

ELECTRONIC DESIGN

February 4, 1959

FEBRUARY 18, 1959

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An *ELECTRONIC DESIGN* Staff Report on

CONNECTIONS

... Page 53

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ON CENTER GEARHEAD RATIOS				OFF CENTER GEARHEAD RATIOS	
NO. OF CLUSTERS	RATIO	NO. OF CLUSTERS	RATIO	NO. OF CLUSTERS	RATIO
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5	348	3	43.35	3	98
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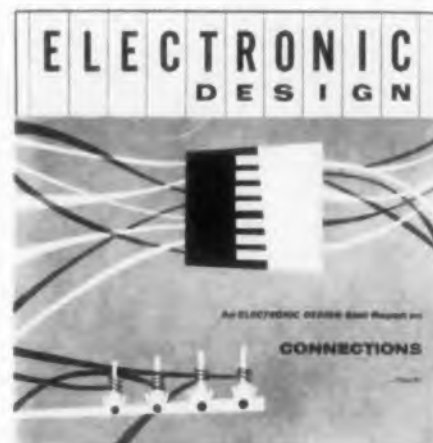
ENGINEERS—Join a dynamic leader in the field—Write David D. Brown, Personnel Director, Dept. D.

CLIFTON PRECISION PRODUCTS CO., INC.

CLIFTON HEIGHTS, PA.

CPPPC

HIGHLIGHTS OF ISSUE



Connections (Cover) 53

Connections play a vital part in the operation of any piece of electronic systems especially those built on a modular basis. Though the subject of connections may seem to be a simple one, it is not. Debates can easily be started among people who specify them whenever such topics as solderless vs soldered connections, or eyeletted vs plated-through holes are broached. This issue of ELECTRONIC DESIGN contains a special report on connection developments made within the last year. It reviews the latest trends and some of the newest connectors made available.

Component Temperatures in Forced-Air Cooled Equipment 24

Air temperature is electronic equipment varies rapidly. Therefore, it is nearly impossible to predict accurately component operating temperature by measuring air temperature. This article shows how components can be rated by surface temperature, resulting in a simple method of temperature prediction.

Russian Translation Availability 178

ELECTRONIC DESIGN suspends its pioneer progress in the translation of Russian magazine contents with this issue as the government and others are now performing the service. A table of current sources is given.

Next Issue

Preview of Products
at the
1959
IRE National Convention
and
Radio Engineering Show

← CIRCLE 1 ON READER-SERVICE CARD

FEB 13 1959

February 18, 1959 Vol. 7

N U M B E R

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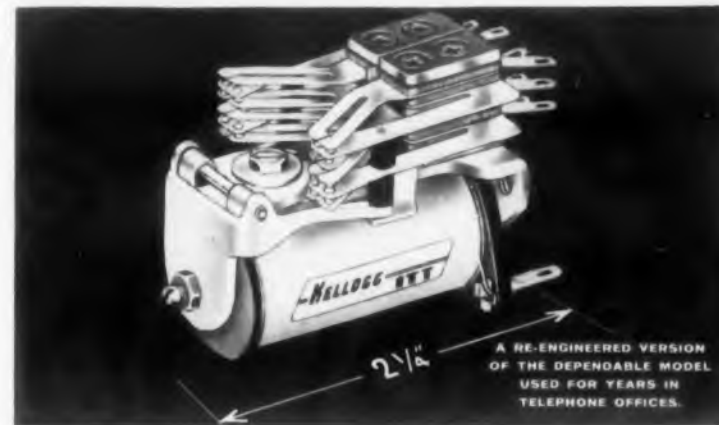


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Dimensions: 2-1/4" L x 1-1/8" W, height ranges from 17/32" to 1-1/16" (max.)

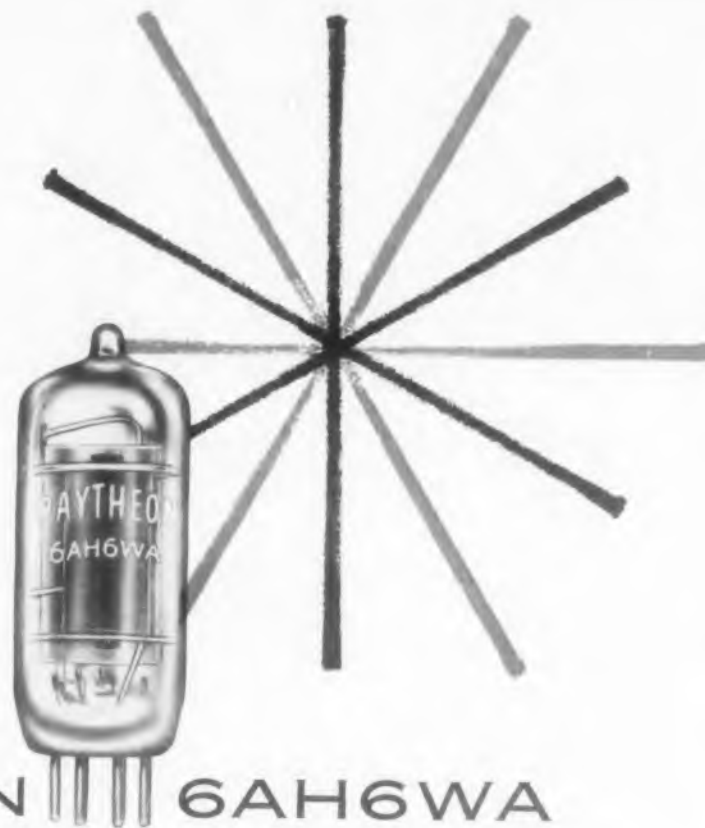
Operating voltages: up to 220 volts D.C.

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CIRCLE 3 ON READER-SERVICE CARD

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BEHIND THE NEWS

Simple Electronic Circuit Simulates Living Nerve Cell

EXPERIMENTAL electronic circuits are being used to simulate functions of the biological nerve cell, or neuron, on basic research on signal interpretation by the brain. Groups of circuits have been combined into networks that are roughly analogous to the nerve systems of the eye and ear. Scientists at Bell Telephone Laboratories hope to improve methods of communication from results and knowledge gained from these experiments.

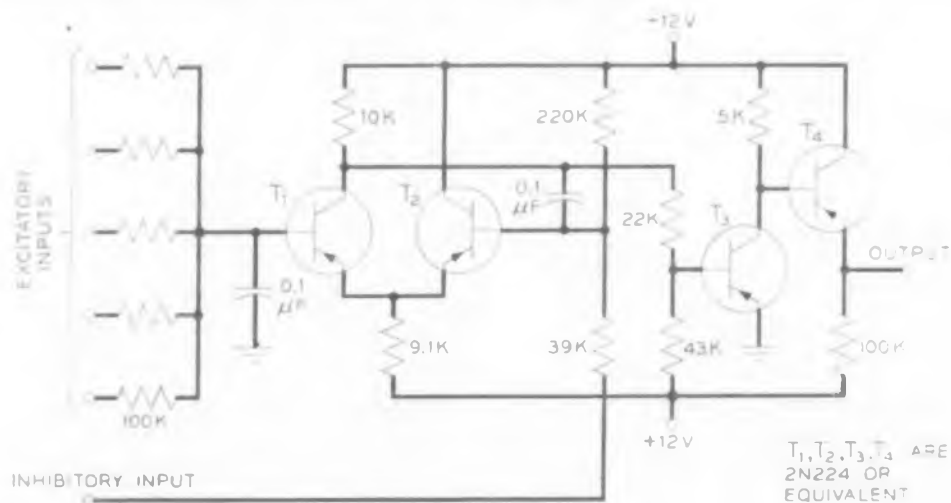
The neuron circuit, consisting of four transistors plus associated components, is mounted on a 3" x 4" printed circuit card with plug-in facilities for ease in circuit grouping. Since inputs and outputs are compatible, the cells can be assembled into chains and assemblies.

Designed by R. M. Wolfe, the circuit fires electrical pulses of standard amplitude and dura-

tion, similar to the action of a biological cell. If the circuit is driven by a constant stimulus, simulating receptor cells as in the eye or ear, trains of pulses are emitted. A higher intensity of excitation increases the frequency of pulsing; when the neuron is excited continuously, the frequency of pulses can be made to decrease with time, exhibiting accommodation like a living nerve cell.

Input excitation must, as in a biological cell, surpass a threshold value, and the cell will integrate two or more input pulses below threshold value to cause firing. A particular input connection can also, while energized, inhibit firing of the neuron by other inputs. Similarly, immediately after firing, the electronic neuron's threshold rises to infinity and for a few milliseconds no input signal can fire the neuron again.

(Continued on following page)



Schematic of electronic nerve cell (left).

A network of electronic nerve cells (right) is assembled by L. D. Harmon, who initiated the project at Bell Telephone Laboratories.



Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON MANUFACTURING COMPANY, WALTHAM 54, MASS., Vol. 1, No. 2

NEW ONE-WATT COMMUNICATION KLYSTRONS COVER GOVERNMENT AND COMMON CARRIER BANDS

Designed primarily for use in microwave relay links, the QK-661 and the QK-754, one-watt transmitter klystrons, operate at frequencies of 7,125 to 8,500 Mc and 5,925 to 6,425 Mc, respectively. The QK-661 is the first tube of its kind to cover the entire government band. The QK-754 is the first of a planned series of tubes to cover the entire communications band.

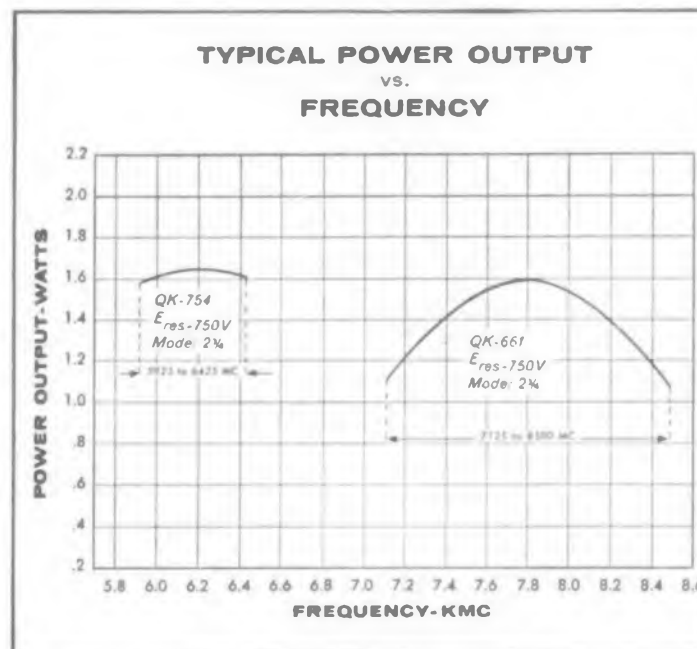
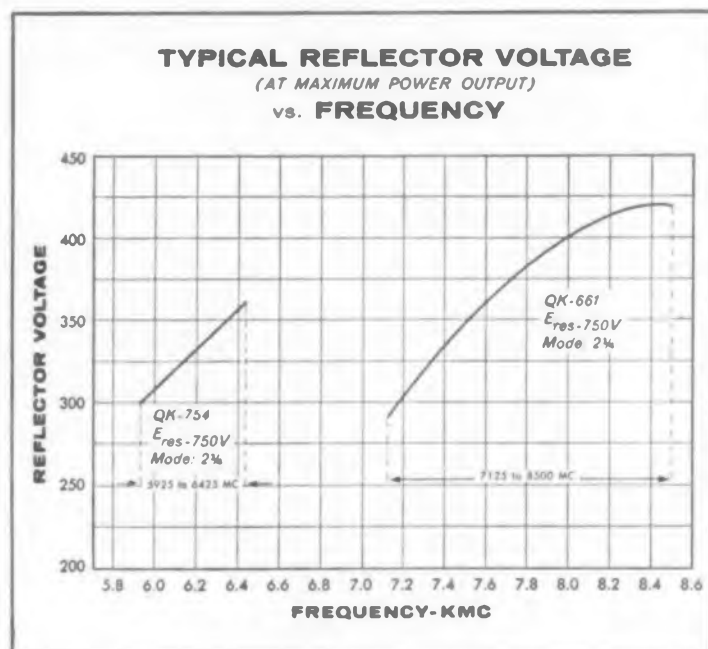
Both are mechanically tuned, integral-cavity, long-life, reflex-type tubes. The QK-754 uses a coaxial output; the QK-661, a waveguide output.

To insure efficient operation the tubes are available with integral cooling fins or with a heat-sink attachment suitable for connection to the chassis.



Typical operating characteristics

	QK-754	QK-661
Frequency Range	5925 to 6425 Mc	7125 to 8500 Mc
Power Output	1.5 watts	1.6 watts
Electronic Tuning (to half-power pts)	50 Mc	25 Mc
Modulation		
Sensitivity (10 V pk-to-pk mod volt)	1 Mc/V	600 Kc/V
Temp. Coefficient	± 0.1 Mc/°C	± 0.1 Mc/°C



You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Manufacturing Company, Waltham 54, Massachusetts

Excellence in Electronics



A LEADER IN CREATIVE MICROWAVE TECHNOLOGY

BEHIND THE NEWS

Electronic neurons can be combined with photo-resistive cells to simulate simple functions of nerves in the retina. Some receptors, known as "on" receptors, fire only when the light intensity they receive is increasing; "off" receptors fire only when the light is decreasing; and "during" receptors fire while they receive a steady light. Flicker-fusion phenomena have also been produced. In the human eye, these can cause a sequence of flashes to be seen as continuous illumination; this property of vision is exploited in motion pictures and television.

The mutual inhibition of cells in an array has been demonstrated experimentally. Some animals have been observed to possess this arrangement, in which a cell receiving a greater light intensity inhibits the firing of nearby cells that receive less light. This results in local sharpening of image boundary detail.

L. D. Harmon, who initiated the project, has combined the cells into groups that simulate simple functions of the eye, and similar experiments with ear models are being started by W. A. Van Bergeijk.

Wind Computer

To overcome the effects of near-surface winds on missile accuracy, a compact computer, using Perkin-Elmer Corp. adjustable nonlinear function generators, has been developed by the U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N. J.

Due to the relatively low velocity of a missile immediately after firing, near-surface winds have a considerable effect upon its trajectory. To insure that the missile hits a predicted impact point, low altitude winds must be determined accurately. Pilot balloon runs are made shortly before a firing to measure these winds, and to provide data from which their effect can be rapidly computed.



Tape from computer contains an answer to a specific air conditioning problem.

Computer to Determine Cooling Needs of Home

How large an air conditioning unit is required for a seven-room ranch house, facing northwest, and shaded by a grove of oak trees? An electronic analog computer developed by engineers of the Westinghouse Electric Corporation can analyze the facts about this and other dwellings and, in 24 seconds, come up with the answers to its cooling needs.

Known as "Warac" to signify "Westinghouse Analog Recording Air Conditioning Computer," the unit is designed to consider systematically over 50 factors which influence the indoor temperature of a house; information related to these factors is programmed into the machine.

The principle behind the analog computer's operation is that voltage represents temperature, and current is equated to the flow or transfer of heat. Capacitors serve to denote the storage of heat energy while resistors are comparable to thermal resistance.

The computer is likely to find application in major housing projects, where many homes are basically similar in construction, but varied in design, size and juxtaposition; factors which influence the size of the air conditioning unit which should be selected for each home. It also presents a very useful means of studying the type of home construction most economical from an air conditioning point of view.

The equipment will be initially used to train salesmen and dealers to properly determine air conditioning needs of prospective customers.



Missile Guidance—Body English

Contortions of the human body have not, as yet, proven themselves acceptable means for overcoming component failures in missile guidance systems. While you may be able to "will" a golf ball into a cup, no one has ever "willed" a missile back on course. We at Hughes Products feel that missile component reliability can take a more scientific form. The tight quality control procedures at Hughes Products insure you component reliability that can be counted upon, even under the most severe environmental conditions.

On the following three right-hand pages you will find specific examples of reliable Hughes Products components—Gold Bonded Germanium

Diodes, TONOTRON* storage tubes, and High Frequency Crystal Filters.

In addition to these, other Hughes Products devices which provide you with this "built-in" reliability include: Special-purpose oscilloscopes...Rotary Switches...Thermal Relays...MEMOTRON® and TYPOTRON® display storage tubes...Diodes, Transistors and Rectifiers with uniform performance...and Industrial Systems which automate a complete and integrated line of machine tools.

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For additional information regarding any component or system please write: Hughes Products, Marketing Dept., International Airport Station, Los Angeles 45, California.

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MTR636-30	6-36	30
MTR28-2	24-32	2
MTR28-5	24-32	5
MTR28-10	24-32	10
MTR28-30	24-32	30
MTR28-100	24-32	100

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VOLTAGE "SPIKES" IN THE D. C. OUTPUT.

D. C. OUTPUT:	6-36 Volts @ 15 Amperes
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STATIC REGULATION:	Line — ± 25 MV; Load — ± 50 MV
DYNAMIC REGULATION:	Line: ± 50 MV; Load: ± 75 V. No Load to full load & FL to NL
RIPPLE:	5 MV RMS Maximum
DYNAMIC IMPEDANCE:	50 Milliohms (0 CPS to 20 KC)
PROTECTION:	Short Circuit Proof — Automatic Current Limiting at 18 Amperes. (Short Circuits and Overloads can be sustained indefinitely without damage to the power supply)
WEIGHT:	Approximately 125 Lbs.
DIMENSIONS:	19" W x 15" D x 12 $\frac{1}{4}$ " H (Rack panel mount) 20 $\frac{1}{2}$ " W x 16 $\frac{1}{4}$ " D x 14" H (in cabinet)
SPECIAL FEATURE:	Through the use of a special combination magnetic amplifier transistor circuit and conservative design techniques, this power supply provides full load output even in the case of a transistor failure.

CIRCLE 6 ON READER-SERVICE CARD

BEHIND THE NEWS



Western Electric engineer measures thickness of synthetic quartz crystals grown in pilot plant at rate better than 60 thousandths of an inch daily.

Large Synthetic Quartz Crystals Produced in WE Pilot Plant

Pilot plant production of large synthetic quartz crystals for telephone communications purposes has proved so successful that its innovators, Western Electric and Bell Telephone Labs, now compare it in importance with production of synthetic rubber, nylon and rayon.

The Bell System, which uses large quantities of quartz for filters, oscillators and frequency standards, first felt the natural supply shortage in World War II, when it had to use other piezoelectric materials as substitutes in sonar and communication devices. Natural quartz crystals, largely mined by free-lance operators in Brazil, are no more abundant today, and Bell turned to engineering to supplement or substitute for nature.

Bell Labs scaled up its hydrothermal process to the pilot plant stage, and ultra-modern production facilities were set up at Western Electric's Merrimack Valley Works in North Andover, Mass.

Quartz crystals five to six inches long and two to three inches in each cross-section dimension now are being grown. Economical growth rate "considerably in excess of 60 thousandths of an inch per day," was reported.

Advantages of Synthetic Quartz

In addition to its availability in quantity and

size, synthetic quartz offers these advantages over natural quartz:

- Seeds can be cut so as to grow crystals which can be sawed in the most efficient manner.

- Synthetic quartz has natural crystal faces allowing easier orientation of the stock for cutting into units.

- It has none of the foreign inclusions of natural quartz.

- It can be produced without optical or electrical twinning.

The greater yield resulting from these factors was estimated at two-and-a-half times that of natural quartz.

Crystal Growth Process

In the hydrothermal process, the nutrient (now small pieces of natural quartz, eventually high quality sand) is placed in the bottom of an autoclave filled with sodium hydroxide. Seed plates cut from either natural or synthetic quartz crystals are hung from a rack in the upper section of the vertically mounted autoclave, which is then sealed. The high-pressure autoclave is maintained under a constant temperature differential from top to bottom for the requisite processing time—from a week to several weeks, depending on the experiment.

The process depends on maintenance of the temperature differential between the nutrient area and the seed plate area. The nutrient dissolves in the hotter lower region and is carried by convection currents to the upper region. The lower temperature here leads to a supersaturated condition in the nutrient solution, which causes the dissolved quartz to redeposit onto the seed plates in single crystal form.

Can Satellite Broadcast After Its Batteries Have Gone Dead?

The possibility of a radio station which would continue to broadcast after losing its electrical power source is being explored at Michigan State University by Dr. Wells and Dr. Leitner under a grant from the U. S. Army Ordnance Research Office.

If an antenna were broadcasting on exactly the right frequency for its size, Drs. Wells and Leitner believe it would continue to broadcast after losing its power source.

"To use a poor analogy," Dr. Wells explained, "It would be remotely similar to a pendulum continuing to swing for a short time after the force that started it has been removed. In this case, the antenna would continue to oscillate after losing its power."



seven shades of gray

with the Hughes TONOTRON* Storage Tube

Able to present as many as seven shades of gray, the Hughes TONOTRON* cathode-ray storage tube now provides you with high-fidelity picture reproduction.

In addition, the Hughes TONOTRON* tube features high picture brightness (in excess of 1500 foot lamberts with full half-tone range) and controllable persistence.

Other Hughes electron tubes include the MEMOTRON® storage tube, the TYPOTRON® storage tube, and a family of microwave tubes. With a wide variety of reliable tubes designed to meet your strictest requirements, Hughes continues to maintain leadership in the field of storage and microwave tubes.



Typical installation in a commercial aircraft.

*TRADE-MARK OF H. A. C.

Collins Airborne Weather Radar System WP-101 incorporates the Hughes Type 7033 Magnetic Deflection TONOTRON* tube. This system provides the pilot with a continuous high-fidelity picture of weather conditions within a radius of 150 miles. Ground mapping—a secondary function—shows the location of cities, lakes, rivers, mountains, and shorelines, and dangerous obstacles. *Even in direct sunlight, no viewing hood is required.*

For additional information regarding any of the Hughes electron tubes please write: Hughes Products, Marketing Dept.—ELECTRON TUBES, International Airport Station, Los Angeles 45, California.

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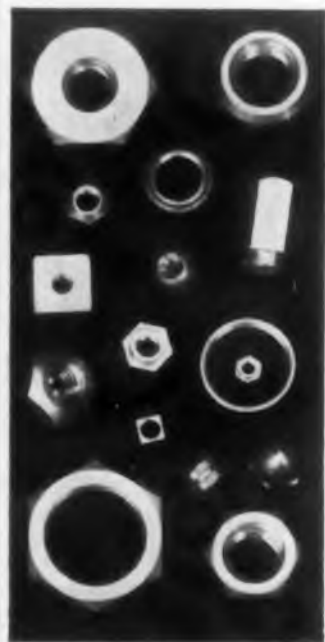
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CIRCLE 7 ON READER-SERVICE CARD



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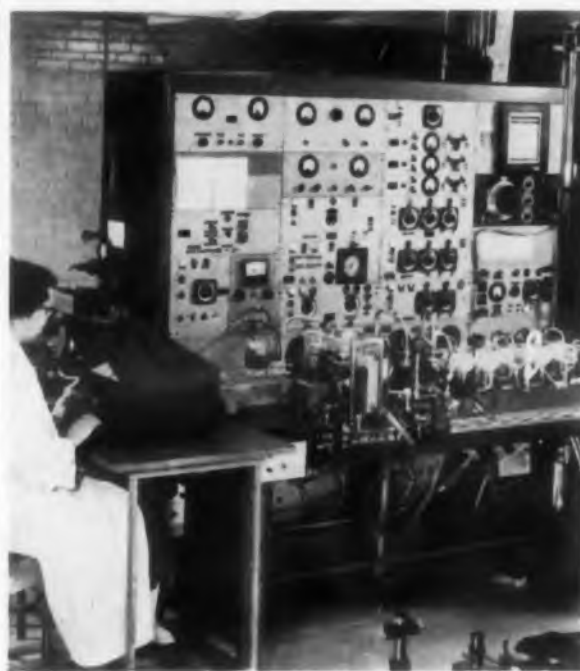
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CIRCLE 8 ON READER-SERVICE CARD

BEHIND THE NEWS



AUTO ETCH-PLATE MECHANISM



SHUFFLEBOARD MACHINE

Transistor

THREE times faster than manual methods, a series of machines, two of which are completely automated and account for 33 operations, can produce 450 transistors an hour. The F.A.T. line (fast automation transfer), developed at Philco's Lansdale Tube Company Division, is capable of etching and plating the germanium blank of a transistor to precise measurements, as thin as 0.0017 in. It forms and attaches fine wires to the electrodes and chemically cleans, washes and dries the assembly. It checks itself through control points that feed back corrective information to previous operations. With manual assistance it vacuum dries and bakes the assembly and pressure welds the tops.

With the F.A.T. line, 18 workers can assemble and test about 1,000,000 transistors a year. This rate is several times faster than present methods of transistor production using the same labor. Types of transistors initially being produced by automation methods are high and middle

frequency varieties for use in portable radios, automobile radios, phonographs, eventually in television receivers. Transistorized portable television sets manufactured at reasonable cost are envisioned in the near future.

Carrier Concept

The key problem in the automation of transistor production was the ability to transfer transistors with precision from operation to operation across the assembly line shown in three photographs above. In answer to this problem, the carrier concept evolved. The carrier is a stainless steel block fitted with a grip-jaw which positions the transistor's germanium blank for various operations with precision as the assembly proceeds via an automatic transfer conveyor through the machines.

The first photograph shows a hooded instrument where germanium blanks are soldered to a tab on the carrier. The carrier is then placed on a conveyor belt



→ ROTARY COLD WELD

Automation

and moves to the auto etch-plate mechanism. Here the emitter and collector are etched and plated. The second photograph shows the shuffleboard machine where the whiskers are attached to the emitter and collector. The final photograph shows the dust shield where both whiskers are welded to respective stem levels. The operator to the extreme right cold welds the top case to the stem and the completed transistor then goes to final testing.

Reduction In Cost

Price reduction is an important result of these automation techniques. As an example, one type of MADT, 2N999, in quantities of 100 and more is now priced at \$3.50, whereas transistors of this type in the same quantity were formerly priced at \$5.50. Significant price reductions are also effective on most alloy junction types. This will also affect the prices of many electro-chemical types of transistors.



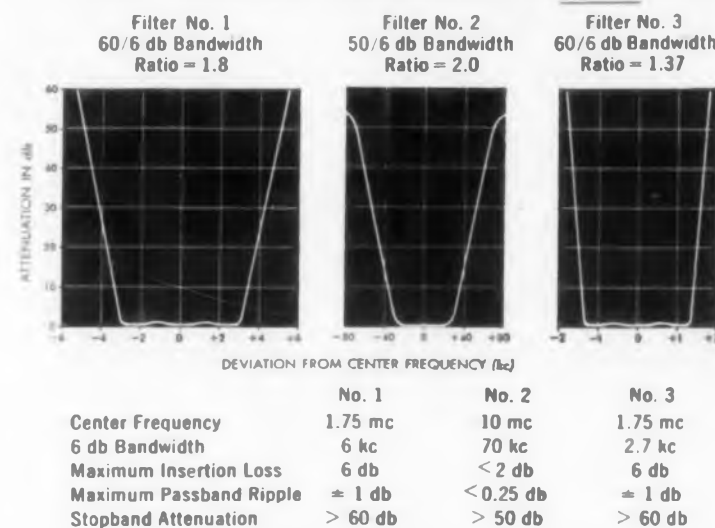
precision performance levels set by Hughes Crystal Filters

Hughes Products now offers high performance crystal filters previously available only for special military developmental contracts and Hughes-built systems. Utilizing unique design and advanced manufacturing techniques, these Hughes crystal filters provide a degree of performance previously unattainable.

With center frequencies of 30 kc to 30 mc and fractional bandwidths of 0.01% to 6%, these crystal filters have seven distinct advantages:

1. High frequency filtering
2. High selectivity
3. Low passband ripple
4. Low insertion loss
5. Small size and weight
6. Excellent temperature stability
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SPECIFIC PERFORMANCE CHARACTERISTICS FOR TYPICAL FILTERS



For further information please write HUGHES PRODUCTS, Crystal Filters, International Airport Station, Los Angeles 45, Calif.

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\$845.00

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1. Standard Cell Reference
2. Direct in-line readout
3. Mirror Scale Meter
4. Eight Search and four Null ranges

DC

Accuracy: .05% from .1 volt to 500 volts

Input voltage ranges: 500-50-5-.5v

Null ranges: 10-1-.1-.01v

Input Resistance: Infinite at Null

Resolution: .005v at 500v to .00005v at .1v

AC

Accuracy: .2% from .5 volt to 500 volts from 30 CPS to 5 KC

Input voltage ranges: 500-50-5v

Null ranges: 10-1-.1-.01v

Input Impedance: 1 Meg. shunted by approx. 25 mmf

Resolution: .005v at 500v to .00005v at .1v

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CIRCLE 10 ON READER-SERVICE CARD

BEHIND THE NEWS

Mechanization of Drafting Heralds A "Revolution"

Mechanization of drafting to the extent that it is diagrammatic, noncreative and conventionalized, according to engineering theorists, would be the ultimate stage in design efficiency—a stage presumed beyond this decade. But now the Intertype Co. and General Electric have combined their talents to come up with a system that permits mechanical drafting of elementary diagrams.

The development is timely. For in today's complex technology of multimillion parts, components and circuits requiring multimillion drawings to be delineated, handled and filed, it is estimated that drafting and design costs represent 70 per cent of the average engineering budget.

Already a number of photographic methods for reducing and recovering filed drawings, plus use of templates, lettering devices and so-called drafting machines, have helped improve efficiency. But until now, the advances in the field have not greatly reduced the draftsman's drudgery.

Along with these advances there has developed a trend away from the beautiful drawing with over-detailed and projected views, toward the simplified freehand drawing—a trend from art to communication. Where employed, this "functional" drafting has saved from 30 to 50 per cent of the time ordinarily spent on "text-book" drafting, though it has done little to reduce the size of diagrams for easier reference, or to permit their wider distribution.

The Next Step

But now the engineering fraternity is going a step further. Despite a few murmurs of protest based on the old bugaboo of "technocracy," the old fear of machines displacing men, industry is beginning to move into that ultimate stage of drafting and design efficiency.

Application to drafting of Intertype's 22-year-old concept of photographic composition has made possible and practical the mechanical ruling of lines, drawing of symbols and lettering of identifications, specifications and instructions. According to those now using the method, a real "revolution" in drafting techniques looms for many industries, not the least of them electronics.

For cost-conscious electronics executives, the recent Harris-Intertype Corp. seminar at which the machine and the method were demonstrated proved to be an eye opener. They saw a man with one week's experience on the modified Intertype perform in two hours a drafting job that

took 12 hours by hand. While the \$31,500 cost of Intertype's Fotosetter seemed to rule it out for all but heavy-volume production, the \$560 monthly rental was judged close to the monthly salary of just one draftsman skilled enough to do such a job in 12 hours.

Conceived in 1936 and produced in 1949, the Intertype Fotosetter is much like an ordinary type-setting machine except that its matrices contain a film negative instead of hollow molds or hot lead type.

For ordinary printing, the film negative has the image of a letter of the alphabet. But for drafting with the system developed in the past two years by General Electric's industry control department at Roanoke, Va., the film negative carries the image of a line or of a symbol for a piece of equipment, such as resistor, transistor or coil.

When put together by the machine, the images provide a photograph of a complete electrical circuit design or any other elementary diagram, translated from the engineer's freehand "chicken scratches" to a uniform, legible drawing with easily handled 8-1/2 x 11 in. dimensions.

No Hand Work

No hand drafting is involved; the operator types out the diagram by pressing keys for any of the 228 available symbols designed by GE. The symbols are photographed at 480-per-min. rate. A film positive is made with all symbols and lines, another positive is made in a separate operation for textual data, and the two are overlaid and registered for making contact prints in any required quantity.

The resulting diagrams, one-fourth the size of hand drawings, are "sharper, more readable, more easily handled, less costly and are found to be highly acceptable to our customers," according to GE, now using two Fotosetters. Besides electrical diagramming, applications include electronic circuits, piping layouts, flow charts, and construction and architectural drawings.

The Fotosetter can be bought or rented from the Intertype Co. of Brooklyn, division of the Harris-Intertype Corp. Magazines of film matrices can be devised, in consultation with GE experts, to suit individual needs of firms.

Unveiled at Copyrama

At the recent Copyrama business show in Washington, meanwhile, a solution to the problem of copying engineering drawings quickly, accurately and inexpensively was offered. Equipment brought together in one system for that purpose included a microfilm camera, tabulating cards (each diecut to hold a single frame of film), and a xerographic device called a XeroX



GOLD BONDED

HUGHES GERMANIUM DIODES

first of all for reliability.

Typical performance levels: @ 25°C. unless otherwise stated		
Forward Current (I_F) (mA max.)	Inverse Current (I_R) (μ A max.) (@ Specified Voltage)	Maximum Inverse Voltage (Volts)
1N270	200	100 (@ -50V)
1N276	40	100 (@ -50V) 100 (@ -10V*)
1N277	100	250 (@ -50V*) 75 (@ -10V*)

*Measured @ 75°C.

*For additional information write: Hughes Products,
Marketing Dept.—Semiconductors, International
Airport Station, Los Angeles 45, California.*

Hughes gold bonded diodes exhibit fast recovery together with high forward conductance, low reverse leakage and high peak inverse voltage. They are fusion sealed in a subminiature one-piece glass envelope. This assures you complete isolation from damage or contamination.

Under varied and severe environmental and operating conditions, Hughes Gold Bonded diodes exhibit outstanding performance. You can be assured of reliable performance, since Hughes diodes exhibit the following characteristics: shock resistance... vibration resistance... thermal stability... electrical stability.

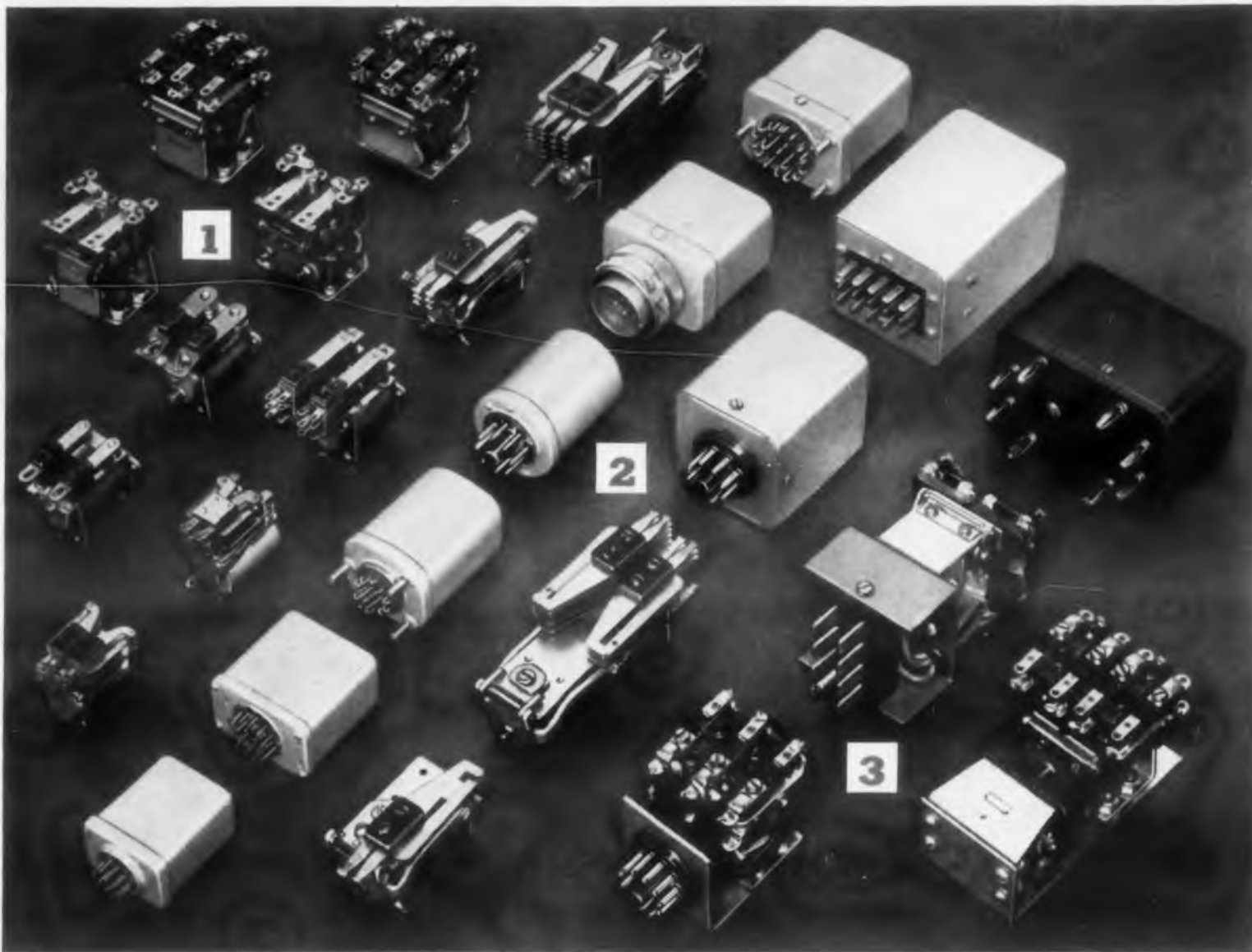
Creating a new world with ELECTRONICS

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3. Relays with Special Construction

EXCLUSIVE! Contact Combinations on New Ohmite Relays Are MOLDED

Permanence and ease of adjustment of the individual contact springs are the result of a revolutionary, new innovation found in two new Ohmite Relays—Models TT and TS. This innovation is the unique "Molded Module" contact spring construction. The "module" is a standard, single-pole, double-throw spring combination molded into a single compact assembly. As many as six modules can be incorporated into a relay. **(Pat. Applied For)*

QUALITY CONSTRUCTION All Ohmite relays embody the same meticulous engineering, strict quality control, and generous use of high quality materials which have made Ohmite components the standard of the industry. Parts are plated where necessary for corrosion resistance. Springs are of nickel-silver or phosphor-bronze. Contacts are fine silver. Special contact materials, such as silver, tungsten, palladium, or gold alloy, can be supplied. Protection against humidity and moisture is paramount and is accomplished in layer-wound coils, through complete sealing with cellulose-acetate. Relays are available in a wide range of coil operating voltages and contact combinations in both AC and DC types.

65 TYPES IN FOUR STOCK MODELS For fast service, four

models in the Ohmite relay line are carried in stock in 65 types at the factory, and by Ohmite Distributors from coast to coast.

HERMETICALLY SEALED AND DUST-TIGHT RELAYS—You can specify many of the basic Ohmite relays in nonremovable, hermetically sealed enclosures for applications requiring complete relay protection. These high-quality relays are sealed in seamless steel enclosures which are exhausted and filled with dry, inert gas under control of Ohmite engineers. Ohmite hermetically sealed relays are available with either plug-in or solder terminals. Relays are also made with nonremovable dust-tight covers and removable dust covers.

RELAYS WITH SPECIAL CONSTRUCTION—Ohmite relays are available with special terminals or special construction, such as relays with push-on or screw terminals, relays with binding-post terminals. Where quantities warrant, Ohmite will manufacture relays made to your specifications. Ohmite can furnish not only special terminals, special contact combinations, contact materials, and coils but also special enclosures, connectors, impregnation, or frames. Ohmite relays can be engineered to meet your special pull-in, drop-out, or time-delay requirements.

For your special or unusual relay applications, let Ohmite's experienced engineers help you work out the best solution.

Write on company letterhead for Catalog and Engineering Manual 58

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RELAYS
TAP SWITCHES
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VARIABLE TRANSFORMERS
DIODES

BEHIND THE NEWS

Copyflo 24 (trade mark) continuous printer that automatically spews out printed material at a rate of 20 feet a minute.

Enlarging microfilm back into workable prints on a high volume basis has proved costly, and Xerography is being hailed as the solution. It is a near-instantaneous copying process that reproduces from microfilm onto plain, unsensitized paper. It turns out dry, inexpensive prints up to 24 inches wide.

New Filmsort Machines

The Filmsort Co. of Pearl River, N.Y., division of Miehle-Goss-Dexter, Inc., meanwhile announced that six new machines to be used with microfilmed engineering drawings in Filmsort aperture cards are being released early this year.

They will include two small engineering readers, two larger-sized engineering readers, a manually operated card-to-card diazo UNPrinter, and a raised semiautomatic optical mounter. In addition, a completely redesigned automatic card-to-card diazo UNPrinter is scheduled for release later this year.



From -1 to 6% Efficiency

Among new thermoelectric generators developed by Minnesota Mining and Manufacturing is this five-watt air-cooled unit for use with an isotope heat source, operating at six per cent efficiency. (See ED Nov. 12, 1958, p 10 for other recent developments.) The 3M generators use heat applied to semiconducting materials. In addition to this air-cooled unit, 3M is designing others for cooling with water or by radiation. New units, which conceivably could range from 1/2-watt to several thousand watts, will include some commercial applications.

CIRCLE 13 ON READER-SERVICE CARD

TUBE DESIGN NEWS

FROM THE RECEIVING TUBE DEPARTMENT OF GENERAL ELECTRIC COMPANY



Five-Star 6829's Help Guide Atlas ICBMs to Target 6,325 Miles Distant And into Earth-Circling Orbit!



High reliability of General Electric's 6829 twin triode was a factor in the historic full-range test flight of Convair's U.S. Air Force Atlas missile November 28—the nose-cone dropping well within the target area.

Ground radio-command guidance for the range shot used 6829's both in computer sockets, and for general-purpose triode functions such as cathode-follower, coincidence, pulse-generator or amplifier, and gating.

In the Atlas satellite shot, Type 6829 was used for many ground-base sockets because of its dependability. DC and pulse life tests of hundreds of 6829's show 1,350,000 tube hours with no defectives.

With high perveance, μ , and transconductance, plus uniform, controlled cut-off, the 6829 is a military tube having wide usefulness. Ask any General Electric tube office on the next page for circuit applications!

Six 7077 Ceramic Triodes Used in RF Stage of Collins ARC-52 Military Communications System

Low noise, high gain, exceptionally small size—these qualities of General Electric's 7077 were responsible for Collins Radio Company's choice

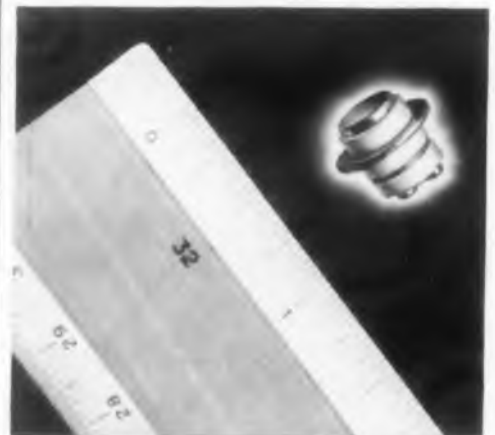
of the tube for RF amplifier and mixer sockets in their new military airborne communications equipment.

Now in production, Collins' advanced system meets the needs of the newest, fastest planes because of its communications range, compact size, and ability to stand up in hard service. The tough metal-ceramic construction of Type 7077 contributes to the ARC-52's ruggedness.

New 5-Star 6688 Amplifier Pentode Features High G_m -to-Cap. Ratio!

Developed for use in broad-band IF amplifiers, General Electric's new high-reliability 6688 has a transconductance of 180 micromhos per microfarad of tube capacitance (G_m over $2\pi \times C_{in} \times C_{out}$), or approximately twice that of Type 5651/6AK5. Double the gain bandwidth product of the 5651 may therefore be anticipated from the new tube.

Also the frame-grid design of the new 6688 makes possible a very high G_m -to-cathode-current ratio. This helps produce an exceptionally low-noise grid-cathode structure. See next page for information on the performance of General Electric's 6688 when the tube is triode-connected!



This actual-size picture of the G-E 7077 shows the triode's small dimensions—only .44" long by .48" wide. Extreme compactness was one reason Collins specified Type 7077.



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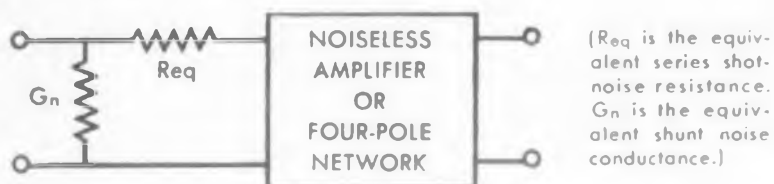
Tear off and keep this sheet for reference. It contains useful tube-application data.

New Parameters Help Pinpoint Tube RF Noise Characteristics!

Designer's Choice of Correct Type Made Easier
by Curves That Show R_{eq} and G_n
as Functions of Tube Operating Frequency!

The curves at right enable the circuit designer to analyze, in advance, the noise characteristics of a triode at different frequencies of operation. Type 6688, triode-connected, has been chosen for this example.

The equivalent parameters employed— R_{eq} and G_n —are based on recent work* on the specification of tubes at high frequencies. The fundamental circuit is:



The value R_{eq} already is familiar as the term for shot-noise resistance, and describes the relative amount of shot-noise voltage present in the tube. G_n is a comparatively new term. G_n may be assumed to be equal to five times transit-time conductance, a familiar value.

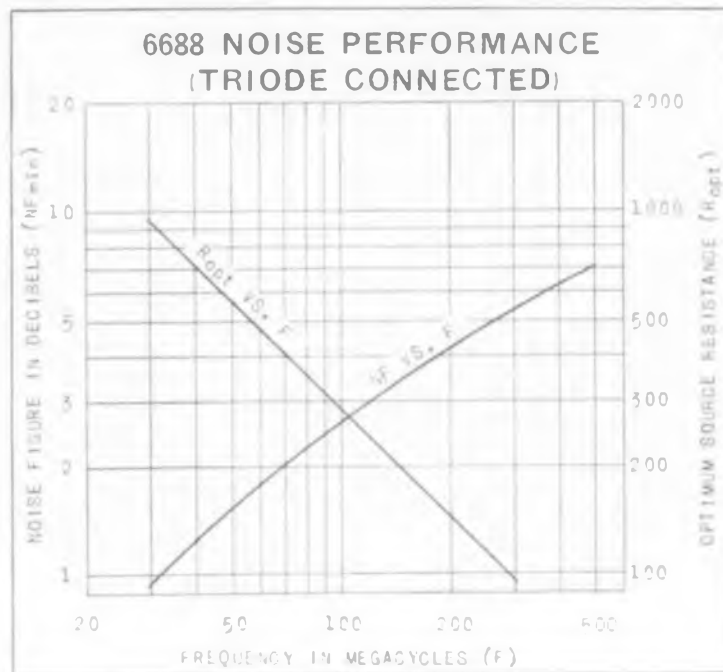
R_{eq} is essentially constant over a tube's useful frequency range, while G_n varies directly with frequency squared. In the light of these facts, simple equations can be written for minimum noise figure and optimum source resistance:

$$NF_{min} = 1 + 2 \frac{f_x}{f_0} \sqrt{R_{eq} G_n} \quad R_{opt} = \frac{f_0}{f_x} \sqrt{\frac{R_{eq}}{G_n}}$$

—where f_x is frequency at which noise figure and optimum source resistance are desired, and f_0 is frequency at which the value of G_n has been measured.

At lower right are values of R_{eq} and G_n , as measured on commercially available samples, for most of the popular high-frequency tube types. From these values, the noise characteristics of any type listed can easily be determined and charted. Ask any General Electric receiving-tube office listed below for additional facts!

* Rothe, H., and Dahlke, W., "Theory of Noisy Fourpoles", PROCEEDINGS OF THE I.R.E., Vol. 44 (June, 1956) pp 811-818.



MEASURED VALUES OF R_{eq} AND G_n

Tube type	R_{eq} (ohms)	G_n at 90 mc (micromhos)
Military and Industrial:		
6201	600	320
6688	120	1160
7077	350	140
Entertainment:		
6AM4	260	600
6AN4	250	550
6BC4	260	540
6BC8	600	320
6BK7-A	240	520
6BN4	420	390
6BQ7-A	435	290
6BZ7	490	350
6CE5	650	1200
2CY5	525	640
PC86	170	710

NOTE: pentodes are connected as triodes.

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

EASTERN REGION

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

CENTRAL REGION

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

WESTERN REGION

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

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GENERAL  ELECTRIC

2-411-101

"Banshee" Whistles When Surrounded by Radiation

Made from commercially available components, the Banshee is an inexpensive device that can provide the public with its own nuclear fall-out warning alarm. Though not in production yet, the estimated market cost would be about \$5.

Developed by Tracerlab of Waltham, Mass., the device can be used in any piece of electronic equipment with an audio section—radios, hi-fi and TV sets, and jukeboxes. Radiation causes an audible oscillatory effect; pitch and decibel level are proportional to the intensity of the nuclear field.

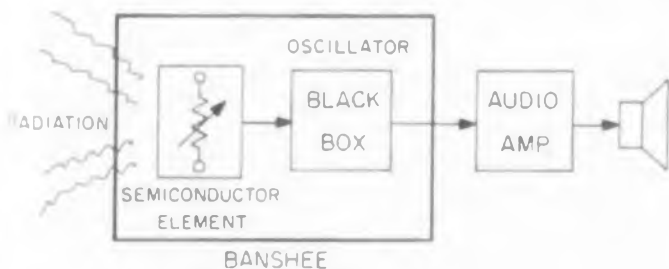
The brain of the Banshee is about the size of a pencil eraser. It can be made sensitive to as little as 100 milliroentgens of radiation per hour. At this radiation concentration the Banshee produces a popping sound. At a radiation density of 1 roentgen per hour and beyond, the unit causes a continuous high-pitched wail. Because of patent considerations, officials of Tracerlab are tight-lipped about publicly disclosing additional technical information.

They hint, however, that the active element of the Banshee is a semiconductor which changes its resistance with radiation. Changes in the resistance produce an oscillation as shown in the block diagram.

For use in audio sets having tubes, the Banshee can be packaged in a tube adapter. The tube is removed, the adapter plugged in, and then the tube placed into the adapter. How the Banshee would be packaged for transistor sets is still under consideration. The unit draws no current in the standby condition.

When used with auto or portable home radios, the unit can act as a pathfinder to lead survivors out of a radiation area. By travelling in the direction which causes the pitch of the wail from the radio to fall, a person can escape from the danger zone.

Banshees also existed in Scottish and Irish folklore; they were female spirits that wailed outside a house as a warning that a death would occur shortly in the family—in case you didn't know.



Banshee's brain is a semiconductor element whose resistance changes with the amount of nuclear radiation surrounding it.

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HIGH VOLTAGE, GLASS-ENCASED DIFILM® VITAMIN Q® CAPACITORS

New leakproof dual dielectric design meets severe life tests
... withstands high altitude applications

HIGH-ALTITUDE and HIGH-VOLTAGE capacitor applications in airborne electronic equipment are simplified with Sprague's new Type 205P Difilm Vitamin Q capacitors! These glass-encased, dual-dielectric capacitors are specifically designed to minimize corona problems.

In addition to their use in airborne equipment, Type 205P capacitors also find application in high-voltage ground equipment, including power supplies for transmitters, induction heating equipment, and electro-static precipitators... as well as in coupling and bypass applications in various industrial electronic control devices and allied equipment.

Ruggedness and dependability are built right into

these capacitors. Special, heavy-walled tempered glass housings encase the capacitor sections. A new end-seal design and a sealing technique eliminate the plague of impregnant leaks associated with other glass-encased capacitors. The dual dielectric used in Type 205P units results in capacitors with the best electrical properties of both polyester plastic film and the highest grade kraft condenser tissue. The outstanding electrical properties of Vitamin Q, Sprague's exclusive inert synthetic impregnant, are well known.

Type 205P capacitors are available in standard catalog ratings up to 10,000 volts for both 85°C and 125°C ambient temperatures; higher voltage designs are furnished to meet your special application needs.

For complete technical data, write for Engineering Bulletin No. 2312 to Technical Literature Section, Sprague Electric Company, 347 Marshall Street, North Adams, Massachusetts.

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CIRCLE 14 ON READER-SERVICE CARD

BEHIND THE NEWS

Instrumented Test Ship Joins Polaris Program

Polaris, heralded as the "ultimate" weapon, is a missile with intermediate range designed for intercontinental warfare, for its launching pad—a submerged submarine—could roam the world's coastlines, bringing targets near. But Polaris' worth will depend not only on the missile's ability to follow its ordered path; its effectiveness will be in direct ratio to the sub's ability to pinpoint its exact position at launch. And that problem, the Navy believes, has been solved by electronics.

Commissioning of the 17,600-ton U.S.S. Observation Island at Norfolk, Va., on Dec. 5 gave the Navy and its seven main Polaris contractors a highly instrumented flight test base. This base may justify the Navy's confidence in its navigational aids, and insure launch readiness for the fleet ballistic missile program by its 1960 target date.

First to Fire Polaris

The solid-fueled, 1500-mile Polaris will be fired from nuclear-powered subs being built by General Dynamics' Electric Boat Division. The Observation Island, operating out of Cape Canaveral, will be the first ship to test-fire the assembled IRBM.

The Observation Island also will serve as a meeting place and consulting center for engineers from across the country. They will come from Lockheed's test facility at the Cape; from Sperry Gyroscope's Great Neck, N.Y., plant supplying navigation equipment; from GE's Pittsfield, Mass., plant developing guidance and fire control components; from Westinghouse's Sunnyvale, Calif., plant now building launch equipment; from Aerojet-General's Sacramento, Calif., plant where rocket engines are being developed, and from North American Aviation's frame-making plants.

Data obtained from Polaris test shots will be sent to the Sunnyvale headquarters of Lockheed, the prime contractor, for reduction and analysis, then will be discussed with missile specialists of the Special Projects Office, Navy Bureau of Ordnance.

High-Precision Instrumentation

Instrumentation aboard the Observation Island, and ultimately aboard the Polaris subs, includes these systems from Sperry:

BEHLMAN INVERTRON® FOR 1959

SILENT, DEPENDABLE COMPLETELY

LOWER DISTORTION

Standard INVERTRONS are available with maximum distortion of 1% . . . or lower on special order.

BETTER REGULATION

Standard INVERTRONS feature voltage regulation of 1% no load to full load . . . with 0.1% or better available on special order.

HIGH QUALITY

Modular techniques result in neat, simplified chassis layouts at low cost with the very highest quality materials and workmanship . . . thus easing the problem of supplying units to special or military specifications.

VARIABLE or FIXED Frequencies

Wide range of exceptionally accurate variable or fixed output frequencies available, from 20 CPS to 3000 CPS . . . with other frequencies available on special order.

HIGHER POWER

Single phase Invertron available up to 5 KVA output, two phase up to 10 KVA output and three phase up to 15 KVA output . . . other power rating available on special order.

TYPICAL UNITS FROM OUR WIDE VARIETY OF STANDARD MODELS

SINGLE PHASE: Model 161-K-1 has an output of 160VA, single phase frequency variable from 300 to 2000 CPS; from an input of 115 volts, 60 CPS, single phase.

TWO PHASE: Model 502-C-1 has an output of 500 VA, two phase, frequency fixed at 400 CPS; from an input of 115 volts, 60 CPS, single phase.

THREE PHASE: Model 15003-D-1 has an output of 15 KVA, three phase, frequency variable from 350 to 450 CPS; from an input of 460 volts, 60 CPS, three phase.

SPECIAL UNITS TO ORDER

FIRST CHOICE of Missile and Aircraft

For further information . . . WRITE or CALL . . .

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VISIT OUR BOOTH NO. 3928 . . .

ELECTRONIC DESIGN • February 18, 1959

I (R)

AC ELECTRONIC POWER SOURCE

3



Printed circuit board is inserted into a GE Fire Control System computer, just one of the high-precision instruments installed aboard the test ship U.S.S. Observation Island under the Polaris program.

■ Ship's Inertial Navigation System (SINS), jam-proof, extremely accurate, entirely self contained, will determine the vessel's exact position, true heading, ground speed, pitch and roll. This arrangement of high-precision gyroscopes, accelerometers and integrators will permit extended underwater navigation without dependence on such external references as radio, radar or celestial fixes.

■ Navigational Data Assimilation Center (NAVDAC) will work in conjunction with SINS. Absorbing information from occasional references to sonar mapping, celestial fixes and dead reckoning, it will use digital computer techniques to collate, analyze, decode, and automatically feed the data back into the system.

■ Loran-C will provide radio navigation.

■ JOG LOG will measure ocean currents.

■ Mark 14 gyro-compasses, paired, will provide constant, accurate true-north indications to check on the inertial system.

■ Single steering stand will give the vessels what the Navy calls the tightest, completely automatic steering system in existence. Controlled by the pair of Mark 14's, it automatically will apply corrective rudder movement to compensate for the slightest direction change, with a rough-sea accuracy of plus or minus one degree.

■ Gyro Transfer Table System (GTTS) will

2



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Manufacturers ... for RESEARCH and DEVELOPMENT of GUIDANCE and INSTRUMENTATION

The INVERTRON'S exceptional stability makes it the favorite of the greatest names in space age hardware for AC power of types not obtainable from regular 60-cycle lines. Since it functions entirely electronically the Invertron eliminates the noise,

mechanical difficulties and lack of flexibility inherent in rotating equipment. In addition to a wide range of standard models, the INVERTRON is available in custom configurations at only slightly above production line prices.

INSTITUTE OF RADIO ENGINEERS SHOW

CIRCLE 16 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 18, 1959



These are *Simpson* panel instruments...



engineered and built to stay accurate...



available from stock
or custom-built

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BEHIND THE NEWS

align the missile's guidance system with the target.

Firing the Polaris

GE's contribution will be its Fire Control System, a battery of analog and digital computers which takes data from SINS, combines it with precalculated target position data, and feeds the result into the missile's guidance system. As the vessel rolls, pitches or changes direction prior to missile launch, the Fire Control System makes constant corrections of the guidance intelligence.

The GE system, which also provides data for monitoring and countdown procedures, will be installed in two dozen enclosures and consoles at various command points aboard the Observation Island. Transistorized plug-in type printed wiring boards facilitate equipment miniaturization, assembly, maintenance, reliability, and high-speed performance.



Super-Shaker for Super-Planes

To test effects of vibration on components before such "super-aircraft" as the F-108 interceptor and X-15 space probe take to the air, Wyle Manufacturing Corp. has provided this "Hydrashaker." North American is first manufacturer to install electronically controlled, hydraulically driven shaker, which has blocked force output of 24,000 lbs, operates at frequencies up to 2000 cps.

CIRCLE 18 ON READER-SERVICE CARD >

PULSE

GENERATION



Five plug-in pulse generators provide any code—1 to 5 pulses—with completely independent adjustment of width and delay for each pulse.

PULSE DELAY:
variable 0 to 300 microseconds

PULSE WIDTH:
variable 0.2 to 2 microseconds

PULSE TIME MODULATION:
Sensitivity, 2 volts RMS per microsecond

**CODED
MULTIPULSE
GENERATOR**

Model MP-1A

RISE AND DECAY TIME:
0.1 microsecond

GROUP REPETITION RATE:
10 to 10,000 pps

Used to modulate r f signal generators with coded pulse groups. Internal or external sync; square wave output, 10 to 10,000 pps. Pulses can be independently pulse time modulated by external signal.

APPLICATIONS: Design and testing of missiles, radar, beacons, IFF, telemetry, etc.

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on Microwave Measurements"

**POLARAD
ELECTRONICS
CORPORATION**

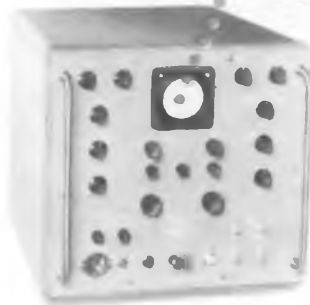
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TESTING



JITTER



PULSE JITTER TESTER

Model PJ-1

Displays the magnitude and waveform of pulse jitter (time deviation) in rate generators, pulse width modulators, encoding devices and precision time generators.

MEASURES:

PULSE WIDTH JITTER: Peak-to-peak time deviation (ΔT) at the half-amplitude points, between the leading and trailing edges of a recurrent pulse having a nominal width represented as "T" in the diagram at left.


ABSOLUTE JITTER: Time deviation (ΔT) at the half-amplitude points, from leading edge to leading edge of successive pulses (of duration "T" in the diagram) in a pulse train.

RELATIVE JITTER: Peak-to-peak time deviation (ΔT_r) at half-amplitude points of the leading edge of one pulse to the leading edge of a reference pulse. The time difference between the two is "T" in the diagram.

Repetition Rate Jitter: 5 millimicroseconds to 100 microseconds full scale. Relative or Width Jitter: 5, 10, 100 millimicroseconds

POLARAD ELECTRONICS CORPORATION:

Please send me information and specifications on:

- ED Model MP-1A Coded Multi-Pulse Generator 
- Model PJ-1 Pulse Jitter Tester
- Model VS-2 Rapid-Scan Ratio-Scope (see reverse side of page)
- Model ESG Electronic Sweep Generator (see reverse side of page)

My application is: _____

Name _____

Title _____ Dept. _____

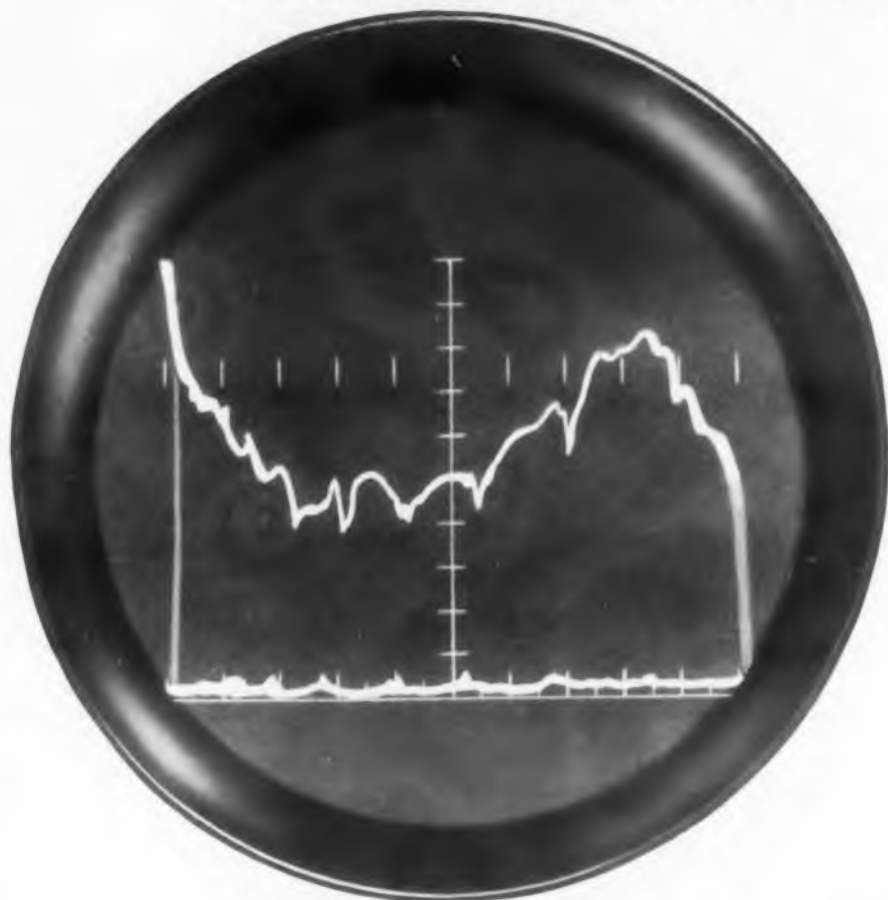
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Address _____

City _____ Zone _____ State _____

INSTANTANEOUS MICROWAVE ANALYSIS

SINGLE FREQUENCY OR OVER A FULL OCTAVE



Complete VSWR pattern of a microwave component over an entire frequency octave is displayed on a calibrated 7" CRT.

Instantaneous measurements at a single frequency or over an entire swept frequency range can be obtained with an Electronic Sweep Generator and a Rapid-Scan Ratio Scope



VSWR at any single frequency is indicated on the Ratio-Scan front panel meter.

Saves Engineering Manhours

1,000 to 15,000 mc

ELECTRONIC SWEEP GENERATOR

Model ESG 1,000-15,000 mc

Sweep width continuously adjustable. single frequency to an entire octave.

RAPID SCAN RATIO-SCOPE

Model VS-2

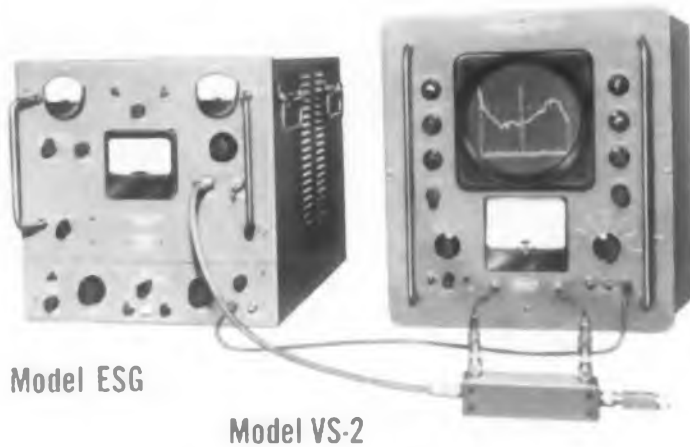
Displays the ratio of two input signals. gives visual plot of VSWR as a function of frequency

Measure and Analyze:

VSWR, transmission and reflection coefficients, gain and attenuation, image rejection, sensitivity, selectivity, band width and filter characteristics, antenna patterns, etc

Microwave Components :

Radars, receivers, beacons, waveguides, antennas, pads, terminations, couplings and hybrid junctions, attenuators, crystal mounts, preselectors, amplifiers.



Model ESG

Model VS-2

Typical set-up for measuring VSWR of a microwave component. Directional coupler outputs feed incident and reflected signals separately into the Ratio-Scope. Scope displays the pattern of the ratio between the two inputs over the entire frequency range swept.

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NEWS BRIEFS . . .

• • • **RAPID GROUND TESTING** of civil or military air navigation equipment while it remains undisturbed in an aircraft, is now possible with a 20 lb portable test set in production at ITT Federal Division of International Telephone and Telegraph Corp. The equipment, designated as Type NUS 3156, checks the operation of both the distance and the direction measuring equipment of the military's TACAN (Tactical Air Navigation) system and the distance-measuring equipment of the VORTAC civil air navigation system.

The system operates by transmitting to an aircraft on the ground, or on the deck of an aircraft carrier, directional signals simulating those of a TACAN ground beacon plus distance-measuring signals simulating those of TACAN and VORTAC ground beacon signals, the latter two signals being identical.

• • • **USERS OF PRINTED CIRCUITS** are now eligible for membership in the Institute of Printed Circuits. The IPC, which has recently published a book entitled "How to Design and Specify Printed Circuits" is a national trade association. The objectives of this association are to accelerate the growth of the industry through the development of standards, through activities which will advance the technology, and through promotion of the attributes of printed circuits. Dues for Allied Membership is \$500 per year. Further information can be obtained by contacting the Institute of Printed Circuits, 27 East Monroe Street, Chicago 3, Ill.

• • • **DU MONT'S NEW RUGGEDIZED CC-TV camera**, interchangeably using transistor or subminiature tube preamplifiers, can withstand acoustic noise over 175 decibels, vibration and shock of more than 0.06 in. displacement at 5-33 cycles and 20 g in 3 axes, and even a nearby explosion without losing high picture quality. It's considered ideal for monitoring at jet or rocket test stands.

• • • **MEMBERS** of the Dry Battery Section of the NEMA, meeting in New York City, were pleased to learn that their products are rated among the most reliable sources of power by the military. More glamorized sources, such as solar energy, are limited because of comparative brief periods in which sunlight is obtained; nuclear energy, on the other hand, is always available but presents radioactive shielding problems. Batteries, as compared to the newer sources, are cheaper, produce more power per unit weight and volume, and can supply peak pulses of power more effectively.

◀ CIRCLE 18 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 18, 1959

TANTALUM

Started

At

Fansteel

THE TENS OF MILLIONS of tantalum capacitors put into service since 1949 pay tribute to the man who made tantalum possible.

The late Dr. Clarence W. Balke, Fansteel's Director of Research, produced in 1922 the first tantalum "ingot" ductile and malleable enough to be rolled into sheet or drawn into wire.

Dr. Balke, with his research group, then began to look closer at the unique properties of tantalum, to discover new uses. One of his experiments with current flow between tantalum plates immersed in an electrolyte resulted in the development of the tantalum-lead (Balkite) rectifier. In his laboratory log entry dated December 1, 1922, Dr. Balke wrote: "... In addition to functioning directly as a rectifier... apparatus built along similar principles may be used for electrolytic condensers..."

Thus emerged the first tantalum capacitors and Fansteel had them on the market by 1930—principally, in telephone service. One model used electrodes of crimped tantalum sheet in a cell about the size of a pint fruit jar, providing 800 mfd. at 24 volts. Another used coiled electrodes welded to tantalum rods. The tantalum capacitor did a good job in those days, but it was unwieldy and expensive. Fansteel scientists later developed a way to eliminate expensive sheet metal and still retain large capacity characteristics, stability, and extremely long life of the tantalum capacitor.

Porous tantalum electrodes, made from powder, compacted around tantalum wires, resulted in an anode which exposed a great amount of surface to the electrolyte. This type capacitor first operated as a railway signal surge arrester. Single high-peak voltage surges, caused by lightning, momentarily break down the tantalum oxide film, but as soon as



DR. CLARENCE W. BALKE holds a replica of his first tantalum ingot. This was the basic discovery that made tantalum capacitors possible. For his pioneer work in tantalum he received many awards, among them, the Perkin Medal.

the surge voltage disappears, the oxide film heals and re-forms immediately.

ENTER THE TRANSISTOR

Shortly after World War II the Bell Telephone Laboratories introduced the transistor which started the age of miniaturization in electronic components. In 1949 we were asked to produce a Tantalum Capacitor of 4 mfd., 60 wvdc to occupy a space of less than one-tenth cubic inch and with a life expectancy of 30 years. Commercial production began that same year.

The result of this development was the Fansteel "PP" Type Tantalum Capacitor now made in a wide range of sizes and ratings. As this is written, more than twelve million capacitors of this type have been put into service.

Along with this major development, Fansteel metallurgists created the first tantalum made especially for capacitor use—Fansteel Capacitor Grade Tantalum.

Using Fansteel Capacitor Grade Tantalum in your capacitors is taking full advantage of Fansteel's experience. It's your assurance of only the finest tantalum made expressly for capacitors—a premium tantalum by the world's foremost producer. Fansteel Metallurgical Corporation, Rectifier-Capacitor Division, North Chicago, Illinois.

FANSTEEL[®]

**CAPACITOR GRADE
TANTALUM**

A Premium Grade of Tantalum available to capacitor manufacturers in these forms:

FOIL • SHEET • STRIP • WIRE • ROD • FABRICATED WIRE LEADS
SINTERED POROUS ANODES • METAL POWDER

CIRCLE 19 ON READER-SERVICE CARD

THOMAS A.

EDISON

Time Delay Relay assures sharp, clear aerial photos... automatically



The F8U-1P Crusader recently set new coast to coast speed record. CAI camera control system with Edison Time Delay Relay was used to automatically provide sharp, clear aerial photographs of the entire flight.

HERE'S WHAT A CUSTOMER SAYS ABOUT EDISON TIME DELAY RELAY...

"The CAX-12 servo power unit is a very vital part of the intricate 'brain' of the automatic camera control system, and naturally, we must have absolute reliability in all components. Therefore, as you know, we have relied on Edison Thermal Time Delay Relays since the original design of this CAX-12 and similar units. Since space for this type of equipment is at a premium, the compact size was a most important factor in original selection, but our units must also withstand severe environmental testing, involving vibration, moisture, shock, pressure fluctuation and extremes of temperature. Needless to say, the Edison Relay met all of these exacting requirements in our laboratories, and we've been specifying Edison ever since!"

(The above letter was received from Chicago Aerial Industries)



Edison's Thermal Time Delay Relay being inserted in the CAX-12 servo power unit.

Chicago Aerial Industries has developed a camera control system that allows one jet pilot to do the job of ten expert aerial photographers... automatically.

Heart of this new unit is the CAX-12 servo power unit. It accurately synchronizes film speed with speed of the jet — changes lens openings in response to electronic signals — regulates shutter speed and controls driving motor on cameras.

Because this power unit is vital to the camera control system component reliability is a must. That's why CAI relies on

Edison Thermal Time Relays exclusively for CAX-12.

Edison's line of miniature time delay relays are available for a wide range of electronic applications. They are light, small, rugged and offer these advantages:

- Designed to withstand vibration frequencies to 500 CPS
- Exceptionally high rate of contact closure
- Permanent calibration and hermetic seal
- Extremely rigid mechanical structure using high-strength, high-expansion alloys.

Thomas A. Edison Industries INSTRUMENT DIVISION

55 LAKESIDE AVENUE, WEST ORANGE, N. J.



EDISON FACTORY OFFICES ARE LOCATED IN: EVANSTON, ILLINOIS; DALLAS, TEXAS; DAYTON, OHIO; SHERMAN OAKS, CALIFORNIA

BEHIND THE NEWS

ASCOP Claims Major Data Handling Breakthrough

By applying the techniques of generalized harmonic analysis and information theory to the telemetering art, the Applied Science Corp. of Princeton has scored what it considers to be "a major breakthrough in data handling."

ASCOP is delivering telemetering equipment designed to improve handling of data on missile and aircraft performance by statistically analyzing the information and extracting its significant content for transmission to the ground, recording and analysis.

Principal advantages claimed are conservation of telemetering bandwidth, reduction in weight-to-data ratio of airborne equipment, and a marked decrease in data reduction and processing time.

The development program was based on the fact that most high frequency data encountered in missiles and aircraft tests are of random nature. As such, they can be analyzed to give low frequency, slowly varying results, such as power frequency spectra, and correlations between various functions.

First units of the statistical data handling line are three small, light, solid-state airborne devices for analyzing vibration-produced random data. Information content is in standard IRIG D.C. signal form, and analyzed data can be transmitted by any standard telemetry system (PWM, FM, PAM, FM/FM, etc.) with resulting bandwidth saving.

The devices save weight by reducing the required number of high-frequency, multi-transmitter installations in an airborne vehicle. Data reach the ground in pre-analyzed, meaningful form, and in many cases no further computation or processing is needed.

The airborne devices are a spectrum analyzer for extracting the

spectral density of high-frequency phenomena; an amplitude probability analyzer for extracting each phenomenon the amplitude probability distribution; and a time-reference marker for determining the exact time transient events take place in the vehicle.

Also developed by ASCOP is a large ground-based statistical unit, transfer function computer, to determine cause-and-effect relationship between an input and an output signal.

Signal Sequencing Via Phase Position

"Phase Multilock," Robertshaw-Fulton's new digital data transmission system designed to facilitate point-to-point communication of multichannel binary signals by radio, wire or teletype, is winning recognition as a significant advance over the conventional frequency-shift keying method.

Signal sequencing is dependent on phase position instead of frequency channeling, resulting in substantial reduction of noise interference and of band-widths necessary for communication.

The intelligence-transmitting carrier wave is phase shifted by a predetermined amount under control of a keying signal. For reception, the carrier wave is compared with a reference wave, and only those signals representing the proper amounts of phase shift are used to operate the receiving equipment.

Major feature of the system is the method employed to obtain the reference signal. It is derived directly from the transmitted carrier wave, in any of its selected phase shift positions, and is accomplished through multiplication of a portion of the incoming signal by a factor representing the number of permissible phase shift positions used in the signaling system. The resultant signal then is divided down by the same factor to provide a phase stable reference with which the incoming signal may be compared.



Avco // **Crosley**

Crosley Communications For . . . Today's Armed Forces

Years of experience in communications have made Crosley a name that is respected for both commercial and defense business. Crosley's latest contribution to communications is the VRC-12, designed for use in communicating with practically every type vehicle used by the Armed Services, including tanks, jeeps, ducks, airplanes, helicopters and command cars.

The VRC-12 Ground Communications system provides narrow-band FM communications over 920 channels. The unit is transistorized and miniaturized in a package that is both rugged and light in weight.

Crosley engineering, working from initial concept to the final phase of manufacturing, has developed many new products such as the VRC-12.

CROSLEY'S COMPLETE CAPABILITIES

Together with its associated Avco Divisions, Crosley provides facilities and personnel for:

- Research, development and engineering of: communications, air traffic control systems, sonar, infra-red, radar, fire control systems, telemetering, automatic test and support equipment, ground handling equipment and logistics.
- Production and manufacturing for missiles and aircraft systems.
- Weapons system management from initial concept to production.

If Crosley's capabilities fit your needs, write to: Vice-President, Marketing-Defense Products, Crosley Division, Avco Manufacturing Corporation, Cincinnati, Ohio.



WASHINGTON REPORT



Ephraim Kahn

Defense Electronic Spending Up

Defense spending for electronics is slated to move up again in fiscal 1960—but just how much can't be told. The Defense Department has re-jiggered its budget classifications. Congress wanted the change so that it could better examine military spending.

Whether Defense has succeeded in making the Budget easier for Congress to analyze is open to question. It has certainly become more difficult to estimate with reasonable accuracy how much of the whole pie will go to the electronics industry. There are now six broad categories of defense spending for Budget purposes. Electronics will share in at least three: "Operation and Maintenance," "Procurement," and "Research, Development, Test, and Evaluation."

Though no figures for electronics procurement as such are given in the fiscal 1960 Budget (the old category of "electronic and communications equipment" has gone by the board), it is stated that there will be "a substantial increase" in programs using these devices. Much of the rise will go for equipment to detect enemy aircraft and missiles and to guide air defense weapons to their targets. Accelerated buying for the ballistic missile early warning system (BMEWS) will continue. The SAGE and BMEWS air defense systems alone will take one-third of fiscal 1960 electronics and communications procurement funds.

Congress is being asked to give the military \$45.8 billion for fiscal 1960—59.5 percent of total Budget expenditures. New obligational authority for electronics and communications procurement, the Defense Department says, will come to about \$1.451 billion in fiscal 1960, up \$210 million from the \$1.241 billion of 1959, and more than double the \$696 million allowed in fiscal 1958. New obligational authority is not necessarily related to current contracting, since the funds can be spread over several years.

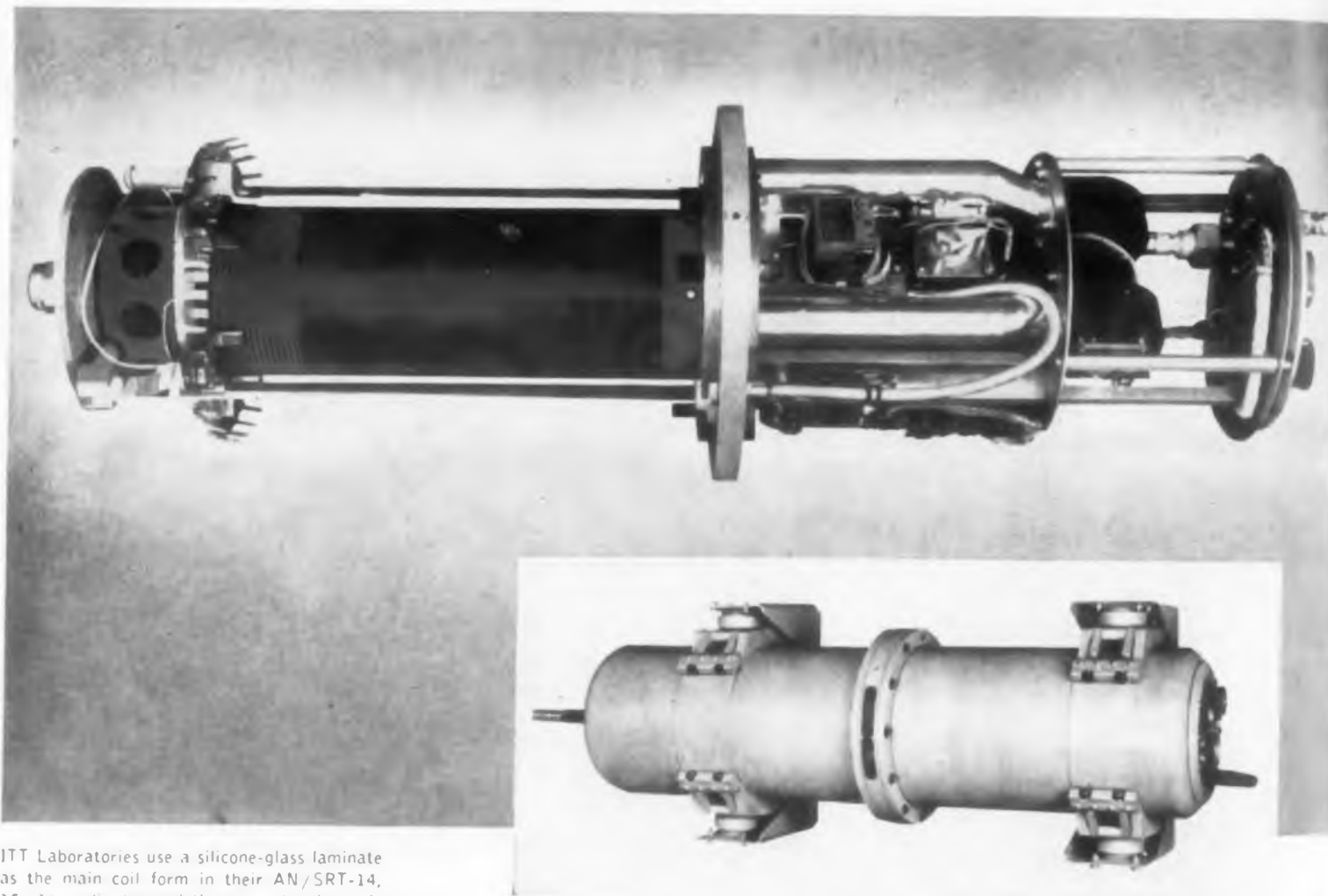
By Services, the breakdown, in the millions, is:

FY	Army	Navy	Air Force
1960	\$203	308	940
1959	257	181	803
1958	N.A.	144	552

Design better products with Do

SILICONE-GLASS LAMINATES

... low loss factor, high moisture resistance



ITT Laboratories use a silicone-glass laminate as the main coil form in their AN/SRT-14, 15, 16 radio transmitting set. Laminate is tubular, 5.62" dia., wound with .064" silver wire. Primary reason for specifying silicone-glass: low loss factor at high frequencies.

TYPICAL PROPERTIES OF SILICONE GLASS-LAMINATES*

Flexural Strength, psi	
at 25C	24,000
at 260C after 100 hr at 260C	4,600
Water Absorption, percent	0.05
Electrical Strength, volts/mil	
initial	310
after 200 hr at 260C	327
after 5000 hr at 260C	180
Dielectric Constant at 10 ⁶ cycles	
Condition A ¹	3.67
Condition D ²	3.68
Dissipation Factor at 10 ⁶ cycles	
Condition A ¹	.002
Condition D ²	.004

* As measured on samples 1.8 inch thick.

¹ As received.

² After 24 hr immersion in water at 23C.



Laminates made with glass or asbestos cloth and Dow Corning silicone resins make excellent dielectric materials. These strong, lightweight laminates maintain their properties at continuous operating temperatures of 250 C . . . for short periods will withstand greater heat. Silicone-glass laminates have good mechanical strength in addition to low loss factor, low water absorption, superior resistance to arcing, corona, corrosive atmospheres and contaminants. They can be laminated in very thin sections; have fine machinability. Supplied as tubes, sheets, punched or molded shapes by leading laminators. Write for free booklet.

first in
silicones

Dow Corning CORPORATION

MIDLAND, MICHIGAN

ELECTRONIC DESIGN • February 18, 1959

Dow Corning Silicone Dielectrics



Southwestern Industrial Electronic's S-16 Geophone

SILICONE COMPOUNDS SEAL OUT MOISTURE

Highly effective as dielectrics, Dow Corning compounds are easy to apply. They provide protection against arcs, grounds, shorts . . . improve surface resistivity. These silicone compounds retain their properties from -75 to 200 C. Employed as filling, potting, or coating materials for various types of electronic gear, they seal out moisture, increase reliability, retain their initial grease-like consistency.

CIRCLE 97 ON READER-SERVICE CARD



Resistors by Tru-Ohm Division of Madril Engineering and Manufacturing Co

SILICONE VARNISH MAKES IMPROVED RESISTOR CEMENT

Heat-stable and exceptionally moisture-resistant, Dow Corning varnishes make very good bonding cements. In addition, they can take fairly high loadings of inorganic fillers without loss of properties. An appropriately filled Dow Corning varnish is often far superior to conventional materials for sealing wire wound resistors and other electronic devices. Set-up time is good.

CIRCLE 98 ON READER-SERVICE CARD

WIRE COVERING OF SILASTIC INSULATES FROM -90 to 250 C

Here is a resilient dielectric that keeps its properties from -90 to 250 C. Silastic[®], the Dow Corning silicone rubber, forms a durable, moisture resistant coating for wire, cable, and other electronic and electrical components. It resists arcing, corona, ozone, weathering, corrosive atmospheres, and many fuels and solvents. Meets MIL-W-8777 specifications. Available from leading wire manufacturers.

CIRCLE 99 ON READER-SERVICE CARD



Wiring panel for Convair B-58 Hustler.

Spending for electronic and related equipment is estimated by the Department as follows:

FY	DoD	Army	Navy	Air Force
1960	\$1,570	\$251	\$233	\$573
1959	735	215	175	346
1958*	877	198	143	537

Note, however, that these figures do not include the electronic equipment that is an integral part of other weapons—radar in tanks, electronics in missiles, for example. Total spending for electronic gear will be far higher than the figures above would indicate—forecasts have pegged the figure to be 4 to 5 billion.

Missile Expenditures as Barometer

Place of missiles and aircraft in military plans can readily be inferred from Budget figures. The Army will reach a strength of four missile commands and three heavy field artillery missile groups by June 30, 1959; no expansion is scheduled for fiscal 1960. But there will be an increase from 71 to 73-1/4 in the number of anti-aircraft guided missile battalions during fiscal 1960.

Air Force will boost its power by converting all of its heavy bomber wings to 45 B-52's per wing by June 30, and a portion of a twelfth wing will be operational by the end of fiscal 1960. Concurrently, the first supersonic B-58's will go into service and B-52's will be armed with the Hound Dog air-to-surface missile. The Atlas ICBM (cost: \$35 million each, on the firing line) will become operational in fiscal 1959, too.

A total of 1,610 aircraft will be bought in fiscal 1960. The Air Force will buy 703; the Navy, 668; and the Army, 239. AF will stress B-52's and KC-135 jet tankers. It will buy no interceptors and fewer fighter-bombers, "reflecting the increased reliance on missiles." Navy will step up purchases of fighters, but cut back on new attack aircraft. Army will place stress on turbo-prop observation aircraft and reduce helicopter purchases. Spending on the supersonic intercontinental B-70 (thought by some to be the "bombers that cost their weight in gold" referred to by President Eisenhower in his State of the Union Message) will be increased during fiscal 1960 and money will be poured into development of a new high-speed long-range interceptor system using the F-108. Both the B-70 and the F-108 are expected to fly at speeds up to three times the speed of sound.

Funds for the Atlas and Polaris missiles will be boosted. A 50 percent funds hike is slated to go to the Titan ICBM, while funds for the Minuteman ICBM will move up to 40 percent. "Presently planned programs" for the Thor and

* Actual

For further information on these products write Dept. 1614

MINIATURIZED SEALED RELAYS



HOT . . . but still in service!

We don't see many hot-skillet applications for sealed relays these days. But, if there were, General Electric miniaturized sealed relays could do the job—even in scorching bacon grease!

The best of laboratory equipment is used to check the continuous operation of all G-E sealed relays at ambient temperatures of *plus 125 C*. And, special forms are now available for use at ambients up to *200 C*! Inherent temperature-resistant characteristics qualify *all* General Electric sealed relays for use on

any job where extreme heat is a serious environmental problem.

Extreme high-temperature operation is just one of the many "plus" features—such as high-shock resistance, high-vibration resistance, low-temperature operation, and rugged construction—you get with all Miniature, Sub-miniature, and Micro-miniature G-E sealed relays. Today, General Electric sealed relays are proving their reliability on a wide variety of military and industrial electronics applications.

What's more, all G-E relays are avail-

able for dry-circuit jobs. Special manufacturing processes—plus a monitored run-in of each relay—provide reliable service in low-level circuitry.

For further information, contact your G-E Apparatus Sales Office—or—write to General Electric Co., Section 792-9, Schenectady 5, N. Y., for your copy of the brand new G-E sealed relay catalog. *Specialty Control Dept., Waynesboro, Va.*

Progress Is Our Most Important Product

GENERAL  ELECTRIC

WASHINGTON REPORT

the Jupiter IRBM's will be completed, and money is allocated for the Bomarc, Nike-Hercules, and Hawk. The Redstone is being phased out in favor of the Pershing, and development of the Regulus II "is being terminated as emphasis shifts to the development of the submarine-based" Polaris.

Object of the shifts in missile programs, including phase-outs, is to spend less on missiles yet to have more of them ready to go if military operations should become necessary.

SBA Certificates of Competency To Rule

SBA certificates of competency are final, according to the Comptroller General. For the second time in recent months, the Comptroller General has told the Pentagon that in disputes involving the competency of small firm low bidders, the certificate of competency issued by the Small Business Administration must be regarded as conclusive.

Expect the plight of small business to be aired extensively in the 86th Congress. The House Small Business Committee is concerned about the small share of military research and development dollars that goes to small business—3.7 percent last year.

Weapons system contracting policy is the cause, the Committee feels, because now major companies control funds and subcontract as they see fit—often to other large companies.

There will also be pressure for more sealed bids and less negotiated contracts. This drive is intended to cut down on negotiated contracts made with a select few. There is not common agreement among small businessmen, who theoretically would stand to gain most by this practice, that sealed bids are best. Strategic Industries Association, for example, does not favor such a trend.

EDITORIAL

Are Special Connectors Necessary?

In a sense, this might very well be considered the "era of the special connector." Manufacturers of connectors are often asked to make special units to meet unusual situations. Not all of these special connectors are justified. They often have to be ordered because of poor planning in the early design stages of a piece of electronic equipment.

The origin of this "era of special connectors" might be traced back to an attitude prevalent among some design engineers. They consider connectors as just a "piece of hardware," and therefore give the connector the least amount of design consideration.

Normally all other electronic components are carefully selected and tested in a circuit. When the circuit has been proved out, the packaging phase begins. At this point, late in the game, it is remembered that some "hardware" must connect the components and circuits. Sometimes a depressing discovery is made—there is very little room left to accommodate the desired connector in the package or on the rack.

A search through the catalogs often shows no connectors of the desired size with the required characteristics. Those available may be too big, or do not have enough contacts, or are disqualified by some other consideration. Consultation with the connector sales representatives confirms the nonexistence of the ideal connector.

At this juncture the design engineer has two alternatives: He can either redesign his equipment to include an existing connector of the proper characteristics (which might have been done in the beginning), or he can have a special piece of "hardware" built for his equipment. The latter course leads to the birth of another new and special connector.

Special connectors are headaches for everyone. They take time to engineer, produce and test. They usually cost more. And they mean the stock room has to find space for another special item.

All of this delay and extra cost could be avoided if connectors were viewed as an integral piece of electronic equipment. They are more than "hardware." They are, in fact, just as important as the other components in electronic equipment. For connectors are subjected to virtually all the environmental stresses that components must withstand.

They deserve just as much attention, and require just as much good judgment in their selection as any other electronic component.

Leon N. Tolopko

BLADE ANTENNAS



A new series of high performance blade antennas has been developed for high speed aircraft and missile applications which provide the following features:

- All metal leading edge for maximum strength and erosion resistance
- High aspect ratio with straight or swept back leading edge
- Simple installation, no space required inside airframe
- Circular radiation pattern, small ground plane
- High temperature resistance
- Broad band design



APPLICATIONS

- COMMUNICATION
- NAVIGATION
- TELEMETERING
- RADAR BEACONS
- DATA LINK
- COMMAND CONTROL

TECHNICAL SPECIFICATIONS

Model No.	Center Freq. Mc.	Band width Percent	VSWR Max.	Dimensions		Weight
				Length inches	Height inches	
9928	5600	20	1.5	0.76	0.375	4 7/8 oz.
9933	3400	35	1.5	1.30	0.75	2 oz.
9927	3000	25	1.5	1.30	0.75	2 oz.
9934	2200	20	1.5	1.75	1.00	2 oz.
9926	1100	27	2.0	3.55	1.70	3 1/4 oz.
9925	310	55	2.0	15.00	7.00	7 lb.
9937	600	20	1.5	6.50	3.10	10 oz.

Other blade antennas are also available for special applications.

Resumes from engineering personnel qualified in the areas of microwave components, antennas, pulse and digital techniques, servomechanisms, radar systems, circuit design, semiconductor applications and radio telemetry will be welcomed

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CIRCLE 23 ON READER-SERVICE CARD

DESIGN TIPS...ON LIQUID COOLING

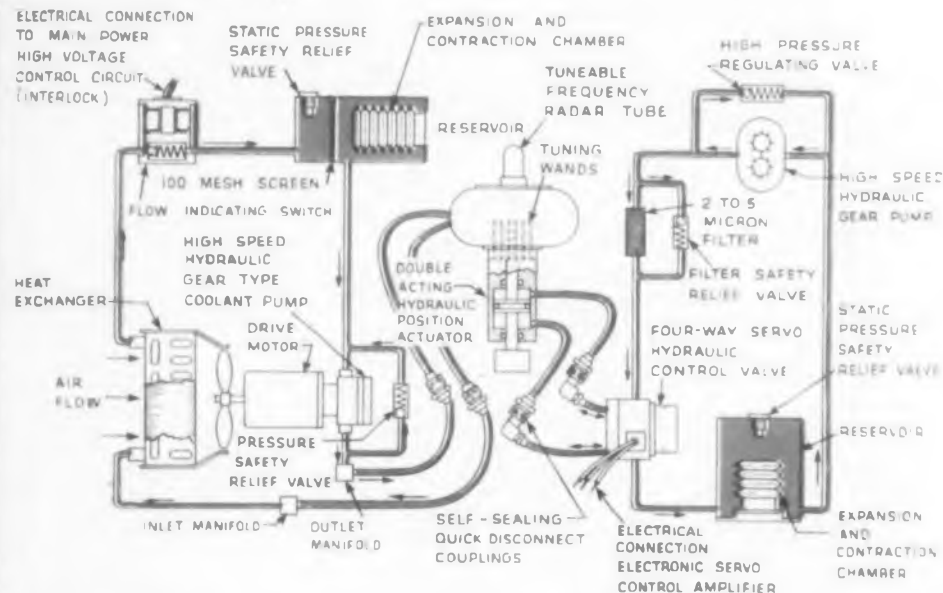
No. 1 Design Simplification



PROBLEM: Cool magnetron tube.
Supply hydraulic power for tuning. Keep design simple.

SOLUTION: Use one fluid, Coolanol 45, as coolant for tube and hydraulic fluid for power transmission.

EXAMPLE:



Engineers at Eastern Industries, Inc., Hamden, Connecticut, actually solved his problem by using two units: a liquid heat-dissipating unit (Model E/HT 00), shown at the left in the diagram, and a hydraulic tuning unit (Model /HS 100), on the right. Sealed in both units, Coolanol 45 cools the magnetron tube and actuates the mechanical tuning mechanism.

Coolanol 45 was selected for this application because it fully met the rigid requirements. Consider its outstanding qualities: wide temperature range (-65° to 400° F.), excellent lubricity and material compatibility, good dielectric and heat-transfer properties, extreme purity (must pass 0.8u filter).

END FOR NEW DESIGN BOOKLET
Design Tips on Liquid Cooling with

When you need a synthetic fluid, come to Monsanto—creator of fluids for the future
CIRCLE 26 ON READER-SERVICE CARD

Coolanol 45™ describes cooling approaches, fluid properties essential to equipment reliability, a typical design, and other important design aspects. For your copy, circle the reader-service number . . . or write:

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Aviation Fluids Department
St. Louis 66, Missouri

Component Temperatures

Predicting operating temperatures of components is a very difficult task. Many variables are involved. In this article, the author discusses techniques for reducing all the variables into a fairly accurate prediction of operating temperature.

