14	24	34	44	54	64	74	84	94	104	114	124	134	144	154	164	174	184	194	204	214	224	234	244	254	264	274	284	294
5	15	25	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175	185	195	205	215	225	235	245	255	265	275	285	295
6	16	26	36	46	56	66	76	86	96	106	116	126	136	146	156	166	176	186	196	206	216	226	236	246	256	266	276	286	296
7	17	27	37	47	57	67	77	87	97	107	117	127	137	147	157	167	177	187	197	207	217	227	237	247	257	267	277	287	297
8	18	28	38	48	58	68	78	88	98	108	118	128	138	148	158	168	178	188	198	208	218	228	238	248	258	268	278	288	298
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300	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590
301	311	321	331	341	351	361	371	381	391	401	411	421	431	441	451	461	471	481	491	501	511	521	531	541	551	561	571	581	591
302	312	322	332	342	352	362	372	382	392	402	412	422	432	442	452	462	472	482	492	502	512	522	532	542	552	562	572	582	592
303	313	323	333	343	353	363	373	383	393	403	413	423	433	443	453	463	473	483	493	503	513	523	533	543	553	563	573	583	593
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305	315	325	335	345	355	365	375	385	395	405	415	425	435	445	455	465	475	485	495	505	515	525	535	545	555	565	575	585	595
306	316	326	336	346	356	366	376	386	396	406	416	426	436	446	456	466	476	486	496	506	516	526	536	546	556	566	576	586	596
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309	319	329	339	349	359	369	379	389	399	409	419	429	439	449	459	469	479	489	499	509	519	529	539	549	559	569	579	589	599

600	610	620	630	640	650	660	670	680	690	700	710	720	730	740	750	760	770	780	790	For employment brochures	870	880	890
601	611	621	631	641	651	661	671	681	691	701	711	721	731	741	751	761	771	781	791	give home address	871	881	891
602	612	622	632	642	652	662	672	682	692	702	712	722	732	742	752	762	772	782	792		872	882	892
603	613	623	633	643	653	663	673	683	693	703	713	723	733	743	753	763	773	783	793		873	883	893
604	614	624	634	644	654	664	674	684	694	704	714	724	734	744	754	764	774	784	794		874	884	894
605	615	625	635	645	655	665	675	685	695	705	715	725	735	745	755	765	775	785	795		875	885	895
606	616	626	636	646	656	666	676	686	696	706	716	726	736	746	756	766	776	786	796		876	886	896
607	617	627	637	647	657	667	677	687	697	707	717	727	737	747	757	767	777	787	797		877	887	897
608	618	628	638	648	658	668	678	688	698	708	718	728	738	748	758	768	778	788	798		878	888	898
609	619	629	639	649	659	669	679	689	699	709	719	729	739	749	759	769	779	789	799		879	889	899

If 25 or more items circled
please describe reasons:

For Change of Address:
Old Company Name ______________________

Old Company Address ______________________ City ______________ Zone ______ State ______

- ☐ I Do Design Work
- ☐ I Supervise Design Work
- ☐ I Do No Design Work

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Company ______________________

Company Address ______________________ City ______________________ Zone ______ State ______

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Characteristic	Your requirement
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Collimation simplicity	______
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Type Number	Description	Maximum Diameter (Inches)	Minimum Useful Viewing Diameter (Inches)	Writing Speed (Inches) per Second)	Maximum Brightness (Foot-lamberts)	Typical Resolution (Lines per Inch)
2053	High-writing speed catches microsecond phenomena. Integral magnetic shield. Electrostatic Deflection.	5.56	3.8	300,000	2500	50
4412	Large Screen. Designed to withstand severe environmental conditions of shock, vibration, temperature, humidity, altitude. Integral magnetic shield. Electrostatic deflection.	10.88	8	30,000	200	44
7183	Magnetic Deflection.	5.19	4	—	12000	50
7315	Slow writing speed. Excellent integrating and half-tone capabilities. Electrostatic Deflection.	5.31	3.8	3,000	2500	50
7448	High writing speed to "freeze" microsecond transients. Electrostatic Deflection.	5.31	3.8	300,000	2500	50
C73904	Two writing guns for simultaneous writing of two independent signals. Electrostatic Deflection.	5.31	3.8	75,000	2500	50
C73922	Increased display area. Selective erasing gun erases specific parts of stored signal without affecting other parts. Electrostatic Deflection.	7	5.2	8,000	750	45
C73959	High-resolution capability with slow writing speed. Electrostatic Deflection.	5.31	3.8	3,000	200	110

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