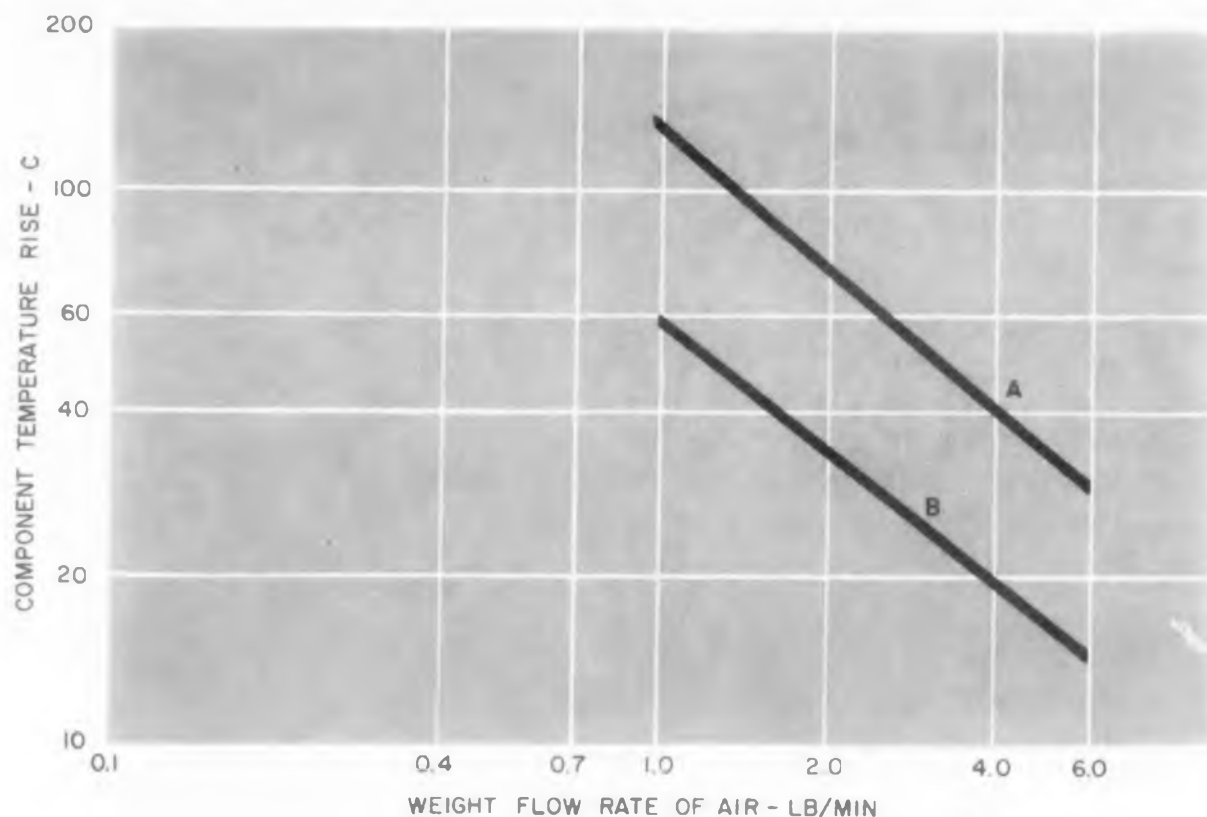


Fig. 1. Temperature rise plotted against weight flow rate of air.



ABOUT THE AUTHOR

"I saw the need for a simple method of correlating cooling test results," states Larry Fried. And he speaks with authority in this field as a result of his extensive research on the solution of heat transfer problems. With General Electric, he handles mechanical design of airborne computer devices and communication equipment.

Table 1 — Typical Test Results

Component	Flow Rate (lb/min)	Inlet Air Temperature (C)	Component Surface Temp. (C)	Temperature Rise (C)
A	1.0	25	160	135
B	1.0	25	85	60
A	3.0	50	103	53
B	3.0	50	76	26
A	6.0	75	105	30
B	6.0	75	90	15

in Forced-Air Cooled Equipment

INCREASING demands made upon electronic components by subminiaturization and high-speed flight make it imperative that we specify accurately the conditions under which the components operate. An operating condition of major importance is temperature—not just any temperature, but temperature at the critical points. For example, at the insulation inside a transformer or at the junction of a transistor.

Temperature Specifications

It is ordinarily impractical to measure the actual temperatures at critical locations. Because of this, operating temperatures are usually specified in one of two ways:

1. The first method of specification gives the maximum allowable temperature at a particular point on the outside of the component—for instance, the maximum envelope temperature on a vacuum tube. There is a consistent relationship between the temperature at the critical location and the temperature at the surface—therefore, specifying one temperature closely specifies the other.

2. The other method by which operating temperatures are specified for components is by the use of ambient temperatures. This concept may still be satisfactory for a generator in a large power station, but it is outmoded for electronic equipment. For one thing it starts with the temperature of the air an undefined distance from the component. Unfortunately, the air temperature in electronic equipment may vary rapidly in a short distance. But even more important is the cooling effect of the air, which may vary over a range of 100 to 1, or even more, depending upon the air flow conditions. Small wonder then, that a component will burn up in one equipment, but work fine in another equipment—in both cases being at the same ambient temperature! Where components are rated by surface temperature, however, we are always talking about the same thing.

Applicability of Method

The method of temperature prediction outlined here applies to the surface temperatures of components in forced air cooled electronic equipment. In such equipment, nearly all the

heat generated is removed by the flowing air. The rate of air supply is always given in terms of "pounds of air per minute" not "cubic feet per minute." The reason for this is that the cooling effect of the air is proportional to the weight flow and not the volume flow of the air. Another advantage is that prediction of temperatures is thereby made generally independent of temperature level and altitude.

Extending Test Results

Frequently, cooling data is needed for an electronic equipment long after the necessary tests have been completed. To get the data might mean setting up a complicated test arrangement again. Instead it is possible to obtain the required data merely by plotting the old data. Similarly, the number of flow rates and inlet temperatures used during a group of tests may be reduced to a minimum.

Suppose we have run tests at three air flow rates for two components with results as shown in Table 1. When we look at the component surface temperatures, they don't appear to make sense. For instance, component A gets cooler and then warmer as the inlet air temperature becomes hotter. But component B in the same equipment becomes just a little warmer after 50 C rise in inlet air temperature.

Does this mean our tests are worthless and have to be rerun? To find out, from each component temperature subtract the temperature of the air coming into the equipment. This gives the temperature rise of the component over that of the incoming air. Plot, on log-log paper, this temperature rise versus the weight flow rate of air. Repeat the procedure for the other weight flow rates. Draw a straight line between the corresponding points for each component. (Fig. 1.) The points for each component should lie on a straight line (only on log-log paper). All the points for components A and B do lie on their respective lines; therefore the test results may be assumed correct.

Since our test results are presented in such a simple form, it seems logical to assume that we can predict temperatures at unknown conditions. Here are two examples:

Example(1) Find the component tempera-

L. Fried

Light Military Electronic Equipment Dept.
General Electric Co.
Utica, N. Y.

tures at 0.7 lb/min airflow and at 50 C inlet air temperature.

Solution: From Fig. 1 or Table 1, the temperature rises for components A and B of the given airflow are 135 C and 60 C respectively. Therefore, the surface temperatures will be $50 + 135 = 185$ C and $50 + 60 = 110$ C respectively.

Example(2) Find the component temperatures when 4 lb/min at 70 C are blown through the equipment.

Solution: From Fig. 1, the temperature rises of components A and B of the given airflow are 42 C and 21 C respectively. Therefore, the temperatures of the components will be 112 C and 91 C respectively. This solution is independent of altitude.

Tests at two flow rates are the only requirement. To measure the air flow rate, any standard means may be employed, such as a plenum chamber. If it is suspected that some of the components transfer a major proportion of their heat by radiation, this may be checked by running a test at a third flow rate to see whether a straight line relationship is still present. Even with high radiant heat transfer a straight line will generally be found.

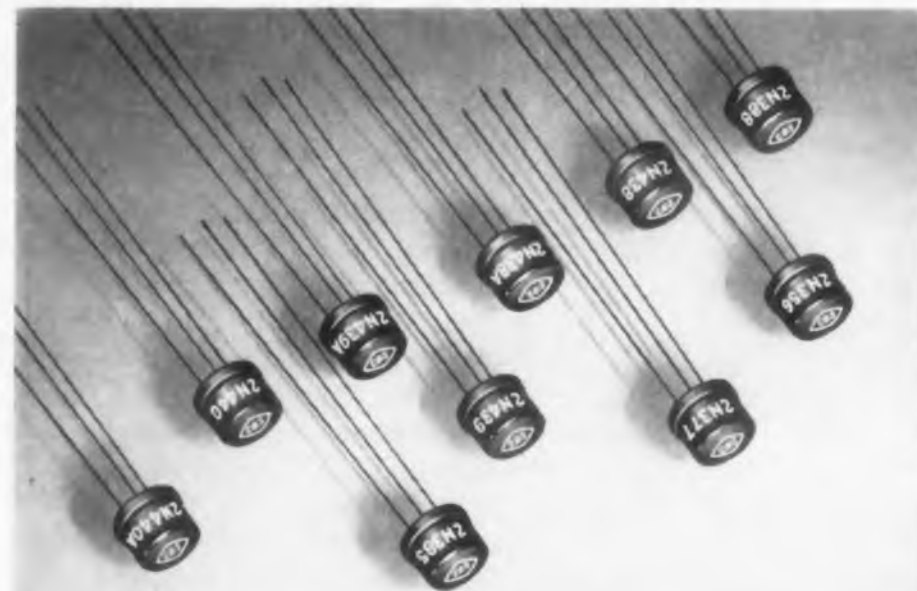
Component Temperature Prediction

Where possible, the method outlined in the preceding sections should be used to determine component temperatures. The obvious features are the accuracy, the ease of use and simple mathematical operations involved. However, there are occasions where it is desirable to predict temperatures before the equipment is built.

Consider the equipment as a special type of heat exchanger. The unique features of such heat exchangers are that the heat dissipated at one particular spot is not related to the heat dissipated at other locations and that the form factor or passage configuration is nonrepetitive. It is futile to not take this into consideration when evaluating electronic cooling.

(Continued on following page)

NPN switching transistors PROVE MORE RELIABLE than PNP



CBS-Hytron NPN Switching Transistors

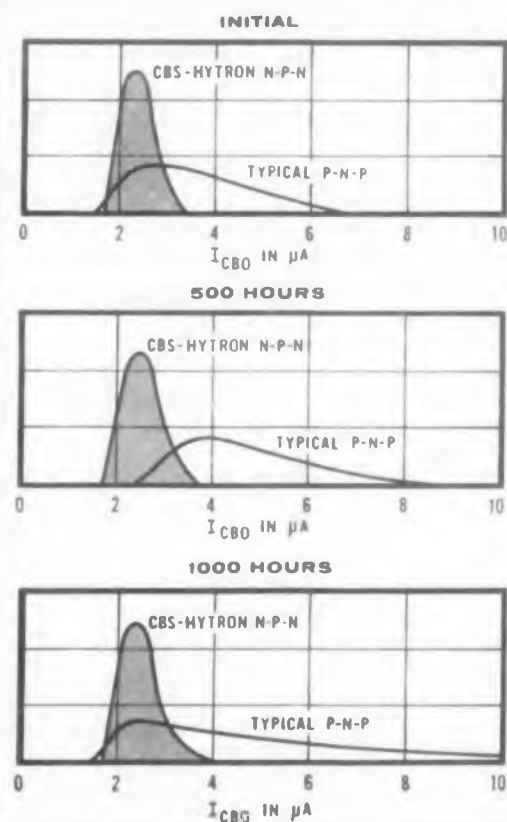
Type	Minimum BV_{CBO} (Volts)	Dissipation @ 25°C (Milliwatts)	Minimum h_{FE} @ I_C (Ma)	Typical f_{ab} (Megacycles)	Application
2N356	20	100	20	100	Core Driver
2N377	25	150	20	200	Core Driver
2N385	25	150	20	200	Core Driver
2N388	25	150	30	200	Core Driver
2N438	30	100	20	50	Logic Circuit
2N438A	30	150	20	50	Logic Circuit
2N439	30	100	30	50	Logic Circuit
2N439A	30	150	30	50	Logic Circuit
2N440	30	100	40	50	Logic Circuit
2N440A	30	150	40	50	Logic Circuit

Operating and storage temperature, $T_j = -55$ to $+85^\circ\text{C}$

Some design engineers specify PNP switching transistors because they consider them inherently more reliable. Actually NPN transistors can give you superior reliability along with their well-known higher speed. Life tests covering hundreds of thousands of CBS-Hytron NPN alloy-junction germanium switching transistors proved this during the past year. See graphs comparing these transistors with typical military-approved PNP transistors.

The superiority of CBS-Hytron NPN transistors is achieved by special processing: For example, advanced surface chemistry techniques seal out moisture and contamination. Precise control of alloying produces high back voltages. Thorough bake-out stabilizes gain. The result is reliable NPN computer-type switching transistors featuring fast switching . . . high voltage . . . low cutoff current . . . and low saturation resistance . . . in a welded JETEC TO-9 package.

Comparative Life Tests
NPN vs. PNP Switching Transistors.



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CIRCLE 27 ON READER-SERVICE CARD

Manufacturers of standard heat exchangers have made up charts of cooling power (by a different name) versus weight flow rate for their various styles of heat exchangers. Something of the same sort may be done for passages in electronic equipment. An electronics manufacturer will have a limited number of equipment constructions because of manufacturing considerations; for each construction, a chart may be made by giving the factors P and m to be described. It will not be necessary that the heat distribution of the equipment to be evaluated by the same as that of the chart—the airflow patterns should be similar however.

Component Temperatures

To find the temperature of a component, the following equation must be evaluated:

$$T_s - T_c = \frac{1}{W_d} \left[\frac{C_1}{W_d^{m-1}} + J \right]$$

Where:

- T_s = temperature of the surface of the component, F
- T_c = temperature of air entering channel in which component is located (inlet temperature), F
- W_d = weight flow rate of air in channel in which component is located, lb/hr
- C_1 = a constant incorporating constant air properties plus constants relating to the component under study, plus channel properties

Table 2 — Heat-Flux Density, d^*

Component Part	Btu/hr/ft ²	watts/cm ²
1/2 - watt resistor Allen-Bradley	1230	0.39
1 - watt resistor Allen-Bradley	1020	0.32
2 - watt resistor Allen-Bradley	1200	0.38
Small capacitor	0	0
Silicon diode, Hughes 6007, 200 mw, at 25 C	800	0.25
National Semiconductor Diode IN215, 150 mw at 25 C	280	0.088
Crystal Can Relay (Allied KH, 675-ohm coil)	260	0.082

*Based on no derating

$J = 4.15$ (heat dissipated, in Btu/hr, into channel from point where air enters channel, at T_i , to component)

m = an exponent defining the response of the component temperature to changes in airflow rate

Constant C_3 must be evaluated. It consists of the product of the heat-flux density, d , and air flow passage characteristics, P . The heat-flux density, d , is the heat dissipated by the component divided by the component surface area through which the heat flows. This surface area is somewhat arbitrary, but the use of a consistent system will avoid difficulties.

Table 2 shows values of d for several components based upon full rated heat dissipation and full area. The passage characteristic factor, P , must be determined from a chart made for the type of channel in which the component is located. As a matter of convenience this factor, P , may be made to include certain properties of air which do not change much from one equipment to another. For example: What is the surface temperature of a capacitor and of a 2-watt resistor, 50 per cent derated, in a channel through which 2 lb/min of air are flowing? The air enters the channel at 71 C. The components are at a location where the following conditions apply: $F = 3.2$, $m = 0.6$, heat dissipated into channel by preceding components is 70 watts.

Find the surface temperature of the capacitor first. $C_3 = (d) \times (P)$. From Table 2, $d = 0$, because the capacitor dissipates a negligible amount of heat. Therefore, $C_3 = 0$. To find J : 70 watts = 70 x 3.41 = 240 Btu/hr. Then $J = 4.15 \times 240 = 990$. $T_i = 71 \text{ C} = 160 \text{ F}$. $W_d = 2 \times 60 = 120 \text{ lb/hr}$. From the equation, $T_s = 160$

$+ \frac{1}{120} 990 = 168 \text{ F}$. For the resistor, $d = 1200/2 = 600$ (because it dissipates only 1 watt). Then:

$$T_s = 160 + \frac{1}{120} \left[(600) (3.2) 120^{0.4} + 990 \right] = 278 \text{ F}$$

Both the English and metric systems of units may be used. This is acceptable for any particular solution so long as a consistent system of units is used. The conversion from watts to Btu/hr is 1 watt = 3.41 Btu/hr. Where components receive heat from adjacent components, the temperatures found using the equation may be a little low.

Reference

Prediction of Temperatures in Forced-Convection Cooled Electronic Equipment, L. Fried, *IRE Transactions, Component Parts*, Volume CP-5, Number 2, June 1958.

The advertisement features a large, stylized 'BULOVA' logo in the center. To the left of the logo, there are three product images with their respective descriptions:

- CRYSTALS**: Available for any frequency from 2 KC thru 100 mc to meet and exceed all military specifications.
- CRYSTAL FILTERS**: Center frequencies from 10 KC thru 20 mc, band widths of 0.1% to 8% of center frequency.
- OVENS**: Complete from multi purpose AM thru to the specific BHC series, temperature stabilization to 1°C.

To the right of the logo, there are two more product images with their descriptions:

- PACKAGED OSCILLATORS**: 30 cps thru 70 mc frequencies available as tube type or transistorized oscillators.

The central logo itself contains several illustrations: a satellite dish at the top, a rocket launch, a jet airplane, and a person working in a control room at the bottom.

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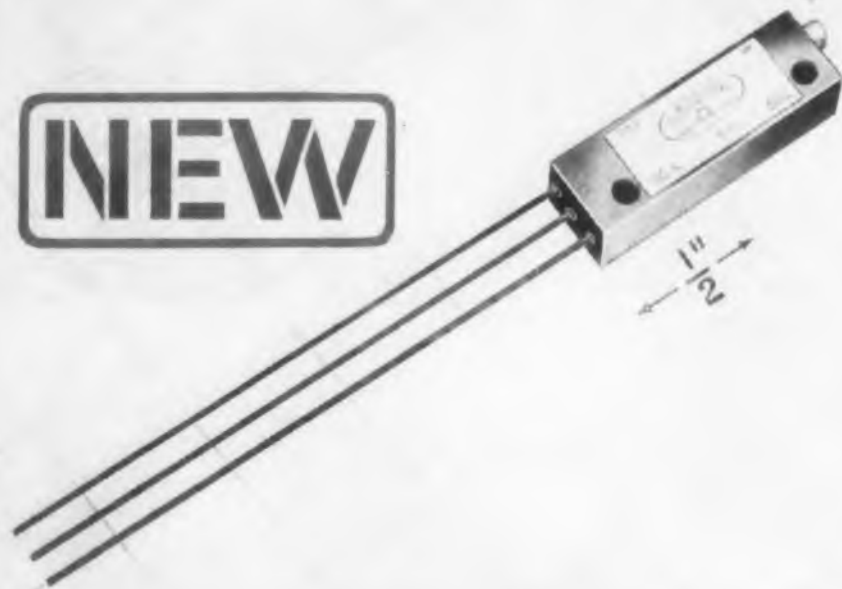
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It has a space saving design for advanced electronic circuits where it's mandatory to meet demanding conditions of miniaturization, reliability, precision and severe operating conditions.

Two terminal styles available: 750W—with leads extending from end of case; 750WP—with leads extending from bottom of case for printed circuits.

- Rated at 2 watts, up to 70° C. ambient
- Resistance range from 100 ohms to 30K ohms.

- Standard tolerance: ± 5%, closer tolerance available

OPERATING TEMPERATURE RANGE: -55° C. to 175° C.

SUPER-MINIATURE SIZE: .180 x .300 x 1.00 inch.

RESOLUTION: .1% to 1%, depending on resistance.

SHAFT TORQUE: 5 inch ounces max.

BACKLASH: 10° maximum.

SCREW ADJUSTMENT: 18 turns, nominal.

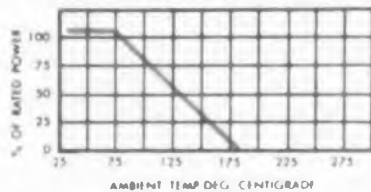
MOUNTING: Individually or in stacked assemblies with standard 2-56 screws.

SAFETY CLUTCH: Clutch arrangement on movable wiper contact prevents breakage due to over-excursion.

WEIGHT: 1.8 grams

MILITARY SPECIFICATIONS: Surpass applicable paragraphs of MIL-R-19A, MIL-R-12934A, MIL-E-5272A and MIL-STD-202A.

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CIRCLE 29 ON READER-SERVICE CARD



PHASE ANGLE or time delay, in the frequency range of 10 mc to 500 mc, can be measured to an accuracy within ± 0.05 deg or ± 1 per cent. High precision results from the use of a comparison method rather than a direct indication device.

Basic Operation

Fig. 1 shows the block diagram of the Type 205B Precision Phase Detector manufactured by Ad-Yu Electronic Labs Inc., 249 Terhune Ave., Passaic, N. J. A continuously variable delay line, constructed coaxially, is the standard phase-shifting or time delay element. This is followed by a vector sum/difference amplifier, which produces signals directly related to the phase

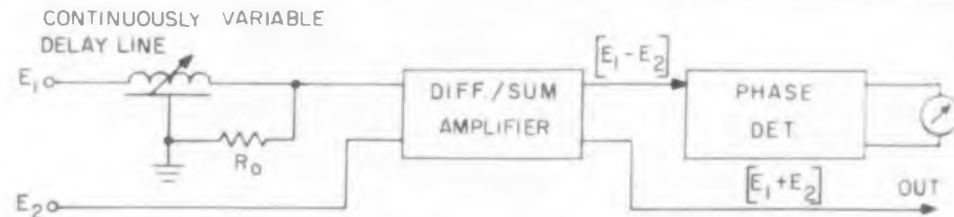


Fig. 1. Simple block diagrams of the precision phase detector.

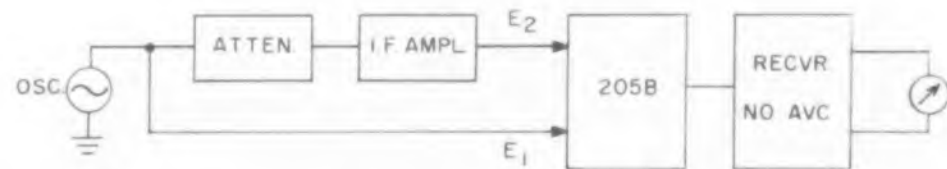


Fig. 3. Connection for measuring phase shift of an i-f amplifier with 20 mc bandwidth at 60 mc center frequency and with amplitudes of E_1 and E_2 below 30 mv.

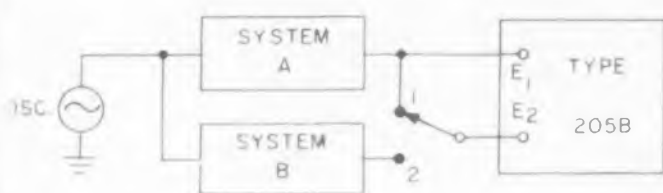


Fig. 2. Comparison of phase angle of two transmission systems, A and B, with accuracy better than 0.05 deg up to 500 mc.

angle to be measured. The developed signals are applied to a balanced phase detector to indicate a phase-null condition.

By adjusting the continuously variable delay line until the unknown signal becomes in phase with the reference signal at the input of the vector sum/difference amplifier, the phase null detector will indicate zero phase angle. The phase angle between the unknown signal and the reference signal is read on the dial of the continuously variable delay line.

Phase Angle Between Two Networks

For accurate comparison of phase angle between two networks of "A" and "B," such as in transmission systems or radar equipment, an arrangement shown in Fig. 2 would be used.

The time delay of both inputs of the instrument is first equalized by applying an identical signal to both inputs; the continuously variable delay line is then adjusted until minimum reading is obtained at the output meter. This step is to eliminate the phase error introduced by different lengths of interconnecting cable between E_1 and E_2 . Next, both input signals are applied to their respective input points and the continuously variable delay line is again adjusted for minimum output. The unknown phase angle between the two systems, "A" and "B," is the difference between the final dial reading and the initial reading for input equalization.

Phase Shift of IF Amplifiers

Using a similar operating procedure, the phase shift of i-f amplifiers can be checked. A receiver without avc (or with avc disabled) is connected to the $E_1 + E_2$ output signal of the Type 205B. This permits signal levels as low as 20 uv to be applied to the i-f amplifier input; possibility of overload is thus greatly reduced.

For further information on this instrument, turn to the Reader-Service card and circle number 101.

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Standardization on only *one size* of capacitor—0.55" diam—for most values, permits scientific selection of ceramic materials with the *optimum* dielectric constant for each capacitance value. Through such advanced design technique, Allen-Bradley Type A ceramic capacitors provide greater dielectric strength and greater breakdown voltage... creepage paths are also increased. In addition, the coefficients of temperature, frequency, and voltage are lower... and the power factor is lower, too.

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Allen-Bradley Type A capacitors are available in general purpose, stable, and temperature compensating types in the most frequently used values. Send for new data sheets.

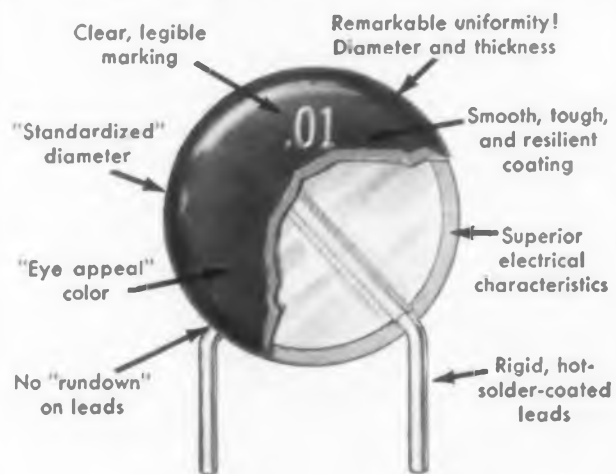
Allen-Bradley Co., 1344 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

New "Auto-Coat process" makes high speed machine assembly possible—but it also makes manual assembly quicker—at lower cost!

Allen-Bradley's new "Auto-Coat process" provides a tough, smooth insulating coating of uniform thickness—it does not use wax or other sticky impregnants which are bound to clog automatic machines. The physical uniformity of these capacitors permits accurate mechanical or manual insertion on printed boards.

With "rundown" on leads eliminated, the capacitor is permitted to rest directly on printed boards—for solid, three-point mounting. Costly cleaning or crimping of wires to prevent soldering failures is a nightmare of the past; lead inductance is less.

Allen-Bradley Type A Ceramic Capacitor



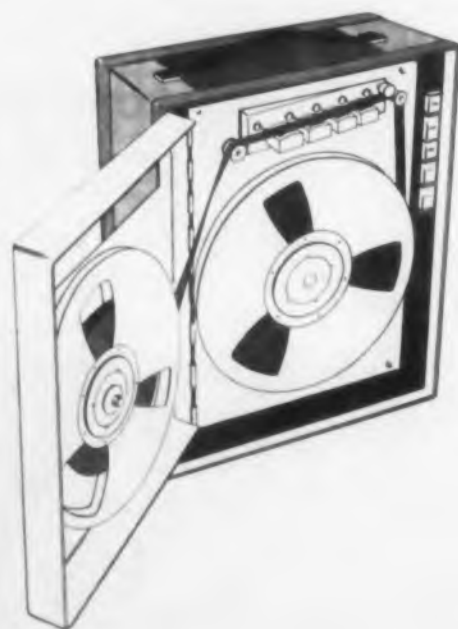
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ELECTRONIC COMPONENTS

QUALITY

CIRCLE 30 ON READER-SERVICE CARD

Reels Driven on Coaxial Shafts in Miniature Tape Recorder



CLEVER transport assembly techniques using coaxial shafts and transistorization of all the electronics reduced the size of this instrumentation tape recorder from the standard 17 cu ft, 600 lbs to 1.54 cu ft, 50 lb. Power consumption is cut from the usual 1100 w to 175 w.

Seven channels of information are accepted and reproduced with accuracies comparable to much larger pieces of equipment by the PS-200 which was designed and manufactured by the Precision Instrument Company, 922 Terminal Way, San Carlos, Calif.

Design

Sporting coaxial shafts to drive reels stacked on top of each other instead of mounted side-by-side, the PS-200 supplies standard tape speeds of 30, 15, 7-1/2 and 3-3/4 ips with less than 0.1 per cent flutter and wow. A novel technique of guiding the tape through a coplanar recording/reproducing station allows very little tape twist. The slanting head block guides the tape through a difference in level without distorting it—when the magazine shown in Fig. 1 is closed, that twist in the tape disappears.

The magazine contains 2500 feet of tape. A reel change can be made in 5 sec.

Applying a new technique, saturable cores are used for the timing devices. Design is such that the timing function is independent of the transistor characteristics and temperature, so germanium devices can be used with no decrease in accuracy. The PS-200's record oscillator, designed by Precision Instrument's Bob Peschel, is shown in Fig. 2. T_1 conducts until the core reaches saturation, when coupling to the base

Fig. 1. (Left) Magazine-loaded magnetic recorder performs with the accuracy of seven-channel devices using ten times its volume. The 2500 feet of tape can be changed in about five seconds. Stacking reels instead of mounting them side by side saves space.

stops. T_2 begins to conduct. The regenerative connection produces additional base drive to T_2 ; it continues to conduct until the core reaches saturation in the opposite direction.

Conduction duration is described by

$$t = KN \phi_{max} / E_s$$

where t is time, E_s is the applied voltage, N is the number of turns on the core, K is a constant for the particular core used, and ϕ_{max} the saturation flux density of the core. The equation assumes that the voltage drop across T_1 in the saturated state is negligible compared to E_s and that the switching process will always occur at the specified value of saturation flux density. Both these conditions are readily satisfied with the proper circuit design.

Since the transistors are operated as switches, changes in their characteristics are unimportant. Manipulation of the equation will show that the frequency of oscillation is a linear function of E_s for all values of E_s . No second order corrections are necessary.

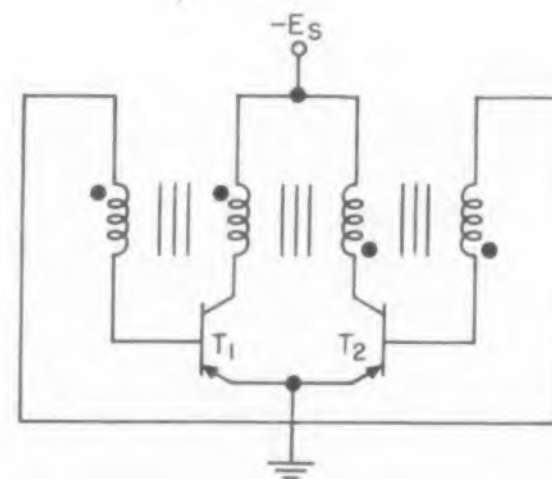


Fig. 2. Basic form of the fm record oscillator used in the new tape recorder. The transistors are used as switches; temperature characteristics have no effect on operation.

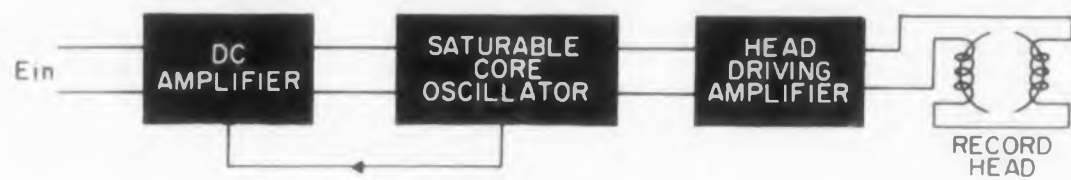


Fig. 3. Fm oscillator block diagram shows positive feedback (on the order of 30 db) applied to the dc amplifier from the oscillator, resulting in good stability.



Fig. 4. Fm reproduce discriminator needs large signal amplification and limiting because of fluctuations of output from tape recorder head. This is a standard problem in recorders due to tape, head-to-tape contact and dust.

The basic form of the oscillator is shown in Fig. 3. The internal signal levels involved, the inherent oscillator stability and the 30 db feedback used, produce high stability over the temperature range 40 to 120 F, Precision Instruments reports. Further manipulation of the above equation shows that the square wave output voltage E_s , is a linear function of the input frequency. Here again no importance is attributed to the stability or uniformity of transistor characteristics. Only the core characteristics and the frequency determine E_s . Linearities of ± 0.25 per cent of full scale are realized over a wide range of parameter variations.

A block diagram of the reproduce discriminator is drawn in Fig. 4. To get the proper system characteristics, much gain limiting is necessary before the reproduce head output is given to the discriminator. Because the output from a reproduce head may rapidly fluctuate by as much as 20 to 40 db in any recorder, provision must be made to insure that these changes do not appear in the system output as data errors. The limiter amplifier of the PS-200 has a voltage gain of about 120 db.

To get maximum freedom from drift

and distortion, no active elements are used after the discriminator. The low pass filter separates the carrier and data.

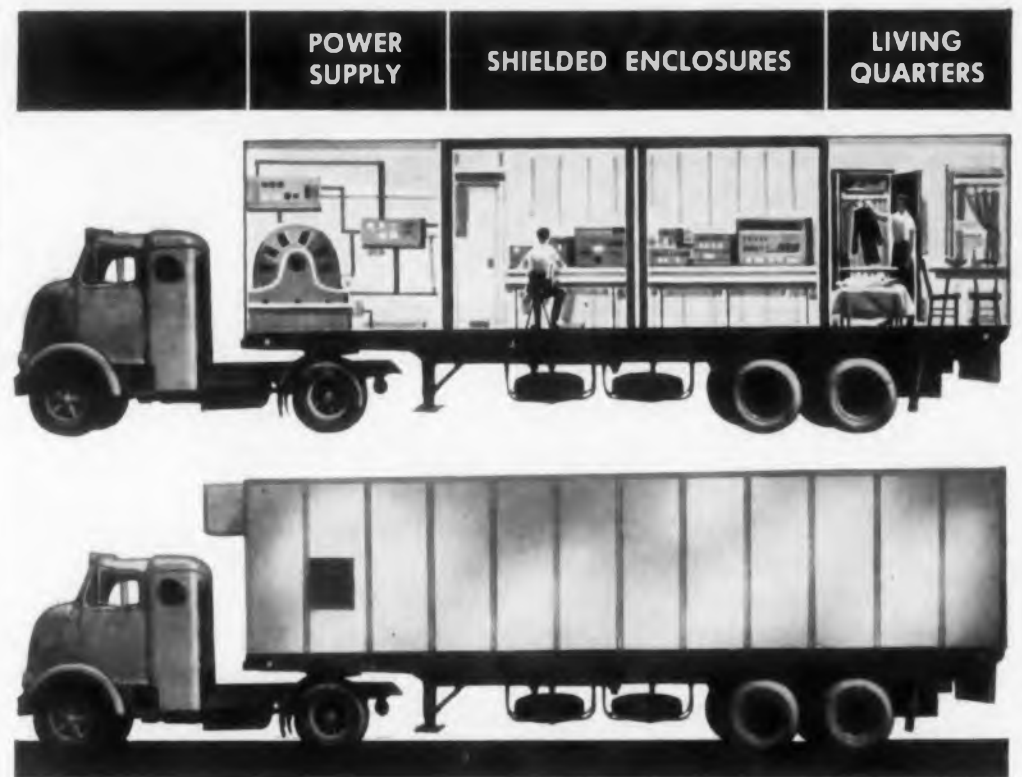
Specs

Frequency response of the PS-200 ranges from a lower limit of 300 cps to upper limits of from 7.5 to 50 kc, depending on the tape speed used. Rms pass-band noise level is 40 db or more across the board. Harmonic distortion is 1 per cent (mostly third order) of a 500 cps signal. On fm, distortion is 2 per cent for a full scale signal.

Input impedance is 100,000 ohms direct, 10,000 ohms fm, unbalanced to ground; input level is 0.15 to 40 v rms and 0.5 to 50 v rms, direct and fm respectively. Output impedance is 100 ohms in series with 100 μ f direct and 5,000 ohms fm, at direct and fm levels of 1 v rms nominal across a 10,000 ohm load impedance.

Total dimensions are 14-3/4 x 17-1/2 x 10 in., and the weight of the unit is about 50 lbs. Power requirement is 175 w, 115 v, 60 cps. The PS-200 can be supplied for use with 12 or 24 v dc.

For further information about this miniature recorder turn to the Reader-Service card and circle 102.



MOBILE SHIELDED ENCLOSURES

custom designed for on-the-spot interference testing

Now you can get the reliability and the outstanding performance of ACE Shielded Enclosures on wheels! . . . complete with self-contained power source and living accommodations . . . custom designed to your specific requirements.

1. ACE SHIELDED TRAILERS & TRUCKS

Fabricated to ACE's patented RFI* design, using one, two or three shields, these enclosures provide over 100 db attenuation at all frequencies from 15 kc through 1,000 mc and will closely approximate 100 db at 10,000 mc . . . exceeding the attenuation requirements of MIL-E-4957A (ASG). Provisions can be made for mounting antennas, shock-mounting test equipment, installing intercom systems and coaxial connector panels.

2. SELF-CONTAINED POWER SUPPLY

The mobile unit can be equipped with a power control panel and a diesel driven generator, having outputs up to 20 kw. External power connections can also be furnished.

3. LIVING QUARTERS

Complete living quarters having all the facilities necessary for the comfort of operating personnel can be furnished. The entire trailer can be air conditioned or heated.

ACE handles the entire mobile shielded enclosure package — from the wheels on up. Every detail is carefully engineered to give the highest attenuation and the most efficient performance. The trailer is designed to meet the legal specifications of all states. Write to ACE outlining your mobile shielded requirements. Be sure to request a copy of ACE's standard enclosure catalog.

*Lindsay Structure



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CIRCLE 31 ON READER-SERVICE CARD

Microwave Test Instruments

Part 5 Impedance Measuring Instruments

Slotted lines, automatic impedance and standing-wave indicators and displays are taken up. Ways of measuring vswr and impedance are discussed along with a number of common pitfalls to be avoided.

David Fidelman
Roslyn Heights, N. Y.

MICROWAVE IMPEDANCE measurements are made by determining the standard wave patterns or reflections set up in the waveguide or coaxial transmission system by the unknown impedance. The standing wave ratio is measured by inserting a slotted line between the signal source. The unknown impedance, and the variation in rf voltage along the slot is measured by a probe containing a detector. The value of the reflection coefficient can be measured directly with a reflectometer, by sampling the incident and reflected waves and obtaining their ratio, which is equal to the reflection coefficient.

Impedance Measuring Techniques

A typical setup for making slotted line measurements is shown in Fig. 1. An amplitude-modulated signal is applied to the transmission system, with the slotted line introduced between the system and the load impedance under test. The output of the detector probe is connected to a calibrated amplifier, which measures the modulation, therefore the rf signal level, and indicates it on a meter which may read directly in standing-wave ratio or in db. Both phase and magnitude of the unknown impedance can be determined by this method.

A typical reflectometer setup is shown in Fig. 2. Two directional couplers are inserted in the transmission line to sample the input wave and the reflected wave. The two signals are detected and fed to the two inputs of a ratio computer where their amplitudes are compared. Their ratio indicated on the meter reads the reflection coefficient. The reflectometer provides a fast and convenient method of making impedance measurements, and is especially useful for sweep-frequency and production measurements. However, this method is generally not as accurate as measurements made with slotted lines. In addition, it will indicate the magnitude of the impedance, but will not provide phase angle information as does the slotted line.

Measurement of vswr and impedance may be made automatic in a number of different ways. One method is to attach a motor drive to the

probe carriage, and thus move the probe along the slotted line automatically, observing the variation in signal amplitude on a meter or oscilloscope. If it is desired to show the variation of impedance with frequency, a swept-frequency oscillator may be used in a reflectometer setup, and the reflection coefficient (or the impedance) computed and displayed on an oscilloscope screen or a graphic recorder. The display may be set up to show either a rectilinear graph of variation of vswr with frequency, or impedance by means of a Smith chart overlay on the cathode-ray tube.

Slotted Lines

Table 1 lists slotted lines for microwave impedance measurement. The slotted line and probe assembly must be made very carefully and meet stringent mechanical requirements in order to be useful for accurate measurements: (1) there must be no mechanical play between probe carriage and transmission lines; (2) the probe must move perfectly parallel to the axis of the transmission line; (3) there must be no wear between the carriage and the guide; (4) in coaxial slotted lines the center conductor must remain perfectly straight and concentric to the outer line.

Great care is taken in the mechanical design and construction of slotted lines to meet these requirements. Special measures are used, such as milling transmission line sections from solid blocks of metal, using special boring process to make outer sections of coaxial lines, or using ground steel rods for inner conductors. Extremely precise supports, guides, and bearings are used to attain high precision of motion of the carriage and probe along the line.

Even with the great care taken in construction of the slotted line, certain errors may prove troublesome when highest accuracy of measurement is required. These errors may be due to probe effect, slot effect, and inherent structural irregularities. Probe errors are due to the fact that the probe extracts some power from the line, and in addition sets up reflections. The probe insertion should therefore be kept at a

minimum. The effect of the slot is to cause a slight increase in the characteristic impedance of the line, therefore the slot is tapered at the ends to achieve a smoother impedance transformation. The effects of inherent structural defects cannot be avoided. Therefore it is necessary to estimate them, for example, by making a measurement with the line very nearly matched. Make proper allowances when great accuracy is required.

VSWR and Reflection Coefficient Indicators

A standing wave indicator for use with slotted lines consists of a high-gain amplifier with a low noise level. The indicator is generally tuned to a fixed audio frequency, i.e., the modulation frequency of the rf signal, and presents the amplifier output on a square-law calibrated meter reading directly in vswr or db. Inputs may be provided for both crystal and bolometer detectors. A highly accurate attenuator is included for accurate level comparisons, and a gain control to adjust the reading to a convenient reference level. In some units there is an expanded scale for more accurate measurement of very flat systems, and there may also be a dc output to a recorder for making permanent records. Standing wave indicators are listed in Table 2 along with reflection coefficient indicators.

A ratio computer is required when the reflectometer method is used. This unit relates the incident and reflected signals to reflection coefficient through electronic computation, and indicates it on a meter calibrated directly in percentage reflection coefficient. There is usually an automatic amplitude compensation, so that there is no error and no correction required for a wide range of variation of incident power. A dc output is generally provided so that the ratiometer can be used in sweep-frequency setups to provide oscilloscope presentation of the reflection coefficient at varying frequencies. Since there are two inputs, ratiometers generally have a switch to operate on one channel as a vswr indicator.

Automatic Impedance Measurement

Automatic impedance and standing-wave indi-

Table 1. Slotted Lines

Manufacturer	Model No.	Type	Frequency Range	Price	General Comments - Accessories required
Andrew Corp.	3101, 3101A	Coaxial	850-3000 MC	\$375, \$350	Includes probe, probe carriage, and detector; millimeter scale attached to line. Impedance of 3101 is 51.5 ohms, of 3101A is 50 ohms.
B J Electronics	62	Coaxial	100-3000 MC	\$1680	Carries two independent probes and probe carriages for differential measurements; engraved millimeter scale. To be used with Model 62 VSWR indicator.
DeMornay-Bonardi Corp.	D3A-825 to DBJ-825	Waveguide	XN to E bands	\$440 to \$560	Waveguide block and probe interchangeable on carriage (two sizes of carriage units cover total frequency range); carriage units, waveguide sections, probes purchasable separately; millimeter scale with vernier, reads probe travel to 0.01 mm.
Diamond Antenna and Microwave Corp.	Carriages: 111, 211, 311	Waveguide	L, S, C bands	\$695	Consists of universal carriage with interchangeable slotted sections.
	Slotted sections: 312, 412, 512			\$500 to \$370	
	2011, 2012, 2013	Coaxial	1.0-4.00; 4.5-1.5; 0.45-1.2 KMC	—; \$450, \$750	
Douglas Microwave Co.	301, 300	Coaxial	1,000-4000 MC, 4000-10,000 MC	—	Includes probe and probe carriage (units for XB band and higher, have built-in probes), centimeter scale attached to carriage, reads to accuracy of 0.01 cm.
	310L to 310T	Waveguide	L to V bands	—	
Federal Telephone & Radio Co.	LMD	Coaxial	300-3000 MC	\$995	Includes probe, probe carriage, detector and indicator (calibrated in VSWR); engraved scale with vernier permits reading to 0.1 mm.
F-R Machine Works, Inc.	N101A, N101B	Coaxial	1.00-4.00 KMC, 4.00-10.00 KMC	\$470, \$440	Includes probe carriage; requires B200A tunable probe; engraved carriage scale and vernier permits reading to 0.1 mm.
	V101A, V101B	Coaxial	1.00-4.00 KMC	\$470 ea.	
	L101A to X101A	Waveguide	L to X bands	\$245 - \$1340	Includes probe carriage, require series 205B and 206B tunable detector mounts, 102 series has vernier scale giving position indication to ±0.001 cm, 103 series has precision dial indicator reading carriage position to 0.0001 inches.
	Y102A, K102A, U102A	Waveguide	KU, K, V bands	\$545 ea.	
	Q103A, M103A, E103A	Waveguide	Q, M, E bands	\$995 - \$1650	
General Radio Co.	874-L BA	Coaxial	300-5000 MC	\$220	Includes probe carriage, probe, and detector; micrometer vernier attachment available graduated to 0.001 cm; can be used with motor drive for automatic operation.
Hewlett-Packard Co.	805A, 805B	Coaxial	500-4000 MC	\$475 ea.	Includes probe carriage probe and detector, centimeter scale with vernier permits reading to 0.1 mm.
	S810A	Waveguide	2.6-3.95 KMC	\$450	Includes probe carriage, requires probe and detector.
	Carriage: 809B	Waveguide	C to KV bands	\$160	Carriage and interchangeable slotted sections, requires probe and detector, centimeter scale on carriage with vernier reading 0.1 mm.
	Slotted sections: G810B to P810B	Waveguide		\$90 to \$110	
	Carriage: 814A	Waveguide	KU, K, V bands	\$225	Carriage and interchangeable slotted sections; requires 446A probe, cylindrical dial, can be interpolated to 0.01 mm.
	Slotted sections: P815A to R815A	Waveguide		\$200 ea.	
	806B	Coaxial	3-12 KMC	\$200	Fits 809B probe carriage
Microwave Associates, Inc.	1022, 1022A	Waveguide	26.5-40.0 KMC	\$650; \$625	Includes probe and carriage, 1022 includes detector, others do not; S45A is high-power unit (40 KW) with 40 db output attenuation; carriage moved by micrometer with 0.001 inch/div.
	S45A	Waveguide		\$1075	
	S84	Waveguide	50.0-75.0 KMC	\$900	
Narda Microwave Corp.	226; 225	Waveguide	1.12-1.70 KMC, 1.70-2.60 KMC	\$950 ea.	Includes probe carriage, requires probe and detector, centimeter scale with direct reading vernier to 0.1 mm.
	224 to 219	Waveguide	S to KU bands	\$425 to \$250	
	218, V217 to E217	Waveguide	K to E bands	\$500 to \$1650	Includes probe carriage, probe, detector, and slide-screw tuner to match probe impedance to detector; precision dial indicator reading probe position to 0.001 inch.

ators and displays are listed in Table 3. A typical instrumentation setup of an automatic system for measurement of impedance is shown in Fig. 3. It consists basically of a reflectometer, a vswr computer, and an oscilloscope or recorder presentation of the response to a swept-frequency input signal.

The information may be presented in different ways. If the spot is moved horizontally across the screen of the oscilloscope in proportion to the frequency of the signal generator, and deflected vertically in proportion to the reflection coefficient, the result is a graph of reflection coefficient vs frequency. In another type of display, the impedance may be computed directly, and the spot on the cathode-ray tube deflected by the computer voltages so its position reads impedance directly from a Smith chart overlay. ■ ■

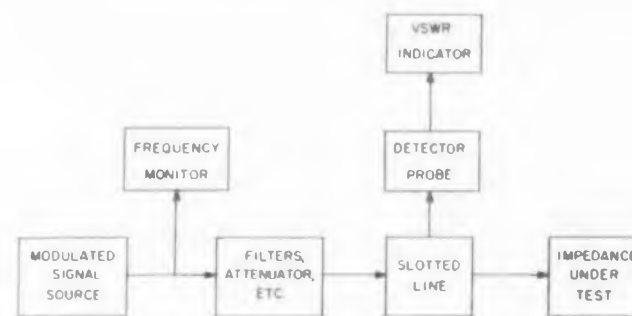


Fig. 1. Typical setup for making slotted line measurements.

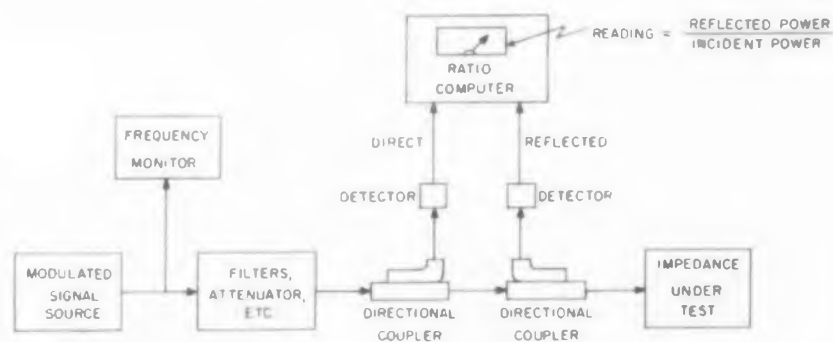


Fig. 2. Typical setup for reflectometer method of measuring reflection coefficient.

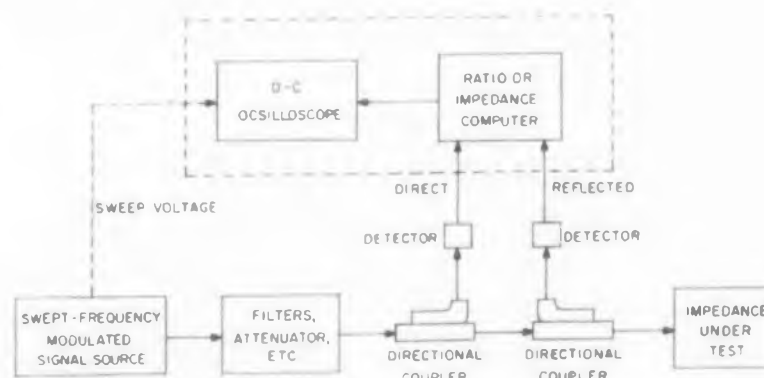
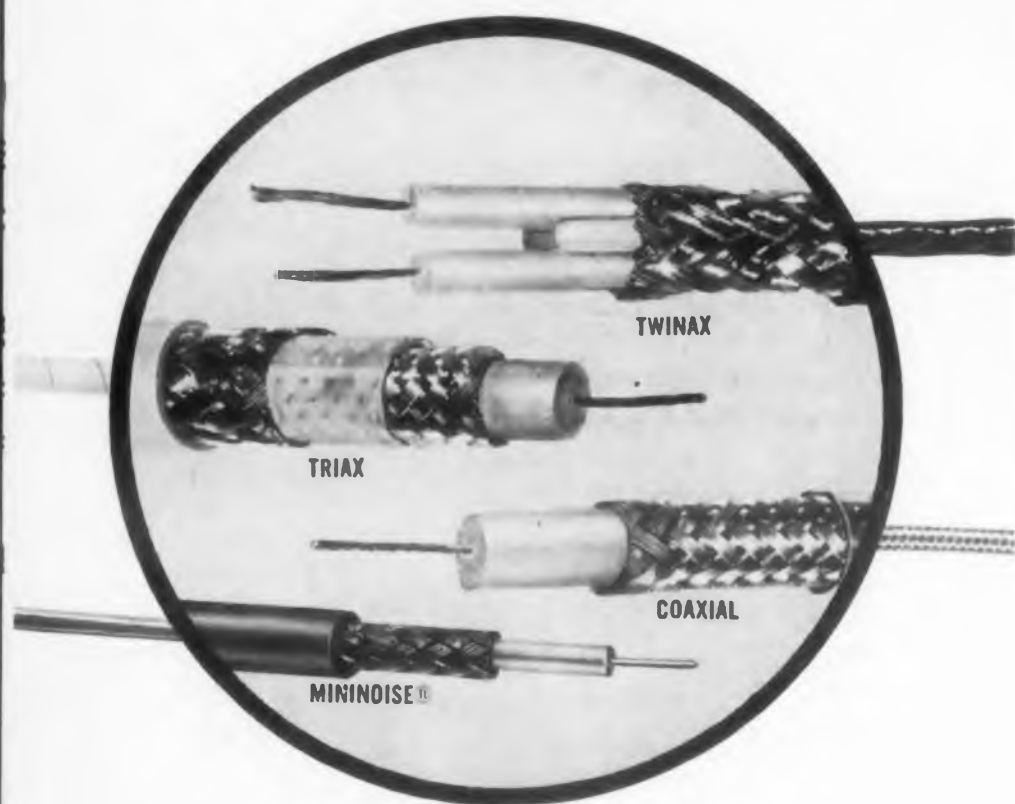


Fig. 3. Typical instrumentation setup of automatic impedance measuring system.



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70 ohm	93 ohm	160 ohm
75 ohm	-----	-----
93 ohm	-----	-----
95 ohm	-----	-----

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CIRCLE 32 ON READER-SERVICE CARD

Manufacturer	Model No.	Type	Frequency Range	Price	General Comments - Accessories required
	230 N to 230L T	Coaxial	425-4000 MC	\$475 to \$675	Includes probe carriage, probe and detector; seven units available for different connectors, centimeter scale and vernier reads to 0.1 mm.
	231N, 231C, 231TNC	Coaxial	1.5-12.4 KMC	\$360 to \$475	Includes probe carriage, requires probe and detector, centimeter scale and vernier reads to 0.1 mm.
	213 to 209	Waveguide	C to KU bands	\$2117-\$1375	High power units (1000 KW peak power for 213, to 250 KW peak power for 209), 45 db output attenuation, output is waveguide, requires detector and mount.
Polytechnic Research and Development Co., Inc.	200-C, 200-S3	Coaxial	1.0-5.0 KMC	\$475, \$825	Includes probe carriage, requires probe and detector, centimeter scale with vernier reading to 0.1 mm.
	215-A, 205-A	Coaxial	1.0-4.0, 4.0-10.0 KMC	\$475 ea	
	201-A to 204-B, 209-A to 212-BF2	Waveguide	S to V bands	\$280 to \$590	Includes probe carriage, requires probe and detector, centimeter scale with vernier, reads 0.1 mm at low frequencies, 0.02 mm at high frequencies.
	216A	Waveguide	M band	\$1250	Includes probe carriage, probe and detector; dial indicator reads carriage position to 0.01 mm.
Sivers Lab	SL5200-1 - SL5200-3	Coaxial	S, C bands	—	Includes probe carriage, probe and detector, centimeter scale with vernier, reads 0.01 mm, can be used with motor drive for automatic operation.
	SL5550-1 - SL5550-3	Waveguide	C, XN bands	—	
	SL5341-1 - SL5341-5	Waveguide	XII to XU bands	—	
Sperry Gyroscope Co.	351A	Coaxial	0.65-4.0 KMC	—	Includes probe carriage, probe and detector, centimeter scale with vernier reads to 0.1 mm.
	103B, 201, 145	Waveguide	C, XN, X bands	—	
	345	Waveguide	V band	—	Includes probe carriage, probe and detector, dial indicator reads carriage position to 0.01 mm.
Waveline, Inc.	264 to 565	Waveguide	S to X bands	\$440 to \$225	Includes probe carriage, requires probe and detector; centimeter scale with vernier reads to 0.1 mm (has magnifier).
	764, 864, 1064	Waveguide	KU, K, V bands	\$550, \$550, \$730	Includes probe carriage and probe; has both millimeter scale with vernier reading to 0.01 mm, and dial indicator reading to 0.001 inch.

Table 2. VSWR And Reflection Coefficient Indicators

Manufacturer	Model No.	Frequency	Meter Indication	Range	Sensitivity	Accuracy	Price	General Comments
BJ Electronics	62	100 cps	VSWR	1.02:1 to 100:1	2-20 MW at RF	±2%	\$295	Contains input connectors and suitable switching for single-probe or for two-probe differential measurements for better accuracy at low VSWR's.
Browning Laboratories	TAA-16B	500-5000 cps broadband or selective	VSWR and DP scales	0.50 DB	0.5 μ v for full-scale deflection	±2%	\$365	Peak frequency of selectivity response continuously variable, dual selectable inputs, gain control of amplifier over 10 db range, DC output to recorder.
California Technical Industries	(See comments)	1000 cps	VSWR and DB	VSWR 1.02-1.2 and 1.1-2.5	—	±2%	(See comments)	VSWR computer and indicator using reflectometer method, part of Model 110B VSWR measuring system (per 8.5-9.6 KMC range) which also includes oscillator, bi-directional coupler and wavemeter (total price \$2195).
Cubic Corp.	621B	1000 cps	(a) Percent reflect. coeff. (b) VSWR	(a) 0.5% to 0-100% full scale (b) 1.01-1.1 and 1.1-3.0	Direct channel 1.5-30 mv reflected channel 0.15 μ v - 30 mv	±3%	\$590	VSWR computer and indicator using reflectometer method, used with CU-52-620 or CU-52-621 reflectometer assemblies, has automatic amplitude correction, provides DC output for recorder or automatic sweep-frequency display.
F-R Machine Works, Inc.	R810A	1000 cps and 300-4000 cps	VSWR scale	1-3 to 30-100	0.1 μ v volt	—	\$200	Contains bolometer protection circuit to prevent transient burnout.
	R811A	1000 cps	(a) VSWR (b) Reflection coeff (c) DB	(a) 1.02-1.1 (b) .01-1 (c) 0-40 db and 0-70 db	0.1 μ v volt (max)	±3% as ratiometer ±0.1 db per 10 db step or VSWR amplifier	\$610	Universal ratiometer and VSWR amplifier, can be used for both reflectometer and slotted line measurements, has automatic amplitude correction, indication on two front panel meters with two cycle logarithmic scale, provides DC output for recorder or sweep-frequency display on an oscilloscope.

Manufacturer	Model No.	Frequency	Meter Indication	Range	Sensitivity	Accuracy	Price	General Comments
General Radio Co.	874-VI	—	Voltage	0.1-2 volts	—	±0.05 volts	\$ 70	Voltmeter-indicator, used with either 874-VR rectifier or 874-VQ detector to indicate DC output.
Walt-Clark Co.	415B	1000 cps	VSWR and DB	70 db	0.1 μ volt	±0.1 db per 10 db step	\$200	Permits scale expansion to give 0.2 db range (SWR: 1-1.13).
	416A	1000 cps	(a) Percent reflection coeff (b) VSWR	0.3% to 0-100%	Direct channel 3-100 mv Reflected channel 0.3 μ v-100 mv	±3%	\$450	Ratiometer for using reflectometer method, has automatic amplitude correction, contains r-f power monitor; provides DC output for recorder or sweep-frequency display on oscilloscope.
H. C. Jones Co. Inc.				Consist of directional coupler units and indicating meters which measure incident and reflected power in the frequency range 20-2000 MC. Nine different units cover the power range 0.12 w to 0-40,000 watts. Also listed as power meters.				
Waldo Microwave Corp.	441	1000 cps	VSWR and DB	72 db	0.1 μ volt	±0.2 db	\$200	Has scale expansion (exp VSWR 1-1.3, exp db 0-2) with full sensitivity, plug-in frequency meter when available for 315-3000 cps.
Polytechnic Research and Development Co., Inc.	277-A	1000 cps	VSWR and DB	70 db	0.1 μ volt	—	\$195	Has scale expansion feature (exp VSWR 1-1.3), panel switch selects 15 or 50 cps bandwidth, or broadband 550-2500 cps.
Radio Corp. of America	MI 31074			Consists of directional coupler unit and indicating meter which measures incident and reflected power in the frequency range 1700-2000 MC. Coupling sensitivity 28.5 db, measures power up to 6 watts, measures VSWR of 1.2 or greater. Also listed as power meter.				
Sivers Lab	SL 540C	1000 cps	VSWR and DB	60 db	0.15 μ volt	—	—	Selective or broad-band (50-2000 cps), plug-in units for different tuned frequencies, automatic indication on meter, and designed to be used also as part of automatic system.
Waveline, Inc.	2100	1000 cps	VSWR and DB	70 db	0.2 μ volt	—	\$250	Other frequencies from 250-2500 cps available, two inputs with channel selector switch.

Table 3. Automatic Impedance And Standing Wave Indicators And Displays

Manufacturer	Model No. and Price	Type	Frequency Range	VSWR or Impedance Range	Indication	Accuracy	General Comments
California Technical Industries	125A \$4950	Sweep-frequency VSWR measuring system	8.5-9.6 KMC	1.02-1.20 and 1.1-2.0 (VSWR)	Meter, oscilloscope and output to graphic recorder	±2%	Consists of sweep-frequency oscillator, bi-directional coupler, adjustable mismatch load (calibrated), and VSWR computer-indicator, all or any portion of band can be selected for sweeping at rates of either 1 or 0.1 cps, includes adjustable wavemeter for frequency marker pip in the scan.
	160 \$5900	Sweep-frequency VSWR measuring system	8.4-12.0 KMC	1.02-1.20 and 1.1-2.0 (VSWR)	Meter, oscilloscope and output to graphic recorder	—	Consists of sweep-frequency oscillator, bi-directional coupler calibrated adjustable mismatch load, and VSWR computer-indicator, all or any portion of band can be selected for sweeping at rates of .02, 0.1, 1.0 and 3.0 cps, includes adjustable wavemeter for frequency marker pip in the scan.
Cascade Research Corp.	Z-Scope \$3250 Complete	Visual impedance plotter	8.2-12.4 KMC	(a) 1.02 - (b) 1.02-2.0 (VSWR)	(a) Smith chart (b) Expanded Smith chart	6° of reflection cuff or VSWR 1.02 (whichever is featured)	Consists of waveguide control section and presentation section (2 cabinets); presents information on 7 inch oscilloscope with Smith chart reticle, presentation sweep rate 30 cps, has outputs to X-Y recorder; requires sweep-frequency microwave source.
Federal Telephone & Radio Co.	ZDD \$5380	Visual impedance plotter	300-2400 MC	0.02Z ₀ to 50Z ₀	Light spot on (a) Smith chart (b) polar overlay	±3° at Z ₀ (an impedance meter)	Uses one directional coupler in coaxial test line, another in reference line, and compares them; different overlays provided for use as impedance meter, indicator of network transmission properties, phase angle, available in Z ₀ = 50 or 60 ohms; requires external signal generator.
General Radio Co.	874 (See comments) \$525	Motor-driven slotted line	300-5000 MC	—	Oscilloscope presentation of standing-wave pattern on line	—	Consists of motor drive 874-MD on slotted line 874-LBA and adjustable stub, standing-wave pattern is displayed on oscilloscope as carriage moves back and forth along line, supplies synchronized horizontal sweep voltage to oscilloscope; requires external oscilloscope and signal generator.
Sivers Lab	(See comments)	Motor-driven slotted line	Different assemblies for S to KU bands	—	Meter, oscilloscope or recorder	—	Consists of motor-drive assemblies (SL 5645/1 to SL 5645/3) for slotted lines to give automatic indication of standing-wave pattern as probe waves along line, requires external signal generator and indicator.

1 *REGATRON POWER SUPPLY DOES THE WORK OF 3 ORDINARY POWER SUPPLIES

a case history



(Model 212AM:
0-100 V dc, 0-100 ma,
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A MANUFACTURER required three different regulated voltages. The voltages, which were to be used alternately, could be furnished by three separate power supplies or by a single power supply and a voltage divider. But, three power supplies were expensive. On the other hand, a voltage divider meant a loss of power and regulation plus the expense of high-wattage components.

THE SOLUTION: Three 1-watt resistors and a *Regatron Programmable Power Supply. An exclusive programming feature permits changing output voltage by shunting two terminals with a resistor. For each 1000 ohms, the Regatron delivers one volt . . . at rated current and regulation.

IN THE PROBLEM quoted here, the required voltages were 14.5, 28, and 45 V dc. The three resistors were 14.5K, 28K, and 45K. Regatron Programmable Power Supplies are available in many ranges up to 600 V dc and 3 amperes. Bulletin 765A tells more about how Programmable Regatrons solve d-c problems. Write for your copy.

POWER FACT No. 3

Output Impedance:

This important parameter of a power supply varies greatly with frequency. It is determined to a large extent by the design and often determines the usefulness of a supply in a given application. Its definition, specification, and measurement are very important to the design engineer and his associated test department.

For a useful discussion of these matters send for Technical Bulletin No. 2003. It is free of charge.

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CIRCLE 33 ON READER-SERVICE CARD

ANNOUNCING

A NEW TENSILE TESTER FOR WIRE TERMINALS

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THE HUNTER MODEL "TT" TERMINAL PULL TESTER



The Hunter Model "TT" Tester is ideal for testing wire cable assemblies under MIL-T-7928 (ASG).

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The "TT" Tester—latest addition to Hunter's growing line of quality control equipment—brings laboratory accuracy to production-line testing ($\pm 0.5\%$ of full-scale reading). Though you'll find it adaptable to many other tensile tests in ranges up to 0-500 pounds, its special job is checking the secureness of solderless terminals crimped on wire. Automatically opening and closing jaws grip the wire sample; a turret-type gage head indexes quickly to hold any size terminal; load is applied at a preset rate by an adjustable air cylinder; and breaking load registers and is held on a direct-reading dial until reset by a touch of the quick-reset tab. Over-all speed of testing is up to ten times faster than by conventional methods.

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CIRCLE 34 ON READER-SERVICE CARD



MPG-1 pulse generator provides pulse durations from 30 to 2500 millimicrosec at frequencies from 2000 to 4000 mc

Millimicrosecond Pulses From Microwave Signal Generator



Fig. 1. Block diagram of MPG-1 pulse generator.

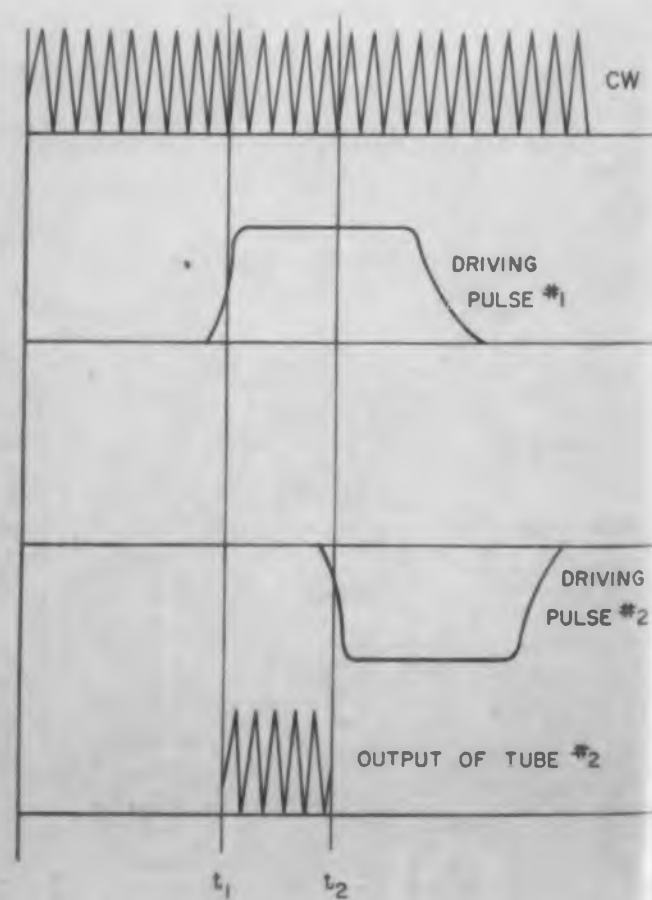


Fig. 2. The duration of the microwave output is equal to $t_1 - t_2$, where t_1 is the time of gate on pulse and t_2 is the time of gate off pulse.

FOR THE first time millimicrosec pulse durations can be generated at microwave frequencies. MPG-1 pulse generator, containing two traveling wave tubes in its circuitry, generates pulse durations from 30 to 2500 millimicrosec at frequencies ranging from 2000 to 4000 mc. Up to now the smallest pulse width microwave signal generators could generate was usually greater than 0.5 μ sec in duration.

How It Works

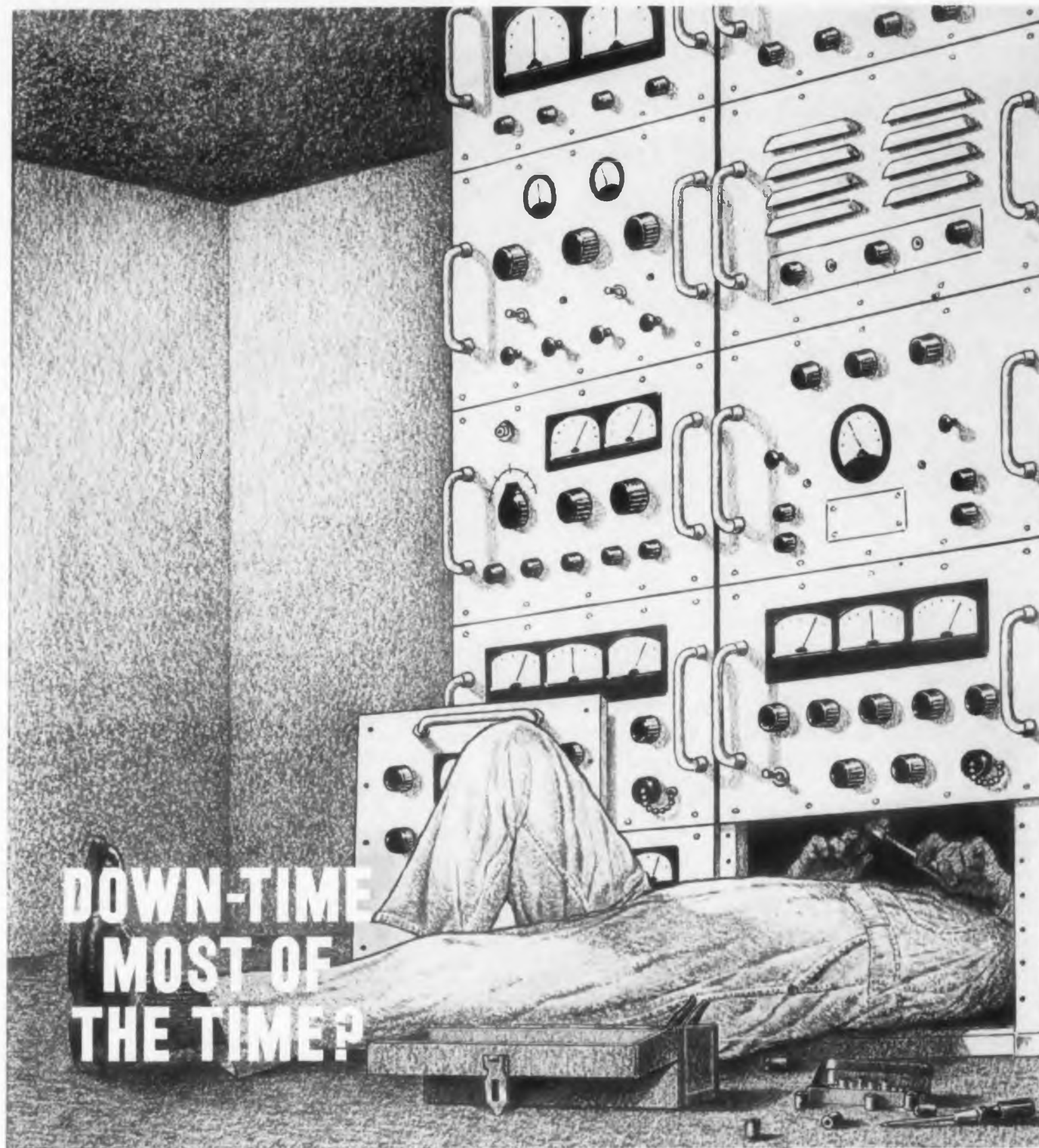
MPG-1 pulse generator was developed by the Hallicrafters Co., 4401 W 5th Ave., Chicago 24, Ill. A block diagram illustrating its components is shown in Fig. 1. The system operates as follows. *Twt 1* is normally cut off while 2 is normally conducting. The microwave signal is generated in the cw oscillator, the output of which is coupled to the input of *twt 2*. *Twt 1* being cut off will not allow any signal to reach 2. A signal will not appear in the output until a pulse is generated by the pulse generator. The pulse generator sends a pulse to *driver 1* directly, and to *driver 2* through a variable delay network. The positive pulse from *driver 1* brings *twt 1* into conduction which allows the signal from the cw oscillator to pass through both 1 and 2 and arrive at the final output. At the time 1 was brought into conduction by the pulse from *driver 1*, the pulse for *driver 2* was being delayed in time by the variable delay network. *Twt 2* receives a pulse from *driver 2* which is delayed from the pulse on 1 and is negative in polarity. *Twt 2* is thereby cut off and its output drops to zero until another pulse is generated in the pulse generator. It can be seen that the duration of the microwave output is equal to the time difference between the two driving pulses arriving at the grids of the traveling wave tubes. See Fig. 2. The maximum pulse duration is determined by the width of the pulse applied to 1. Since the leading edge of both driving pulses are used to generate both rise and fall of the microwave pulse, the minimum pulse duration obtainable will be dependent upon the rise times of the driving pulses.

Other Characteristics

MPG-1 signal generator can also be used as a stabilized cw oscillator, an amplifier or as a serrodyne amplifier (frequency translation). Other characteristics include:

- Pulse repetition rate range of 2 pps to 10,000 pps
- Power output (cw and pulse) of 10 mw
- Maximum frequency translation of 50 kc
- Output impedance of 50 ohms nominal

For further information on this microwave pulse generator, turn to the Reader-Service card and circle 103.



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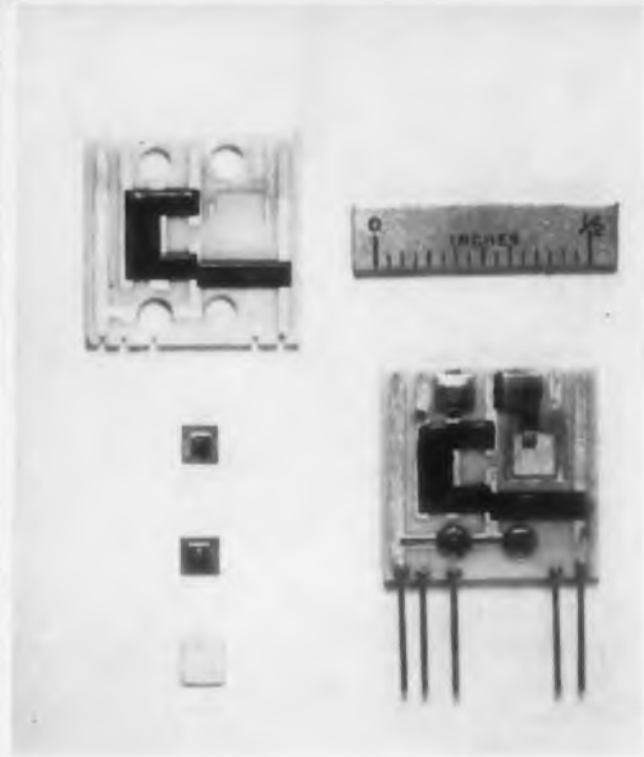


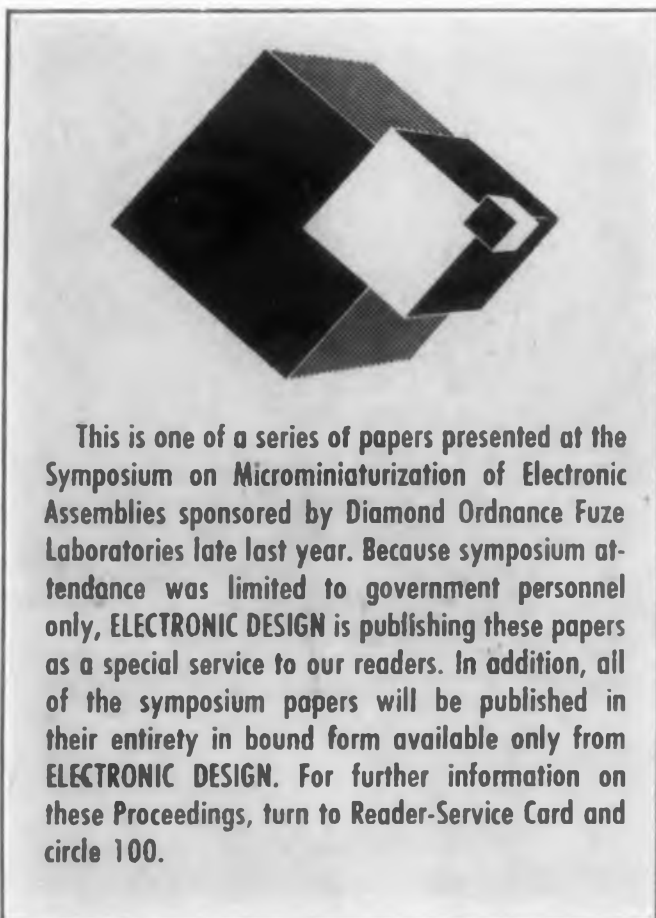
Fig. 1. Module (lower right) will permit a component density of 2800 components per cu in. Base plate wafer (upper left) has conductors and resistors printed on it. Lower left, top to bottom, are a transistor, diode and capacitor for insertion in the base plate.

Equipment Adaptable to Microminiature Circuit Technology

John E. Sensi*

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Washington 25, D. C.

Equipment for mass producing micro-miniature modules must incorporate handling methods that are compatible with the processes required for producing the modules. In this article, the author discusses some handling methods which can be used to adapt currently available machinery to microminiature applications.



This is one of a series of papers presented at the Symposium on Microminiaturization of Electronic Assemblies sponsored by Diamond Ordnance Fuze Laboratories late last year. Because symposium attendance was limited to government personnel only, *ELECTRONIC DESIGN* is publishing these papers as a special service to our readers. In addition, all of the symposium papers will be published in their entirety in bound form available only from *ELECTRONIC DESIGN*. For further information on these Proceedings, turn to Reader-Service Card and circle 100.

SEVERAL types of elements must be handled in the fabrication of a microminiature electronic circuit. They include:

- Dielectric base plates
- Conductors
- Resistors
- Capacitors
- Transistors and diodes
- Inductors
- Protective coatings

Designers must be familiar with type, general physical characteristics, status of the art in handling the component, and equipment that could be adapted to handling the component in production. Fig. 1 illustrates a microminiature circuit assembly and also the individual components used in the circuit.

Dielectric Base Plates

In a sense the base plate is the nucleus of a microminiature electronic unit; it is essentially the matrix. The base plate is a thin wafer of dielectric material and upon it are attached all the components of the circuit. In an effort to miniaturize, the physical dimensions of the base plate are kept so small that it in itself is fragile. But the finished unit becomes rugged because of the addition of a protective coating and the arrangement of the components on the base plate. At the Diamond Ordnance Fuze Laboratories, an electrical grade of steatite is used for this wafer which is usually twenty thousandths of an inch thick and either one-half inch square or one-quarter inch square. Holes are placed in the wafer to receive the transistors and diodes, and cavities are made for capacitors.¹ The fragile

wafers are at present handled by hand methods with the aid of tweezers and micromanipulators.

In mechanizing the assembly-operation of microminiature electronic circuits, one of the most formidable problems is the handling and indexing of these wafers without damage during the successive operations involved in producing a finished unit. The operation to be performed on the wafer is an important factor in the selection of a mechanism for conveying and positioning the wafers.

Certain phases of the handling are basic and can be applied generally to all operations. The conveying device for all operations could be either some type of endless belt or an indexing rotary table.

In the conveyor carrier assembly (Fig. 2), the wafer is dropped into the carrier nest and is hence oriented with the indexing cones that orient the printing head with the wafer. The wafers can be picked up from a stack and placed on the conveyor carrier by an arm with a vacuum finger. If there is any particular desired orientation for the wafers, they should be put in the stack oriented.

A vacuum arm may not be practical as a take-off mechanism for a wet printed wafer because the vacuum finger would smear the wet pattern on the top of the plate. In this case a tweezer-type arm would pick up the wafers by their edges and place them on the conveyor that will carry them to the next operation.

A straight pusher-type of take-off mechanism, where a finger pushes the wafer off the conveyor

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onto some horizontally moving receiving device, can also be employed. Another type of take-off mechanism can be used where the carrier is made so that at the take-off position a member of the carrier assembly raises the wafer vertically. A fork-like finger picks up the wafer and transfers it to a position over a second conveyor where the wafer is displaced onto the conveyor by a pusher in the fork arm mechanism (Fig. 3).

Conductors

In a microminiature electronic circuit with component densities in excess of two thousand per cubic inch, the conductors, except for terminal leads, are usually of the deposited metal type. The conductor patterns can be deposited on a dielectric material by screen printing, spraying, or vacuum deposition. Terminal leads are attached to the unit by soldering or by conductive cements.

Hand operated equipment is currently being used for screen printing conductive patterns onto small wafers. Screen printing has been carried out for many years.² Automatic machinery for screen printing is currently available for large plates and appears to be adaptable to small wafers. Here the problem is not so much in the printing operation itself as in the feeding, conveying, indexing, holding and take-off of the fragile wafer.

An automatic high-speed screen printing machine (Fig. 4) is capable of printing conductive patterns on dielectric plates at rates of six thousand plates per hour. The dimensions of the plates currently printed on this machine are 1.0 x 1.25 x 0.1 in.

In a suggested redesign of the screen printing machine, an indexing rotary table, instead of an endless belt conveyor, should be considered. It probably will be necessary to have more complex carriers than those presently employed, and a rotary table requires only a few carriers.

The portion of the printing head that carries the patterned screen can be made to float, that is,

to have some movement in the plane of the wafer surface, angularly and in two directions perpendicular to each other. The patterned screen frame can then have two members with tapered holes which will mate with tapered pins that are a part of the carrier unit, and are precisely located with reference to the wafer indexing mechanism. This modification would optimize the indexing accuracy of the machine, which, in its current form, produces ninety-four per cent acceptable plates.

Conductors are also deposited on dielectric wafers by vacuum deposition methods.^{(3), (4)} At the present time, vacuum deposition is generally a batch-type process. This batch process could be made continuous.

Conductor patterns can be placed on dielectric wafers by spraying techniques. Spraying is not as widely used as screen printing. The masking problem becomes somewhat difficult in the spraying process and hence the pattern definition is sometimes not sharp. Smearing of the mask with the wet paint also contributes to poor pattern definition. It appears that where silver patterns are to be applied a screen printing process will generally be employed.

Wire (about 0.12 in. diam) is used for terminal leads as shown in Fig. 1. They are placed in the circuit assembly by hand operations and attached to the circuit either by soldering or with a conductive cement.⁽⁵⁾

Soldering presents problems in the small wafers: the heat applied to components, such as transistors and resistors, can modify their electrical characteristics, and the thermal shock on the thin wafers, due to local applications of intense heat required for soldering, may cause the wafer to crack.

In production, wire could be fed from spools, through dies, cut to size, and attached to the circuit with conductive cement.

Resistors

Methods which have been employed to apply

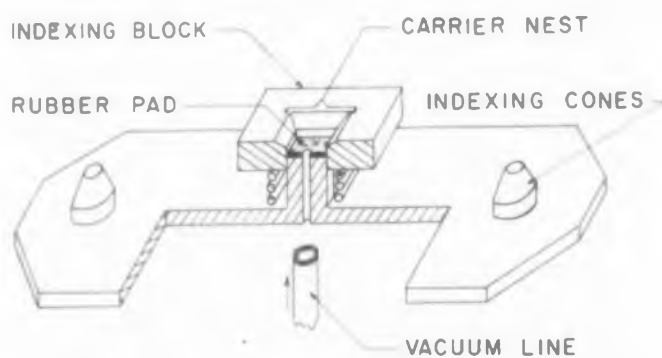


Fig. 2. Carrier assembly for conveying and indexing wafers. Indexing block is in raised position.

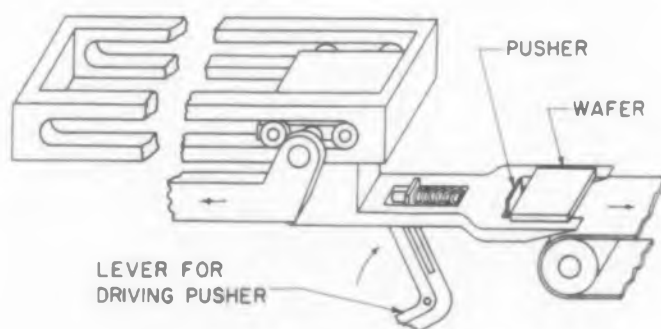


Fig. 3. Fork-type arm for transferring printed wafers.

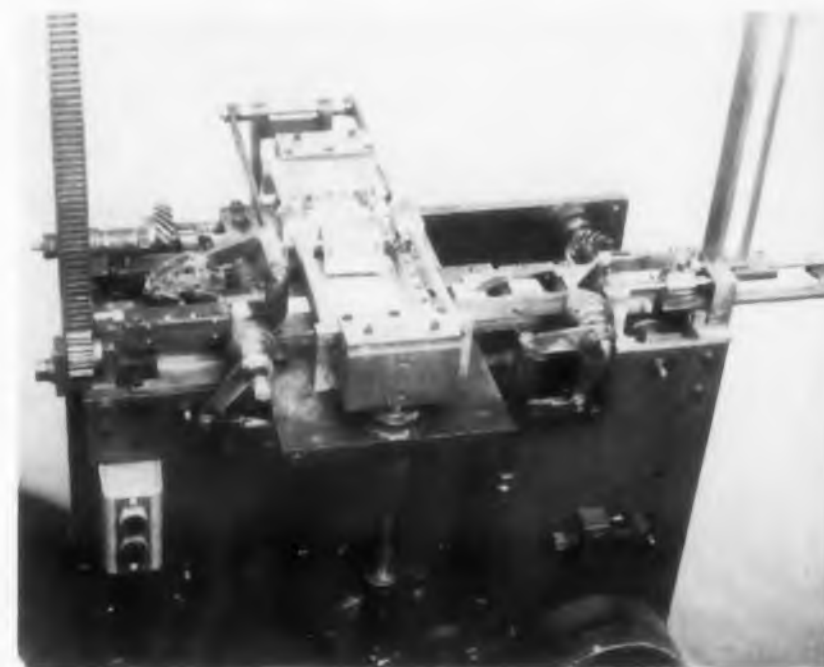


Fig. 4. Screen printing machine. Feed is from the right.

printed resistors to circuits are:

- Screen printing
- Injection molding
- Pen
- Vacuum evaporation
- Tape

The same screen printer as described for applying conductive patterns on dielectric materials could be used for printing resistors simply by using an appropriate pattern and a resistor ink formulation, rather than silver paint. Hand screening methods are presently being used in the laboratory production of printed resistors for microminiature circuits. Screen-printing of resistors has proven to be satisfactory but the method is not as versatile as some others which allow greater control in the depth of each resistor.

The injection molding method for resistor printing is based on the pressure filling of an appropriate matrix with resistor ink and transferring the ink from the matrix to the surface of the dielectric plate.

The value of the printed resistors is controlled by varying the resistor ink formulation used, and by varying the dimensions of the matrix-cavities which in turn define the length, width, and depth dimensions of the resistor. An injection molding-type machine (Fig. 5) for printing resistors is designed so that it can simultaneously print up to twelve resistors on a dielectric plate, each having, if necessary, a different formulation of resistor ink.

The pen method is another process by which resistors can be printed.⁶ The mechanism is essentially a tube containing resistor ink. The tube has a hypodermic-needle-like outlet and the ink is forced out of the outlet by air pressure. The

tip of the needle is passed across the surface of the dielectric plate leaving a ribbon-like layer of wet resistor ink on the plate. In this process, a pen assembly is required for each different resistor to be printed.

Thin-film resistors produced by vacuum evaporation techniques can also be used in microminiature circuit assemblies. In the vacuum deposition of resistive materials, as with conductive materials, batch processes are presently used but a continuous-type production operation could be obtained.

Another type resistor that can find applications in microminiature circuit assemblies is the tape resistor.⁷ Resistor ink is placed on a thin asbestos tape by a continuous spray process and the resultant resistor tape is then cut to the desired dimensions and placed on the circuit plate. This process has been used in the production of large printed circuit assemblies with satisfactory results and could be applied to the microminiature applications by adapting similar machinery.

Capacitors

An example of a typical capacitor⁸ used in microminiature circuits is the one shown at the lower left of Fig. 1. It is 0.1 in. sq. and 0.01 in. thick and has a capacitance of 0.1 μ f. Silver electrodes are screened on each side of the wafer. These wafers are attached mechanically and electrically to the circuit with conductive cement.

The capacitor could also be attached to the circuit by soldering, but in that case thermal shock may be a problem and, since the capacitor is placed in a cavity in the wafer, a conductor would have to be applied in the cavity and contact made with the rest of the circuit. These small capacitors could be placed in the circuit with a machine having similar feed, conveying, indexing and take-off mechanisms as discussed previously.

Another approach to the capacitor insertion problem is to use a body with high dielectric constant as the base plate and let it serve as the dielectric of the capacitor. This would eliminate the capacitor insertion problem and require only the printing of the electrodes which would be done during the conductor printing operation.

Transistors and Diodes

Microminiature transistors are produced by applying photolithographic and vacuum deposition techniques to a germanium wafer forty-five thousandths of an inch square and ten thousandths of an inch thick. A more detailed description of the fabrication of these transistors is available in the literature.^{1,9} These transistors are presently being produced by hand methods in the laboratory,¹⁰ but can be mass produced by implementing photolithographic and vacuum

deposition techniques for large scale production.

The finished transistors and diodes consist of the processed germanium wafer. They are soldered to a thin metal base plate in order to facilitate the insertion of the component in the circuit assembly. The transistor is placed in a hole in the dielectric base plate and the thin metal base plate which has been soldered to the transistor overlaps the hole edges and locates the transistor so that the surface of the transistor-contacts are in the plane of the base-plate surface.

Voids in the hole in the ceramic wafer between the transistor and the wafer are filled with a suitable resin prior to depositing leads connecting the transistor with the rest of the circuit. Contact between the transistor and the rest of the circuit is made by vacuum depositing aluminum leads from the contacts on the transistor to the proper points on the conductor pattern on the ceramic wafer.

Inductors

Inductive components tend to be large and, although considerable progress has been made in miniaturizing them, there does not exist at the present time an inductive component that meets

the size requirements of the microminiature circuit assemblies. Small inductive coils have been developed by the manufacturers of hearing aids and although they represent great accomplishment in microminiaturization they occupy greater volumes than entire microminiature circuit assemblies.

The approach taken at the present time, in order to realize optimum space savings, is to substitute R-C circuits for inductive circuits wherever possible. In some cases, coils can be printed but they require considerable surface area of the base plate and only a very limited range of values from one tenth to one microhenry can be achieved. In the limited number of cases where printed coils can be used, the same printing methods described earlier for printing conductors or resistors can be applied.

Protective Coatings

Protective coatings are an essential part of any printed circuit assembly. This is especially so of a fragile microminiature circuit assembly for operational military applications which must undergo extreme environmental and handling conditions. Units are protected against moisture, heat, pressure, shock and vibration, arcing between components, and long periods of storage under adverse conditions. Each microminiature circuit can be protected individually, or where the individual circuit is a stage of a larger assembly, the entire unit can be protected.

Methods which are generally used for applying protective coatings to electronic circuit assemblies are:

- Screen printing
- Spraying
- Dipping
- Potting

The same screen printing equipment that is used for printing conductors and resistors can be used for applying protective coatings. Screen printing is generally used when certain portions of the circuit are to be electrically insulated prior to completing the assembly operations.

A plastic protective coating can also be sprayed on either the finished unit or at some intermediate stage during the fabrication of the electronic assembly.

Protective coatings can be applied to a unit by dipping the entire unit in an appropriate coating material. Care must be taken that the coating material can be applied and cured at a temperature sufficiently low that it will have no ill effects on the components in the circuit.

In selecting a dip-coating material it is also desirable that it jell at room temperature so that it will not run off prior to curing. In production, the coating can be applied to each unit by using an endless belt conveyor to which the units will



Fig. 5. Injection molding resistor printing machine. Conveyor pauses under the printing head.

and the conveyor will convey the units through the dipping and curing operation.

Potting is a process that will be especially useful in protecting larger units such as stacks of small assemblies. The stacks can be placed in reusable molds or in casings that will stay with the unit. The potting material can then be poured into the mold or casing as it is conveyed by resin dispensing equipment.

Caution should be exercised in deciding the degree of mechanization that is economically desirable to achieve. A certain amount of mechanization will be essential to the production of large quantities of electronic assemblies. However, since microminiature technology is so new and there is almost day-to-day change in the type of components used, machine developments should not be undertaken where the equipment cannot be amortized. In all cases equipment should be designed so that it can be adapted to meet new requirements.

More detailed information on the processes described in this article will be found in the complete paper to be published in our Proceedings of the Symposium on Microminiaturization of Electronic Assemblies. For further information on the Proceedings, turn to Reader Service Card and circle 100.

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		Collector-Base Rating BVCBO	Oper. Volt V_{CEM} min. $I_{CMAX} = 10\mu A$ $V_{BE} = 1.5V$ $R_{\theta} = 62K$	D.C. Current Gain h_{FE}	Conditions	Delay + Rise Time $t_2 - t_1$ μ SEC	Storage + Fall Time $t_1 + t_1$ μ SEC	
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2N316A	PNP	30V	18V	20 - 50	$I_C = 200ma, V_{CE} = .2V$	0.4	0.9	12
2N358A	NPN	30V	20V	25 - 75	$I_C = 300ma, V_{CE} = .25V$	0.4	0.9	9
2N357A	NPN	30V	25V	25 - 75	$I_C = 200ma, V_{CE} = .25V$	0.5	0.9	6
								Minimum
2N523A	PNP	20V	10V	100 - 400	$I_C = 20ma, V_{CE} = .25V$	0.2	0.6	21
2N522A	PNP	25V	12V	80 - 300	$I_C = 20ma, V_{CE} = .25V$	0.3	0.8	15
2N521A	PNP	25V	15V	60 - 250	$I_C = 20ma, V_{CE} = .25V$	0.4	0.9	8
2N447A	NPN	30V	15V	80 - 300	$I_C = 20ma, V_{CE} = .25V$	0.4	0.7	9
2N446A	NPN	30V	18V	60 - 250	$I_C = 20ma, V_{CE} = .25V$	0.7	1.0	5
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Stability of Semiconductors in Microminiature Assemblies

This article describes factors in processing semiconductor material necessary to insure a good stable surface. Techniques of measurement and some important surface properties observed are also discussed.

DETAILED information about the semiconductor surface can be obtained from the field effect experiment. A dc current is passed through a small bar of germanium in the circuit shown in Fig. 1. Plate electrode P is positioned over the bar and an ac voltage of 50-3000 cps applied. Changes in the conductivity of the surface appear as modulated dc in the oscilloscope.

Curves appearing on the scope show change in surface conductivity, G , versus surface charge Y due to the field effect. The experimental curve is wider than a calculated theoretical curve due to the charge held in traps.

Surface Stability

In the field effect experiment the patterns ap-

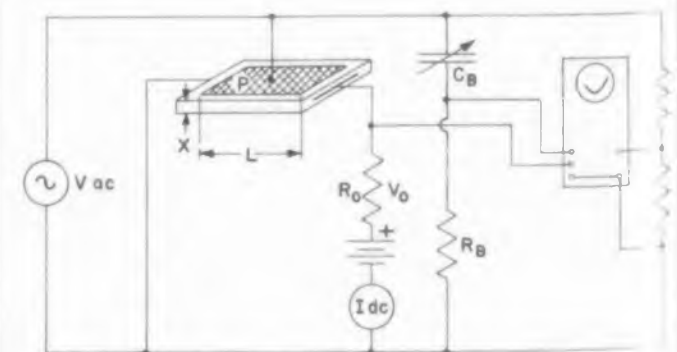
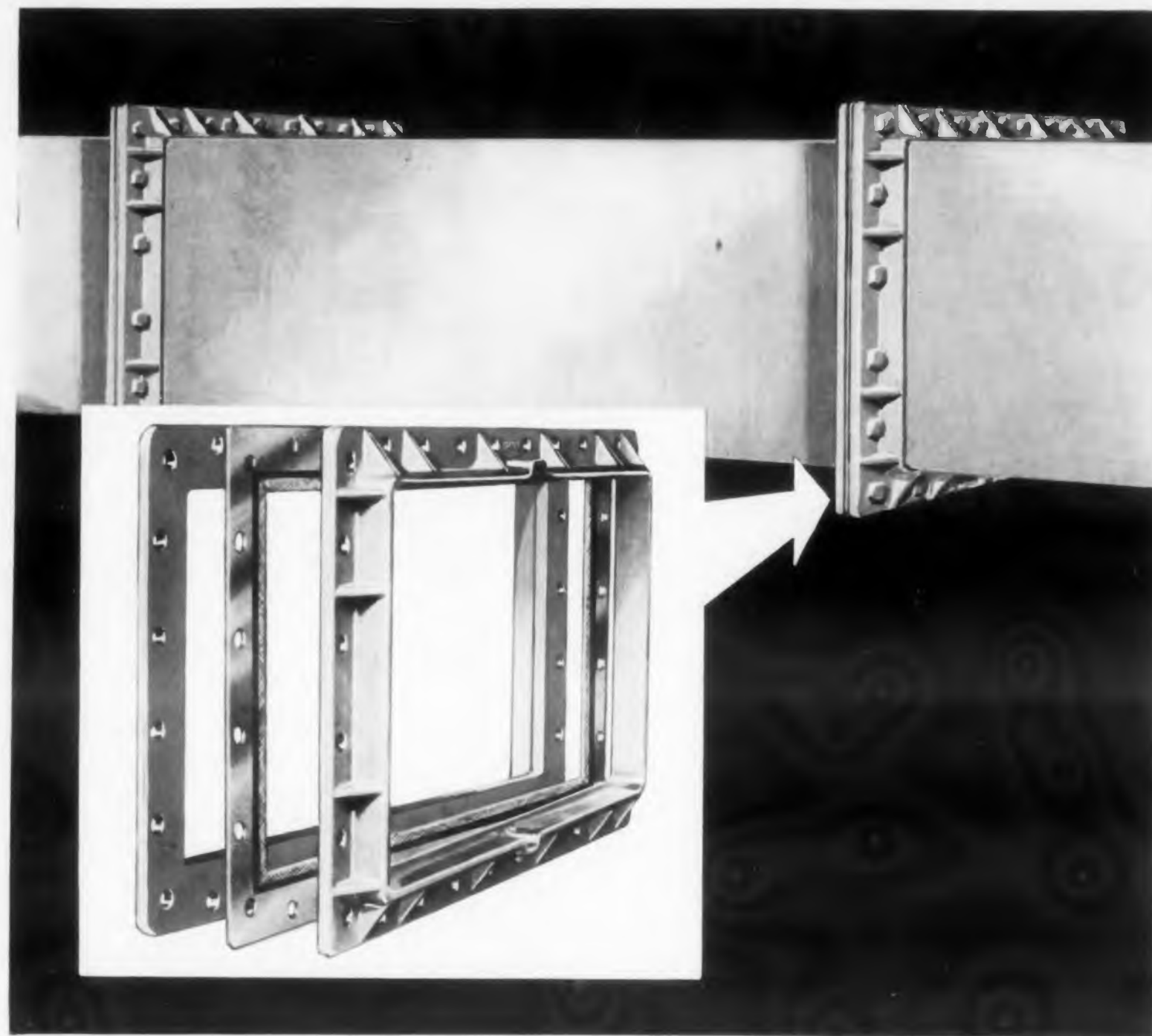
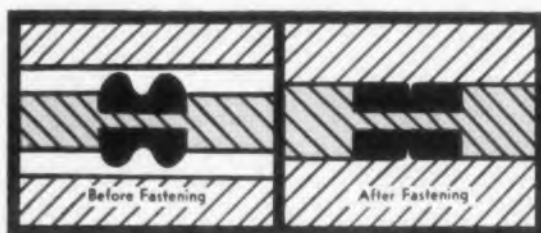


Fig. 1. Circuit of the "Field Effect" experiment for obtaining surface characteristic of germanium.



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Another article of the exclusive series on micro-miniaturization. See note accompanying article p. 38 in this issue regarding the entire series.

J. M. Stinchfield and O. L. Meyer

Diamond Ordnance Fuze Labs.,
Washington 25, D. C.

... appearing on the oscilloscope (Fig. 2) show clearly the type of surface present on the semiconductor. The type of surface conductivity (either *n*-type or *p*-type) is shown by the slope direction of the curve for the surface conductivity, since near the minimum point in the curve a change from *n*-type, through intrinsic, to a *p*-type surface is indicated. The untreated semiconductor surface is observed to change from a strong *n*-type surface to a strongly *p*-type surface and back again as the gaseous ambient surrounding it is changed from wet nitrogen through dry nitrogen and dry oxygen to ozone and back again. The sensitivity of the semiconductor surface to such an "ambient cycle" is used here to test the surface stability. The degree to which the surface is resistant to disturbance by the "ambient cycle" will be used as a measure of surface stability. Some change is usually observed even with specially treated and coated surfaces.

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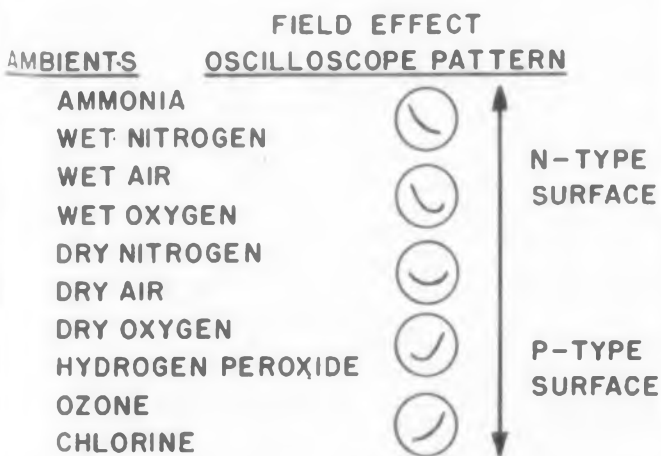


Fig. 2. Ambients arranged according to the degree of *n*-type or *p*-type surface produced in germanium.

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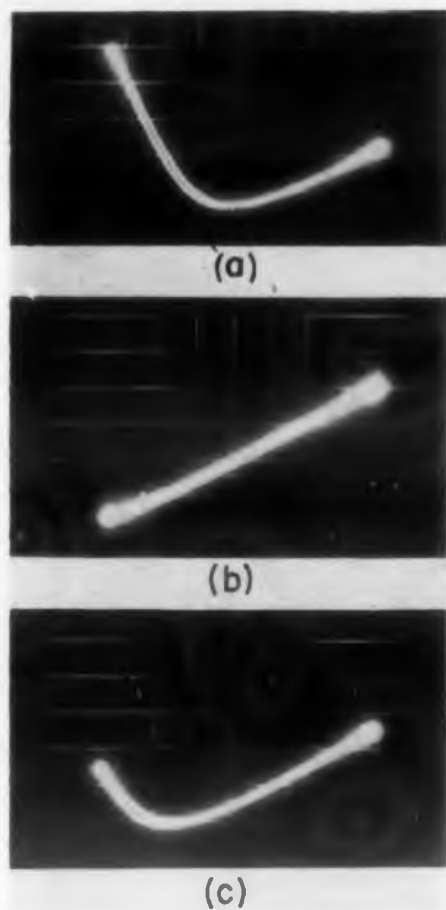


Fig. 3. Experimental surface conductivity versus applied field for oxygen and ozone. (a) Dry O_2 ; (b) O_3 10 sec; (c) Dry O_2 3 min. after O_3 .

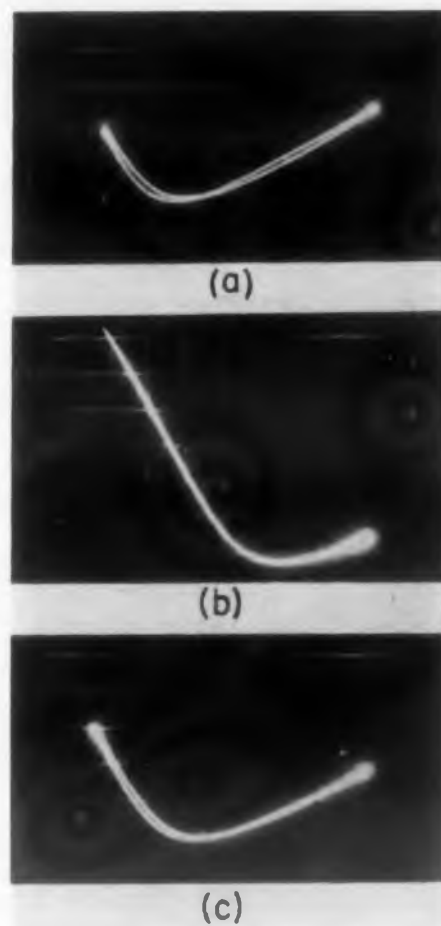


Fig. 4. Experimental surface conductivity versus applied field for dry and wet nitrogen. (a) Dry N_2 5 min.; (b) Wet N_2 10 sec.; (c) Dry N_2 1 min. after wet N_2 .

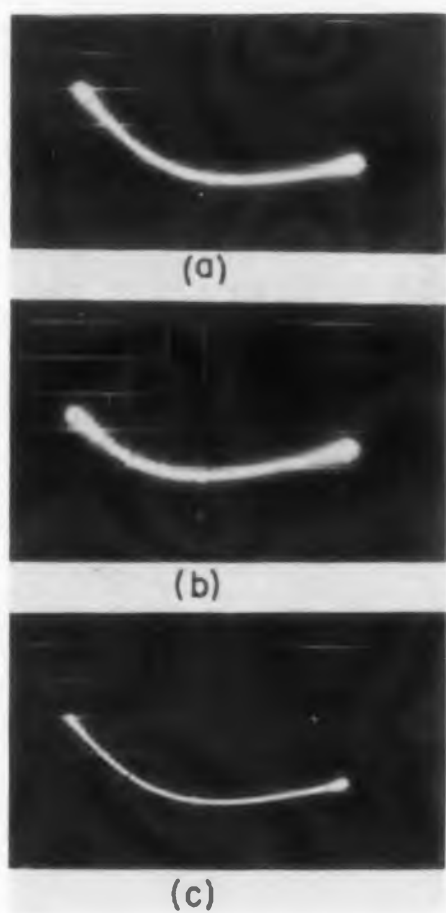


Fig. 5. Experimental surface conductivity versus applied field for a stabilized surface exposed to oxygen and ozone. (a) Dry O_2 5 min.; (b) Dry O_3 5 min.; (c) Dry N_2 1 min.

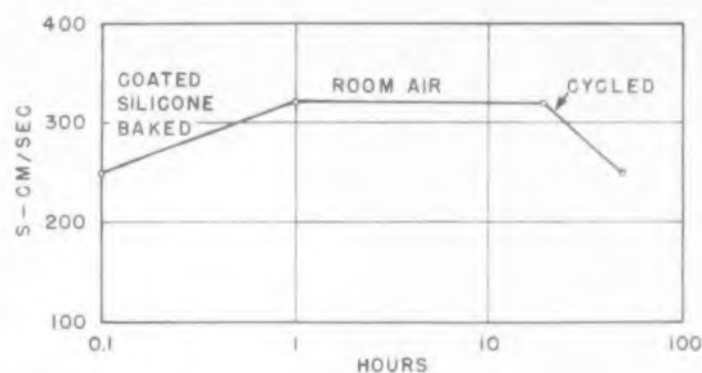


Fig. 6. (Above) Surface recombination velocity versus time in air for silicone coated n-type germanium.

Fig. 7. (Below) Surface recombination velocity versus time in air for polystyrene coated n-type germanium. "UP wash" used ultra-pure deionized water for rinsing after cleaning with household cleanser.

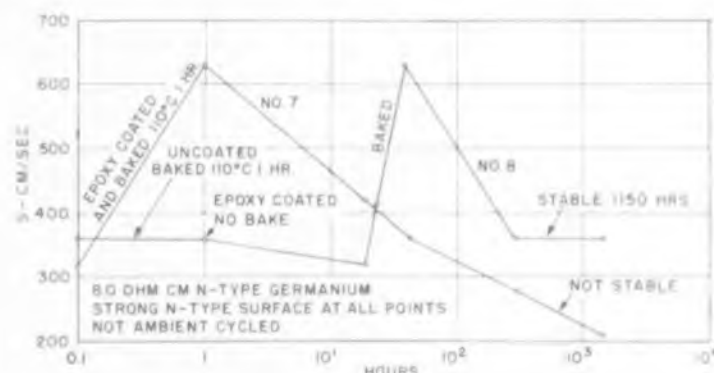
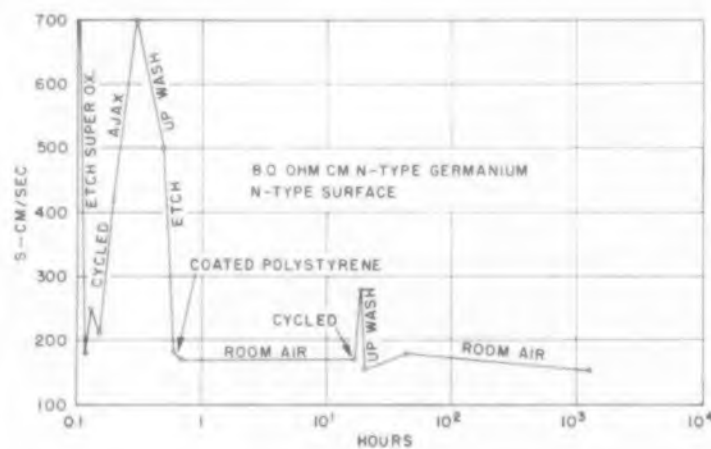


Fig. 8. (Above) Surface recombination velocity versus time in air for epoxy coated and baked (No. 7) and baked, epoxy coated and baked (No. 8) in n-type germanium.

Fig. 9. (Below) Surface recombination velocity versus time in air for silicone coated n-type germanium.

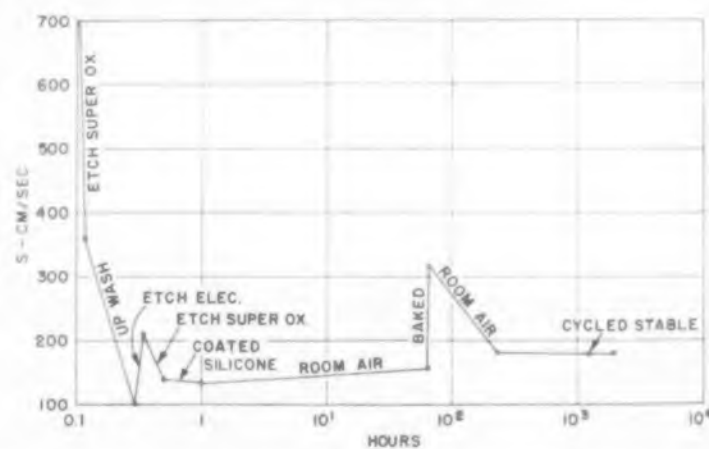




Fig. 10. Surface recombination velocity versus time in air for n-type germanium treated with tetra-n-butyl titanate and coated with a photo-resist (KPR).

This illustrates how readily the ambient atmosphere can shift the surface from strongly *p*-type to strongly *n*-type.

Fig. 5 shows similar curves on this sample after it has been coated with a silicone resin. The center curve *j* obtained after 5 min exposure to ozone shows only a slight change in the *p*-type direction compared to a change completely to a *p*-type surface in 10 sec when the surface is uncoated.

The surface recombination velocity *S* is shown in Fig. 6 for this sample.

Some typical curves illustrating several surface treatments under study at DOFL are shown in Figs. 7, 8, 9 and 10.

Many of the germanium etching baths (for example the superoxol etch bath) leave weak *n*-type or weak *p*-type surfaces on the semiconductor. These surfaces are easily disturbed by slight traces of stray contaminants. Vapor encountered during removal from the bath, the rinsing, the drying and the room ambients all can easily change such surfaces.

A semiconductor surface remaining stable for hundreds of hours in room air can show a large change due to a few seconds exposure to nearly pure oxygen, a small per cent of ozone, a high relative humidity, or a slight amount of chemical vapors.

A combination of chemical treatment plus coating shows promise for producing stable microminiaturized assemblies. In the final stages of fabrication the semiconductor device should be etched, cleaned, and processed to produce the desired surface. This surface should be made resistant to ambient disturbance so that surface properties do not change over the period of normal life expectancy and in any of the environments to which it might be exposed.

More detailed information on the processes described in this article will be found in the complete paper to be published in our Proceedings of the Symposium on Microminiaturization of Electronic Assemblies. For further information on the Proceedings, turn to Reader Service Card and circle 100.

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TECHNICAL DATA

Typical Electrical Characteristics at 25°C

	2N1147 2N1146	2N1147A 2N1146A	2N1147B 2N1146B	2N1147C 2N1146C
Collector to Emitter Voltage Shorted Base (IC = 1 amp)	30V (Min)	40V (Min)	60V (Min)	75V (Min)
Saturation Voltage (IC = 15 amps)	1.0V (Max)	1.0V (Max)	1.0V (Max)	1.0V (Max)
DC Current Gain (IC = 5 amps)	60-150	60-150	60-150	60-150
DC Current Gain (IC = 15 amps)	35	35	35	35
Absolute Maximum Ratings				
Collector Current	15 amps	15 amps	15 amps	15 amps
Collector to Base Voltage	40V	60V	80V	100V
Collector to Emitter Voltage	40V	60V	80V	100V
Power Dissipation at 70°C				
Case Temperature	25W	25W	25W	25W
Junction Temperature	95°C	95°C	95°C	95°C

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Another article of the exclusive series on microminiaturization. See note accompanying article p. 38 in this issue regarding the entire series.

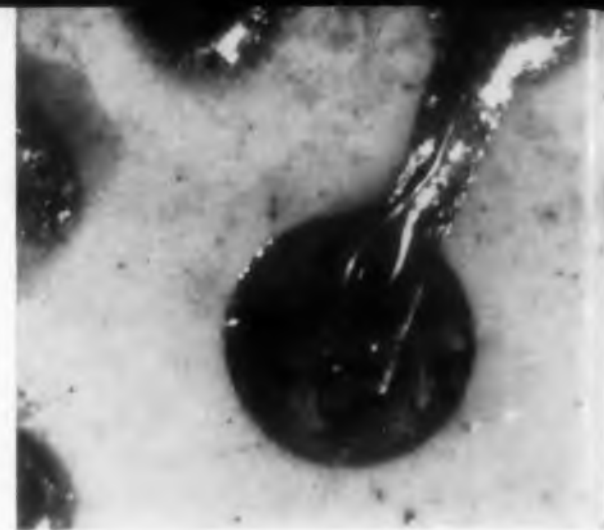


Fig. 1. Typical microtransistor greatly magnified.

Role of Semiconductors in the Army Micromodule Program

Irving J. Ross

U. S. Army Signal Research
and Development Laboratory
Ft. Monmouth, N.J.

This program, now underway, with RCA as leader contractor, promises a completely new component form factor. Technical requirements of the program and various new approaches to packaging are described in this article.

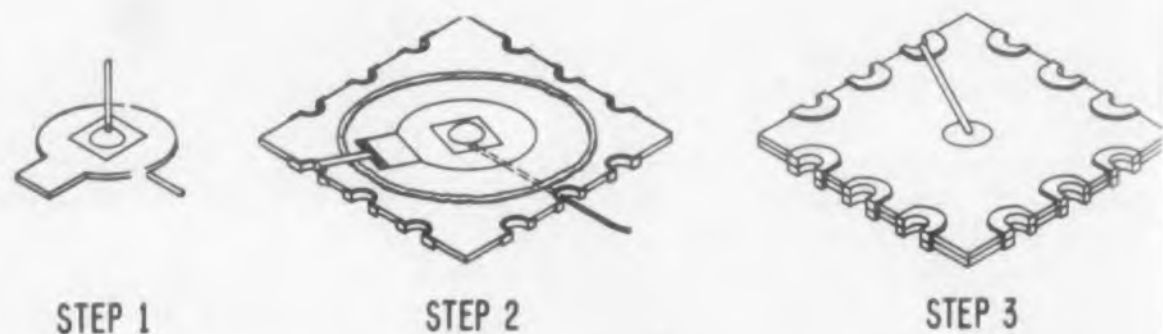


Fig. 2. Three steps in constructing micro-transistors; (1) leads welded to the base tab; (2) base tab glued to wafer; (3) assembly of two wafers using epoxy as adhesive.

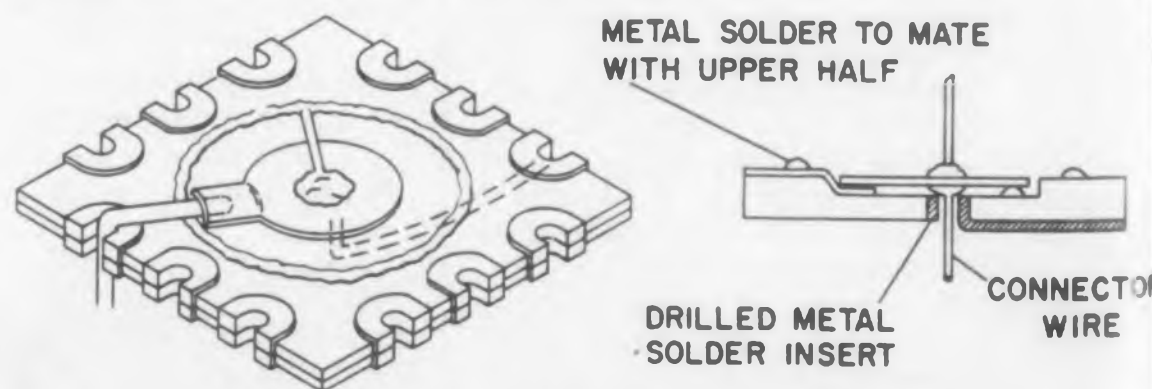


Fig. 3. Experimental hermetically-sealed transistor.

SEMICONDUCTORS play an impressive and significant role in the Army Micromodule Program. Because of their advantages in size and power, the initial Army micromodule program was geared to the use of transistors and diodes as active elements. The present program aims at the repackaging of existing transistor and diode types into wafer form factors, the dimensions of which have been tentatively set as 0.300 x 0.300 x 0.030 in.

Microtransistors and microdiodes are separated into distinct groups. At present, there are five major groups for microtransistors, and six major groups for microdiodes.

Technical Requirements

Technical requirements and objective specifications for these devices are shown in Tables I and II. The initial phase of the microtransistor program is directed toward pnp germanium devices, but silicon microtransistors will certainly be incorporated into the program later on. Except for one germanium group, F1, the microdiode program is an all-silicon program.

This first work is directed toward ambient temperatures of -65°C to 85°C , and junction temperatures of 100°C for the germanium microelements. With the advent of silicon into the program, these temperatures will be raised to 125°C ambient and 200°C junction temperature.

In addition to testing electrical parameters, extensive life tests will be conducted at high storage temperatures, and tests for mechanical ruggedness and operation under different environmental conditions will be carried out. These tests will be performed only on devices which have passed hermetic seal tests.

For parameter characterization, only one microdiode or microtransistor per wafer is contemplated. However, it is anticipated that multiple mountings per wafer can be accomplished.

The wafer material or substrate has not been definitely selected. It may be necessary to utilize different substrate materials for each of the groups previously mentioned. Substrate materials now under test include alumina and glass, Fotoceram, beryllium oxide, and steatite.

Semiconductor Micromodule Program

The semiconductor micromodule program is divided into three phases in terms of samples. These are designated preliminary, prototype, and final samples.

Preliminary Samples. Preliminary samples (Fig. 1) are constructed by starting with electrically tested pellet assemblies. Connector wires are reinforced with a silicone resin, and 0.003 in. nickel leads are welded to the base tab and existing clipped emitter and collector leads. After suitable

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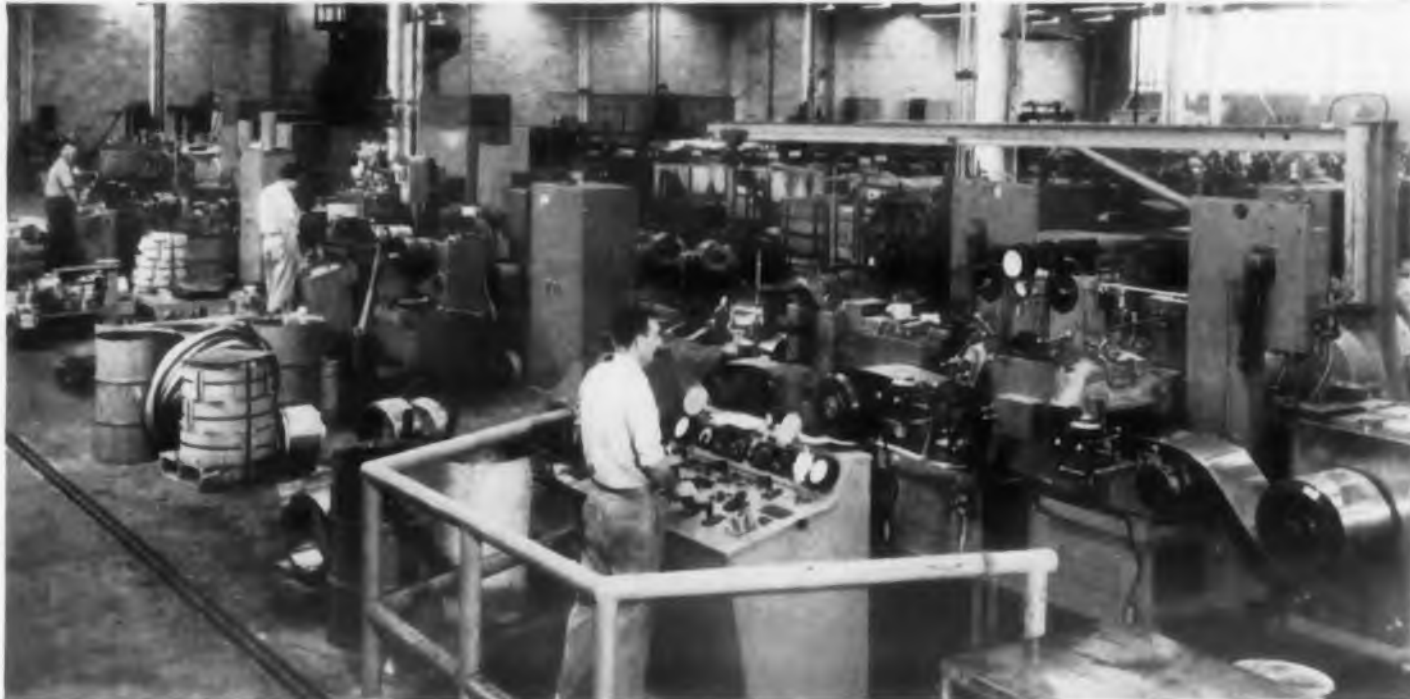
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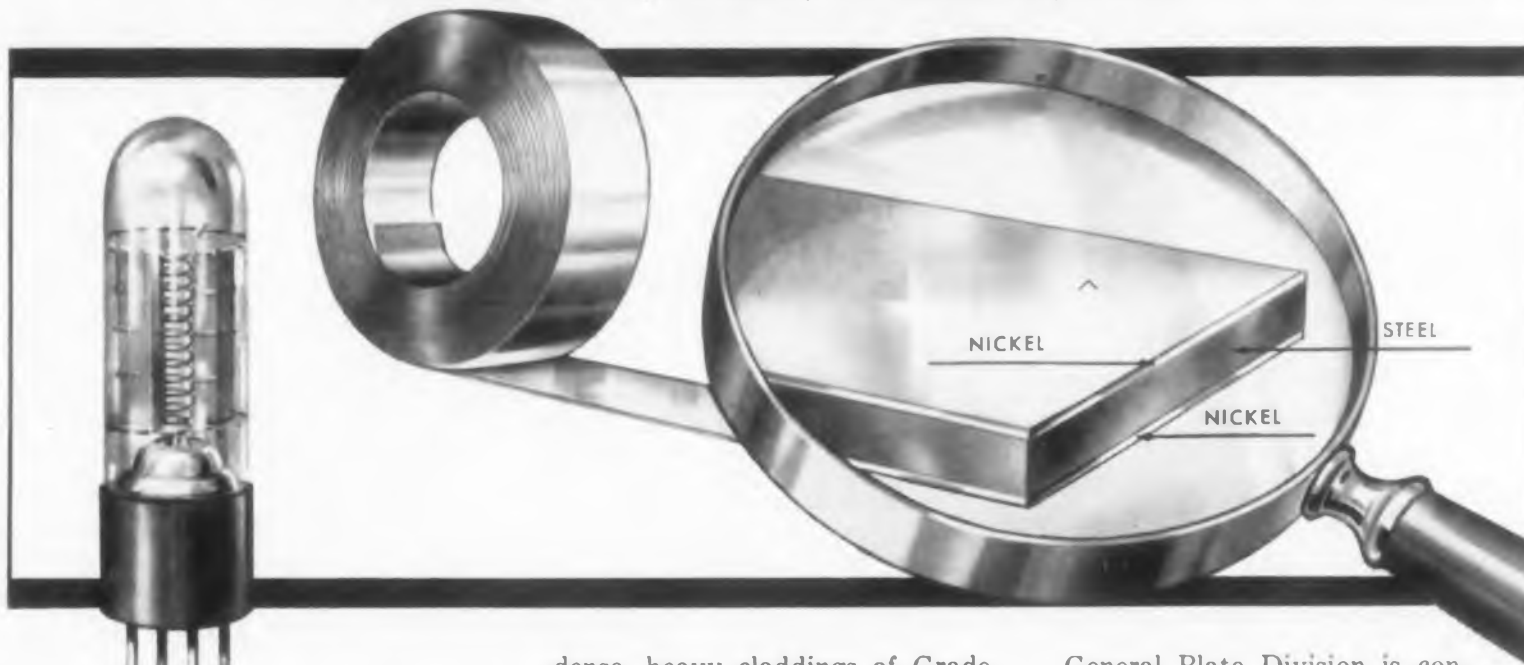
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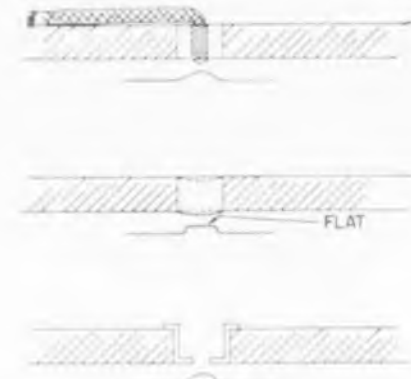


Fig. 4. Various methods of hermetic sealing include (top) molded-in contact point, (middle) indium or solder-filled insert making contact with shaved dot and (bottom) metal shell insert for solder filling.

Table I—Technical Requirements for Microtransistors

Group	Application	Typical Types
A	General Purpose Audio	2N140
B	Switching	2N404
C	12.5-30 Mc IF	2N384
D	70 Mc IF	2N700
E*	70 Mc 1 watt	(Under Development)

*Group E represents the upper limit.

Table II—Technical Requirements for Microdiodes

Group	Application	Typical Types
F1	Low Frequency Rectifier Detector	IN277
F2	Fast Sw Computer Silicon Junction	IN643
G1	Regulator	IN665 IN667
G2	Reference	IN430
H1	Reactance Modulator AFC and FM	V39 V56
H2	Reactance Tuning	V27E V58E

bakeout, the pellets and base tabs are glued in place on the wafer substrate with an epoxy resin. The collector lead is threaded through a hole in the side of the wafer, and the base lead is soldered to its terminal. The collector is then soldered to its terminal.

Assembly of two wafers is accomplished by using an epoxy resin for the adhesive. These "in plastic" samples (Fig. 2) will not be evaluated in life tests, but will be used as tools by circuit designers attempting to translate circuits pertaining to specific equipment subassemblies into the micromodule concept. To accomplish this breadboarding, sufficient quantities of the different groups will be assembled.

Prototype Samples. Prototype samples (Fig. 5)

will aim at true hermetic sealing. The pellet assembly is positioned in the wafer, and the base tab is held by solder to one corner. Connection to the emitter and collector is made by using drilled inserts to accommodate solder. A dielectric coating over the pellet assembly is being considered to shield it from solder poured into the connector holes. The base lead, which is normally attached to a side terminal of one wafer, could be brought through the top wafer to reduce capacitance if necessary.

The main seal uses a solder ring and may be made by using hot techniques involving simple heating, cold techniques involving molecular bonding of metals, resistance heating, or rf heating. Since the transistor elements are sensitive to fluxes, no fluxes will be used in any of the sealing approaches. With the use of a cold swaging seal using indium solders, additional mechanical strength can be achieved by injecting a plastic having the same thermal expansion coefficient into the space between the wafers, but external to the seal.

If resistance heating is used, the unused portion of the wafer will serve for electrical contacts, and direct heating will melt the solder. An alternative approach is to have many holes in the wafer to achieve contact resistance soldering.

In connection with these methods, work is in progress on ceramic-to-metal and metal-to-metal bonding using various metallizing compounds.

Other possibilities for hermetic sealing (Fig. 4) include a molded-in contact point for either emitter or collector connection, or deformation of an indium or solder-filled insert making contact with a resin-coated shaved dot. An alternative procedure is to fill the hole with solder, making contact to the shaved dot. The third approach is to utilize a metal shell insert for solder filling. Still another method is to use copper tubing soldered to the main seal and brought through holes in one of the wafers. The metal-to-ceramic bond has been evaluated and found hermetic.

Microdiode Program

The microdiode program is also in three phases. Preliminary samples consist of remounted diodes in wafers. Glass silicon diode envelopes are fractured, and a 0.001 in. diam copper lead is welded to the aluminum stud. For germanium diodes, a small hole is cut into the glass envelope, and an epoxy resin is placed at the wire-to-germanium surface for mechanical rigidity.

More detailed information on the processes described in this article will be found in the complete paper to be published in our Proceedings of the Symposium on Microminiaturization of Electronic Assemblies. For further information on the Proceedings, turn to Reader Service Card and circle 100.

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Two Dimensional Transistor Packaging

J. W. Lathrop*, J. R. Nall and R. J. Anstead

Diamond Ordnance Fuse Laboratories
Washington 25, D. C.

Volume occupied by the case of the smallest commercial transistor is about 100 times that of the volume of its semiconducting material. If the transistor is to become comparable in size with other components, its case must be discarded. In this article, the authors describe several techniques for working with ceaseless transistors.

AS THE operational frequency range of transistors is extended, the dimensions must necessarily shrink. One of the most exacting operations involved in fabricating high frequency transistors is the attachment of leads to the small active areas. A photolithographic technique has been developed which permits connections to be made to these areas and at the same time allows the transistor to become an integral part of a printed circuit.

In this technique, parts of the transistor are selectively masked with an insulating film, over which connections may be vacuum deposited. The principle is illustrated schematically in Fig. 1. The presensitized coating (resist) is all organic and is applied in liquid form and allowed to dry.

When dry, it is exposed to ultraviolet radiation through a suitable pattern or mask. Those portions of the coating which are not exposed to the ultraviolet are removed by the developing process, revealing the original substrate. Leads may now be deposited which contact the device only at points where the resist has been removed.

This process has been used in making the connections from a diffused-base transistor to the wiring on a ceramic printed circuit board. The base and emitter contacts, 0.004 x 0.012 in. each, are on a pedestal (Fig. 2a) which was formed by etching the germanium die. The die, 0.045 x 0.045 x 0.010 in. is soldered to a base plate which becomes the collector contact.

Photo resist is applied to the transistor surface

Another article of the exclusive series on micro-miniaturization. See note accompanying article p. 38 in this issue regarding the entire series.

and exposed so as to bare only two rectangular areas directly over the metallic bars as shown in Fig. 2b. Note that the resist forms a protective coating over the active areas of the transistor. While obviously not a hermetic seal, field effect measurements on germanium surfaces exposed to various ambients indicate that this coating does give some added short-term stability.

The transistor with the resist coating is next inserted into a hole in the ceramic board and the space between the transistor and board filled in with an epoxy resin (Fig. 2c). The epoxy need have no special properties as far as the electrical operation of the device is concerned since it does not come in contact with any of the active areas. Mechanically, the resin serves to attach the transistor firmly to the printed board and at the same time forms a bridge upon which the leads will be deposited. Epon 828 has been used successfully.

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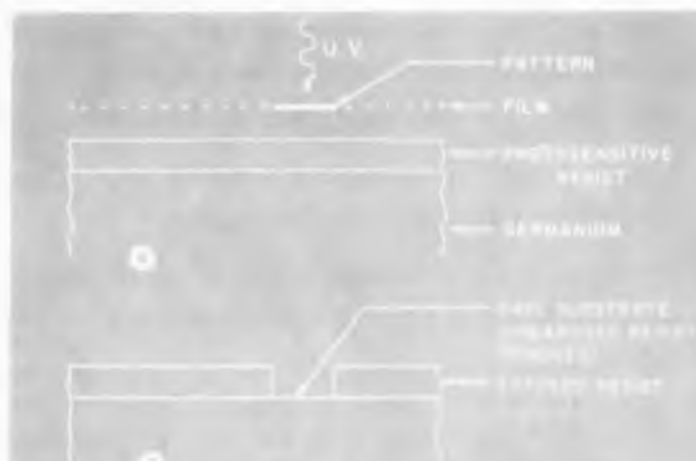


Fig. 1. Exposure of photo resist pattern (a), and surface after development (b).

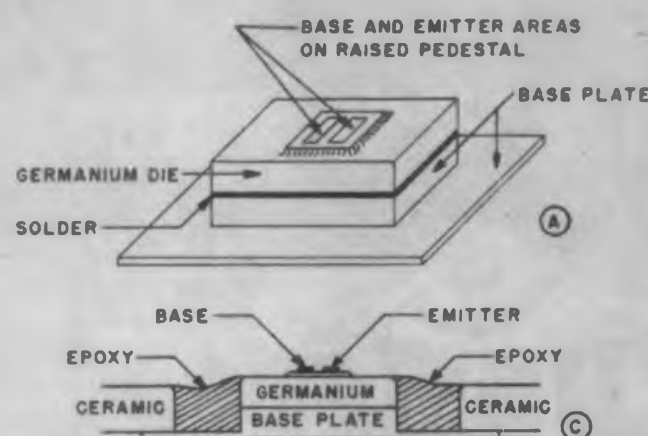
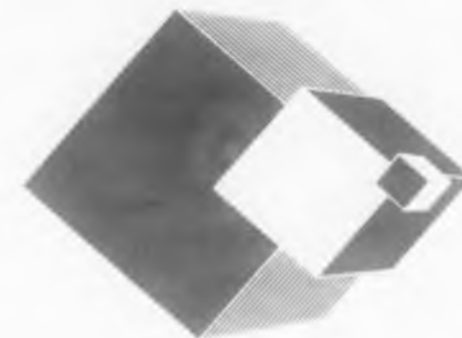


Fig. 2. Steps in connection of a diffused-base transistor to wiring on a printed circuit board starting with transistor soldered to base plate (a). Cross section view (b) of surface after exposure of photo resist, (c) cross-sectional view of transistor in place on the board, and completed unit (d).



Final step in the sequence is the actual deposition of the leads. For large areas the leads can be screened on, but for dimensions like those discussed here, vacuum deposition is much more satisfactory. Mechanical masking is used to confine the deposited area during deposition. This masking need not be exact; it is only necessary that the two areas on the transistor not be shorted and that they be electrically connected to their respective printed leads on the board. One half of the completed unit is shown in Fig. 2d. Fig. 3 is a photomicrograph of a unit with evaporated leads.

Nonhermetically-Sealed LF Transistor

Fig. 4 shows a graphical cut away of a typical low-frequency germanium alloy transistor. Emitter and base connections are made on one side of the die while the collector connection is made on the other. Grooves around the emitter and collector are made by electrolytic etching.

A ceramic board, 0.020 in. thick, which has the printed wiring and resistors on it, is machined to give a level rectangular depression approximately as deep as the thickness of the transistor die and slightly larger in area. At the point in the depression where the collector will fall, a hole with tapered sides is sandblasted through the ceramic. Then the transistor is coated with a photosensitive lacquer and allowed to dry. Lacquer is applied to form a thin protective coating for the transistor to prevent shorts.

Then the transistor is inserted into the depression collector side down. Since the conical hole is smaller than the indium collector, the transistor will not lie flat in the bottom of the depression. Both the transistor and ceramic circuit board are heated to above the melting point of indium, and

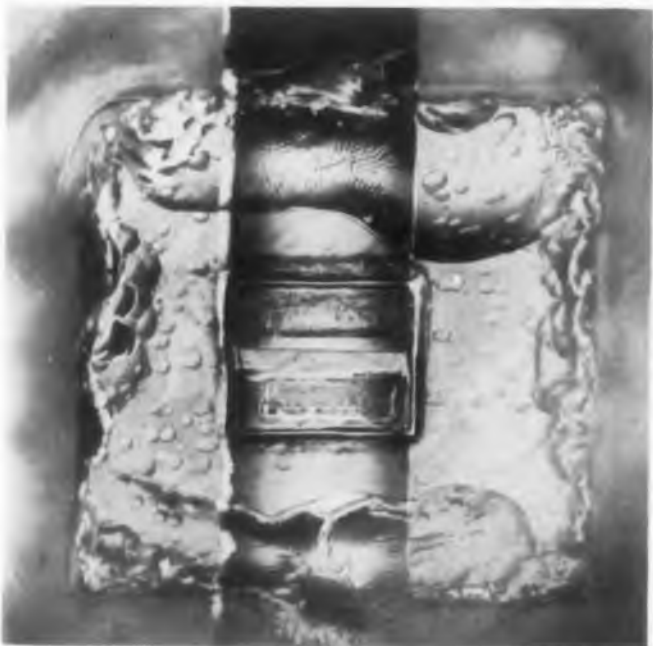


Fig. 3. Photomicrograph of leads vacuum deposited to base and emitter.

pressure is applied to the top side of the die. This forces the molten indium of the collector to completely fill the tapered hole, with some indium passing through and forming a ball on the other side of the ceramic. The conical shape of the hole minimizes spreading of the indium, and the photosensitive lacquer coating of the transistor prevents shorts from occurring if spreading does occur.

Epoxy is now placed around the transistor, filling the space between the die and the ceramic and also covering the exposed semiconductor surface, but not the emitter or base tab. After the epoxy has set up, the excess indium on the emitter is removed so that it is level with the epoxy surface. The indium from the collector which has formed a contact on the other side of the ceramic may be connected to the printed wiring. Connections from the emitter and base tab to the printed wiring on the ceramic surface are made with a conductive epoxy-silver cement.¹

Hermetically-Sealed LF Transistor

While the construction described serves to incorporate the transistor in a printed circuit, it does not protect the device from ambients. Presumably, the entire circuit would have to be encapsulated under these conditions. It is possible, however, by some modification of the processing to provide only the transistor with a hermetic enclosure and at the same time retain the "two-dimensional" printed circuit structure.

One method of construction is shown in Fig. 5. A rectangular depression is machined in the ceramic printed circuit board approximately two to three times as deep as the thickness of the transistor die and slightly larger in area. Two holes with tapered sides are sandblasted through the ceramic in the recessed area as shown.

The ceramic is metallized and coated with an indium solder around each hole on the one side and around the periphery of the depression on the other. The ceramic is metallized: (1) around the base and emitter holes in a circular pattern fifty mils in diameter, (2) around the periphery of the rectangular recession in a strip 30 mils wide. These indium solders have different melting points; the former, indium-silver, has a melting point in the order of 230 C; the latter, indium tin, 117 C.

Metallizing the ceramic is essentially a process described by Nolte and Spurck.² It involves firing coatings of molybdenum and manganese at 135°C in wet hydrogen. The molybdenum mixture forms a chemical bond to the ceramic under these conditions, insuring a true hermetic seal. Nickel oxide is then coated over this metallized surface and reduced to give a layer of nickel. In order to facilitate wetting by the indium solders, a layer of gold is deposited over



the entire metal surface by immersing the ceramic board into a gold displacement bath.

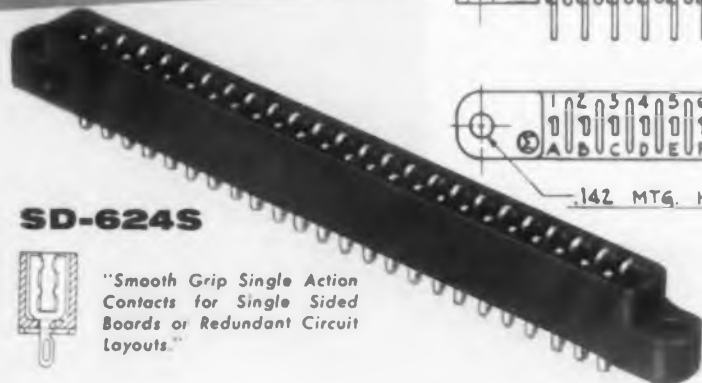
The transistor is coated with the photosensitive lacquer and the base tab is removed to expose the base of the transistor. A connection is made to the base with indium to insure good wettability during subsequent processing. Previous to inserting the transistor into the ceramic, the ceramic is metallized and coated with indium as mentioned previously. When the high melting point indium solder is applied to the metallized surface around the base and emitter holes, it fills the lower portion of the hole cavities while at the same time wetting the gold around the holes. Since this solder melts at 230 C, it will not be disturbed during subsequent operations where solders having lower melting points are used.

A ball of indium is placed in one of the holes and the transistor placed over it in the depression so that the emitter falls in the empty hole and the base contacts the indium ball in the other. Heat is applied to the ceramic and transistor to above the melting point of indium. Pressure is applied as before. This forces the indium into the two holes and at the same time causes the ball to wet the base connection. Epoxy is now placed around the recessed transistor, filling the space between the die and the ceramic and also covering the exposed semiconductor surface except for the raised collector contact.

After the epoxy has set up, part of the collector is removed to the level of the epoxy surface and

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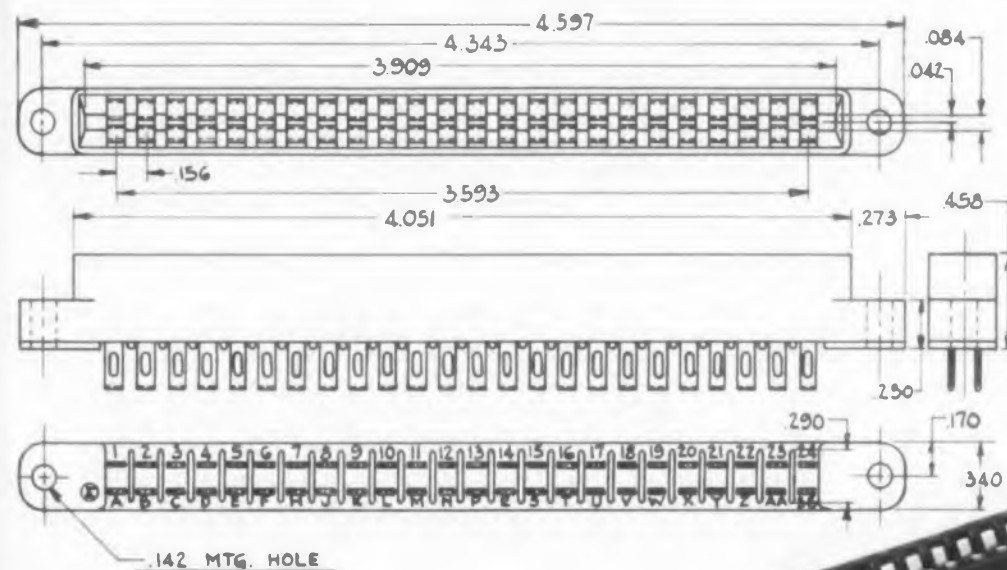
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LD-600 Latch Dog. This locking device assures positive seating of even an oversize card with numerous heavy components mounted in any plane. Fabricated of special steel and heat treated to produce the most desirable spring characteristics, and finished with .003 minimum cadmium, and iridized this clip is available as a separate unit or assembled with either the S-600 series single side card receptacle socket or the F-600 series double side card receptacle.

Designed for switch gear, computers, instruments, telephone panels, airborne communications equipment, guidance systems and other automatic control devices using printed circuitry for military and commercial applications.

S-600 and F-600 Series Card Receptacles available with 24 contacts for single side printed circuit cards or 48 contacts for double side cards, these units feature Military Quality materials and finishes. Designed for standard 1/16" thick boards with .156 tab spacing these units will accommodate boards made to Class I NEMA standards. Also available in 22, 18, 15 and 10 contacts for single side as well as 44, 36, 30 and 20 contacts for double side boards.

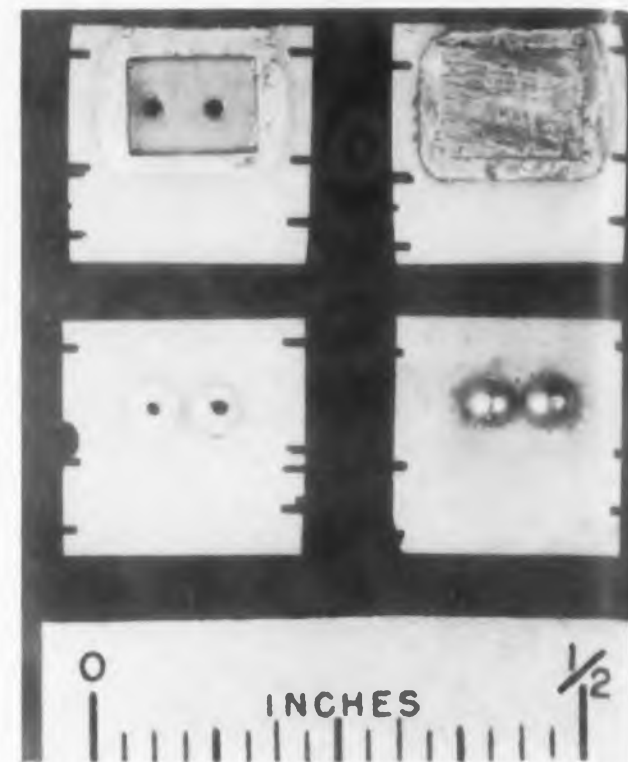


Fig. 6. Top and bottom view of ceramic before installation of transistor (left) and finished and sealed assembly (right).

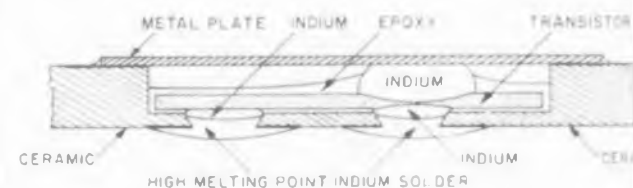


Fig. 7. Hermetically sealed transistor package.

the cover plate is soldered on. The melting point of this solder, as mentioned is 117 C. In soldering the cover plate to the metallized ceramic in an inert atmosphere, a solder connection is also made between the plate and the collector. Thus the transistor is completely sealed in an inert atmosphere in a ceramic package only 0.020 in. thick. Examples of this type of construction are shown in Figs. 6 and 7.

These units have been exposed to an ammonia vapor for thirty minutes and to an atmosphere of 95 per cent humidity and 71 C for a period of 16 hrs with no change in transistor characteristics.




More detailed information on the processes described in this article will be found in the complete paper to be published in our Proceedings of the Symposium on Microminiaturization of Electronic Assemblies. For further information on the Proceedings, turn to Reader Service Card and circle 100.

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CONNECTIONS

An *ELECTRONIC DESIGN* Staff Report on Recent Developments

1	2	3
		
Connections Between Equipment page 54	Connections Inside Equipment page 58	RF Connections page 61

L. N. Tolopko
Assistant Editor

In the laboratory, while working with either dc or low frequency ac circuits, the engineer may simply twist pairs of wires together to make satisfactory electrical connections. The twisted wires can be easily disconnected to allow testing and modification of the circuits. Connection problems are relatively nonexistent for the design engineer at this point.

But once the circuit gets off the bread and drawing boards, the ends of wires must be connected in a sturdy and enduring manner. This holds true for circuits that operate from dc to the rf frequencies.

Volumes can be written, and have been, on how to select the right connector and make the best connection; the field of electrical connections is enormous.

In considering the area this special report should cover, we decided to limit ourselves to the most recent developments in the field. In questionnaires which went to more than 200 connector manufacturers, we asked for information on connectors made commercially available within the last 12 to 15 months.

In that way we hoped to avoid deluging the reader with information he knew some time ago.

Our search for information led us, among other places, to Dallas, Tex., to the Third EIA Conference on Reliable Connections. There we interviewed both users and producers of electrical connectors. We discussed problems, and tried to discover common factors adding up to reliable electrical connections.

Everyone had strong opinions on the subject.

Our search also took us through the latest literature on the subject. Results of this research, plus data obtained at the EIA technical meeting, have been integrated into this report.

This report is broken into three parts. The first covers connections made between pieces of electronic equipment, including such items as cable connectors and connectors used with rack mounted equipment. The second part deals with connections made inside a piece of equipment—such items as printed circuit connectors and terminal blocks. The third part covers rf connectors.

1 Connections Between Equipment

WITH connectors being used in ever increasing quantities, more and more attention is being given by design engineers today to the problems encountered in making reliable electrical connections.

Reliable connections are especially important when electronic equipment is built on a modular basis—that is, when the electronic system is broken into many subassemblies to be interconnected. Here, the connector can almost be considered the “heart” on the system. But an unfortunate aspect of modular construction, particularly for the military user, is that it has spawned a large number of different types of connectors (see the Editorial, p. 23, this issue). This has cluttered military supply lines and complicated logistic problems.

When Is A Connection Faulty?

Despite the great number of connections being made, experts disagree on what constitutes a faulty connection. Some even prefer to remain noncommittal. At the recent Third EIA Conference on Reliable Electrical Connections, some defined a faulty connection as one that has become open. Others define a faulty connection more stringently. A small amount of resistance is considered ample to label a connection faulty. (Low connection resistance is especially important in printed circuit applications where the volts may be measured in millivolts and the amperes measured in milliamperes.)

Because of this disagreement, the final answer to what constitutes a faulty connection will have to be made by the design engineer. Tolerance

limits of resistance should be established for each connection and a judgment made accordingly.

Factors In Reliable Connections

There are two basic factors in making reliable connections. One is the intelligent selection of the connector and the other factor is the connection of the wires or the cables to the connector. Considerations in specifying connectors are given in the box on the right hand page.

The trend these days is towards the solderless type of connection for attaching wires and cables to connectors. Some of the reasons for the solderless connection's growing popularity are:

- They're cheaper than soldered connections.
- They lend themselves to automatic processes.



Fig. 1. Good conduction and reliability in a solderless connection depends on the deformation of the wires. In the cross-sectional photograph the compression-type connection is shown.



Fig. 3. Hermaphroditic connectors have both plug and receptacle characteristics.



Fig. 2. Cut-away view of the taper pin connector.

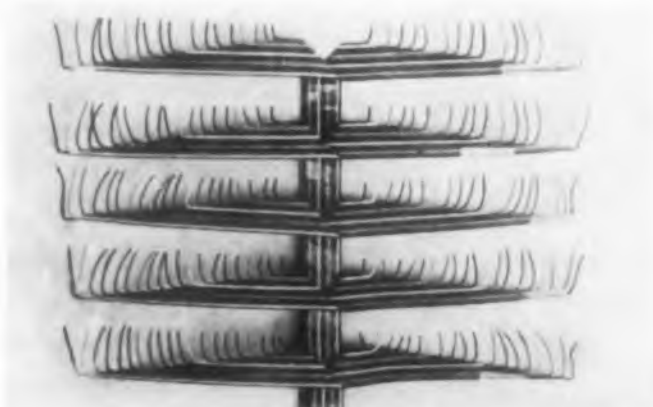


Fig. 4. Flat cables offer controlled capacitance and uniformity between one harness and another.

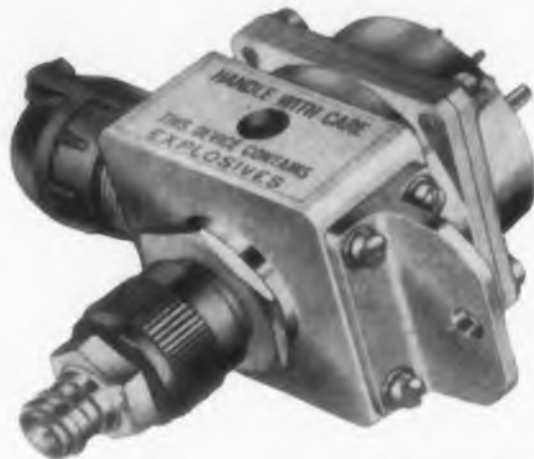


Fig. 5. Cable and harness assemblies can be ordered as a unit.



(courtesy Amp Inc.)

Fig. 6. Contacts on this rack and panel connector are gold-plated for protection against corrosion.



(courtesy Cannon Electric Co.)

Fig. 7. For missile applications, plugs like these are disconnected from their mates by an explosive charge located inside.

- They provide repeatability.
- They're easier to use in tight quarters.

Wire Deformation Necessary

In both the crimp and wrap-around variety of solderless connections, the wire attached to a contact is deformed. It is this deformation which provides good electrical contact.

For a crimp (compression) connection, the wire is inserted into a terminal; then the terminal is squeezed so as to compress the wire within it. The deformation of the wires in this type of connection is shown in Fig. 1. In the wrap-around variety, as the name applies, the wire is tightly wrapped around a terminal. Contact is made by the edges of the wire and terminal cutting into one another. Telephone switchboards are being built using this wrap-around technique.

Solderless-type contacts used in connectors go by a variety of names and among them are: "Taper Pin," "Poke-Home" and "Snap In." Basically they are all alike. Wire is compressed within the contact and the contact is then inserted into the connector.

An example of the solderless-type contact used in a cable connector is shown in Fig. 2. A big advantage of this type of connector is that the wires can be cut, stripped and the solderless contacts installed long before a cable form is made. Also, maintenance men can easily remove a wire or wires from the connection for point to point inspection without abusing adjacent wires. The solderless contacts can be removed and reinserted many times without any loss of retention.

The Case Against Solderless Connections

Some quarters recognize the advantages of the

solderless connection, and do agree that they are satisfactory in some applications. But it is not admitted that solderless connections are good for all applications.

One often heard case against the solderless connection is that wide temperature cycling of the connection will eventually have harmful effects. This, of course, happens when the wire and the terminal are made of different materials, and therefore have different coefficients of expansion. Different expansion rates of the wire and the terminal allow air and corrosive gasses to penetrate the connection and, in time oxidize and corrode unprotected metal surfaces. This action results in a high resistance connection, and eventually to an unreliable one. Solderless connections, which are surrounded by a potting compound or sealed off from the atmosphere, will be immune to these effects.

Soldered connections, a corollary argument runs, are better because an alloy of wire and solder is formed at the surface of the wire.

Proponents of the solderless connection are not silent. They have a string of countercharges which they are ready to recite without too much prompting. Among the points made at the Reliable Electrical Conference last December were: soldered connections are difficult to test. On the surface a soldered connection may look satisfactory, and a continuity check may confirm this. But the trouble lies in no one really being able to see if the connection is a cold one, or if there are holes or other undesirable characteristics within the soldered joint. What seems like a good connection may shortly become a faulty one.

Soldered connections require more care, too. After the solder has been melted onto the con-

Before Buying A Connector Think About . . .

1. Who will buy the final product? If it is to be used in a unit that must meet military specifications, then choosing a connector that meets Mil Specs will save time and money.

2. Where the connector will be used? Will the environment be hot, cold, or alternately both, and for how long? Other environmental conditions—altitude, humidity, shock, vibration, corrosive atmospheres, and magnetic fields—are vital considerations, too. Each applicable factor is important in selecting the type of coupling and the type of connector shell.

3. How plugs and receptacles must be mated. Should they be the quick-disconnect type, or should the normal threaded (or reverse threaded) types be used? Where and how the connector is to be used will influence the final choice.

4. How many contacts are needed? The number of wires or circuits that must be connected is important here. It might be wise, however, to order a few more contacts than are required. If circuit and equipment changes are envisioned, extra contacts will come in handy.

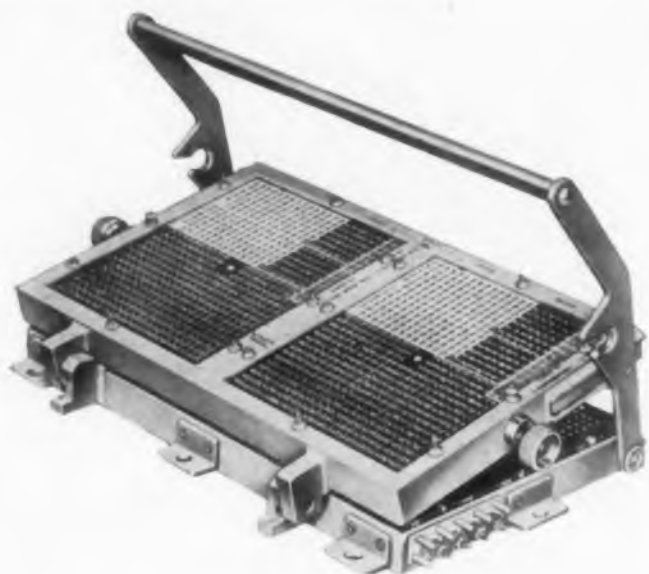
5. What style of contacts are most suitable? There are a wide variety on the market: eyelet terminal, solder pot terminal, pin contact, crimp terminal, taper pin types, and others. The wire size used will play an important role here. Pick the contacts which you need and which meet your purpose best.

6. How much current must be carried? The more current a contact is expected to carry, the bigger it must be. Contacts that are too small in crosssectional area for their intended purpose will become hot (I^2R) and possibly ruin the connector.

7. Insulation required between contacts. Again, there is a wide variety—plastics, ceramics, glass and others. Each type of insulation is particularly suited to meet different environmental stresses. Amount of voltage between contacts is another consideration.

8. How much room is available? Often overlooked, but just as important as any other consideration, is the amount of room available to mount the connector. Space determines whether the connector should be square, round, or rectangular.

9. Whether the connection must be "idiot-proof." If it must, then choose polarized connectors. It is possible to mate them in only one way: the right way.



(courtesy Anplenal Electronics Corp.)

Fig. 8. For ground support equipment programming boards like this one are sometimes used. This one has 1280 contacts.



(courtesy Amp Inc.)

Fig. 9. Arcing is a problem at high altitudes. This combination lead and connector can take up to 35,000 v at 5 amp.



(courtesy Amp Inc.)

Fig. 10. Permanent connections between subassembly cables can be made with this type of crimp connection.



(courtesy E.S. Components Inc.)

Fig. 11. Designated the FBI series, these connectors have "floating body isolation." Stresses and strains are absorbed by the frame and not transmitted internally.

nection it is extremely important that the wire(s) does not move. If it does while the solder is solidifying, then an imperfect crystalline structure of the solder will be formed, and an important connection made.

Soldering Methods

The soldered connection has not been abandoned; it is still being made on a very wide scale. And studies have recently been made on how to make the best soldered connection. Results of these studies, such as made at General Electric,¹ indicate that the resistance soldering method helps considerably in achieving a reliable soldered connection. Resistance soldering is accomplished by passing a current through the contact, the wire and the solder (if preformed solder is used). The current heats up the contact and wire and melts the solder to form the connection.

Among the advantages of resistance soldering are that it applies heat only to the desired contact. Thus no other connection can become loose or insulation burned. Then, too, it has been found that it reduces holes in the solder cup, and thereby insures a more reliable connection. Last, the tips of the resistance soldering tool are small and easy to manipulate while working in very tight quarters such as on miniature connectors.

"Follow-Through" Needed For Reliable Connections

Because of the myriad of connectors available and the variety of connections possible, there are no specific rules on how to make the best connection. Each connection has to be judged in relation to what is expected of it and the environment in which it must operate. If these two considerations are carefully analyzed, the design engineer's chances of specifying the right connector and the right connection are excellent.

After the connector and the method of attaching the wires to it have been decided on, three "follow-through" factors must be observed:

- Care
- Cleanliness
- Craftsmanship

Care should be exercised in the selection of tools to be used, whether they be automatic or manual. For instance, special tools are available for making crimp connections; ordinary pliers just won't do. Care should be taken in the selection of solder and the type of soldering iron used.

Cleanliness is a production line consider-

High Temperature Soldered Connections

One of the demands being made these days, especially by the military, is for equipment that will operate at high temperatures. High temperatures used to mean 100 C, then 125 C. And now 500 C and 1000 C are quoted as high. High temperatures affect everything in a piece of equipment including soldered connections.

At Hughes Aircraft,² not too long ago, an investigation into high temperature effects on soldered connections was made. The results:

- For solderability and resistance to metallic diffusion at 260 C these platings were found good: gold plate over nickel plate, rhodium plate over silver plate, and nickel plate over copper base metal.
- For strength and corrosion resistance at 260 C, solder alloy Ag 1.5 per QQ-S-571 was judged satisfactory.
- For proper operation of high impedance circuits, all flux residues must be removed.

Preparation Of Wire

In most cases a wire has to be stripped before it can be properly joined to either a solder or solderless contact of a connector. There are two methods of removing insulation. One is by mechanical methods such as pliers or automatic

ation. All material, such as contacts and wire, must be clean before a good connection can be established. Cleanliness of the soldering iron is important too. A corroded tip will interfere with the transmission of heat. After the connection has been made, extraneous material such as drops of solder and wire clippings must be removed. Some manufacturers go so far as to recommend removal of flux. They believe enough dirt can adhere to the flux to cause damaging effects.

Craftsmanship, is, essentially, the attitude of the workman who finally makes the connection. Indifference on his part leads to poor connections. The craftsman's pride in his work is an important factor in reliability. Often craftsmanship can be encouraged and developed by simple means. An elementary explanation of why reliable connections are important, and what disastrous results can occur from bad connections, may be all that is needed to make just another workman into a craftsman. Some companies have instituted training programs to school their personnel in making reliable connections and to explain how important their work is in missile programs. Results of this educational approach are good.

rippers. The other method involves the application of heat to the insulation at a desired distance away from the end of the wire. A small amount of insulation is burned away and then the remaining insulation is pulled off. For a more reliable connection, the latter method is preferred by some in industry. It is felt that a wire is usually nonconcentric with respect to its insulation and that there is the possibility that the wire will be nicked by mechanical strippers. And nicked wires break easily under vibration, leading to open circuits.

Some Recent Developments

Hermaphroditic (having both plug and receptacle characteristics) connectors were recently introduced by the Elco Corp. The mating members of these connectors have identical mating faces. Design of the connectors is this: where high points extend above the mating plane, low points are provided below the mating plane on the opposite side of the symmetry line of the connector. See Fig. 3.

The hermaphroditic connector, like other connectors, can be used to interconnect cables for the transmission of energy from one point to another. But they are most useful when various equipment of the same type at distant places must be connected in parallel and a network formed with the help of several cables in series.

These connectors are completely pressure sealed, polarized and have features for easy coupling in the dark. Units are available for power connections, where the contacts are recessed to prevent shorting. This type of connector has a stock room advantage: less different types of connectors have to be kept in supply.

Flat cables are another new twist when it comes to connections between equipment. These cables offer controlled capacitance and uniformity between one harness and another. Since no strings are tied around the cable, there is no possibility of the insulation being cut, and no need for a protective cable jacket. Also, because there is no jacket, the wires stay cooler and costs are kept down. An example of flat cable, manufactured by Spectro-Strip Wire & Cable Corp., is shown in Fig. 4.

A relatively new innovation in the field of connections is the production of a complete harness assembly. Such units are normally guaranteed as a whole. In ordering these types of units it is important to specify the type of connectors required, wire sizes, cable shape (circular or otherwise), and jacket material. Special qualification tests should also be spelled out. An example of a harness assembly, made by Cannon Electric Co., is shown in Fig. 5.

Other recent connector developments are shown in Figures 6 through 11. ■ ■

the first real "BREAK" for airborne harnesses

THE ALL NEW A-MP HELICON CONNECTOR



FEATURES

- helical construction imparts a connection so firm that a special A-MP tool is required to connect and disconnect.
- "o" ring and metal wire-insulation ring make moisture-tight seal
- wiping action cleans pin and socket for assured maximum conductivity
- positive wire-stops prevent over-insertion of stripped conductor

FEATURES

- serrations inside barrel assure maximum crimp-contact between barrel and conductor
- inspection ports permit examination of conductors in barrel
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Never before has such a unit been available—a reliable, pre-insulated "manufacturing break" for aircraft and missile harnesses. Designed as a quick connect/disconnect for all high-reliability circuits, the all new A-MP HELICON Connector is completely environmental-proofed and fully pre-insulated. Equally important, it requires a special A-MP tool to connect and disconnect, thereby preventing tampering and unintentional breaks in circuits.

The HELICON Connector can be attached to airborne circuit wires with remarkable speed and ease . . . permits multiple connect/disconnects without harm to unit . . . offers the highest reliability.



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Connections Inside Equipment

Printed Wiring

PRINTED circuit boards, which have helped unclutter the interior and reduce the size of electronic equipment, are still a matter of controversy when it comes to feed-through connections.

The dispute centers around whether plated-through holes or eyelets are the more reliable connection elements. Proponents of the eyelet say they are the best choice when frequent maintenance work is done on a printed board, for eyelets reduce damage to conductors when components are being changed. And they make the point that plated-through holes are very sensitive to dip-soldering. The heat of the solder generates gas within the laminate which may blow through the plating where it is thin.

On the other hand, advocates of plated-

through holes say they form the more effective connection because they "follow the surface" that has either been punched or drilled out of the board. Plated-through holes are cheaper, too.

Eyelets were favored over plated-through connections as of the middle of 1958 (*ELECTRONIC DESIGN*, June 11). At the Institute of Printed Circuits meeting last October, however, many delegates reported that plated-through connections had proved more reliable than eyelets, and predicted that they would find increasing use.

One conclusion is evident: with proper care in production techniques, both sides are getting very good results with their favorite type of feed-through connection.

Vibration is the worst enemy of the printed cir-

cuit board when it is used in airborne and missile equipment. It flexes the laminate and plays havoc with the soldered joints. Studies made at Westinghouse³ show that a large solder fillet around the eyelet will reduce vibration failures. Another study, made at General Electric,⁴ shows that a petal-shaped eyelet more evenly distributes vibration stresses around the eyelet.

New Component Mounting Method

A different way of connecting components to printed circuit boards was introduced within the last four months by Amp Inc. The company put a tip on the market which, when attached to the lead wires of a component, permits the component to be mounted on a board that has neither eyelet nor plated-through connections. These tips are currently being used by some large manufacturers. Application of the tips is shown in Fig. 1.

During production runs and soldering the tips hold the component lead wires firmly to the board. The shape of the tip promotes capillary action during dip soldering causes fillets to be formed on both sides of the board. Another advantage is that the circuitry can be checked even before soldering because the tip makes good connection with the wiring on the board. Also, since the component is held firmly in place, there can be no cold solder joint problems. There are machines which can attach these tips at rates up to 7200 an hour.

Another approach to connecting components to printed circuit boards was developed by Atlas E-E Corp., the lead wire connectors are gold-plated units which are press fitted into the board, dip-soldered in place and then the component wires inserted into them. Although soldering the component wires to the connector is not necessary, doing so would improve connection reliability. Currently available for 0.016 and 0.02 in. lead wire diameters, the units have an 8 oz minimum withdrawal force. They are made for computers, guided missiles and can stand 79 g's. They have no resonant frequencies below 3000 cps.

Dip vs. Hand Soldering

Though the printed circuit board has been around for some time, axes are still being ground over the best way to solder components to them. Some companies (Boeing Aircraft, for instance) are firm believers in hand soldering methods. More reliable connections, they say. Boeing's experience with some dip-soldering methods indicates that dip-soldering has a tendency to leave "icicles" around the soldered joints. That is, thin needle-point structures are formed.

At the Third EIA Conference on Reliable Connections, a spokesman for General Electric said that their experience shows that perfectly acceptable connections can be achieved with dip-

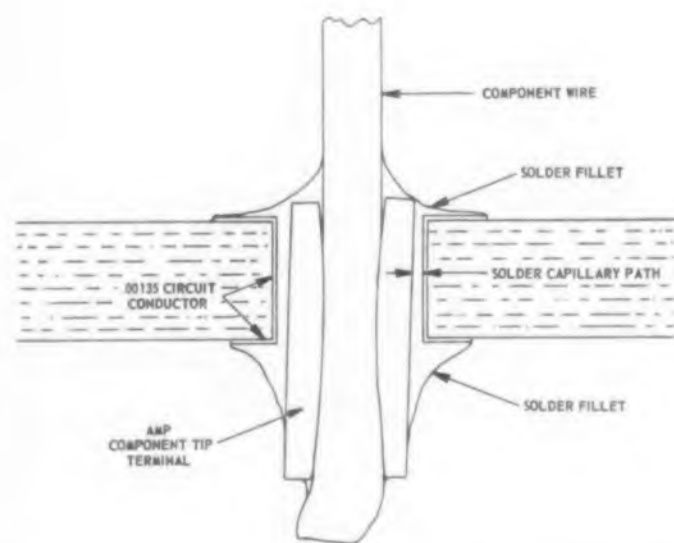


Fig. 1. (above) Made by Amp Inc., these component tips provide a way of attaching component parts to printed boards that have neither plated through nor eyelet connections.

Fig. 3. (right) For test points on printed circuit boards, connectors such as these are used.



(courtesy Methode Mfg. Corp.)

Fig. 2. Spring latch dogs on these P-C receptacles insure vibration-proof mounting of circuit boards.



(courtesy Winchester Electronics Inc.)

soldering methods. In fact, he said, the hand soldering method defeats the whole purpose of printed circuit boards—which is the automatic assembly and production of electronic circuits.

It seems that dip-soldering is everyone's goal, however, and that it will be universal as soon as companies find processes which are satisfactory to them.

What To Do With The Residue?

Although cleanliness is considered next to godliness in all types of connections, opinions differ on how far this concept should be carried with relation to flux residues. In printed circuit applications it is generally recommended that all flux be cleaned off after the board has been soldered. It is felt that flux will catch dirt or other extraneous matter and will eventually lead to short circuits, and other damaging effects. The point of contention here is that it is very difficult to guarantee removal of all the flux. And that if it must be removed, then it must be done with meticulous care or not at all. The reason is that flux is a nonconductive substance. Once it is dissolved in the solvent during removal it becomes reactivated and may flow into undesirable nooks and crannies on the board and eventually have more harmful effects than if it were left on.

Printed Circuit Connectors

The trend with all printed circuit connectors today is towards miniaturization. As to which type of connector provides the most reliable connection: they all seem to do equally well if designed and used properly. Each type has its good and bad points and the final application must be evaluated carefully before a final connector selection is made.

Printed circuit connectors fall into three general categories. There is the one-part connector, where the board fits directly into a receptacle. And there is the two-part connector, where a plug is attached to the board which then fits into a receptacle connector. These are the two more generally used types. And as practically all printed circuit connectors available today, they are of the multi-contact type.

Advantage of the one-part connector: it is cheap and simple to use. But moisture will expand the board and cause insertion difficulties. As for the two-part connector, the plug attached to the board prevents board warpage and offers more sturdy polarization contacts. Also, there is no moisture problem.

The third type of connector consists of contacts attached to a board at regular or irregular intervals. Wires can be wrapped around these contacts, or the contacts can be mated to other connectors.

(Continued on following page)

HYFEN™

CONNECTORS

with crimped, snap-locked contacts



15 contact, multi-purpose connector. Mates with, or replaces existing solder connectors.

Cutaway view of MINIATURE MS-type HYFEN with closed-entry sockets (enlarged)

Feed-thru, modular design, multiple insert connector. 35 contact inserts, can be removed from frame for easy contact insertion or removal. 5 or 8 insert frames available.



CRIMP pins or sockets on wire

SNAP-LOCK contacts into plug or receptacle

MATE with HYFEN or equivalent solder types

SAVE WEIGHT, SPACE, TIME—Burndy's HYFEN method brings added Reliability and Versatility to the connector field, allowing the design of lighter and more compact equipment... saving space, weight and time. Pins and Sockets can be bench-installed on the wire and can be snap-locked in place even after the Plug and Receptacle have been mounted on the equipment.

Designed to replace or mate with virtually all existing connectors, including AN, MS, and other Miniature types, the HYFEN meets or exceeds MIL specs. The HYFEN method ends the high rejection rate inherent with the use of solder... especially important in today's continuing trend toward miniaturization.

AN-type HYFEN connector, showing HYFEN method adapted to round design.

HYFEN types illustrated are typical of those already supplied to the Industry by Burndy. HYFEN connectors are engineered to meet specific requirements. For other types and sizes, contact Burndy.

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CONNECTIONS

Examples of all three types of connectors can be found in Figs. 2 through 5.

Withdrawal and Insertion Forces

A topic of continuing interest is the insertion and withdrawal forces of printed circuit connectors. The higher the forces, the lower the resistance in the connection. This is good. However, higher insertion forces in the receptacles have damaging effects. High insertion forces mar the surface of plug contacts and pull off the tabs on boards. There is only one answer, so far, to this problem. The design engineer must study his particular connection application, and seek a compromise that meets his situation best.

There are two things that can be done to help tabs on printed circuit boards stand high insertion forces. One is the use of a rounded and smooth contact in the receptacle instead of a straight stamped one. Also, in a report made at the Stanford Research Institute,⁵ it was found that a slight chamfer (or rounding) at the edge of the board will cut down insertion force and increase tab life.

Although exhaustive tests have shown that insertion and withdrawal forces increase with the number of times contacts are used, this does not seem to permanently bar one-part connectors from certain military applications. The reason is that the number of insertions and withdrawals in certain applications is not large enough to cause damage. When a large number of insertions and withdrawals are anticipated, however, the two-part connector performs best.

Why Connectors Fail

Connectors used with printed circuits do fail. The Stanford report found that most frequent failures were due to:

- Damage to foil tabs.
- Moisture condensation.
- Contact corrosion.

The least frequent causes of failure were:

- High voltage.
- High currents.
- Sustained unidirectional forces.
- Low ambient temperatures.

And the symptom most often associated with failure was erratic contact resistance.

Conventional Wiring

Despite the inroads made by printed circuit, a good portion of electronic equipment still has



(courtesy of Elex Corp.)

Fig. 4. These contacts are staked and dip-soldered to the board. They are available for mating boards in either a parallel or perpendicular fashion. They permit spacings of 0.06 in. one row, with an airgap of 0.02/in. between contacts. Similar contacts are available with 0.05 in. spacings in two rows.

wire for making internal connections. Some quarters even feel that truly reliable connections between components can be made only with wire and point to point soldering.

Wire, of course, has some obvious advantages. Circuits are not frozen as they are with printed circuit boards. Not only can components be changed when wiring is used, but circuit modifications are also relatively easy.

Crimp connections at the ends of wires are also growing in use when it comes to terminating wires inside equipment. As mentioned, in part 1 of this report, crimp connectors are simple to attach, and easy to use. In tight quarters fitting a



(courtesy Maleu Tool and Mfg. Co.)

Fig. 5. To speed up production and cut costs of radio and television sets, these "Wire-a-Wire" terminals are available.



(courtesy Twin-Lock Inc.)

taper pin into a terminal block is easier than making a soldered connection. Lugs that crimp onto wires are available from a wide source of manufacturers, also, terminal blocks that work with crimped lugs. Some examples of crimp terminals available are shown in Figs. 6 and 7.

Microminiaturization Wiring

The microminiaturization of electronic equipment has led to the development of new methods for making connections. One basic technique involves stacking the wafer circuits in such a



(courtesy DeLur-Anisco Corp.)

Fig. 7. These terminal blocks accept taper pins. For computer applications, the receptacles are molded-in for maximum durability.

Fig. 6. Designed for ground support applications, the contacts on this connector are gold plated. After set screw is fastened, 100 lb of force are needed to withdraw the connection.

manner that all leads protrude from one side of the assembly. The assembly is then encapsulated in resin and the side containing the leads is faced off to expose the interconnection points. Chemically deposited copper or printed silver wiring can be used for interconnections. This technique was reported feasible with modules larger than 0.005 cubic inches at last year's Symposium on Microminiaturization, sponsored by the Diamond Fuze Laboratories and held in Washington, D. C. A detailed explanation of this technique is given by authors N. J. Doctor and E. L. Hebb in an article that appears in *ED*, Feb. 4, page 34. ■ ■

3

RF Connections

IN THE realm of radio frequency connections, the trend is toward the lighter, the smaller and the more reliable connector. Behind this trend have been: (1) the requirements of missile and avionic instrumentation, where size and weight must be kept down, and (2) the application of long experience and the latest advances, to the design and manufacture of connectors.

Increasing use of solderless connectors has accompanied this trend, and they have evoked different reactions from the experts. Last December, at the Third EIA Conference on Reliable Electrical Connections, some delegates reported satisfactory results with solderless connections even when they were used throughout the rf spectrum. Others said, "Yes, they're good, but only up to a certain frequency." (Upper limits

such as 10 and 30 kmc were mentioned for crimping to the shield of the cable). And others expressed doubt about the value of solderless rf connections at any frequency.

Some of the arguments presented against the solderless connection: (1) It is difficult to tell if such a connection is a reliable one. Under vibration the connection may be an intermittent one and introduce noise. (2) Crimping a connection to the shield of a cable may deform the cable's dielectric. This will alter the characteristics of the cable.

How good a soldered rf connection can be is illustrated by General Electric's⁶ experience. Its engineers "cast" molten solder around the ground lead and the shield of the coaxial cable used with airborne electronic equipment. After seven

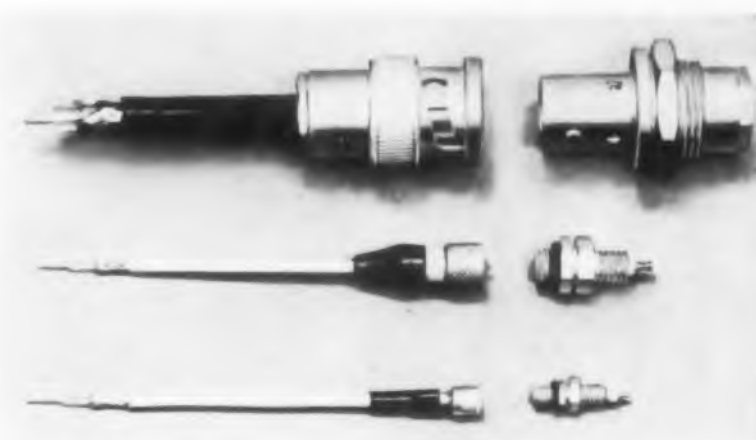


Fig. 1. From top to bottom: A standard BNC connector, a micro-miniature connector and a "sub-miniature" connector. Made by Microdot Inc., these connectors illustrate today's trend toward miniaturization.

USED ON THE NEW BOEING B-52 JET BOMBER



New MS Miniature Plug WITH SOLDERLESS SNAP-IN CONTACTS Cuts Wiring Assembly Time as much as 80%

**CANNON KM SERIES
FIRST TO MEET MIL-C-25955
(USAF) SPECIFICATIONS**

THE PROBLEM—To design a miniature environmental-resistant connector, suitable for use on present and future aircraft, missiles and equipment, in accordance with military requirements. Dependability with simplicity to facilitate assembly, installation and field service were vitally important.

THE SOLUTION—Crimp-type solderless contacts, with wire insulation support, are used in the new KM. They can be easily snapped into place, or removed as necessary. Individual contacts can be serviced one at a time, without removing others. A specially designed moisture-sealing grommet replaces potting. Closed entry, machined socket contacts are probe-proof. All materials are of finest obtainable quality. Shells and related parts are of aluminum alloy, cadmium plated. Contacts are plated

with gold over a heavy silver undercoat.

These features combine to provide a plug of optimum reliability that can be assembled and installed with utmost speed and be easily serviced in the field.

The new KM mates with the Cannon KO Plug Series, and is available in a wide variety of shell sizes, styles and insert layouts. Hermetically sealed receptacles also available. For complete information write for Catalog KM-1.

Come to Cannon for all plug needs—27,000 kinds to choose from. If we do not have what you want we'll make it for you. The largest facilities in the world for plug research, development and manufacturing are at your service. Write us today about your problem. Refer to Dept. 438

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AUDIO-VIDEO AIRCRAFT SWITCHING POWER MISSILE UNIT PLUG-IN INDUSTRIAL

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CONNECTIONS



(courtesy Burndy Corp.)

Fig. 2. Solderless connections are being made in the field. This connector is used to ground the shield of a coaxial cable.

years they reported that "no field failures were attributed to malfunctioning terminations." It is recognized, however, that deficiencies may be expected in field reporting.

Some of the antisoldering arguments presented at the conference: (1) Heat generated during soldering may injure the dielectric and change the characteristics of the cable. (2) Highly skilled personnel are needed to make a soldered connection to miniaturized rf connectors.

Solderless connection advantages noted were similar to those mentioned in Part 1 of this report.

Captivated Center Pins

The captivated center pin, a relatively recent innovation in rf connectors, has helped overcome the problem of dielectric creepage that often resulted in discontinuity of the center conductor in a coaxial cable.

Normally the dielectric of a coaxial cable is fastened to the connector clamp. Environmental changes and the application of severe mechanical stresses cause dielectric creepage. When the dielectric shrinks it pulls with it the center conductor of the connector. Result: an open or high resistance connection may be established. The creepage problem is especially acute when dielec-



(courtesy Amphenol Electronics Corp.)

Fig. 3. Captivated center pins, which are built into the rf connector, prevent dielectric creepage from causing discontinuities in the center contact.

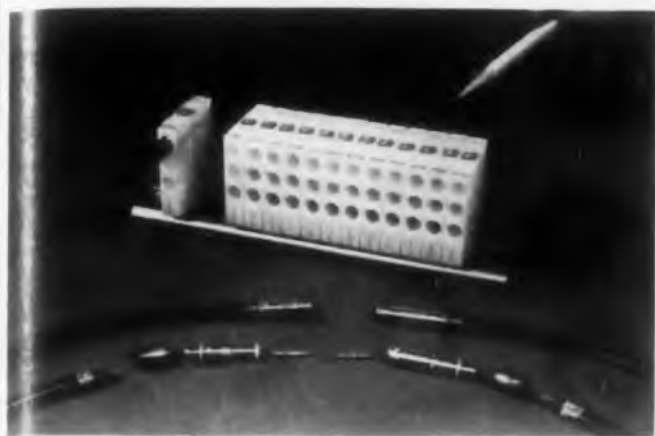


Fig. 4. In these rf connectors, the inner pin or socket is crimped to the inner conductor. The contact is then snap-locked into the outer pin or socket, which has the insulation factory-assembled into it. Introduced last fall by Burndy Inc., the contacts can be easily removed. The connectors can also be used with Burndy's Modulok strips.

tries, such as Teflon, have low coefficients of friction.

The captivated center pin, however, is butressed against the body of the connector. This prevents movement of the center conductor, eliminating the possibility of a discontinuity. Though captivated center pins provide extra protection, they are not mandatory in all applications. In the missile instrumentation area, particular interest is being shown in them.

The Big Picture

Proper operation of an rf system depends, in part, on the careful evaluation of the vswr limitations that can be tolerated. That is why the cumulative vswr effect of all the rf connectors must be considered when connectors are being specified. This is especially important at microwave frequencies.

Improperly made rf connections will result in the system's not working satisfactorily. But perhaps equally important, energy will be reflected back to the output circuit of the transmitter. And this energy, if it causes the output circuit to exceed its wattage rating, will shorten the life of the transmitter.

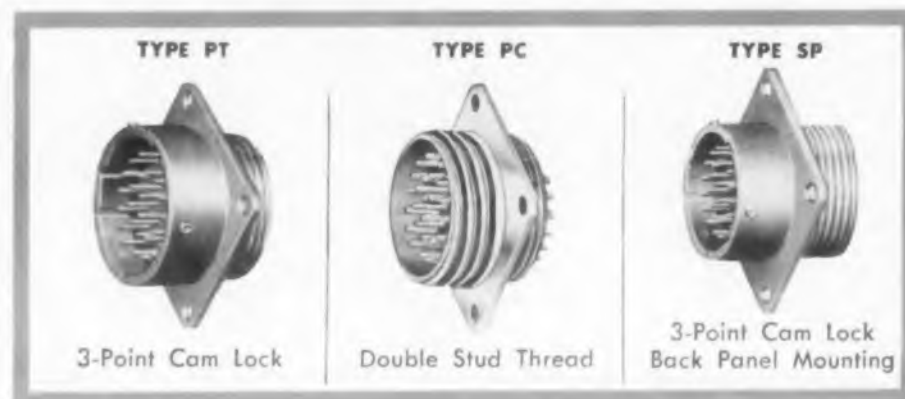
Proper Assembly Necessary

After the rf system connection requirements have been evaluated and the cable and the connector selected, the connector must be attached to the cable. The importance of good production techniques in attaching rf connectors is underlined by this statement from Hoffman Electronics Corp.: "Overwhelming evidence indicates that a properly assembled connector has never failed in production or use." ■ ■ ■

BENDIX* PYGMY* MINIATURE ELECTRICAL CONNECTORS



Presenting our big and growing family



FAMILY FEATURES

Lightweight, Compact	5 Key Polarization on PT & SP Series
Resilient Inserts	Heavily Gold Plated Contacts
Closed Entry Sockets	Moisture and Vibration Resistant
MS Mtg. Dimensions on PC & PT Series	Quick Disconnect—All Series



Specify Bendix Pygmy Miniature Electrical Connectors for the minimum space and weight required to serve the most critical circuitry.

Scintilla Division

SIDNEY, NEW YORK



Export Sales & Service: Bendix International Division, 205 E. 42nd Street, New York 17, N. Y. Canadian Affiliate: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec.

CIRCLE 51 ON READER-SERVICE CARD

a GUIDE

TO **AMPHENOL** CONNECTORS

MEETING THE BASIC
COMPONENT NEEDS
OF INDUSTRY

AN/MS CONNECTORS a complete selection of standard MIL-C-5015 connectors, including new "Stub E" environmentally resistant constructions. Miniature AN-type 165 series; miniature "Minni E" environmentally resistant connectors. Request Catalog A5 for complete data.



RF CONNECTORS every standard RF Series, N, BNC, C, HN, BN, LC, LT, UHF is available from AMPHENOL. Subminax RF connectors are an expanding line of subminiature types made only by AMPHENOL. Complete engineering services stand behind each AMPHENOL RF. Request Catalog D3.



RACK & PANEL CONNECTORS from the remarkable Blue Ribbon connectors with their smooth-working "ribbon" contacts to new "Poke Home" contact designs. AMPHENOL connectors meet every rack & panel application need. Request Catalog B6.



MISSILE CONNECTORS Breakaways, umbilical and interstage, are designed and produced by AMPHENOL for a large number of missile projects. Each is a special purpose connector, application-engineered for a particular requirement. Write for additional information.



HERMETIC SEAL CONNECTORS new "Identoseal" marking on AMPHENOL hermetically sealed connectors provides clear contact identification in the compression sealed glass inserts. Receptacles to mate with AN/MS, 165 and MinniE connectors. Headers also available. Request Catalog A5.



PRINTED CIRCUIT CONNECTORS 143 Series receptacles mate with standard .055"-.073" boards, 6 to 22 contacts, and with 133 Series plugs and adapters, 10 to 22 contacts. Superior gold-plated contacts, other reliability features. Request Catalog B6.



CABLE & WIRE PRODUCTS are important AMPHENOL components, also. Request Catalog WZ.

*amphenol connector division
amphenol cable & wire division
amphenol western division*

AMPHENOL BOBO ELECTRONICS CORPORATION • Chicago 50, Illinois

AMPHENOL

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CONNECTIONS

Acknowledgments

Space limitations prevent us from providing a complete list of all the connector manufacturers which contributed information for this report. Presented below, however, are some that were especially helpful.

AiResearch Mfg. Co., Los Angeles, Calif.
American Lava Corp., Chattanooga, Tenn.
Amp, Inc., Harrisburg 10, Pa.
Amphenol Electronics Corp., Chicago, Ill.
Atlas E-E Corp., Woburn, Mass.
Belden Mfg. Co., Chicago 44, Ill.
British Electronics Sales Co., Inc., Flushing, N. Y.
H. H. Buggie, Inc., Toledo, Ohio
Burndy Corp., Norwalk, Conn.
Cambridge Thermionic Corp., Cambridge 38, Mass.
Cannon Electric Co., Los Angeles 31, Calif.
Cinch Mfg., Corp., Chicago, Ill.
Circon Component Co., Goleta, Calif.
Coaxial Connector Co., Inc., Mt. Vernon, N. Y.
Consolidated Electrodynamics Corp., Pasadena, Calif.
Continental Connector Corp., Woodside 77, L. I.
DeJur-Amsco Corp., Long Island City, N. Y.
The Deutsch Co., Electrical Connector Div., Los Angeles, Calif.
Eitel-McCullough Inc., San Bruno, Calif.
Elco Corp., Philadelphia 24, Pa.
Fidelity Amplifier Corp., Chicago 14, Ill.
Garrett Corp., Los Angeles 45, Calif.
Harvey Hubbell Inc., Bridgeport, Conn.
Industrial Products Co., Danbury, Conn.
Jettron Products, Hanover, N. J.
Joelin Mfg. Co., Wallingford, Conn.
Keystone Electronics Corp., New York 13, N. Y.
Kulka Electric Corp., Mt. Vernon, N. Y.
Malco Tool and Mfg., Co., Chicago 24, Ill.
Manger Electric Co., Stamford, Conn.
Methode Mfg. Corp., Chicago, Ill.
Microdot, Inc., South Pasadena, Calif.
Molex Products Co., Brookfield, Ill.
Mosley Electronics, Inc., St. Louis 14, Mo.
Nugent Electronics Co., Inc., New Albany, Ind.
Panduit Corp., Midlothian, Ill.
Pyle-National Co., Chicago 51, Ill.
Reeves Instrument Corp., New York 28, N. Y.
The Richardson Co., Melrose Park, Ill.
Scintella Div., Bendix Aviation, Sidney, N. Y.
Sealectro Corp., Mamaroneck, N. Y.
Shakeproof Div. Illinois Tool Works, Elgin, Ill.
Spectro-Strip Wire & Cable Corp., Garden Grove, Calif.
Stanwyck Winding Co., Newtonville, Mass.
Stromberg Carlson Co., Rochester 3, N. Y.
Switchcraft, Inc., Chicago 30, Ill.
Tubular Rivet and Stud Co., Wollaston 70, Mass.
Twin-Lock, Inc., Inglewood, Calif.
Willor Mfg., Corp., Bronx 72, N. Y.

Book Acknowledgments

1, 2, 3, 4, 5, 6, 7: Reliable Electrical Connections 1958, 286 pp. Engineering Publishers, Division of The AC Book Co., Inc., N. Y.

Connection Developments

As We Go To Press



This Terminal Pull Tester was developed to test the tensile strength of electrical connections of all types. Produced by Hunter Spring Co., Lansdale, Penn., it is designed to provide simply and inexpensively an inspection rate that can keep pace with automatic production machinery. In operation, the terminal is inserted in the appropriate notch in the gage's turret head, which accepts standard wire sizes up to #12 primary cable inclusive, and up to #10 heavy duty cable. The wire is placed between the open jaws facing the gage. When the motor is started the wire is pulled until the connector fails. The gage dial holds the force reading at which the sample failed. Seven models of the unit have maximum capacities of 20, 50, 75, 100, 150, 200, or 500 lbs., respectively. Accuracy of each is 0.5 per cent of full scale.



Work being done to terminate flexible cable was revealed by Amp Inc. By modifying the crimp design on their solderless lug, they can connect flexible cable in a very simple manner. The process works like this: Material between the conductive element is slotted out. Then a short piece of the conductor is bent back and a solderless lug crimped on. The solderless terminal can then be attached to terminal boards and connectors. All processes are done automatically. Also developed was a special terminal block for flexible cable, as shown in the photograph. It completely shields each solderless termination from the others. This reduces the flashover problem and permits use of the flexible cable at high altitudes.

See the first page of the New Products section for another connection development.

in missiles

**UAP CAN COOL
EVERYTHING**
including the mouse!

	missile type	Surface-Surface	Air-Surface	Air-Air	Surface-Air	ICBM	IRBM	ICBM	Drone	Tactical	Unknown	service use	Army Ordnance	USAF	NAVY	Army Sig. Corps	Bur. Aeronautics	Unknown	propulsion	Liq. Fuel Rocket	Solid Fuel Rocket	Booster	Ram Jet	Turbo Prop	Gas Turbine	Unknown	guidance	Radar	Inertial	Infra Red	Radio	Unknown	ground support
cooling systems	Mechanical Refrigeration																																
	Expendable Refrigeration																																
	Cryogenic																																
	Heat Transport																																
	Console Cooling																																
heat exchangers	Evaporative																																
	Liquid/Air																																
	Ammonia/Glycol																																
	Liquid/Gas																																
	Evaporative																																
	Liquid/Liquid																																
valves	Liquid Ammonia/Liq. Oxygen																																
	Hot Gas/Nitrogen Tetroxide																																
	Ammonia/Air																																
	Cold Plate																																
	Rupture																																
	Explosive																																
hand pumps	Bleed																																
	Bypass																																
	Temperature Control																																
	Pressure Control																																
oil tanks	Solenoid																																
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CIRCLE 53 ON READER-SERVICE CARD



NEW PRODUCTS

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

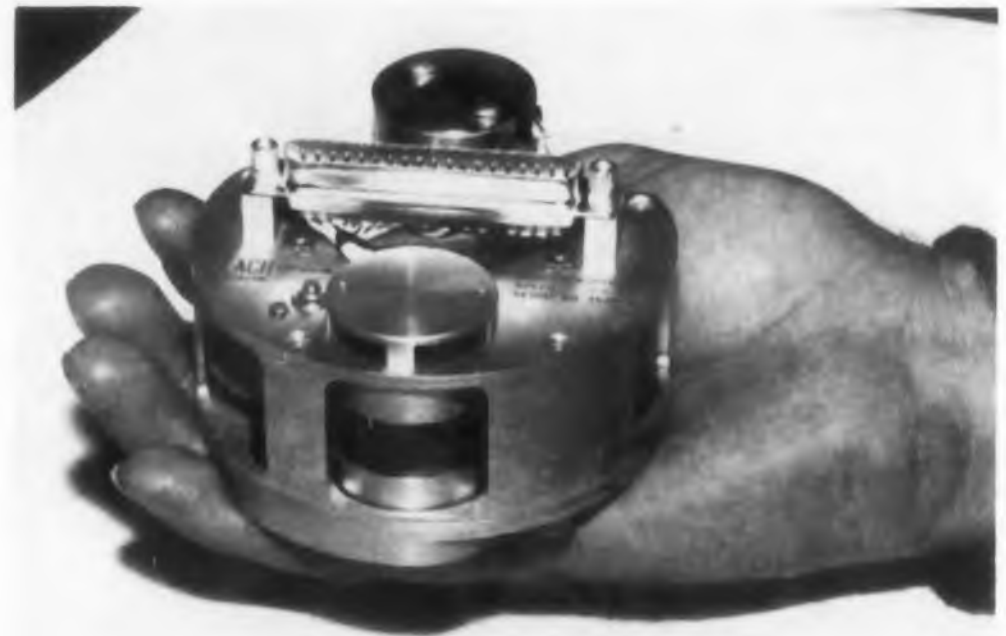


CONNECTOR

Using a ball and socket principle, this connector was designed to handle high shock and vibration. Two ball-type pins are connected by a split sleeve held together by two garter springs. Action of the ball-contacts in the sleeve is that of a universal joint and a close tolerance does not have to be held of the location of the sleeve. Connectors now available are rated for 50 amp at 30 C rise. They have been qualified for vibration over a scan of 2000 cps at 45 g in three axes. They can stand 50 g shock and operate from -65 to 250 C.

Cole Electric Co., Dept. ED, 8439 Steller Drive, Culver City, Calif.

CIRCLE 54 ON READER-SERVICE CARD



TAPE RECORDER

Weighing 24 oz, this tape recorder was engineered for airborne applications. Tape speeds are 0.25, 0.5, 1.0, 1.875, 3.75, 7.5, and 15 in. per sec. The unit handles 0.5 and 1 in. tape widths and recording times are 60, 30, 15, 8, 4, 2 and 1 in. Operating from 24 v dc, it can take 200 g of acceleration. It operates in a temperature range of -50 to 200 F; wow and flutter, under static conditions, is less than 1%.

Leach Corp., Dept. ED, 18435 Susana Rd., Compton, Calif.

CIRCLE 55 ON READER-SERVICE CARD

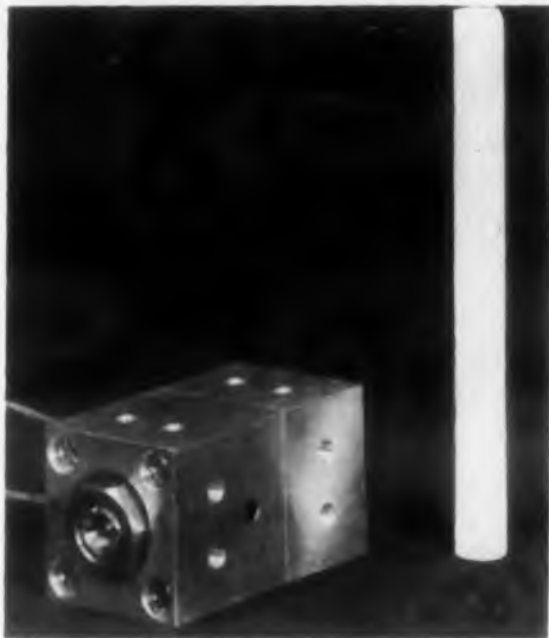


ENCAPSULATED TANTALUM CAPACITORS

These disc-shaped solid tantalum capacitors have grid type leads which allows other wiring to be easily bridged. The units are encapsulated in an epoxy resin which reduces weight more than 30% from conventional can types. Encapsulation insulates the body and prevents short circuiting with adjacent components.

P. R. Mallory & Co. Inc., Dept. ED, 3029 East Washington St., Indianapolis 6, Ind.

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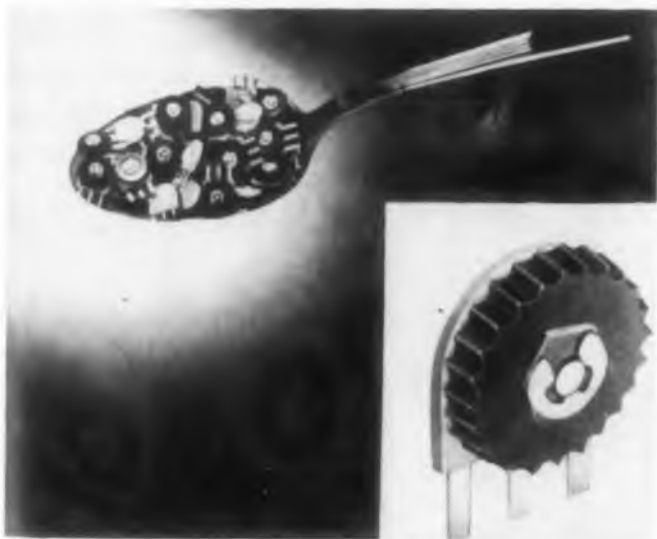


ACCELERATION SWITCH

This acceleration sensitive switch is continuously adjustable for sensitivity to positive and negative acceleration along a single axis. In the standard model sensitivity is adjustable from -30 to $+30$ g. Weighing 50 oz, the unit has silver and rhodium plated hardened contacts which can carry up to 2 amp. Switching arrangement is spdt.

Eastern Technical Associates Inc., Dept. ED, 31 Sudbury Road, Concord, Mass.

CIRCLE 57 ON READER-SERVICE CARD



MICROMINIATURE VARIABLE RESISTOR

Rated at 0.1 w, this microminiature variable resistor has a component density of 188 per cu in. Designated the Model 8 Radiohm, it is available in resistance values from 500 ohms to 10 meg in a wide range of tapers. The unit has a minimum rotational life of 25,000 cycles and measures 0.286 in. in diameter and 0.11 in. in depth.

Centralab, Division of Globe-Union Inc., Dept. ED, 900 East Keefe Ave., Milwaukee 1, Wisc.

CIRCLE 58 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 18, 1959



Patent Pending

NEW FROM

COMPLETELY SEALED MINIATURE QUARTZ SEALCAPS

Moving upstairs? Then you'll welcome the new JFD precision Miniature Quartz Sealcaps that seal out moisture, seal in reliability and accuracy, regardless of atmosphere.

These new JFD variable trimmer piston capacitors combine the unique characteristics of Sealcap construction and miniature quartz capacitor design. Each is filled with dry nitrogen under pressure and then sealed to maintain the compression, prevent corona and voltage breakdown at high altitude. Linear tuning with fine resolution is assured permanently, without breaking of seal.

Sealcap design also blocks the formation of moisture inside the unit, increases insulation resistance and dielectric strength. The use of quartz dielectric results in high Q, ultra low loss high frequency operation, greater stability, and approximately zero temperature coefficient.

JFD Standard Sealcaps are available unpotted or encapsulated in epoxy resin for higher dielectric strength. Our engineering staff will welcome the

opportunity to relate the advantages of Sealcaps to your specific application. In the meantime, why not write for Bulletin No. 215? Also available in glass dielectric, Bulletin No. 207A.

FEATURES

1. Sealed interior construction locks out all atmospheric effects.
2. High Q.
3. Anti-backlash design assures excellent tuning resolution — no capacitance reversal while tuning.
4. Extreme stability at high and low temperatures.
5. Ultra linear tuning for accurate alignment.
6. Low temperature coefficient of capacitance.
7. Low-loss low inductance coaxial tuning for high frequency use.
8. Special alloy plating protects metal parts against corrosion.
9. Fused Quartz dielectric with excellent electrical properties offers no derating at 150° Centigrade.
10. Rugged construction for shock and vibration resistance.
11. Miniaturized construction supplies maximum capacity in minimum space.
12. Positive mechanical stops at both ends of adjustment.
13. Available in panel and printed circuit type mountings — unpotted or encapsulated for complete imperviousness to humidity and moisture.



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Ranges from .6 to 1.8 pf. to .8 to 16 pf. in 12 standard models.

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CIRCLE 59 ON READER-SERVICE CARD

FAST! — up to 200 cps
SENSITIVE! — low as ± 2.5 milliwatts

NEW CLARE Type HGS Mercury-Wetted Contact Relay

IDEALLY SUITED TO HIGH SPEED SWITCHING DEVICES

The Type HGS Relay is a new variety of CLARE Mercury-Wetted Contact Relay, developed to meet the needs of modern design engineers for faster and more sensitive relays. The HGS Relay is especially suited to all types of high-speed switching devices, over-voltage and overload protection devices and high-power chopper applications.

Operating speeds may be up to 200 cps or more. Sensitivity may be as low as ± 2.5 milliwatts for a bi-stable adjustment, as low as 5 milliwatts for a single-side-stable adjustment. Contact rating is 2 amperes, 500 volts, with a limit of 100 volt-amperes.

Supplements Clare HG and HGP Relays

The new CLARE Type HGS Relay will not supplant the revolutionary Types HG and HGP. It will supplement these relays in applications which require higher speed or greater sensitivity.

The Clare Type HGS is similar to the Types HG and HGP except that the HGS is always biased with permanent magnets. These are adjusted to single-side-stable or bi-stable operation.



Cutaway view of a CLARE Type HGS Relay. Mercury-wetted contact switch is sealed in glass and surrounded by the operating coil. Biasing magnets are attached to the upper ends of the side plates.

ELECTRICAL FEATURES

Long Life: Over one billion operations at rated load.

Operation Speed: Up to 200 cps with consistent performance. Higher if some variation is tolerable.

High Sensitivity: 5 milliwatts for single-side-stable adjustment; ± 2.5 milliwatts for bi-stable adjustments.

Stable Operation: 0.1 millisecond maximum operating time variation.

Freedom from Chatter: Absolutely NO CONTACT BOUNCE.

Low, Stable Contact Resistance: Initial contact resistance, 25 to 50 milliohms, does not vary by more than 1 or 2 milliohms during life of contacts.

Low Ratio Coil Inductance: Low inductance-to-resistance ratio of coil suits relay well for transistor-drive applications.

MECHANICAL FEATURES

Conveniences: Small, light-weight; plugs in like vacuum tube; completely protected from atmospheric conditions; contacts cannot wear, weld, stick or chatter; tamper-proof; requires no maintenance.

Durability: Easily withstands normal handling and transportation shocks.

Send for CLARE Sales Engineering Bulletin No. 125 for complete information on the new Type HGS Relay. Bulletins 120 and 122 describe HG and HGP Relays. Write: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable Address: CLARELAY.

CLARE RELAYS

FIRST in the industrial field

NEW PRODUCTS

Magnetic Storage Drum

Holds 1.5 million bits

In a dust tight cabinet 25 x 25 x 35, the 1016-A magnetic storage drum has a capacity of 1.5 million bits. Drum surface T.I.R. runout is 0.0001. The integral precision motor provides speeds from 900 to 3600 rpm.

Bryant Chucking Grinder Co., Computer Products Div., Dept. ED, Springfield, Vt.

CIRCLE 61 ON READER-SERVICE CARD

Pressure Switch

1% accuracy and repeatability



For indicating absolute air pressure, model 5120 switch has 1% accuracy and repeatability. It operates on 28 v dc at 35 ma and is rated 2 amp at 30 v dc and 3 amp at 115 v ac. The standard range is 0.4 to 15 psia, and 0.1 to 1 and 13 to 20 psia ranges are available. The unit withstands -65 to $+220$ F.

Aero Mechanism, Inc., Dept. ED, 13918 Saticoy St., Van Nuys, Calif.

CIRCLE 62 ON READER-SERVICE CARD

Instrument Movement

Provides maximum flux density

In all dc panel and portable meter sizes, this Bar-Ring movement provides self-shielded instruments of maximum torque and high performance. Its short working gap allows for maximum flux density and insures magnet permanence.

The Triplett Electrical Instrument Co., Dept. ED, Bluffton, Ohio.

CIRCLE 63 ON READER-SERVICE CARD

CIRCLE 60 ON READER-SERVICE CARD

Telemetry Antennas

Have circular polarization

Featuring circular polarization, type G-1054 antennas are suited for the reception of telemetering information from orbital and into-space transmitters. With 6, 8, or 10 ft diameter parabolic reflectors, they have a choice of helical feeds and a manually controlled mount for either ground or vehicle installation. Gain is 23 to 26 db over an isotropic source, and the nominal beam width is 8 to 14 deg, depending on size. Standard frequency range is 940 to 980 mc and vswr is less than 1.3. Completely balanced, the unit has an azimuth adjustment of 360 deg and an elevation adjustment of 0 to 90 deg. Markers are provided for both azimuth and elevation readings. Transmission line feed is through a type N connector with a terminal impedance of 50 ohms.

Technical Appliance Corp., Dept. ED, Sherburne, N.Y.

CIRCLE 64 ON READER-SERVICE CARD

Converters

115 v, 60 cps output

Featuring high power to weight ratio, arc free operation, and long life, these static inverters provide outputs of 115 v, 60 cps. Respectively, models MAC-6-30-1 and MAC-12-20-1 have 6 and 12 v battery inputs and 150 and 170 w maximum fixed load outputs va. Both units measure 8 x 5-1/2 x 3 in. and weigh 7 lb. Model MAC-12-30-2 is designed with a 12 v battery input, 250 w maximum output va, and 10% no load to full load regulation. Case size is 4-3/4 x 5-7/8 x 7 in.; weight is 16 lb. In all units, output voltage varies directly with input voltage. Cases and porcelain terminals are hermetically sealed.

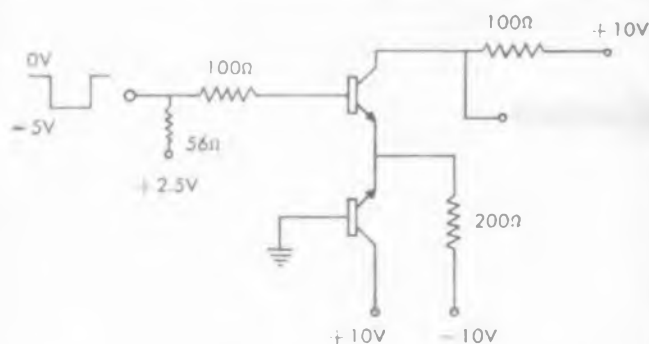
Freed Transformer Co., Inc., Dept. ED, 1727 Weirfield St., Brooklyn 27, N.Y.

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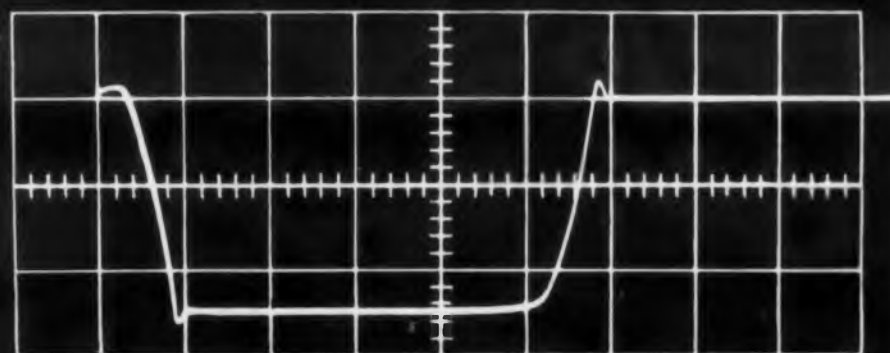
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NEW SILICON TRANSISTORS

FOR FAST POWER SWITCHING



SWITCHING TEST CIRCUIT



50 ma pulse .2μsec/cm on Tektronix 541 Oscilloscope



Featuring fast switching, low capacitance, and good bottoming voltage in the range of 10 to 100 milliamperes, Transistron's 2N1140 extends what is already industry's widest range of silicon switching transistors. The 2N1140 is designed for use as a drum memory driver, core driver-driver, and high level multivibrator.

Additional new types ST4080 and ST4081, because of their Beta linearity and superior bottoming, offer many advantages over types 2N339, 2N342 and 2N343.

For further information, write for Bulletin *TE-1355*.

ABSOLUTE MAXIMUM RATINGS

	2N1140	ST4080	ST4081	2N339	2N342	2N343
V_{ce}	40	60	60	55	60	60 Volts
V_{eb}	5	3	3	1	1	1 Volts
Power Dissipation 100°C amb.	0.5	0.5	0.5	0.4	0.4	0.4 Watts
100°C case	1.2	1.2	1.2			Watts

SPECIFICATIONS AND TYPICAL CHARACTERISTICS AT 25°C

h_{fe} at 1Kc $I_c = 10 \text{ ma}, V_{ce} = 10 \text{ Volts}$	50	20-50	30-90	9-90*	9-32*	29-90*
I_{co} at Max. rated voltage	15	25	25	50	50	50 μa
Max R_{cs} at $I_c = 20 \text{ ma}, I_e = 5 \text{ ma}$	50**	100	100	300	350	350 ohm
h_{fe} at 10 mc typical	5					
C_c at $V_{eb} = 10 \text{ volts}, I_e = 0$	16					$\mu\text{f.}$
h_{fe} at $I_c = 50 \text{ ma}, V_{ce} = 6 \text{ V}$	50					
Rise time	.13					$\mu\text{SEC.}$
Fall time	.10					$\mu\text{SEC.}$

*at $I_c = 5 \text{ ma}$
 $V_{ce} = 10 \text{ Volts}$

**at $I_c = 50 \text{ ma}$
 $I_b = 5 \text{ ma}$

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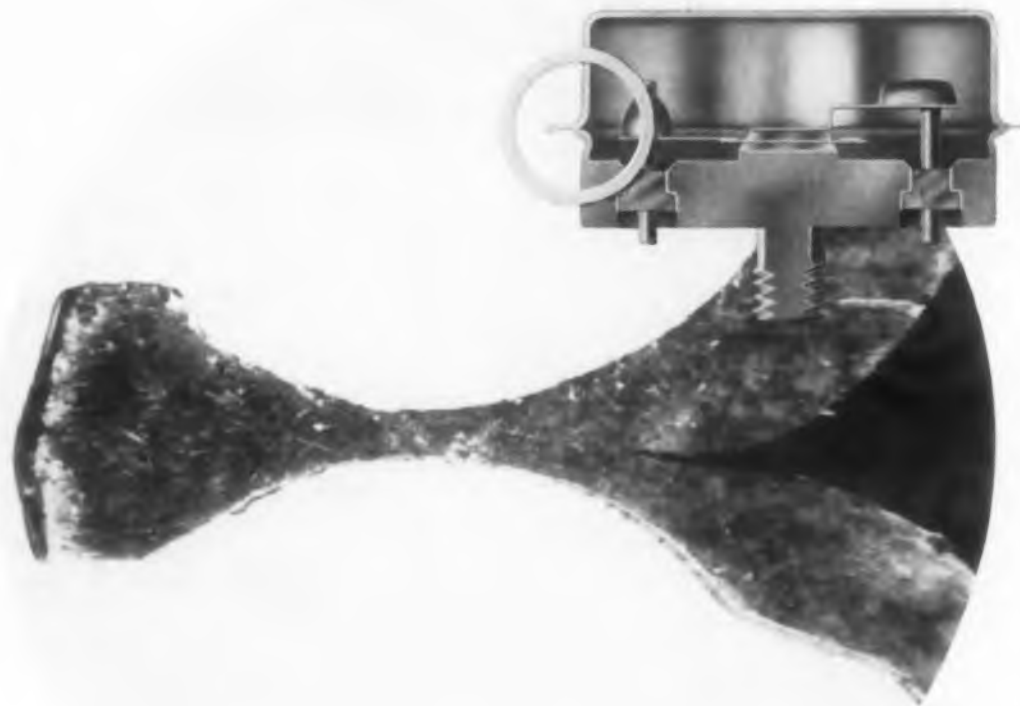
High power transistors with new **cold-weld** seal

Improved cold-weld seal gives new Tung-Sol high-power transistors three-way quality boost

- True hermetic, copper-to-copper seal improves transistor thermal characteristics.
- Elimination of heat-damage, heat-caused moisture and "splash" increase reliability.
- Vacuum-tight, moisture-proof cold-weld seal lasts even through "breathing" over long life operation.

Once again Tung-Sol shows the way. Now, for the first time, Tung-Sol brings designers high-power germanium transistors with quality benefits of the advanced cold-weld seal.

The new Tung-Sol types feature a stud-mounted package and maximum collector current of 13 amps. Military environmental tests combine with the radioactive gas leak detection test to assure maximum reliability.



Photomicrograph (45X) shows circled area of cross section of Tung-Sol high-power germanium transistor cold-weld seal. Note absence of seam, indicating actual integration of copper molecules and a true, hermetic, copper-to-copper seal.

Technological advancements such as this keep Tung-Sol ahead of the field. For full data on the new high-power switching transistors . . . to meet any need with the latest in transistor design and efficiency, contact: Semiconductor Division, Tung-Sol Electric Inc., Newark 4, New Jersey.

TUNG-SOL

CIRCLE 67 ON READER-SERVICE CARD

NEW PRODUCTS



Unidirectional Rotary Switch
Solenoid operated

Solenoid operated, the 6634 unidirectional rotary switch has 6 poles with 24 nonshorting positions per pole. It withstands 50 g acceleration and operates up to 125 C and 80,000 ft. With the solenoid, it is 2-3/4 in. square and 9 in. deep. The Daven Co., Dept. ED, Livingston, N.J.

CIRCLE 68 ON READER-SERVICE CARD

Computer Element File

Holds 24 card type units



Type R-1 plated steel card file assembly is designed to accommodate up to 24 printed circuit plug-in card type computer elements 4-1/2 x 5 in. The unit occupies 5-1/4 in. of standard 19 in. relay rack panel space and has a depth of 7 in. Plastic sliders are provided for guiding the cards to the connector and to give lateral support against vibration and shock. The assembly is available with either Amphenol 143-022-01 Pan-Cir or Kennedy KI-1500-22 connectors, or without connectors. It can be arranged for removal of computer elements from the panel side or from the back of the unit.

Ransom Research, Dept. ED, 323 W. Seventh St., San Pedro, Calif.

CIRCLE 69 ON READER-SERVICE CARD

Potential Test Set

0 to 3 kv or 0 to 5 kv ac ranges

For high potential testing, portable Megpot model 573 provides high sensitivity, continuously variable tests for current leakage, calibrated from 20 μ a to 3 ma, and full scale output with up to 0.0025 μ f load capacitance. Ranges are 0 to 3 kv ac or 0 to 5 kv ac.

General Hermetic Sealing Corp.,
Hermetronics Div., Dept. ED, 99 E.
Hawthorne St., Valley Stream, N.Y.

CIRCLE 72 ON READER-SERVICE CARD

Ferrite Phase Modulator

9.75 to 10.75 kmc frequency range



For use as a frequency translator, side band generator, or controlled phase shifter, the W-183-1E phase modulator is 6 x 1-5/8 in. It has a 9.75 to 10.75 kmc frequency range with 0.5 db insertion loss; 360 deg phase shift; and 1.1 vswr. Amplitude is modulated within ± 0.3 db.

Kearfott Co., Inc., Microwave
Div., Dept. ED, 14844 Oxnard St.,
Van Nuys, Calif.

CIRCLE 73 ON READER-SERVICE CARD

Printed Circuit Card Guides

Mount on standard relay racks

For various card sizes, these modular printed circuit card guides can be provided with an adjustable metal frame that mounts on standard 19 in. relay racks. The units are made of rubber phenolic or Bakelite.

Ministrut Products Co., Dept. ED,
933 W. Washington Blvd., Chicago
7, Ill.

CIRCLE 74 ON READER-SERVICE CARD

CIRCLE 75 ON READER-SERVICE CARD

"better than we expected!"

SMI-C Subminiature Series Precision Connectors

When our connectors meet your specifications perfectly . . . well that's all part of our job. But when they exceed requirements, we drop all modesty and do a little shouting. This was the case with our new SMI-C Connector Series, causing one of our leading customers to exclaim "Better than we expected!" These are the newest members of the family of over 150 reliable types of U. S. COMPONENT connectors, products of a close liaison between application engineers and our design team. Read all about it . . .

- STAINLESS STEEL REINFORCING RETAINER provided under each screwlocking element removes all torque stresses from molded bodies, avoiding breakage.
- POSITIVE RE-ENTRANCY OF MALE PINS assured each time by flanged guide female contact.
- SELF-ALIGNMENT ACTION assisted by provision of wider countersink on upper end of contact.
- IDEAL FOR CRITICAL ENVIRONMENTAL CONDITIONS and extremes of military applications.
- 7-11-14 20-26-34 contacts. Other configurations upon request.



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minals and multiple headers, seals for all applications. Call or write for data on E-I standard seals, mentioning terminal types in which you are interested. Send drawings for quotations on custom seals.

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A Division of Philips Electronics, Inc. MURRAY HILL, NEW JERSEY

CIRCLE 76 ON READER-SERVICE CARD

NEW PRODUCTS

Lighted Pushbutton Switch

7/16 in. maximum diameter



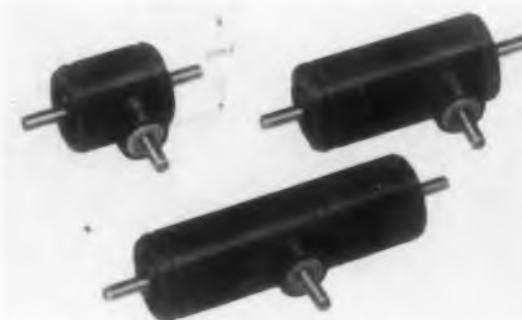
Rated at 1 amp, 115 v ac, model 40-1 lighted pushbutton switch has a minimum life of 500,000 operations. The light circuit incorporates an NE 2 neon bulb and is independent of the switch circuit. The units have a maximum diameter of 7/16 in. and a 3/8-32 threaded bushing. They extend less than 1-1/4 in. behind the panel.

Grayhill, Inc., Dept. ED, 561 Hillgrove Ave., LaGrange, Ill.

CIRCLE 77 ON READER-SERVICE CARD

Angle and T Drives

Handle up to 24 oz-in. torque



For use with any of the company's miniature speed reducers, series 12 angle and T drives are 1 to 1 ratio units that handle up to 24 oz-in. of torque. Used between two or more speed reducers they permit takeoffs with different speed reductions. Maximum power transmitted is 0.025 hp, and speeds to 10,000 rpm can be reached. The black anodized aluminum cases have an OD of 1.062 in. and size 11 servo mounts. The stainless steel shafts are 3/16 in. in diameter.

Metron Instrument Co., Dept. ED, 432 Lincoln St., Denver 3, Colo.

CIRCLE 78 ON READER-SERVICE CARD

Transistor Sockets

For variety of pin configurations

Available with flat saddles or mounting rings, series 3300 transistor sockets accommodate 0.016 or 0.03 in. diameter pins and triangular, round, or in-line pin configurations. Current rating is 1 amp; contact resistance, 0.03 ohm; insulation resistance, 1000 meg.

Elco Corp., Dept. ED, M St. below Erie Ave., Philadelphia 24, Pa.

CIRCLE 80 ON READER-SERVICE CARD

Differential Transformers

Operate continuously at 1000 F



Available for prototype and model evaluation, type 6208 HHK and 6206 HHK differential transformers withstand 1000 F continuously and 2000 F for 5 min. The units are for linear displacement measurements to ± 0.15 and ± 0.5 in., respectively.

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

CIRCLE 81 ON READER-SERVICE CARD

Binding Posts

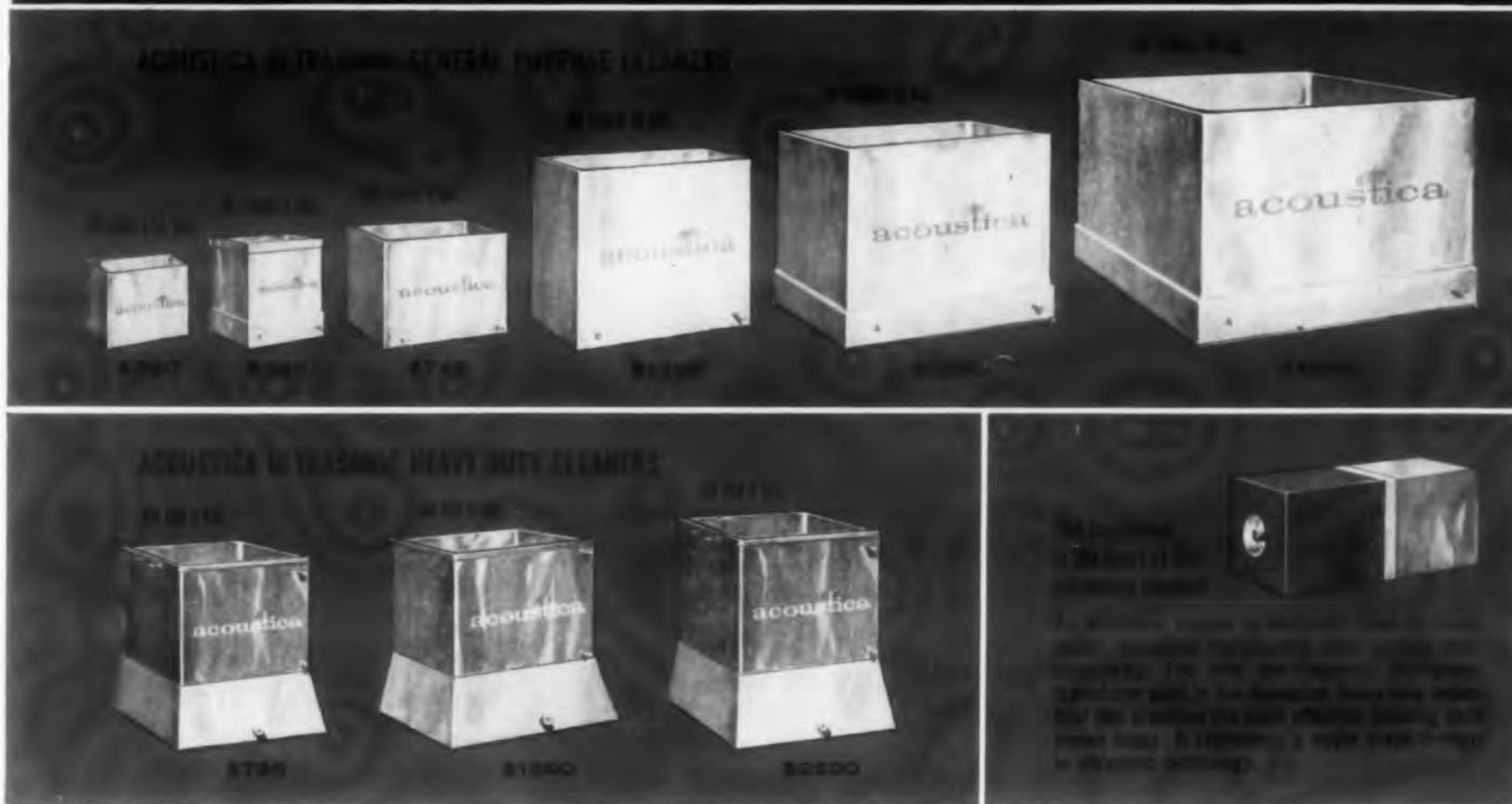
Plunger operated

With these binding posts, contact is made by depressing the plunger, inserting a lead, and releasing the plunger. The spring pressure assures a firm contact. Nickel plated brass with molded phenolic button caps, the units extend 3/4 in. above the mounting surface. Type 29-100 is made with a threaded stud, type 29-104 with molded phenolic insulating washers.

Grayhill, Inc., Dept. ED, 561 Hillgrove Ave., LaGrange, Ill.

CIRCLE 82 ON READER-SERVICE CARD

CIRCLE 83 ON READER-SERVICE CARD



All prices include tank and matching generator

Choose the correct cleaner for your purpose!

In determining which ultrasonic cleaning unit to buy, remember that all ultrasonic cleaning systems are not alike. The principle is the same, but the results are not. *The power and frequency of the transducer* are the key factors in determining the success or failure of applying ultrasonic energy for solving industry's cleaning problems. Acoustica research has developed *two* types of transducers for its ultrasonic cleaning units—the *General Purpose* 40kc barium titanate transducer and the *Multipower* heavy duty 20kc transducer. Expert Acoustica engineers are ready to advise you which type will better suit your needs. Mail the coupon below for information—there is no obligation.


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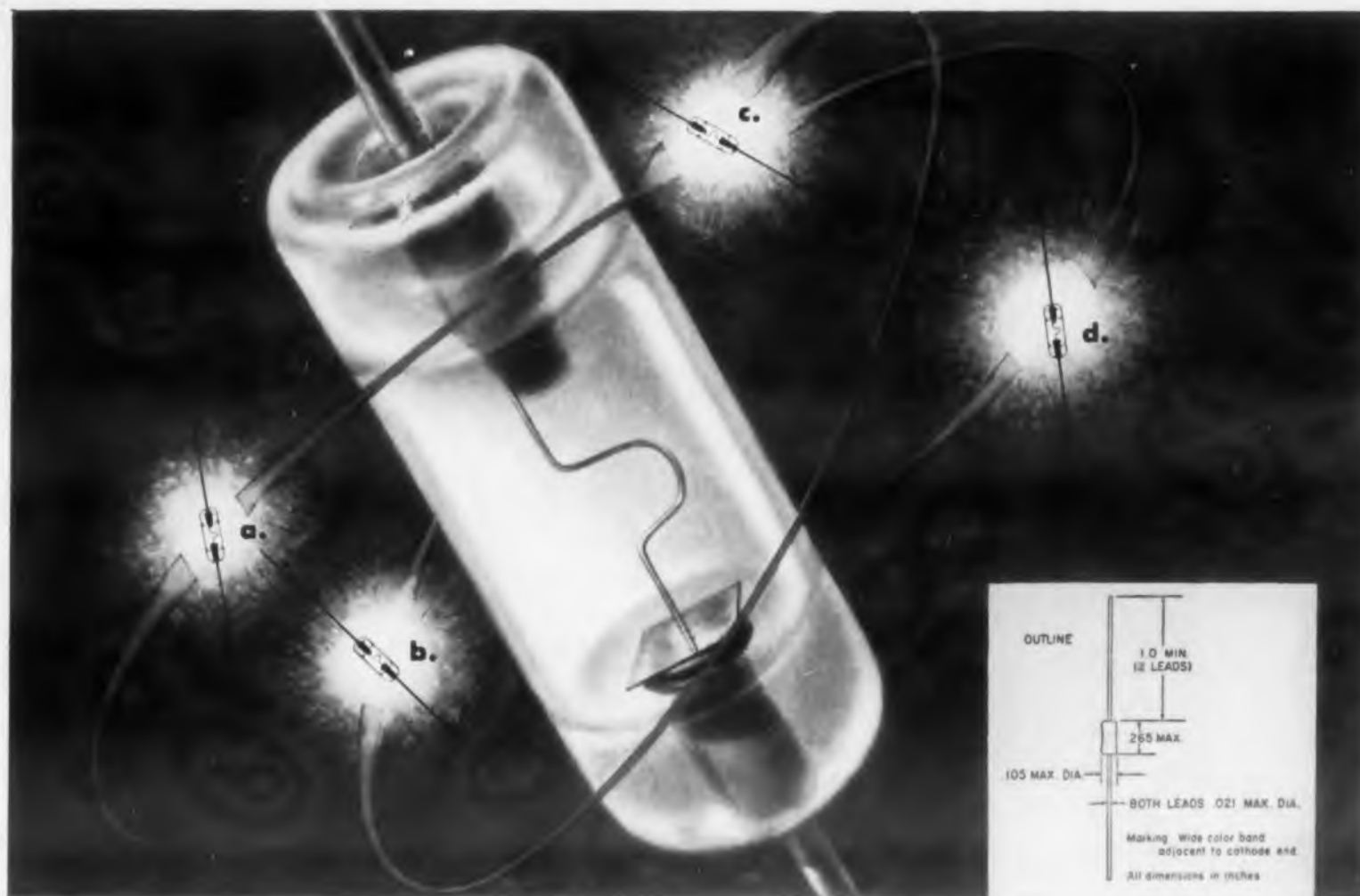
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a. Computer Types

b. Gold Bonded Types

c. Point Contact Types

d. Silicon Junction Types

Sylvania **ALL-GLASS** Subminiatures

...nucleus of the industry's most complete diode line

Sylvania now complements its complete diode line with the newest all-glass, subminiature package. Smallest diodes ever produced by the semiconductor industry, Sylvania all-glass subminiatures increase the opportunities for a more compact circuit design and layout, and are especially adaptable to automatic production techniques.

A broad line gives you a wide choice of diode types to meet your particular application needs. Computer types feature extra-fast recovery time with good stability and high conduction. If you want very high forward conduction and increased temperature capabilities, you'll find the most practical combination of characteristics among Sylvania's Gold

Bonded series. Silicon junction types offer temperature operation up to 150°C with fast recovery time and high reverse resistance.

Wide reverse resistance and voltage ranges are found in the Germanium point contact types.

For further information on any or all of these diodes, contact your Sylvania representative, or write. Of course, Sylvania all-glass diodes, like all Sylvania semiconductors, can be purchased in small quantities directly from your nearby Sylvania Distributor.

POPULAR SYLVANIA SUBMINIATURE DIODES

Computer Types:	Gold Bonded Types:	Point Contact Types:	Silicon Junction Types:
1N191	1N270	1N126A	1N251
1N192	1N276	1N127A	1N252
1N198	1N279	1N128	1N456-1N464
	1N281		1N625-1N629
	1N283		



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CIRCLE 84 ON READER-SERVICE CARD

NEW PRODUCTS

Precision Resistor Networks

Accuracies to $\pm 0.005\%$

These 400 cps precision resistor networks have accuracies to $\pm 0.005\%$ from 0 to 70 C, and slightly wider tolerances from -55 to +125 C. Resistances to 4 meg per cu in. are available with quadrature effects as low as 0.1 mv per v input.

General Resistance Inc., Dept. ED, 577 E. 156th St., New York 55, N.Y.

CIRCLE 85 ON READER-SERVICE CARD

Heavy Duty Toggle Switch

For 1000 w landing lights

Cockpit toggle switch A3-50/G4-10 is made to handle aircraft landing lights of 1000 w. Its ratings are 40 amp at 30 v dc, resistive; 30 amp at 30 v dc, inductive; 9 amp at 30 v dc lamp load; 9 amp lamp load at 115 v ac, 400 cps. Specially designed for Boeing Aircraft Co., the unit can be modified for other requirements.

Electrosnap Corp., Dept. ED, 4218 W. Lake St., Chicago 24, Ill.

CIRCLE 86 ON READER-SERVICE CARD

Miniature Beam Switching Tubes

Have 10 outputs

Operating at low transistor voltages, these miniature beam switching tubes retain all the characteristics of regular size units. Both shielded type BD 316 and unshielded type BD 203 have ten output positions, each with automatic memory and high impedance switching, which are controlled by a single electron beam.

Burroughs Corp., Electronic Tube Div., Dept. ED, P.O. Box 1226, Plainfield, N.J.

CIRCLE 87 ON READER-SERVICE CARD

Static Power Inverter

Output of 80 va

With transistor and magnetic amplifier circuitry this static power inverter converts 18 to 30 v dc to 115 v ac, 400 cps, single phase. Designed to produce a stable power output of 80 va, it is built to MIL-E-5400 and MIL-E-5572 specifications and has 1.5% regulation no load to full load.

Magnetic Amplifiers, Inc., Dept. ED, 132 Tinton Ave., New York 55, N.Y.

CIRCLE 88 ON READER-SERVICE CARD

Precision Potentiometer

Linearity to 0.0075%



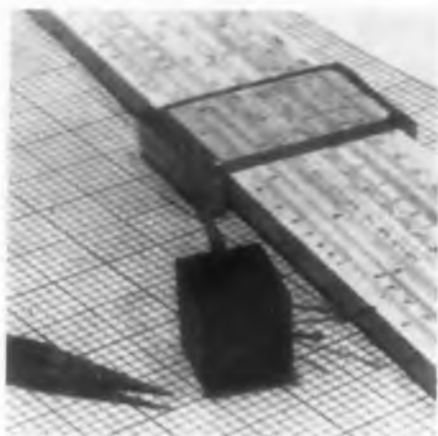
Model MD 20-25, a 25 turn, precision potentiometer has a linearity as close as 0.0075%. Overall length of the unit is 2-9/16 in., and diam is 2 in. It comes with standard servo mounts when required. The unit meets or exceeds all temperature, vibration and shock requirements listed in Mil specs for potentiometers.

Litton Industries, Inc., Dept. ED, 215 South Fulton Ave., Mount Vernon, N.Y.

CIRCLE 89 ON READER-SERVICE CARD

Magnetic Switches

Rotary, sliding, or push-pull



Provided with capacities of 15 amp and 250 v, these custom designed switches are actuated by a permanent magnet or electromagnet and have push-pull, sliding, or rotary motion. Inner switches and potting compounds are selected to suit the required characteristics and environmental conditions of a particular application, and the potting compound may be of any thickness. Called Magnaswitches, the units can be furnished with any length leads and any type connectors potted in place.

Reed Research Inc., Dept. ED, 1048 Potomac St., N.W., Washington 7, D.C.

CIRCLE 90 ON READER-SERVICE CARD

Inside ESC: Number Two



ESC DELAY LINES are CUSTOM-BUILT, CUSTOM-CHECKED!

At ESC, America's leading producer of custom-built delay lines, the challenge of perfection is renewed with every prototype assignment. Each delay line must meet precise, individual specs...each is painstakingly built under close engineering supervision...each is rigorously custom-checked against specially devised test standards.

In addition, complete and definitive laboratory reports—which include submitted electrical requirements, photo-oscillo-

grams (which indicate input and output pulse shape and output rise-time), the test equipment used and an evaluation of the electrical characteristics are submitted with all prototypes.

This is the way ESC custom-builds and custom-checks every unit. Backed by exciting new developments at ESC's research laboratories, these facilities insure a steady flow of custom-built delay lines for the most stringent requirements of military and commercial applications.



ESC

CORPORATION

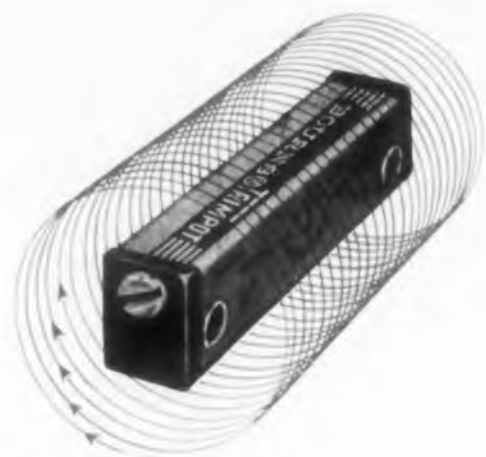
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CIRCLE 91 ON READER-SERVICE CARD



YOU GET **33 TIMES** THE ADJUSTABILITY
WITH **BOURNS** POTENTIOMETERS!

Compared with the conventional single-turn rotary potentiometer, the adjustability of Bourns potentiometers is a 33:1 improvement.

Providing 9000° of rotation instead of 270°, Bourns potentiometers *simplify* and speed up the adjustment or balancing of circuits.

You can repeat any setting quickly and easily.

Settings are virtually immune to shock, vibration and acceleration.

Translatory action of wiper provides inherent stability. The rigidly mounted wiper is driven by a threaded stainless steel shaft, which is actuated by your screwdriver. No need to recheck settings after a lock-nut is tightened. There *isn't* any lock-nut.

Available with printed circuit pins, solder lugs, or stranded insulated leads.



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Model Summary Brochure

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Protected by U. S. Patents 2,706,230, 2,777,926 Other Patents Pending.

CIRCLE 92 ON READER-SERVICE CARD

NEW PRODUCTS

Switch
Magnetically actuated



Actuated by a 0.1 oz Alnico magnet, model DC-01 spst switch operates in any position under high and low pressures from -85 to +350 F. Rated at 0.1 amp, 125 v ac, it detects small mechanical movements and can be used for position indicating and counting.

Hamlin, Inc., Dept. ED, 1316 Sherman Ave., Evanston, Ill.

CIRCLE 110 ON READER-SERVICE CARD

Convection Ovens
Ranges to 260 C

Mechanical convection ovens in the Test-All series have temperature ranges of 40 to 180 and 40 to 260 C. The ovens have a motor driven turbo blower that propels heated air horizontally through a definite air flow pattern to insure constant, uniform temperatures. Suited for pre-heating, aging, drying, and electronic research, the units are available in bench and floor styles. Bench model capacities range from 1.5 to 24 cu. ft.

Blue M Electric Co., Dept. ED, 138th and Chatham St., Blue Island, Ill.

CIRCLE 111 ON READER-SERVICE CARD

Waveguide Switch
Weighs 0.37 lb

Remotely controlled, the Delta miniature waveguide switch provides a reliable means of switching a single waveguide input to either of two outputs. Designed for the X band, it weighs 0.37 lb. Maximum vswr over the entire frequency range is 2.1 to 1 during the switching cycle and 1.1 to 1 in either position. Switching time is 0.007 sec; isolation is 50 db down; and if power rating is equal to the associated waveguide.

Don-Lan Electronics Co., Dept. ED, 1101 Olympic Blvd., Santa Monica, Calif.

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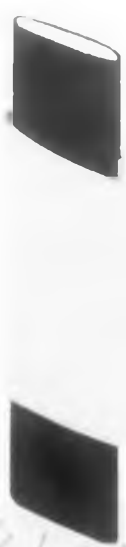
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ELECTRONIC DESIGN • February 18, 1959

Electron Tube News

—from **SYLVANIA**

Announcing the Sylvania
SARONG CATHODE



A NEW ERA IMPROVEMENT IN THE HEART OF THE ELECTRON TUBE

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The Sylvania Sarong Cathode—A New Era

Sylvania Sarong Cathodes pave the way to new performance standards for present and future tube types

Out of the advanced research laboratories of Sylvania's Electron Tube Division comes a revolutionary innovation in cathode coating, Sylvania Sarong. Sylvania scientists and engineers have succeeded in transforming conventional cathode coating into a thin uniform film that is precision-wrapped and securely bonded around each cathode sleeve.

Now in use in nearly one million Sylvania tubes, it is already contributing to a new efficiency in electron tube performance. It promises to open the way to new tube designs that will outperform many of today's advanced devices. First tubes to incorporate the Sarong Cathode are a number of Sylvania Tuner Types.

New Cathode Uniformity

Sylvania Sarong insures that every cathode will be

coated uniformly and precisely because its thickness, texture, length and weight are pre-controlled before application. The **thickness** of Sylvania Sarong coating is held to tolerances five times closer than conventional sprayed coatings. This new superiority in coating uniformity has already contributed to a reduction in cathode-grid shorts and intermittent short circuits.

Reduced Noise

The uniformity of Sylvania Sarong coating makes it possible to obtain an over-all uniformity in spacing between cathode and grid never before achieved in mass produced electron tubes.

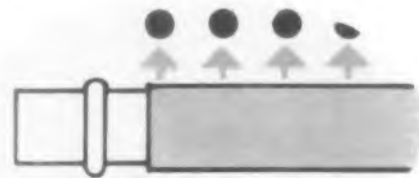
Preliminary tests indicate that this results in an improved noise figure of up to 0.6 db for TV. It also contributes to more uniform and higher levels of



Here are some of the ways Sarong



1. Uniform coating thickness of Sylvania Sarong Cathode means more uniform plate current, higher and more uniform levels of Gm and reduced noise

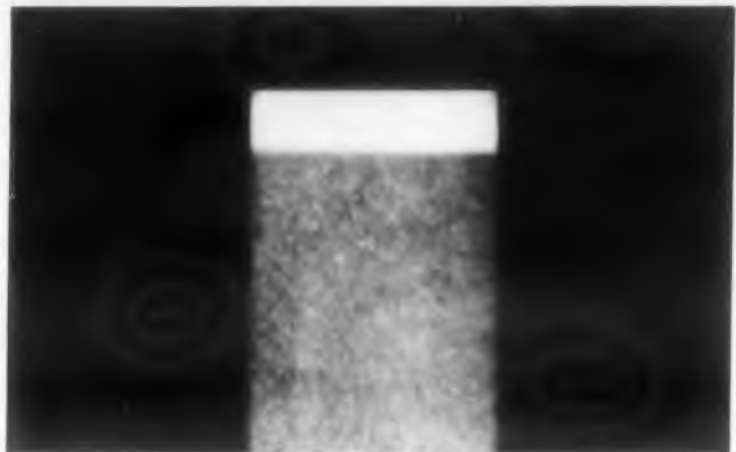


2. Sharp even edge and greater uniformity of Sarong coating virtually eliminates the possibility of end-leakage and contributes to better cut-off

improvement in the heart of the electron tube



Photomicrograph comparison of a conventional cathode, left, and Sylvania's Sarong Cathode in operation shows its



superior coating uniformity contributing to better emission and more uniform heat distribution

Gm and also to a more uniform plate current.

Because Sarong coating can be held to much closer tolerances, new tube designs incorporating more closely spaced elements become possible . . . opening the way to standards of tube performance never before achieved.

More Uniform Emission

The even distribution and smooth texture of Sylvania Sarong assures a new uniformity in cathode emission. The possibility of hot spots is virtually eliminated. Preliminary tests have already shown that Sarong Cathodes have pulse emission characteristics some 10^7 greater than conventional cathodes. Interface impedance due to poor coating adherence has also been improved, promoting better electron flow.

Better Cut-Off

Because Sylvania Sarong results in a more uniform surface and a more clearly defined coating, sharper cut-off characteristics and better control are achieved. The Sarong coating also eliminates the possibility of coating particles adhering inside the cathode sleeve.

Improved Temperature Distribution

All of the physical properties of Sylvania Sarong coating contribute to a new uniformity in cathode temperature. This contributes to noise reduction and better over-all performance throughout life. It enables the tube to tolerate a wider range of operating conditions, such as varying heater voltages, without great changes in emission.

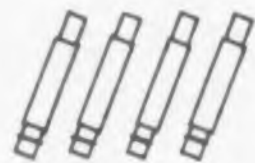
Cathodes contribute to better tube performance



3. Better diameter control with Sarong coating makes a closer spaced tube structure possible with higher Gm, more gain

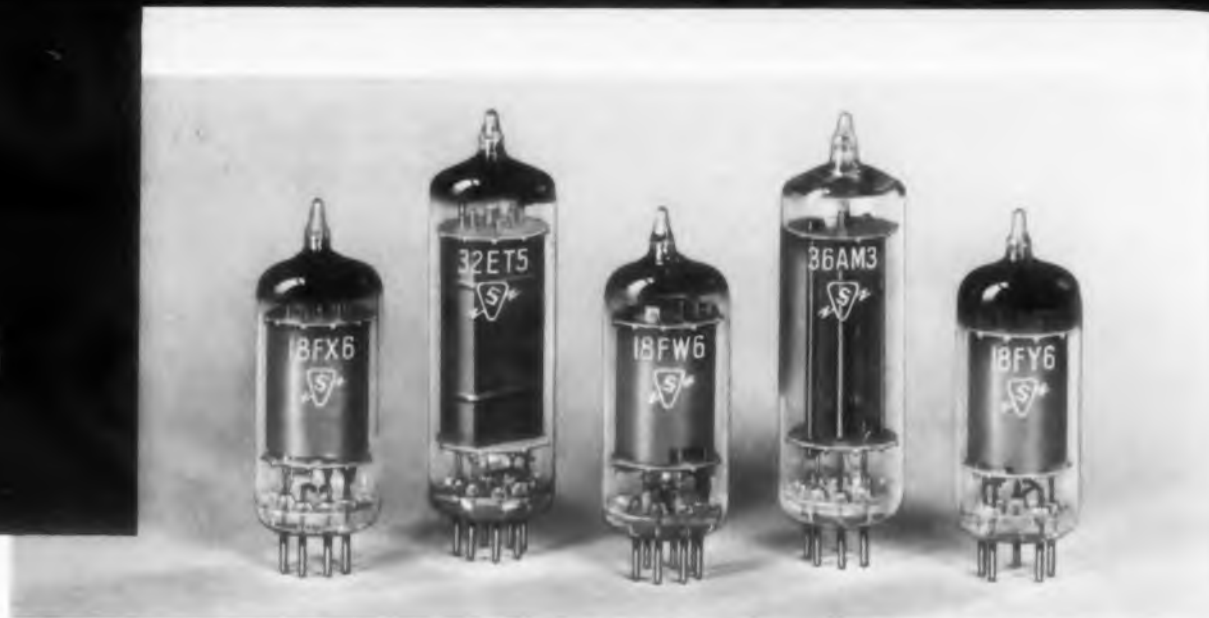


4. More uniform heat distribution is possible with Sylvania Sarong Cathodes. Hot spots are virtually eliminated and the life and over-all performance of the tube is improved



5. Sylvania Sarong Cathode coating makes possible a new uniformity of cathode emission from tube to tube

Other New Sylvania Developments



Type 18FX6—
Dual control miniature semi-remote cut-off pentode

Type 32ET5—
Miniature beam power pentode

Type 18FW6—
Miniature semi-remote cut-off pentode

Type 36AM3—
Miniature half-wave rectifier

Type 18FY6—
Miniature high mu triode double diode



New 100 ma All American Five

Radio set designers can now secure all of the performance advantages of the famous All American Five design with lower heater power and reduced heat dissipation. This opens the way to substantial economies in set components without a sacrifice of over-all set quality.

The Sylvania 100 ma All American Five includes the following types: 18FX6, 18FW6, 18FY6, 32ET5

and 36AM3. The function of each type corresponds directly in order to the standard All American Five types 12BA6, 12BE6, 12AV6, 50C5 and 35W4.

The new 100 ma All American Five tube complement is already being designed into the sets of one major radio manufacturer. Contact your Sylvania representative now for full information on the new types or write Sylvania directly.

New Spiral Accelerator C-R-T

Now ready for production at Sylvania's Industrial and Military C-R-T Department is one of the new high-quality cathode-ray tubes—the Spiral Accelerator. Designed for high-quality scope applications the advanced tube sets a new standard for high linearity and superior resolution. This is achieved through the spiral design that gives a smoother voltage gradient from deflection plates to screen.

Sylvania stands ready to produce Spiral Accelerator types to fit your specific needs. Contact your Sylvania representative or write Sylvania directly. We will welcome the opportunity to discuss your special cathode-ray tube requirements with you.



New Sylvania Spiral Accelerator C-R-T



SYLVANIA

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Silicon Solar Cell Modules

8% conversion capability



Capable of converting up to 8% of the radiant energy falling on their surface, these silicon solar converter modules will supply 100 w of power per 14 sq ft of cell area. Each basic module contains five series-connected 1 x 2 cm cells embedded in an epoxy mold that provides a rugged, weatherproof housing. With specially processed contact strips, the modules may be interconnected in series-parallel configurations to supply any desired power rating. Used with storage batteries, they can supply continuous power for long periods. A typical installation applies a charging current of 25 ma to over 1 amp into a 12 v nickel cadmium battery in bright sunlight. Modules with higher rates of conversion efficiency may be obtained for satellites and other special applications.

International Rectifier Corp., Dept. ED, 1521 Grand Ave., El Segundo, Calif.

CIRCLE 114 ON READER-SERVICE CARD

Transistorized Power Supply

0 to 36 v



Model SC-36-2 transistorized power supply delivers 0 to 36 v, and 0 to 2 amp. Regulation for no or load is less than 0.1% or 0.003 v, whichever is greater. Ripple is less than 1 mv rms. Recovery time is less than 50 μ sec. Operating ambient temperature is 50 C max. Output impedance is less than 0.02 ohm and power requirements are 105 to 125 v, 50 to 65 cps.

Elenco Laboratories, Inc., Dept. ED, 131-38 Sanford Ave., Flushing 55, N.Y.

CIRCLE 115 ON READER-SERVICE CARD

CIRCLE 113 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 18, 1959

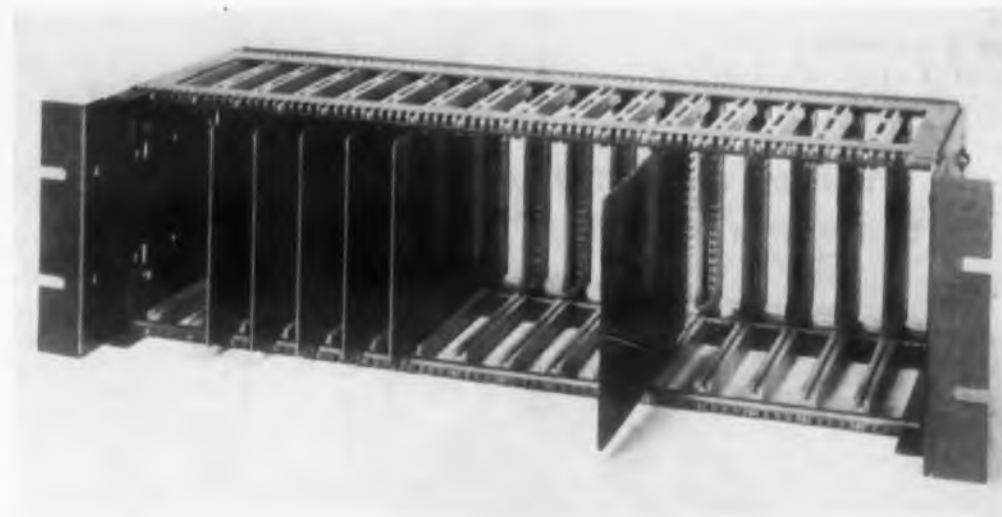
BOOTH 2806 - I. R. E.

**How you can solve
your earth-bound
space problems
... and others ...
with versatile**

VARIPAK

"Varipak" is designed to be adapted to any packaging technique utilizing printed or etched circuitry; and to provide maximum density from shelf-stocked parts. It holds boards and p. c. connectors in alignment; is fabricated in 5 standard sizes of which one (9006-02) is the most common; is a stock item permitting immediate delivery. "Varipak" consists of only 4 major parts: (1) *Mounting Hanger*—Available as standard in five sizes for the following nominal panel heights: 4 $\frac{1}{8}$ ", 5 $\frac{1}{4}$ ", 7", 8 $\frac{1}{4}$ " and 10 $\frac{1}{2}$ ". Elongated slots permit adjustment of cage height to suit odd p. c. board sizes. Other sizes and shapes available on request. (2) *Guide Plate*—has 82 rectangular holes at top and bottom at .200 spacing for fastening guides. Any of these positions may be selected. The greatest density possible is 41 guides at .400 spacing. Any equal or variable spacing can be selected to suit the particular space required for components of the p. c. boards. (3) *"Varipak" Guides*—made of rubberized polystyrene and offer excellent dielectric properties combined with high mechanical strength. Guides are designed to snap into place at any of the 82 positions provided; and are available for 3 p. c. board thicknesses: 1/16", 3/32" and 1/8".

Standard Rack, front view, into which four "Varipaks" have been mounted.



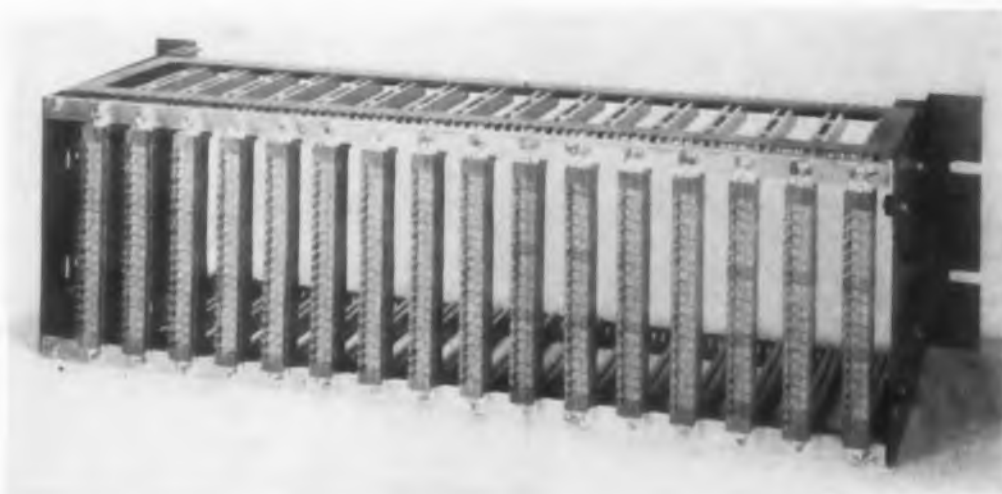
PRINTED - CIRCUIT CARD ENCLOSURES

(1) *Connector Panel*—Can be provided with slots for front or back mounting of connectors. Tooling to provide these slots for all Elco's p. c. connectors (5002, 5004, 6001, 6002, 6003, 7001, 7004) is on hand. Other slot sizes for other connectors can be made easily upon request. It is also possible to mount connectors directly to Guide Plate with the help of special mounting straps tailored to your needs. Instead of metal connector panel, a p. c. back panel can be used to mount p. c. connectors directly. A score of Elco p. c. connectors and contacts may be used for such application. "Varipak" is made of steel .062 thick, painted grey. Where weight is a factor, "Varipak" can be supplied in aluminum. In addition, "Varipak" is designed to meet all EIA standards; and passes vibration requirements per MIL 202A. For further specifications

... REQUEST TECHNICAL BULLETIN A-2 TODAY!



Standard Rack, rear view, showing three methods of employing the "Varipak."



IF IT'S NEW... IF IT'S NEWS... IT'S FROM

ELCO CORPORATION

"M" St. below Erie Ave., Phila. 24, Pa., CU 9-5500

Elco-Pacific: 3260 Motor Ave., Los Angeles, Cal., TEXAS 0-3000

CIRCLE 116 ON READER-SERVICE CARD

NEW PRODUCTS

Trimmer Potentiometer Operates from -55 to +225 C



A moisture proof, rectilinear unit, the Aceohm trimmer potentiometer meets MIL-E-5272A and MIL-STD-202A specifications and operates from -55 to +225 C. Fully adjustable through 25 turns, the unit features an anti-jam overtravel limiting device, straight line dual contacts, and welded construction throughout. Available in a wide range of resistances, it has a rated power of 1.6 w at 40 C and 0.13% resolution.

Ace Electronics Associates, Inc., Dept. ED, 99 Dover St., Somerville 44, Mass.

CIRCLE 117 ON READER-SERVICE CARD

Digital Voltmeters

Provide remote readout



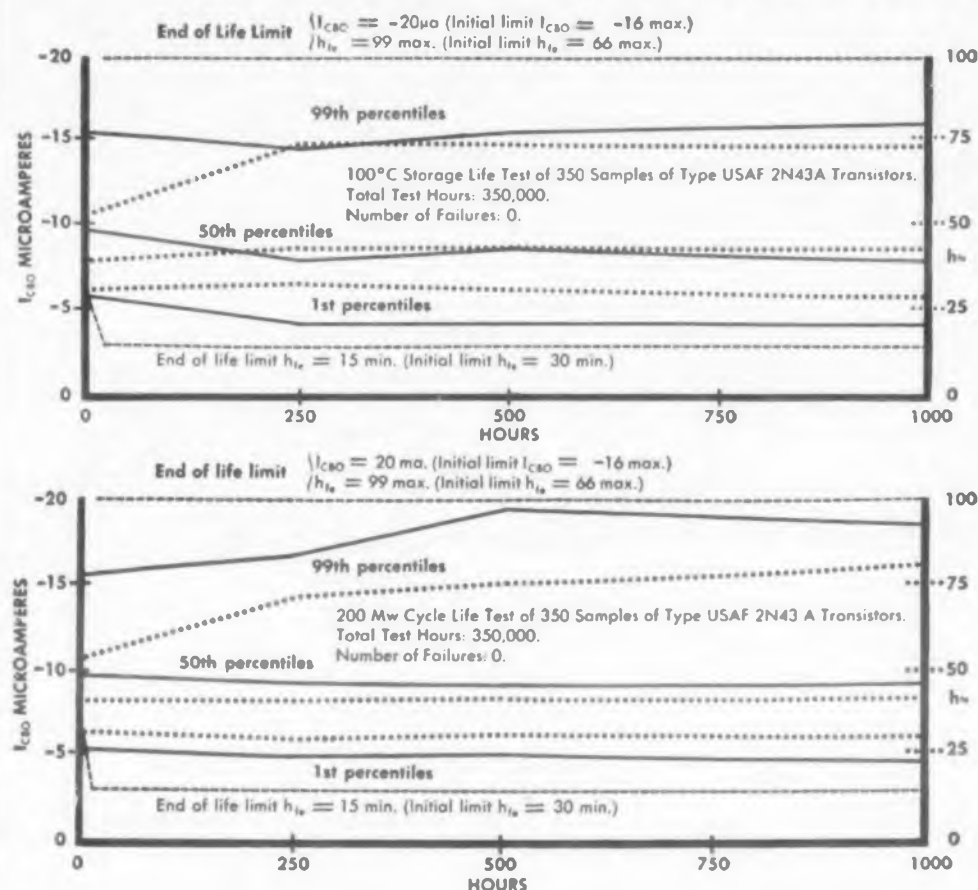
Series D Digicorders measure millivolts with both a digital visual indication and direct remote electrical readout. Full scale ranges of 0 to 10 mv, 100 mv, 1 v, 10 v, and 100 v are available without the use of external amplifiers. Operating from 110 v, 60 cps, the units have a sensitivity of 2.5 mv and an accuracy of 1 part in 1000. They are portable and measure 6 x 6.5 x 14.5 in.

Computer Equipment Corp., Dept. ED, 1931 Pontius Ave., Los Angeles 25, Calif.

CIRCLE 118 ON READER-SERVICE CARD

General Electric Semiconductor News

One-million unit-hours without failure



G-E 2N43A LIFE-TEST DATA OBTAINED AT 1000-HOUR POINTS. Upper chart shows results of 100°C storage test (25°C storage test not shown). Lower chart shows results of 200 mw operating test. Broken lines in each chart indicate h_{FE} . Solid lines indicate I_{CBO} in microamperes. After 1000 hours of testing, there were no failures. The 2N43A transistor's high standard of quality is inherent in all G-E germanium PNP audio and switching transistors.



Dick Welch (left), Transistor Evaluation Engineer and Lee Leinweber, Transistor Production Engineering, take readings at cycled-life-test rack. In addition to electrical testing, G-E 2N43A transistors are subjected to all mechanical-test requirements specified in MIL-T-19500/18.

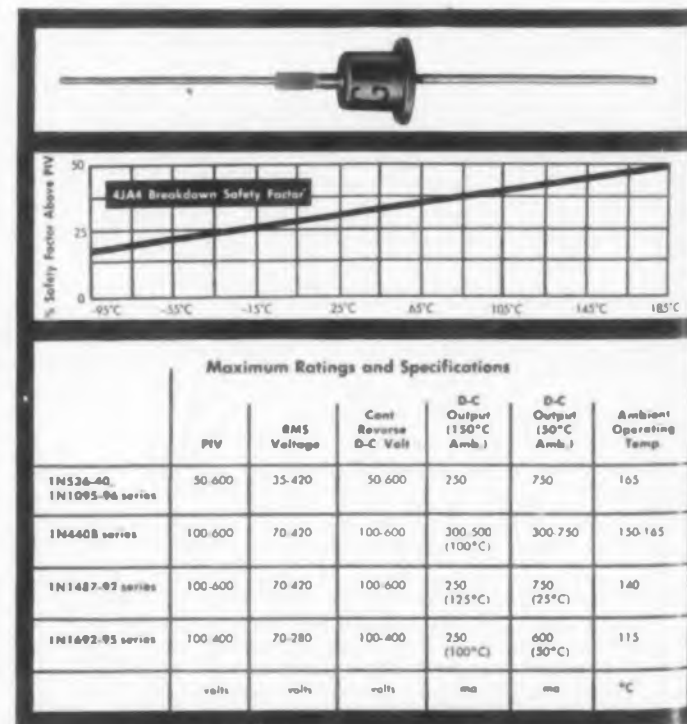
20% Safety Factor for silicon rectifiers aids designers

Designers who now apply their own safety factor to the published peak inverse voltage rating may avoid this step by using G-E low-current silicon rectifiers.

General Electric's PIV figures are set by allowing a 20% safety margin at -65°C. This margin is applied at the point of sharp breakdown voltage and increases with temperature until a maximum safety factor of 33% is reached at 150°C.

If you are derating published PIV figures to provide over-voltage protection, you may be buying costlier cells than you need, or, in series applications, more cells than necessary. Thus the built-in safety margin of G-E low-current silicon rectifiers could save you money. Note: This safety factor is provided for over-voltage protection only. Designs should, in all cases, be maintained within published maximum ratings.

This is only one reason why you should consider G-E low-current silicon rectifiers for all your power requirements. You'll find these devices more attractive to use than ever before—both in quality and price—with equally fine values in low-current silicon stacks. Stud-mounted units are also available. Ask your G-E semiconductor representative for the "big news" on low-current silicon rectifiers.



for General Electric audio transistors

General Electric's 1958 process and quality-control advances were reflected in recent life-test results exhibited by G.E.'s line of germanium PNP audio transistors. Random samples of Type-2N43A transistors were subjected to rigorous mechanical testing . . . drop-shock, detergent-bomb, lead-fatigue (i.e., all the MIL-T-19500/18 mechanical test requirements). Then a total of 1050 Type 2N43A transistors were put on Life Test, with the following results:

350 (10 lots, 35 units each) were given a 100°C storage test for 1000 hours. No failures.

350 (10 lots, 35 units each) were given a 25°C storage test for 1000 hours. No failures.

350 (10 lots, 35 units each) were given a 200 mw cycled-life test for 1000 hours. No failures.

Engineering test data indicate that, without exception, parameters remained stable (see curves at left).

The G-E 2N43A transistor is representative of the outstanding quality built into General Electric's entire line of germanium PNP audio and switching transistors.

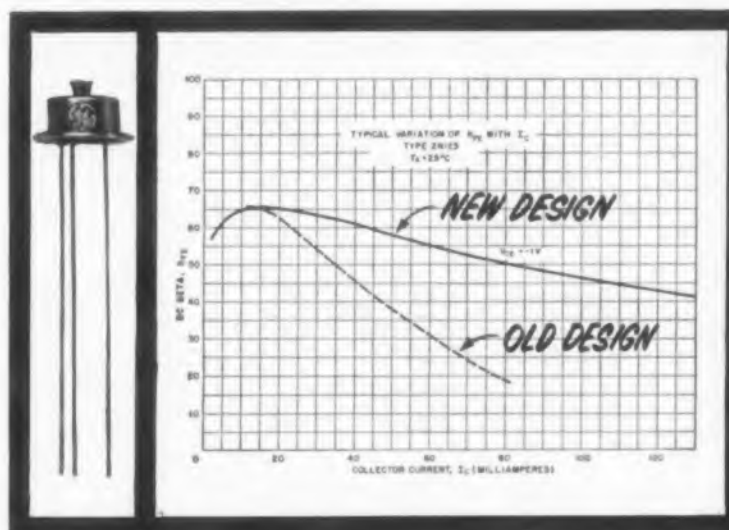
RATINGS: AUDIO AND LOW-FREQUENCY SWITCHING TRANSISTORS								
		2N43	2N43A	2N44	2N44A	2N1056	2N1057	
Collector-to-base Voltage (25°C)	V_{CB}	-45	-45	-45	-45	-60	-45	volts
Collector-to-emitter V. (25°C)	V_{CE}	-30	-30	-30	-30	-75	-45	volts
Total Dissipation (25°C)	P_D	240	240	240	240	240	240	mw
Forward D-c Current Gain, Common Emitter I_C/I_B ($V_{CE} = 1v$; $I_C = 20 ma$)	h_{FE}	53	53	31	31	32	58	
($V_{CE} = 1v$; $I_C = 100 ma$)	h_{FE}	48	48	25	25		52	
Collector Cutoff Current ($V_{CB} = -45v$) ($V_{CE} = 75v$; $I_E = 0$)	I_{CO}	-8	-8	-8	-8		-18	μa
	I_{CO}					-18		μa

NOTE: All figures represent design-center ratings.

High frequency transistors modified for higher Beta

Recent design improvements in high frequency switching transistors (Types 2N123 and 2N250) have improved their d-c beta at higher collector currents. The result is higher gain and improved saturation characteristics at these high currents.

Refinements in quality control tests have also been put into practice on the production line. These units are affected: Types 2N123, 2N450 and the 2N396 series. Units are aged at 100°C for 96 hours to stabilize characteristics. All transistors are subjected to a high-pressure detergent test for hermetic sealing. D-C characteristics are warranted to be within the limits shown on specification sheets. As a result, these transistors are now widely accepted in missile computer work and other rigorous applications.



General Electric Company, Semiconductor Products Dept., Section 523259, Electronics Park, Syracuse, N. Y.

GENERAL ELECTRIC

Frequency Meter

Has 0 to 300 and 0 to 3000 cps ranges

Designed specifically for adjustment of tone selectors in two way communication systems, model T-3 frequency meter can measure the frequency of any periodic function with 1% accuracy. It has two ranges, 0 to 300 and 0 to 3000 cps, and operates on any 60 to 400 cps line.

Jones-Porter Instrument Co., Dept. ED, Box 302, Millburn, N.J.

CIRCLE 120 ON READER-SERVICE CARD

Vibration Test Chamber

-100 to +350 F temperature range



With a free test space of 4 x 4 x 4 ft, this vibration test chamber has an automatically controlled temperature range of -100 to +350 F and is furnished with a flexible diaphragm and a removable insulated plug. For testing with the vibration table in a horizontal position, the diaphragm is inserted in the base aperture of the test space, and the complete installation is rolled over the vibration equipment. For testing with vertical vibration equipment, the diaphragm is inserted in the side aperture and the plug in the bottom.

The American Research Corp., Dept. ED, Farmington, Conn.

CIRCLE 121 ON READER-SERVICE CARD

Decade Counters

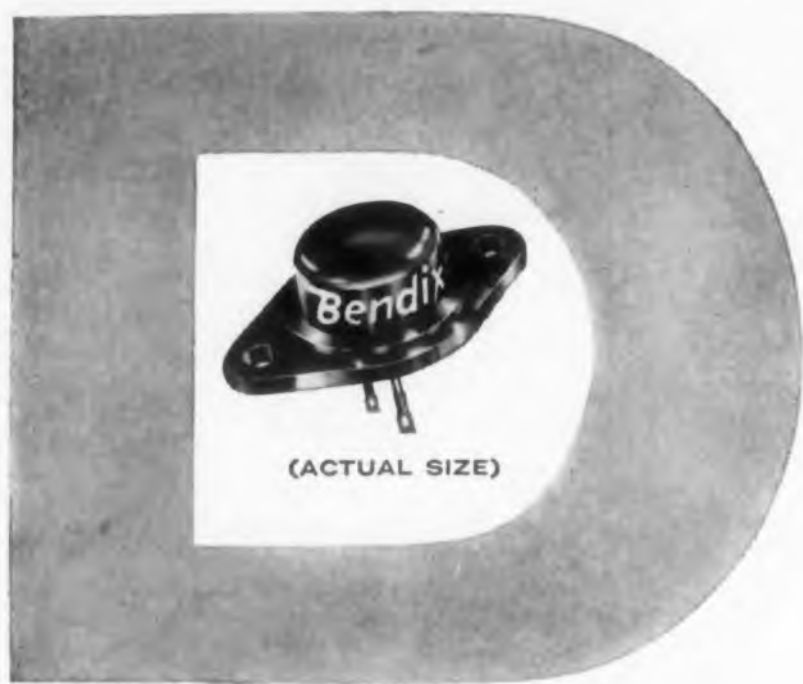
For frequencies to 110 kc

For driving local or remote Nixie indicator tubes, these low cost decade counters have 10 electrical outputs for operation to 100 kc. The DC-106-A provides visual numerical readout at distances to 40 ft; the DC-106-B, remote visual reading. Both are compatible with the company's DC-105 1.1 mc counter.

Burroughs Corp., Electronic Tube Div., Dept. ED, P.O. Box 1226, Plainfield, N.J.

CIRCLE 122 ON READER-SERVICE CARD

CIRCLE 119 ON READER-SERVICE CARD



D I F F U S E D A L L O Y P O W E R T R A N S I S T O R S



Features

Faster Switching Times 0.5-5 μ Sec
 Switching Currents up to 10 amperes
 Flatter Frequency Response 40 Kc
 Higher Breakdown Voltage up to 120 Volts
 Current Gain of 40 at 5 amperes
 Standard Power Transistor Package
 Lower Base Resistance, 2 ohms
 Lower Saturation Resistance, 0.1 ohm

Uses

TV Horizontal Output
 Hi-Fi Amplifiers
 Core Drivers
 High Current Switching
 Power Converters
 Ultrasonic Generators
 Modulators

Because no other transistor offers this combination of features and uses, you will want to try out the DAP transistor in your circuits. Get full details now on new Bendix diffused alloy power transistors by writing SEMICONDUCTOR PRODUCTS, BENDIX AVIATION CORPORATION, LONG BRANCH, NEW JERSEY.

	Ratings		Typical Performance			
	Vdc	Pc (25°C)	B (Ic=5 Adc)	Vs (Ic=5 Adc)	f α	rbb'
2N1073	40	35 W	40	0.5 Vdc	1.5 mc	2 ohms
2N1073A	80	35 W	40	0.5 Vdc	1.5 mc	2 ohms
2N1073B	120	35 W	40	0.5 Vdc	1.5 mc	2 ohms

West Coast Office: 117 E. Providencia Ave., Burbank, Calif.
 Canadian Distributor:
 Computing Devices of Canada, Ltd., P. O. Box 508, Ottawa 4, Ontario
 Export Sales and Service:
 Bendix International Division, 205 E. 42nd St., New York 17, N. Y.

Red Bank Division



CIRCLE 124 ON READER-SERVICE CARD

NEW PRODUCTS

Pushbutton Switch

Life of 1 million operations



Model 7711 pushbutton switch has a mean life of 1 million operations per station. Each station offers up to four type A contacts rated at 100 ma, 150 v dc. Normally supplied with Taper-Tab or solder terminals, the switch may be ganged, interbussed, or cross-interlocked. It is available with lockout and automatic release solenoids and may be plated to withstand humidity and salt spray. The contact material is bifurcated palladium, supported by Perma-nickel full hard heat treated springs.

American Electronics Co., Div. of American-Monarch Corp., Dept. ED, 2801 37th Ave. N.E., Minneapolis 21, Minn.

CIRCLE 125 ON READER-SERVICE CARD

Band Pass Filters

Impedance from 50 to 10,000 ohms



These band pass filters are offered in wide ranges of frequencies with impedance from 50 to 10,000 ohms. They are available with different input and output impedances for matching purposes. Shown in the photograph is model BF-101 which has a 1/2 db attenuation from 40 to 310 kc. Its attenuation is greater than 40 db at 450 kc and above. It has an insertion loss of less than 3/4 db, and has a constant impedance of 50 ohms within the pass band.

Control Electronics Co., Inc., Dept. ED, 10 Stepar Place, Huntington Station, L.I., N.Y.

CIRCLE 126 ON READER-SERVICE CARD

FLIGHT DATA and CONTROL ENGINEERS

Cross new frontiers in system electronics at The Garrett Corporation.

High-level assignments in the design and development of system electronics are available for engineers in the following specialties:

1. ELECTRONIC AND FLIGHT DATA SYSTEMS AND CONTROLS A wide choice of opportunities exists for creative R & D engineers having specialized experience with control devices such as: transducers, flight data computers, Mach sensors, servo-mechanisms, circuit and analog computer designs utilizing transistors, magamps and vacuum tubes.

2. SERVO-MECHANISMS AND ELECTRO-MAGNETICS Requires engineers with experience or academic training in the advanced design, development and application of magamp inductors and transformers.

3. FLIGHT INSTRUMENTS AND TRANSDUCERS

1) **DESIGN ANALYSIS** Requires engineers capable of performance analysis throughout preliminary design with ability to prepare and coordinate related proposals.

2) **DEVELOPMENT** Requires engineers skilled with the analysis and synthesis of dynamic systems including design of miniature mechanisms in which low friction freedom from vibration effects and compensation of thermo expansion are important.

4. PROPOSAL AND QUALTEST ENGINEER For specification review, proposal and qualtest analysis and report writing assignments. Three years electronic, electrical or mechanical experience required.

Forward resume to:

Mr. G. D. Bradley

THE GARRETT CORPORATION

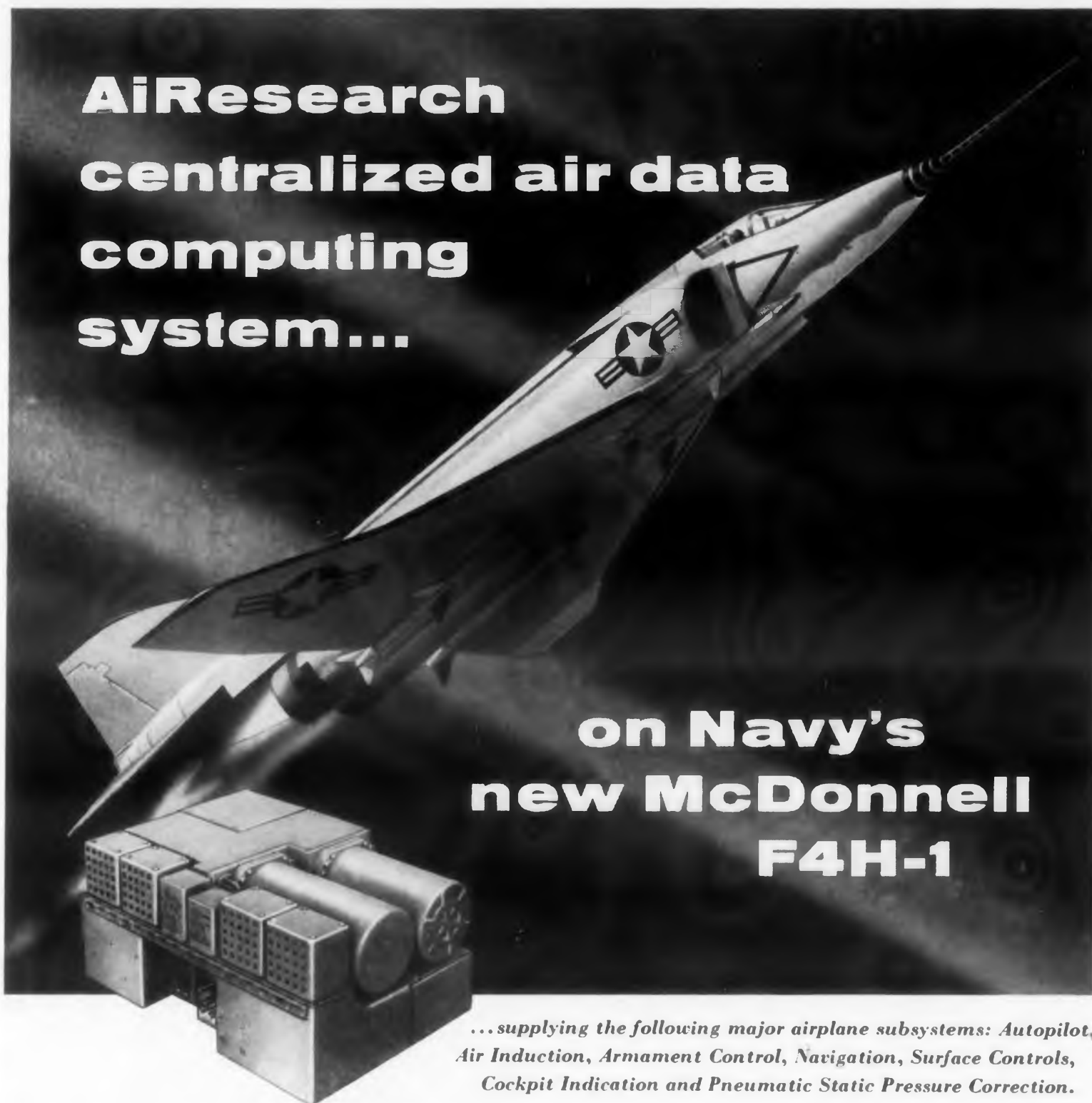
9851 S. Sepulveda Blvd.
Los Angeles 45, Calif.

DIVISIONS:

AiResearch Manufacturing—Los Angeles
AiResearch Manufacturing—Phoenix
AiResearch Industrial
Air Cruisers • Airsupply
Aero Engineering
AiResearch Aviation Service

CIRCLE 870 ON READER-SERVICE CARD

AiResearch centralized air data computing system...



on Navy's new McDonnell F4H-1

...supplying the following major airplane subsystems: Autopilot, Air Induction, Armament Control, Navigation, Surface Controls, Cockpit Indication and Pneumatic Static Pressure Correction.

The AiResearch centralized air data computing system integrates pneumatic, electronic, electrical and mechanical components on one of the Navy's fastest jets. It senses, measures, and automatically corrects all air parameters affecting flight. It supplies air data information to the pilot and all major airplane subsystems.

This centralized combination of transducers, computers and indicators is the

most complete air data computing system ever devised. It enables aircraft to operate at maximum efficiency continuously.

Eliminating duplication of components, the AiResearch centralized air data computing system cuts down space and weight requirements over decentralized systems by many times. Its principal functions: angle of attack, true static pressure (electrical and pneumatic), true air speed,

true Mach, altitude, rate of climb, total temperature, dynamic pressure and altitude and Mach error.

AiResearch has been the leader in the development of centralized computing systems. The F4H-1 installation is the first, single package air data computer possessing completely interchangeable, modular construction.

Your inquiries are invited.

THE GARRETT CORPORATION
AiResearch Manufacturing Divisions

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Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS
CIRCLE 127 ON READER-SERVICE CARD

PLAIN FLANGE BRACKET STUD

POWER REQUIRED — MODEL 650
300 MW. FOR 5 MILLISECONDS
at 6, 12, 24 and 48 V. D.C.

CONTACT RATINGS —
2 A. at 28 V. D.C.
OR 115 V. A. C.

VIBRATION IMMUNITY —
30 G'S UP TO 2000 CPS

SHOCK — 100 G'S

MINIMUM LIFE — 100,000 OPERATIONS
AT 125° C

Micro-Miniature Latching Relays by Iron Fireman

5 MS PULSE AT 300 MW:

This very short burst of power and the shock and vibration immunities shown above are features of the newest addition to the Iron Fireman line of micro-miniature relays.

The model R650 relay was designed specifically to meet requirements when operating power is at a pre-

mium and ruggedness and dependability are essential.

Conforming to and exceeding the test specifications of MIL-R-5757C, the performance and reliability of the R650 relay is assured by the use of high temperature materials and a unique permanent magnetic structure.

Complete performance data available on request. Write to the address below.



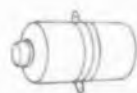
MICRO
MINIATURE
RELAYS



HIGH
SPEED
RELAYS



SLIP RINGS
AND
BRUSHES



FREE AND
VERTICAL
GYROS



IRON FIREMAN *Electronics* **DIVISION**

2838 S. E. NINTH AVENUE, PORTLAND 2, OREGON

CIRCLE 130 ON READER-SERVICE CARD

NEW PRODUCTS

Electronic Counters

Reads to 12,000 cpm



Capable of counting speeds to 12,000 cpm, Model 1000-B combines a plug-in electronic decade with a five-digit mechanical register. With an accuracy of ± 1 count, the unit will respond to electrical pulses with a peak amplitude of ± 2.5 v. The counter operates on from 105 to 125 v ac.

Performance Measurements Co., Dept. ED, 15301 W. McNichols, Detroit 35, Mich.

CIRCLE 128 ON READER-SERVICE CARD

Panel VTVM

1 meg input impedance



Designed for use in aircraft, missiles, and ground support equipment, model SPD-25 panel vtvm occupies 2-3/4 x 2-1/2 in. of panel space. Less than 6 in. deep, it is held in place with three meter screws. Completely self-contained, the unit is available in any range between 0 to 30 mv and 0 to 300 v. Frequency response is 40 cps to 50 kc; input impedance is 1 meg, 15 μ f; and accuracy is $\pm 3\%$. Stability with 10% change in line voltage is better than 2%. The unit operates on power of 400 cps, 115 v ac, single phase. It is designed to meet MIL-T-945A specifications.

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

CIRCLE 129 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 18, 1959

Pressure Transducer

Provides 0 to 5 v dc output



Suitable for telemetering applications, static test stands, and data systems, this pressure transducer is available in gage, absolute, and differential models. Providing 0 to 5 v dc output at constant impedance, it offers continuous resolution, low hysteresis, good linearity, and high natural frequency. The unit contains a solid state carrier oscillator and demodulator combined with a variable reluctance pickup.

Wiancko Engineering, Dept. ED, 255 N. Halstead, Pasadena, Calif.

CIRCLE 131 ON READER-SERVICE CARD

Time Delay Relay

Stands 20 g vibration



Engineered to withstand continuous 20 g vibration at frequencies up to 1000 cps, this hermetically sealed thermal time delay relay has a seated height of only 7/8 in. above the mounting panel. Contacts are spdt, either normally open or normally closed. Rating is 2 amp resistive at 115 v ac, or 28 v dc. Relays are offered in ten factory set and sealed delays which range from 2 to 75 sec. Heater voltages are either 6.3, 28, or 115 v. Non-standard delays and heater voltages are available on special order.

G-V Controls, Inc., Dept. ED, Okner Parkway, Livingston, N.J.

CIRCLE 132 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 18, 1959

NEW TI DIFFUSED-BASE



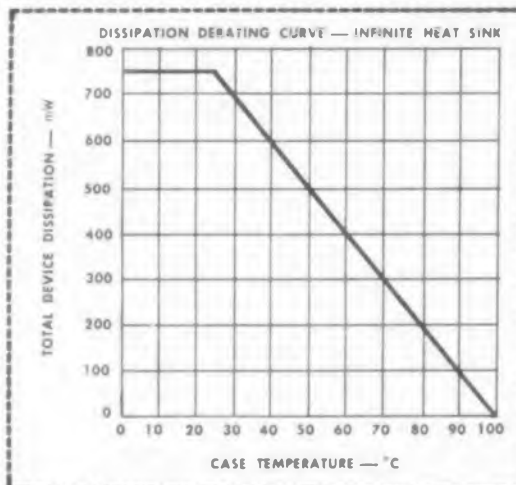
750 MC • 750 mW

HIGH FREQUENCY TRANSISTORS

Guaranteed current gains of 12, 10 and 8 db minimum at 100 mc with new TI 2N1141, 2N1142 and 2N1143 diffused-base "mesa" germanium transistors! Alpha cutoff ratings up to 750 mc coupled with 750 mW power dissipation at 25°C case temperature make these newest TI transistors ideal for military VHF power oscillators and amplifiers where assured reliability and performance are of primary importance.

All units are 100% production stabilized at temperatures well above their 100°C rated junction operating point... far exceed MIL-T-19500A specifications... and are *in stock now*.

Contact your nearest TI sales office or nearby TI distributor today... *for immediate delivery*.



absolute maximum ratings @ 25°C case temperature

	2N1141	2N1142	2N1143	
Collector Voltage Referred to Base	-35	-30	-25	V
Emitter Voltage Referred to Base	-1	-0.7	-0.5	V
Collector Current	-100	-100	-100	mA
Emitter Current	100	100	100	mA
Device Dissipation (infinite heat sink)	750	750	750	mW
Collector Junction Temperature	+100	+100	+100	°C
Storage Temperature Range	-65 to +100			°C
Thermal Resistance Junction to Mounting Base	0.1	0.1	0.1	°C/mW

typical characteristics @ 25°C case temperature

Frequency Cutoff (Common Base)	750	600	480	MC
Collector Reverse Current, $V_{CB} = -15V, I_E = 0$	1	1	1	μA
Saturation Voltage, $I_C = -70mA, I_E = 17.5mA$	2	2	2	V
Small Signal Short Circuit Forward Current Transfer Ratio, $V_{CB} = -10V, I_C = -10mA, f = 1000cps$	0.97	0.97	0.97	

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CIRCLE 569 ON READER-SERVICE CARD

**IMPROVED
CHARACTERISTICS**

**...OF
SPECIAL
INTEREST
TO EVERY
ENGINEER**

DELCO HIGH POWER TRANSISTORS



UNEXCELLED FOR SWITCHING, POWER HANDLING, EFFICIENCY, RELIABILITY

TYPICAL CHARACTERISTICS AT 25°C.

	2N1100	2N1099	2N174A	2N174	2N173	2N278	2N277	2N443	2N442	2N441
Maximum Collector Current	15	15	15	15	15	15	15	15	15	15 amps
Maximum Collector Voltage (Emitter Open)	100	80	80	80	60	50	40	60	50	40 volts
Saturation Resistance	.02	.02	.02	.02	.03	.03	.03	.03	.03	.03 ohms
Thermal Gradient (Max.) (Junction to Mounting Base)	.8	.8	.8	.8	.8	1.0	1.0	1.0	1.0	1.0 °C/watt
Base Current I_b ($V_{EC} = 2$ volts, $I_c = 5$ amps)	135	100	135	135	100	100	100	150	150	150 ma
Collector to Emitter Voltage (Min.) Shorted Base ($I_c = .3$ amps)	80	70	70	70	50	45	40	50	45	40 volts
Collector to Emitter Voltage Open Base ($I_c = .3$ amps)	70	60	60	60	50	45	40	55	45	40 volts

*Designed to meet MIL T-19500 13A (Jan) 8 January 1958 †Formerly DT100 ‡Formerly DT80

Check your requirements against the *new, improved* characteristics of Delco High Power transistors. You will find improved collector-to-emitter voltage . . . higher maximum current ratings—15 amperes, and extremely low saturation resistance. Also, note the new solid pin terminal design.

And of special importance to you is the fact that diode voltage ratings are at the maximum rated temperature (95°C.) and voltage.

Write today for engineering data on the *new, improved* characteristics of *all* Delco High Power transistors.

DELCO RADIO

Division of General Motors • Kokomo, Indiana

BRANCH OFFICES

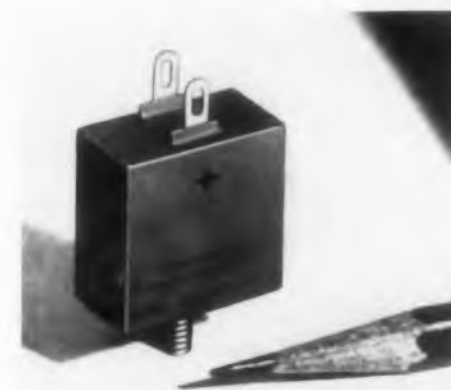
Newark, New Jersey
1180 Raymond Boulevard
Tel: Mitchell 2-6165

Santa Monica, California
726 Santa Monica Boulevard
Tel: Exbrook 3-1465

CIRCLE 134 ON READER-SERVICE CARD

NEW PRODUCTS

Selenium Rectifiers Encapsulated



Encapsulated to provide optimum heat dissipation, type QM50 selenium rectifiers can withstand high current and voltage surges. Designed for small radio, phonograph, relay, and other power supply applications, they have a rectified dc output current rating of 50 ma with a maximum rms input voltage of 130 v. Their rugged, phenolic-encapsulated package completely seals the rectifier cell surfaces to assure insulation from other chassis components. Stud mounted, the units have terminal lugs which may be plugged directly into printed circuit boards.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.

CIRCLE 135 ON READER-SERVICE CARD

Crystal Can Relay

Four pole unit



A four pole crystal can relay, type AR comes with dry circuit to 2 amp contact ratings and nominal operating voltages up to 115 v dc. It withstands vibration of 2000 cps and temperature of 125 C. With header leads arranged on a 1 10 in. grid and several case styles available, the unit is compatible with printed circuits, miniature packaging, and micromodular construction.

Branson Corp., Dept. ED, 41 S. Jefferson Rd., Whippany, N.J.

CIRCLE 136 ON READER-SERVICE CARD

EXPANDING
THE
FRONTIERS OF
SPACE
TECHNOLOGY
... Reconnaissance



(above) Setting up a diffraction image for a research study in near-infrared optics



(bottom left) Research and Development facility in the Stanford Industrial Park at Palo Alto, California, provides the latest in technical equipment



(bottom right) Nation's first successful re-entry tests were conducted with the Lockheed X-17

Lockheed
MISSILES AND SPACE
DIVISION

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

Lockheed Missiles and Space activities in reconnaissance are among the most advanced in industry. They include such areas as radar, optics, infrared and TV. Work in the fields of radar and data link is concerned with research, design and development of systems and equipment for missile tracking, command guidance, detection and relay of information. Noise modulation techniques are under study as part of statistical communication theory and implementation of automatic space communication systems. Of special significance is the development of a radar firing error indicator that measures the intercept trajectory between target and attacking missile. Solid state work in infrared embraces the devel-

opment of new systems and sub-systems for long range infrared communications, surveillance, range findings and target tracking. Considerable work is being conducted in optical devices and systems employing optics. Capability in this area also extends to scanners, encoders, detectors, read-out devices, and analytics of information processing.

Opportunities exist for engineers and scientists of inquiring mind to contribute to the solution of new problems in these fields. If you are experienced in physics, mathematics, chemistry, or one of the engineering sciences, we invite your inquiry. Write: Research and Development Staff, Dept. B-21, 962 W. El Camino Real, Sunnyvale, California.

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

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Find the missing memory plane

The seven memory planes above each solved some special memory problem. There is one plane missing. It's the one which will solve your problem. You'll find the plane at General Ceramics which offers a complete memory plane service, backed by broad experience in the design, engineering and mass production of planes, frames and cores.

DESIGN SERVICE—An experienced design engineering staff stands ready to analyze your memory plane requirement, recommend and develop the plane that will meet your application in the most efficient and least expensive manner.

MANUFACTURE—Skilled factory personnel, utilizing the most advanced equipment and techniques and continually working in all phases of memory plane development and manufacture will produce the plane. General Ceramics has developed and

wired memory planes containing from 64 to 16,384 cores each. (Core sizes range from 50 mil OD to 80 mil OD.)

QUALITY CONTROL—An expanded testing department with fully automatic and semi-automatic testing equipment, developed at General Ceramics, assures you complete quality control and the highest standards of manufacture.

STANDARD LINE—Perhaps some of General Ceramics' line of standard memory frames will meet your requirements. Write for literature on General Ceramics standard planes. Address inquiries to General Ceramics Corporation, Keasbey, N. J.—Dept. .D.

GENERAL CERAMICS

ORIGINATOR OF THE SQUARE LOOP FERRITE

Manufacturers of FERRAMIC CORES, MAGNETIC MEMORY CORES, MEMORY PLANES, MICROWAVE FERRITES, SOLDERSEAL TERMINALS, HIGH TEMPERATURE SEALS, STEATITE, ALUMINA and CHEMICAL STONWARE

NEW PRODUCTS

Centrifugal Blowers

Low flow



Series 300 blowers provide high efficiency at low flows and pressures of up to 110 in. of water. They are 4 in. wide, 5-1/2 in. long, and weigh 2-1/2 lb including motor. The illustrated unit generates 55 in. of water pressure at 2 psi with a flow of 7 to 20 cfm. Its twin blowers are driven by a 1/10 hp, 400 cps ac motor or a 1/10 hp, 12 or 24 v dc motor.

Sawyer-Bailey Corp., Dept. ED, 1559 Niagara St., Buffalo 13, N.Y.

CIRCLE 138 ON READER-SERVICE CARD

Trimmer Potentiometer

1/2 in. long

For plug-in use in high temperature circuitry, trimmer potentiometer model H-0621-T is 5/8 in. in diameter with a body length of 1/2 in. In resistance values up to 100 K, it is capable of 150 C operation at rated load. The brush contact and winding can carry 4 ma of current. The unit meets the humidity requirements of MIL-STD-202, Method 106 and can withstand 150 g shock and 30 g vibration from 50 to 2000 cps. External bushing has been eliminated, and the only extension is the 0.02 in. shaft extension.

Tucson Instrument Corp., Dept. ED, 1050 E. Valencia Rd., Tucson 2, Ariz.

CIRCLE 139 ON READER-SERVICE CARD

◀ CIRCLE 137 ON READER-SERVICE CARD

Stepping Motors

Prevent double indexing

Available in unidirectional and bidirectional units, MotoStep and MotoSwitch stepping motors cannot double index during shock, vibration or overvoltage. The MotoSwitch model contains a 10-point etched circuit precision stepping switch. In the bidirectional units, two identical stepping motors are used to drive the same shaft in opposite directions. The output shaft is rotated 36 deg for each input impulse, up to 40 steps per sec. Both units come in standard 24, 48, and 90 v dc and 110 v ac voltages with maximum input power ratings of 12 w for dc models and 15 w for ac models. In sealed, dustproof cases, they are 2.31 in. high, 3.06 in. wide, and 2.11 or 3.67 in. deep.

Telecomputing Corp., Data Instruments Div., Dept. ED, 12838 Saticoy St., North Hollywood, Calif.

CIRCLE 140 ON READER-SERVICE CARD

Scaler System

Preset count from 20 to 10⁷

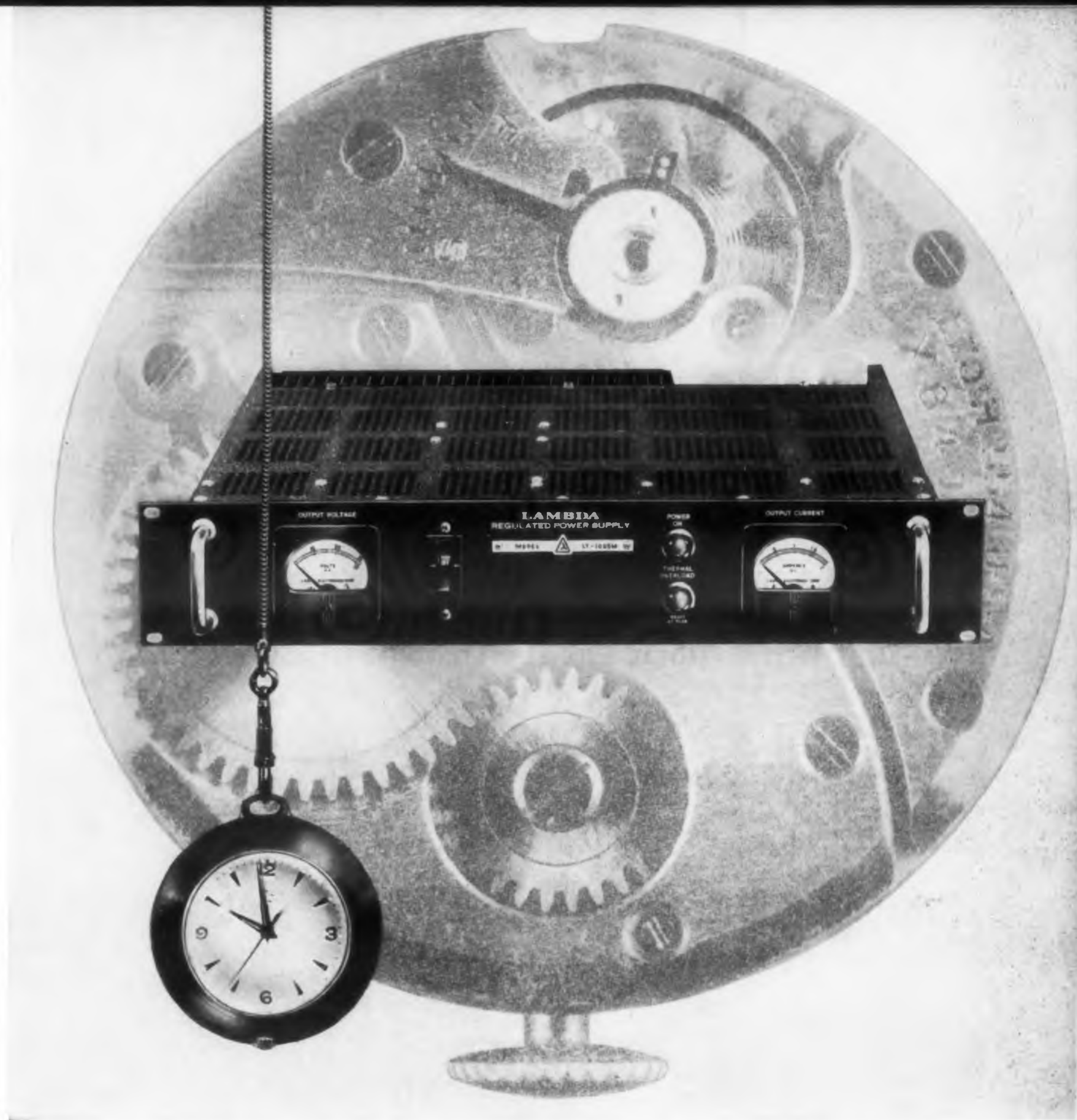


Used with an external decimal printer, model 49-4 scaler amplifier is a fully automatic counting system with preset count from 20 to 10⁷ and preset time from 0.02 to 1000 min. It stops scaling at a preset count or time, whichever occurs first. If the count is first, it prints elapsed time; if the time is first, it prints count data. After printout, the system automatically resets and starts anew.

Radiation Instrument Development Lab, Inc., Dept. ED, 5737 S. Halsted St., Chicago 21, Ill.

CIRCLE 141 ON READER-SERVICE CARD

CIRCLE 142 ON READER-SERVICE CARD



Guaranteed: around-the-clock performance for five years

Freedom from worry about major maintenance or extensive replacement for *five full years*. That's the guarantee given with every Lambda power supply—the first such guarantee in the electronics industry. It proves the point engineers keep making in preference studies: When operating conditions make dependability a "must," they specify Lambda...

LAMBDA POWER SUPPLIES

LAMBDA ELECTRONICS CORP., 11-11 131 STREET, COLLEGE POINT 56, N. Y.

Send
for New
1959 Catalog



The strong ^{REG. U.S. PAT. OFF.} **SCOTCH** No. 27 Glass Cloth Electrical
BRAND

Tape  in this mercury lamp stabilizer transformer coil costs 12 cents.

It insures trouble-free operation under rugged conditions for a minimum of 20 years.

Annual insulation cost: 6/10¢!



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Electrical Tapes

For complete information on "SCOTCH" BRAND No. 27 Glass Cloth Electrical Tape, write on your letterhead to 3M Co., St. Paul 6, Minn., Dept. ON-29.

SCOTCH IS A REGISTERED TRADEMARK FOR THE PRESSURE SENSITIVE ADHESIVE TAPES OF 3M CO., ST. PAUL 6, MINN. EXPORT: 99 PARK AVE., NEW YORK 16, CANADA: LONDON, ONTARIO.

MINNESOTA MINING AND MANUFACTURING COMPANY

... WHERE RESEARCH IS THE KEY TO TOMORROW



CIRCLE 143 ON READER-SERVICE CARD

NEW PRODUCTS



Zipper Y's and T's

Make waterproof cable assemblies

Designed for instant construction of waterproof cable assemblies, these Y's and T's zip around wire bundles at branchout points. They are joined to the rest of the cable with high temperature tapes or potting compounds. When the potting method is used, the Y or T serves as a flexible mold and the compound is poured inside. Available in a variety of materials and colors, the harnesses are furnished in ID's of 1/2 in. up in increments of 1/8 in. A liquid sealer may be provided to permanently fuse the zippered head.

The Zippertubing Co., Dept. ED, 752 S. San Pedro St., Los Angeles 14, Calif.

CIRCLE 144 ON READER-SERVICE CARD

Cathode Ray Tube

7 in. long



Electrostatically focused and deflected, model 3YP cathode ray tube has a rectangular face 1-1/2 x 3 in. and an overall length of 7 in. It can be operated at anode potentials of 500 to 2750 v with vertical and horizontal sensitivities of 26 and 40 v dc per in., respectively. The tube is available with P2, P7, and P11 phosphors.

Waterman Products Co., Dept. ED, 2145 Emerald St., Philadelphia, Pa.

CIRCLE 145 ON READER-SERVICE CARD

Transistorized Gaussmeter

Measures flux fields up to
30,000 gauss

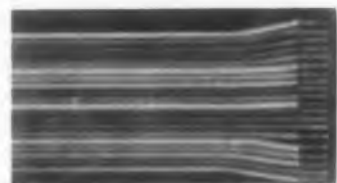
Completely transistorized and modified to operate on either a 105 to 125 v power supply or internal batteries, the D-855 gaussmeter provides accurate measurement of flux fields up to 30,000 gauss. It measures flux density, determines flow direction, locates and measures stray fields, plots variations in strength, and checks production lots against a standard. It can be equipped to measure the earth's field flux density. The unit measures 13-1/2 x 8-3/4 x 7-1/4 in. and utilizes a probe 0.025 in. thick with an active area of 0.01 sq in.

Dyna-Empire, Inc., Dept. ED,
1075 Stewart Ave., Garden City,
N.Y.

CIRCLE 146 ON READER-SERVICE CARD

Flat Bonded Cable

Wide range of sizes



A flat, bonded cable, Codastrap is color coded and comes in a wide variety of sizes. Different wire sizes can be combined in the same cable.

Phalo Plastics Corp., Dept. ED,
330 Boston Turnpike, Shrewsbury,
Mass.

CIRCLE 147 ON READER-SERVICE CARD

Photoelectric Control

Tubeless

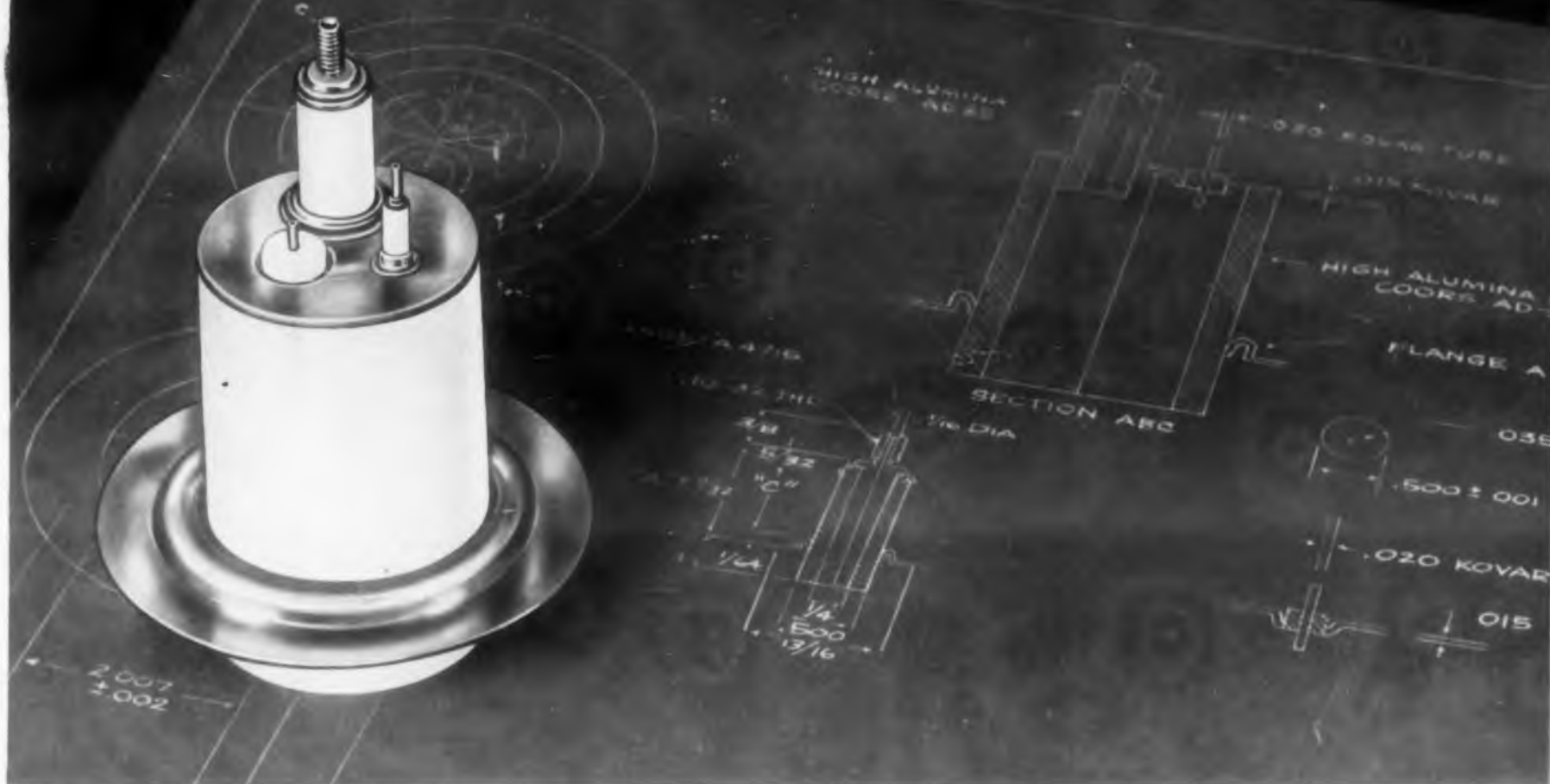
Using a cadmium cell sensing element with magnetic amplifier, tubeless model BMI photoelectric control requires 10 ft-c with 0.04 sec minimum dark and light time. Delay contacts are dpdt, rated 10 amp at 115 v ac, noninductive load.

Autotron, Inc., Dept. ED, P.O.
Box 722, Danville, Ill.

CIRCLE 148 ON READER-SERVICE CARD

CIRCLE 149 ON READER-SERVICE CARD

Coors high strength ceramic-to-metal assemblies



COORS CAN FURNISH COMPLETE CERAMIC-TO-METAL ASSEMBLIES TO YOUR SPECIFICATIONS

The finest in manufacturing facilities and technical know-how are available to you at Coors—whether your requirement calls for a simple terminal bushing or a complex assembly of ceramic and metal parts. Coors high strength ceramic parts, metalized using high temperature techniques, are brazed to metal parts to provide the combination of physical, electrical and heat resisting characteristics needed for so many appli-

cations today.

Ceramic-to-metal bond strengths range normally from 9,000 to 12,000 p.s.i.—or higher depending on design. Brazes can be made at temperatures as high as 1083°C (1981°F.) using copper.

Extremely close dimensional tolerances can be maintained where Coors manufactures the ceramic components, does the metalizing and makes the final assembly of the

ceramic and metal parts. Also, this places responsibility in one place.

However, for those who do their own assembly work, Coors will supply the ceramic parts only—either plain or metalized.

Coors engineers will help you work out the mechanical design details of your metalized ceramic parts or ceramic-to-metal assemblies. Contact us at the earliest possible stage of design in order to save time.

COORS PORCELAIN COMPANY

GOLDEN, COLORADO

Manufacturers of

COORS SPACE AGE CERAMICS

COORS PORCELAIN CO., 600 9th St., Golden, Colo.

Please have your sales engineer see me to discuss ceramic-to-metal assemblies.

Name.....Title.....

Company.....

Address.....

City.....State.....

Please refer to our 12-page catalog in Sweet's Product Design File

NEW PRODUCTS

Speed Controls

For larger fhp motors

Heavy duty Zero-Max speed reducers provide infinitely variable speed from 0 to 400 rpm and a constant torque of 60 or 100 in. lb delivered from 1/2 or 3/4 hp motors, respectively. They feature accurate repeating of speeds and instant speed changes whether the units are running or not. They will also serve as clutches going to zero rpm. The output shafts drive in either direction and are free wheeling in the direction of drive. Available with or without motors, the units alone are approximately 6 x 8 x 12 in. The basic motor is an open frame, drip proof, 60 cps, 115 or 230 v, single phase, capacitor start unit.

Reveco Inc., Dept. ED, 1900 S. Lyndale Ave., Minneapolis 5, Minn.
CIRCLE 150 ON READER-SERVICE CARD

Variable Capacitance Diodes

Cutoff frequencies to 60 kmc



Diffused silicon pn junction diodes, Varactors are designed to be variable capacitances with low loss at high frequencies. In the standard MA-460 series, the pin end of the diode is connected to p-type material, and the n-side of the silicon element is connected to the base. MA-450 units are mechanically reversible. The diodes fit most standard crystal holders and have minimum cutoff frequencies to 60 kmc.

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

CIRCLE 151 ON READER-SERVICE CARD

Continental

LEADING THE ELECTRONIC INDUSTRY IN CONNECTORS FOR

STANDARD SERIES

MICRO-MINIATURE — Ultra miniaturization without performance loss. Ruggedized to withstand shock and vibration extremes. Available with 5, 7, 9, 11, 14, 20, 26, 29, 34 and 44 contacts for #22 AWG wire. 3 amps, 1800V RMS.



SERIES MM-22
ACTUAL SIZE



SERIES SM 20
ACTUAL SIZE

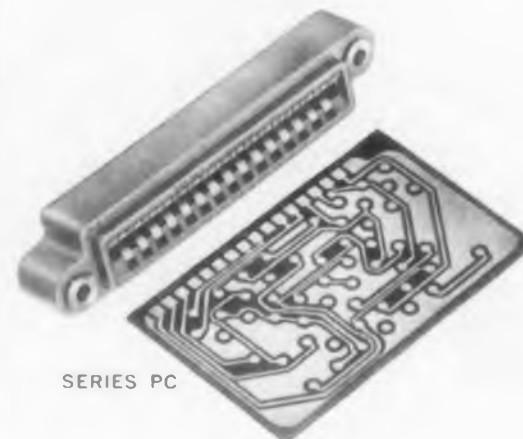
SUB-MINIATURE — A rugged component, ideal where space and weight are at a premium. Available with 5, 7, 11, 14, 20, 26, 34, 42 and 50 contacts for #20 AWG wire. 5 amps, 1900V RMS.

QUICK RELEASE* — Spring loaded pin contacts eliminate pulling and prying. Prevent damage to contacts. Up to 34 contacts for #16 or #12 AWG wire. 10 amps, 4500V.



SERIES E Z

*Pat. No. 2,736,870



SERIES PC

PRINTED CIRCUIT — Provide a direct connection of wiring to printed circuitry. For 1/16", 1/32", and 1/8" boards. Carry up to 58 new "BELLOWS ACTION," bifurcated contacts for utmost reliability. Various terminations including wire wrap, solder lug and taper pin are available.

SPECIAL ACCESSORIES

POLARIZING SCREW-LOCKS* — Prevent accidental disconnection due to vibration. Available in Micro-Miniature, Sub-Miniature and Miniature connectors.



*Pat. No. 2,746,022



PROTECTIVE ALUMINUM SHELLS — Complete protection against physical damage. For Miniature and Sub-Miniature series. With or without stainless steel polarizing screw-locks.

You can rely on Continental Connectors to solve any precision connector problem.

MOLDING COMPOUNDS — The following molding compounds are available: Melamine, Mineral filled, Plaskon, Glass filled, Diallyl Phthalate, Orlon filled, Diallyl Phthalate, Mineral filled, Phenolic Mica and Silicone Glass.

SPECIAL APPLICATION PROBLEMS — You are invited to present your special application problems to our engineers for intensive study, consultation and prototypes. Write for tech-

nical literature on any of the connectors illustrated above.

NEW CLOSED RING ENTRY CONTACT — Extremely high reliability. Solid ring limits contact expansion to maximum tolerance of pin diameter. Cannot be forced out of shape. Maintains low mv. drop under constant and uniform insertion pressure.

Connectors

GUIDED MISSILES, COMMUNICATIONS, AND COMPUTERS

MINIATURE — A compact, lightweight connector available with a wide range of contacts from 4 to 104. Types available with coaxial contacts — 50-ohm or 70-ohm matched impedance.

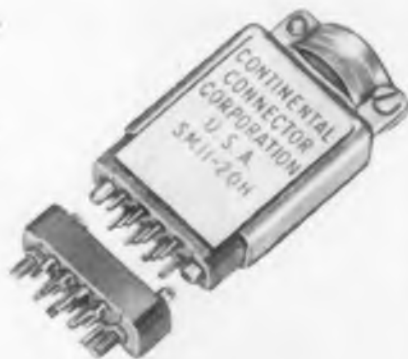


SERIES 20
ACTUAL SIZE

RIGHT ANGLE PRINTED CIRCUIT — Pin and socket connectors for dip soldering to printed circuit boards or cable. Available in various contact sizes and terminations.



ALUMINUM HOODS — Relieve cable strain, act as convenient grip for disconnecting. Available for all connectors, except printed circuit.



FREE SLIDE RULE CONNECTOR GUIDE — A slide rule guide that shows standard Continental Connectors with electrical and mechanical ratings as well as a Body Molding Comparator for standard molding compounds will be mailed to you with our compliments if you write on your company letterhead. There is no obligation, of course.

Manufactured by Continental Connector Corporation,
America's fastest growing line of precision connectors.



SERIES 14
1/2 ACTUAL SIZE

POWER — Many types available. Heavy duty Series 14 shown, features telescoping contact barriers for unusually long creepage paths: 7, 9, 10, 15 and 18 contacts; #14 or #16 AWG wire; 10 amps, 4500V.



SERIES 145-48
1/3 ACTUAL SIZE

TERMINAL BLOCKS — Rugged, molded, machine tapered pin terminal blocks. Available in any combination of shorting or non-shorting terminals. Single, dual or triple row.



HERMETIC SEAL — Designed especially for high altitude and similar applications. Contacts are individually sealed and fused in glass. Available with Miniature and Sub-Miniature series.

STANDARD SERIES

SPECIAL ACCESSORIES

EXCLUSIVE SALES AGENT—DeJUR-AMSCO CORPORATION
45-01 NORTHERN BLVD., LONG ISLAND CITY 1, N. Y.

you're
always
sure
with

DeJUR

electronic
components

Klystron Transmitter

Produces 50 kw peak power

Using an Eimac X581Q klystron with a power gain of 45 db, model 215T transmitter can produce 50 kw peak power at a maximum duty cycle of 0.06. It operates from 700 to 900 mc. Pulse width is 6 to 2000 μ sec; repetition rate, 0 to 1500 pps; and input power 15 kva at 208 v, 3 phase, 60 cps.

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

CIRCLE 152 ON READER-SERVICE CARD

Thyratron Grid Control

For outputs to 20 kw



Series 901 shift networks control thyratron outputs up to 20 kw with a dc control signal of 1 mw. Each unit provides balanced control for two full-wave thyratrons. Phase shift is linear for 180 deg, with a maximum of 270 deg.

VecTrol Engineering, Inc., Dept. ED, P.O. Box 1089, Stamford, Conn.

CIRCLE 153 ON READER-SERVICE CARD

Frequency Meter

125 kc to 1000 mc range

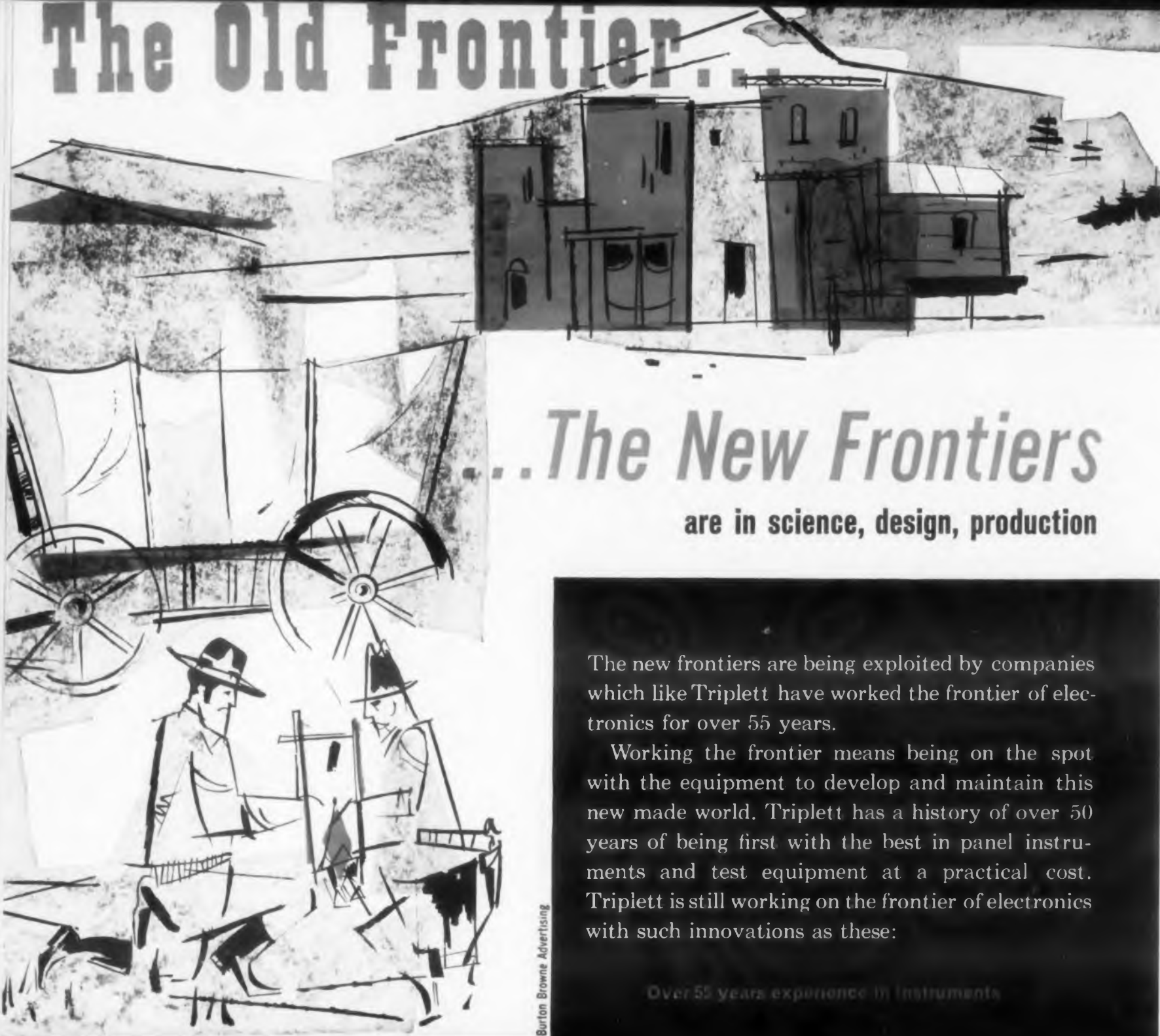
Frequency meter D-W-E 1021 has fundamental ranges of 125 to 250 kc, 2.5 to 5 mc, and 65 to 130 mc. Harmonics extend these ranges to 2.5, 65, and 1000 mc. Accurate to 0.005%, the unit provides minimum rf outputs of 100 μ v at fundamental frequencies, 50 μ v at harmonic frequencies, both into a 50 ohm load. It generates voltages of known frequency from 125 kc to well over 1000 mc. Stability is 0.0025%.

Divco-Wayne Electronics, Dept. ED, 9701-B Reading Rd., Cincinnati 15, Ohio.

CIRCLE 154 ON READER-SERVICE CARD

◀ CIRCLE 568 ON READER-SERVICE CARD

The Old Frontier...



...The New Frontiers

are in science, design, production

The new frontiers are being exploited by companies which like Triplet have worked the frontier of electronics for over 55 years.

Working the frontier means being on the spot with the equipment to develop and maintain this new made world. Triplet has a history of over 50 years of being first with the best in panel instruments and test equipment at a practical cost. Triplet is still working on the frontier of electronics with such innovations as these:

Over 55 years experience in instruments

Burton Browne Advertising



Model 310 a complete miniature V-O-M with single switch selection and the ranges and accuracy of units several times its size. Used with Model 10 clamp-on ammeter plugged in it becomes one of the world's most versatile pieces of test equipment—even measuring current flow without stripping wires.



Model 630-PL V-O-M with such advanced features as an unbreakable clear plastic front for wide range, shadowless, instant vision, polarity reversing switch, single king size knob for selecting both range and circuit, continuous resistance readings from 0.1 ohm to 100 megohms.



Model 690-A, a new Transistor Tester with more Triplet "plus" in accuracy and simplicity, for testing leakage and gain of all low and medium power PNP and NPN transistors. Small, rugged, battery-operated, it measures DC Beta from 5 to infinity. Affords exact tests for shorts, checks forward & reverse leakage of diodes. Features single switch selection of transistor types, positive "off" to prevent accidental battery drain, separate "calibrate" and "gain" buttons eliminate errors, transistor socket and external leads for any basing arrangement.



New Unimeters—a great step forward in increasing meter inventory flexibility while cutting inventory cost. These Select-Your-Range unimeters consist of only two basic meter movements, which can be combined with any one of a number of separate dial-component units for a wide variety of meter ranges. Movements quickly and simply slide onto dial-components and lock together—no soldering, no wiring. Exclusive Triplet Bar-Ring construction for self-shielding, greater accuracy and sensitivity.

TRIPLET

Triplet Electrical
Instrument Company
Bluffton, Ohio

Throughout the world Triplet first... to last

NEW PRODUCTS

Digital Voltmeter

Provides fully automatic reading

Model 405AR dc digital voltmeter reads positive and negative voltages from 100 mv to 999 v with an automatic selection of range and polarity. Voltages are displayed in three significant figures and the decimal point is automatically placed. The unit has an accuracy of $\pm 0.2\%$ of the reading ± 1 count. Its features include a floating input, electronic analog-to-digital conversion, digital recorder output, and a hold control which permits manual positioning of the decimal. The voltage sampling rate is variable from 1 reading every 5 sec to 5 readings per sec. It can also be controlled externally by a 20 v positive pulse. Input impedance to dc is 11 meg on all ranges. The unit is 7 in. high and weighs 26 lb.

Hewlett-Packard Co., Dept. ED
275 Page Mill Rd., Palo Alto, Calif.

CIRCLE 157 ON READER-SERVICE CARD

Servo Motor

1.062 in. long



In a size 8 BuOrd frame, the BT 705-1 servo motor is 1.062 in. long and develops 0.33 oz in. stall torque. The two phase winding is designed for 26 v on the fixed phase and a center tapped control phase of 20/0/20 v. Power input is 2.7 w per phase at stall; speed at maximum power output, 3500 rpm; rotor moment of inertia, 0.65 gm cm². For transistor operation in aircraft and missiles, the unit has a -55 to $+150$ C temperature range.

Induction Motors Corp., Dept. ED, 570 Main St., Westbury, N.Y.

CIRCLE 158 ON READER-SERVICE CARD

CIRCLE 156 ON READER-SERVICE CARD

Sweeping Oscillator

100 kc to 225 mc range

With six switch-selected bands, model CP sweeping oscillator offers continuously variable sweep widths over a range of center frequencies from 100 kc to 225 mc. Into a nominal output impedance of 70 ohms, it provides an rf output of 0.25 v rms below 12 mc and 1 v rms above, flat within ± 0.4 db over the widest sweep. Attenuation is in steps up to 20 db, or continuously variable to 6 db. Sweep rate is variable around 60 cps. Up to 18 crystal-controlled pulse markers are available at any specified frequencies within the range of the instrument.

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

CIRCLE 159 ON READER-SERVICE CARD

Brake-Clutch

6 oz-in. minimum torque



With a minimum torque of 6 oz-in., the PMC-8 electromagnetic brake-clutch will not drop a load below 2.5 oz-in. while switching from brake to clutch. It consumes 4.5 w and has 8 msec response, zero backlash, and zero end play. It passes MIL-E-5272A tests.

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

CIRCLE 160 ON READER-SERVICE CARD

Carbon Film Resistors

Low cost

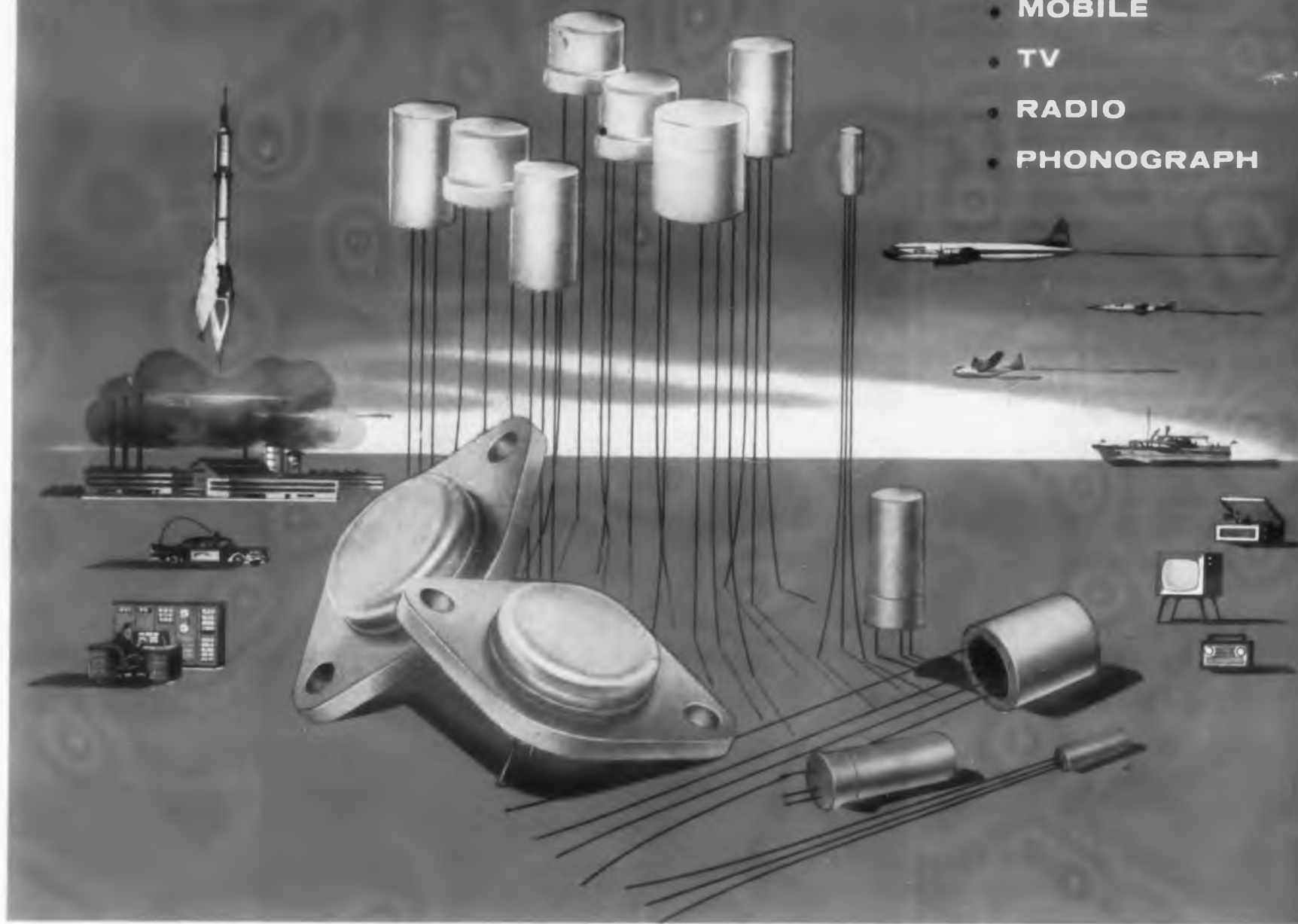
Low cost units for computer and commercial equipment use, these carbon film resistors come in 1/2, 1, and 2 w sizes.

Electra Mfg. Co., Dept. ED, 4051 Broadway, Kansas City, Mo.

CIRCLE 161 ON READER-SERVICE CARD

RCA offers superior-quality TRANSISTORS for these applications...

- INDUSTRIAL
- MILITARY
- COMPUTER
- AIRCRAFT
- MARINE
- MOBILE
- TV
- RADIO
- PHONOGRAPH



RCA's comprehensive line of TRANSISTORS offers you reliability, electrical uniformity, top performance, and mass-production availability! They are produced and controlled to meet the most critical performance requirements. Whatever your needs in transistors—from special one-of-a-kind projects to production-run apparatus... from dc to VHF—contact your RCA Field Representative or your local Authorized RCA Distributor for a discussion of the RCA TRANSISTORS best suited to your own designs. For technical data on specific types, write to RCA Commercial Engineering, Sec. B-18-NN-2, Somerville, N. J.



RADIO CORPORATION OF AMERICA
Semiconductor & Materials Division
Somerville, N. J.

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1625 "K" Street, N. W.
Washington, D. C.
District 7-1260

AVAILABLE TOO AT YOUR LOCAL
AUTHORIZED RCA DISTRIBUTOR

NEW PRODUCTS

Multiple Preset Counter

For predetermining control applications

Multiple preset counter type 2020-4-6 is designed for counting and sequential predetermining control applications. Suited for use with a machine or process that is started manually and stops automatically at several preset counts, it can be applied to the winding of tapped toroidal or transformer coils. The unit can be operated at speeds of 4000 counts per sec and presets one through six. It provides a maximum 4 digit count of 9999. Various inputs supplied include photocell, switch closure, and pulse. The output is a dpdt 5 amp relay with a 105 to 125 v, 50 to 60 cps power supply. Dimensions are 11 x 13 x 8-5/8 in., and weight is 19-1/2 lb.

Freed Transformer Co., Inc., Dept. ED, 1727 Weirfield St., Brooklyn 27, N.Y.

CIRCLE 163 ON READER-SERVICE CARD

Printed Circuit Card Receptacles

Single and double side



Reli-Acon printed circuit card receptacles accommodate Class 1 tolerances on NEMA nominal 0.062 in. laminates. Single side units have 10, 15, 18, 22, and 24 contacts; double side, 20, 30, 36, 44, and 48. Both types have 0.156 centers and a maximum initial insertion force below 14 oz per contact for cards of nominal thickness.

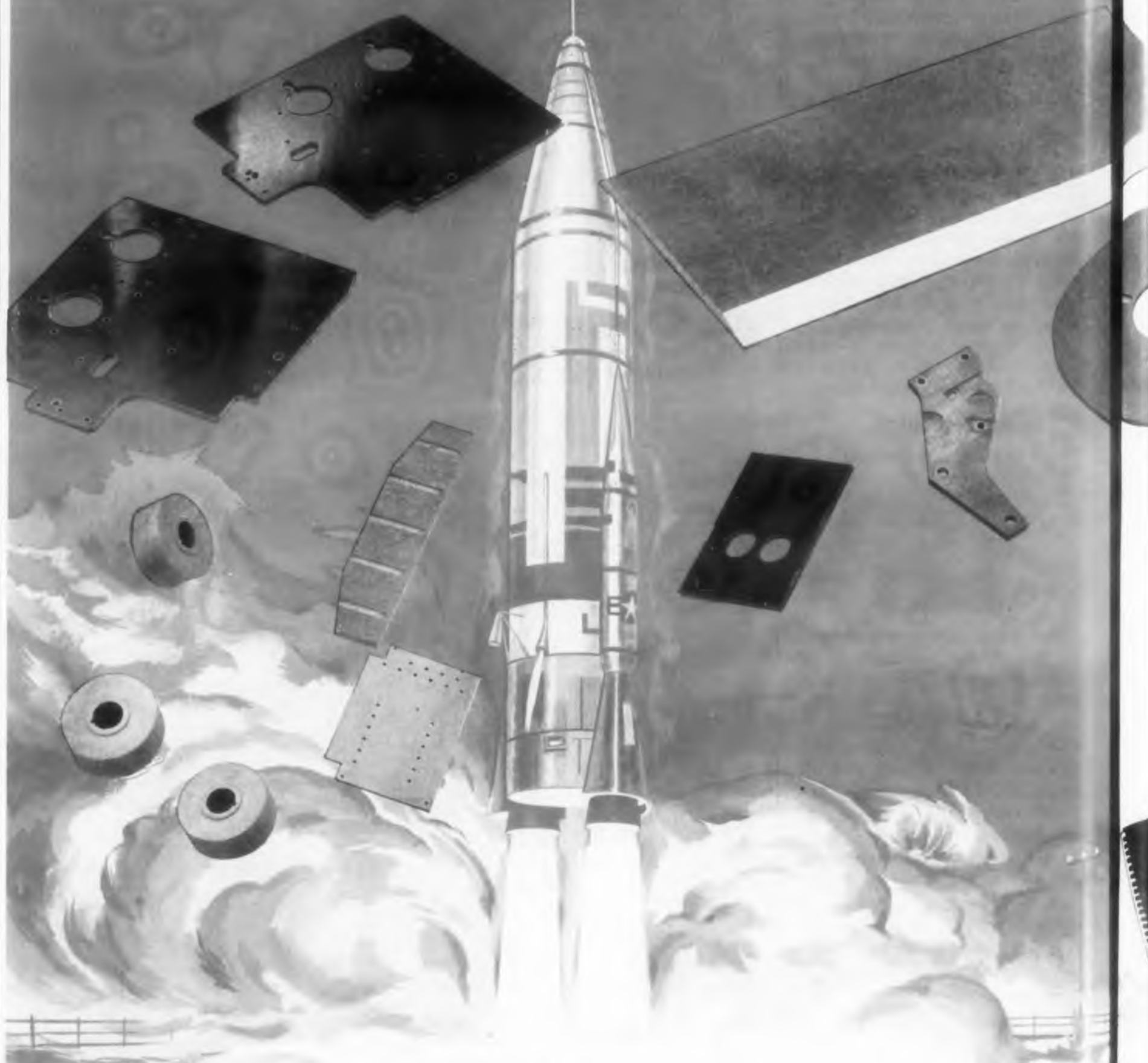
Methode Mfg. Corp., Dept. ED, 7447 W. Wilson Ave., Chicago 31, Ill.

CIRCLE 164 ON READER-SERVICE CARD

Another Formica "first"

new ... FORMICA[®] fabricated parts

Laminated Plastic



vital fabricated parts

for missiles, spacecraft and aircraft, automotive, machinery, electrical machinery, instruments and other manufacturing industries. Produced and delivered faster by your regional Fabricator of Industrial Formica laminated plastics strategically located near you.

service now available locally...

from your Fabricator of Industrial Formica laminated plastics

Now you get fabricated parts faster, direct from your own local Fabricator of Industrial Formica laminated plastics.

This new nationwide network of regional fabricators represents over 50 times the productive capacity ever offered for this purpose. It saves days and weeks on delivery by giving you a thoroughly competent fabricator practically in your own backyard.

The new service recognizes the need of industry for a dependable, big volume source of fabricated parts. Formica is proud to be the first to make available field fabrication facilities with these four key advantages:

- 1. Faster, direct service.** Truckload or tote-boxful, you'll get parts faster direct from your regional Fabricator of Industrial Formica laminated plastics.
- 2. High quality production** of Formica laminated plastic parts by plastics fabricating specialists.
- 3. Application engineering service** from Formica's home and district offices, as well as through field fabricators.
- 4. Widest grade selection.** Streamliner inventories maintained of 42 standard grades; most can be shipped within 48 hours. Ample research facilities for new grade development.

For further information on how the new Formica field fabricator program will speed up your production schedules, get your free copy of "Man of Many Parts." Write Formica Corporation, subsidiary of American Cyanamid, 4512 Spring Grove Ave., Cincinnati 32, Ohio.

new fact book... free!

Brand new concept in the presentation of laminated plastic properties and application data. Valuable aid to designers, production engineers, purchasing agents. Send today for your free copy.



A product of 

Laminated plastic sheets, tubes, rods, molded parts. Field fabricator service.



ALBUQUERQUE, N. M. Plasticrafts, Inc.	LOS ANGELES, CALIF. Conroy & Knowlton, Inc. Leed Insulator Corp. Tri-State Supply Co.
ARLINGTON, VA. Milton H. Brooks & Son	LOUISVILLE, KY. C. Lee Cook Co.
ATLANTA, GA. Southeastern Plastics Sales Co.	MEMPHIS, TENN. Norrell, Inc.
BRISTOL, VA. Williams Co.	MIAMI, FLA. Commercial Plastic & Sup. Corp. of Fla.
BUFFALO, N. Y. Curbell, Inc.	MILWAUKEE, WISC. General Plastics, Inc.
CHICAGO, ILL. Colonial Kolonite Co. Tingstol Co.	NASHVILLE, TENN. Plastic Fabricator Co.
CINCINNATI, OHIO Aqua Sportsman Inc. Durham Mfg. Co.	NEW ORLEANS, LA. Prager, Inc.
CLEVELAND, OHIO Jaco Products Co.	NEW YORK, N. Y. Commercial Plastics & Sup. Co. Frank Products Thomas J. Long, Inc.
COLORADO SPRINGS, COLO. Empire Plastics	OZONE PARK, N. Y. Comco Plastics
COLUMBUS, OHIO Dayton Plastics, Inc.	PHILADELPHIA, PA. Laminated Materials
DAYTON, OHIO Dayton Plastics, Inc.	PITTSBURGH, PA. Earl B. Beach Co.
DENVER, COLO. Plasticrafts, Inc.	POMONA, CALIF. Plastic Stamping, Inc.
EAST RUTHERFORD, N. J. Insulating Fabricators, Inc.	ROCHESTER, N. Y. General Circuits, Inc.
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FORT WORTH, TEXAS Plastelite Engineering Co. Service Engineers, Inc. Standard Parts & Equip. Corp.	ST. PAUL, MINN. Plastics, Inc.
GIBSONVILLE, N. C. Engineered Plastics, Inc.	SAN DIEGO, CALIF. Ridout & Co.
GRAND RAPIDS, MICH. Novel Products	SAN FRANCISCO, CALIF. Laminated Fabricators Tri-State Supply Corp.
HOUSTON, TEXAS Houston Gasket & Packing F. H. Maloney Co. Replacement Parts Co.	SEATTLE, WASH. Tri-State Supply Corp.
HUNTINGTON, W. VA. O'Neill Industrial Plastics, Inc.	TAMPA, FLA. Manatee Corp.
INDIANAPOLIS, IND. Automatic Machinery Co., Inc.	UNIONVILLE, CONN. Fabricon Corp.
JACKSONVILLE, FLA. St. John's Fdry. & Mch. Co., Inc.	WATERTOWN, MASS. Insulating Fabricators of N. E.
KANSAS CITY, MO. Brooks Beatty Co.	WEST ALLIS, WISC. Colonial Kolonite Co.

Transistorized Inverter

$\pm 1\%$ stability

A transistorized inverter that operates from any dc source, the Sineverter offers clean sine-wave power without bulky filtering. Input voltage is up to 50 v dc, and output voltage can be obtained as desired with a frequency from 50 to 1500 cps. Total harmonic content is normally less than 5% and can be specified to 1%. Voltage regulation is $\pm 2\%$ for normal line changes and 2% for no load to full load changes. Frequency stability, normally $\pm 1\%$, can be 0.001%, and power output may be up to 1 kva. The Sineverter cannot be damaged by open or short circuits.

Power Sources, Inc., Dept. ED,
Burlington, Mass.

CIRCLE 166 ON READER-SERVICE CARD

DC Power Supplies

6 to 300 v outputs



Operating from 110 v, 60 or 400 cps, these plug-in power supplies deliver 6, 12, 24, 75, 150, 250, or 300 v dc with currents to 400 ma. Regulated and unregulated models are available. Standard regulation is 0.25%, but special units regulated to 0.01% can be supplied.

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

CIRCLE 167 ON READER-SERVICE CARD

Frequency Converter

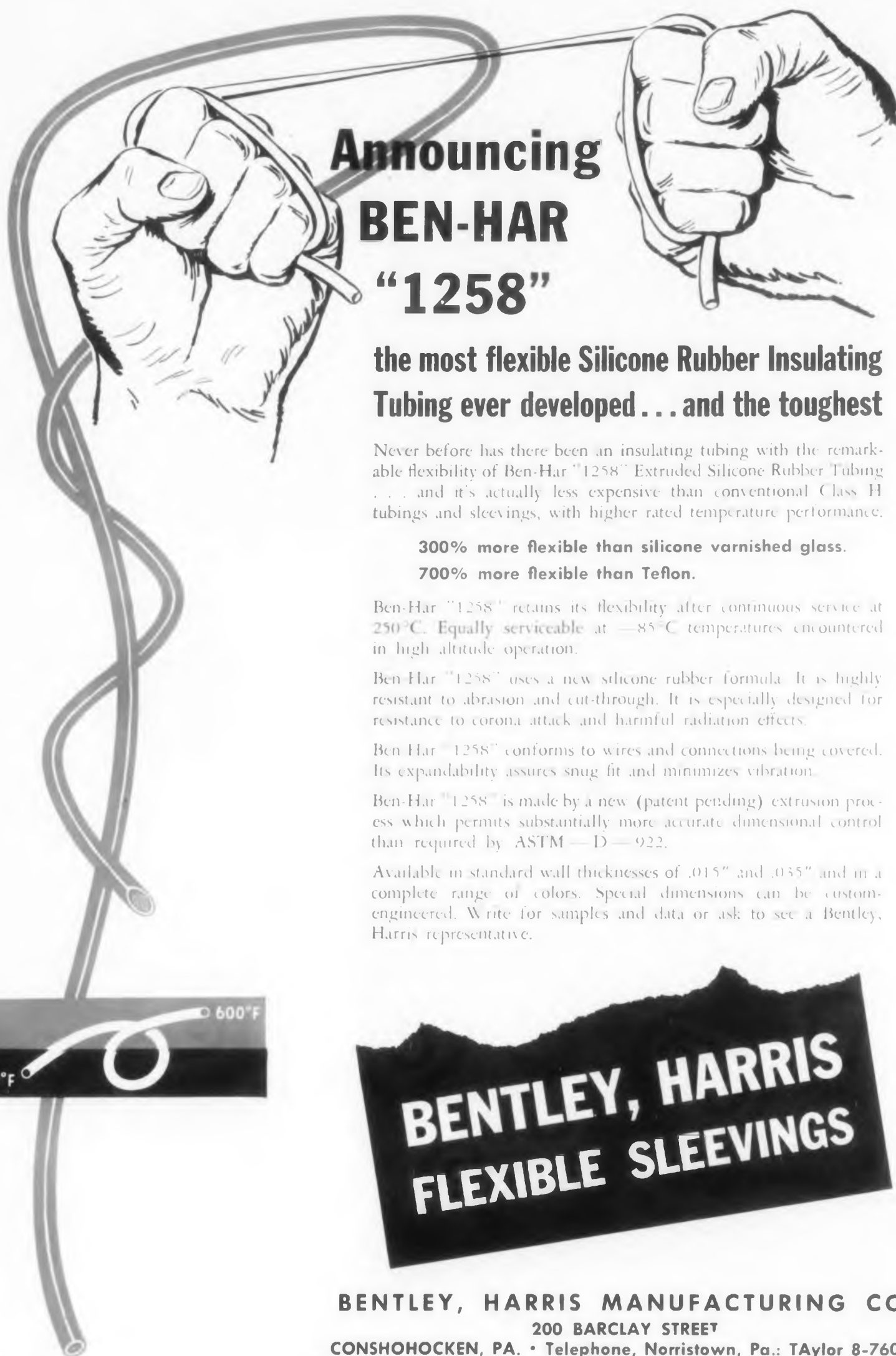
Transistorized

Transistorized model PS6001 frequency converter has a 120 v, 60 cps input and a 115 v, 400 cps, 250 w square wave output. It operates from -30 to $+52$ C and measures 10.5 x 5 x 7 in.

Power Sources, Inc., Dept. ED,
Burlington, Mass.

CIRCLE 168 ON READER-SERVICE CARD

CIRCLE 165 ON READER-SERVICE CARD



Announcing BEN-HAR "1258"

**the most flexible Silicone Rubber Insulating
Tubing ever developed . . . and the toughest**

Never before has there been an insulating tubing with the remarkable flexibility of Ben-Har "1258" Extruded Silicone Rubber Tubing . . . and it's actually less expensive than conventional Class H tubings and sleeveings, with higher rated temperature performance.

300% more flexible than silicone varnished glass.

700% more flexible than Teflon.

Ben-Har "1258" retains its flexibility after continuous service at 250°C. Equally serviceable at -85°C temperatures encountered in high altitude operation.

Ben-Har "1258" uses a new silicone rubber formula. It is highly resistant to abrasion and cut-through. It is especially designed for resistance to corona attack and harmful radiation effects.

Ben-Har "1258" conforms to wires and connections being covered. Its expandability assures snug fit and minimizes vibration.

Ben-Har "1258" is made by a new (patent pending) extrusion process which permits substantially more accurate dimensional control than required by ASTM—D—922.

Available in standard wall thicknesses of .015" and .035" and in a complete range of colors. Special dimensions can be custom-engineered. Write for samples and data or ask to see a Bentley, Harris representative.



**BENTLEY, HARRIS
FLEXIBLE SLEEVINGS**

BENTLEY, HARRIS MANUFACTURING CO.
200 BARCLAY STREET
CONSHOHOCKEN, PA. • Telephone, Norristown, Pa.: TAYLOR 8-7600
CIRCLE 169 ON READER-SERVICE CARD

NEW PRODUCTS

Transmit-Receive Switch

Has selectable bandswitching

Suitable for a-m, cw, ssb, and dsb, model 351 T-R transmit-receive switch has selectable bandswitching and covers the 80 through 10 meter bands. It is designed particularly for high power transmitting use. Under swr conditions up to 1.5 to 1, it will handle more than 1 kw a-m phone and up to 5 kw on ssb and cw with a 72 ohm coaxial line. It matches 52 to 75 ohm coaxial lines.

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

CIRCLE 170 ON READER-SERVICE CARD

Transistorized Power Supply

0.1% line and load regulation



Providing stable output voltages from 0 to 36 v dc at 5 amp continuous duty, model 100 transistorized power supply has 0.1% line and load regulation. Output can be limited to any value from 0 to 5 amp with a selector. Recovery is 50 usec; ripple and noise are 1 mv at full load.

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

CIRCLE 171 ON READER-SERVICE CARD

Transmitter Booster Amplifier

For aircraft use

Coupled to a 1/4 to 2 w aircraft transmitter, this booster amplifier increases power output to 5 w. Self-contained with its own power supply, the 1-1/2 lb, 2-1/4 x 4 x 9 in. unit can be mounted anywhere in an aircraft. It connects to either a 12 or 24 v primary power source and may be added to the output of any low power vhf transmitter in use on present day aircraft. Either 12 or 24 v power supplies may be furnished since all units are interchangeable.

Topp Industries, Inc., Dept. ED, 5255 W 102nd St., Los Angeles 45, Calif.

CIRCLE 172 ON READER-SERVICE CARD

Operation Monitor

100 channel

For industrial and MIL-E-4158B applications, this operation monitor simultaneously records up to 100 separate operations and events on a chart 12 in. wide. Electric writing provides a response of up to 500 signal changes per sec.

Brush Instruments, Div. of Clevite Corp., Dept. ED, 37th and Perkins, Cleveland 14, Ohio.

CIRCLE 173 ON READER-SERVICE CARD

Power Relays

Control 20 amp

The switch in these heavy duty power relays is UL approved for a rating of 20 amp, 2 hp, at 230 v ac. The units are 2-1/16 in. long and come in a variety of circuit arrangements. Available coil voltages are 24, 32, 115, and 230 v ac and 12, 30, and 115 v dc.

Robertshaw-Fulton Controls Co., Aero Div., Dept. ED, Columbus 16, Ohio.

CIRCLE 174 ON READER-SERVICE CARD

RF Choke Kits

Contain 0.1 to 10,000 μ h units

For immediate selection of rf choke parameters, these kits contain units with preferred inductance values. Series S kit has 19 chokes with values from 0.1 to 100 μ h; series M has 19 with values from 1 to 1000 μ h; and series L has 25 with values from 1 to 10,000 μ h.

Essex Electronics, Dept. ED, 550 Springfield Ave., Berkeley Heights, N.J.

CIRCLE 175 ON READER-SERVICE CARD

Solderless UHF Connector

Easily installed



Compatible with existing connectors, the R-8-UHF Crimpee is a solderless 50 ohm uhf connector for RG-5-U coaxial cable. One model needs no special tools, while the others are quickly installed with a low cost assembly tool.

Edlen Inc., Dept. ED, 8105 Woodmont Ave., Bethesda 14, Md.

CIRCLE 176 ON READER-SERVICE CARD

Announcing Epsco's **NEW**

DVOM

A MAJOR ADVANCE IN
**DIGITAL
VOLT-OHM
METERS**



1/2 ACTUAL SIZE

FULLY TRANSISTORIZED
No Stepping Switches • No Relays

Epsco

First in data control

● **VERSATILE** accurately measures both resistances and AC-DC voltages and counts external events, too! Directly drives printers, punches and memory storage units and can be directly used as a bi-directional tele-meter.

● **FAST** less than 2 millisecond reading time . . . up to 100 completely independent measurements per second for any system use.

● **EASY TO READ** in-line, in-plane visual display . . . lamp life up to 10,000 hours . . . numerals 1 1/8 inch high . . . automatic indication of polarity, decimal point and mode of operation

True dependability and versatility have at long last come to digital volt-ohm meters in EPSCO'S new DVOM. Fully transistorized . . . adjustment-free . . . no stepping switches or relays. Provides precise numerical measurement of AC-DC voltages, resistances . . . fast, accurate visual or printed quality control data . . . high-speed data acquisition for direct print-out or storage . . . remote indication and data transmission over a single line. Compact, lightweight, portable — also for rack-mounting. Write for Bulletin 95801, Epsco, Inc., Equipment Division, 588 Commonwealth Ave., Boston 15, Mass.; in the West: Epsco-West, 125 E. Orangethorpe Ave., Anaheim, California

DVOM price \$1,475

Ask for a demonstration.

CIRCLE 177 ON READER-SERVICE CARD



synchros

in the popular Size 8 line

are now in production at Daystrom Transicoil. The new size 8 Synchro Line includes high quality, top performance transmitters, control transformers, differentials, and repeaters. Frame size equal to BuOrd Size 8. Operation: 115V 400 cycles or 26V 400 cycles. Accuracies to $\pm 5'$ are available. Corrosion resistant construction throughout. Conforms to MIL-E-5272-A.

Write for complete specifications. Be sure to ask about our 24 Hour Service for rotating components. Daystrom Transicoil, Division of Daystrom, Inc., Worcester, Montgomery County, Pa. Phone JUNO 4-2421. In Canada: Daystrom, Ltd., 840 Caledonia Rd., Toronto 19, Ont. Foreign: Daystrom International Div., 100 Empire St., Newark 12, N. J.

 **DAYSTROM TRANSICOIL** DIVISION OF DAYSTROM, INC.
Representatives in Canada and Other Foreign Countries

CIRCLE 178 ON READER-SERVICE CARD

NEW PRODUCTS

Transistorized Servo Amplifier

Delivers 13 w

Used with a servo or synchronous motor, the 1800-0300-4 plug-in transistorized servo amplifier delivers up to 13 w. Input may be from a synchro control transformer, tuning fork oscillator, or electrical bridge. Input impedance is 10 K, gain 70 db.

M. Ten Bosch, Inc., Dept. ED, 80 Wheeler Ave., Pleasantville, N.Y.

CIRCLE 179 ON READER-SERVICE CARD

Oscillograph Attenuator

Handles 100 w

A 100 w attenuator, model BS-1 operates direct writing oscillographs from high voltage power equipment without the use of an amplifier. Current drain from the source is 0.1 amp; output impedance is about 250 ohms; and full scale voltage range is 40 to 1000 v.

Marduth Products, Dept. ED, R.D. 4, Box 225, Medina, Ohio.

CIRCLE 180 ON READER-SERVICE CARD

Multitester

For ac and dc

A 2 K per v multitester, model TE-117 has a 2-1/2 in. meter and 17 precision shunts and resistors. It has seven ac and dc voltage ranges from 0 to 2.5 kv; three dc current ranges from 0 to 500 ma; and two resistance ranges from 0 to 1 meg. The unit is 3-1/4 x 1-3/8 x 4-3/4 in.

Olson Radio Warehouse, Dept. ED, 260 S. Forge St., Akron 5, Ohio.

CIRCLE 181 ON READER-SERVICE CARD

B Battery Replacements

Provide up to three voltages

Operating from an ac line voltage, Powertran B battery replacements provide ungrounded ac voltages from 7.5 to 90 v. Each voltage is regulated and can supply 40 ma minimum to a load. Up to three fixed voltages can be delivered by one unit.

Ferrotran Electronics Co., Inc., Dept. ED, 63 Broadway, New York 12, N.Y.

CIRCLE 182 ON READER-SERVICE CARD

Quartz Clock

Reliable frequency standard

An accurate timekeeper which varies less than 0.01 sec per day, the B-288 quartz clock is also a reliable frequency standard. Made by Ebauches S.A., Switzerland, it generates frequencies of 1,000,000, 10,000, 1000, 200, 60, and 50 cps.

Freeport Engineering Co., Dept. ED, 350 Fifth Ave., New York 1, N.Y.

CIRCLE 183 ON READER-SERVICE CARD



Oscilloscope

Has 17 in. crt

Designed for use with telemetering and data processing equipment, model 917 large screen oscilloscope has a 17 in. cathode ray tube. Both the X and Y axis have 1% linearity. Amplifier response is rated at 10 mv sensitivity up to 500 kc, with an accurately calibrated time base system for both driven and recurrent operations. Other features of the unit include magnetic deflection, constant deflection sensitivity, hand calibrated controls, small spot size, and high resolution. Provided in a cabinet, the component parts may be removed and mounted in any standard 19 in. rack.

Eastern Precision Resistor Corp., Dept. ED, 675 Barbey St., Brooklyn 7, N.Y.

CIRCLE 184 ON READER-SERVICE CARD

Linear Horns

For 1000 to 12,000 mc

For 1000 to 12,000 mc, these linear horns have virtually identical E and H beam widths and good coaxial to waveguide transformation. They are equivalent to Signal Corps AT448, AT551, AT552, and AT553 units.

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

CIRCLE 185 ON READER-SERVICE CARD

NEW SANDWICH TAPES!



Recommended specifically for digital recording and most AM, FM and PDM applications

"SCOTCH" BRAND Sandwich Instrumentation Tapes eliminate ruboff and head buildup—reduce head wear—last longer

Here's the solution to the problem of excessive wear and ruboff—"SCOTCH" BRAND Sandwich Instrumentation Tapes. These tapes have a thin layer of plastic over the magnetic coating. This layer protects the iron oxide to produce a smooth, low-frictional head-to-tape operation that eliminates ruboff, head buildup and connected problems.

The addition of this protective layer (50 micro-inch thickness) naturally modifies the magnetic properties of the tapes somewhat. This amounts to a slight (but not critical) reduction in the high frequency or short wave length response. The medium and long wave length responses are completely unaffected. In all applications where extremely high frequency response is not required, "SCOTCH" BRAND Sandwich Tapes offer the ultimate in performance, combined with new freedom from maintenance problems.

Three Sandwich Tapes are now available:

- #188—For applications requiring standard output level. 1.5 mil polyester base, 0.35 mil magnetic coating, 50 micro-inch protective layer.
- #186—For instrumentation and computer applications higher than standard output. 1.5 mil polyester base, 0.50 mil magnetic coating, 50 micro-inch protective layer.
- #189—Standard output level with 50% more recording time. 1.0 mil polyester base, 0.35 mil magnetic coating, 50 micro-inch protective layer.

WRITE TODAY for illustrated brochure on Sandwich Tapes. Special reels, end-of-reel sensing items and other accessories required for digital computer operations are also available. Address: Instrumentation Tape Division, 900 Bush Avenue, St. Paul 6, Minn.



REG. U.S. PAT. OFF.
SCOTCH
BRAND
Magnetic Tapes

MINNESOTA MINING AND MANUFACTURING COMPANY

... WHERE RESEARCH IS THE KEY TO TOMORROW



"SCOTCH" and the plaid design are registered trademarks of 3M Co., St. Paul 6, Minn. Export: 99 Park Ave., New York 16, Canada: London, Ontario.

CIRCLE 186 ON READER-SERVICE CARD

NEW PRODUCTS

Variable AC Power Supplies

Ratings from 60 to 500 va

Series MVAU regulated variable ac power supplies have no moving parts, vacuum tubes, or internal adjustments. Self-protected against short circuits, they have voltage and current meters of 2% accuracy and output terminals both front and rear. Models are available with ratings of 60 to 500 va and 3 to 20 amp. All are continuously adjustable from 0 to 130 v with output voltage regulation of $\pm 1\%$. Output is isolated from line. Harmonic distortion is less than 3% rms and response time is less than 1.5 cps. The units are designed for panel mounting.

Nutron Mfg. Co., Inc., Dept. ED, 67 Monroe Ave., Staten Island 1, N.Y.

CIRCLE 187 ON READER-SERVICE CARD

DC Filament Supply

Output of 28 v dc at 1.2 amp

From 117 v ac, 60 cps, model 227 plug-in filament supply provides 28 v dc at 1.2 amp. At maximum output, ripple is 2%. Dimensions are 3.5 x 3.75 x 4.5 in.

C. J. Applegate & Co., Dept. ED, 1840 24th St., Boulder, Colo.

CIRCLE 188 ON READER-SERVICE CARD

Variable Transformers

Have direct reading dials

Model VT4 and VTS variable transformers are rated 3.5 and 7.5 amp, respectively, with overvoltage feature, and 4.75 and 10 amp without. The direct reading dials are calibrated for overvoltage connection on one side and for normal line connection on the other.

Ohmite Mfg. Co., Dept. ED, 3680 Howard St., Skokie, Ill.

CIRCLE 189 ON READER-SERVICE CARD

ACCURATE, WIDE-RANGE Time Measurements and Pulse with **Type 1391-B PULSE, SWEEP, and**

\$1975

**RISE TIME
0.015 μ sec.**

★ Push-Pull Pulses with Durations from 0.025 μ sec to 1.1 sec.

★ Time Delays from 1 μ sec to 1.1 sec.

★ Linear Sweep Voltage from 3 μ sec to 0.12 sec.

★ NO Duty Ratio Restrictions.

★ Very Small Jitter and Overshoot.

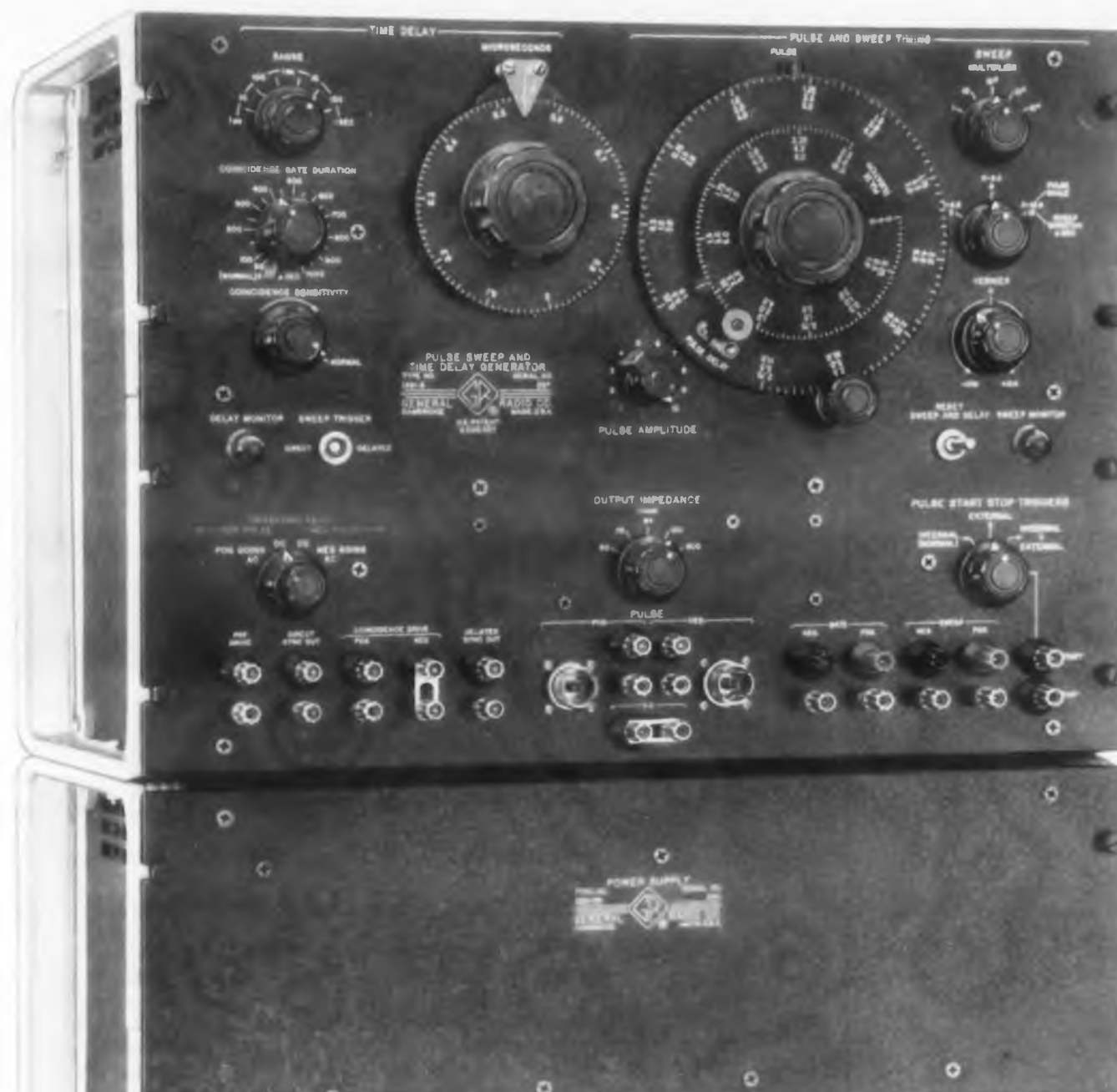
★ High Accuracy and High Resolution Throughout.

★ Circuits Stable Against Hum and Line Transients.

★ Coincidence Circuitry For Multiple Pulsing and Time Selection

★ Variable Output Impedance For Correct Termination with Variety of Transmission Lines.

★ Extreme Versatility — Panel Controls for Important Pulse Characteristics Binding Posts Provide Ready Access to Sync Pulses, Gates, Delayed Signals, Pulses, and Internal Sweeps



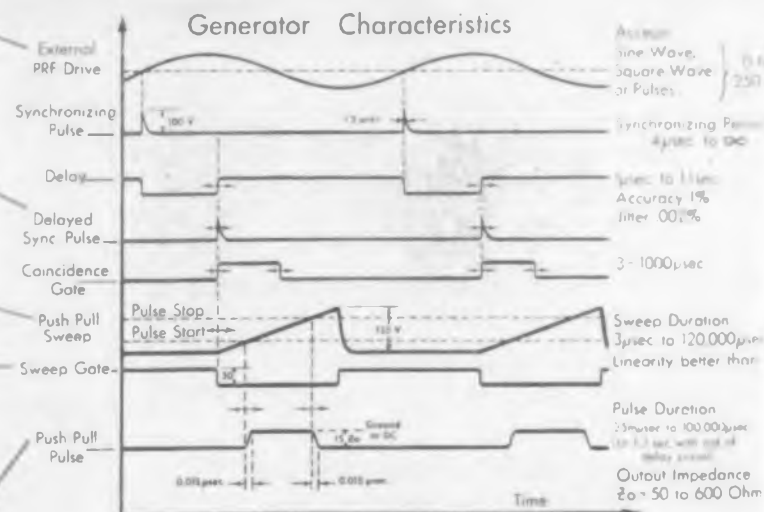
Direct synchronizing pulse timed by the input signal.

Delayed synchronizing pulse accurately adjustable in time by delay generator. Built-in coincidence circuit for timing the delayed synchronizing pulse by externally generated pulses fed into the instrument

Push-pull sawtooth voltage of sufficient amplitude to be applied to the deflection plates of oscilloscope for examining the generator's output pulses, or for use in driving auxiliary equipment.

Push-pull gating pulses with same duration as the sweep

Positive or negative pulses with excellent shape characteristics, continuously adjustable in duration, amplitude, impedance level, and delay with respect to (a) the direct sync pulse and (b) the sweep.



Waveform Synthesis

TIME-DELAY GENERATOR

One instrument for: ECHO RANGING, TELEMETERING, COMPUTER DESIGN, TELEVISION, RADIO NAVIGATION, and PHYSIOLOGICAL RESEARCH

INPUT SYSTEM

Accepts Sine Wave, Square-Wave, or Other Cyclic Waveform: dc to 250 kc

Minimum Required Amplitude to Form Direct-Sync Pulse: (triggering threshold control provided):

Sine Wave: 0.1v, rms

Square Wave: 0.3v, p-p

Pulse (+ or -): 1.0v, p-p

DIRECT SYNC PULSE

Amplitude: +75v to 300 kc; down 20% at 500 kc

Duration: 1 μ sec

TIME-DELAY CIRCUIT

Range: 1.0 μ sec to 1.1 sec in six ranges

Maximum PRF: 400 kc

Absolute Accuracy: $\pm 2\%$ of full scale; incremental accuracy, $\pm(1\% + 0.05 \mu\text{sec})$

Resolution: 1 in 8800

Stability and Duty-Ratio Effects:

	Low End of Dial	High End of Dial
Time Jitter	1:10,000	1:50,000
10% Line Change	2:1000	2:10,000
Duty-Ratio Effects on Delay Accuracy	less than 2% error for duty ratios up to 60%	less than 2% error for duty ratios up to 90%

Output Characteristics of Delay Sync Pulse: Positive, 60v, 1- μ sec duration at half amplitude

Output Impedance: 600 Ω , cathode follower

COINCIDENCE CIRCUIT

Gate Duration: Adjustable 3-1000 μ sec

Can be triggered by positive pulses between 5 - 20 volts, or by negative pulses between 10 - 100 volts.

SWEEP CIRCUIT

Sweep Duration: 3, 6, or 12 μ sec to 30,000; 60,000; or 120,000 μ sec in five decade ranges

Sweep Linearity: Determined by accuracy of pulse timing

Sweep Repetition Rate: 0 - 250 kc

Sweep Duty-Ratio Effects: Duty ratios up to 50% cause no more than 5% error in slope on short sweep duration, less effect on longer ranges.

BOTH AN ACCURATE MEASURING APPARATUS AND PRECISION GENERATOR

Through Use of Switching and Circuit Terminations You Can:

- Start the Sweep with either the Delayed or the Direct Synchronizing Pulse
- Time the Pulse by the Sweep Circuit, by the Delay Circuit, or by externally generated pulses
- Use the Delay System independently for oscilloscope-sweep calibration, or as an accurate measuring system
- Drive external systems with accurately timed "Start" and "Stop" pulses derived from the Sweep
- Use the coincidence circuit for self-multiple pulsing
- Pulse at frequencies to 3 Mc with the aid of supplementary generating equipment (GR Type 1330-A Bridge Oscillator and Type 314-S86 Variable Delay Line).

PULSE GENERATING CIRCUIT (Push-Pull Pulse)

Pulse Duration Range: 0.025 to 2.5, 0.05 to 5.0, and 0.05 to 10.0 μ sec, with the 3, 6, and 12 μ sec sweeps respectively. Five-decade sweep multiplier extends pulse duration to 100,000 μ sec; pulse can be extended to 1.1 seconds if timed by delay circuit.

Pulse Duration Accuracy: After sweep calibration, $\pm 1\%$ of dial reading, or $\pm 0.02 \mu\text{sec}$ (whichever larger)

Pulse Position Accuracy: 0.5 $\mu\text{sec} \pm 1\%$ of dial reading

Pulse Repetition Rate: 0 to 250 kc

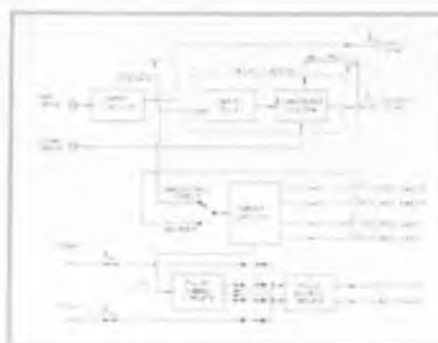
Pulse Shape: Under properly terminated conditions rise and decay times are less than 0.015 μsec . Overshoot and other defects are less than 3% of pulse amplitude. Pulse ramp-off does not exist. Unity duty ratio possible.

Output Impedance: 50, 72, 92, 150, 600 Ω , all $\pm 10\%$

Output Pulse Amplitude: 150-ma current source into any output impedance from 0 to 600 Ω ; voltage from each phase of push-pull channel is 0.15 x output impedance. Stable against line-voltage transients.

Power Supply Input: 105 to 125 (or 210 to 250) volts, 50 to 60 cycles, 420 watts

Dimensions: Generator, 19 x 14 x 12 $\frac{1}{2}$ inches; Power Supply, 19 x 10 $\frac{1}{2}$ x 12 $\frac{1}{2}$ inches



GENERAL RADIO COMPANY

275 MASSACHUSETTS AVENUE, CAMBRIDGE 39, MASSACHUSETTS

NEW YORK AREA
Broad Ave. at Linden
Ridgefield, N. J.
N. Y. WOrth 4-2722
N. J. WHitney 3-3140

CHICAGO
6605 W. North Ave.
Oak Park, Ill.
Village 8-9400

PHILADELPHIA
1150 York Rd.
Abington, Pa.
HAncock 4-7419

WASHINGTON, D.C.
8055 Thirteenth St.
Silver Spring, Md.
JUiper 5-1088

SAN FRANCISCO
1182 Los Altos Ave.
Los Altos, Cal.
WHitecliff 8-8233

LOS ANGELES
1000 N. Seward St.
Los Angeles 38, Cal.
HOLlywood 9-6201

IN CANADA
99 Floral Pkwy.
Toronto 15, Ontario
CHerry 6-2171

Millichoimeter

Measures down to 30 μ ohms

Battery powered model 502 portable millichoimeter has 13 overlapping ranges from 0.001 to 1000 ohms full scale and measure down to 30 μ ohms. Accuracy is 3% of full scale except on the 1 milliohm range where it is 5%. The unit applies 2 μ w across test circuits.

Keithley Instruments, Inc., Dept. ED, 12415 Euclid Ave., Cleveland 6, Ohio.

CIRCLE 191 ON READER-SERVICE CARD

Encoders

Analog to digital



Mainly for use with the series 800 ElectroSyn indicating receiver, series 2100 ElectroSyn analog to digital encoders can be applied to any shaft whose rotation may be stopped for short intervals. Digital ranges are 0 to 999 or 0 to 1999, and discs can be designed for any type of code including standard teletype. The units give no ambiguous or between point readings.

Norwood Controls, Dept. ED, Norwood, Mass.

CIRCLE 192 ON READER-SERVICE CARD

Aircraft Circuit Analyzers

Handle 37 or 61 circuits

For checking all circuits in aircraft using Deutsch connectors, SI 3001 analyzers come in models that handle 37 or 61 circuits. They measure ac and dc voltage and current, resistance, leakage, and signal characteristics with oscilloscopes or appropriate meters.

Scott Instrument Co., Dept. ED, 3734 W. Slauson Ave., Los Angeles 43, Calif.

CIRCLE 193 ON READER-SERVICE CARD
CIRCLE 190 ON READER-SERVICE CARD

Now ... from Phelps Dodge ...



First complete line of Solderable Magnet Wires for the Electrical Industry!

S-Y BONDEZE®

answers the long-awaited need for a self-bonding wire that is solderable at low temperatures. The high temperature cut-thru resistance of the underlying film will reduce the number of shorts in your coils.

NYLEZE®

a tough, all-purpose, solderable wire for your most severe applications. Especially suited for use in high speed automatic winding equipment or wherever extreme varnish or compound treatment is involved.

SODEREZE®

the magnet wire that is solderable at low temperature, proven over the years in thousands of customer applications.

GRIP-EZE®

a solderable film wire with controlled surface friction for use in lattice-wound coils. A special surface treatment provides mechanical gripping between turns and keeps the wire in place.

All Phelps Dodge solderable magnet wires are red in color.

Any time your problem is magnet wire, consult Phelps Dodge for the quickest, easiest answer!

FIRST FOR
LASTING QUALITY
—FROM MINE
TO MARKET!



**PHELPS DODGE COPPER PRODUCTS
CORPORATION**

INCA MANUFACTURING DIVISION

FORT WAYNE, INDIANA

CIRCLE 194 ON READER-SERVICE CARD

NEW PRODUCTS

Sine and Square Wave Generator

20 cps to 1 mc coverage



Model 710 sine and square wave generator covers 20 cps to 1 mc. In the sine wave section harmonic distortion is below 1%, and square wave rise time is under 0.1 μ sec. The output amplifier section can be fed from either sine or square wave functions.

The Hickok Electrical Instrument Co., Dept. ED, 10525 Dupont Ave., Cleveland 8, Ohio.

CIRCLE 195 ON READER-SERVICE CARD

Delay Line Chassis

Contains 30 separate units



Delay chassis model DU-10, compatible with the company's series T digital modules, contains 30 independent 1 μ sec electrical delay lines. These units can be used individually or joined in series by taper pin jumper connections to form a desired delay. Accurate to $\pm 2\%$, the basic 1 μ sec delay interval per line can be used directly with the other series T modules. Accurately preserving the waveshape of video and pulse information, these M-derived lumped constant delay lines have a cutoff frequency of 5.6 mc and a characteristic impedance of 91 ohms. Attenuation is 1 db per μ sec of delay. The chassis is a standard 19 x 1-3/4 in. unit for rack mounting. It has many applications in computers, test equipment, and pulse circuits.

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

CIRCLE 196 ON READER-SERVICE CARD

Recording Amplifiers

Drift less than 0.5 mv per hr



Built for a variety of rack-panel and portable oscillograph recording uses, B series amplifiers drift less than 0.5 mv equivalent input per hr and operate from 115 v \pm 5 v power lines without additional regulation. With a 2 meg input impedance and optional zero suppression, they may be used with a wide variety of transducers. The units have plug-in frequency compensation to extend galvanometer range to 200 cps, and automatic signal overload protection to prevent galvanometer burnout. Model S105B has flat frequency response from dc to 500 cps, down 50% at 5 kc. In high position, it has a gain of 5000 and a useful input range of 150 μ v to 100 mv. In low position, gain is 150 and useful input is 10 mv to 125 v. Model S106B provides a gain of 150 and has a frequency response that is flat from dc to 1500 cps, down 30% at 8 kc and 50% at 15 kc. Its useful input is 10 mv minimum, 125 v maximum.

Edin Co., Inc., Div. of Epseo, Inc., Dept. ED, 207 Main St., Worcester 8, Mass.

CIRCLE 197 ON READER-SERVICE CARD



Numerical Controller

Makes 5000 counts per sec

Using magnetic amplifiers, series 5800 industrial counter-controllers will count up to 100,000 events at rates to 5000 per sec. Switches select one or two count totals at which output signals occur. The outputs are relay contact closures rated at 5 amp.

Beckman Instruments, Inc., Berkeley Div., Dept. ED, 2200 Wright Ave., Richmond 3, Calif.

CIRCLE 198 ON READER-SERVICE CARD

VARACTORS NOW!

YESTERDAY . . . a multiple breakthrough in the laboratory.

TODAY . . . a production fact from Microwave Associates.

This Microwave Associates varactor is a diffused silicon PN junction diode designed to be a variable capacitance with low loss at high frequencies. The unit complies with MIL-E-1 outline 7-1 for cartridge type crystal rectifiers and will fit most standard crystal holders.

In the standard form, the pin end of the diode is connected to P-type material on the top of a small "mesa" and the N-side of the silicon element is connected to the base. Reverse polarity units are also available. Mechanically reversible units in both polarities may be ordered but the single-ended units are generally recommended because they insure placement in holders with the proper end in contact with a heat sink.

TYPE	CUT OFF FREQUENCY (kMc)	CAPACITY AT ZERO BIAS ($\mu\mu$ f)
MA-460A	20	8
MA-460B	30	6
MA-460C	40	4
MA-460D	50	4
MA-460E	60	3

VOLTAGE TUNED MICROWAVE CIRCUITS

PARAMETRIC AMPLIFIERS

HIGH LEVEL MODULATORS

REACTIVE LIMITERS

HARMONIC GENERATORS

VOLTAGE TUNED MICROWAVE CIRCUITS

The high Q of the varactor at microwave frequencies and its voltage variable capacitance provide excellent qualities for use in circuits as AFC, voltage variable filter networks, tuned microwave oscillators.

PARAMETRIC AMPLIFIERS

The varactor used in very simple circuits requiring no refrigeration has demonstrated low noise, high gain performance from 1 to 6000 mc. Noise figures of approximately 1 db at UHF and 5 db at 6000 mc. are typical. We believe the varactor will be the component of choice for receiver inputs from 30 to 6000 mc.

HIGH LEVEL MODULATORS

For the difficult problem of imposing VHF and UHF intelligence on a microwave carrier, the varactor is a top performer. The varactor accomplishes the mixing function with signal gain in the side bands as opposed to present low efficiency techniques.

REACTIVE LIMITERS

The varactor has been used as a passive reactive limiter at UHF frequencies. It is believed that the varactor will be an ideal "receiver protector" as an adjunct to present UHF radar duplexing systems.

HARMONIC GENERATORS

The unique properties of the varactor provide highly efficient harmonic generation. Useful harmonics have been generated up to 100 kMc. With inputs at HF, VHF, UHF and lower microwave frequencies, conversion losses of considerably less than 1 db per harmonic have been observed. The varactor driven by transistor or tube oscillators appears very promising as a signal source in the microwave region.

Send for catalog 59V



MICROWAVE ASSOCIATES, INC.

BURLINGTON, MASSACHUSETTS • Telephone: Browning 2-3000

CIRCLE 199 ON READER-SERVICE CARD

NEW ELECTRICAL RIBBONS

With *Synkote*[®] Dependability and Efficiency

Any Width . . .
Any Number of Conductors



COAXIAL RIBBON



TWISTED PAIR RIBBON



SINGLE CONDUCTOR RIBBON



- Easier to handle
- Easier to work with
- Saves time, Saves space
- Weighs less
- Strips and separates easily
- Color coded
- Gives a clean, smooth appearance to the job

AVAILABLE IN SINGLE CONDUCTORS, TWISTED PAIRS AND COAXIAL CABLES

Of course, Plastoid is in the forefront with this latest development in eye-appealing, space-saving multi-conductor cables. Their unique, ribbon-like construction is your key to the neatest, quickest, space-saving hook-ups.

Cost? . . . it's even lower than the old type jumbled up leads — the space consuming heavy cabled kinds. Get our quotation NOW! You'll be agreeably surprised!

Send for Free Catalog P-2



PLASTOID

Corporation

OFFICES: 42-61 24th Street, Long Island City 1, N. Y. PLANT: HAMBURG, N. J.

CIRCLE 200 ON READER-SERVICE CARD

NEW PRODUCTS



Vacuum Power Switches

For high voltage interruption

Type RH and RL vacuum power switches are designed for high voltage interruption. Individually, they will handle recovery voltages up to 45 kv peak when interrupting 600 amp rms; in series, they may be used for operating voltages up to 230 kv. Available with continuous current ratings up to 600 amp and momentary surge ratings up to 20,000 amp, the switches also interrupt currents to 4000 amp. With vital areas encapsulated, they are resistant to mechanical or electrical damage. They may be used for capacitor switching, load break switching, fault current interruption, transformer magnetizing current and inductive switching, and high voltage transmission line dropping. They require no maintenance and are easily incorporated into existing installations.

Jennings Radio Mfg. Corp., Dept. ED, 970 McLaughlin Ave., San Jose 8, Calif.

CIRCLE 201 ON READER-SERVICE CARD



Differential Incrementer

0.05% accuracy

A differential instrument and stable reference combined, the differential "63" incrementer has 0.05% accuracy. Sensitivity is 200 μ a to 10 amp and 200 mv to 1000 v full scale. An incremental switch selects each 10% of the full scale range, extending the 6.3 in. scale to 63 in. and the 100 divisions to 1000. Direct reading; the unit requires no nulling or balancing.

Sensitive Research Instrument Corp., Dept. ED, 310 Main St., New Rochelle, N.Y.

CIRCLE 202 ON READER-SERVICE CARD

Electrodynamic Shakers

500 and 150 lb force output



Electrodynamic wideband shaker models 219 and 227 have the following respective ratings: force output, 500 and 150 lb; first bare table resonance, 6000 and 9000 cps; compensation requirements, none below 3000 and 5000 cps.

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

CIRCLE 203 ON READER-SERVICE CARD

Current Integrating Electrometer

500 μ ia to 1 ma range

For measuring radiation dosage from particle accelerators, model AEI-101 current integrating electrometer can also be used in industrial measurement control and instrumentation systems. With zero input impedance, it measures currents of 500 μ ia to 1 ma in six decade ranges. Integrator range is 1 millimicrocoulomb to 10 coulombs. Accuracy is $\pm 0.5\%$ of reading.

Applied Radiation Corp., Dept. ED, 2404 N. Main St., Walnut Creek, Calif.

CIRCLE 204 ON READER-SERVICE CARD



Signal Generator

4450 to 11,000 mc range

With two plug-in tuning units, model PMX signal generator covers 4450 to 11,000 mc. It generates internal pulse, square wave, or fm signals; or it can be externally modulated. Variable pulse width is 0.2 to 10 μ sec; delay, 2 to 2000 μ sec; repetition rate, 10 to 10,000 pps; rise and decay time, 0.1 μ sec. Frequency accuracy is $\pm 1\%$.

Solarad Electronics Corp., Dept. ED, 43-20 34th St., Long Island City 1, N.Y.

CIRCLE 205 ON READER-SERVICE CARD

concerned about



SPACE? or WEIGHT?

USE NEW IRC MOLDED METAL FILM PRECISION RESISTORS

If you need the precision of a wire wound resistor, but in a space-saving, weight-saving size, IRC's new Type ME Metal Film Precision Resistors are for you.

Not only do they save weight and space but they are equal or superior to wire wound resistors in many respects as noted at right:

1. Higher environmental performance
2. Higher statistical performance on environmental tests
3. Higher ambients, extended lives, extended moisture and temperature cycling
4. Better RF characteristics
5. Comparable or lower in cost
6. Resistance values are stable—just as stable for a 1% resistor as for a 0.10% resistor—just as stable for low T.C.'s as high T.C.'s.

TEMPERATURE COEFFICIENT—In order to meet the variety of T.C. requirements, precision metal films are offered in eight classifications. You may order T.C.'s as close as those for precision wire winds... or, where it is not critical, T.C.'s up to ± 100 PPM are available. Classifications are listed below:

Classification	PPM	Temperature span
T-1	± 100	$-55\text{ C } +165\text{ C}$
T-2	± 50	$-55\text{ C } +165\text{ C}$
T-3*	$-0 +100$	$-55\text{ C } +165\text{ C}$
T-4*	$+0 -100$	$-55\text{ C } +165\text{ C}$
T-5	± 25	$-25\text{ C } +105\text{ C}$
T-6*	$+50 -0$	$-55\text{ C } +165\text{ C}$
T-7*	$-50 +0$	$-55\text{ C } +165\text{ C}$
T-8*	± 25	$-55\text{ C } +165\text{ C}$

*Special types.

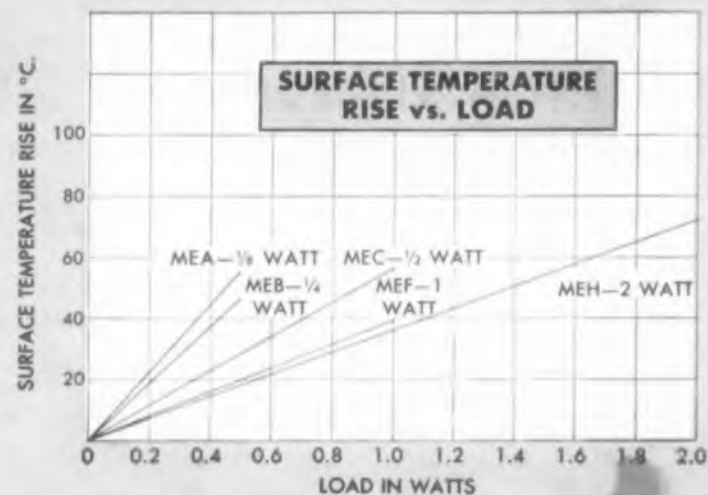
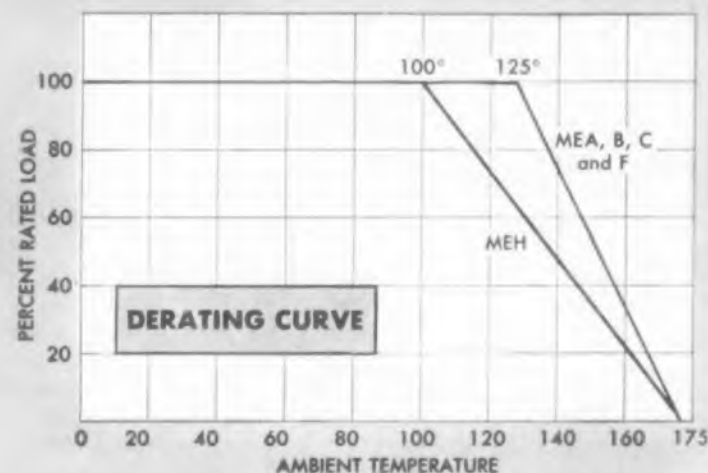
OTHER CONSTRUCTION ADVANTAGES—The new IRC Molded Metal Film Resistors eliminate two other bugaboos of wire wound resistors.

1. No cold joint problem. There is no unsolderable resistance wire in the metal film resistor to be soldered to the terminals. 2. No failure due to excess winding stresses because there are no windings.

IRC Type	5 Wattage Ratings (125 C Ambient)	Maximum Continuous Voltage Rating	New Range Minimum** Ohms	New Range Maximum** Ohms
MEA	1/8	250 V	30	500 K
MEB	1/4	300 V	50	1 meg
MEC	1/2	350 V	50	1.5 meg
MEF	1	500 V	50	4 meg
MEH	2*	750 V	100	10 meg

*100°C Ambient Max. below 500 K ohms.

****NEW EXTENDED RANGES**—These new ranges have lower minima and higher maxima by far than our former corresponding values.



Write for New Catalog Data Bulletin



INTERNATIONAL RESISTANCE COMPANY • Dept. 331 • 401 N. Broad St., Phila. 8, Pa. • In Canada: International Resistance Co. Ltd., Toronto, Licensee
CIRCLE 206 ON READER-SERVICE CARD

Electronic Products **NEWS**

by **CARBORUNDUM**

Registered Trade Mark



"QUAIL" Contact Arc Suppression Problems solved with GLOBAR[®] silicon carbide varistors

Less publicized than its more spectacular cousins, the "Quail" decoy missile, shown above, nevertheless represents an important development of the missile art. It is designed for air launching from bombers such as the B-47 and B-52 and, once in flight, is under continuous radio control. The Quail is powered by a GE J-58 engine and is manufactured for the Air Force by McDonnell Aircraft of St. Louis.

The electronic control circuits involve many relays. Contact arc suppression and suppression of RF in-

terference are achieved with GLOBAR silicon carbide varistors. Choice of these components results from their extreme ruggedness, small size, reliability and excellent performance characteristics — all essential in missile applications.

Catalogs on types, ratings and other characteristics of varistors and other forms of silicon carbide resistors are obtainable by writing to GLOBAR Plant, Refractories Division, Dept. EDV 29, The Carborundum Company, Niagara Falls, N. Y.

High Purity MgO Swaging Tubes for Thermocouple Insulation



Insulation of thermocouple wires, used in such equipment as gas turbines and nuclear reactors, involves stringing them through a tube of sintered magnesium oxide, inserting in a stainless steel sheath and then swaging.

For correct packing of the MgO insulation, which is crushed in the swaging operation, close tolerances apply to diameters and location of the holes in the swaging tubes. MgO must be of high purity, particularly for nuclear work.

These tubes are typical of the many examples of magnesia, alumina and zirconia insulating ware made by Carborundum and widely used in electronic components. For information, write Latrobe Plant, Refractories Division, Dept. EDM 29, Carborundum Company, Latrobe, Pa.

NEW PRODUCTS

Integrating Accelerometer Transistorized



Closing a set of contacts at predetermined velocities, this transistorized integrating accelerometer provides analog outputs relative to acceleration and velocity. These outputs are used in turn to actuate various control functions. The velocity contacts can be closed at any speed from a few feet to 50,000 ft per sec with accuracies up to 0.25% over extended operational periods. The unit has a pressure range of 0 to 35 psia and a temperature range of 30 to 150 F. It will operate under ± 15 g vibration to 2000 cps and withstand 75 g shock. Acceleration ranges from ± 1 to ± 20 g and greater are available. The unit weighs 4 lb.

Donner Scientific Co., Transducer and Systems Dept., Dept. ED, Concord, Calif.

CIRCLE 208 ON READER-SERVICE CARD

Integrator

Prints out recorder chart data



For simultaneous integration of recorder chart data, integrator model 194 automatically prints out chart area measurements at rates to 1000 counts per min. It prints numerals on standard adding machine tape. One of its uses is the integration of rocket thrust with transducers to obtain propulsion efficiency.

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

CIRCLE 209 ON READER-SERVICE CARD

NEW HIGH TEMPERATURE RESISTORS handle up to 25 watts at 1000F. with no de-rating

Limited quantities of high temperature resistors developed by Carborundum are now available. These answer a definite need in many defense and possible commercial electronic applications. They may be well suited to equipment where nuclear

radiation is present, since the materials from which they are made have relatively low sensitivity to induced radio activity.

RESISTANCE RANGE

Watts	Size	Resistance Range
0.5	3/8" x 1/8"	0.2 - 2 K
1.0	1/4" x 1/8"	0.4 - 4 K
2.0	1 3/4" x 1/8"	0.8 - 8 K
5.0	1 1/4" x 3/8" (i.d. .0168")	0.1 - 1.8 K
10.0	2" x .4125" (i.d. .288")	0.2 - 2.3 K
25.0	4" x 1/2" (i.d. 3/8")	0.1 - 1.1 K

Terminations are suitable for spot welding or brazing. Fuse clip terminations are also offered in the larger sizes. Write to GLOBAR Plant, Refractories Division, Dept. EDR 29, The Carborundum Company, Niagara Falls, N. Y.

NEW BOOKLET AVAILABLE ON GLASS-TO-METAL SEALS



Glass-to-metal seals are essential in many types of electronic equipment. This is a complete catalog of types, specifications and applications. For your copy, write Latrobe Plant, Refractories Division, Dept. EDS 29, Carborundum Co., Latrobe, Pa.



CERAMIC PARTS AND METALLIZED ASSEMBLIES GLASS-TO-METAL SEALS KOVAR ALLOY CERAMIC RESISTORS VARISTORS THERMISTORS

CIRCLE 207 ON READER-SERVICE CARD



Terminal Blocks For printed circuits

Miniature type 520 terminal blocks have screw connections integral with terminal pins that slip into standard connector mounting holes in printed circuit boards. To connect the assembled units, the pins passing to the under side of the board are dip soldered. The blocks come with 2 to 24 terminals.

Vulka Electric Corp., Dept. ED, 633-643 S. Fulton Ave., Mt. Vernon, N.Y.

CIRCLE 210 ON READER-SERVICE CARD



Precision Bridges

Checks synchros or resolvers to 20 ppm

For checking synchros or resolvers every 5 deg of arc, model PSB-5 and PRB-5 bridges have 0.002% accuracy from 0 to 4000 cps. They may be used at reduced accuracies to 10 kc. Arm resistance is 10 K \pm 0.01%, input voltage, 115 v ac; and harmonic distortion, zero.

Julie Research Labs, Inc., Dept. ED, 556 W. 168th St., New York 32, N.Y.

CIRCLE 211 ON READER-SERVICE CARD

Precision Phase Detectors

100 kc to 15 mc range



Type 205A1 and 205A2 phase detectors measure phase angle or time delay within 0.05 deg or 1 ns from 100 kc to 15 mc. Respectively, resolution times are 8×10^{-11} and 8×10^{-12} sec and delay ranges are continuously variable from 0 to 11 and 0 to 1.1 μ sec.

Jul-Yu Electronics Lab, Inc., Dept. ED, 249 Teaneck Ave., Passaic, N.J.

CIRCLE 212 ON READER-SERVICE CARD

flyweight champ goes the limit....



New SUBMINIATURE RELAY SHOWS UNVARYING HIGH PERFORMANCE UNDER VIOLENT ENVIRONMENTAL ASSAULT.

Wheelock Signals, Inc. has successfully packaged high performance and superior environmental stability in an unprecedented relay design of exciting import to airborne electronics designers. In fit and fighting trim, the new Crystal Case Relay (weight 0.4 oz.) is designed for a minimum of 100,000 functional operations in ambients from -65° to $+125^{\circ}$ C. Shock, vibration and acceleration immunity exceed MIL spec demands.

Now, spatial requirements are eased significantly in your guidance electronics package telemetering transmitter—radar "black box"—mobile communications equipment modulators, amplifiers, power supplies.

Available with standard terminations for plug-in, solder or printed circuit use. Write for descriptive literature: Bulletin 160-1.



SPECIFICATIONS

Shock	50g per MIL-R-5757C
Vibration	10-55 cps, 1/8" excursion 55-2000 cps at 20g
Ambient Temperature	-65° C to $+125^{\circ}$ C
Dielectric strength	1000 volts rms
Dielectric strength across open contacts	500 volts rms
Contact life, operations	100,000 min. @ rated load
Contact material	Palladium-to-gold flashed silver other material available
Contact resistance	05 ohms max.
Pickup time, nominal voltage	5.0 millisees max.
Drop out time	5.0 millisees
Insulation resistance at 125° C	100 megohms
Contact arrangement	DPDT (SPDT on request)
Contact rating, 28v d.c. or 115v a.c.	2 amperes—resistive
Coil power, for min. operate	350 milliwatts
Coil resistance, 26.5 volt DC winding*	580 ohms
Relay weight	0.4 oz.

*Coils available for other voltages.

In this corner! the most reliable fractional ounce in your guidance package!

Wheelock SIGNALS
W S

CIRCLE 213 ON READER-SERVICE CARD



RELIABILITY IS ONE REASON WHY ENGINEERS SELECT
ASTRON METALLIZED MYLAR* CAPACITORS FOR

**critical
military and
industrial
applications**

RELIABILITY AT HIGH TEMP LIGHT WEIGHT SPACE SAVING

See us at IRE Show Booth #2716

MYLAR* METALLIZED, ASTRON TYPE RQL

A remarkably versatile unit in a miniature, hermetically sealed, metal case . . . assured reliability at high temperatures . . . to +125° C without derating . . . designed in a variety of military type cases and mounting styles . . . far superior to conventional metallized paper capacitors. For military reliability equipment . . . missiles . . . critical industrial uses.

METALLIZED MYLAR*, ASTRON TYPE RLR

A small size, uncased durable unit in a tough Mylar* wrap with epoxy end seal . . . reliable performance at high temperatures to +125° C without derating . . . low cost unit for potted and hermetically sealed assemblies . . . military high reliability equipment . . . communications . . . noise suppression systems . . . superior unit to conventional cardboard cased metallized tubulars.

WRITE TODAY FOR COMPLETE SPECIFICATIONS ON ASTRON'S RELIABILITY SERIES OF METALLIZED MYLAR* CAPACITORS, MYLAR* CAPACITORS, PAPER DIELECTRICS, METALLIZED PAPERS AND SAFETY MARGIN** ELECTROLYTICS.

ASTRON BULLETIN
RM-300
FOR TYPE RQL



ASTRON BULLETIN
RM-375
FOR TYPE RLR

CIRCLE 214 ON READER-SERVICE CARD

**ASTRON
CORPORATION**

255 GRANT AVENUE E. NEWARK, N. J.



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ROCKE INTERNATIONAL CORP.
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QUICK DELIVERY OF
ASTRON PRODUCTS IS
AVAILABLE THROUGH
AUTHORIZED ASTRON
STOCKING DISTRIBUTORS.

NEW PRODUCTS



**Transistorized
Shift Registers**

Operate at 2 mc rates

Transistorized shift registers SR-4-2M and SR-10-2M have four and ten register stages, respectively, and handle up to 2 million binary bits a second.

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

CIRCLE 215 ON READER-SERVICE CARD

Sound Level Meters

Portable

Small, light, and easy to hold, type 1551-B portable sound-level meter has a meter circuit which closely approximates rms response. It also has a calibration circuit for amplifier gain standardization which does not require a power line connection, and an adjustment for microphone sensitivity which facilitates the use of special purpose microphones.

General Radio Co., Dept. ED, 275 Massachusetts Ave., Cambridge 39, Mass.

CIRCLE 216 ON READER-SERVICE CARD

Regulated DC Power Supply

Transistorized



Transistorized model MTR2S-10 power supply provides 24 to 32 v dc at 10 amp from a 100 to 125 v ac, single phase, 60 cps input. Regulation is $\pm 0.1\%$ for line and ± 0.4 v no load to full load. Output impedance is 0.05 ohms; ripple, 2 mv rms.

Perkin Engineering Corp., Dept. ED, 345 K Street, El Segundo, Calif.

CIRCLE 217 ON READER-SERVICE CARD

DC to DC Converters

30 to 1000 v outputs



From standard 6, 12, and 28 v dc sources, series DC transistorized converters provide outputs from 30 to 1000 v dc. The 6 v models handle up to 100 w; the 12 v models, up to 200 w; and the 28 v models, up to 150 w.

Sorensen & Co., Inc., Dept. ED, Richards Ave., South Norwalk, Conn.

CIRCLE 218 ON READER-SERVICE CARD



Differential Voltmeter

For dc and ac

Model 803 dc and ac differential voltmeter has 0.05% dc and 0.2% ac accuracy from 0.1 to 500 v. Frequency response of the ac converter section is 10 cps to 5 kc. The unit provides direct in-line digital readout and automatic decimal placement.

John Fluke Mfg. Co., Inc., Dept. ED, 1111 W. Nickerson St., Seattle 99, Wash.

CIRCLE 219 ON READER-SERVICE CARD

Servo Assembly

For null balance systems



Designed for use in automatic null balance systems, this servo assembly includes a Holtzer-Cabot 4 pole 60 cps motor, digital counters with automatic shutter action to indicate plus or minus digital output, and one or more balance or output potentiometers. Synchro output and a Coleman decimal Digitizer are optional.

Datran Electronics, Dept. ED, 1836 Rosecrans Ave., Manhattan Beach, Calif.

CIRCLE 220 ON READER-SERVICE CARD

SETTING THE PACE IN KLYSTRON

Power Supplies

on the production line or in the laboratory

a leader in the

PRD PACEMAKER LINE



For lower voltage klystron tubes, PRD type 809 Klystron Power Supply provides flexible, economical performance. Built to the same highest quality standards as type 812, this compact, low cost unit insures optimum performance of a wide variety of klystron oscillators. A clamping circuit in the reflector supply reduces the possibility of double-moding the klystron.



For use with all available klystrons in the low power range and for klystrons at power levels up to 5 watts, the completely new type 812 Universal Klystron Power Supply provides:

- widest application
- closest regulation
- greatest range
- minimum ripple and noise
- pulse, square wave, sawtooth and sine wave modulation.

PLUS THESE SPECIAL FEATURES:

- digital read-out for beam and reflector voltages.
- dual outputs for simultaneous operation of two klystrons.
- grid and reflector voltage clamped to CW level in square wave or pulse operation.
- front panel check calibration of grid and reflector voltages.
- multi-range overload protection for beam current.
- safety lock when transferring from + to - grid voltage.
- external triggering of internal pulse generator

For additional details, contact your local PRD Engineering Representative or write to Technical Information Group, Dept. TIG-1.

POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC.

202 Tillary Street • Brooklyn 1, N. Y.

CIRCLE 221 ON READER-SERVICE CARD



SPECIFICATIONS			
OUTPUT		Type 812	Type 809
Beam	Volts, dc	200 to 3600	250 to 600
	Current, ma	0-125	0-65
	Ripple, mv rms	5 max.	5 max.
Reflector	Volts, dc	0 to -1000	0 to -900
	Current, μ a	50 max.	50 max.
	Ripple, mv rms	1 max.	10 max.
Grid	Volts, positive	0 to 150	—
	negative	0 to 300	—
	Current, ma	5 max.	—
	positive grid Ripple, mv rms	3 max.	—
MODULATION		Type 812	Type 809
Square Wave	Frequency, cps	500 to 5000	400 to 2000
	Volts*	0 to 150 (clamped)	0 to 90
Pulse	Frequency, cps	500 to 5000	—
	Volts*	0 to 150 (clamped)	—
Sawtooth	Frequency, cps	40 to 120	60, fixed
	Volts*	0 to 200	0 to 125
Sine Wave	Frequency, cps	60, fixed	—
	Volts*	0 to 200	—

*Volts, peak to peak

MINIATURE AND SUB-MINIATURE

relays by **Hi-G**



HG-25M

Rugged and reliable relays are manufactured at Hi-G in a wide range of standard units... and to customer order with special designs to meet your particular requirements.

Complete experimental and prototype facilities permit Hi-G engineering personnel to study and evaluate your relay needs.

New, complete illustrated specification sheet available. Write for your free copy today.

And for information on special relay units, send your specifications to Hi-G for study and recommendations at no obligation.

rugged / reliable / shock and vibration resistant

A FEW OF THE WIDE RANGE OF HI-G STANDARD RELAYS



HG-25MP

HG-4SL

HG-2MS

HG-4R

Hi-G inc.

BRADLEY FIELD

WINDSOR LOCKS, CONN.

CIRCLE 423 ON READER-SERVICE CARD

1/3 the size... 1/2 the cost!

Metronix
ELECTRONIC VOLTMETERS
Panel-mounted, single and multi-range

FROM 1/3 to 1/8 smaller than conventional units, these METRONIX instruments occupy no more panel space than the meter.

METRONIX AC and DC models are the smallest available with such a wide choice of ranges. Single-range, military, rack-mounted and plug-in types.

Ask for Bulletin M-602

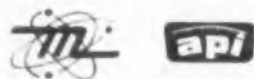
MODEL 300 D. C. (illustrated)

RANGES: 0-1 3 10 30 100/300/1000 volts D. C.

ACCURACY: ±3%, full scale deflection

INPUT RESISTANCE: 10 megohms

PRICE: \$94.50



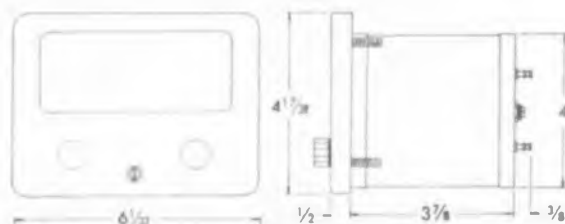
Metronix INC

A SUBSIDIARY OF

Assembly Products Inc.

Chesterland 17, Ohio

CIRCLE 424 ON READER-SERVICE CARD



NEW PRODUCTS



PDM Multicoder

Low level

In all standard IRIG sampling rates and channel configurations, series ML low level pdm multicoders have 0 to 10 mv full scale input sensitivity. The amplifier gain adjusts to provide any range to 100 mv full scale.

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

CIRCLE 223 ON READER-SERVICE CARD



Cathode Follower Probe

For use with long cables

For crystal type accelerometers, this cathode follower probe permits the use of cables up to 100 ft long without loss of accelerometer sensitivity. In low g level studies, because the cable going into the probe can be short, sensitivity can be increased as much as four times. Composed of passive circuitry, the unit is free from microphonics and withstands 600 F.

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

CIRCLE 224 ON READER-SERVICE CARD

Facsimile Packages

Duplicate components' shape

Shaped like the components they contain, these rugged, flexible film packages can be die cut and sealed in virtually any shape and size. Airtight, they are easily opened with a tear notch. Made from various thermoplastic materials such as cellophane, polyethylene, Pliofilm, glassine, Saran, and laminated combinations of foil, they can be joined in running strips and individually coded and imprinted.

Ivers-Lee Co., Dept. ED, 215 Central Ave., Newark, N.J.

CIRCLE 225 ON READER-SERVICE CARD



DON'T TURN TO THIS



call

H. O. Boehme, Inc.

Make your headache our challenge. We are specialists in precision product design and manufacture. Whether your problem is a precision electrical, electro-mechanical, or electronic product, we are ideally equipped to provide you with a satisfactory solution. Our organization integrates the finest engineering skills, the highest standards of craftsmanship, and the most modern physical facilities to enable you to meet the precision demands of this highly competitive, ever-growing field.



Spiral Gears



Spur Gear Clusters



Quadruple Thread Worms



Worm Wheels

The need for custom-made precision gears has been steadily growing to keep pace with the rapidly developing arts of automation and instrumentation. Since 1917 we have also been in the business of the design and manufacture of custom-made fine pitch precision gears and we have grown steadily in meeting these fine precision demands of modern industry. If your gear requirements include 1/8" to 3" O.D., 180 to 16 D.P., up to A.G.M.A. Precision #3, write or call us today. There is no obligation, of course.

H. O. Boehme, Inc.

Contractors, Designers, Manufacturers of Precision Electrical, Electro-Mechanical and Electronic Equipment since 1917

915 Broadway

New York 10, N. Y.



CIRCLE 226 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 18, 1959

Three different
relays with one
thing in
common . . .



Miniature Relay Type 95

Miniature Telephone-Type 115

High Voltage Relay Type 134-3468

Sure, these three relays were obviously built for three very different applications—yet they have one common denominator—AEMCO ingenuity. Originally developed to meet rigid electrical and mechanical requirements, these three relays are typical of AEMCO engineering and production facilities.

Although AEMCO manufactures a wide variety of relay types now available as "standards," custom development and manufacture to tight tolerances are AEMCO specialties. Want fast delivery on prototypes? Want outstanding engineering and production facilities at your disposal? Then, send us the specifications on your next relay—we may have an AEMCO "standard" that will save you tooling and valuable time—or if your problem is development, we'll be happy to design a relay to meet your specific requirements.

Need relays?
ask



AEMCO offers a complete line of relays in a wide choice of spring and coil combinations, operating potentials, and contact ratings. If one of hundreds of standard AEMCO relay types does not exactly meet your requirements, we will be happy to design and manufacture a unit to meet or exceed your requirements.

AEMCO also manufactures a complete line of Settable and Automatic Re-Set Timers, Time Switches and Sign Flashers.



WRITE TODAY

Your inquiries are invited. Ask for our free copy of Relay Catalog describing all standard relays in the AEMCO line.

AEMCO INCORPORATED

25 State St., Mankato, Minn.

CIRCLE 227 ON READER-SERVICE CARD

DC Ammeter-Voltmeter

49 possible ranges

Provided with clamp-on precision shunts and series resistances, this dc ammeter-voltmeter has 49 possible ranges. It has a hand calibrated mirrored scale 6.1 in. long and is accurate to 0.5% on all scale divisions.

National Electronics, Dept. ED, Sheridan, Wyo.

CIRCLE 228 ON READER-SERVICE CARD

PM Motor

±3% speed regulation

A 1-1/4 in. pm governed motor, type 13R-9102-00 stays within ±3% of 60 rpm with 60 oz-in. load and 24 to 29 v dc. The unit meets MIL-E-5272 environmental and MIL-I-681B radio noise specifications.

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

CIRCLE 229 ON READER-SERVICE CARD

Regulated Power Supply

High voltage



From inputs of 105 to 130 v, 60 cps, model 15K + 10C power supply provides a continuously adjustable output from 1 to 15 kv dc at 0 to 10 ma. Regulation is 0.1 v; ripple and noise are 50 mv; and output impedance is 10 ohms.

Moran Instrument Corp., Dept. ED, 170 E. Orange Grove Ave., Pasadena, Calif.

CIRCLE 230 ON READER-SERVICE CARD

Pulse Generator

For nuclear applications

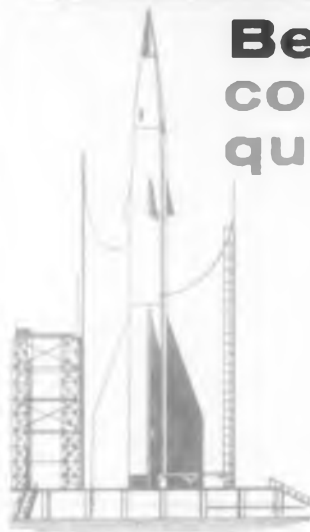
Designed to check and calibrate nuclear instruments, portable model PRG-127 precision pulse generator delivers positive or negative pulses with 7 μsec rise and 300 μsec decay time. Output is variable from 1 μv to 10 v.

Atomic Accessories Inc., Dept. ED, 244-02 Jamaica Ave., Bellerose 26, N.Y.

CIRCLE 231 ON READER-SERVICE CARD



Before you specify . . .
countdown the **EMCOR**[®]
quality cabinet features



EMCOR Console of eight standard frames and their components.

The EMCOR MODULAR ENCLOSURE SYSTEM consisting of a complete line of standard cabinets offers design engineers flexibility and craftsmanship features comparable to custom-made units. Heavy gauge, prime quality, cold rolled steel gives EMCOR frames rugged structural support . . . "Heliarc" welding used specifically for its superior quality . . . Adjustable panel mounting angles engineered to easily recess equipment . . . BONDERITE coating provides maximum protection and adhesion for the final finish . . . EMCOR finish is a special metallic baking enamel in two tones of gray which has been carefully developed and selected for its pleasing, dignified two-tone contrast without clashing with other colors introduced within an installation . . . these are some of the many quality cabinet features found in standard EMCOR enclosures.

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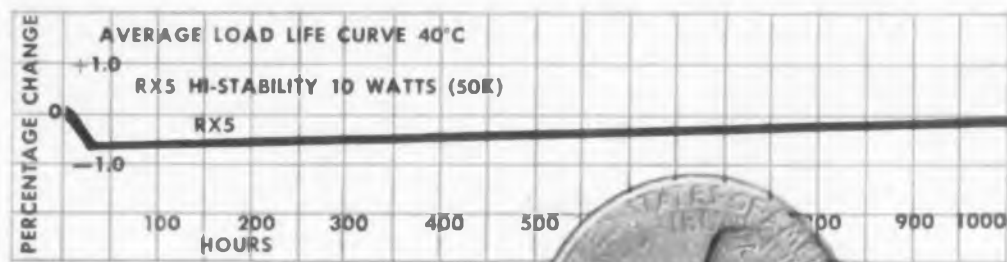
Originators of the Modular Enclosure System



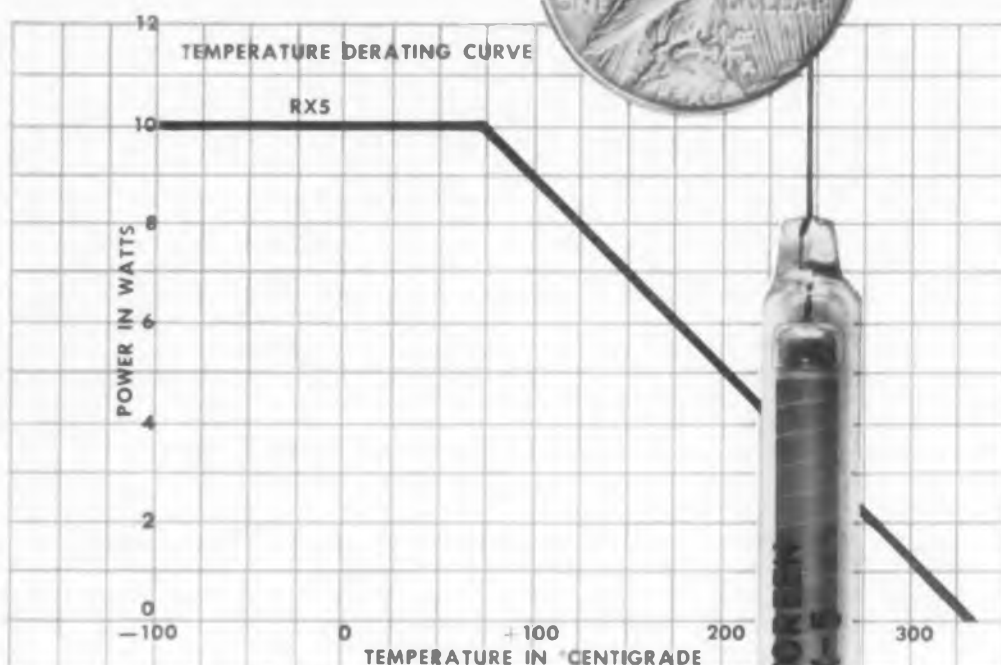
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Now—under a dollar



Now—the same
**HIGH QUALITY
VICTOREEN**
deposited carbon
resistors at the new
LOWER PRICE

Victoreen Glass-Sealed Resistors have always been synonymous with the highest product quality. You get high power with high stability . . . absolute independence from unfavorable environments . . . closer production and inspection tolerances.

And now—because of new quality-volume production techniques—Victoreen can offer these superb components at highly competitive prices. New pricing structure, with large quantity discounts, brings prices down below a dollar. The trend is to Victoreen Deposited Carbon Resistors—get with it *now*. AA-9242



Victoreen

5806 Hough Avenue • Cleveland 3, Ohio

CIRCLE 233 ON READER-SERVICE CARD

NEW PRODUCTS



Rate Gyros

Serve as two units

With one motor that drives two wheels, series RG-18 rate gyros can be used to measure rates about two axes. RG-20 units cover two rate ranges about the same axis. Built with two independent pickoffs, these gyros operate from -65 to $+180$ F and are resistant to shock and vibration.

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

CIRCLE 234 ON READER-SERVICE CARD



Variable Speed Drive

85 to 95% efficiency

This Servotran variable speed drive has a constant output torque and 85 to 95% efficiency. A maximum of 2 in. oz. on its control shaft changes speed from full forward to full reverse in 0.05 sec. Without the motor, it is 3-3/4 in. long and 2 in. in diameter.

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

CIRCLE 235 ON READER-SERVICE CARD



Connectors

Withstand 750 F

Designed for use with remote handling equipment, these connectors withstand 750 F and large doses of radiation. Available with various pin combinations up to 250 contacts, they allow for misalignment up to 3/4 in. and 15 deg in mating. Suited for aircraft and missiles, they contain a locking mechanism to prevent disengagement under severe vibration.

Anderson Electric Corp., Dept. ED, Birmingham 1, Ala.

CIRCLE 236 ON READER-SERVICE CARD



**why AMPEX
squares the
hysteresis loop**

Ampex Instrumentation Tape inherits the same versatility and quality which make Ampex first in magnetic tape instrumentation.

Coercivity and retentivity are carefully balanced to square the hysteresis loop for uniformly higher output over the entire frequency spectrum. This optimized B-H curve suits Ampex tape to any recording mode: direct, FM-carrier, PDM or NRZ-digital.

The exclusive Ferro-Sheen process makes Ampex the smoothest of magnetic tapes. Improved head contact means consistently higher output and less noise from the very first run, unlike other tapes which get "hotter" as they wear smooth.

Smoothness means uniformity of output, too, within a range of 0.25 db on each reel for low frequencies, a 1.5 db range for the highs. And regardless of base type or thickness, Ampex tapes are interchangeable without equalization or bias adjustment.

Ampex Instrumentation and General-Purpose Tapes are available on hubs, NAB-type or die-cast magnesium-alloy Precision Reels. Widths of 3/4, 1/2 and 1" are standard on either Mylar* or acetate base, in the following lengths, reel diameters, and base thicknesses:

AMPEX STANDARD TAPE LENGTHS (feet)		
REEL DIAMETER	BASE THICKNESS (mil)	LENGTH
7"	1800	12'
10 1/2"	2600	25'
14"	7200	50'

*DU PONT TRADEMARK

For complete specifications and additional tape literature, write:

**AMPEX
MAGNETIC TAPE**

934 CHARTER STREET, REDWOOD CITY, CALIF.

CIRCLE 237 ON READER-SERVICE CARD

STODDART

COAXIAL ATTENUATORS AND TERMINATIONS

made with exclusive Stoddart Filmistors for highly accurate and stable resistive values from dc to 3000 mc.

2, 6 and 10-position
TURRET ATTENUATORS
with simple "PULL-TURN-PUSH"
operation, small and rugged.



Protected under
Stoddart Patents

ATTENUATOR PADS



Available in any conceivable combination of male and female Type C and Type N connectors. Maximum length of 3" for any attenuation value.

GENERAL SPECIFICATIONS

VSWR: Less than 1.2 to 3000 mc.
Characteristic Impedance: 50 ohms.
Attenuation Value: Any value from 0 db to 60 db including fractional values.
Accuracy: ± 0.5 db; values above 50 db have rated accuracy of attenuation through 1000 mc only.
Power Rating: 1.0 watt sine wave.

COAXIAL TERMINATIONS



Small-stable-50 or 70 ohms

1/2-Watt: 50 ohms impedance, TNC or BNC connectors, dc to 1000 mc, VSWR less than 1.2.

1-Watt: 50 ohms impedance, dc to 3000 mc or dc to 7000 mc, Type N or Type C connectors, male or female; VSWR less than 1.2, 70 ohm, Type N, male or female terminations available.

Fast delivery on all items.
Send for complete literature.

STODDART

AIRCRAFT RADIO CO., INC.
44 Santa Monica Blvd., Hollywood 38, Calif.
Hollywood 4-9292

CIRCLE 238 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 18, 1959



Test Point Connectors

Check printed
circuitry

For checking printed circuitry, these test point connectors accept standard 0.08 test probes and have pins for right angle dip soldering to a printed circuit board. Single contact series TJ and multicontact series 672 and 145-60 all have current ratings of 5 amp continuous and 7.5 amp maximum.

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

CIRCLE 239 ON READER-SERVICE CARD

Oscillographs

Multichannel



Compact and rugged, these oscillographic recorders simultaneously handle six continuous analog data channels and three on-off channels for timing and event markers with an accuracy of better than 1%. The output of the units is a series of continuous light beam traces which are recorded against a built-in time base on photographic paper. The transducers which supply the inputs are precalibrated, permitting quick read-out and interpretation of the output trace without computation. Both smaller and larger models are available. The smaller, 6 x 3-1/2 x 3 in. and 3-1/3 lb, provides 4 to 6 analog data channels and 2 on-off channels for event timing. With different gear trains, running time can be 2 min to 1-1/2 hr. The larger model weighs 22 lb and measures 13-1/4 x 6-3/4 x 7-1/2 in. It provides 10 analog data channels, 6 on-off channels, and up to 100 hr playing time. The units operate from 28 v dc and withstand accelerations to 20 g.

Applied Science Corporation of Princeton, Dept. ED, P.O. Box 44, Princeton, N.J.

CIRCLE 240 ON READER-SERVICE CARD



CLOSE-TOLERANCE PERFORMANCE

ON VERY TINY CURRENTS

WITHOUT SIGNAL AMPLIFICATION api VHS* MEASURING RELAYS SENSE AND SWITCH ON SMALL INPUT

*Very High Sensitivity with exceptional reliability are inherent characteristics of the A.P.I. measuring relay. It will actuate on inputs as small as 0.2 microampere or 0.1 DC millivolt to give you discrete switching action at the precise current or voltage value you specify.

The VHS measuring relay has the ability to differentiate between "normal and abnormal", "yes and no" on the basis of very minute electrical variations. In typical cases, it monitors 450 volts to $\pm 5\%$; in another, 14 microamps to ± 1 microamp.

Exceptional reliability and repeatability are achieved by the unique A.P.I. locking-coil design. At the point of contact, torque of the D'Arsonval movement is supplemented by the torque of the locking coil. Decisive switching action occurs with firm contact pressure. Contact resistance is low.

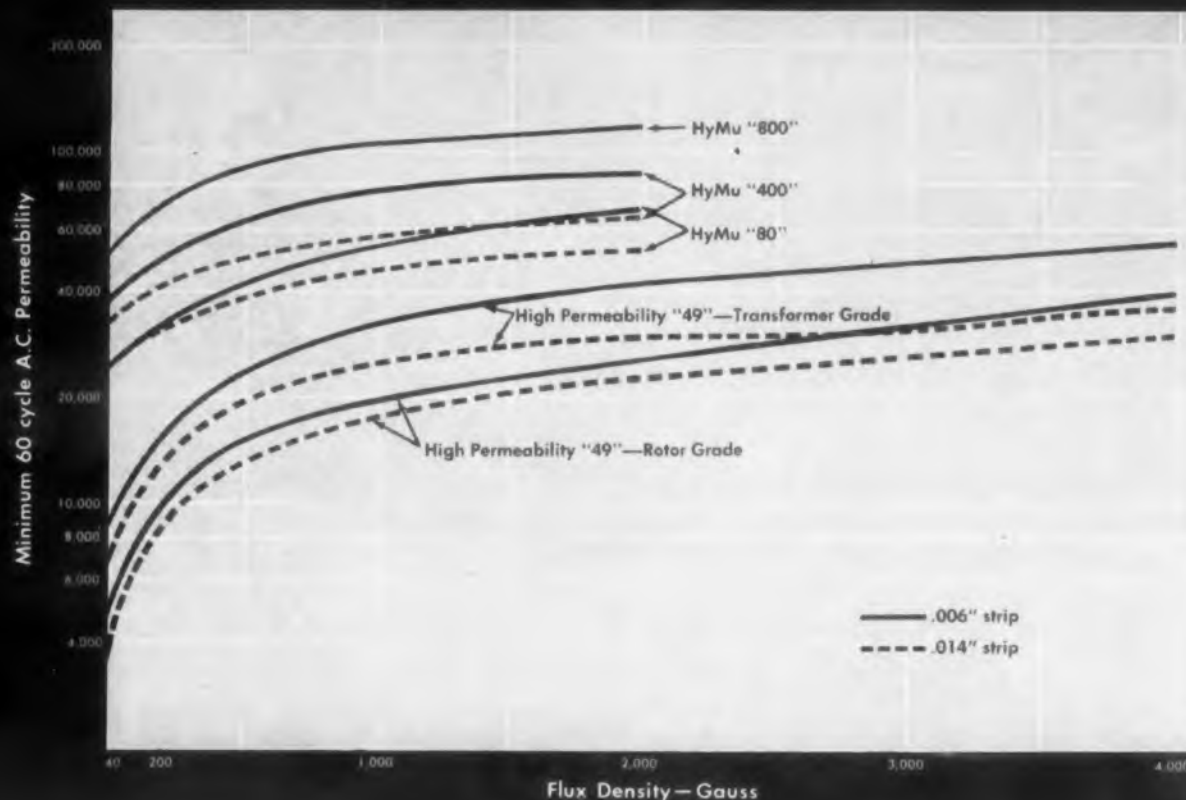
VHS measuring relays are available with high- and low-limit contacts, or either alone. Special models are available for excessive shock and vibration conditions.

Send today for Bulletin 104-D.



ASSEMBLY PRODUCTS, INC.
Chesterland 17, Ohio

CIRCLE 241 ON READER-SERVICE CARD



now... **higher magnetic permeabilities**
at low flux densities

Never before has precise control of magnetic and electronic components been so essential and never before has *Carpenter* been able to offer you as wide a selection of high permeability alloys for your low flux density requirements.

The new and improved alloys whose magnetic properties are shown above, represent the most recent developments in our continuing efforts to produce magnetic alloys that meet or exceed the ever-tightening requirements of modern electronic design.

Call *Carpenter* for the widest selection of magnetic alloys available from any steelmaker, anywhere. In addition to ten special grades of high permeability alloys for laminations and magnetic shielding applications, *Carpenter* offers a wide variety of alloys for magnetic cores including silicon core irons and stainless steels, and five types of temperature compensator alloys.

It's a rare set of special requirements that can't be answered by this selection.

Tell us your requirements. Write today, fully describing the magnetic characteristics you need . . . and ask for your free copy of *Carpenter's* new 64-page booklet describing the engineering properties of alloys now available for electronic, magnetic and electrical applications. The Carpenter Steel Company, 145 W. Bern St., Reading, Pa.

Carpenter STEEL

The Carpenter Steel Company

Main Office and Mills, Reading, Pa.

Alloy Tube Division, Union, N. J.

Webb Wire Division, New Brunswick, N. J.

Carpenter Steel of New England, Inc., Bridgeport, Conn.

CIRCLE 242 ON READER-SERVICE CARD

NEW PRODUCTS

Terminal Blocks

For feedthrough connections

These heavy duty terminal blocks are designed by the Bureau of Ships. Typical is type 7TB12, made to Navy drawing 9000, S6505B, 73214, Rev. H., which provides for feedthrough connections at top and bottom. Molded per MIL-M-14E, it comes with different lengths and terminal numbers.

Kulka Electric Corp., Dept. ED, 633-643 S. Fulton Ave., Mt. Vernon, N.Y.

CIRCLE 243 ON READER-SERVICE CARD

Double Slug Transformers

Match vswr of 4 to 1



For matching impedances where accurate vswr measurements are required, these coaxial double slug transformers match vswr as high as 4 to 1 at the design center frequency. They will also match small reactive vswr within ± 500 mc of the design center frequency. Designated series ST, type 1, the units have locking and tracking controls and use type N connectors. Available at any design center frequency between 1000 and 3500 mc, they handle 200 w cw and have a nominal impedance of 50 ohms.

Maury & Associates, Dept. ED, 10373 Mills Ave., Pomona, Calif.

CIRCLE 244 ON READER-SERVICE CARD

Thermal Time Delay Relays

Seated height of 1-3/32 in.

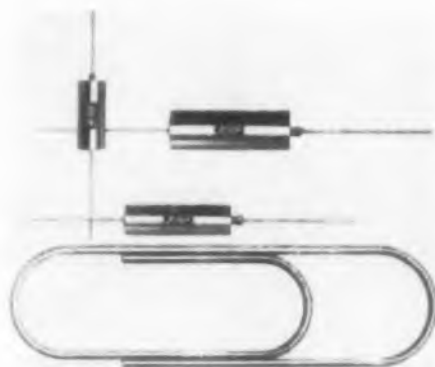
For delays from 1 to 300 sec, these time delay relays have a seated height of 1-3/32 in. and withstand -65 to $+125$ C temperature, 10 g vibration from 5 to 1000 cps, and 50 g shock. They are offered in heater voltages to 150 v interchangeable on dc or ac of any frequency with a power drain of 4 w. Contacts are rated at 6 amp, 115 v ac or 3 amp, 28 v dc resistive.

Dialtron Corp., Dept. ED, 203 Harrison Place, Brooklyn 37, N.Y.

CIRCLE 245 ON READER-SERVICE CARD

Solid Tantalum Capacitors

Miniature



The smallest type TES solid electrolyte tantalum capacitor available is 1/8 in. in diameter and 1/4 in. long; the largest is 11/64 in. in diameter and 7/16 in. long. Suited for computers, aircraft, and missiles, the units have capacitances ranging from 0.0047 to 47 μ f, with average variation $\pm 5\%$ at 25 C. Dissipation factor is less than 0.06, and leakage current at rated voltage and 25 C is 0.05 μ a per μ f per v, or 2 μ a, whichever is greater. Designed to MIL-C-3965 specifications, the units will operate at full rated working voltage from -80 to $+85$ C, and at 75% of rated voltage up to 125 C. They are contained in a conductive metal case hermetically sealed with a glass terminal. They have no external welds and may be completely encapsulated and mounted in any position.

Astron Corp., Dept. ED, 255 Grant Ave., East Newark, N.J.

CIRCLE 246 ON READER-SERVICE CARD

Transistorized Power Supplies

Provide 0 to 36 v dc



Operating from 100 to 130 v ac, 60 cps, model TR36-4M, -8M, -12M, and -20M transistorized power supplies deliver 0 to 36 v dc at 4, 8, 12, and 20 amp, respectively. Line regulation is $\pm 0.05\%$; load regulation, $\pm 0.1\%$.

Electronic Research Associates, Inc., Dept. ED, 67 Factory Place, Cedar Grove, N.J.

CIRCLE 247 ON READER-SERVICE CARD

GLOBE TYPICAL A.C. & D.C. ACTUATORS

2" DIA.

2 1/2" DIA.

2 3/4" DIA.

A.C. UNITS
synch. speed: 5 to 1000 rpm
power: up to 230 v a.c.
weight: about 30 oz.
housing: meets MIL specs for protection

5 1/4" TYPICAL

5 1/4" TYPICAL

5 1/4" TYPICAL

D.C. UNITS
governed speed: 5 to 1000 rpm
power: up to 70 v d.c.
weight: about 20 oz.
housing: meets MIL specs for protection

REQUIREMENTS EXCEEDING THOSE SHOWN ARE INVITED. SPECIAL ACTUATOR SHAPES WELCOMED.

GLOBE SPECIAL ACTUATORS / FROM STOCK PARTS

Globe Industries designs and builds rotary and linear actuators to your specifications . . . custom units can be in your hands quickly. Moreover, if required, Globe can deliver the correct precision motor and planetary gear reducer in 2 weeks if you want to breadboard the actuator first.

Specific reason for fast delivery and low cost—Globe builds actuators in many standard sizes; into the protective housing can go any of 10 different frame size motors with literally hundreds of standard windings. Hundreds of gear reducers are stocked or readily available, as are components for governors, switches, relays, potentiometers and other take-off and control elements. Our special engineering group quickly puts these standard components together to meet your prototype requirements. Intermittent torques to 2500 in. oz. (150 in. lb.)

Write for Bulletin 2000. Please outline your actuator needs for an engineering recommendation. Globe also makes precision timers, gyros, stepper motors, blowers and fans, servos, clutches and motorized devices. GLOBE INDUSTRIES, INC., 1784 Stanley Avenue, Dayton 4, Ohio.

CIRCLE 248 ON READER-SERVICE CARD



GLOBE INDUSTRIES, INC.

specialists in fasteners for industry

speed · versatility · positive performance

Outstanding creative engineering at Camloc has produced a variety of fastening devices. For access panels, doors, other closures, for simplified replacement of components and sub-assemblies. There are other fastening devices, designed for a variety of specialized applications, all of them retaining the three important features that characterize all Camloc products... speed, versatility and positive performance.

- | | |
|-----------------------------------|-----------------------------------|
| 1. SF fastener for thin materials | 6. Push Button Latch |
| 2. 2600 Series Quarter-Turn | 7. 28F Series Quarter-Turn |
| 3. Miniature Toggle Tension Latch | 8. 7C Harness Clamp |
| 4. 91F Heavy Duty Quarter-Turn | 9. 4002 Series Quarter-Turn |
| 5. Electronic Chassis Latch | 10. SPF (Stressed Panel Fastener) |

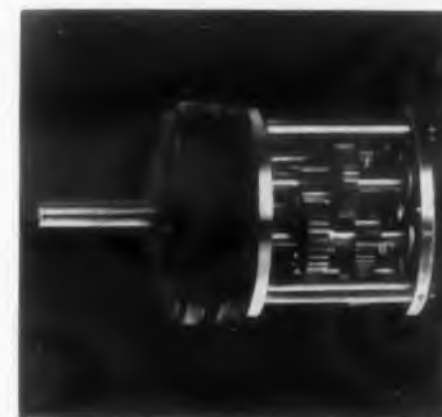
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The new Condensed
Catalog No. 59.
Write for your
free copy now.



NEW PRODUCTS

Gear Heads and Speed Reducers

30 min maximum backlash



Size 8 to 18, these precision gearheads and speed reducers have a high torque transmittal capacity to size ratio and a maximum backlash of 30 min. Available in a variety of ratios, they operate from -55 to $+150$ C.

Synchrosolve, Inc., Dept. ED, 269 Green St., Brooklyn 22, N.Y.

CIRCLE 251 ON READER-SERVICE CARD

Synchronous Timing Motors

7/8 in. thick



For 25, 50, or 60 cps operation in five standard voltage ratings, series 22100 synchronous timing motors are 7/8 in. thick. Over 125 standard output speeds from 300 rpm down to 1 revolution in six hours can be supplied with either standard or heavy duty gear trains. The units meet MIL-5272A requirements and have a nominal running torque of 30 oz-in. at 1 rpm. A nonmilitary version, series 42100, is available for high volume industrial and commercial applications.

The A. W. Haydon Co., Dept. ED, Waterbury, Conn.

CIRCLE 252 ON READER-SERVICE CARD

CAMLOC FASTENER CORPORATION • 61 SPRING VALLEY RD., PARAMUS, N. J. • LOS ANGELES, CALIF. • FT. WORTH, TEXAS

CIRCLE 250 ON READER-SERVICE CARD



Output Transformers

60 and 100 w
power ratings

Available in 2 to 8 K models, series P6000 output transformers have power ratings of 60 and 100 w. Their secondary windings are brought out as four separate sections which can be connected in series or parallel to match speaker impedances of 0.95, 3.8, 8.5, and 15 ohms. Frequency response is flat within ± 0.5 db from 20 cps to 30 kc, and total harmonic distortion is less than 1% at full power ratings and 25 or 35 cps. Made by Partridge Transformers, Ltd., England, the units are 4-5/8 x 4-5/8 x 4-7/8 in.

M. Swedgal Electronics, Dept. ED, 258 Broadway, New York 7, N.Y.

CIRCLE 253 ON READER-SERVICE CARD

Sweep Generators

High output, low leakage



Designed for production test or developmental checkout applications, precision generator models H-3, H-D, L-D, and S-D feature flatness, high output, and low leakage. They are engineered with crystal controlled single frequency or harmonic plug-in markers, with external marker provisions on all models. The cabinets, 20 x 10 x 15 in. have perforated tops and integral cooling vents. Slide-track chassis mountings and full width top openings afford easy accessibility for servicing. The units operate on standard 115 v ac power.

Telonic Industries, Inc., Dept. ED, Beech Grove, Ind.

CIRCLE 254 ON READER-SERVICE CARD



Truly sub-miniature, these capacitors were devised especially for printed circuits and automatic assembly. Since they retain all the properties of larger, pig-tail capacitors, they are well suited to general circuitry as well.

Now—Corning Fixed Glass Capacitors in new sub-miniature size

Packing up to 1,000 uuf at 300 V. and 125°C. into 0.010 cubic inches, these new capacitors are designed for use on printed circuit boards and all applications requiring high-quality components. Advantages include fixed temperature coefficient, high insulation resistance, low dielectric absorption, the ability to operate under high humidity and high temperature conditions, plus the added advantage of increased miniaturization.

You can now up-grade your specs for miniature capacitors used on printed circuits.

These new capacitors measure only $\frac{9}{32} \times \frac{1}{64} \times .115$, yet have capacitances up to 1000 uuf at a full 300 V. rating at 125°C. Such exceptional thinness makes these capacitors particularly well suited for vertical mounting in small, high-rated units.

The capacitors have high temperature soldered leads which allow direct connection to circuit boards. The leads are .100 inches long, fitting most circuit board thicknesses and eliminating any trimming.

Reliable • Since the new construction is extremely simple, reliability is correspondingly high.

Rugged • These capacitors, when mounted, successfully withstand a standard five-hour vibration cycling test at 10 to 55 cycles, 15G Max.

Known as WL-4 capacitors, these units are in mass production. Your inquiries concerning data and prices are welcome.

FEATURES

1. to MIL C-11272A except smaller
2. 1 to 1,000 uuf
3. 300 volts
4. 125°C. full rating
5. .010 cubic inches

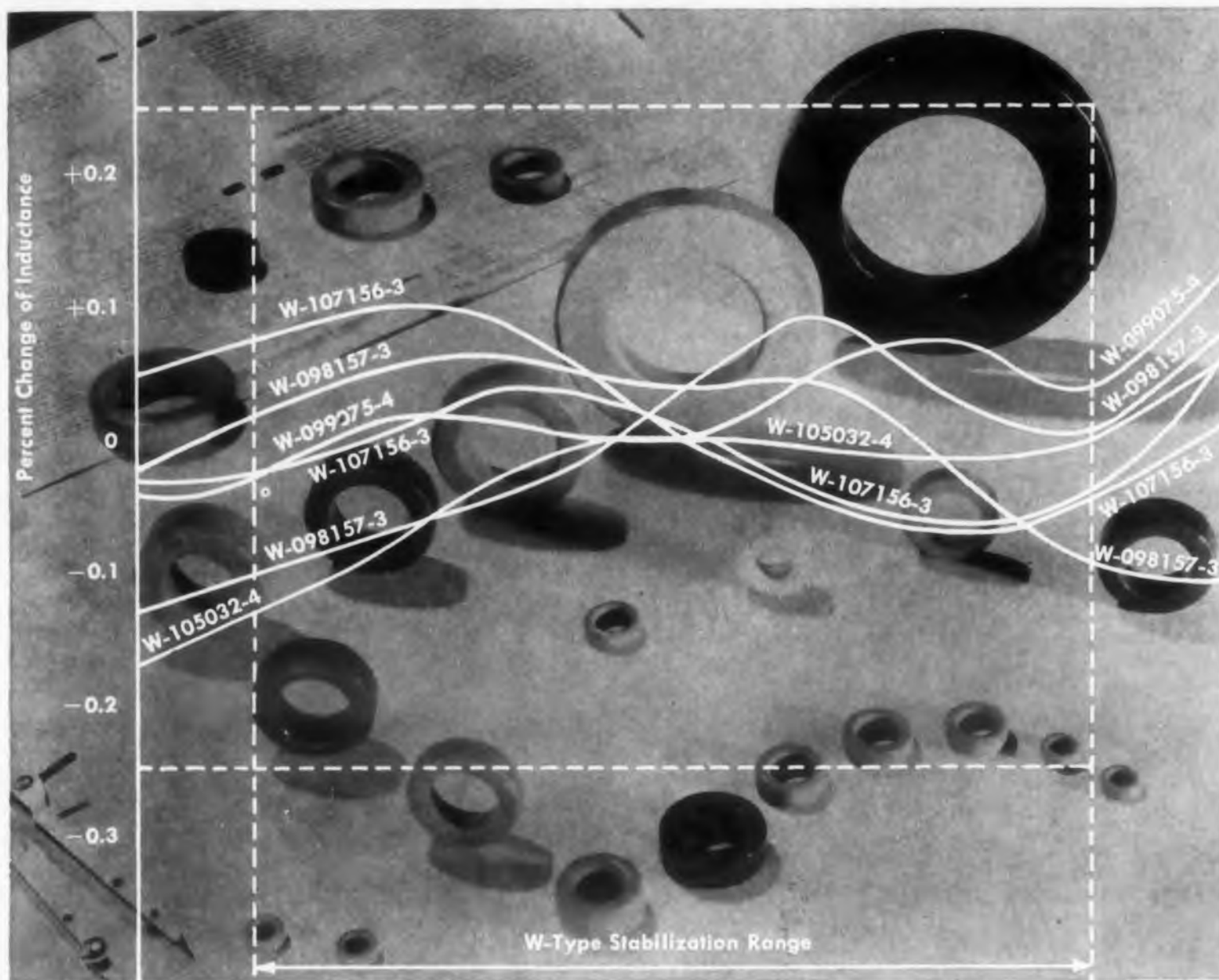
Corning means research in Glass



CORNING GLASS WORKS, Bradford, Pennsylvania

Electronic Components Department

CIRCLE 255 ON READER-SERVICE CARD



ARNOLD offers you the widest selection of Temperature Stabilized MO-PERMALLOY POWDER CORES

Arnold Molybdenum Permalloy powder cores are available with the temperature coefficient of inductance controlled within certain limits over specific temperature ranges. Most core sizes and permeability combinations can be supplied in at least one of the four different types of temperature stabilization available.

For example, most of the popular core sizes are manufactured in the new type of wide range—"W"—stabilized cores whose temperature coefficient of inductance does not exceed 0.5% over the temperature range covered by the

MIL-T-27 specification of -55°C to $+85^{\circ}\text{C}$.

This type of guaranteed maximum change of inductance with temperature, as well as the constancy of permeability with time and flux level, are of particular importance to apparatus and circuit engineers. Many precision military and industrial applications demand the uniform performance and the excellent physical properties found only in Arnold Mo-Permalloy powder cores.

For design flexibility they are furnished in a full range of sizes, up to 5.218" O.D., in four standard permeabilities: 125, 60, 26 and 14. You will find them dependable and easy to use. You will find most sizes and types in stock now for immediate shipment.

Let us furnish your requirements for temperature stabilized Mo-Permalloy powder cores, or any magnetic materials you need, from the most complete line in the industry. ● Address *The Arnold Engineering Company, Main Office and Plant, Marengo, Illinois.*

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Find them FAST in the YELLOW PAGES

For more information write for Bulletin PC-104B

Lists complete line of Mo-Permalloy Powder cores . . . available in 25 sizes from 0.260" O.D. to 5.218" O.D. Furnished also with various types of temperature stability from Type "A" unstabilized to Type "W" stabilized over the temperature range of -65°F to $+185^{\circ}\text{F}$.

ADDRESS DEPT. ED-92

CIRCLE 258 ON READER-SERVICE CARD

NEW PRODUCTS

Voltage Regulator Tubes

for 3 kv to 12 kv operation



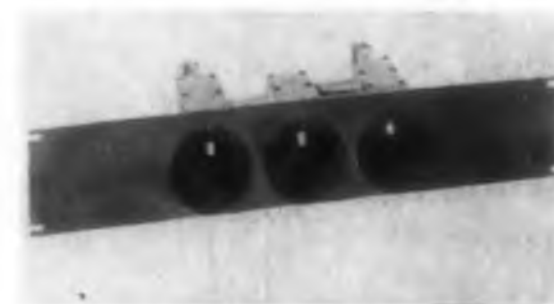
In metal enclosures, these corona type regulator tubes operate from 3 to 12 kv with good voltage regulation. Suited for the regulation of airborne radar power supplies, they are 9/16 in. in diameter and 3-9/16 in. long.

The Victoreen Instrument Co., Dept. ED, 5806 Hough Ave., Cleveland 3, Ohio.

CIRCLE 259 ON READER-SERVICE CARD

Variable RF Attenuators

Operate from dc to 500 mc



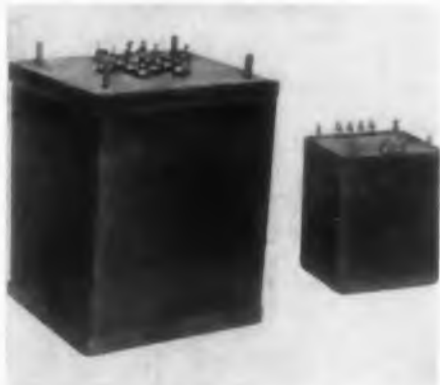
Designed to operate from dc to 500 mc, these variable step rf attenuators are rotary adjustable and can be supplied as individual unmounted units or in various combinations on rack mounted panels. They incorporate highly stable resistors precured to minimize long term drift and mounted in cavities which eliminate reactive components over the useful frequency range. Three 50 ohm and four 75 ohm attenuators are available, and combinations of up to four can be supplied on standard 3-1/2 x 19 in. rack mounted panels. The units extend 5 in. behind the panel.

Ortho Filter Corp., Dept. ED, 196 Albion Ave., Paterson 2, N.J.

CIRCLE 260 ON READER-SERVICE CARD

Transistorized Converters

150 to 600 v dc output



Enclosed in hermetically sealed cans with rf filters included inside the case, these transistorized converters provide high power to weight ratio and arc-free operation. Models are available with 6 to 26 v dc battery inputs and output voltages from 150 to 600 v dc.

Freed Transformer Co., Inc., Dept. ED, 1727 Weirfield St., Brooklyn 27, N.Y.

CIRCLE 261 ON READER-SERVICE CARD

20 Watt Servo Amplifier

Operates continuously with 2500% overload



A 20 w, solid state servo amplifier designed for heavy industrial and automation applications, model AS-20 has an input circuit that operates with a continuous input overvoltage of 2500%. It will not be damaged by loss of load, even when driven by the maximum rated input signal. At 60 cps, input impedance is 20 K; output impedance, $(750 + j 250)$ ohms; voltage gain, 57; power gain, 50 db; over-all phase shift, less than 10 deg; input voltage, 2 v rms for the full 115 v rms output. Resistant to shock and vibration, the unit is 4 x 5 x 11 in. and has a life expectancy of 10,000 operations. It operates from -55 to $+55$ C. A miniaturized version, model AS-20M, is available to meet MIL-E-5400 requirements.

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

CIRCLE 262 ON READER-SERVICE CARD

THE FACTS ABOUT MAGNESIUM AND CORROSION

Once this basic law of nature is recognized, proper design and protective measures permit excellent service life.



EXPOSURE TESTS on many assembly protection methods and new finishing developments are constantly in progress on these seaside test racks (International Nickel Test Station, Kure Beach).

MAGNESIUM, the world's lightest structural metal, has a successful history of application in aircraft, missiles, military ground equipment, portable tools, and materials handling equipment.

Yet some designers and production men hesitate to use magnesium because they have heard that it "corrodes." What are the facts about this important matter?

It's quite true that magnesium corrodes under certain environmental conditions—as does every other basic structural metal. Each has its own distinct corrosion "personality" in the presence of corrosive elements. For example, magnesium has excellent resistance to corrosion in strongly alkaline surroundings and readily becomes subject to attack under acidic conditions. Conversely, aluminum is resistant to many acids but suffers attack in strongly alkaline environments.

Approximately 95% of all corrosion problems with magnesium stem

from galvanic corrosion. This type of corrosion is caused by differences in the electrical potential of dissimilar metals coupled together and immersed in an electrolyte. By understanding the source of corrosion currents, metals and their environments can be controlled so as to minimize or eliminate these sources. Techniques of joining magnesium to other metals have been developed which effectively overcome the conditions causing galvanic corrosion.



NIKE GROUND GUIDANCE—Large magnesium assemblies are easily and effectively protected by standard finishing methods.



TO AID YOU IN APPLYING the correct design and proper protective measures for magnesium, write for your free copy of "MAGNESIUM FINISHING". Either contact your nearest Dow Sales Office or write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Department MA 1483 BC 2-18.

THE DOW CHEMICAL COMPANY • Midland, Michigan

DOW

CIRCLE 263 ON READER-SERVICE CARD

The corrosion behavior of metals is as much an inherent characteristic of materials as tensile strength, elongation and other physical properties. The laws of corrosion are well understood. Thus they can—and should be—taken into full consideration in any design analysis of a product or part. With this concept

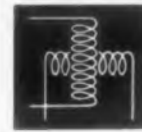


RYAN FIREBEE, with 75% of its exterior surface magnesium, has withstood repeated dunkings in the ocean with no adverse effects. The reason—Ryan applied the proper protective measures.

in mind, almost any corrosion problem can be "designed out" from the beginning when working with magnesium.

Whenever the corrosion characteristics of magnesium are acknowledged, and preventative measures are incorporated into designs, magnesium gives outstanding performance in service. Proof of this statement is evident by the growing use of magnesium alloys for such applications as: aircraft skins, wheels and engines; missile frames, fins and skins; radar antennas; military vehicle platforms and wheels; chain saws, hand trucks and dock boards.

KEARFOTT PRECISION RESOLVERS FOR EVERY SYSTEM APPLICATION



Kearfott has available a complete line of precision resolvers for every system application. Computing resolvers range in functional accuracy from .05% to .005%, in bridge accuracy from 3 minutes to 20 seconds of arc and in size from 11 to 25. Non-compensated resolvers range from 5 minutes to 20

seconds of arc in accuracy, from 8 to 25 in size. All Kearfott resolvers feature stainless housing, shafts and bearings and corrosion-resistant lamination materials for maximum environmental resistance. Optional designs available for operation at 200°C and in environment of 2000 cps vibration at 30 g's.

Computing Resolvers

Available with integral compensating windings. Can be provided with trimming networks to match existing isolation amplifiers or Kearfott-designed transistorized amplifiers.

Size 11

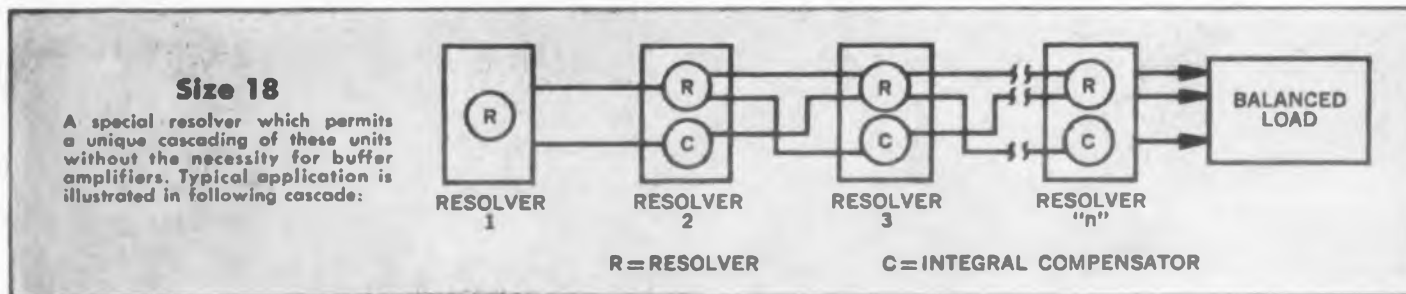
For applications where size and good functional accuracy are of paramount importance. Functional accuracy as good as .05% and bridge errors of 3 minutes of arc are in production.

Size 15

A 2:1 improvement in functional accuracy and bridge error obtained in this configuration. Unit tabulated is the direct equivalent of standard Navy BuOrd Mark 4 Mod 3 and contains necessary trimming net-

Size 25

work for standard buffer amplifiers. Transformation ratio is 1.000 ± .0001, phase shift 0° ± 1 minute. Functional accuracy of .025% and bridge error of 1.5 minutes of arc are standard.



Size 18

A special resolver which permits a unique cascading of these units without the necessity for buffer amplifiers. Typical application is illustrated in following cascade:

COMPENSATED RESOLVERS FOR PRECISE COMPUTER APPLICATIONS

SIZE	11	15	18	25	
PART NUMBER	R980-01	R980-41	T980-51	V980-004	425506-1
Excitation Volts—(Max.)	60	60	26	26	25
Frequency—(cps)	400	400	400	400	400
Primary Impedance	629 + j2510	450 + j2200	220 + j1000	3000 + j (0 ± 40)	1630 / 78.5°
Secondary Impedance	695 + j2750	500 + j2300	240 + j1100	3000 + j (0 ± 40)	1620 / 80°
Transformation Ratio (Primary to Secondary)	.980	.980	.980	.775	.980
Transformation Ratio (Compensator to Rotor)	.985	.985	.950	.775	.985
Phase Shift (Lead)	8.5°	7.5°	8.5°	0° ± 10'	1°
Fundamental Null (MV)	15	15	8	15	15
Bridge Error From E.Z. (Max.)	7 mins.	5 mins.	3 mins.	3 mins.	20 Seconds
Primary	Stator	Stator	Stator	Stator	Stator

Non-Compensated Resolvers

Basically for application in precise data transmission systems. These synchro resolvers permit system designer to achieve system errors of better than 1 minute of arc without using 2-speed servos and elaborate electronics. By proper impedance matches up to 64 resolver control transformers can also operate from one resolver transmitter.

Size 11

Where size is important. These units have a maximum unit error of 3 minutes of arc.

Size 25

Where highest accuracy is required. These units have a maximum error as low as 20 seconds of arc.

NON-COMPENSATED RESOLVERS FOR PRECISE DATA TRANSMISSION

	SIZE 11			SIZE 25		
	Transmitter	Differential	Control Transformer	Transmitter	Differential	Control Transformer
Type Resolver	R982-004	R982-011	R982-012	Z5161-001	Z5191-001	Z5151-003
Part Number						
Excitation Volts (Max.)	26	11.8	11.8	115	90	90
Frequency (cps)	400	400	400	400	400	400
Primary Impedance	170 / 77°	850 / 80°	2000 / 80°	400 / 80°	800 / 80°	8500 / 80°
Secondary Impedance	42 / 80.5°	1000 / 79°	8000 / 76°	260 / 80°	900 / 80°	14000 / 80°
Transformation Ratio	.454	1.000	1.906	.7826	1.000	1.278
Max. Error from E.Z.	3 mins.	3 mins.	3 mins.	20 seconds	20 seconds	20 seconds
Primary	Rotor	Stator	Stator	Rotor	Stator	Stator

Write for complete data.

KEARFOTT COMPANY, INC., Little Falls, N. J.
A subsidiary of General Precision Equipment Corporation
Sales and Engineering Offices: 1378 Main Ave., Clifton, N. J.
Midwest Office: 23 W. Calendar Ave., La Grange, Ill.
South Central Office: 6211 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinado Avenue, Pasadena, Calif.

Kearfott



CIRCLE 266 ON READER-SERVICE CARD

NEW PRODUCTS

DC Power Supplies

Outputs to 700 v



Available with inputs of 6, 12, 24, 28, and 32 v dc, these transistorized power supplies provide outputs to 700 v. Regulated or unregulated, they have power ratings of 30, 100, and 200 w and operate up to 60 C.

Digitrols, Dept. ED, P.O. Box 985, Baltimore 3, Md.

CIRCLE 267 ON READER-SERVICE CARD

REACTIVE RESIN MIXER.—Manually operated model MM-2 meters, mixes, and dispenses reactive resin formulations. Low cost unit for laboratories and small run production.

Meter-Mix Corp., Dept. ED, 626 Dorchester Ave., Boston 27, Mass.

CIRCLE 268 ON READER-SERVICE CARD

FUSE AND FUSEHOLDER.—Type GLR fuse and HLR holder comprise a combination unit for protecting fluorescent fixtures and other equipment operating on 300 v or less. Over-all length is 2-7/16 in.

McGraw-Edison Co., Bussmann Mfg. Div., Dept. ED, University at Jefferson, St. Louis 7, Mo.

CIRCLE 269 ON READER-SERVICE CARD

SNAP-IN AIR FILTER.—For commercial and industrial heating and air conditioning systems, the Elektra filter consists of a flexible steel frame with a metal grid and a snap ring to hold disposable filter pads in place.

Extraer Inc., Dept. ED, 1210 Chenevert, Houston, Tex.

CIRCLE 270 ON READER-SERVICE CARD

MOISTURE MONITORS.—Series 26-350 monitors accurately measure trace quantities of moisture in gases and vapors at sample pressures up to 10,000 psig. Suited for verifying dryness of aircraft breathing oxygen, checking compressed air used to drive missile turbines, and testing moisture in pneumatic control systems.

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

CIRCLE 271 ON READER-SERVICE CARD

HAND WRAPPING TOOL.—For wrapping and unwrapping solderless wrapped connections, Wire-Wrap tools are available in eight sizes with various terminal hole diameters and depths. They handle wire gauges from 26 to 14.

Gardner-Denver Co., Dept. ED, Quincy, Ill.

CIRCLE 272 ON READER-SERVICE CARD

PREAMPLIFIER KIT.—Model 83 YX 776 contains parts for a high-fidelity monaural and stereophonic preamplifier with a frequency response of 10.5 db from 7 cps to 120 kc.

Allied Radio Corp., Dept. ED, 100 N. Western Ave., Chicago 80, Ill.

CIRCLE 273 ON READER-SERVICE CARD

PORTABLE PARTS CLEANER.—In a sheet steel case 20 x 20 x 10 in., solvent type Kwik-Kleaner has a built-in pump which permits continuous reuse of cleaning fluid. Includes a fountain brush with adjustable flow and a built-in soak tank 7-1/4 x 13-1/4 x 7-1/2 in.

Nielsen Saw & Mfg. Co., Dept. ED, 7th Place and McKeniley, Eugene, Ore.

CIRCLE 274 ON READER-SERVICE CARD

BINDING POST KIT.—Model AS-407 contains six universal binding posts, six banana plugs, and six pin plugs. Units are color coded to show polarity in constructed equipment.

Olson Radio Warehouse, Dept. ED, 260 S. Forge St., Akron, Ohio.

CIRCLE 275 ON READER-SERVICE CARD

ROLL FILES.—Modular, slide-together units to hold rolled drawings up to 27 or 33 in. long. Each module is 4 in. high and 12 in. wide, contains four 2-5/8 in. ID tubes. Supplied with or without steel filing cabinet.

Plan Hold Corp., Dept. ED, 5204 Chakemco St., South Gate, Calif.

CIRCLE 276 ON READER-SERVICE CARD

HAND MARKER.—The Magic Marker can be used to prepare circuit drawings, color code electrical connections, and mark fuses. Constructed with a felt point, it can write in four widths. Marks indelibly and dries instantly on almost any surface.

Speedry, Dept. ED, P.O. Box 97, Richmond Hill, Jamaica 18, N.Y.

CIRCLE 277 ON READER-SERVICE CARD

VARIABLE TRANSFORMER.—Heavy duty type T502U, rated at 25 amp, is suited for use with heavy power supplies and electric furnaces. Load rating is 7.5 kva; input, 230 v; output, 0 to 270 v.

Standard Electrical Products Co., Dept. ED, 2240 E. Third St., Dayton, Ohio.

CIRCLE 278 ON READER-SERVICE CARD

BELLOWS.—Compounded of conductive rubber, these bellows dissipate high voltage static discharge to the ground.

Millman Rubber Co., Dept. ED, 5811 Marilyn Ave., Culver City, Calif.

CIRCLE 279 ON READER-SERVICE CARD



Microwave delay line for use in airborne equipment.

MICROWAVE RESEARCH

The expanding role of electronic equipment in modern military operations has given high priority to microwave research. No field today offers greater challenge to the scientist and engineer.

In support of current electronic countermeasures programs and in anticipation of future systems requirements, Ramo-Wooldridge Division is engaged in microwave research to develop new techniques and to refine conventional components.

Research is under way at Ramo-Wooldridge for new methods and new designs to reduce substantially the over-all size, weight and complexity of electronic equipment for both airborne and ground-based uses.

For example, the low-loss delay line in the photograph above was designed, developed and manufactured by Ramo-Wooldridge for use in airborne equipment. Packaged for use in the system for which it was designed, this miniature

ceramic unit weighs less than two pounds. It replaces a component which weighed more than twenty pounds and occupied more than five times as much volume.

Special opportunities exist for those with qualified experience in microwave research—in technique evaluation, component development, and design of such systems equipment—at Ramo-Wooldridge.

Engineers and scientists are invited to explore openings at Ramo-Wooldridge in:

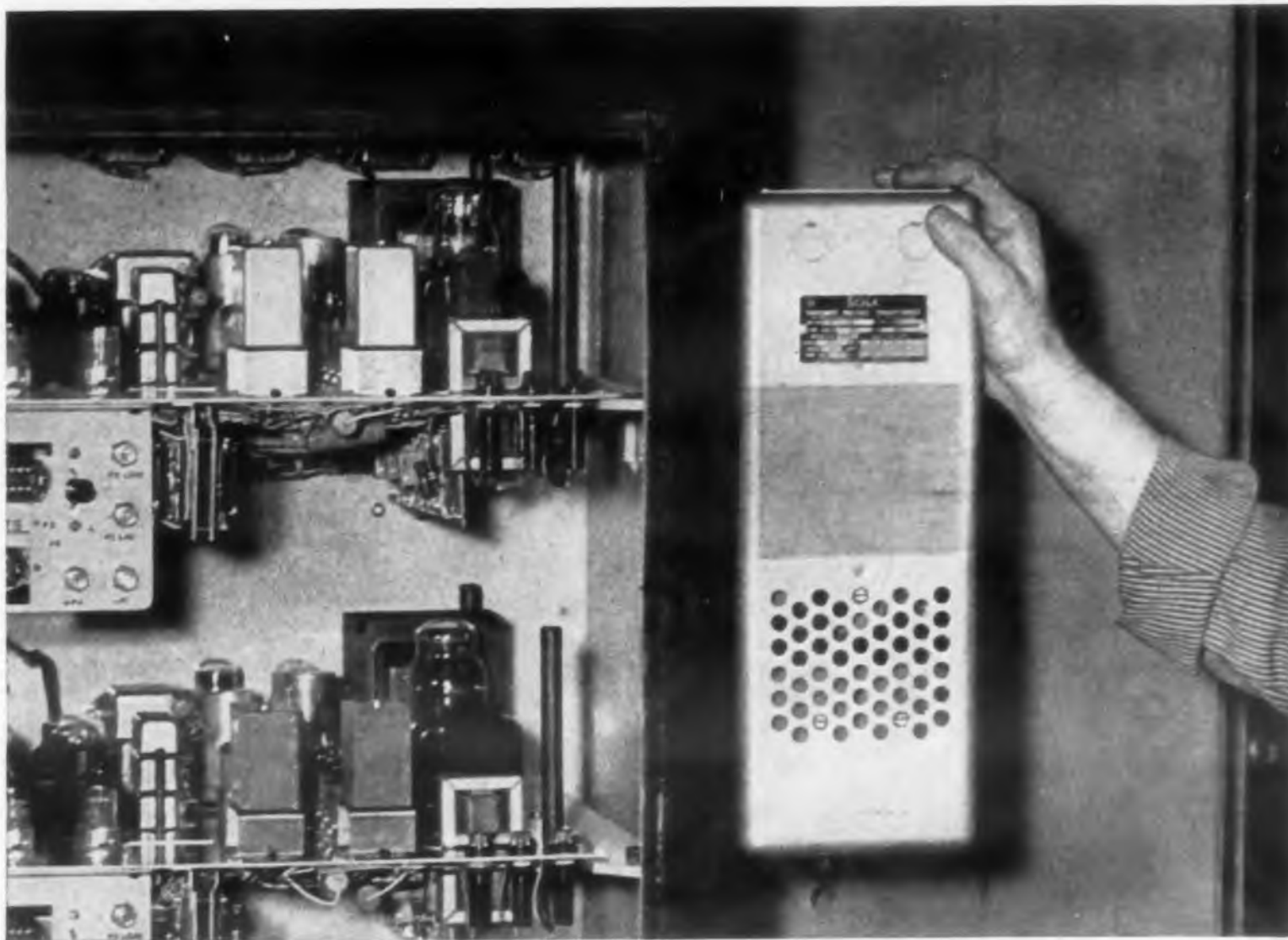
- Electronic Reconnaissance and Countermeasure Systems
- Infrared Systems
- Analog and Digital Computers
- Air Navigation and Traffic Control
- Antisubmarine Warfare
- Electronic Language Translation
- Information Processing Systems
- Advanced Radio and Wireline Communications
- Missile Electronics Systems



RAMO-WOOLDRIDGE

P.O. BOX 90534, AIRPORT STATION • LOS ANGELES 45, CALIFORNIA

a division of *Thompson Ramo Wooldridge Inc.*



Sola's Standard-type Constant Voltage Transformer, mounted at right of control cabinet, supplies regulated input voltage for dependable operation of Hurlertron printing register control.

Equipment delivers full-efficiency performance with input voltage Sola-regulated within $\pm 1\%$

Built in or added as an accessory, Sola Constant Voltage Transformers permit voltage-sensitive equipment to operate at full efficiency. Variations in line voltage as great as $\pm 15\%$ are stabilized to within $\pm 1\%$ of equipment nameplate voltage. This eliminates performance variations and failures caused by irregular voltage—highs, lows, or most transients. Sola-regulated input voltage also gives tubes and other components the correct electrical environment for full life.

The Sola Constant Voltage Transformer is a static-magnetic regulator whose action is automatic and virtually instantaneous—it responds to variations in input

voltage within 1.5 cycles. It has no tubes or moving parts and requires no manual adjustments or maintenance.

The Standard-type CV illustrated is only one of a complete line of Sola voltage regulators having wide application in electrical and electronic devices. Such special types as harmonic-free, filament, plate-filament, and adjustable harmonic-free transformers all provide the benefits of regulated input voltage. More than 40 models of these economical, compact regulators are available from stock. Sola also manufactures custom-designed units (in production quantities) to meet special needs.

For complete data write for Bulletin 31B-CV-170

Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill., Bishop 2-1414 • Offices in principal cities • In Canada, Sola Electric (Canada) Ltd., 24 Canmotor Ave., Toronto 18, Ont.

SOLA



CONSTANT VOLTAGE TRANSFORMERS



REGULATED DC POWER SUPPLIES



MERCURY LAMP TRANSFORMERS



FLUORESCENT LAMP BALLASTS

A DIVISION OF BASIC PRODUCTS CORPORATION

CIRCLE 281 ON READER-SERVICE CARD

NEW PRODUCTS

ISOLATION TRANSFORMER.—Providing 1 to 1 impedance ratio at 0 dbm from 20 to 20,000 cps, model A-210P eliminates ground loop feedback in stereophonic systems where either amplifiers or preamplifiers use a common ground.

Triad Transformer Corp., Dept. ED, 4055 Redwood Ave., Venice, Calif.

CIRCLE 282 ON READER-SERVICE CARD

LOCKING CONNECTORS.—Series MH miniature hexagonal connectors have positive locking rings and 4 to 10 contacts. They are designed for uniting cables subject to vibration, pulls, or other stresses.

U. S. Components, Inc., Dept. ED, 454 E. 148th St., New York 55, N.Y.

CIRCLE 283 ON READER-SERVICE CARD

PHOTOELECTRIC PAPER TAPE READER.—Model PR-2 accepts any 5, 6, or 7 channel numeric tape for computer input, reads tapes from all types of off-line recording devices.

Bendix Aviation Corp., Bendix Computer Div., Dept. ED, 5630 Arbor Vitae St., Los Angeles 45, Calif.

CIRCLE 284 ON READER-SERVICE CARD

MINIATURE ELECTRIC EYES.—For counting, positioning, monitoring, or sequencing operations, these units measure 1-1/2 x 1-5/16 x 11/16 in. They have a 1/4 in. standard pipe for mounting.

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

CIRCLE 285 ON READER-SERVICE CARD

SWITCHES.—All the company's switches can now be obtained with side terminal boards. Supplied in XXXP phenolic or glass base epoxy, they meet applicable MIL-S-3786 and environmental MIL-E-5272 specifications.

The Daven Co., Dept. ED, Livingston, N.J.

CIRCLE 286 ON READER-SERVICE CARD

AUDIO POWER CONTROL SYSTEM.—Combining an expander with a 50 μ sec limiter in one audio amplifier, the LE-2 Limpander is designed for two-way radio applications. Distortion is 25 db.

Electronic Systems Engineering Co., Dept. ED, 903 Craven Bldg., Oklahoma City 2, Okla.

CIRCLE 287 ON READER-SERVICE CARD

CATHODE RAY TUBE.—Model 5/71 CM tube, 5 in. across, resolves 5000 lines and has a spot less than 0.001 in. in diameter. It operates at 30 kv and 75,000 ft without danger of breakdown.

Ferranti Electric Inc., Dept. ED, 95 Madison Ave., Hempstead, N.Y.

CIRCLE 288 ON READER-SERVICE CARD

LIQUID COOLER.—For cooling high powered electronic tubes, model E/HT-200, type 204A is adaptable to ground-to-air missiles under severe conditions. The complete assembly is 9-1/2 x 6 x 7 in. It has 1600 w capacity and operates on 28 v dc. Temperature range is -65 to +160 F.

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

CIRCLE 289 ON READER-SERVICE CARD

STEREOPHONIC CARTRIDGES.—With a dynamically balanced, single ceramic element, these units provide 20 db channel separation over the full audio frequency range. Model 1301 has dual sapphire styluses; model 1302 has a 0.7 mil diamond and a 1 mil sapphire.

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

CIRCLE 290 ON READER-SERVICE CARD

MINIATURE COMPUTER.—Designed to teach computer operation to engineers and management personnel, the Microlog can be used to simulate processes and find approximate solutions to test the stability of systems. It measures 13 x 17 x 3 in.

EBE, Inc., Dept. ED, 1015 Atkin Ave., Salt Lake City 6, Utah.

CIRCLE 291 ON READER-SERVICE CARD

PREHEATING AND DRYING OVEN.—With dehumidifier, model PLHD-2-5 maintains proper moisture content prior to molding in such materials as Zytel, Lucite, Plexiglas, cellulose acetate, and Tenite. A drawer type unit with 10 compartments, it also provides corrosion free storage for electrical components.

Despatch Oven Co., Dept. ED, 619 S.E. 8th St., Minneapolis, Minn.

CIRCLE 292 ON READER-SERVICE CARD

STEREOPHONIC CARTRIDGES.—Model SC-1D, -1S, -2D, and -2S twin-ceramic cartridges have diamond or sapphire styluses and in-phase or out-of-phase connections.

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

CIRCLE 293 ON READER-SERVICE CARD

MICROFILMING CAMERA.—Portable 35 mm Copiflash microfilms any document or wiring diagram up to 9-1/2 x 15 in. Carrying case is 17 x 11 x 7 in.

Camcopy, Inc., Dept. ED, P.O. Box 27, Matawan, N.J.

CIRCLE 294 ON READER-SERVICE CARD

ADJUSTABLE SCRIBER.—No. 3237-12 Leroy scriber can form characters of varying height at any angle up to 45 deg forward. Takes pens from -0000 to -8 and can be used with Leroy lettering templates up to size -500 C.

Keuffel & Esser Co., Dept. ED, Adams and Third St., Hoboken, N.J.

CIRCLE 295 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 18, 1959

News about

RAYTHEON'S

SEMICONDUCTOR DIVISION—the place for the man

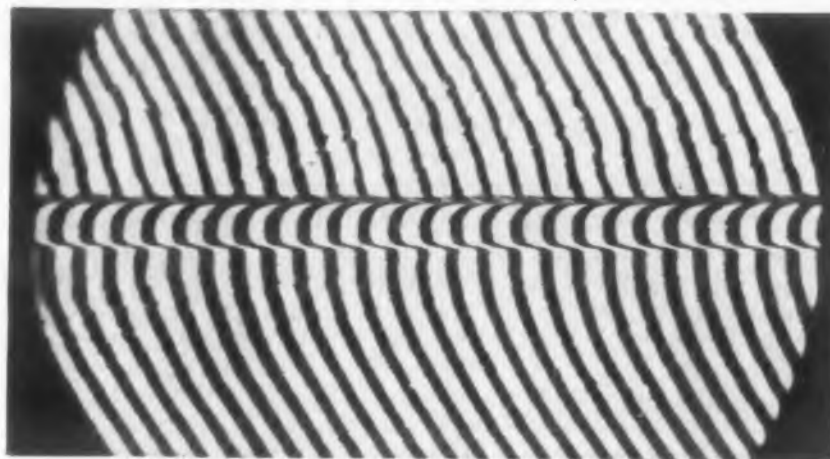
who is growing faster

than his associates



Bright Field ↑

↓ Interference



INTERFERENCE FRINGES are useful in determining slight changes in elevation and measurement of thin coatings such as those that might be laid down by vacuum evaporation. The above photomicrographs (112x) show gallium diffused silicon used in making Raytheon diffused base NPN silicon high frequency transistors. The silicon is at the bottom of each picture. The depth of the gallium penetration is .0007". The height of the junction step after etching is .0000088". The bright field picture shows how the junction looks normally under a metallurgical microscope. The interference picture shows how this same junction looks under an interference microscope.

STRICTLY IN CONFIDENCE...

If you would like to explore the growth possibilities for yourself, please send your resume to Mr. Allen Moorhead, RAYTHEON MANUFACTURING COMPANY, Semiconductor Division, 150 California Street, Newton 58, Mass.

Here is where transistors were first mass-produced to open up the fast-growing semiconductor industry... where a major "all-out push" is under way... where 1,008 new people were added in the last half of 1958... where 220,000 sq. ft. of new modern facilities are being added... where management says: "Here are the tools you asked for!"... where men with growth potential play a *recognized* role.

In the major league now with a broad line, Raytheon's Semiconductor Division will continue to be a leader in the research, engineering and manufacture of semiconductors.

For the man who is growing faster than his present associates and who seeks diversified assignments, there are exciting growth opportunities in:

- Device Design and Development
- Material Development
- Product Design
- Product Evaluation
- Mechanization
- Automatic Electronic Testing
- Application Engineering

If you are looking for a place to grow faster, there's plenty of elbow-room for you at Raytheon's Semiconductor Division.

"The place for the man who is growing faster..."

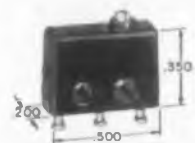
SEMICONDUCTOR DIVISION of



Excellence in Electronics



MICRO SWITCH Precision Switches



ACTUAL SIZE

More news about the "SX" miniaturized subminiature switch

New actuators add to versatility of "SX" Series

Two of the auxiliary actuators for the "SX" are shown below. Others, not shown, are pivoted lever and pivoted roller lever variations. All are made of stainless steel.



LEAF ACTUATOR



ROLLER LEAF ACTUATOR

The new "SX"—smallest precision snap-action switch—offers a new kind of answer to switching problems involving space, weight, and reliability. Here are some of the reasons:

SIZE (of case): .500" x .200" x .350" high—ten to the square inch.

WEIGHT: 1 gram . . . 28 switches to the ounce.

ELECTRICAL RATING: 28vdc: 7a. resistive, 4a. inductive-sea level; 2.5a inductive-50,000 ft.; 4a. motor load, 24a. max. inrush. 115/230 vac: 5a. resistive, 15a. max. inrush.

Other useful and newsworthy features of this remarkable switch include these:

Mechanical life is in the millions of operations. The case of the "SX" has two through holes that will accept #2 screws. One hole is slightly elongated to facilitate mounting.

The "SX" operates dependably in temperatures from -65° F. to $+250^{\circ}$ F.

Operating force is controlled and predictable within 3 oz. to 5 oz. limits.

Terminals are integrally molded.

Special plating on terminals improves ease of soldering.

The normally-open and normally-closed terminal-contact inserts are solid silver and in one piece for maximum conductivity and heat dissipation.

For more information about this important switch, ask for Data Sheet 148.

MICRO SWITCH . . . FREEPORT, ILL.

A division of Honeywell

In Canada: Honeywell Controls Limited, Toronto 17, Ontario



Honeywell

MICRO SWITCH PRECISION SWITCHES

CIRCLE 297 ON READER-SERVICE CARD

NEW PRODUCTS

PRESSURE TRANSDUCER.—For nuclear applications, these units are maintenance free and suitable for sealed operation. Span and zero trimming adjustments are remote from the transmitter.

The Bristol Co., Dept. ED, Waterbury 20, Conn.

CIRCLE 298 ON READER-SERVICE CARD

PULSED OSCILLATOR.—High powered model PG-650-C has a Helipot delay potentiometer for covering three overlapping ranges to 200, 1100, and 11,000 usec. Pulse length is continuously variable from 1.5 to 15 usec; rise and fall times are 0.3 usec above 20 mc and within 3 cps at lower frequencies.

Arenberg Ultrasonic Lab, Inc., Dept ED, 94 Green St., Jamaica Plain 30, Mass.

CIRCLE 299 ON READER-SERVICE CARD

CONTACT PINS.—Seamless and butt seam units in brass, copper, steel, or aluminum. Diameters are 3/32, 1/8, 7/64, and 5/32 in.; lengths, 3/8 to 1-1/2 in. Miniature hollow units with 1/16 in. diameters and lengths to specifications are also available.

A. L. Johnson Co., Dept. ED, 8031 N. Ridgeway Ave., Skokie, Ill.

CIRCLE 300 ON READER-SERVICE CARD

TRANSPARENT PLASTIC RODS.—Made of type 100 plastic, these rods are 1/4 to 2 in. in diameter and up to 36 in. long. Resistant to chemicals, they withstand 230 F.

The Homalite Corp., Dept. ED, 15 Brookside Dr., Wilmington 4, Del.

CIRCLE 301 ON READER-SERVICE CARD

AIR FLOW SAFETY SWITCH.—Monitors air flow on fan suction or discharge ducts of processing systems. Standard unit is for pressures of 1/4 in. water gage; others for pressures to 3 in. water gage can be built. Rated 5 amp, 115 v, or equivalent currents to 230 v.

The R. C. Mahon Co., Dept. ED, E. 8 Mile Rd., Detroit 34, Mich.

CIRCLE 302 ON READER-SERVICE CARD

NOISE RESISTANT TV CAMERA.—Model 1986CN operates in noise environments to ± 145 db without an acoustical housing. With a housing it has been successfully used above 190 db. Suited for rocket or jet engine test stands, it provides 600 line resolution.

Kin Tel, Div. of Cohu Electronics, Inc., Dept. ED, 5725 Kearny Villa Rd., San Diego 12, Calif.

CIRCLE 303 ON READER-SERVICE CARD

CARBON-RESISTOR TUBE FURNACES.—For high temperature research and natural and synthetic mineral fabrication, these furnaces reach 5000 F in 15 hours.

Hevi-Duty Electric Co., Dept. ED, Milwaukee 1, Wis.

CIRCLE 304 ON READER-SERVICE CARD

VIBRATION METER-RECORDER.—Mechanically operated, the Hand Vibrograph magnifies and permanently records frequency, amplitude, and wave form of vibrations and other mechanical motions. Frequency range is 0 to 20,000 cpm; amplitude range, 0.0004 to 0.8 in.

The Korfund Co., Inc., Dept. ED, 48-15 32nd Pl., Long Island City 1, N.Y.

CIRCLE 305 ON READER-SERVICE CARD

ALUMINUM MAGNET WIRE.—In a wide range of sizes and shapes, these wires are available with film or fibrous insulations in operating temperature classes A, B, F, and H.

Kaiser Aluminum & Chemical Sales, Inc., Dept. ED, 919 N. Michigan Ave., Chicago 11, Ill.

CIRCLE 306 ON READER-SERVICE CARD

VEHICULAR ANTENNAS.—Provide omnidirectional coverage and a restriction of vertical radiation pattern to the horizon. In the 150 mc band, gain is 3 db; in the 450 mc, 5 db.

Mark Products Co., Dept. ED, 6412 W. Lincoln Ave., Morton Grove, Ill.

CIRCLE 307 ON READER-SERVICE CARD

FHP MOTOR PROTECTOR.—Model MP-1620 circuit breaker trips in response to either rising motor temperature or excessive current draw. It restores motor operation when temperature or current drops.

Mechanical Products, Inc., Dept. ED, Jackson, Mich.

CIRCLE 308 ON READER-SERVICE CARD

CRT SHIELDS.—In Netic or Co-Netic materials or multiple layers of both, these shields conform closely to tube contours, need no periodic annealing. Helium welding on all seams prevents magnetic leakage.

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

CIRCLE 309 ON READER-SERVICE CARD

ALUMINUM CAPACITOR FOIL.—Free from oil films and ionizable substances, Electro-Dry has minimum surface contamination, replaces Driwynd foil.

Republic Foil and Metal Mills, Inc., Dept. ED, 55 Triangle St., Danbury, Conn.

CIRCLE 310 ON READER-SERVICE CARD

PRESSURE CONTROLS.—These five additions to the J40 line extend its range of pressures to 350 psi. They have differentials as close as 12 ± 4 oz.

United Electric Controls Co., Dept. ED, 79 School St., Watertown 72, Mass.

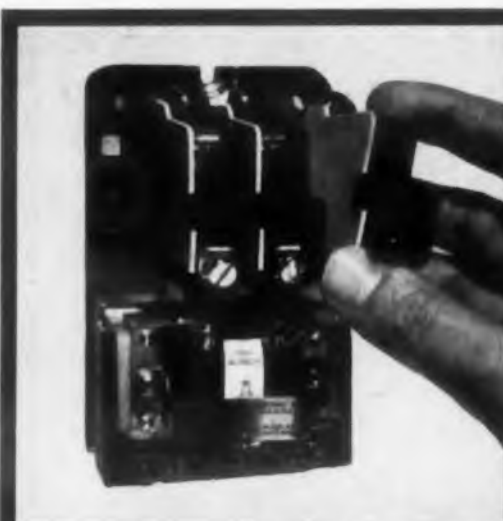
CIRCLE 311 ON READER-SERVICE CARD

ALUMINUM CARRYING CASES.—Dust and spray tight per MIL-STD-108C, these units have a Neoprene gasket, nickel plated latches, and aircraft type hinges. Sizes range from 4 x 7 x 4-1/4 to 9-3/16 x 13 1/4 x 9 in.

Zero Mfg. Co., Dept. ED, 1121 Chestnut St., Burbank, Calif.

CIRCLE 312 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 18, 1959



"Unitized" poles protect contacts



double-break, silver-to-silver contacts are self-cleaning, self-aligning



rugged steel base plates

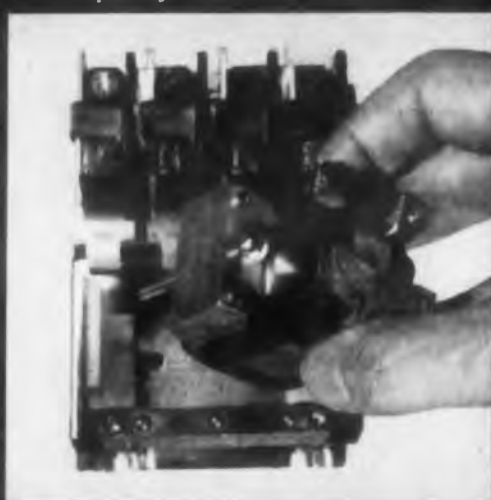


powerful AC or DC solenoids



friction-free nylon parts

**THIS IS A
RELAY
YOU CAN
STAKE YOUR
REPUTATION ON**



simple, fast, easy installation speeds assembly into your equipment



molded coils minimize "burnouts"

every aspect of Ward Leonard bulletin "HR" relays is designed for maximum reliability . . . these are components you can buy, install and then forget

Ward Leonard "HR" relays are engineered for industrial and electronic applications requiring: ultra-long life, high speed, high reliability, compactness and versatility.

Consider the powerful solenoids, just one of the features shown above. Every HR relay, AC or DC, is equipped with a powerful solenoid to assure fast, consistent, long-life operation so essential in the circuitry of any high reliability relay. The "E-1" laminated magnet ar-

mature is free-floating and self-aligning to minimize noise level. DC solenoids feature exceptionally fast operation. Nylon armature guides minimize operational friction. All AC and DC power plants are readily interchangeable.

2 to 8 pole "HR" relays are but one of five W/L lines of industrial power relays . . . all designed with emphasis on reliability. Write for bulletin 4470. Ward Leonard Electric Co., 77 South Street, Mount Vernon, N.Y. © 1

CIRCLE 313 ON READER-SERVICE CARD



**WARD
LEONARD**

ELECTRIC COMPANY
MOUNT VERNON, NEW YORK

LIVE BETTER...Electrically

Rebuilt-Engineered Controls Since 1892



RESISTORS RHEOSTATS RELAYS CONTROLS DIMMERS

Coaxial Attenuators

Terminations

Impedance Transformers

DC to 2500 mcs.

using type BNC, TNC, and N coaxial connectors



ARI presents an integrated line of coaxial attenuators, terminations, and impedance matching transformers for use in the DC to 2500 mcs frequency range. To provide the user with a greater flexibility than heretofore realized, type BNC, TNC, and N coaxial connectors are incorporated in this family of attenuators and terminations. The impedance matching transformers use type BNC coaxial connectors.

The attenuators and terminations exhibit a nominal impedance of either 50 or 75 ohms and a maximum V.S.W.R. of 1.2 at the highest rated frequency.

The impedance matching transformers have been designed to match, with minimum loss, 50 to 75 ohms, 50 to 93 ohms, and 75 to 95 ohms, over the frequency range of DC to 1000 mcs.

CHARACTERISTICS

Model	ATTENUATORS & TERMINATIONS				IMPEDANCE MATCHING TRANSFORMERS			
	NFA & NFT		NFA/T & NFT/T		NFA/N & NFT/N		NFAM	
Input/output impedance, ohms	50, 75	50, 75	50, 75	50, 75	50	50	50, 75, 93	75, 93, 95
Nominal attenuation (db)	1, 2, 3, 4, 6, 10, 12, 15, 20 / 2, 3, 6, 10, 20		1, 2, 3, 4, 6, 10, 12, 15, 20 / 2, 3, 6, 10, 20		1, 2, 3, 4, 6, 10, 12, 15, 20		minimum loss	
Frequency range (mcs)	DC-1000		DC-2000		DC-2500		DC-1000	
Maximum V.S.W.R.	1.2 at 1000 mcs		1.2 at 2000 mcs		1.2 at 2500 mcs		1.2 at 1000 mcs	
Connectors	Type BNC		Type TNC		Type N		Type BNC	

For full information and prices write to

Applied Research inc.

76 SOUTH BAYLES AVENUE, PORT WASHINGTON, NEW YORK

CIRCLE 314 ON READER-SERVICE CARD

PRODUCTION PRODUCTS

Resin Dispenser

Provides variable ratio

This resin dispenser has a lever adjustment that readily changes resin-to-hardener ratios over a wide range. It has a reference scale to assure accurate ratio resetting and a lock to prevent accidental changes. Available in hand and motor operated models, it is equipped with drip proof outlet valves.

Delsen Corp., Dept. ED, 719 W. Broadway, Glendale 4, Calif.

CIRCLE 315 ON READER-SERVICE CARD

Rotary Parts Feeder

Handles 20,000 parts per hr



This rotary hopper provides a continuously controlled flow of up to 20,000 parts per hr and virtually eliminates jamming or part damage. Lifting parts from the bowl, it places them on an inclined discharge track where it orients them and directs them to the machine being fed. Tracks are available for simple cylindrical, rectangular, headed, or disc type parts, and can be arranged to feed several machines at once.

Radio Corporation of America, Industrial Automation Equipment, Dept. ED, 13541 Auburn Ave., Detroit 23, Mich.

CIRCLE 316 ON READER-SERVICE CARD

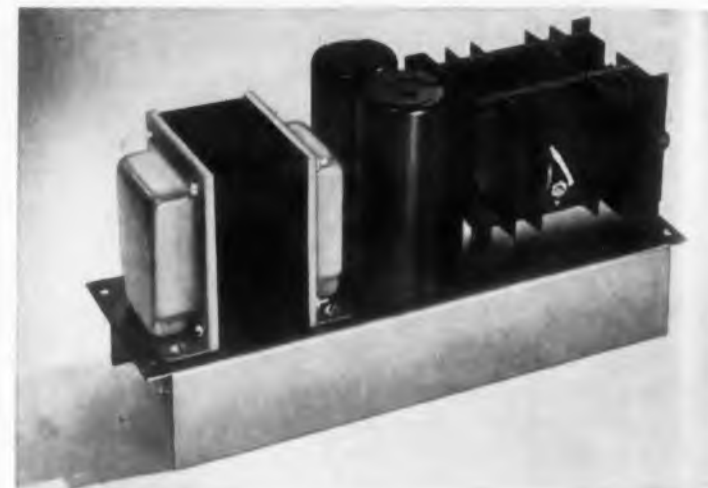
Production Lathes

For finishing small armatures

Designed for high speed finishing of small motor commutators, these automatic and semi-automatic lathes have a time cycle of 6 sec, holding 0.0001 to 0.0002 in. runout. They are easily adjusted for armatures of various sizes. The units are equipped with a 110 v motor and require 60 lb of air pressure.

Frank N. Wood Co., Dept. ED, 344 W. Main St., Waukesha, Wis.

CIRCLE 317 ON READER-SERVICE CARD



Models 22-111 thru 22-117

D/B

fully transistorized modular power supplies

—for use as components in your original equipment

You can build these sub-chassis power supplies right into your deliverable equipment, saving design time and production expense.

These Dressen-Barnes units—fully transistorized—are available in seven ranges, from 5-7 volts at 3.0 amps., up to 27-32 volts at 1 amp. The wide choice enables you to fill many special requirements with shelf items—available at low cost.

Units can be operated in series to provide higher voltages, and can be mounted on panels for standard rack mounting if required. These supplies are built to typical D/B quality standards. Complete specifications, prices and delivery data on request.

STANDARD OUTPUTS

Model No.	Voltage Range
22-111	5-7 VDC @ 0-3.0 amp.
22-112	7-10 VDC @ 0-2 amp.
22-113	9-12 VDC @ 0-2 amp.
22-114	12-17 VDC @ 0-1.5 amp.
22-115	17-22 VDC @ 0-1.5 amp.
22-116	22-27 VDC @ 0-1 amp.
22-117	27-32 VDC @ 0-1 amp.

SPECIFICATIONS (all models)

Ripple:	2 MV RMS
Regulation:	Line and Load combined .5%
Max. Transient:	NL to FL: 200 Mv.
Max. Operating Temp:	50 C. Ambient
Physical Size:	4" x 12" Sub-chassis, 1 3/4" below, 4 1/2" above

dressen-barnes

DRESSEN-BARNES CORP.

250 North Vinedo Avenue, Pasadena, Calif.

CIRCLE 318 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 18, 1959

Digital



MODEL
400B

V T V M

- ± 0.1% comparative accuracy
- 0 to 1000 V ac or dc
- 0 to 1 megohm

Franklin's all-electronic Model 400B provides a new standard of dependable, repeatable accuracy. In comparing one measurement against a reference, the 400B gives an accuracy of better than $\pm 0.1\%$. For example, it will measure the voltage difference between several 7.5 V batteries, with an accuracy of better than ± 0.0075 V.

Available for rack or table mounting.

Request Data Sheet 40B. OEM request Data Sheet 31A also.

BRIEF SPECIFICATIONS

D-C RANGE 0 to 10, 100, and 1000 V.	ABSOLUTE ACCURACY $\pm 0.3\%$, 0 to 10 volt range; $\pm 0.5\%$, all other ranges. INPUT IMPEDANCE 20 megohms
A-C RANGE 0 to 10, 100, and 1000 V.	ABSOLUTE ACCURACY $\pm 1\%$, all ranges (at 60 cps and voltages greater than 0.5 V). FREQUENCY RESPONSE ± 0.5 db, 50 cps to 100 KC. INPUT IMPEDANCE 20 megohms shunted by 200 mmf.
OHMS RANGE 0 to 10 K, 100 K, and 1 meg.	ABSOLUTE ACCURACY $\pm 0.2\%$ all ranges.

COMPARATIVE ACCURACY $\pm 0.1\%$, all ranges.



CIRCLE 319 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 18, 1959

Welding Control

For small parts

A synchronous welding control, Model 10E49E-A can control the weld current of all types of resistance bench welders. Suited for delicate parts such as radio tubes, it is available for 115 or 230 v operation and has two plug-in thyatron firing tubes. The thyatron contactor is rated at 12 amp at 50% duty cycle with a 5 sec averaging time.

Robotron Corp., Dept. ED, 21300 W. Eight Mile Rd., Detroit 19, Mich.

CIRCLE 320 ON READER-SERVICE CARD

Automatic Zone Melting Apparatus

Prepares semiconductor materials



Zone melting apparatus model Z-81 is an integrated, fully automatic machine which prepares pure materials for semiconductor applications. It can be operated vertically or horizontally for zone refining, zone leveling, and crystal pulling. The machine features automatic control of the number of passes, a wafer-thin melting zone, and a 45 deg tube tilting mechanism. A Herculite glass shield that protects the tube can be pivoted out of the way or removed entirely during operation. A liquid nitrogen vapor trap removes all gaseous impurities from the charge tube. To assist in vacuum measurement and control, the machine has a vacuum gage and three sensing elements at points of critical interest. The apparatus is shock mounted on a tubular frame which provides vibration free support.

Materials Research Corp., Dept. ED, 47 Buena Vista Ave., Yonkers, N.Y.

CIRCLE 321 ON READER-SERVICE CARD

ADVANCE

—YOUR PRODUCTION
—YOUR PROFITS
WITH
STAMPINGS



These are actual size
advance stampings,
which saved production
costs.



PROFITS INCREASE...

when you engineer in stampings. Save on material, labor and assembly costs. Here are just a few of the Advance Stampings, which have been fabricated in various materials to meet tolerance specifications, delivery and price.



- MAXIMUM 4" BLANKS • MAXIMUM 2 3/4" DRAW
- CAPACITY TO 65 TONS

Advance Stamping has been helping metal working industries of various kinds, attain higher production at lower cost, for over 35 years.

Send us your blue prints or samples for quotations. Advance engineers are available to consult on ways to improve your competitive position.

Write for Small Stamping Specialists Brochure

ADVANCE STAMPING CO.

12023 Dixie Ave., Detroit 39, Michigan

CIRCLE 322 ON READER-SERVICE CARD

SRV-215



Frequency range 34.2 to 35.4 kmc
Electronic tuning range 110 megacycles
Vibration 1 mc p-p (10g. freq.: 10-1,000 cps)
Warm-up drift ± 10 mc (max.)



New Sperry klystron for K_a band has 110 mc electronic tuning range

■ Frequency stable within 10 mc from sea level to 70,000 feet

■ Fixed-gap design with locked tuner to take missile shock and vibration

■ Delivers up to 1 watt of pulsed power

Here's a new reflex klystron—the SRV-215—developed by Sperry especially for tough assignments aboard missiles and high-speed aircraft. Easily modified for any application in K_a band from 26.5 to 40 kmc, the SRV-215 is the

logical choice for jobs like anti-collision radar or automatic landing systems.

In addition to its extremely wide electronic tuning range of 110 mc from 34.2 to 35.4 kmc and its low tuning torque, the SRV-215 is outstanding for frequency stability at all altitudes—a key factor in airborne applications. This new tube combines wide tuning range with exceptional frequency stability under extreme environmental conditions and features long operating life.

The SRV-215 requires only one-half

the heater power of similar tubes, and the flange can be mounted to a heat sink to avoid fan-cooling.

Write or phone today for more information on this outstanding new Sperry klystron.

SPERRY

SPERRY ELECTRONIC TUBE DIVISION, SPERRY RAND CORPORATION, GAINESVILLE, FLORIDA

Address all inquiries: Gainesville, Florida, or Sperry Gyroscope offices in New York • Cleveland • New Orleans • Los Angeles • San Francisco • Seattle

CIRCLE 324 ON READER-SERVICE CARD

NEW MATERIALS

Conducting Plastic

Provides 100% effective shielding

Available for use in conventional extrusion equipment, Conduxit is a polyvinyl chloride material with current carrying capabilities. As a shielding, it is 100% effective.

Phalo Plastics Corp., Dept. ED, Shrewsbury, Mass.

CIRCLE 325 ON READER-SERVICE CARD

Resins

For insulation

The Scotchcast electrical insulating resin line has 17 additions: resins 501 through 503, highly filled casting resins with low shrinkage during cure and low coefficients of expansion; 504, an epoxy with a soft filler for easy machineability; 505, an unfilled, rigid, two-part casting resin; 506, a highly filled material capable of operation above 500 F; 507, a filled, room-curing impregnating resin; 509, a filled, one-part silicone casting resin for temperatures to 600 F; 510, a rigid, unfilled material with a hot-melt part B that maintains electrical stability at class H temperatures; 601, a two-part epoxy foaming material with a cubic foot density of 7 lb; 602, a two-part, self-extinguishing epoxy foaming material; 603, an epoxy, one-part powder with good shelf life and a cubic foot density of 7 lb; 604, a self-extinguishing version of 603; 606, a silicone rubber foam for coating vacuum tubes; and 808 and 810, epoxy coating and sealing resins with the viscosity of petroleum jelly.

Minnesota Mining and Mfg. Co., Dept. ED, 900 Bush St., St. Paul 6, Minn.

CIRCLE 326 ON READER-SERVICE CARD

Epoxy Adhesive

Volume resistivity exceeds 10^{16} ohm-cm

A one part, 100% solid epoxy adhesive, Isobond 331 sticks to metals, glass, ceramics, and most plastics. Shear strength to aluminum is 3000 psi. Stable at room temperature, the material can be cured in 2-1/2 hr at 250 F or in 15 min at 335 F. It requires no mixing or metering and can be used at operating temperatures from -70 to $+175$ C. Volume resistivity exceeds 10^{16} ohm-cm.

Isochem Resins Corp., Dept. ED, 221 Oak St., Providence 9, R.I.

CIRCLE 327 ON READER-SERVICE CARD

Ferrite

For magnetic cores

For use in magnetic cores, ferrite MN-31 combines high initial and maximum permeabilities with high saturation magnetization and low losses in the 10 to 500 kc range. Curie temperature is 180 C, dc resistivity is 250 ohm cm, and flux density is 4300 gauss at 7 oersteds. Highly machineable, the material may be ground to virtually any shape with ± 0.001 in. tolerances.

Kearfott Co., Inc., Dept. ED, 1500 Main Ave., Clifton, N.J.

CIRCLE 328 ON READER-SERVICE CARD

Metal Film Resistance Cards

For use as microwave attenuators

Suited for use throughout the microwave spectrum, Filmohm metal film resistance cards can serve as microwave attenuators and terminations, as terminations for directional couplers, and as mode suppressors. They can also be used for isolation and impedance matching and for protection of crystals. As attenuators, the cards can provide up to 70 db attenuation with vswr held below 1.1 over relatively broad bands. Minimum insertion loss for a typical 40 db X band attenuator card is about 0.25 db. Composed of a metal resistance film deposited on a laminated fiberglass base, the cards are dimensionally stable and have low moisture absorption. They can be punched, drilled, sheared, machined, and sanded. Standard size is 5 x 12 in. Resistivity range is 25 to 750 ohms per square.

Filmohm Corp., Dept. ED, 48 W. 25th St., New York 10, N.Y.

CIRCLE 329 ON READER-SERVICE CARD

Magnesium Oxide Grains

For electronic use

These medium and high purity magnesium oxide grains are suited for ceramic and electronic applications. Type 12730, 12731, and 12733 fine grain periclase is available in completely crystalline form with magnesium oxide purity of 96 to 99.5%. It may be used in extrusion, as a filler, in molding and pressing shapes, and for other refractory applications. Electrically fused periclase grain with 96 and 99% magnesium oxide is also available in refractory grades.

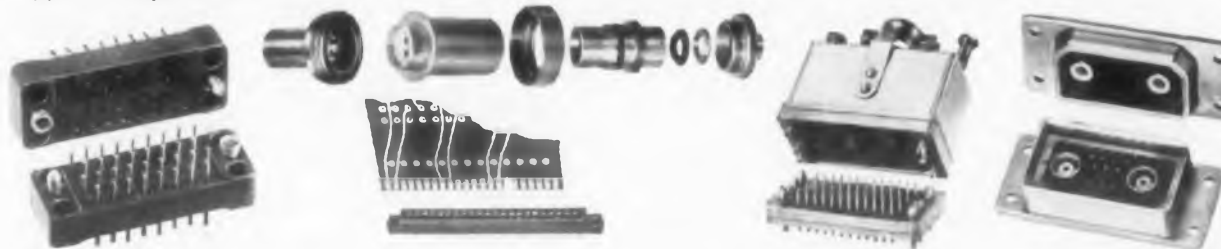
General Electric Co., Chemical Materials Dept., Dept. ED, 1 Plastics Ave., Pittsfield, Mass.

CIRCLE 330 ON READER-SERVICE CARD

RELIABLE COMPONENTS ARE YOUR NEED AND OUR SPECIALTY

ANTON PRECISION-BUILT CONNECTORS

incorporate new techniques in hermetic sealing, high-altitude operation, molding and waterproofing. Our facilities include complete design and model making shops as well as the full range of shock, vibration and environmental test equipment. We welcome your "difficult" as well as standard connector design and application problems.



ANTON CORONA DISCHARGE V-R TUBES

have been found to be extremely reliable over the wide range of military shock, temperature, current and voltage requirements. Fixed and adjustable tubes are available to stabilize voltages from 300 V—30 KV at currents below several milliamperes with voltage tolerances within $\pm 1\%$. JAN approved types available. Well suited for use as voltage reference tubes, stabilizing all high voltage-low current power supplies and for control of high voltage, accelerating potentials of cathode ray devices (radar scopes, TV, etc.)

Send for valuable FREE application and design notes.

SPECIAL TEST EQUIPMENT

like the Anton 245 Electronic Multimeter for measurements in the frequency range 30 cps. to 500 mc. Ideal for military, laboratory, production line, test shop, broadcast station and field use. Send for complete catalog information.



SEND
FOR
FREE
DATA
NOW!

ANTON ELECTRONIC LABORATORIES, INC., 1226 Flushing Avenue, Brooklyn 37, New York

Send complete data about:

Connectors Corona Discharge V-R Tubes Electronic Multimeter

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CITY.....

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ANTON ELECTRONIC LABORATORIES, INC.

A subsidiary of United States Hoffman Machinery Corporation
1226 FLUSHING AVE., BROOKLYN 37, N. Y.

CIRCLE 331 ON READER-SERVICE CARD



KEITHLEY MODEL 150 MICRO VOLT-AMMETER

MEASURES
DOWN TO

0.03 μ v

AND 2×10^{-12} AMPERE

The Keithley 150 sets new standards in sensitivity, stability and noise figure for dc micro-voltmeters. It also serves as an amplifier, null detector, micro-microammeter, and (with an external voltage supply) meg-megohmmeter. Functions and measurement spans include:

DC Voltmeter, 1 microvolt to 1 volt full scale
Ammeter, 10^{-10} to 10^{-3} ampere full scale
DC Amplifier, gains of 10 to 10,000,000
Null Detector, with 0.5 to 2 second period.

OTHER FEATURES of the 150 include zero suppression of up to 100 times full scale; optional floating or grounded input; high input resistance; zero stability as a voltmeter within ± 0.1 microvolt per day, and within $\pm 2 \times 10^{-11}$

ampere per day as an ammeter; short term noise within 0.03 microvolt peak to peak (0.006 microvolt RMS). The 150 is rugged, relatively insensitive to vibration, 60-cycle fields, or thermal EMF's. It is available in either rack or cabinet packaging.

USES of the 150 encompass nearly every branch of research and engineering. Examples include measuring the outputs from strain gages, thermopiles, thermocouples, bolometers, phototubes, ionization chambers, scintillation counters, and barrier layer cells. Other applications are found in cell studies, electrochemical potentials, corrosion work, molecular-weight analysis, Hall effect studies.

DETAILED DATA about the 150 Micro Volt-ammeter are now available in Keithley Engineering Notes, Vol. 7 No 1. A request will bring your copy promptly.

BRIEF SPECIFICATIONS

dc voltage: 13 ranges in 1X and 3X steps from ± 1 microvolt to ± 1 volt full scale.

current: 17 ranges in 1X and 3X steps from $\pm 10^{-10}$ to $\pm 10^{-3}$ ampere full scale.

zero stability: within 0.1 microvolt per day, or 2×10^{-11} ampere per day.

noise: less than 0.006 microvolt RMS as a voltmeter; less than 2×10^{-12} ampere as an ammeter.

accuracy: voltage, $\pm 2\%$ of full scale on all ranges; current, $\pm 3\%$ on all ranges.

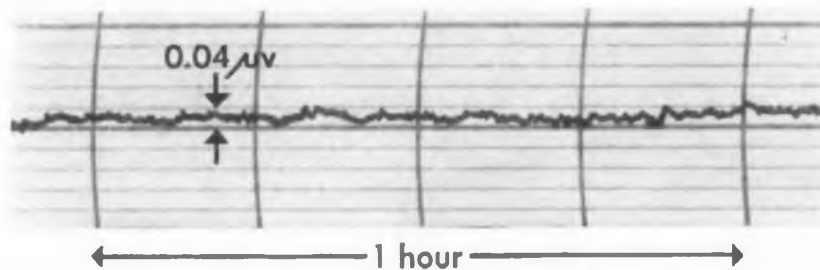
zero suppression: up to 100 times full scale.

response speed: 0.5 to 2 seconds.

gain: 10,000,000 maximum.

output: ± 10 v and 5 ma for full scale deflections

price: \$675.00



Long-term drift of the Model 150 is shown in the above recording. A 1000-ohm resistance was connected across the input. Note the very low peak to peak noise, even at this slow paper speed.



KEITHLEY INSTRUMENTS, INC.

12415 EUCLID AVENUE CLEVELAND 6, OHIO

CIRCLE 334 ON READER-SERVICE CARD

NEW MATERIALS

Power Ferrite

5200 gauss maximum flux density

At 10 oersted, power ferrite W-07 has a maximum flux density of 5200 gauss. With low hysteresis and eddy current losses, it performs well from 400 cps to 15 kc. Curie point is 280 C. The material can be used in high speed motors, high frequency power transformers, and high power frequency converters.

Allen-Bradley Co., Dept. ED, 136 W. Greenfield Ave., Milwaukee 4, Wis.

CIRCLE 335 ON READER-SERVICE CARD

Ceramic Transducer Element

Has wide temperature range



Suited for missile systems, telemetering, and airborne sensing circuits, type US 100 ceramic transducer element has high frequency stability over a wide temperature range. Upper Curie temperature is 150 C; loss factor, 0.5%; and frequency constant, 90 kc in. The material is available in all sizes and shapes needed in the ultrasonic industry.

U. S. Sonics Corp., Dept. ED, 625 McGrath Highway, Somerville, Mass.

CIRCLE 336 ON READER-SERVICE CARD

Encapsulating Resin

Provides high flame retardance

A silicone modified filled encapsulating resin, Fosterite SFR BT-3199 is designed for treating electronic components that require high moisture resistance and flame retardance. It is suited for use on filament, power, and plate transformers for communications, fire control, radar, and guided missiles.

Westinghouse Electric Corp., Micarta Div., Dept. ED, Manor, Pa.

CIRCLE 337 ON READER-SERVICE CARD

Silicone Rubber Coated Sleeving

Stands rough usage, 250 C

Coated with silicone rubber, Ben-Har 1151 glass fiber sleeving has good electrical properties and will stand rough abuse without damage to its electric film. It can be used at 250 C and also at very low temperatures. Made by an extrusion process which includes continuous inspection of electrical properties, the sleeving has a high degree of electrical reliability and can be expanded to four times its original size to cover irregular shapes. It meets MIL-I-18057A specifications and appropriate NEMA and ASTM standards.

Bentley, Harris Mfg. Co., Dept. ED, Conshohocken, Pa.

CIRCLE 338 ON READER-SERVICE CARD

Plating and Etching Resist

For printed circuits

For printed circuit production, type 1997 B plating and etching resist force dries in 15 min at 150 F and air dries in an hour. Dimensionally stable, it expands about 0.0005 in. Resisting the usual plate cleaning solutions and etchants, it can be removed easily with a perchlorethylene, trichlorethylene, or carbon tetrachloride vapor degreasing system. Screens can be cleaned with mineral spirits. The resist is nontoxic.

Screen Process Labs, Dept. ED, 5-33 48th Ave., Long Island City 1, N.Y.

CIRCLE 339 ON READER-SERVICE CARD

Power Ferrite

Has rectangular hysteresis loop

For 400 cps to 15 kc operation, power ferrite H-03 has an almost perfectly rectangular hysteresis loop which reduces with temperature so that loss per cycle is less at higher temperatures than at lower temperatures. For use in i-f magnetic amplifiers, static switching devices, transistorized inverters, and power supplies, it has a 2.9 μ sec switching time at 2.5 Hc. At 1500 cps, initial permeability is 325 and maximum permeability is 3500. Saturation induction at 10 oersted is 3900 gauss, remanence induction is 3360 gauss, and Curie temperature is 315 C.

Allen-Bradley Co., Dept. ED, 136 W. Greenfield Ave., Milwaukee 4, Wis.

CIRCLE 340 ON READER-SERVICE CARD

NEW CONCEPT IN SOLID STATE POWER SUPPLIES . . .

NEW MAGITRAN[®] SOLID STATE POWER SUPPLIES

ERA's new MAGITRAN design combines the properties of a special magnetic controller with the fast response characteristics and advantages of the transistor regulator. Pre-regulation and line transient protection is achieved by the magnetic controller. This controller is also designed in a manner so as to provide zero output in the event excessive current flows due to overload or short in the external circuit. The transistor regulator accommodates all fast line or load variations and transients and provides for ripple reduction. This unique combination results in minimum heat dissipation for all transistors independently of line voltage variations. Under short circuit conditions, substantially zero voltage appears across the transistors together with minimum heat dissipation and unlike conventional designs, complete protection is obtained under the most extreme conditions.

New Transistor-Magnetic Designs Obsolete Conventional Transistor, Vacuum Tube, and Related Types

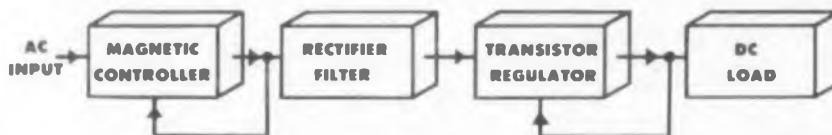
COMPLETE SHORT-CIRCUIT PROOF DESIGN

*Short It Intermittently!
Short It Continuously!
Flick It On and Off!*

RECOVERS INSTANTLY . . . WITHOUT DAMAGE TO UNIT!

No Fuses . . . No Circuit Breakers . . . No Thermal Relays

Combines The Advantages Of Transistor and Magnetic Regulators



STANDARD MODELS (100-130 VAC Input, 60 cps)						
Model No.	Voltage VDC	Current Amps	Regulation Line	Regulation Load	Ripple V RMS	Price FOB Factory
TR36-4M	0-36	0-4	$\pm 0.05\%$	0.1%	0.01%	\$495
TR36-8M	0-36	0-8	$\pm 0.05\%$	0.1%	0.01%	545
TR36-12M	0-36	0-12	$\pm 0.05\%$	0.1%	0.01%	655
TR36-20M	0-36	0-20	$\pm 0.05\%$	0.1%	0.02%	895
TR160-1M	10-160	0-1	$\pm 0.05\%$	0.05%	0.01%	495
TR300-1M	150-300	0-1	$\pm 0.05\%$	0.1%	0.02%	595

Models listed are stock units normally available for quick delivery 400 cycle models also available. Also special designs made to customers specifications. Write for quotations.

ELECTRONIC RESEARCH ASSOCIATES, INC.

67 Factory Place, Cedar Grove, N. J. • Center 9-3000 • TWX-Verona NJ1144

SUBSIDIARIES

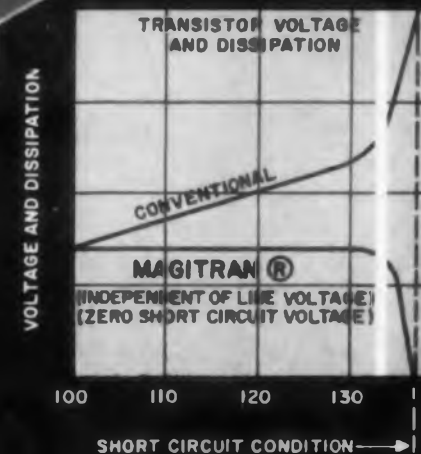
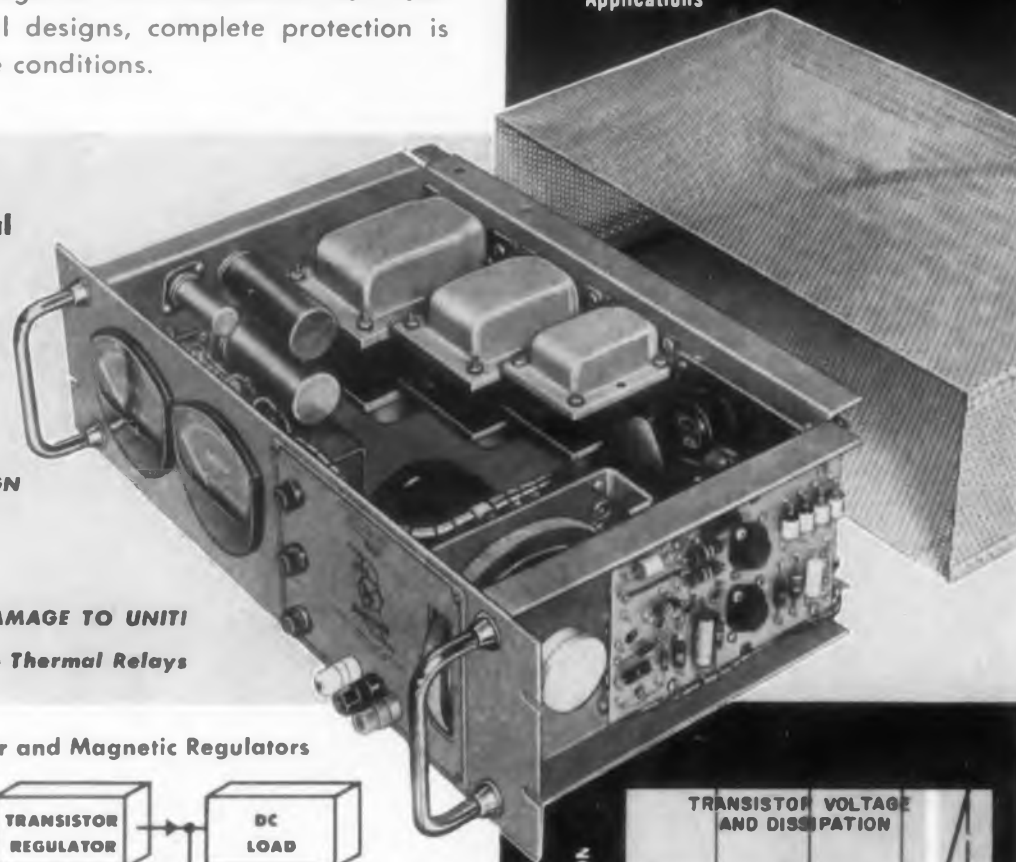
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- New Transistor-Magnetic Designs
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- Closely Regulated Load and Line
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Write for Era's New Magitran Solid State Power Supply Catalogue and Companion Technical Bulletin #591



EL84 (6BQ5)

Supplies available from:

In the U.S.A. International Electronics Corporation, Dept. ED2, 81 Spring Street, N.Y.12, New York, U.S.A.
In Canada. Rogers Electronic Tubes & Components, Dept. JN, 116 Vanderhoof Avenue, Toronto 17, Ontario, Canada.



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CIRCLE 342 ON READER-SERVICE CARD

NEW LITERATURE

Sampling Switches 343

A series of mechanical sampling switches is described in a 5-page booklet by Lind Corporation. Photographs and drawings illustrate the mechanical commutator, which has a radically different type of construction permitting sampling at rapid rates for an extended period of time. Lind Corp., Research Park, Princeton, N.J.

Switches 344

Revised Catalog 83c covers a complete line of industrial enclosed switches. Complete details of nine housing groups of metal-enclosed switches for industrial uses are given. Explosion-proof, maintained-contact, pre-wired, hand-operated and sealed switches are of few of the 99 different listings shown. This 20-page catalog is an aid to the plant engineer and maintenance man, as well as the designer of original equipment. Switches with a variety of actuator types to fulfill almost any requirement for general-purpose industrial enclosed switches are listed. Micro Switch, Freeport, Ill.

Plastic and Ceramic Foams 345

A 20-page brochure entitled Eccofoam contains information on both plastic and ceramic foams. The foams are used primarily in electrical and electronic applications. The line covers flexible and rigid sheet stock, liquid foam in-place resins, artificial dielectric foams, pack-in-place foams for electronic embedment, powdered materials and an extensive series with adjusted electrical properties. Technical data is supplied on each product including applications such as microwave lenses, radome cores, void filling, circuit encapsulation, thermal insulation, packaging and re-enforcement of structures. Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.

Components Catalog 346

This 1959 catalog illustrates and describes the entire line of sheet metal products and electronic components including an outline of special fabrication facilities, sizing information on each product, suggestions for uses. Bud Radio, Inc., 2118 East 55th St., Cleveland 13, Ohio.

Instrument Bearings

347

Line of thin-section ball bearings, made in precision and ultraprecision grades to dimensions of the AFBMA B-5000 series, is described in 24-page catalog. Known as the "T" series, these thin-section ball bearings feature the exclusive SBB method of construction which makes possible a full ball complement without loading slots, plus integral shielding, and one-piece retainers for radial type bearings. Twelve sizes are encompassed. A wide variety of applications can be obtained because of five different types of T series bearings. Also catalogued is the Midget T Series which extends the size of range of the T series thin-section bearings into the range between miniature bearings and conventional inch series bearings. Split Ballbearing Division Miniature Precision Bearings, Inc., Lebanon, N.H.

Self-Clinching Nuts

348

Bulletin SL-858 gives complete data on the PEM line of all-metal, self-locking, self-clinching nuts. It provides information on thread sizes and shank lengths for various sheet thicknesses, mounting hole dimensions, suggested installation forces, torque and push-out resistance, metals of construction and finish, and temperature ranges. Penn Engineering & Mfg. Corp., Doylestown, Pa.

Jewel Bearings

349

This 26-page, two-color manual was prepared as an engineering, design and purchasing specifications guide to the complex field of jewel bearings and other industrial applications of sapphire. Manual #5 contains general information on the properties of industrial sapphire and availabilities of material; Jewel bearings, designating the types, nomenclature and tolerance of five basic jewel bearing types; design data, including graphs, formulae for calculating frictional losses, basic design factors and listings of stock sapphire ring and ring jewels sizes; jewel bearing assemblies, providing information on mounting methods, housings, and typical engineering drawings; and typical sapphire applications, showing diversified uses where unique properties of sapphire have solved many industrial problems. Reprint copies of the index of five sections are available without charge from: Mr. A. V. Urisc, General Manager, A. M. Gatti, Inc., 524 Tindall Ave., Trenton, N.J. After receipt of excerpts, inquiries may receive complete copies of Manual No. 5 free on request.



Transducerized Tank NT-5001
Capacity: 10 gallons
Dimensions: 20" L x 11½" W x 10" D

NEW GIANT narda SONBLASTER



Generator G-5001
500 watts output

Generator features tank selector and load selector switches on front panel to operate one or two NT-5001 tanks alternately. Other combinations of tanks and submersible transducers available from stock; larger tanks available on special order.

\$1325

for mass-production ultrasonic cleaning and high capacity chemical processing!

Here's a new Narda SonBlaster ultrasonic cleaner with tremendous cavitation activity and generating capacity! Featuring full 500 watts output, this SonBlaster is available with a fully transducerized giant 10-gallon capacity tank. In addition, it will operate from six to ten model NT-605 high energy submersible transducers, at any one time, for use in any arrangement in any shape tank you need, up to 70 gallon volume.

Install this new Narda SonBlaster, and immediately you'll start chalking up savings over costly solvent, vapor or alkaline degreasing methods! You'll save on chemicals and solvents, cut maintenance and downtime, eliminate expensive installations, save on floor space, and release labor for other work. But perhaps most important, you'll clean faster, cut rejects, and eliminate bottlenecks.

Whether you're interested in mass-production cleaning or degreasing of mechanical, electronic, optical, or horological parts or assemblies... rapid, quantity cleaning of "hot-lab" apparatus, medical instruments, ceramic materials, electrical components or optical and technical glassware... or in speed-

ing up metal finishing and chemical processing of all types—you'll find this new SonBlaster will do your work faster, better and cheaper. Write for more details now, and we'll include a free questionnaire to help determine the precise model you need. Address: Dept. ED-18 BW

Consult with Narda for all your ultrasonic requirements. The SonBlaster catalog line of ultrasonic cleaning equipment ranges from 35 watts to 2.5 KW, and includes transducerized tanks as well as immersible transducers which can be adapted to any size or shape tank you may now be using. If ultrasonics can be applied to help improve your process, Narda will recommend the finest, most dependable equipment available for immediate delivery from stock—and at the lowest price in the industry (\$175 up)!

For custom-designed cleaning systems, write to our Industrial Process Division; for information on Chemical processing applications, write to our Chemical and Physical Process Division; both at the address below.



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CIRCLE 350 ON READER-SERVICE CARD

'DIAMOND H' RELAYS



NEW . . . High Speed Polarized Relays

Fast action with freedom from bounce, plus high sensitivity and consistent operation with low distortion, are provided by small, rugged Series P Polarized Relays. SPDT, with two independent coils, they will handle over 1,000 pulses per second. Various coil resistances up to 5,000 ohms each coil. Contact ratings vary with switching speed but range from 60 MA to 2A with voltages to 120 AC or DC, dependent upon amperages employed.



Aircraft-Missile Series R & S Relays

Miniature, hermetically sealed 4PDT, Series R & S relays provide excellent reliability over their long service life. Electrically and physically interchangeable, the two series differ only in that Series S coils are separately sealed within the sealed cases, with organic matter eliminated from the switch mechanism for greatest reliability in dry circuits. Contacts MA to 10 A.



General Purpose AC, DC Relays

Series W Power Relays are DPDT, double break-double make; measure only 1 1/2" x 1 1/2" x 1 7/8", but are rated to 25 A, resistive, at 112-230 V, AC, 1 HP 115 V, AC, 2 HP, 230 V, AC. Socket, panel and sidewall mountings are standard; others available to meet special needs. 12 possible contact arrangements, including sequencing.



"Diamond H" engineers are prepared to work with you to develop variations on these relays to meet your specific requirements. Tell us your needs . . . by phone or letter.

THE HART MANUFACTURING COMPANY

210 Bartholomew Ave., Hartford 1, Conn.

Phone JACKSON 5-3491

CIRCLE 351 ON READER-SERVICE CARD

NEW LITERATURE

Marking Machines 352

Eight machines for direct-marking with the U.L. manifest label legend are described in an 8-page catalog. Machines included will mark a variety of items from packages and flat objects to meter sockets, rigid conduit to metallic tubing. Special Products Div., Markem Machine Co., Keene 80, N.H.

Transistor Similarity Chart 353

This 4-page chart is for use in determining Raytheon types which are equivalent to germanium transistor types of other manufacturers. It is a similarity, not an exact interchangeability chart. No note has been made of minor electrical or mechanical differences which in some cases may preclude the use of the suggested Raytheon type in a specific application. In cases where the competitive product has been specified loosely, more than one Raytheon type has been suggested. Exact choice depends upon further knowledge of the application. Raytheon Manufacturing Co., Semiconductor Div., 9501 Grand Avenue, Franklin Park, Ill.

Switches 354

Four-page data sheet covers eight precision snap-action switches for use on aircraft, missiles and missile ground handling equipment. Describes sealed, high temperature and shock resistant types. Photographs, dimension drawings, electrical ratings and characteristics are included. Micro Switch, Freeport, Ill., Div. of Minneapolis-Honeywell Regulator Co.

UHF-VHF Calibrator 355

Data sheet of this wide frequency vhf-uhf calibrator describes characteristics of this product. The calibrator covers the spectrum from 50 mcs to 11,000 mcs without tuning controls and has accuracies of plus or minus 0.005% throughout the entire frequency range. It is an accurate secondary frequency standard for laboratory use in calibrating and testing of microwave receivers, radar systems, navigational aids, beacons, signal generators and rf pre-selectors and filters. Control Electronics Co., Inc., 10 Stepar Place, Huntington Station, L.I., N.Y.

Can You Use These NEW JUNCTION TERMINAL BUSHINGS?



1. On final production test lines, quick-disconnect feature has saved time and simplified removal of defective parts.
2. Color coded, the bushings speed assembly and insure correct harness connections.
3. They speed up and simplify the removal and testing of component assemblies.

THREE TERMINAL STYLES
mate with existing female terminations



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Send for samples and try them on your products



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Manufacturers of the Industry Famous
HEYCO STRAIN RELIEF BUSHINGS

CIRCLE 356 ON READER-SERVICE CARD

PRECISION RESISTORS

Type P. wire wound, encapsulated, miniature single ended units for mounting on printed circuit with no support other than wire leads. Resistor element is insulated by Teflon from lead wire, increasing voltage breakdown. Can be operated in ambient temperatures up to 125°C. 7 sizes, from 1/4" to 3/8" diam. Rated from .1 to .4 watt. Resistance values to 2 meg. Tolerance from 1% to .05%. Meets requirements of MIL-R-93B.

Other PRECISION WIRE WOUND RESISTORS: Type L with radial lugs, radial or axial wire leads; Type S, hermetically sealed, with axial wire leads.



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Specialists in manufacturing quality resistors: Precision Wire Wound — High Voltage — High Megohm — High Frequency. Our test equipment and standards for checking and calibrating are matched only by leading laboratories. Write for more information.

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Type H. For electrometer circuits, radiation equipment and as high resistance standards. Resistance available to 100 million megohms. Voltage rating to 15,000 volts. Low temperature and voltage coefficient. Seven sizes, from 3/4" to 3" long, of which 2 meet requirements of MIL-R-14293A. Standard resistance tolerance 10%. Tolerance of 5% and 3% available. Also matched pairs with 2% tolerance.



Microwave Components 358

Illustrated, 4-page catalog gives complete descriptions, applications and technical specifications for signal samplers, monitor tees, dc shorts, and dc blocks. These components are used for sampling signals present in coaxial lines and for adding or removing dc or low frequency signals from rf signals in coaxial lines. T.E.M., Inc., 71 Okner Parkway, Livingston, N.J.

Sweep and Signal Generator 359

Technical Bulletin T-206 describes the new sweep and signal generator for tests of if and rf components. Detailed specifications of Model SSX-2, which offers a complete marker system in a single instrument package, with provisions for obtaining audio and pulse modulated cw, are given. Telonic Industries, Inc., Beech Grove, Ind.

Dielectric Material 360

A 3-page bulletin #11, provides information on the electrical properties of Duroid, a high temperature dielectric material. The Duroid series of reinforced teflons are used especially in high frequency, elevated temperature applications such as missile radomes and nose cones; airborne electronic gear and missile guidance and control. Application details and references are included. Rogers Corp., Rogers, Conn.

Cable Caliper 361

A handy plastic device for measuring diameters of cables is available free on request from this company. When wrapped around wire bundles, the caliper shows at a glance both the actual diameter of the cable and the Zippertubing size. Write: The Zippertubing Co., 752 South San Pedro St., Los Angeles 14, Calif.

Urethane Foam 362

Six-page booklet described foamed-in-place uses of closed-cell rigid urethane foams in radomes for aircraft and guided missiles and numerous other structural parts. Listed in the technical data sheet are formulations, storage requirements, heat and humidity aging properties and methods of pouring and curing of polyester-based rigid urethane foam. Chemical Sales, National Aniline Div., 40 Rector St., New York 6, N.Y.



STOP FLUTTER!

Flutter, a function of the non-uniformity of speed of a recording material passing a translation point, can be substantially eliminated with Westrex tape pulling mechanisms. In terms of image accuracy, any recorded point will be within its ideal location with an error of something less than 1 mil at least 75% of the time. We will be glad to keep you informed of breakthroughs in this field, as well as technological improvements in magnetic heads and synchronous multi-channel recording. Additional information available on request from Westrex Corporation, 6601 Romaine Street, Los Angeles 38, California.



Westrex Corporation

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COUCH CVE TYPE RUGGED ROTARY RELAYS

IMPORTANT SPECIFICATIONS

Contacts: 4PDT (4 form C)
 Size: 1 3/2" D x 1 1/2" H
 Weight: 3.2 oz.
 Pull-in power: 1/2 watt
 Ambient Temperature:
 -65°C to +125°C
 Vibration Resistance:
 20G, 5 to 2000 cps
 Shock Resistance:
 75G operating
 200G non-operating

You can count on Couch relays to measure up whenever the ultimate in reliability is demanded under severe environmental conditions. A unique, patented, rotary armature design, and exacting quality control procedures are but two of many reasons why the Couch family of relays meets or exceeds the requirements of MIL-R-5757, MIL-R-6106, and MIL-R-25018.

Write for our new catalog on the full Couch line of rugged rotary relays.



ORDNANCE INC.

A subsidiary of S. H. Couch, Inc.

3 Arlington Street North Quincy, Mass.

CIRCLE 364 ON READER-SERVICE CARD

NEW LITERATURE

Adhesives 365

Series of technical bulletins on a variety of cements, adhesives and sealants described in 14-page brochure. Application information, and physical and electrical property data is presented for each product. Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.

Space Talk 366

A tiny booklet on the big problem of space is "a down to earth glossary of astronomical terms" which guides the layman through polysyllabic adversity to the stars. Pocket-size and pointed toward clarifying the average earthman's understanding of news reports on missile, rocket and space activities, "Space Talk" reviews 133 words selected from the patois of space scientists and engineers. Translations from the jargon (colloquial in spots) run the gamut from Abort (failure of a rocket or missile) to Zip fuel (special high energy jet engine fuel). Republic Aviation Corporation, Farmingdale, N.Y.

Hybrid Junctions 367

This 4-page catalog is an up-to-date guide for the selection of precision cast topwall short slot hybrid junctions. Electrical data and some common uses for these hybrid junctions are included. Microwave Development Laboratories, Inc., 92 Broad St., Babson Park 57, Wellesley, Mass., for catalog HT 58.

Precision Potentiometers 368

Persons concerned with the purchase of precision potentiometers can obtain a complete brochure covering the test and calibration facilities of this company. The series of technical bulletins illustrate and describe the product. TIC, 7229 Atoll Ave., North Hollywood, Calif.

Aluminum RF Plugs 369

Complete line of lightweight RF plugs utilizing aluminum shells is described in this catalog. Illustrated, 17-page catalog ALRF-1 features line of coaxial plugs and ALA line of cable adaptors. Cannon Electric Co., Advertising Dept., 3208 Humboldt St., Los Angeles 31, Calif.

Lepel induction heating equipment represents the most advanced thought in the field of electronics... the most practical and efficient source of heat developed for numerous industrial applications. You are invited to send samples of work with specifications. Our engineers will process and return the completed job with full data and recommendations, without cost or obligations.

FLOATING ZONE UNIT FOR METAL REFINING AND CRYSTAL GROWING

A new floating zone fixture for the production of ultra-high purity metals and semi-conductor materials. Purification or crystal growing is achieved by traversing a narrow molten zone along the length of the process bar while it is being supported vertically in vacuum or inert gas. Designed primarily for production purposes, Model HCP also provides great flexibility for laboratory studies.

Model HCP



Features

- A smooth, positive mechanical drive system with continuously variable up, down and rotational speeds, all independently controlled.
- An arrangement to rapidly center the process bar within a straight walled quartz tube supported between gas-tight, water-cooled end plates. Placement of the quartz tube is rather simple and adapters can be used to accommodate larger diameter tubes for larger process bars.
- Continuous water cooling for the outside of the quartz tube during operation.
- Assembly and dis-assembly of this system including removal of the completed process bar is simple and rapid.

Electronic Tube Generators from 1 kw to 100 kw.
 Spark Gap Converters from 2 kw to 30 kw.

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LEPEL HIGH FREQUENCY LABORATORIES, INC.
 55th STREET and 37th AVENUE WOODSIDE 77, N. Y.

CIRCLE 370 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 18, 1959

Memory System

381

Technical Bulletin 58-B describes model 3122 random access store, one of a series of random access memory systems manufactured by company for buffer and memory requirements in data processing systems. The 4-page illustrated bulletin describes the use of the standard apertured ferrite plate as the storage medium and points out the 3122's access time of 12 μ sec, the capacity of 512 8 binary digit characters, and the random access for both writing and reading. Also included are timing diagrams, complete specifications, accessories available, applications and a description of other random access stores in the 3100 series, with capacities to 4096 characters and character lengths to 36 bits. Rese Engineering, Inc., 731 Arch Street, Philadelphia 6, Pa.

Servo System Components

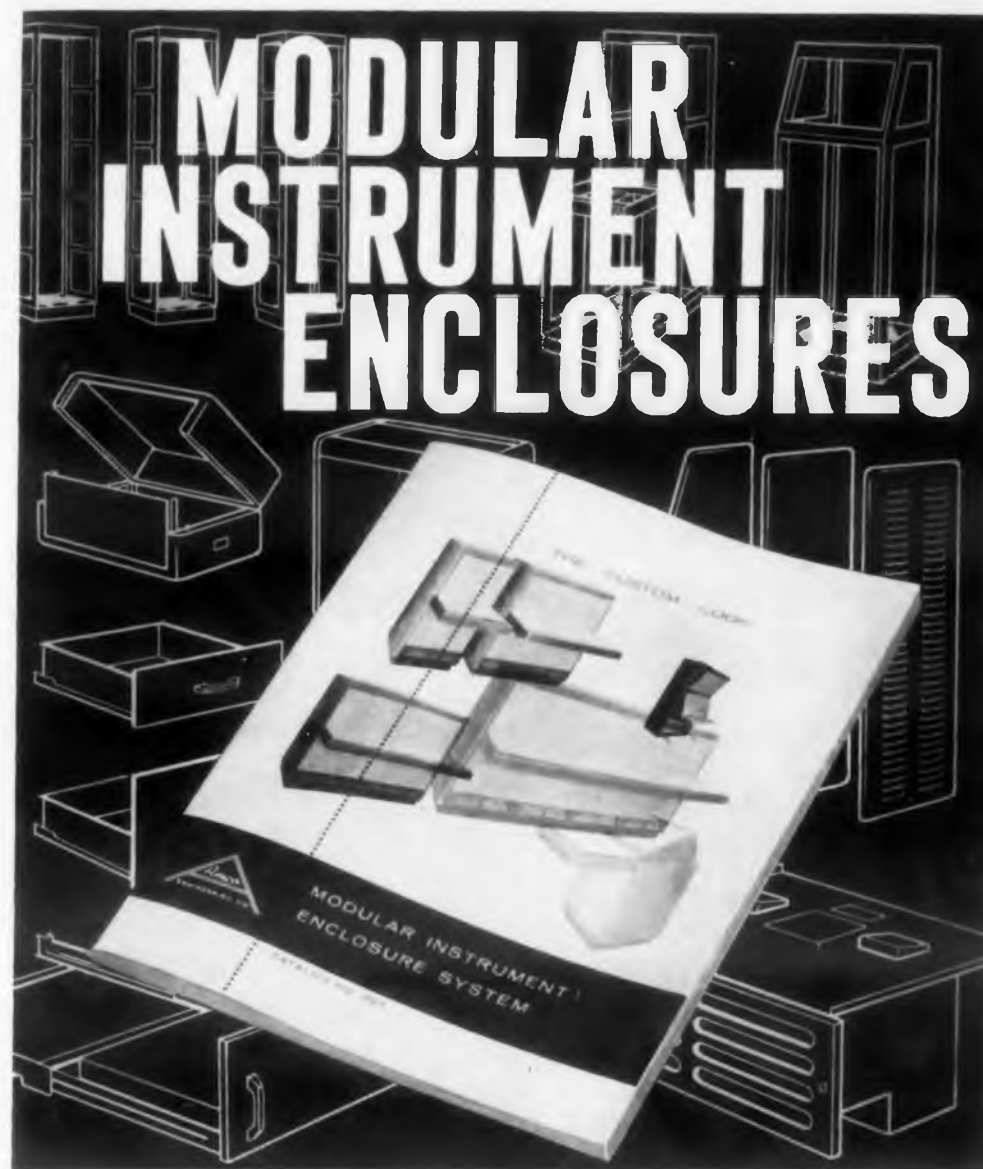
382

Four bulletins supply information on a new line of electrohydraulic servo system components. Bulletin 36100, 8 pages, "New Electrohydraulic Servo Valves," illustrates and describes the construction and principle of operation of this plunger-less valve design. Servocontrol's new concept of single stage, three and four-way servo valves contains only two moving parts and eliminates metal-to-metal contact between valve body and "Swing-Plate" (Flow director plate). Specifications, flow curves and installation dimensions are included.

Bulletin 36200, 4 pages, "New Power Amplifier," covers the specifications, capabilities and operation of Servocontrol's universal type amplifier. The amplifier can be used to drive two phase ac servo motors or dc torque motors while providing for command-feedback input signal summation, comparison, or difference. All transistor, push-pull design increases reliability.

Bulletin 36300, 4 pages, "New Preset Units," illustrates and describes the construction and specifications of these units. Servocontrol's preset dial units are composed of three assemblies for ease of installation in commercial mountings. They provide an accurate means of storing variable preset command signals. The use of O'Rings between the dial face and mounting surface, as well as around the wire-wound potentiometer shaft, insure oiltight mountings.

Bulletin 36400, 4 pages, "New Panels," illustrates many of the different forms and types of "Custom-Built" amplifier and control panels built by Oilgear-Servocontrol for operating electrohydraulic servo systems. All available from: The Oilgear Co., 1579 West Pierce Street, Milwaukee 4, Wisc.



Everything needed for top-quality, custom-appearance enclosures is made by AMCO...and shown in this new catalog!

The multi-width panels, cowlings and writing surfaces, unique with Amco, retain custom quality appearance of single unit construction. Amco's electronics know-how and wide experience in the manufacture of equipment enclosure and relative mounting and cooling accessories assure your complete satisfaction in the appearance, strength and durability of every unit. Amco cabinets and enclosures are designed to accommodate the most complex systems and provide complete service accessibility and operator convenience.

All Amco frames are direct floor-bearing.

A complete selection of basic frames can be arranged in endless variety, all chassis and equipment is mounted directly off of frame members for maximum support. Blowers, chassis slides, heavy-duty dollies and many other parts and accessories, all made by Amco, are supplied under a combined discount rate with other components—a big savings.

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Senior Systems Analysts—Require Senior Systems Analysts with strong theoretical and design knowledge in the electronic engineering field including familiarity with electronic and electro-mechanical digital machines. Should possess minimum of 3 years' experience with commercial application digital data processing equipment, however, would consider experience with scientific or defense application systems. Operational experience with a large data processing system is a distinct asset. Will be required to analyse and direct product improvement on large general purpose computer or small special purpose desk computer series. Advanced degree desired.

Senior Circuit Designers—Experienced in the design, development and analysis of transistorized computer circuits. Familiar with the application of magnetic cores to computer high-speed memory design. Growth opportunities involving decision making, concerning reliability, cost and component selection are offered. Advanced degree desired.

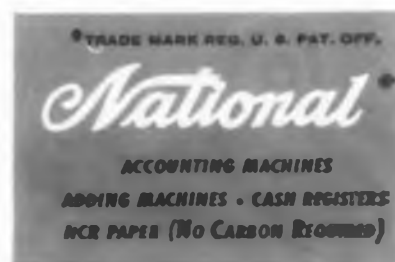
Senior Circuit and Logical Designers—Similar experience and duties as noted for Senior Circuit Designer, plus evaluation and de-bugging arithmetic and control areas of computer systems. Advanced degree desired.

DATA PROCESSING ENGINEERS

Senior Electronic Design Engineers—Experienced in development of logical design using standard computer elements, must also evaluate and design transistorized circuits including voltage regulated power supplies and circuitry related to decimal to binary coding. This data processing system is concerned with bank automation.

SEND RESUME TO:

Mr. K. N. Ross
Professional Personnel Section C,
The National Cash Register Co.
Dayton 9, Ohio



CIRCLE 881 ON READER-SERVICE CARD

NEW LITERATURE

Fans 388

A 4-page, illustrated 2-color catalog describes the new line of Pesco axial flow fans which provide high air displacement and pressure for cooling, heating and ventilating. Specifications for electric motors for 27-v dc, 400 and 60-cycle ac, and special models are included. Significant characteristics such as capacity, static pressure, rotor tip diameter, nominal hp, nominal speed and weight are listed. Pesco Products Div., Borg-Warner Corp., Bedford, Ohio.

Instruments 389

This is a 52-page catalog on process instruments covering indicators, transmitters, recorders and controllers for flow, pressure, temperature, density, viscosity, and consistency. Fischer & Porter Co., 941 Jacksonville Road, Hathoro, Pa.

Vacuum Technology 390

The Duo-Seal Digest covers the area of vacuum technology. It contains, among other things, abridged articles from various periodicals. Volume I, number 1, of the Digest has such articles as "Instrumentation In Vacuum Induction Melting," "Rate of Exhaust Through A Tube Or Orifice." For the first issue and succeeding monthly issues, write to W. M. Welch Scientific Com, Div. of W. M. Welch Manufacturing Co., 1515 Sedgwick St., Chicago 10, Ill.

Epoxy Resins and Hardeners 391

Technical Bulletins ER-1 and ER-2, both four pages, include a discussion of the properties and uses of Epotuf epoxy resins and hardeners. Also covered are such topics as fillers, flexibilizers and handling precautions. Reichhold Chemicals, Inc., RCI Building, White Plains, N.Y.

Heaters 392

Flexible silicone rubber heaters are the subject of a new illustrated catalog sheet, which details the construction features of heaters for greater application flexibility in the design of electric heating units. Specifications included. Bulletin C-102, from Watlow Electric Manufacturing Co., 1376 Ferguson Ave., St. Louis 14, Mo.

Locking screws with LOCTITE increases production 23%



Assembling Hobbs hour meters

Mr. LeRoy L. Rasch
John W. Hobbs Div., Stewart-Warner Corp.
Springfield, Illinois, says.

"We all try to cut costs. For example, we used a resin-type product to hold screws in assembling Hobbs Hour Meters. It was necessary for a girl to dip a little piece of wire into the compound, transfer it to the screw hole, and then assemble the screw. With 18 screws this was a slow and tedious job. We switched to LOCTITE Sealant and increased production while making the job easier for the girls. Operators now produce 23% more meters per hour thanks to LOCTITE! This increased production is accomplished by tumbling large batches of screws with LOCTITE in a polyethylene bag. The screws, treated and ready, are spread in front of the operator within easy reach. LOCTITE will not harden in air, but sets firmly when screws are assembled. LOCTITE saves us time and money by virtually eliminating the labor of applying the staking compound to the screws. LOCTITE cut costs for us with no effort at all."

LOCTITE is a thin liquid that hardens when confined between closely fitting metal parts. One drop replaces all size lock nuts, lock washers, lock screws, staking, jam nuts and interference threads. It forms a tough heat and oil resistant bond that resists any amount of vibration... yet ordinary tools will remove fasteners. LOCTITE requires no heating or mixing... treated parts can be stored for days... lock only when assembled. Write for literature and free sample.



LOCTITE SEALANT
AMERICAN SEALANTS COMPANY
183 Woodbine St., Hartford 6, Conn.

CIRCLE 393 ON READER-SERVICE CARD

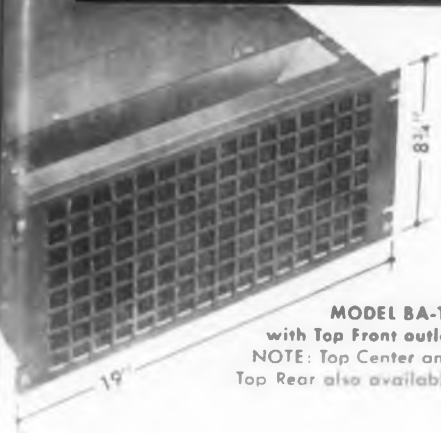
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EXACTLY WHERE NEEDED

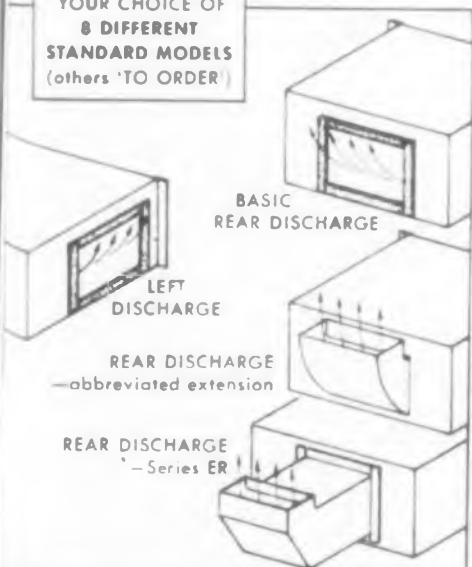
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MODEL BA-TF
with Top Front outlet
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- MIL SPEC QUALITY
Meet radio interference requirements of MIL-I-16910A
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600—1200 CFM output
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Mount as standard 8 3/4" RETMA panel—15" front-to-back
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8 DIFFERENT
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Chassis-Trak Corp., 525 S. Webster Ave., Indianapolis

CIRCLE 394 ON READER-SERVICE CARD

Preamplifiers 395

Bulletin describes the company's standard preamplifier, type PA4401-001 3VA. Physical and electrical characteristic curves are detailed in bulletin P-15, which includes instructions to design engineers for ordering nonstandard preamplifier models. Write Control, Box 391, Butler, Pa.

Instrument Cases 396

A 20-page color illustrated design manual on standard and special instrument cases contains complete detail prints, design information on 120 basic sizes and types, materials and specifications cross-referenced to Mil requirements. All cases are made of drawn aluminum. Each size is illustrated with fully detailed engineering prints. This manual is expressly directed to the design engineer requiring portable instrument cases. Requirements and features are visually presented for quick reference by the engineer or others. Standard sizes provide large savings of engineering design time, as well as tooling costs and delivery schedules. Allows electronic engineers to devote entire talent to instrument design, by eliminating housing problems. TA Mfg. Corp., 4607 Alger Street, Los Angeles 39, Calif.

Shock, Vibration Measuring Systems 397

A 14-page booklet fully describes and illustrates three commercially available shock and vibration measuring systems. The systems described are fully integrated both in instrumentation and packaging, and are complete systems featuring automatic control, self-calibration and requiring no additional equipment. There are four sections to each system—a sensing section consisting of fully matched transducers and their connections; an electronic control section consisting of the switching and programming circuitry; an instrument section composed of the measuring and conversion equipment for analyzing the information and the output section for instantaneous and permanent recording of the raw and processed data. The three systems described are:

1. 12 channel, 3 Station Recording and Monitoring System for Research and Development Work in Missile Studies and Nuclear Detonation.
2. 12 Channel, 3 Station Recording and Monitoring System for Acceptance and Reliability Testing.
3. Wide Frequency Accelerometer Calibration System for the precise and automatic calibration of transducers to frequencies up to 10 kc with an accuracy of 5%.

Columbia Research Laboratories, Bullens Lane and McDade Blvd., Woodlyn, Pa.



... now wind 19,000 times!

If you're dedicated to the cause of high resolution, you could wind your own pots and be sure. Allow yourself plenty of time, though — because the secret's in the number of turns per inch, and the spacing between 'em. Pack those turns right in there closely and accurately, and you might have a pot you'll be proud of!

But if you want to eliminate all bother, but not the high resolution, call on Ace! We've designed and built our own special winding equipment; we use premium, close tolerance resistance wire — and really leave no winding unturned to produce pots with the highest resolution in the industry. All AIA sizes, all mounting styles, specials and standards. So get your resolution the easy way — get Acepots! See your ACErep at once!



Here's highest resolution in a standard sub-miniature pot: The 500 Acepot® 1/2" size, ±0.3% independent linearity. Special prototype section insures prompt delivery on the Acepot® — 1/2" to 6", AIA sizes.

ACE ELECTRONICS ASSOCIATES, INC.
99 Dover Street, Somerville 44, Mass.
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Acepote® Acetrim® Acetset® Aceohm® *Reg. Appl. for
CIRCLE 398 ON READER-SERVICE CARD



RD INSTRUMENTS

FOR RESEARCH AND DEVELOPMENT



MODEL 1230

CARDMATIC[®] AUTOMATIC TUBE TESTER

Laboratory accuracy—within 3% of best known standards.

Automatically provides trillions of switching combinations for accurate test conditions.

Automatic decade systems also permit special purpose tests.

- 1000 filament voltages • 250 Gm ranges • 1000 self-bias conditions
- 500 current sensitivities • Instant shorts and leakage tests • Self-calibrating.

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MODEL 1700

MOST ACCURATE LABORATORY TYPE TUBE TESTER

All voltages and currents are variable, electronically regulated and metered—9 separate meters—to permit tube tests under handbook conditions. Accuracy to 1½% available through use of small Null Indicator accessory—up to 60,000 micromhos in 11 ranges.

\$1175



MODEL 1575

FIELD ENGINEER'S TUBE TESTER

7-range Gm scale to 60,000 micromhos. Line voltage and grid bias voltages are metered separately. 4 signal voltage levels. New VR tube tests. Highly accurate shorts or leakage test, gas test and future tube life test. Meets Western Electric specifications.

\$425

A demonstration or technical literature is available at your request.



RD INSTRUMENTS

FOR RESEARCH AND DEVELOPMENT

The Hickok Electrical Instrument Company • 10514 Dupont Ave. • Cleveland 8, Ohio

CIRCLE 401 ON READER-SERVICE CARD

NEW LITERATURE

Adjustable Speed Drives 402

Catalog 11058 is a 2-color, 16-page, compilation of technical data which includes a discussion of the basic methods for operating dc motors from ac power sources. Typical schematic diagrams are included as representative of the more popular systems in general use. The remaining portion of the catalog includes specifications, speed and torque rating, etc. of the equipment manufactured by company. Copies from: Servo-Tek Products Co., 1086 Goffle Road, Hawthorne, N.J.

Data Handling Systems 403

Improved line of Kybernetes electronic data handling systems are described in bulletin, which presents to the industrial field a new concept for logging, monitoring, and integration of process information. Basic design parameters, programming, switching, analog to digital conversion, linearization, calibration, accuracy, digital ranging, printout and off-normal alarms. Bulletin MSP-154, Kybernetes Div., Hagan Chemicals & Controls, Inc., Box 1346, Pittsburgh 30, Pa.

Lacing Cords and Tapes 404

This 4-page leaflet describes the latest addition to the Alpha Wire line cataloging synthetic lacing cords and tapes, the industry's only complete listing of both military and commercial types. In addition to an extremely wide variety of constructions, this catalog contains a wealth of technical information covering materials, finishes, physical descriptions and military specifications. Price schedule is included. Alpha Wire Corp., 200 Varick St., New York 14, N.Y.

Antenna Systems 405

An addition to the reference library of antenna system planners and engineers. Andrew Catalog 22, a 96-page product and facility book, covers the antennas, antenna systems, and transmission line products of this company. Included are new product developments in 21-in. waveguide, high power transmission lines, ground-to-air and telemetry antennas, microwave and two-way communication antennas, and the introduction of two new sizes of Helix (flexible coaxial line). A special 16-page section covers general antenna systems engineering information. Andrew Corp., 363 E. 75th St., Chicago 19, Ill.

IN THIS SUB-MINIATURE RELAY



SUB-MINIATURE COILS

**Designed and Built by
Forbes and Wagner
In Co-operation with
One of the World's Largest
Electrical Manufacturers**

To reduce the size of this sub-miniature relay, the single coil common to most relay designs was divided into two, and the two halves were connected in series. In this way the ratio of the number of turns to the total ohmic value was kept to a maximum. The magnetic cores were used as coil retaining members as well as flux carrying members.

Ordinary wire insulations are inadequate for the high temperatures encountered in many relay designs. Research is currently going on to find correct insulating materials for magnet wire. Important also is the selection of coil spool materials and coil wrappings for they can seriously effect the reliability of operation.

Let us help YOU with YOUR Electronic Problems

We design and produce both simple and complex components and assemblies. Electronic, Electro-Mechanical and Mechanical for Commercial and Military applications in Radio, Television, Tele-communications, Computers, Radar, Guided Missiles and allied fields; also, Pulse Amplifiers, Triggered Circuits, Wide Band Circuits, Toroidal Windings and Transformers. Write for brochure giving complete information.

Growth Opportunity for Electrical Engineers. To meet the growing demand for our services, we offer steady employment, high base salary plus profit sharing, paid vacation, group life and hospitalization insurance, sick leave policy, retirement program, etc. Located on shore of Lake Erie. Fishing, boating, swimming at your doorstep. Ideal community life. Thirty minutes from Buffalo via thruway. Replies held in strict confidence.



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SILVER CREEK, N.Y. • TELEPHONE 651

CIRCLE 406 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 18, 1959



Clean precision parts more safely

New Freon* solvents by Du Pont minimize cleaning hazards

- **Low toxicity**—"Freon" solvents are odorless and much less toxic than ordinary solvents—vapors won't cause nausea or headaches.
- **Won't burn or explode**—Underwriters' Laboratories report "Freon" solvents non-explosive, non-combustible and non-flammable.
- **Non-corrosive**—"Freon" solvents remain neutral through repeated degreasing use without the need of inhibitors.
- **Negligible effects on plastics, elastomers, insulation and color codes**—"Freon" solvents remove oil and grease with minimum swelling of plastics or rubber and without crazing or softening paint, wire coatings or insulation.
- **Leaves no residue**—"Freon" solvents evaporate completely, leave no deposit.

New "Freon" solvents by Du Pont degrease sensitive mechanical and electronic assemblies without damage to delicate parts. Since no inhibitors are needed, no residue is left on the parts, and "Freon" solvents can be recovered and reused without re-inhibiting. Write for free "Freon" solvents booklet. E. I. du Pont de Nemours & Co. (Inc.), "Freon" Products Division 542, Wilmington 98, Delaware.

*Freon is Du Pont's registered trademark for its fluorinated hydrocarbon solvents.



Better Things for Better Living
... through Chemistry

FREE BOOKLET!
No obligation—write for booklet which tells how new "Freon" solvent by Du Pont minimizes cleaning hazards.

Aircraft and Missile Subsystems 409

Comprehensive brochure, Bulletin 360, covering products for manned aircraft and missiles, is indexed for quick reference—covers a wide range of pumps and hydraulic power units, pressurization-dehydration units, electronic liquid cooling, and refrigeration-type cooling packs, servo-valves and servo systems. Many performance specifications, weights, dimensions and power requirements, make this 12-page guide to aeronautical products and product capability a useful instrument for designers of systems and subsystems. Engineers looking for information on components now in production which may fit their requirements will also find it helpful. Over 50 illustrations, tables, graphs. For one or more copies, write to Eastern Industries, Inc., 100 Skiff St., Hamden 14, Conn.

Sprayed Coatings 410

Basic 8-page engineering data bulletin on wire and powder sprayed coatings of metals and ceramics covers basic characteristics of these coatings. A wide range of mechanical and electrical-electronic applications are both illustrated and described. Bulletin 136A available from Metallizing Engineering Co., Inc., 1101 Prospect Ave., Westbury, L.I., N.Y.

Printed Wiring Boards

Printed wiring design criteria are featured in an illustrated catalog, (E-6). Standardized definitions and military design standards are presented. In addition, the catalog features pictures and descriptions of various electronic components that are adaptable to printed wiring boards. Available on company letterhead request to Rowe Engravers, 262 E. 16th Street, Paterson 4, N.J.

Electron Microscope 411

"Questions and Answers on Electron Microscopes" is a 12-page booklet compiled from actual queries asked in the field and at Norelco Microscope School sessions. The booklet discusses magnification, resolution, specimen preparation and fields of application. Shadow casting, electron diffraction, camera work, stereo techniques, astigmatism correction, lens details, beam wobbler, through focus control, and many other technical matters are also covered. Instruments Div., Philips Electronics, Inc., 750 South Fulton Ave., Mount Vernon, N.Y.

CURTISS WRIGHT



ELECTRONIC COMPONENTS



Miniature TIME DELAY RELAYS Low-cost for commercial applications

Curtiss-Wright offers a reliable and inexpensive thermal time delay relay in the "G" and "K" Series — miniature size hermetically sealed in glass.

SPECIFICATIONS

Time delay.....Preset 3 to 60 seconds
Contact arrangement.....SPST or SPDT
Heater voltage...6.3, 26.5, 117 AC or DC std.
Weight.....Less than one ounce
Base.....Miniature 9 pin
Size.....T6 1/2 bulb—Max. hgt. 2 3/8"



New DIGITAL MOTORS

Stepping motors for high reliability applications. Meet the requirements of assured reliability and long life for aircraft, missile and automation systems.

FEATURES | Bi-directional • Positive lock • Dynamically balanced • Simplicity of design • High pulsing rate.

New ULTRASONIC DELAY LINES

Enables development engineers to employ new concepts in existing and projected applications. Low in cost, small in size and simple to operate.

SPECIFICATIONS

Delay range.....5 to 6000 microseconds
Tolerance.....± 0.1 microsecond
Signal to noise ratio.....Greater than 10:1
Input and output impedance...50 to 2000 ohms
Carrier frequency.....100 kc — 1 mc
Delay to pulse rise time.....Up to 800:1



WRITE FOR
COMPLETE
COMPONENTS
CATALOG
159

COMPONENTS DEPARTMENT
ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION

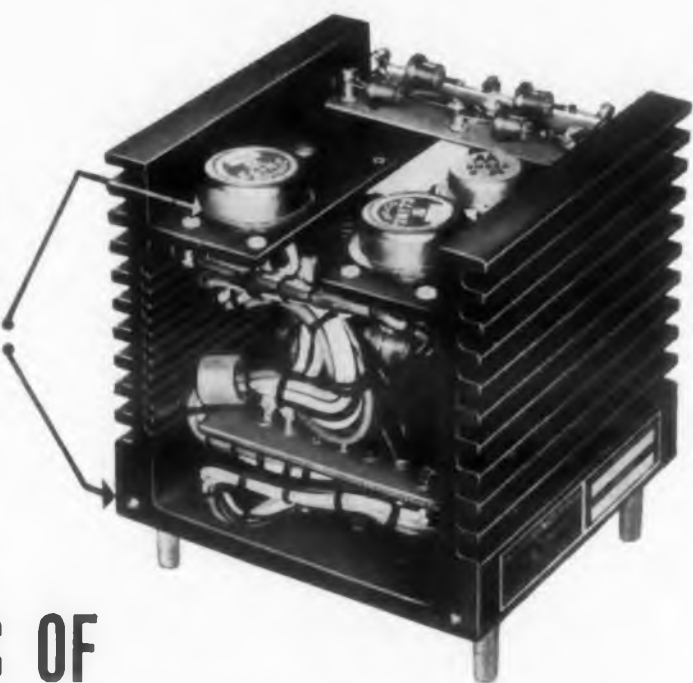
620 PASSAIC AVENUE WEST CALDWELL, N. J.

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CIRCLE 408 ON READER-SERVICE CARD

High efficiency
heat dissipation

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TRANSISTOR BASE
and SUPPLY BASE
NEVER MORE
THAN 2°C



142 MODELS OF TRANSISTORIZED POWER

The high heat dissipation achieved by Avionics' Veridyne Power Supplies results from the unusual one-piece design of the finned aluminum extrusion case. This makes for a highly stable and reliable unit. All parts are accessible for quick easy servicing. Units feature positive short circuit protection, low ripple content, fixed and variable output.

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- AC-DC PLUG-IN SUPPLIES**
 - Input: 115 volts, 60 and 400 cps
 - Output: 6, 12, 24, 75, 150, 250, 300 volts DC
 - DC-AC PLUG-IN INVERTERS**
 - Input: 6, 12, 24 volts DC
 - Output: 115 volts, 60 and 400 cps
 - DC-DC PLUG-IN CONVERTERS**
 - Input: 6, 12, 24 volts DC
 - Output: 12, 24, 75, 150, 250, 300 volts DC
 - LABORATORY POWER SUPPLIES**
 - Input: 105 to 125 volts, 60 and 400 cps
 - Output: 0 to 32 volts; 1, 5, 10, 15 amps
- ALL GUARANTEED to meet specifications

Produced in one of Long Island's most modern electronics plants.



Industrial Products Division

CONSOLIDATED AVIONICS CORPORATION

800 Shames Drive • Westbury, New York

Subsidiary of Consolidated Diesel Electric Corporation

CIRCLE 413 ON READER-SERVICE CARD

NEW LITERATURE

Miniature Clutches

414

Miniature one-way precision roller clutches, that allow drive in one direction and provide free-wheeling action in the opposite direction, are described in a new brochure. Proven by use in instruments, automation controls, servo mechanisms, business machines and recording devices, these clutches meet the most demanding requirements in designs involving near-zero backlash, free-wheeling, selective coupling, automatic cycling, dual or multiple drives and infinitely adjustable ratchets. Stock roller assembly sizes range from 0.1875 in. bore and 0.625 in. O. D. through 0.625 in. bore and 1.625 in. O. D. Complete clutch dimensions range from 0.250 in. shaft with 0.8125 in. housing through 0.375 shaft with 1.3125 in. housings. Right or left hand drives are offered. The Miniclutch Co., 373 Morse St., Hamden, Conn.

Design Maximum System

415

Application Note AN-174, entitled "Design-Maximum System for Rating Electron Tubes," reviews the significant differences between the three rating systems currently in use by the electron tube industry—the absolute-maximum, design-center, and design-maximum systems. The design-maximum system, which is the newest and latest, is discussed in detail. Commercial Engineering, RCA, Harrison, N.J.

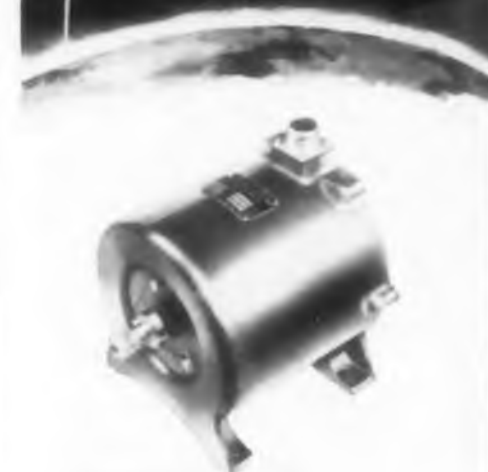
Ceramic Transducers

416

A technical brochure on the subject of a new series of Glennite high temperature, piezoelectric ceramic transducers describes the exceptionally high Curie points of these transducers, that have made it possible to reach higher output voltages per unit input pressure than can be reached with conventional ceramics. Because no cooling is required, applications for the transducers highlight uses in ordnance systems and high temperature electromechanical sensors. The eight-page, two-color, illustrated brochure also describes applications of these components in the fields of underwater sound, ultrasonics, medicine, shock and vibration, and in general equipment such as, surfaces gauges, control devices and delay lines. Copies of the brochure may be obtained by writing to the Sales Manager, Advanced Development and Systems Division, Gulton Industries, Inc., 212 Durham Avenue, Metuchen, N.J.

PRECISION A-C POWER SUPPLIES...

... for
AUXILIARY POWER SYSTEMS
GROUND SUPPORT SYSTEMS
EMERGENCY POWER SUPPLIES



PERMANENT MAGNET ALTERNATORS AND INVERTERS

Extreme Reliability • High Efficiency
Static Voltage Regulation • High Speed

The superior advantages of Pesco produced permanent magnet alternators and inverters are responsible for their use in many of the major missiles and supersonic aircraft. By utilizing a radial air gap permanent magnet rotating field, all brushes and slip rings are eliminated, thus reducing radio interference and explosion danger. Present models range in size from 25 VA to 12 KVA output at speeds of 3000 to 48,000 R.P.M. Pesco's creative research, engineering and production group offer a completely integrated facility for your power supply needs. Please write for full technical data to Dept. 11B

WESTERN BRANCH



PESCO PRODUCTS DIVISION

Borg-Warner Corporation
3310 Vanowen Street
Burbank, California

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ELECTRONIC DESIGN • February 18, 1959

LOW-LOSS KEL-F SOCKETS

... for high-power
transmitting tubes!



for tubes such as:

4X150A
4X150D
4X250B
4CX250B
7034
7035
4X250F



Designed for use with high-power transmitting tubes, these sockets are molded of low dielectric, loss-factor Kel-F plastic. Sockets are available in several designs—with or without screen grid by-pass capacitors. Control grid contact "guide" is machined for greater alignment accuracy—all contacts are low-resistance, silver-plated beryllium copper. Tube pin contacts are heat treated to provide positive contact pressure as well as extended life—annealed soldering tabs may be easily bent or formed. High quality, heat resistant, steatite chimney also available to direct air flow through tube cooling fins.

For details and complete specifications write for free catalog listed below:

New Catalog

Write today for your copy of our newest components catalog, complete specifications and prices!
• Capacitors • Knobs and Dials
• Sockets • Inductors • Pilot Lights • Connectors • Insulators

E. F. JOHNSON CO.

1942 Second Ave. S.W. • Waseca, Minn.

CIRCLE 418 ON READER-SERVICE CARD

Microwave Measurements

419

A 36-page application note describes the latest techniques and instrumentation for making various microwave standards measurements. The booklet, "Microwave Standards Prospectus," presents a detailed description of the techniques used in the general areas of standards measurement, including frequency, attenuation, impedance and power. It contains typical measuring arrangements devised by the company standards engineering staff, with many system block diagrams and accuracy curves. The prospectus also includes a detailed list of the latest equipment available for standards measurements. Copies of "Microwave Standards Prospectus" may be obtained by writing Ron Whitburn, Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif.

Magnetic Amplifiers

420

A 12-page brochure describes expanded facilities for the manufacture of magnetic amplifiers and saturable reactors including associated circuitry and equipment. Booklet also describes advantages of magnetic amplifiers and the reliability, maintainability, and applications for magnetic amplifier equipment. The Branch Manufacturing Co., Div. of the General Bronze Corp., Newark, N.J.

Ceramic Tool Components

421

Bulletin 116, a 4-page catalog, describes a new line of off-the-shelf high temperature ceramic tool components, including a wide variety of bushings, washers, discs, plates, rods, and v-blocks. Bulletin 116 includes information on dimensions, tolerances, how to order special requirements, and complete mechanical and electrical properties of the hi-temp ceramic components. Using this catalog, design and production engineers can now utilize off-the-shelf components which can be obtained rapidly at a fraction of the cost of custom fabricated parts for such applications as hi-temp fixtures for brazing, soldering, welding, sintering, melting or hot forming operations. Bulletin 116 includes Duramic tool components such as round and square rods in the range 1/4 in. in diam, washers to 2 in. OD, discs to 6 in. OD, plates as large as 5 in. x 6 in., and plain and shoulder bushings up to 3 in. OD. All these parts can be further revised by the user by grinding with silicon carbide wheels. Bulletin 116 is the first of a series of standardized components. Duramic Products Inc., 262-72 Mott St., New York 12, N.Y.

NOW 0.1 to 525 KC

in **one** compact
reliable **ultrasonic**
spectrum analyzer



PANORAMIC'S NEW SB-15

Designed for maximum application utility, reliability and automaticity for

- Ultrasonic Spectrum Analyses
- Harmonic and Cross Modulation Investigations
- Ultrasonic Vibration and Noise Measurements
- Telemetry
- Monitoring
- Attenuation Measurements of Filters and transmission lines

In the all-new, precisely developed SB-15, you get expanded frequency coverage... all the way to 525kc! With a single, complete unit, only 8 3/4" high.

Check these specifications for the SB-15:

- Continuously calibrated sweep width from 200 KC to 1 KC
- Exceptional stability at reduced sweep widths
- 100cps resolution capability
- Independently variable resolution or automatically optimized resolution to suit your needs.
- Continuously variable sweep rate from 1cps to 60cps

For Single Line Frequency Response Curve Tracing



... just add the
**Panoramix
G-15**

... highly selective ... discriminates against noise and hum ... virtually unlimited dynamic range. Valuable for analyzing telemetry and carrier current system components, transformers, filters, transducers, amplifiers, receivers and various networks and devices.

GET the full story on the many other uses of the SB-15. WRITE, WIRE, OR PHONE for detailed specification bulletin; and ask to be put on our regular mailing list for The PANORAMIC ANALYZER featuring application data.

For a low-cost, highly stable Spectrum Analyzer 1-300kc for the 300kc range,



Panoramix's
SB-7bZ
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Mount Vernon, N.Y.



AD 497A

THROUGH THE EYE OF HALLAMORE CLOSED CIRCUIT TELEVISION

...each testing complex at the massive
MARTIN-DENVER "Titan" facility

is visually monitored, from as close as 10" from direct missile blast as well as from perimeter checkpoints. Environmentally protected, transistorized Hallamore cameras (Model CC420), remotely controlled from more than 2000 feet, provide a continuously clear picture through every phase of firing. Over 32 Hallamore designed, manufactured, and installed CCTV systems support the Hallamore designed and installed electronic system (over 900 racks) that provides telemetry for the entire Martin-Denver testing complex. Hallamore capability and creativity can be the answer to your systems requirement. Write Hallamore Electronics Company, 8352 Brookhurst, Anaheim, California. TWX: AH 9079...a division of The Siegler Corporation



ENGINEERS — FOR IDEAL WORKING CONDITIONS WITH A DYNAMIC, CREATIVE ORGANIZATION, ADDRESS RESUME TO CHIEF ENGINEER

HALLAMORE

CIRCLE 222 ON READER-SERVICE CARD

NEW LITERATURE

Short-Run Tooling

425

This 28-page brochure called "Short-Run Tooling for Long Range Economy" is thoroughly illustrated and is intended to show how short-run or "soft" tooling may be used to reduce tooling time and expense in the forming of diverse sheet metal products. Arrowsmith designs stress relief and hot sizing forming presses to order, and also uses them in its own plant for contract production runs. Booklet discusses the fact that plastic tooling is dimensionally stable as well as quickly made light in weight. Arrowsmith Plastic Tooling, Inc., 5726 West 96th St., Los Angeles 45, Calif.

Paper Electrical Tapes

426

A new, four-page booklet—intended to aid designers in selecting paper electrical tapes—lists physical and electrical properties of "Scotch" brand paper tapes, as well as the military specifications met by the tapes. Physical and electrical properties are listed in a cross reference chart, complete with recommended temperatures for curing thermosetting adhesives. A front-page chart lists the upper temperature limits of each tape by number. Other sections deal with the properties of "true" electrical grade paper tapes, the problems of corrosion, solvent and moisture resistance, relative age life, and temperature data. Minnesota Mining and Mfg. Co., Dept. D8-363, 900 Bush St., St. Paul 6, Minn.

Flat Type Rectifiers

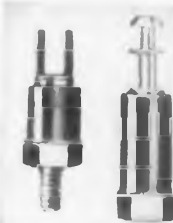
427

A six-page technical brochure, plus a complete price list, announces a new line of flat type Siemens selenium rectifiers that is now in stock and available from this company. Bulletin No. 268, fully describes the flat type rectifiers (which are believed to combine the most efficient ratings in the smallest package yet developed for wide commercial use), details their various sizes, and such operating characteristics as their long life (up to 50,000 hours), higher efficiencies, low forward drop and reverse leakage. These Siemens flat type selenium rectifiers have been in use in Europe for many years, but represent a new concept in the United States, and have application both in entertainment and industrial electronic equipment. Radio Receptor Co., Inc., (Semiconductor Div.), a subsidiary of General Instrument Corp, 240 Wythe Ave., Brooklyn 11, N.Y.

Get the Facts About These Cost Saving Terminals and Molded Components

STANDOFF AND FEED THROUGH TERMINALS

Low cost and high electrical specs. have made these the most popular in the industry. Choice of over 100 varieties—fork, single and double turret, post... standard, miniature, sub-miniature... molded or metal base... wide variety of body materials and plating combinations.



Request Catalog SFT-1

CIRCLE 577 ON READERS SERVICE CARD

INSERT MOLDING SPECIALISTS



Tremendous savings can now be achieved on large volume custom-molded parts requiring metal inserts. This is made possible through automatic insert handling by our exclusive Blow-Loading Method.

Request literature

CIRCLE 578 ON READERS SERVICE CARD

MELAMINE JACKS

Very economical, yet designed electrically and mechanically for long, reliable service. Supplied in a wide range of code colors.



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POINTER KNOBS

A military and industrial favorite by reason of price and practicability. Supplied in attractive black, satin-finished phenolic.



Request details

CIRCLE 580 ON READERS SERVICE CARD

WHITSO, INC.

9326 Byron Street, Schiller Park, Illinois
(Chicago Suburb)

CIRCLE 428 ON READER-SERVICE CARD

reliable micro-miniature RELAYS

MAGNECRAFT
44



designed
for
reliability

Balanced rotary element with radial thrust bearings at both ends of shaft operated by the balanced pull of twin coils: minimizes effect of gravity, shock and vibration, permitting reliable operation where other relays fail.

Rugged frame and header assembly of bridge type construction: minimizes distortion and permits reliable operation under vibration, shock and temperature extremes.

Reliability inspections and tests cover parts, materials and every phase of assembly.

Permanently adjusted, ultrasonically super cleaned and hermetically sealed under ideal conditions: safe from contamination.

Engineering Data

Insulation resistance: 100 megohms, min.

Insulation to ground: 500 VAC, RMS.

Shock: 100g for 11ms.

Vibration: 20g to 2000 cps

Operate Time: 5 ms. max. with nominal voltage

Release Time: 3 ms. maximum.

Temperature Range: 65°C. to 125°C.

Available with required types of terminals and mountings to meet a wide range of applicable military specifications.

Send specifications for quotation or write for literature.

MAGNECRAFT
Electric Company

3350D W. Grand, Chicago 51, Ill.

Solar Cells

430

A 4-page brochure (Technical Information Bulletin 32-58), detailing the electrical and physical characteristics of the Standard Hoffman line of silicon solar cells, gives complete design parameters as well as application notes on nine types of cells. Illustrated are spectral response curves, current-voltage characteristics at various light levels, variations of available power according to temperature, and a magnified view showing construction details of a typical solar cell. The Hoffman cells described are the same as those still powering a radio transmitter in the Vanguard satellite after seven months in space. Semiconductor Div., Hoffman Electronics Corp., 930 Pitner Ave., Evanston, Ill.

Transformers

431

The 1959 edition of this Transformer Catalog is a 32-page, two-color catalog covering more than 750 transformers for industrial, communications, television and radio applications. An important feature of the 1959 catalog is a new indexing system, making it extremely easy to locate the appropriate unit. The catalog gives detailed listings of electrical and physical specifications on the full line of Stancor transformers and includes output transformer charts, performance curves, and a special section that has detailed descriptions and illustrations of mounting styles. Chicago Standard Transformer Corp., 3501 Addison St., Chicago 18, Ill.

Printed Circuits

432

A paper entitled "Materials for the Electronics Industry," is a valuable reference which describes the handling and application of resists and inks used in subtractive and additive methods of the printed circuit production. In addition, other materials are discussed which are used in chassis marking and production of etched and filled nameplates, and the application of colors to various plastics. The silk screen process is used in so many ways in the production of electronics equipment, special silk screen printing departments are being installed in the larger companies. The new catalog of the company is also available for selection of these materials for the electronic industry—in addition to their comprehensive selection of general silk screen process equipment, supplies, and screen-making services. Atlas Silk Screen Supply Co., 1733 Milwaukee Ave., Chicago 47, Ill.



A Gulton VO
"Button Cell" Battery
Powers This
LIFE LITE* Flashlight

*Trademark

reliable ... long-lived
... rechargeable!



You can read a watch in the dark with any flashlight. The difference in the one the night nurse* is using is that it will probably last a lifetime.



That's because it's powered by a sealed nickel cadmium button cell battery that's recharged simply by plugging it into an ordinary wall socket for a few hours.

Result: A dependable flashlight that can't corrode and never needs battery replacement.

How Can You Use These Versatile Batteries?

The rechargeable Life Lite is only one of many interesting ways in which imaginative engineers are employing these Gulton VO batteries.

Other applications: transistorized radios, guidance canes, missiles, photoflash power packs—wherever small size, large capacity, light weight, long life, no maintenance, complete reliability, and easy recharging are desired.

Most Complete Line Available

"VO" cells are available in capacities of 100, 180, 250, 500 and 1750 mah; have a nominal 1.2 voltage; can be packaged in any combination to meet your voltage specs.

Patented sintered plate construction provides exceptional cycling characteristics; highest capacity per unit size. Like more information? Write us for Bulletin No. VO-110.



ALKALINE BATTERY DIVISION

Gulton Industries, Inc.

Metuchen, New Jersey

CIRCLE 433 ON READER-SERVICE CARD

CIRCLE 429 ON READER-SERVICE CARD

ELECTRONIC DESIGN • February 18, 1959

145



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DMETER MANUFACTURING COMPANY
22-24 Larkin Plaza, Yonkers, New York

NEW LITERATURE

Radio Interference Meters 436

Five 4-page bulletins give specifications, military approval data and applications of radio interference and field intensity measuring equipments covering a frequency range of 30 cps to 1000 mc. Stoddart Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood 38, Calif.

Tape Processing Equipment 437

Six-page brochure describes company's special tape processing equipment which offers the following features, singly or in any desired combination: Tape Tester, Tape Interrogate, Tape Editor, Tape Translator or Tape Copier. Equipment is available for purchase or rental. Address inquiries on company stationary to Digitronics Corp., Albertson, N.Y. Ask for APTE UV10158, specifying the type of computer you are using.

Molding Compound 438

Bulletin No. D 200 is a colorful brochure about multi-colored thermosetting polyester molding compounds. Discusses molding equipment, compression molding pressures, closed mold technique pressures, preforming, and preheating. Also treated are mold temperature, curing time, finishing and machining, drilling and tapping, and shelf life. Durez Plastics Div. of Hooker Chemical Corp., North Tonawanda, N.Y.

Soldering 570

Ultrasonic fluxless soldering is the subject of this booklet. Attractively illustrated, its eight pages describe the full line of ultrasonic fluxless soldering equipment, and its various uses. Models vary from the hand unit to a specialized high production unit, with special tips made to suit individual needs. Sonosolder equipment is used for fluxless soldering of silicon, germanium, aluminum, magnesium and many other materials. Request Bulletin SB-5 from Aeroprojects Inc., Box 555, West Chester, Pa.

Probes 571

This new short form catalog covers complete line of thermistor based temperature measurement and control instruments including descriptions of five new temperature ranges extending above and below those previously available; pyrex probes; additions to the thermistor sensing probe series. Yellow Springs Instrument Co., Inc., Yellow Springs, Ohio.

Cryogenics

Kelvin Scale is a news sheet of current information on cryogenics and related subjects, which will be published periodically by Arthur D. Little, Inc. Copies may be obtained by writing The Editor, Kelvin Scale, 20 Acorn Park, Cambridge, Mass.

Nuclear Instrumentation Manual

In this 51-page, illustrated manual is presented, in convenient form, methods of grouping and selecting nuclear instrumentation according to the purpose of the user, such as training, medicine, research and industry. Cost of manual is \$2.00. Radiation Counter Laboratories, Inc., 5121 West Grove St., Skokie (Chicago), Ill.

Aluminum Handles 572

This 2-page data sheet shows some vinyl-coated aluminum handles especially designed for use on portable electronic equipment. Dimensions of handles are also given. National Radiac, Inc., 479 Washington St., Newark 2, N.J.

Pressure Transducers 573

Model S-30 Pressure Transducer is covered in this 4-page bulletin. General description, specifications, dimensions and standard fittings are given. Ultradyn, Inc., P. O. Box 3308 2624 San Mateo, N. E., Albuquerque, N.M.

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High Vacuum Technology

"High Vacuum Technology," a new 6-page illustrated brochure, is of interest to high altitude aircraft and missile industry design engineers and technical management. It includes an 11 in. x 17 in. three-color upper atmosphere vacuum spectrum chart developed by the NRC staff using latest available International Geophysical Year satellite data as well as information from other recently published literature. The chart permits rapid determination of atmospheric density, temperature, pressure and mean free path of gas molecules up to an equivalent altitude of 600 miles. For engineers concerned with selection of equipment for extreme high altitude simulation facilities, the chart also shows the normal operating pressure ranges of various types of vacuum gages and pumps and permits quick determination of effective altitude equivalents which may be achieved in properly designed installations. The new brochure also presents information on NRC manufactured equipment and supporting research for very high altitude component and materials testing and for simulation of space conditions into which ion and other advanced propulsion devices discharge. *Request a copy on your company letterhead from: Manager, Space Activities, National Research Corp., 70 Memorial Drive, Cambridge 42, Mass.*

Voltage Regulator Tubes

440

A complete "Technical Information Package" on corona type voltage regulator tubes is designed to provide a comprehensive, ready-reference source of technical data on the company's complete line of corona type voltage regulators, the package is self-contained and tabbed for filing in standard 11 x 8-1/2 in. files as well as being punched for three-ring binders. The corona regulator Technical Information Package contains: separate data sheets, one for each series of corona regulator tube types produced by company with typical performance curves; and an engineering paper on the application of corona type regulators. The data sheets illustrate the various models, give suggested applications for the particular corona regulators, and list complete performance, specification and dimensional data. The engineering paper presents the information necessary to acquaint the engineer with the operation of this type of regulator. It includes a graphic analysis of the performance of this type of regulated power supply, illustrates stabilization ratios, the effects of temperature, discusses cascade regulation, and the use of the tube as a voltage reference and as a coupling unit for video information. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.



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DC-DC CONVERTER specifications

- OUTPUT POWER: MULTIPLE 150 WATT MAX.
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- LINE REGULATION: LESS THAN $\pm 1\%$
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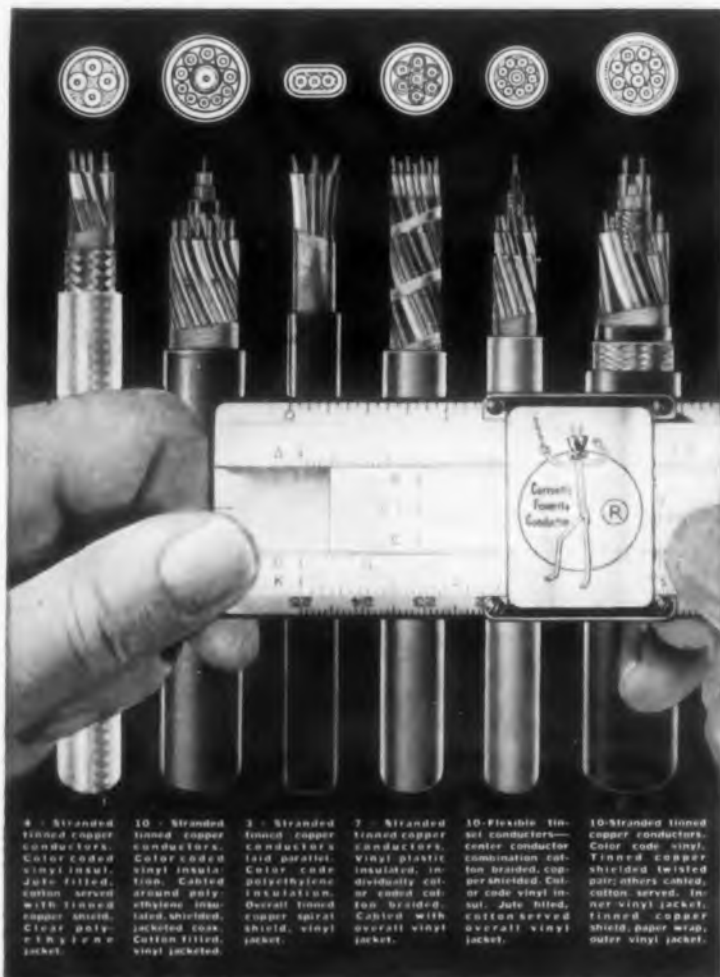
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SPECS...



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tinned copper
conductors.
Color coded
vinyl jacket.
Jute filled.
Cotton served
around poly-
ethylene insu-
lation shield.
Clear poly-
ethylene jacket.

10 - Stranded
tinned copper
conductors.
Color coded
vinyl jacket.
Cotton served
around poly-
ethylene insu-
lation shield.
Clear poly-
ethylene jacket.

3 - Stranded
tinned copper
conductors
lead parallel.
Color code
polyethylene
insulation.
Overall tinned
copper shield.
Vinyl jacket.

7 - Stranded
tinned copper
conductors.
Vinyl plastic
insulation, in-
sufficiently col-
or coded vinyl
jacket.

10- Flexible tin-
ned conductor—
center conductor
combination col-
ored, braided cop-
per shielded. Col-
or code vinyl in-
sulation. Jute filled.
Cotton served
overall vinyl
jacket.

10-Stranded tinned
copper conductors.
Color code vinyl.
Tinned copper
shielded twisted
pair; others coated,
cotton served. In-
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lined, copper
shield, paper wrap,
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CIRCLE 443 ON READER-SERVICE CARD

148

NEW LITERATURE

Photoconductive Cells

444

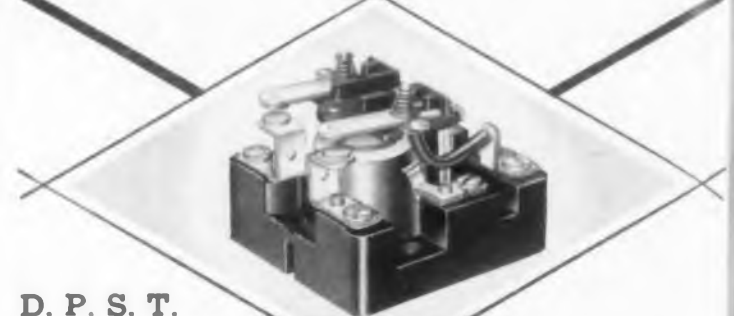
A brochure of particular interest to the design engineer describes series of polycrystalline photoconductive cells with illustrations and graphs of the most important characteristics of each cell. These are the same polycrystalline photoconductive cells which have become familiar to many as the logical replacement for photoemissive vacuum tubes where higher sensitivity is a prime requisite. The literature lists each type of cell available, the type of material used in the cell, its size, peak response, average light resistance and time constant; together with the cell's light to dark current ratio and temperature coefficient of resistance. Since either glass or plastic enclosures may be specified for the cell and the cell's sensitive area may be ordered in a choice of positions as dictated by the application, it can be seen that quite a bit of information must be included in a brochure of equal usefulness for all cell types. Perhaps the most interesting graph in the brochure shows light intensity in food-candles vs. current in micro-amperes for four of the Clairex Corporation's most widely used photoconductive materials. An extensive plot of applied voltage against milliamperes of current through the cell characterizes a section of the brochure which includes a study of eight cells under light source intensities. A convenient plot of power dissipation for each cell is also found in this section. A graphical representation of the time constant as a function of light intensity for each cell is also supplied with the literature. The material described above is now available on request from the Clairex Corp., 19 West 26 St., New York, N. Y.

Thermocouples

445

Data sheet B briefly describes Con-P-Pak thermocouples, which are designed to meet the severe demands required of controls and instruments used in rocket engines, melting furnaces, nuclear reactors and in the processing of liquid hydrogen, fatty acids, alcohols and other materials difficult to handle. A number of metal combinations are used, such as copper-constantan for temperatures down to -300 F and rhodium platinum for temperatures over 1600 F. Con-O-Pak's electrical properties are insulation resistance between wires and sheath ranges up to 100 megohms at 500 vdc and dielectric strengths to 2000 vac. Write for detailed bulletin to Continental Sensing, Inc., 1950 N. Ruby St., Melrose Pk., Ill.

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D. P. S. T.

Contacts: double pole,
single throw, normally open.
Size: 2 1/4" L. x
2 1/2" W. x 2 3/4" H.
Weight: 9 1/2 ounces

25
Amperes

D. P. D. T.

Contacts: double pole,
double throw.
Size: 3 3/4" L. x
2 1/2" W. x 2 3/4" H.
Weight: 11 ounces

Built to meet
UL specifications

Interchangeable Coil Assemblies ...

(No Solder Connections)

◆ Guardian's new double pole, single throw, normally open, 25-ampere power relay and the already popular double pole, double throw, 25-ampere power relay afford a wider latitude of control for motor starting, heater loads and such heavy duty industrial control applications as elevators, conveyors, electronic ovens, machine drives and automated systems. Both versions carry interchangeable coil assemblies that range in value from 6 v. A.C. to 230 v. A.C., or from 6 v. D.C. to 110 v. D.C. Each relay is ideally suited to experimental work, electronic design, prototype units and for on-the-spot changes of electrical characteristics at any stage of design, development or production.

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- Coils: 6 v. A.C. to 230 v. A.C. or 6 v. D.C. to 110 v. D.C.
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- Coil drain—approximately .080 amperes at 115 v., 60 cycles.
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- Two hole mounting 8-32 clearance on 1 1/2" centers.



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TO ORDER

COLOR TUBING
AND TUBING
WITH
AXIAL STRIPES



OVER-NIGHT DELIVERY

NOTE: PF TEFLON* advantages: good dielectric strength: (500 to 1000 volts/mil); lowest dielectric constant (2.0) and dissipation factor (0.0002) of any solid dielectric; no change of electrical properties with temperature (-25°C to +250°C) or frequency (60 cycles to 100 mc); zero moisture absorption; unaffected by any commercial chemical.

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*TEFLON— du Pont trade name for tetrafluoroethylene resin

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Variable Pulses

465

Two-page technical bulletin #1010, describes the operation of the Model 1010 Variable Pulser, an instrument for converting any type signal source with a repetition rate up to 5 megacycles into standardized pulses of controlled amplitude and duration. Operating principles, possible uses, and complete electrical and physical specifications are given. Bulletin 1010 from Technitrol Engineering Co., 1952 E. Allegheny Ave., Philadelphia 34, Pa.

Enclosures

466

More than 11,000 standard deep drawn aluminum boxes and covers are illustrated in this 20-page catalog. Catalog B includes sizes ranging from 7/8 in. x 1-5/8 in. with a height of 7/16 in. to 2 in.; to 20-1/8 in. x 32-1/8 in. with a height of from 2-1/8 in. to 10 in. Zero Manufacturing Co., 1121 Chestnut St., Burbank, Calif.

Toggle Switches

467

This 8-page comprehensive catalog lists 200 models of toggle and trigger switches. Ten of the most popular switch series are treated in detail with dimensional outlines, illustrations, electrical and mechanical specifications and applications. Catalog S106 is available from: Sargent Electric Corp., 630 Merrick Road, Lynbrook, N.Y.

Torque Motors

468

"Improving Performance of Flat-Armature Torque Motors" is a six-page article by R. D. Atchley, president of this firm, which describes the special techniques and drive circuits used to get superior response and resolution from this type of motor. Photos, schematic drawings, graphs, and circuit diagrams supplement the text. Raymond Atchley, Inc., 2340 Sawtelle Blvd., Los Angeles 64, Calif.

Ferromagnetic Materials

469

A new 4-page bulletin on Ferrotron ferromagnetic materials describes a line of non-memory, inductive electromagnetic core components. Data on new types of material which operate in temperatures up to 350 C is included along with physical and electromagnetic property values and typical applications. The Polymer Corp. of Pa., 2140 Fairmont Avenue, Reading, Pa.

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Ruggedly built long frame telephone switchboard jacks in 2 frame designs and all standard circuit arrangements. Welded steel frames for rigidity. Nickel silver alloy springs for greater service life and resistance to corrosion. Made in commercial and military types (Mil-J-641). Special designs on order.

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EECO**

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New York City, March 23-26
BOOTH 3838

Transistorized

DECADES

for extremely
reliable operation
in the 0 to 250 kcs range



ONE-THIRD ACTUAL SIZE



APPLICATIONS

New EECO N-Series Transistorized Decades are miniaturized plug-in units designed for reliable pulse counting and frequency division in the frequency range of 0 to 250,000 pulses per second.

FEATURES

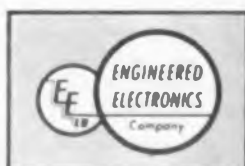
- Small, compact size.
- Simple power supply requirements (for example, Models N-101 and N-102 require only -12 volts).
- Low power consumption.
- Compatible with EECO T-Series circuits.
- Auxiliary 9-step staircase output available.
- Plug into standard 9-pin miniature socket. (Some models require special 13-pin socket, furnished with each such unit.)
- Pin connections arranged for in-line wiring of power and grounds.
- Extreme reliability, due to saturation techniques and consistent derating of component tolerances.

WIDE SELECTION

EECO N-Series plug-in Decades are available in the following standard models:

MODEL	DESCRIPTION
N-101	No readout
N-102	Incandescent readout
N-104	Incandescent readout (remote). Typically a projection readout module
N-105	Nixie readout. (Can be cabled to remote Nixie.)
N-106	Nixie readout with preset control switch. (Can be cabled to remote Nixie.)
N-107	Incandescent readout with inputs for external preset control.
N-108	Incandescent readout (remote) with inputs for external preset control

Additional information on N-Series Transistorized Decades and other EECO products available on request.

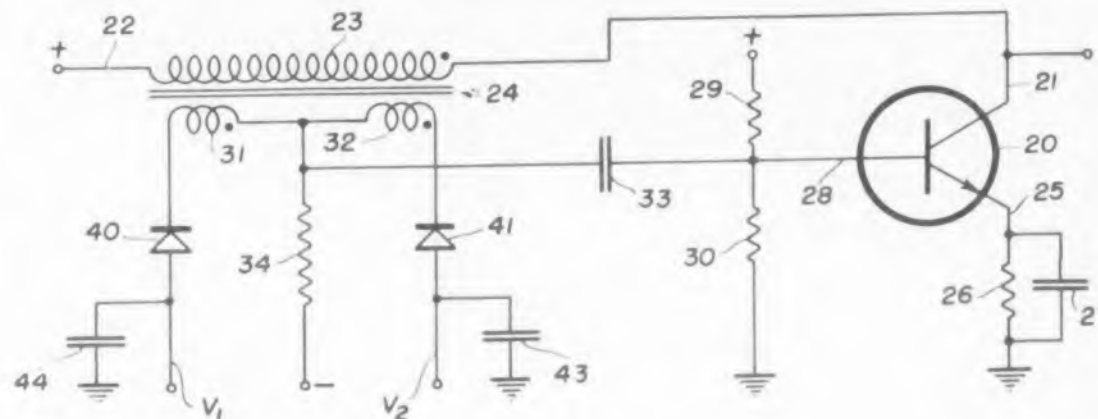


ENGINEERED ELECTRONICS COMPANY
(a subsidiary of Electronic Engineering Company of California)

506 East First Street • Santa Ana, California

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PATENTS



Voltage Comparators

Patent No. 2,858,438. Leslie C. Merrill.
(Assigned to International Telephone & Telegraph Corp.)

Two matched semiconductor diodes control, within a few millivolts, the firing of a blocking oscillator in a "Multair" circuit. Feedback is negative until the diode voltages are equal and then the feedback instantly switches to positive and the network oscillates.

The signal pulses to be compared are coupled to transformer 24 by diode 40

connected to one half of the secondary winding. A sawtooth waveform is fed into the other half of the secondary winding through diode 41. Switching occurs when the sawtooth voltage equals the amplitude of the signal pulses.

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26 ISSUES IN **59**

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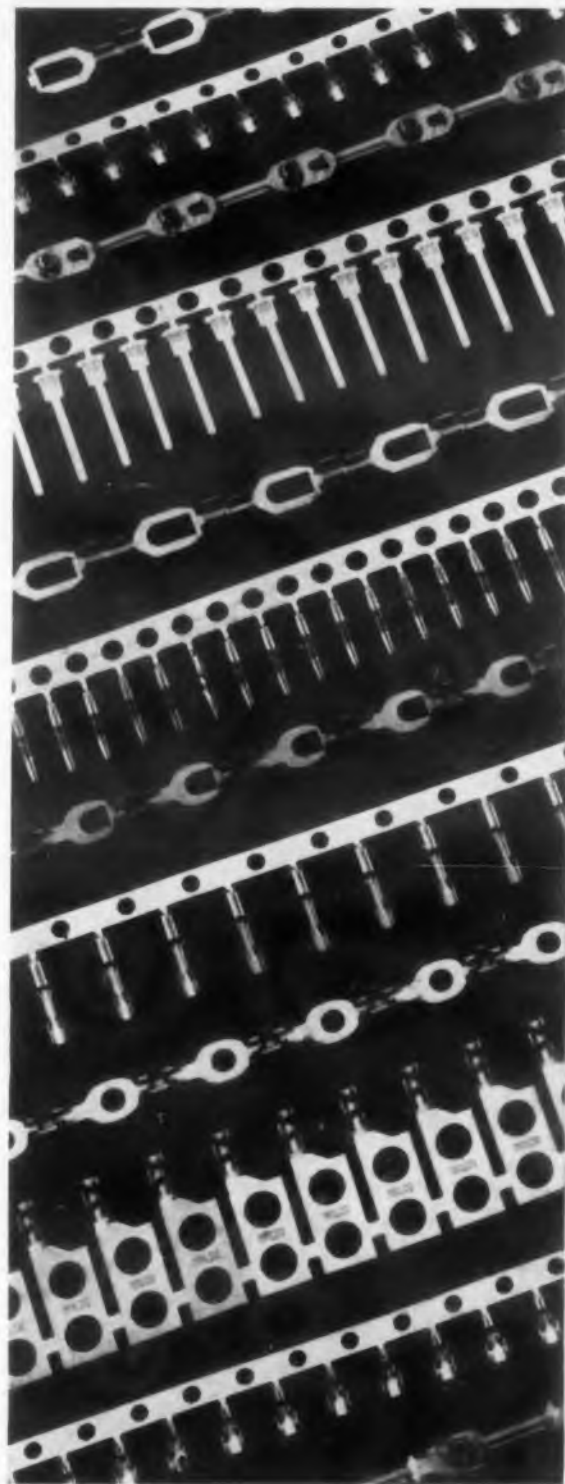
SOLDER LUGS AND INTERLOCK CONNECTORS—Especially designed for production line assembly operations. Interlocks are ideal for interlocking printed circuits or flybacks, as speaker lead connectors or as transformer mounting lugs.

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BOOKS

How To Design and Specify Printed Circuits

The Institute of Printed Circuits, 27 E. Monroe St., Chicago 3, Ill., 92 pp, \$5.25.

The collective know-how of leading printed circuit manufacturers is presented by 16 editors of the IPC. This manual is a general technical explanation of the sequence in adapting electrical and electronic wiring circuits to a single or co-planar printed wiring connecting structure. Over 70 illustrations are included in this publication, reporting on: advantages of printed circuits, layout and design, selection of materials and components, multiple soldering techniques, reliability, production methods, process limitations, printed circuit assembly,

service and repair, artwork, finishing, information on switch plates and components, discs, and new recommended tools for printed circuits. Design engineers in the electronics industry will find this technical manual a practical guide.

Dynamical Analogies, (Second Edition)

Harry F. Olson, D. Van Nostrand Co. Inc., 120 Alexander St., Princeton, N.J., 278 pp, \$6.75.

Scientists and engineers concerned with machines and vibrating systems will find analogies to aid in solving various problems of dynamical systems involved in these applications. No

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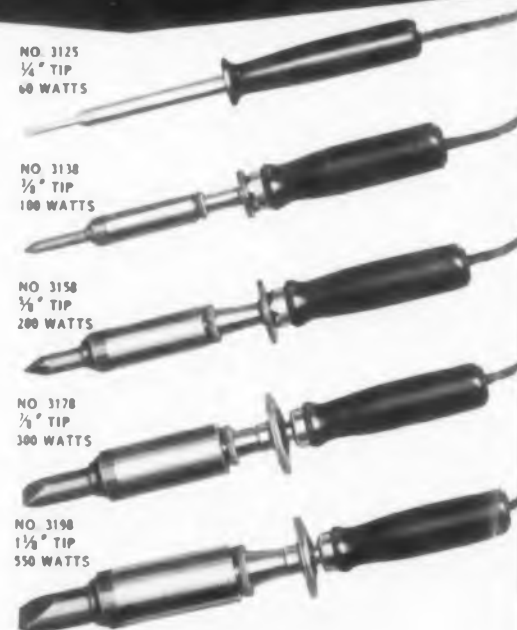
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ELECTRONIC DESIGN • February 18, 1962

highly revised and enlarged, this book
 finishes with the analogies between elec-
 trical, mechanical, acoustical and mag-
 netic systems. The subject matter is de-
 veloped in stages from the simple
 element through a complex arrangement
 of multi-element systems. As an aid in the
 establishment of these analogies, a com-
 plete theme is depicted in each illustra-
 tion. While classical analogies have been
 retained, the book includes important
 chapters on magnetic and mobility
 analogies, noise, distortion and feedback.

Progress in Semiconductors, Volume 3

F. Gibson, P. Aigrain, R. E. Burgess,
 in Wiley & Sons, Inc., 440 Fourth
 Ave., New York 16, N.Y., 210 pp, \$8.50.

The compilation of Volume 3 extends
 the coverage of semiconductor research
 topics in this annual series, which is de-
 signed to meet the needs of the specialist
 in keeping abreast of developments in his
 own field and in related subjects. Con-
 tents are selected to include critical
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 and Silicon; The Chemical Purification of
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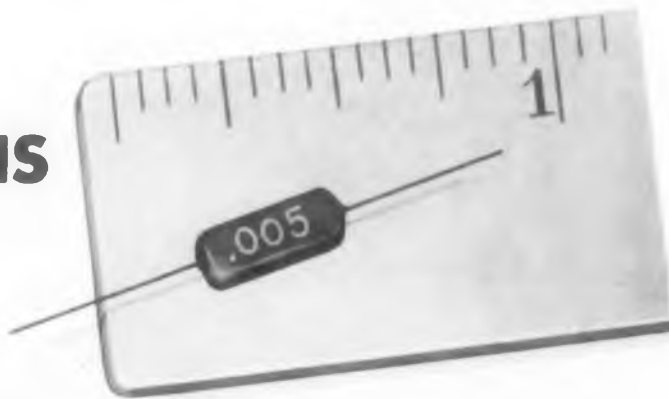
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INPUT VOLTAGE	26/115 ± 10%		
WATTAGE RANGE	26 volt input — 1.2/3/12/30 115 volt input — 1.2/3/12/30/120		
FREQUENCY RANGE	Flat from 50 to 2000 cycles		
ACCURACY	1.0% of full scale watts		
PHASE	1, 2, or 3 phase. The 3-phase meter is suitable for 3-phase, 3-wire, or 3-phase 4-wire measurements.		
POWER FACTOR	0.1 to 1.0 Lag or Lead.		
WAVE FORM FACTOR	Calibrated for use with both sine and square wave. For distorted waveforms, the error will be less than 2% for 5% harmonic distortion.		
ERROR DIFF TO	VOLTAGE CIRCUIT: 0%		
	CURRENT CIRCUIT:	Max. Error (% watts indicated)	P.F.
		0.2	1.0
		2.0	0.1
	linear between these values		
OVERLOAD	VOLTAGE CIRCUIT: 100% continuous overload without damage CURRENT CIRCUIT: 25% at 0.1 PF continuous without damage		
SIZE	8½" x 12" x 4"		
WEIGHT	15 lbs.		
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BOOKS

Transform Method in Linear System Analysis

John A. Aseltine, McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N.Y., 300 pp, \$8.50.

This senior-graduate level text is devoted to the application of integral transforms to the analysis of physical systems which can be described by linear differential equations. The purpose of the book is to demonstrate the transform method and its application to a variety of engineering problems. More importantly, in the opinion of the author, is an attempt to show how the transform method can give an understanding of physical phenomena. To this end, considerable space is given to concepts of system function, frequency response, impulse response, and the like. Finally, the author brings together material related to the analysis of linear systems, and shows the relationships between the various methods. Emphasis is placed on the unified approach to linear systems whether electrical, mechanical, thermal,

or combinations, through the use of the transform method. Recent advances include: analysis of transient behavior of gyroscopes and satellites; use of transforms for treating difference equations; treatment of initial conditions using impulse functions; and unification of the various methods for describing a linear system. Treatment avoids a purely mathematical approach. About 150 problems are given to illustrate the application of the transform method to a variety of physical situations. Approximately 200 line drawings accompany the text.

Nomography

L. Ivan Epstein, Interscience Publishers Inc., 250 Fifth Ave., New York 36, NY 34 pp, \$4.50.

A thorough presentation of the underlying theory of nomograms is presented along with methods of construction. Basic knowledge of analytical geometry plus some differential and integral calcu-



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is sufficient to follow the text material without difficulty. Rudiments of projective geometry, determinants, and matrices can be acquired from the material presented.

Various methods, with several examples included, are discussed with emphasis on the principles involved in setting up the nomograph.

Servicing Transistor Radios

Leonard D'Airo, Gernsback Library, Inc., New York, 11, N.Y. 224 pp \$2.90.

Although specifically aimed towards the radio service field, the material presented includes interesting applications of transistors in consumer product items. After basic transistor theory is covered, commercial circuits of auto (hybrid and all-transistor types), portable, and multi-band receivers are discussed.

Servicing methods applicable to transistor radios are covered with ample illustrations. Test equipment circuits, transistor data listing, and an interchangeability chart offer the experimenter and serviceman sufficient data for the majority of service requirements.

Guide to Mobile Radio

Leo G. Sands, Gernsback Library, Inc., 154 W. 14 St., New York 11, N.Y., 160 pp, \$2.85.

Radio technicians interested in servicing mobile radio equipment, sales engineers, and prospective purchasers or operators of mobile radio equipment are presented with a practical manual of information. Discussion centers on general types of systems, including paging, dispatching, industrial, railroad and citizens' band radio. Mobile unit and base station operation, types of receivers and transmitters, power supplies, antenna systems, remote control, portable equipment, selective calling, maintenance and licensing, are also discussed. Emphasis is placed on the functional aspects of installation, servicing and maintenance. Profuse illustrations, including photographs picturing equipment and operation, circuit schematics, cross-sectional, cut-away and mechanical drawings, lines, graphs, charts, and block diagrams, will prove of inestimable value to the radio technician in applying his knowledge to this rapidly expanding field of mobile radio.

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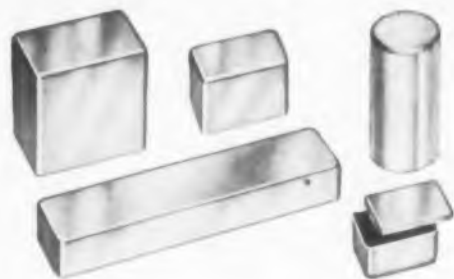
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BOOKS

Switching Circuits with Computer Applications

Watts S. Humphrey, McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N.Y., 264pp, \$8.50.

This work covers the application of switching circuits to digital systems. The treatment of switching-circuit techniques allows the designer to complete the detailed organization of very large systems without drawing a single circuit diagram. The resulting equations can then be converted directly to logical, or simplified schematic form.

The first chapter supplies a general introduction to the subject of computers. The main text begins with a treatment of Boolean algebra with applications to the design of some related networks. Various codes and related topics are then discussed, primarily so they can be used in the examples and problems in later chapters. Following this, several techniques are presented and applied. These include map factoring and the Boolean matrix.

The Junction Transistor and its Applications

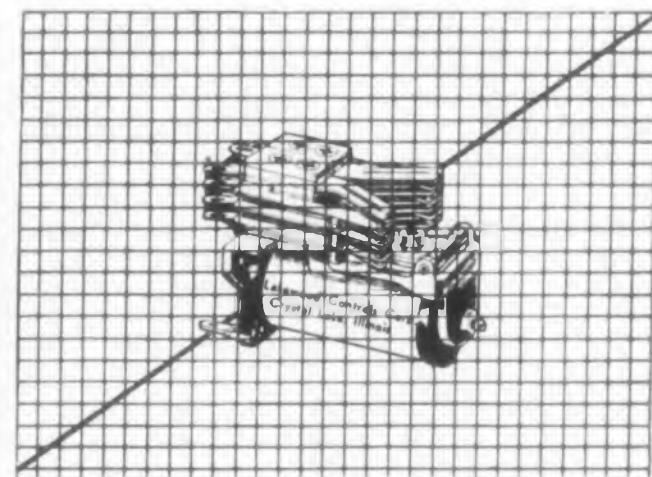
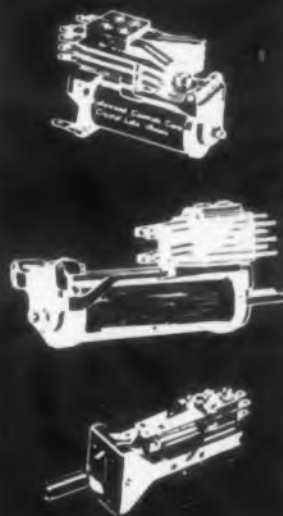
E. Wolfendale, Editor, The Macmillan Company, 60 Fifth Ave., New York 11, N.Y. 394 pp, \$7.50.

The purpose of this book is to provide a comprehensive introduction to the junction transistor, its equivalent circuit applications to the engineer, physicist, and student. A complete account of the physics of pn and pnp structures is given and is intended for the physicist and experienced circuit designer. Remaining subjects concern the design of transistor circuits and include: characteristics, general four-terminal networks and the transistor equivalent circuit; direct current biasing and audio-frequency amplification, sinusoidal oscillators, amplitude modulation and demodulation, the junction transistor in nonlinear circuits, plus transistor dc converters. An appendix on transistor measurements and a comprehensive index of types conclude this volume.

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New Sideband Handbook

Don Stoner, WGTNS, Cowan Publishing Corp., 300 West 43rd St., New York 36, N.Y., 232 pp \$3.00.

Single and double sideband transmission has created quite a stir among military, commercial and amateur operators. A comprehensive and practical approach to the subject is presented by the author, who became an enthusiast after only ten minutes of SSB operation.

Following an introductory review of the various types of modulation in use, pros and cons of SSB are discussed. Circuit descriptions cover types of balanced modulators, phasing exciters and phase shift networks. Double side band details are considered together with synchronous detection and linear amplification.

The handbook is liberally filled with full details on construction, assembly, tuning, and test procedures for DSB receivers and transmitters. Of interest to the experimenter is the selection and explanation of clever circuits developed by manufacturers for these new techniques. The concluding section deals with the various accessories available for the sideband station.

Coil Winding (Second Edition)

William Querfurth, George Stevens Manufacturing Co., Inc., Pulaski Road at Peterson, Chicago 46, Ill., 192 pp, \$5.00.

For the engineer and designer, this volume gives thorough coverage to coil winding procedures, winding machines and associated equipment. Revision includes the enlargement of the book by the addition of alignment charts for universal coils of over 2700 gear ratios, a valuable time-saver for the technician and setup man. Universal types of windings are covered in two chapters. Toroids, deflection yokes and motor armatures comprise the text for two new chapters. Over 100 illustrations of examples of universal coils successfully tried in practice have been added. Detailed instructions are given on how to set up and align winding machines of various types, how to lay out a bench to best advantage for coil winding, how to make an arbor, chuck and collet, how to design cams, how to align wire guides and how to select and adjust various wire tension devices. This helpful how-to guide is believed to be the only text of its kind available.

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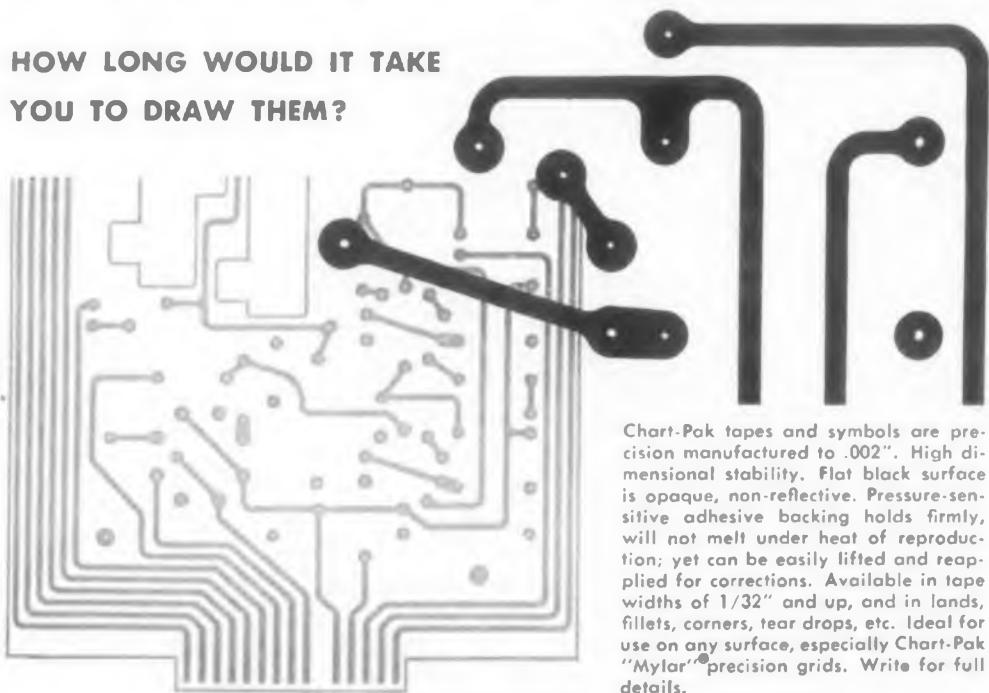


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- VSWR at parallel input is under 1.2; at series input, under 1.5
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- Typical uses include measurement of impedances, production control of impedances, equal division of power, phase comparison, and balanced mixing.

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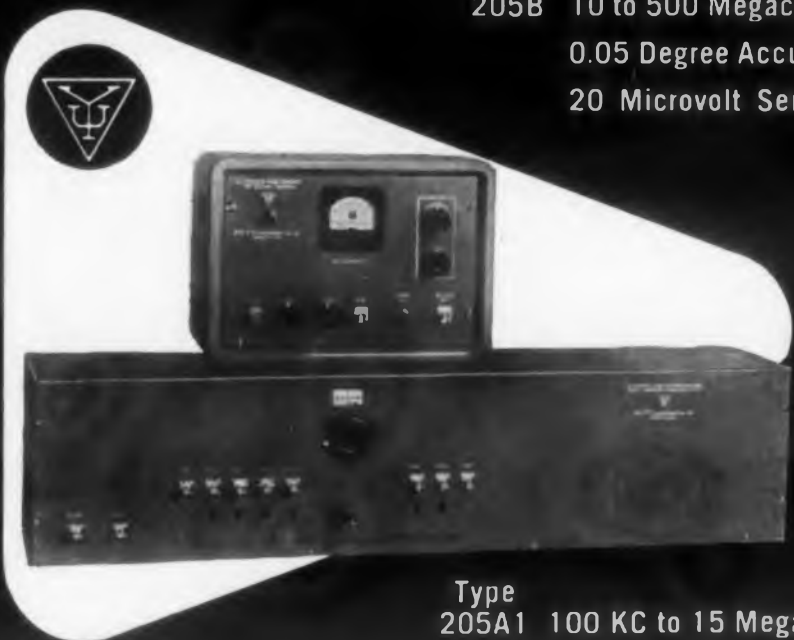
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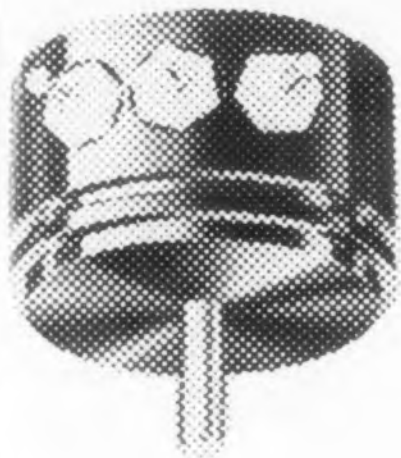
Linear Synchro or Precision Pot

This is **ELECTRONIC DESIGN's** first of a series of articles by Frank Hagen. The practical articles, dealing with servo components and allied equipment, will be reprinted in Daystrom Transicoil Corp.'s *Servo Slants*. Interested readers may get copies of this bulletin by writing to the company.

This first article is based on one which has already appeared in the bulletin. The next one, a more technical article, will deal with the importance of mechanical impedance data in designing servomechanisms.

Characteristics of a Typical Synchro and a Comparable Potentiometer

Characteristic	Linear Synchro (115 v stator, 0.62 v/deg rotor)	Precision Potentiometer
Input Voltage	115 v ac	115 v ac or dc
Input Power (at rated voltage)	0.45 w	0.45 w
Input Impedance	30 K (tuned)	30 K
Output Impedance (maximum)	1270 ohms	7500 ohms
Linearity (standard)	0.25 per cent	0.5 per cent
Resolution	0.00 per cent	0.04 per cent
Maximum Rotation (with specified linearity)	170 deg	356 deg
Sensitivity (with rated voltage)	0.62 v/deg	0.32 v/deg
Electrical Isolation	Yes	No
Phase Shift (nominal)	+ 4 deg	0 deg
Starting Friction (at 25 deg C)	3 gm cm	126 gm cm



Frank Hagen
Daystrom Transicoil Corp.
Worcester, Pa.



THE PRECISION potentiometer and the linear synchro have such similar properties that often the design engineer specifies one or the other out of habit rather than from the specific requirements of his system.

Both are used for processing and transmitting analog data. Both convert a rotary mechanical input into a percentage of line voltage, usually at a linear rate. And both provide excellent system performance. But there are differences, and many applications would be better served by one rather than the other.

The linear synchro is basically a variable transformer. Its primary establishes a magnetic field and the movable secondary couples additional flux at a rate proportional to its angular position. When the secondary or output winding is exactly at right angles to the input winding, no coupling occurs and the unit is at "null."

Rotation in either direction from null results in an output voltage directly proportional to the angle traversed from null and approximately in phase with the exciting line voltage. There are usually mechanical stops 85 degrees on each side of the null.

The linear synchro with restricted mo-

tion has no wiping contacts. The precision potentiometer depends upon a brush, wiping across a wirewound resistor. This motion, over a series of minute but finite steps, creates a small noise, unknown in systems using linear synchros.

Unlike potentiometers, the linear synchro is an inductive device with a Q of about 5. Hence, with proper circuitry, the input impedance may be much higher than a potentiometer's. This is not too important in considering power drain from the line, but in computers, it is often necessary to cascade two or more units. Here, the increased input impedance manifests itself in decreased loading and decreased error.

In potentiometer systems, it is sometimes necessary to include a number of isolation transformers to prevent grounding problems. No such problem exists with synchros, as the primary is completely isolated electrically from the secondary.

Linear synchros have no place in dc data systems. Nor have they a place in systems where required accuracies call for multiturn potentiometers. These areas are the domain of the resistive potentiometer. ■ ■

Table on left, comparing a linear synchro with a single turn potentiometer having the same power input, shows that neither component has an overwhelming advantage over the other.

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The ideal situation would be to equip each lab bench with a complete set of instruments. But requirements vary and the variety of electronic instruments is vast. While a few industrial laboratories can afford the luxury, many more can't.

One alternative, shown in Fig. 1, is to fasten instruments that are commonly used together to a utility cart (the cheap kitchen kind—or the heavier industrial type). The carts are parked in a common area in the lab. The technician goes to the area, picks out a cart that suits his requirements, writes his name on a card and deposits it in a slot on a traffic board that describes the instrument combination. If anyone else needs this particular combination, the traffic board tells

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



Fig. 1. Utility cart for instruments can be wheeled to bench. Lower racks can be used for temporary storage of equipment not in use.

INSTRUMENT CART TRAFFIC

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2 LO-F PULSE GEN.	<input type="checkbox"/>	6 SCOPE	<input type="checkbox"/>
3 HI-F PULSE GEN.	<input type="checkbox"/>	7 RF GEN.	<input type="checkbox"/>
4 L-N BRIDGE	<input checked="" type="checkbox"/>	8 LCR BRIDGE	<input type="checkbox"/>

Fig. 2. The traffic board is the heart of the simple procedure for requisitioning instruments.

where it is. This supermarket instrument cart idea, properly applied as in Fig. 2, can save a medium-sized laboratory thousands of dollars in man hours every year.

Everyday requirements such as multimeters should be available at all benches at all times.

Pulse generator-oscilloscope combinations and other high priced gear rate the cart treatment. Infrequently used instruments that may be required for a short time only on some projects are also eligible cart riders.

Forrest H. Frantz, Sr., Arlington, Tex.

Cold Cathode Thyatron Switch

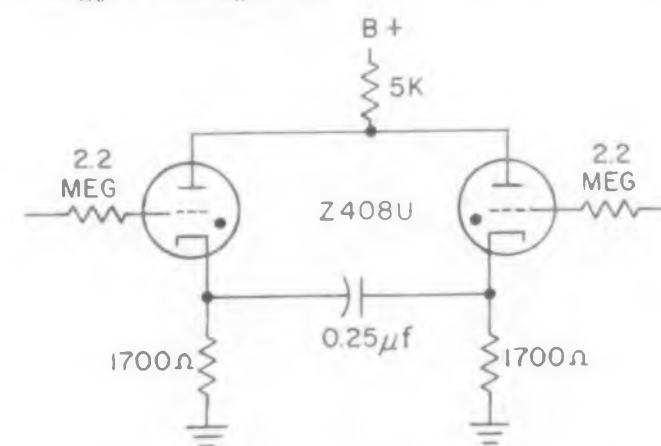
Cold cathode thyatrons do not have any heating arrangement and are very useful tubes in a number of switching circuits. A simple and reliable switch has been described in the French *Electronique Industrielle*, 6-58. The circuit in the accompanying diagram uses two Z408U tubes and can be adapted to any type.

When one of the thyatrons is switched into conduction by a trigger pulse applied to its starter electrode, the cathode coupling raises the cathode voltage of the other thyatron and switches it off. The arrival of another trigger pulse on its grid will switch it on and reverse the process.

The voltage across the cathode coupling ca-

pacitor reverses with a time constant determined by the cathode circuit.

Dr. A. V. J. Martin, Carnegie Institute of Technology, Pittsburgh, Pa.



Simple switch uses cold-cathode thyatrons.

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COLD TEST is conducted in a chamber where temperatures may be specified in a range of -100°C to $+25^{\circ}\text{C}$.



HEAT TEST subjects components to specified temperatures ranging from $+25^{\circ}\text{C}$ to $+550^{\circ}\text{C}$ in a heat chamber.



SHOCK TEST in each of three mutually perpendicular planes is available up to 150 G's—with concurrent electrical testing.



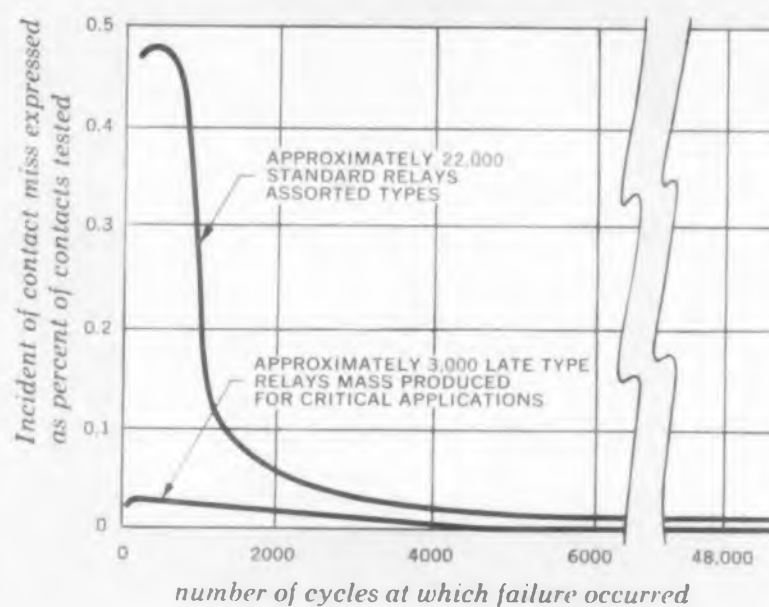
LEAK DETECTION TEST subjects components to minute inspection of hermetic sealing with a mass spectrometer type leak detector.



VIBRATION TEST checks units from 5 cps to 3,500 cps up to 50 G's. This test normally is performed with direction of vibration applied through each of three mutually perpendicular axes.

ELECTRICAL TESTS fall into many categories. These are typical: measuring coil resistance, testing pickup and dropout current, checking dielectric characteristics, and testing millivolt drop across contacts.

RELIABILITY TEST



ACCELERATION TEST places components in a centrifuge for acceleration testing to 500 G's. While undergoing this test, units may be subjected to electrical testing as well.



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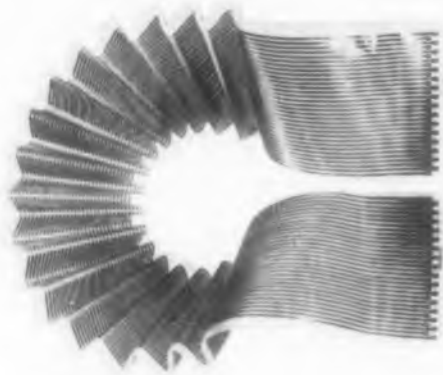
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CIRCLE 562 ON READER-SERVICE CARD

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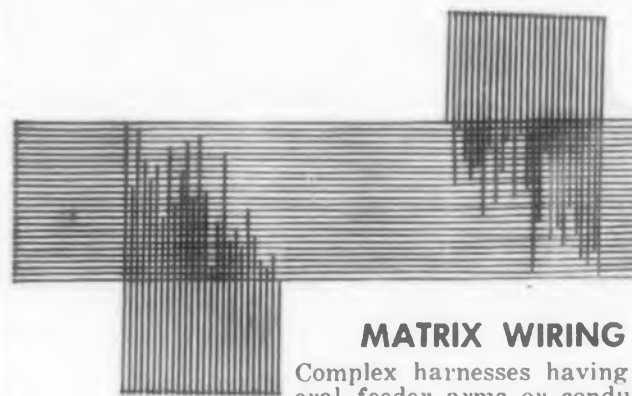
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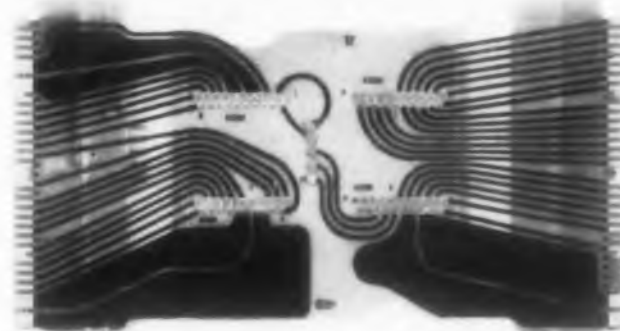
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Complex harnesses having several feeder arms or conductors common to a termination, can be fabricated by the new spot-welded "T" forming technique. Fine conductors can be joined by this method to achieve a high density of interconnections. Crossing conductors are completely insulated.



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CIRCLE 491 ON READER-SERVICE CARD

IDEAS FOR DESIGN

Simpler Fast Voltage Pulse

The "Inexpensive, Short Duration Voltage Pulse" circuit shown in the Ideas for Design section of your October 15 issue of *ELECTRONIC DESIGN* can be simplified as shown in Fig. 2.

A short-duration relay contact closure is provided when the pushbutton is pressed. The duration of the contact closure is determined by the values of C and/or V.

This modification has the following advantages over the original circuit shown in Fig. 1.

- Eliminates relay A.
- Removes restrictions on make and break timing and relay dropout speed.

N. O. Sokal, Senior Engineer, Di-An Controls, Inc., Boston 15, Mass.

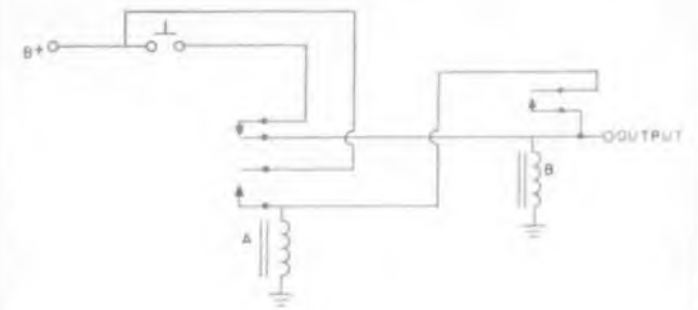


Fig. 1. Original short-duration pulse.

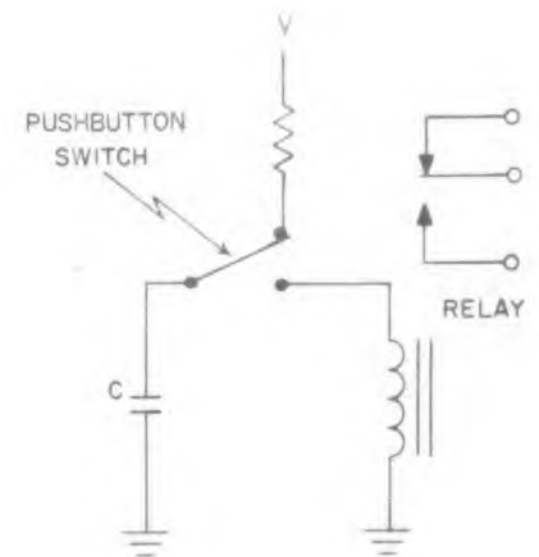


Fig. 2. Modified, simpler short-duration voltage pulse circuit.

The "Inexpensive Short Duration Voltage Pulse" circuit in your October 15th issue can be simplified. If the "make" contacts on relay A close before the "break" contacts open, it matters not

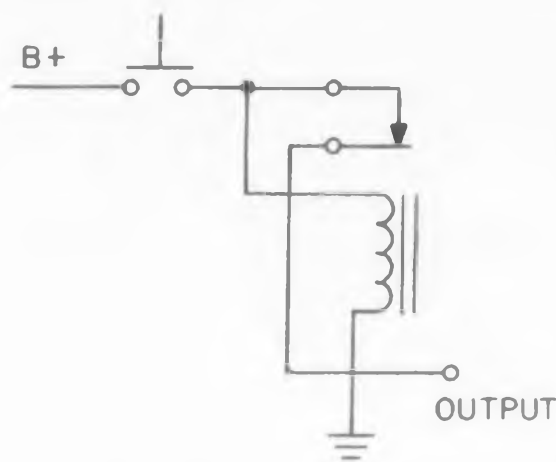


Fig. 3. Another simplified circuit to provide a short voltage pulse.

what the dropout characteristics of relay *B* may be.

The circuit (Fig. 3) will lock when the push-button is depressed, and stay locked till the *B* supply is disconnected. The output will be a step—not a pulse.

Any relay may be used and the output pulse width will be equal to the relay operate time as measured at the break contact. One pulse will be obtained per pushbutton depression.

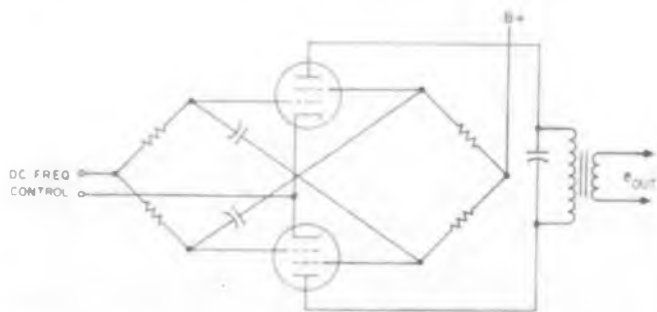
M. L. Aitel, Haddon Heights, N.J.

Simple, Variable Frequency Sine Waves

It is often necessary to generate a sinusoid that can be varied ± 10 per cent in frequency by a dc voltage. Most reactance tube oscillators, while they can deliver a sinusoid, do not work well over a wide frequency range without circuit complexity. The frequency range of multivibrators is easily varied, but multis do not deliver sine waves.

An electron coupled multivibrator with a tuned plate circuit can solve the problem. As shown in the figure, the tank is placed at the output. It provides a good approximation of a sinusoid, a wide frequency range, and easy control.

Richard F. Dubbe, Magnetic Products Lab., Minnesota Mining and Mfg. Co., St. Paul, Minn.



Electron coupled multi with tuned output can provide good, variable frequency sine waves.



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MICROWAVE AND SPECIAL TUBE NEWS

from SYLVANIA

NEW DESIGNS ADVANCE MAGNETRON RELIABILITY



Sylvania microwave scientists and engineers create a new magnetron for airborne radar applications

Out of the microwave research and development laboratories of Sylvania's Special Tube Operations comes a new magnetron, type M4154, with advanced reliability features.

Through new improvements in cathode ruggedization and high pressure windows, the new K band magnetron meets the tough reliability requirements of today's air-borne military equipment. It can operate under 30 g at 20 to 2000 cps. It has a peak power output of 20 KW.

The new type M4154 is adaptable to either high or low altitude applications and easily meets and surpasses current missile vibration and shock requirements.

New developments in ruggedization of X-band fixed frequency magnetrons to meet airborne radar requirements



Two new magnetrons, Type 2J42B and Type 6027H offer important improvements over their basic types, where ruggedization is essential in commercial and military radar. The 2J42B adds superior ruggedness to the already outstanding high altitude performance of the 2J42H. It is particularly adaptable to ruggedized military air-borne applications. Type 6027H is also ruggedized for severe environments and is suitable for high altitude applications. For commercial and ground equipment, type 6027 is also available.

Both new types perform under 5 g at 10 to 500 cps with less than 3 mc. shift in frequency output and less than $\pm .5$ mc. frequency modulation. They easily withstand 50 g shock for 4 ms. and are rated for top performance up to an altitude of 60,000 feet.

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IDEAS FOR DESIGN

The Magnistor A Compact One Bit Comparator

The Magnistor may be used to satisfy the digital comparison function of *greater than*, *less than*, and *equal to*. *Less than* and *greater than* are easily derived from the more general *equal to* case. Fig. 1 shows the truth table that must be satisfied for the detection of equal states. This will be recognized as the logic for the half adder—less carry.

Fig. 2 depicts the circuit elements required to satisfy this logic and includes in addition a flip flop which invariably forms part of the system. Fig. 3 shows the symbolic representation of Potter's MPT-1 Magnistor with the associated logical connections forming, in one component, the full equivalent of the combination of circuit elements shown in Fig. 2.

Fig. 4 shows the practical design parameters used in applying the MPT-1 to the Potter Instrument Company's line of high speed printers, while Fig. 5 shows the base diagram of the MPT-1. A 9-pin miniature header is used for standard socket applications or for direct soldering to a printed circuit board.

N. A. Moerman, Chief Engineer, Potter Instrument Co., Inc., Plainview, N.Y.

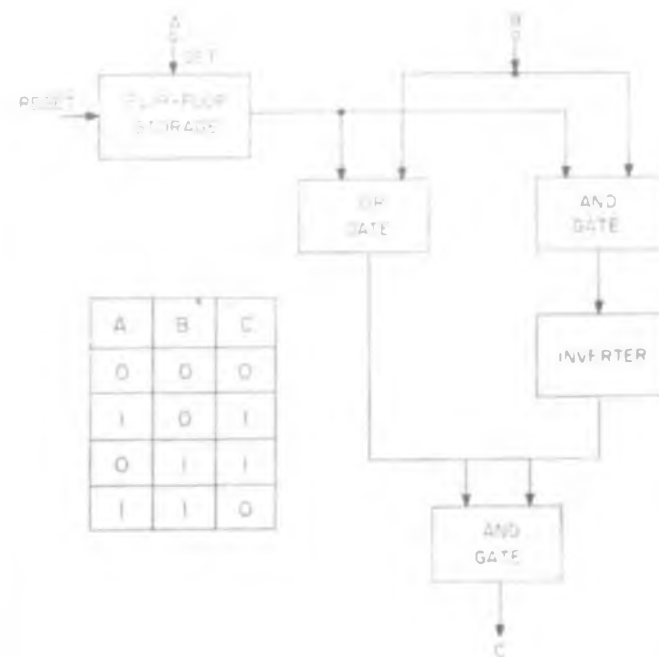


Fig. 1. (lower left) Truth table to satisfy *equal to* function, A and B are inputs, C the output. Fig. 2. Block diagram for *equal to* logic.

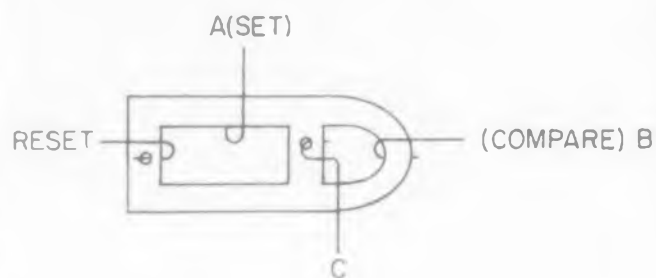


Fig. 3. The Magnistor provides all the functions of the block diagram of Fig. 2.

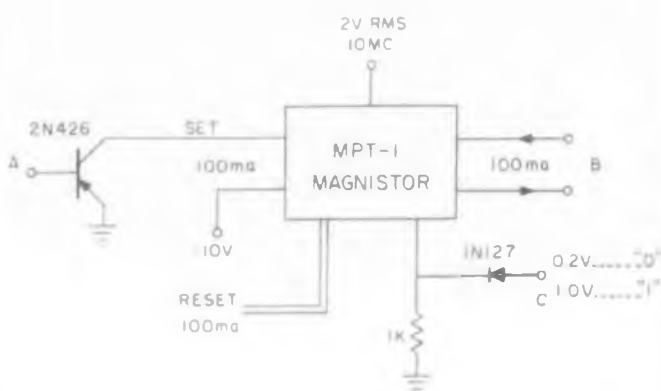


Fig. 4. The Magnistor as used in a line of high speed printers.

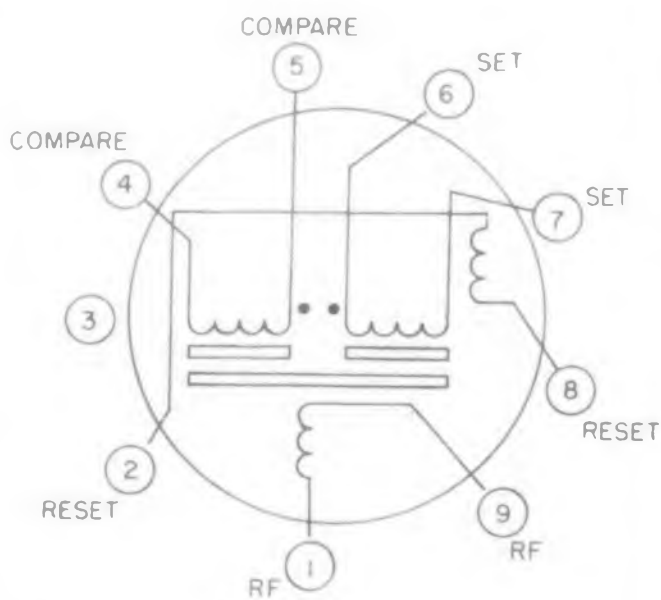
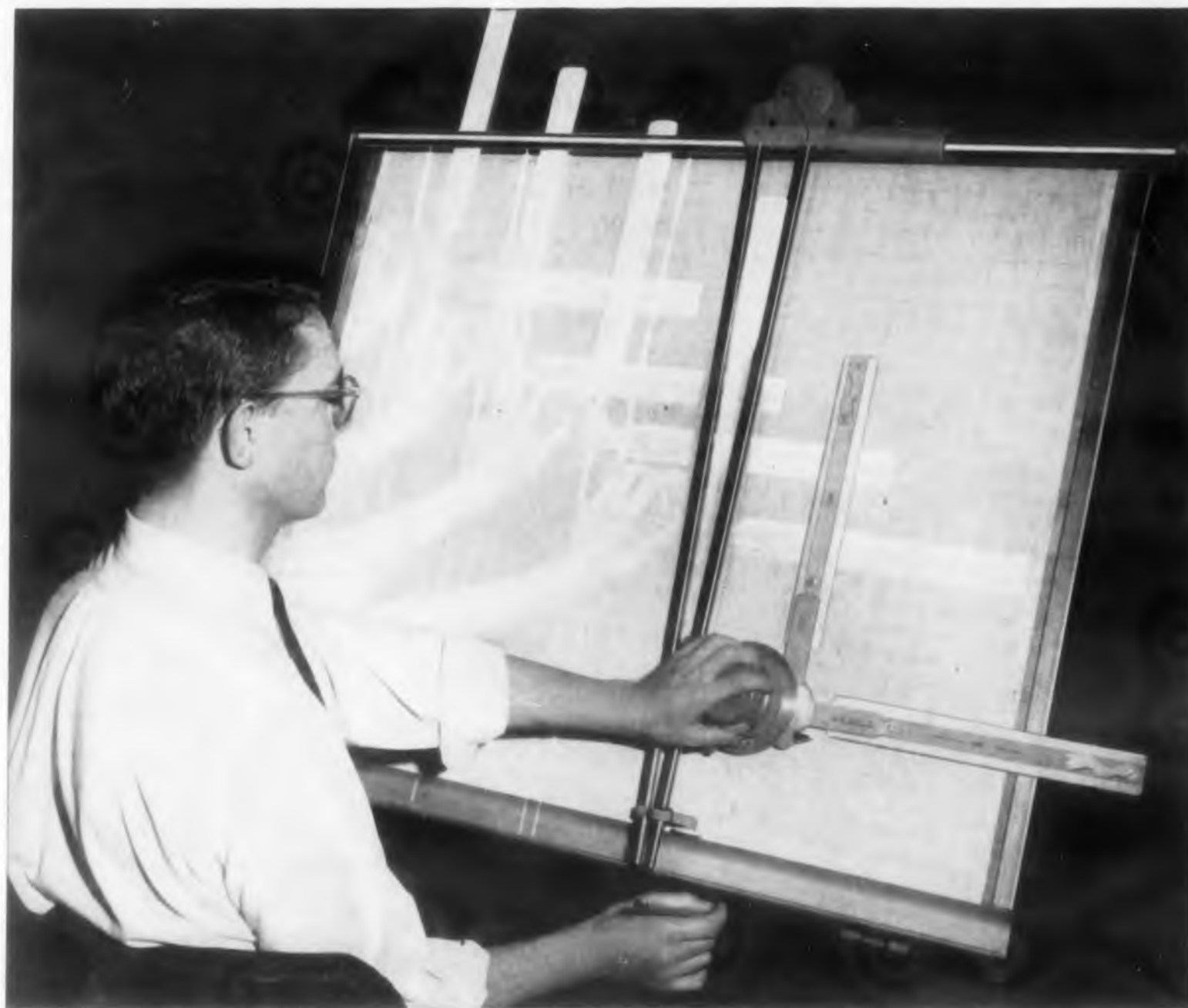


Fig. 5. Base connections for the Magnistor.

Phase Sensitive Error Detector

This error detector (Fig. 1) is very useful for pulse work. It detects any time difference between a reference pulse and other information. When the information lags behind the reference pulse, a positive pulse is generated. If the information leads, a negative pulse results. When the



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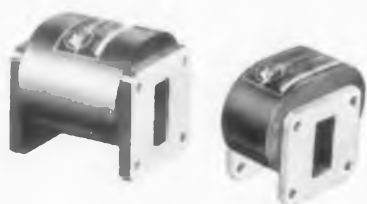
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precision assures reliability



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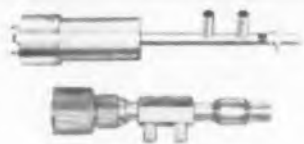
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IDEAS FOR DESIGN

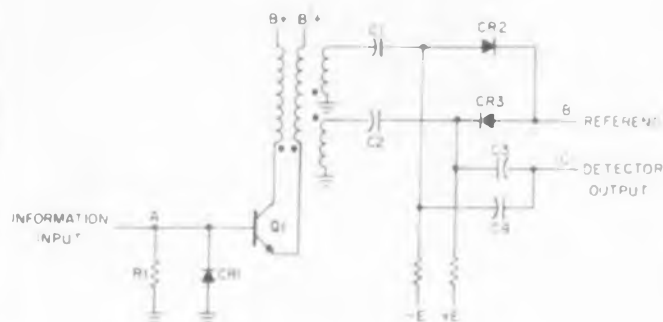


Fig. 1. Time-sensitive error detector.

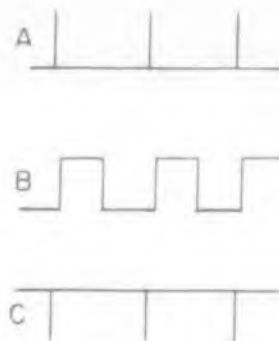


Fig. 2. Output pulse (C) is negative when the information gating pulse (A) leads the reference pulse (B).

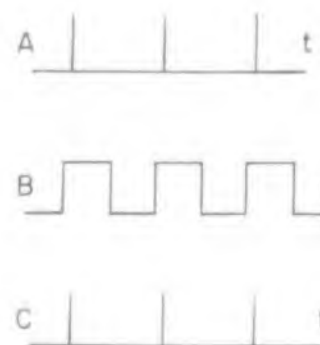


Fig. 3. Output is positive when information lags behind the start of the reference pulse.

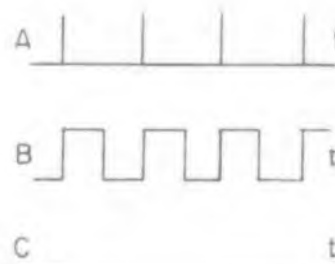


Fig. 4. No output results when the information pulse and reference pulse start at the same time.

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ELECTRONIC DESIGN • February 18, 1959

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RUBBER FINISH		X	X	X	
NON-TOXIC	X	X	X	X	X
INERT	X	X	X	X	X
FLEXIBLE TO °C	-40°	-40°	-40°	-40°	-20°
FUNGUS RESIST.	X	X	X	X	X
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information input and the reference coincide, the output of the detector is zero.

The detector has two main parts, a gating pulse generator and diode gates. The generator, a blocking oscillator type, generates two pulses, one negative and one positive, when a positive pulse appears at the input. The two diode gates are oppositely biased, so the reference pulse cannot pass through until the gating pulses appear.

If the information gating pulse leads the reference, diode CR2 conducts, and a negative pulse is generated as in Fig. 2. If the gating pulse lags, CR3 conducts and a positive pulse results as in Fig. 3. When the gating and reference pulses line up, no output results as in Fig. 4.

John Tai, Senior Electronics Engineer, Litton Industries, Inc., College Park, Md.

Overvoltage Protection For RF Probes

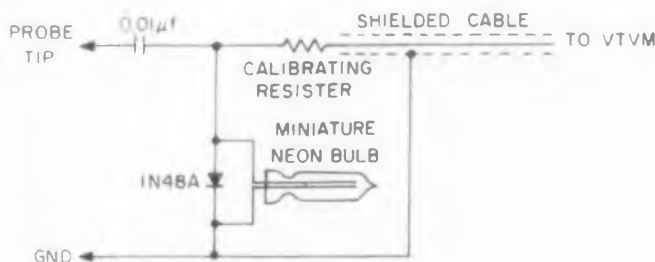
The germanium diode in an rf probe can be ruined if the probe is applied to points where the voltage is large enough to drive excess current through the diode. Replacing the diode is usually very time-consuming.

By shunting a miniature neon bulb across the diode, the diode can be protected. A bulb is used whose firing voltage is somewhat less than the maximum voltage which may be applied across the diode. When the probe is applied to an ac source with an excessive peak voltage, the bulb fires before the diode has excessive voltage applied across it.

After firing, the bulb maintains a relatively constant voltage drop and prevents the peak voltage from being applied to the diode.

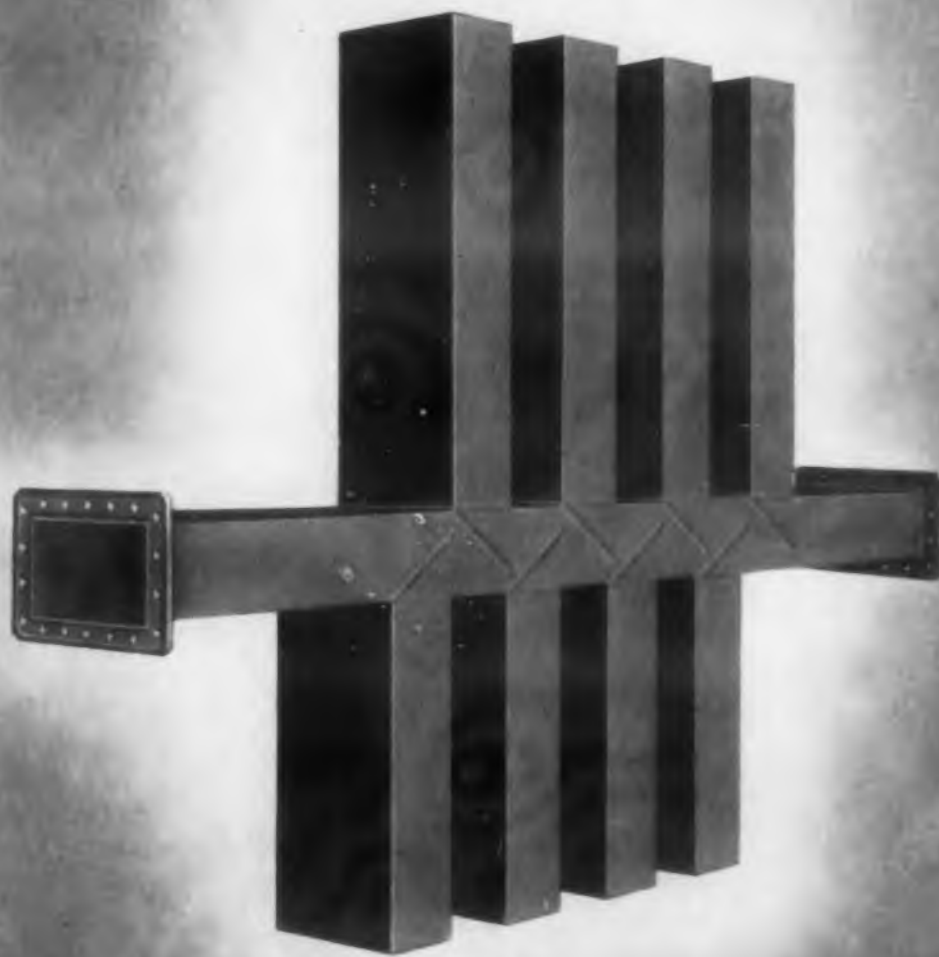
The bulb can be mounted in a small window in the probe case to warn the operator of excess voltage. Though the bulb adds a small capacitance to the probe circuit it usually does not disturb the rf characteristics.

R. G. Middleton, Radio-Electronic TV Schools, Detroit, Mich.



Neon bulb protects diode in rf probe.

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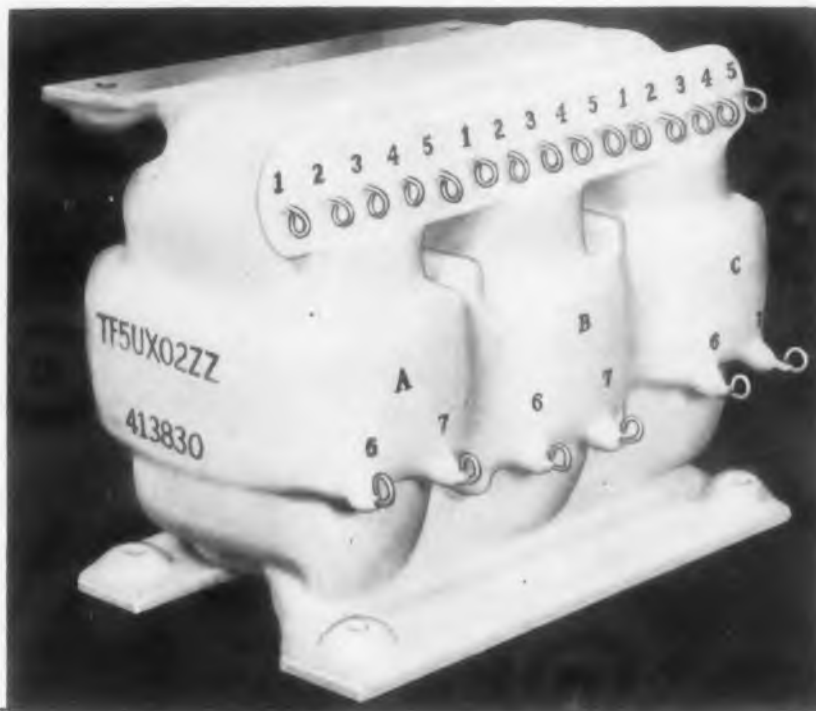
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Vibration: 10-G 10-500 cps
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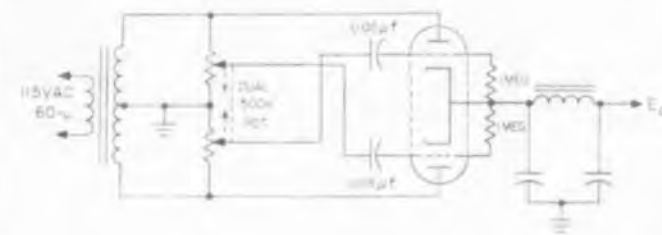
ALLIED CONTROL COMPANY, INC.,
2 East End Avenue, New York 21, N.Y.

CIRCLE 504 ON READER-SERVICE CARD



AL 153

IDEAS FOR DESIGN



Variable dc supply needs few components, no variable transformer. For 20 ma output, the tube can be a 12BH7. A 6BL7 or 6BX7 can serve for 100 ma, and a 6AS7 for 250 ma.

Minimum Component Variable DC Supply

This unregulated dc supply uses very few components, and no variable transformer. In the figure, a dual-ganged 500 K pot picks off a fraction of the ac developed across the power transformer secondary. It delivers this ac (out of phase with the plate voltage) to the tube grids through capacitors. Grids of the dual triode are returned to the common cathode through one meg resistors.

During operation, the amount of out-of-phase voltage on each grid is controlled by the position of the pots. The output is variable from zero to peak voltage at no load, or to slightly less than peak at rated current.

The circuit has inherent regulation against line variations, but none against load variations. Within the capabilities of the power transformer, any pair of triodes or pentodes can be used, depending on the desired current output.

J. Frank Brumbaugh, Senior Marine Engineer, Heath Co., Benton Harbor, Mich.

One Tube Balanced Modulator

One drawback to the use of vacuum tube balanced mixers or balanced modulators has been the large number of components required. Fig. 1 shows a conventional system with three tubes: two as modulators, one as a local oscillator or variable frequency oscillator.

A one tube circuit encompassing all these functions is shown in Fig. 2. The 6BU8 is a dual pentode with common cathode, control grid, and screen grid.

The common elements are connected as a cathode coupled Hartley oscillator. The cathode

bias network $R_k - C_k$ provides approximately $-4v$ bias for the signal input grids $G3_a$ and $G3_b$. These grids can be fed from a push-pull source, or one grid can be grounded and the other fed by a single ended source. The latter method saves components but loses efficiency.

The plates of the two sections are connected in push-pull across a center-tapped tuned transformer. Full wave if output transformers, available for common if frequencies, perform quite well when used backwards.

The output signal is composed of $f_o + f_a$ and $f_o - f_a$ only when they fall within the passband of $T1$. When f_a is an audio frequency signal, the output will be the upper and lower sidebands of f_o , i.e., $f_o + f_a$ and $f_o - f_a$. If f_a is greater than about 1/2 the bandwidth of $T1$ the output will be either the upper or the lower sideband.

Possible modifications of the oscillator circuit include crystal controlled circuits such as the modified Pierce and the simple Robert Dollar circuit.

Michael S. Robbins, Project Engr., Anchor Products Labs., Los Angeles, Calif.

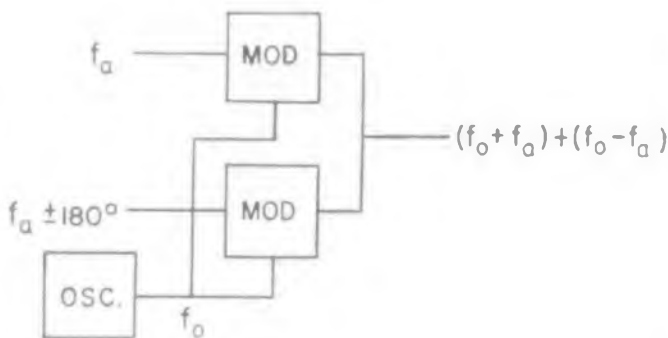


Fig. 1. A conventional balanced modulator with three tubes.

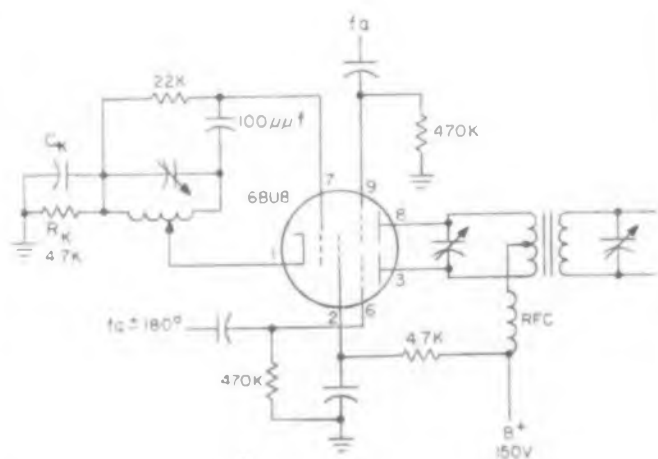


Fig. 2. A one tube balanced modulator with some typical parts values.



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REPORT BRIEFS

High Voltage Low Current Vibrator

The work represented in this report covers investigations leading to the development of a light weight extremely small vibrator for converting low dc potentials to investigations leading to the development of five vibrator test circuit power supplies utilizing the subminiature vibrator, as developed. *High Voltage Low Current Vibrator*, Albert A. Goffstein and Charles G. Compton, American Television and Radio Co., St. Paul, Minn. Nov. 955, 235 pp. microfilm \$10.20, photocopy \$36.30. Order PB 127477 from Library of Congress, Washington 25, D.C.

Design of Low Level DC Amplifiers

Practical design considerations for low level dc amplifiers of the second harmonic type which employ a combination of the magnetic modulator and transistors. Circuit parameters are given for a typical amplifier along with a discussion of expected performance. Report Dg-R-1. *Low Level DC Amplifiers*, James C. Taylor and William T. White, U. S. Army Ballistic Missile Agency, Development Operations Division, Guidance and Control Laboratory, Huntsville, Ala. Feb 1957, 31p, microfilm \$3.00, photocopy \$6.30. Order from Library of Congress, PB 132807, Washington 25, D. C.

Silicon-Germanium Alloy Transistors For High-Temperature Use

The purpose of this contract was to develop point-contact switching transistors which operate without failure at the high temperatures encountered in military equipment. A study was made of techniques of crystal growing, material processing, and capsulation problems peculiar to high temperature devices. The feasibility of fabricating high temperature switching transistors has been demonstrated by the production of over two hundred transistors which met the target specification. *Investigation of Techniques for Production of High Ambient Silicon-Germanium Point Contact Switching Transistors*. Final report under Contract AF 19(604)-1586, covering period 1 Dec. 1955-30 Apr. 1957, G. M. Meyer and D. E. Humez, Clevite Corp., Transistor Products Div., Waltham, Mass. May 1957, 82p, microfilm \$4.80, photocopy \$13.80. Order PB 133327 from Library of Congress, Washington 25, D. C.

Graphical and Tabulated Data for Predicting Dependable Air-to-Air Radar Range

Tabulated and graphically-presented data can quickly provide vital information on the dependable maximum radar range when both the radar and targets are above super-standard layer in the atmosphere under stated conditions. Data were determined through the application of the radio line-of-sight equation. This application of the equation and the accompanying tables are believed to be new. *Graphical and Tabulated Data for Predicting Dependable Air-to-Air Radar Range*, Chester A. Hines, Wright-Patterson Air Force Base, Dayton, Ohio, Apr. 1956, 131p, microfilm \$6.90, photocopy \$21.30. Order from Library of Congress, PB 134409, Washington 25, D.C.

Math for Digital Computers

Multivariate interpolation, with emphasis on its use in connection with modern stored program digital computers, is discussed. The text deals with polynomial interpolation; however, trigonometric interpolation is mentioned briefly. After an introduction to univariate interpolation, bivariate interpolation is discussed in detail. Chapters are devoted to rectangular, triangular, and symmetric arrays. A selected bibliography is also given. *Mathematics for Digital Computers; Volume I—Multivariate Interpolation*, W. E. Milne, W. Arntzen, N. Reynolds, and J. Wheelock, Oregon State College for Wright Air Development Center, U.S. Air Force, Feb. 1958, 111p, \$2.50. Order PB 151200 from OTS, Dept. of Commerce, Washington 25, D.C.

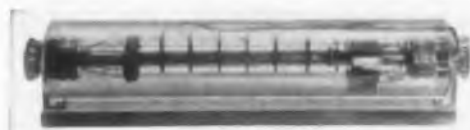
Interference Rejection in FM Receivers

A new role is suggested for the amplitude limiter in fm receivers. By spreading out the spectrum which is necessary for the reproduction of the fm disturbance that is caused by the interference, the limiter makes it possible for a filter to reject an important portion of this spectrum without substantially affecting the spectrum that carries the message modulation. The conditions for the success of this operation are analyzed in terms of an ideal limiter followed by an idealized filter. Cascading of several narrow-band limiters is found to be an invaluable scheme for enhancing the capture capabilities of an fm receiver. *Interference Rejection in FM Receivers*, Elie J. Baghdady, Massachusetts Institute of Technology, Cambridge, Mass. Sept. 1956, 107p, microfilm \$5.70, photocopy \$16.80. Order PB 133455 from Library of Congress, Washington 25, D.C.

Nickelonic News



DEVELOPMENTS IN NICKEL AND NICKEL ALLOYS AND THEIR APPLICATIONS

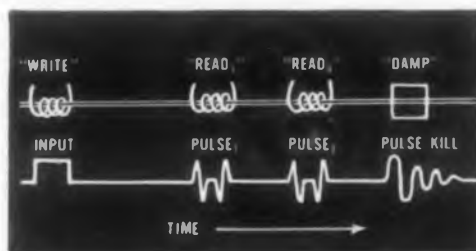


Magnetostriiction of Nickel drives Delttime data storage unit. With these units some 15 million bits of data could be handled in a 3x7x7 foot space, engineers estimate.

Shock waves in Nickel "store" 1500 bits of information

MAMARONECK, N. Y.: Magnetostriiction produces shock waves in Nickel that travel one foot in about 63 micro-seconds. Delttime, Inc. uses this property of Nickel to build electronic delay lines. Their latest is a data storage unit that packs eleven 300-microsecond delays in a small space. Ten lines "store" 150 bits of data each, the other "clocks."

Center rod of unit (shown with plastic cover to reveal detail) is structural. Nickel delay lines are concentrically located around rod. Diagram below shows schematic of a single line with associated pulses.



Delay lines are Inco Electronic-Grade "A" Nickel, drawn fine and stranded to reduce eddy currents. Delttime engineers say Nickel combines large and efficient magnetostrictive response, minimum corrosion, excellent mechanical properties.

Pertinent Literature: Write for Inco Bulletin 127B: "Magnetostriiction".

CIRCLE 563 ON READER-SERVICE CARD

5 new Inconel-protected instruments retain accuracy at missile speeds, heats

... point the way to more reliable high temperature parts design

CHICAGO, ILL.: Streaking through the air on mile-a-second missile nose cones ... fixed in hot, corrosive fluid streams ... the five new instruments described below operate reliably at glowing temperatures. Aero Research standardizes on Inconel® nickel-chromium alloy for parts of these instruments that bear the brunt of this demanding service.

(1) **Total temperature probe** — withstands 1740° F generated by friction during flight on missile nose cones. (See photos below.) For maximum reliability, its Inconel sheathing also withstands oxidation and thermal shock.

(2) **Wide-range thermocouple** — measures temperatures from as low as - 320° up to + 1900° F in high-velocity

fluids. Inconel sheathing effectively resists these severe erosive-corrosive conditions.

(3) **High-accuracy, high-temperature probe**—measures temperatures between 0° and 1800° F. Again, Inconel sheathing assures reliability, protecting its accuracy in supersonic jet exhausts, high-temperature furnaces.

(4) **Jet thrust measuring rake**, water-cooled — operates in 3500° F jet afterburner gases. Inconel alloy construction provides essential high strength at high temperature, plus corrosion resistance.

(5) **Sonic-speed, 4430° F, wind tunnel**, water-cooled — Inconel alloy forms all major components, gives tunnel the backbone needed to stand up under terrific velocity and heat.

You, too, can give parts high temperature stamina with Inconel alloy. It retains useful strength through 2000° F, and can be easily welded and formed into intricate shapes.

Pertinent Literature: Write for Bulletin T-7: "Engineering Properties of Inconel and Inconel X", and "Inco Nickel Alloys for Electronic Uses".

CIRCLE 564 ON READER-SERVICE CARD



Inconel-sheathed total temperature probe mounted on Redstone missile nose cone — assures high strength at high temperatures and readily withstands oxidation, erosion and thermal shock at extreme velocities. Probe (shown at right) is product of Aero Research Instrument Company, Inc., Chicago, Illinois.



Sensitive transducer measures minute changes of pressure in human body

... Monel fluid chambers withstand corrosion, do not affect saline purity

WALTHAM, MASS.: This sensitive pressure transducer measures a wide range of physiological pressures — from 400 mm Hg down to less than 1 mm Hg.

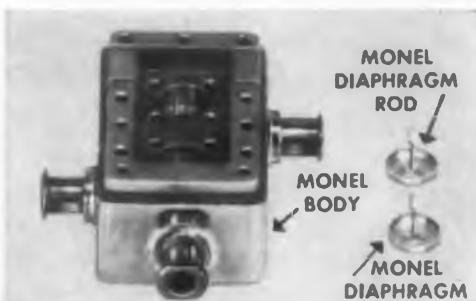
Absolute and differential pressures travel from source (needle or catheter) through a saline-filled tube to actuate two small Monel® nickel-copper alloy diaphragms. Monel diaphragm rods pivot a tiny differential transformer core, producing a signal which is fed

to amplifiers for quick reading.

Monel alloy was chosen for the parts above because it withstands corrosive attack from all common saline and sterilizing solutions. As a result, Monel alloy does not affect saline purity. In addition, Monel alloy is easy to form, machine, to braze, solder and weld.

Pertinent Literature: Write for Bulletin T-5: "Engineering Properties of Monel and R Monel".

CIRCLE 565 ON READER-SERVICE CARD



Monel transducer body and diaphragms resist corrosive saline solutions for long, reliable service. Transducer is made by Sanborn Company, 175 Wyman St., Waltham, Mass.



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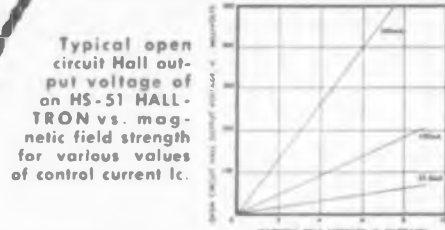
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REPORT BRIEFS

Testing Lead-Acid Storage Batteries

The results of the study show that a fixed-resistance method of high discharge provides an adequate field test of lead-acid storage batteries and should be the least expensive method to use. For laboratory purposes, however, the constant-current method of discharge gives a more accurate measure of a battery's electrical qualities, especially at low temperatures. The purpose of the research was to evaluate the high rate discharge characteristics of lead-acid storage batteries using the fixed-resistance method of loading and to compare these characteristics with those obtained via the constant-current method. Ribflex ribbon-wound, air cooled resistors were used for the fixed resistance load, and manually-adjusted carbon piles in parallel with fixed resistors were used for the constant current load. The high rate discharge characteristics of the types 6TN and ST storage batteries obtained by both methods are given. *High Rate Discharge Characteristics of Lead-Acid Storage Batteries*, C. B. Derricotte, Detroit Arsenal, Oct. 1956, 27p, \$0.75. Order PB 131498 from OTS, U.S. Dept. of Commerce, Washington 25, D.C.

"Instantaneous" Microwave Polarimeter Technique

A new, simple microwave polarimeter technique which permits instantaneous measurement of the polarization characteristics of an electromagnetic wave has been developed by Navy researchers. The report describes the new polarimeter, which utilizes a trimode turnstile junction in a precision dual balanced mixer for circular waveguide, which is said to be capable of high accuracy over a wide frequency band. This is achieved through symmetry of the rf plumbing. Amplitude errors of less than 2 percent over a 12-percent band are reported. The compact size of the trimode turnstile polarimeter makes it a convenient instrument for both laboratory and field use in measuring polarization. It is particularly valuable where signal input is variable or intermittent. The technique is said to have utility in such fields as antennas, propagation, ferrite devices, radar return studies, signal intercept, countermeasures, communication, and radio astronomy. *An "Instantaneous" Microwave Polarimeter Technique*, P. J. Allen and R. D. Tompkins, U.S. Naval Research Laboratory, Sept. 1958, 11p, \$0.50. Order PB 151111 from OTS, U.S. Dept. of Commerce, Washington 25, D.C.

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Broadband Strip Line Filter Design

Basic characteristics of strip transmission line are presented and several components required in the line construction and testing of strip line filters are described. A discussion of techniques for fabricating strip line section and components is presented. Other problems in the design of filters for special applications are considered. These include the complementary pairing of filters and frequency partitioning arrangements. *Broadband Strip Line Filter Design, Martin Rabinowitz and Eugene N. Torgow, Polytechnic Institute of Brooklyn, Microwave Research Institute, Brooklyn, N.Y. Mar. 1956, 89p, microfilm \$4.80, photocopy \$13.80. Order PB 132286 from Library of Congress, Washington 25, D.C.*

Devices for Automatic Data Reduction

This illustrated catalog contains descriptions and operating characteristics of devices useful in automatic data reduction systems. The volume was prepared as a guide for engineers in the selection of commercially available or developmental equipment. Most of the devices described in the catalog are digital. Emphasis is placed on equipment which performs analog to digital conversion (voltage to digital converters and shaft position encoders). Included are digital plotters, printers, digital magnetic tape transports, high capacity memory systems, digital to analog converters, airborne magnetic tape recorders, and semiautomatic devices which produce digital records. (This volume supersedes PB 111928, same title, Part 2, dated Nov. 1954). *A Catalog of Devices Useful in Automatic Data Reduction: Part 2, First Revision. R. S. Hollitch and A. K. Hawkes, Illinois Institute of Technology for Wright Air Development Center, U.S. Air Force, July 1956, 191p, \$5.00. PB 111928R available from OTS, U.S. Department of Commerce, Washington 25, D.C.*

High Power Microwave Filters

In order to obtain filters capable of handling very high power, the use of radial lines and uniform line discontinuities was investigated as the most promising approach. In this connection, it was necessary to consider the equivalent circuit and interaction effects for H mode radial lines mated at each end to uniform TE_{10} waveguide for taper angles of 45 deg. *High Power Microwave Filters, Joseph H. Vogelmann, Griffiss Air Force Base, Rome, N.Y. Oct. 1957, 71p, microfilm \$4.50, photocopy \$12.30. Order PB 132507 from Library of Congress, Washington 25, D.C.*

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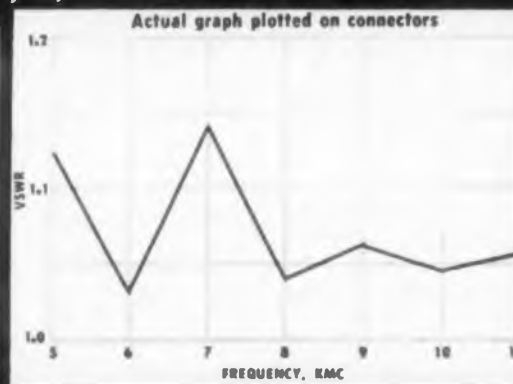
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REPORT BRIEFS

Reliable Equipment Cooler

An evaluation of the MA-5 air conditioner, a new production unit used by the Air Force for cooling electronic equipment, has rated it extremely reliable, efficient, compact, and mobile. Rated at an adequate 36,000 BTU per hour, a capacity which could be exceeded greatly, by varying design conditions, the unit weighs 960 lb, is transportable by air and in 1-1/2 ton vans over rough roads. Two-package fabrication permits remote condenser operation, a space-saving feature. Said to be much smaller than the average air-cooled unit having the same capacity at the same ambient temperature, the MA-5 proved superior to similarly rated units in both efficiency and reliability in operating performance tests. The study produced capacity curves related to both ambient conditions outside and return air temperatures inside, which are recommended as useful for selection of an air conditioner for a particular electronics system. *Test and Evaluation of the MA-5 Air Conditioner*, J. L. Hahn and D. J. Scarafite, Rome Air Development Center, U.S. Air Force, April, 1958, 29p, \$1.00. PB 151039 may be ordered from OTS, U.S. Department of Commerce, Washington 25, D.C.

Standards and Tests for Printed Circuits

A system of standards and test procedures for plastic base materials and boards for printed circuits is described in this report. Samples of commercially available laminated plastic materials suitable for printed circuit base plates were tested and a list of the properties important to printed circuits boards, together with lower limits for the properties was compiled in the form of preliminary specifications. This list was submitted to industry and military organizations for comment, which were used to modify the specifications to reflect the needs and abilities of the organizations involved. New test methods were developed where existing methods of testing the property values were inadequate. Methods were also developed for determining the degree of deterioration in service environments. Factors affecting reliability of printed circuits were also examined. *Preparation of Standards and Test Procedures for Printed Circuits*, C. A. Dodge and S. E. Graf, Stanford Research Institute for Wright Air Development Center, U.S. Air Force, March 1958, 146p, \$3.00. Order PB 131983 from OTS, U.S. Dept. of Commerce, Washington 25, D.C.

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STRAITS TIN REPORT

New developments in
the production, mar-
keting and uses of tin



★

Five times cheaper than stainless steel. That's what the British dairy industry reports about seamless tinned steel milk cans. It finds that a heavy tin coating gives a good adherent finish, provides excellent corrosion resistance, is completely nontoxic, and does not in any way affect the flavor or the nutritive value of the milk.

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The increasingly important role of tin in this age of the jet and missile is again confirmed. A tin-zinc alloy is being used to plate jet aircraft hydraulic brake parts and thus prevent corrosion. The alloy is 75% tin and 25% zinc.

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Characteristics of Insulation

This investigation was to determine the effects of frequency, temperature and moisture absorption on the dielectric strength, dielectric constant, dissipation factor and ac surface resistivity of several ceramic materials. These materials were investigated over the frequency range from 60 cps to 100 mc. Measurements were made periodically over the exposure periods up to six months at nine conditions of temperature and relative humidity ranging from -55°C to 125°C . The ceramic materials examined had excellent electrical properties which were stable over long periods of exposure. Fosterite and alumina did not have high dielectric strength at 60 cps but the decrease in strength was not drastic with increasing frequency. At the higher frequencies these ceramics compare favorably with many materials which have dielectric strength many times greater at 60 cps. *Moisture Resistance and Dielectric Breakdown of Electrical Insulating Materials*, J. J. Chapman and L. J. Frisco, *The Johns Hopkins University for U.S. Army, Feb. 1957, 112p, \$2.50. PB 131630 available from OTS, U.S. Department of Commerce, Washington 25, D.C.*

Growth of Ferrite Single Crystals

A two-year investigation of methods for producing single crystals of nonmetallic ferromagnetic materials is described in a final report. Among results of more than 55 experiments with the "hydrothermal method," it was possible to produce moderate growths of magnetite and nickelous ferrite on seed crystals using 0.5N to 2N ammonium chloride, bromide, and their mixtures and combinations with ammonium iodide solutions were also successfully used.

Hydrothermal synthesis of nickelous ferrite gave best results since experiments could be duplicated. Magnetite runs were not reproducible in respect to growth on seeds.

Experiments with the "flux methods" yielded magnesium and nickelous ferrite crystals, both of the spinel structure, and yttrium ferrite crystals of the garnet structure. The process was carried out by gradually cooling the binary melt, ferrite-flux, in a platinum crucible from about 1300 down to 1000 C, followed by air quenching to room temperature. *Investigation of Methods of Producing Single Crystals of Non-Metallic Ferromagnetic Substances, Final Report*, J. Koenig, *Clevite Research Center for Air Force Cambridge Research Center, August 1957, 25p, \$1.50. The illustrated report, PB 131631, may be ordered from OTS, U.S. Department of Commerce, Washington 25, D.C.*

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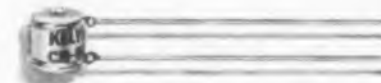
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Nonlinear and Parametric Phenomena in Radio Engineering

Part 12

A. A. Kharkevich

(Translated by J. George Adashko)

Chapter 2

Generation of Oscillations

16. Energy Balance of Self Oscillations— Dynamic Stability

The power dissipated in the resistance R in a tank circuit is

$$P_- = \frac{d^2}{2} \frac{U_m^2}{R}$$

i.e., it is proportional to the square of the voltage across the tank circuit. Let us denote the power received by the tuned circuit from the energy source by P_+ . If the entire oscillator circuit, including the gate and the feedback loop, were linear, the power P_+ would increase with the

square of the amplitude.

Let us show graphically the amplitude dependence of the energy dissipated and that received by the tank circuit, plotting the amplitudes in rectangular coordinates. In such coordinates, both graphs are represented, in the case of a linear system, by straight lines passing through the origin. (Fig. 55.)

If, as shown in the diagram, the line P_+ lies above the line P_- , this means that the tank circuit receives more energy than it dissipates, i.e., that the stored energy in the tank circuit increases, and this in turn, means an increasing oscillation amplitude. If, to the contrary, the line

P_+ lies below P_- , this means that the energy consumption exceeds the incoming energy, and under such conditions only damped oscillations are possible in the tank circuit.

Under the conditions of Fig. 55, the amplitude would increase without limit. This cannot happen in practice; any real circuit is nonlinear. In the case considered here, the nonlinearity may be due, for example, to saturation of the triode or to the effect of grid current.

Thanks to the nonlinearity, the incoming power P_+ increases more slowly than the square of the amplitude, and its graph becomes curved and assumes the form of Fig. 56. At a certain value of the amplitude, the graphs of P_+ and P_- cross.

The point of intersection corresponds to the energy balance, i.e., the dissipated and received energies are exactly equal. Obviously, only under the energy balance condition will the energy stored in the resonant circuit (and consequently the amplitude of the oscillation) remain constant. Thus, the abscissa of the point of intersection (Fig. 56) determines directly the steady state amplitude U_0 of the oscillation.

Thus, the presence of nonlinearity is an essential property of a self oscillating system capable of generating oscillations of constant (steady-state) amplitude.

Energy balance can be attained for more than one amplitude. Let us examine Fig. 57. If there are two points of intersection, the question arises, which of these determines the steady-state amplitude of the oscillation? We must now introduce the concept of stability of oscillatory motion, which we shall call dynamic stability (to distinguish it from static stability, which characterizes not motion, but the state of equilibrium). We shall call an oscillatory motion stable, if there is a tendency for the steady state amplitude of oscillation to remain constant.

Let a certain action change the amplitude of

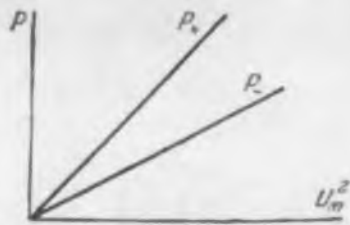


Fig. 55. The power dissipated in a tank circuit (P_-) and the power received from the energy source (P_+) are linear functions of the square of the voltage across the tank in a linear system.

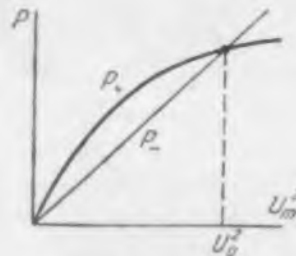


Fig. 56. In a real (nonlinear) system, the incoming power (P_+) increases more slowly than the square of the voltage across the tank.

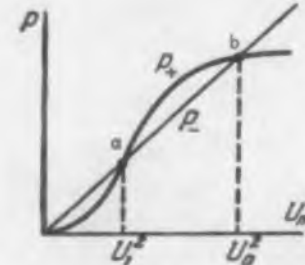


Fig. 57. A situation where there are two apparent points of energy balance in an oscillator system.

oscillation. Let this action then cease and let the system be left to its own devices. If the original value of the amplitude is now restored in the system, we can say that the system is dynamically stable. If, to the contrary, the amplitude will change even further in the same direction, even without an external influence, then the system is dynamically unstable.

It can be readily seen that the concepts of dynamic and static stability are similar in many respects. From this definition we can also deduce a direct test for stability: all we need to do is to disturb the system and see how it behaves subsequently.

Let us apply this method to the system in which the relations are characterized by the graphs of Fig. 57. The problem now reduces to whether the intersection points a and b represent stable or unstable states. Let us start with point a .

Let us assume that for some reason the amplitude becomes less than U_1 . In this region, the straight line P_- lies above the curve P_+ , meaning that the circuit loses energy faster than it receives it. Therefore the amplitude will diminish still more, until the oscillations will become damped out. If, however, we make the amplitude greater than U_1 , we shall have P_+ greater than P_- , and the amplitude will increase.

From this it follows that the point a , although it satisfies the energy balance condition, is not a stable point; the least change in the amplitude produces a tendency towards a further change in the amplitude in the same direction.

If the amplitude becomes greater than U_1 , it will continue to increase until it reaches the value U_0 . The increase in amplitude stops there, for at $U_m > U_0$ we again have $P_- > P_+$. The point b is therefore a stable point, and its abscissa determines the steady state amplitude U_0 .

Thus, the difference between the two systems whose properties are plotted in Figs. 56 and 57, is that the former will spontaneously assume the steady state amplitude U_1 , while the second requires an initial stimulus that would produce an amplitude greater than U_1 , after which further increase in amplitude to U_0 proceeds automatically. The former system is called a system with soft self excitation, or simply a soft system; the second is called a system with hard self excitation, or a hard system.

It must also be noted that the difference between soft and hard systems reduces to whether the system is stable or unstable at rest (i.e., when the amplitude is zero). By applying this reasoning to the origin (which, after all, is also an equilibrium point), it is easy to establish, that a hard system has a stable quiescent position, and the soft system has an unstable one.

(To be continued.)

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ELECTRONIC DESIGN Translations Program Taken Up By Government and Technical Societies

IT IS WITH mixed emotion that we announce that this popular "What The Russians Are Writing" department ends this issue. It is no longer necessary for ELECTRONIC DESIGN to regularly publish translations and abstracts of articles from Russian technical magazines as the government, engineering societies, and private agencies now perform these services. It is difficult to decide to suspend a popular, important feature. But, because there is now duplication of effort, it is no longer vital that we continue. We hope our readers will avail themselves of the subscriptions to translations tabulated below.

ELECTRONIC DESIGN will continue the serial translation of Professor Kharkevich's *Nonlinear and Parametric Phenomena in Radio Engineering*, and will, from time to time, translate Russian articles of particular significance to electronic design engineers.

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ELECTRONIC DESIGN will continue to publish all pertinent information relating to Russian translations.

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RUSSIAN TRANSLATIONS

What The Russians

Are Writing

J. George Adashko



Contactless Relay Using Transistors by F. L. Varpakhovskiy and R. A. Lipman. AT 11/58 1027-1035, 6 figs.

The transistorized relay discussed in this article is a two-stage dc amplifier with deep positive feedback caused by the grounded-emitter resistance. The relay is shown in Fig. 1, where R_0 is the grounded-emitter resistor, $R_2=R_H$ is the load resistance, and R_V is the internal resistance of the signal source.

The input quantity to this circuit is $u_v = e_v - y_0$. When $y_0=0$, the first transistor T_1 is cut off, and $u_{e1} \leq 0$, while transistor T_2 is fully "unblocked." As u_v increases, the output current remains nearly constant for a while (section $A'B'$ in Fig. 2). But as soon as the base current i_{b2} becomes less than $E/\beta_2 R_1$, the output current starts diminishing and the collector

voltage of transistor T_2 reverses and starts increasing, (section $B'C'$ of Fig. 2a), until transistor T_1 becomes "fully unblocked," i.e., until the voltage u_{e2} goes through zero and then reverses.

The operation of the circuit is thoroughly analyzed and experimental results are cited. Certain transistors yielded output powers up to 100 to 200 at a gain of 10^5 to 10^6 .

Simultaneous Detection of Signal, Undamped Noise, and Fluctuation Noise by Means of an Exponential Detector, by M. S. Nemirovskiy. EC 1/58, 9-17, 2 figs.

The exponential detector, Fig. 3, is analyzed for the case of small signals and fluctuation noise. In such a detector (curves 1 and 2, Fig. 4) the signal to noise ratio tends to a certain finite limit,

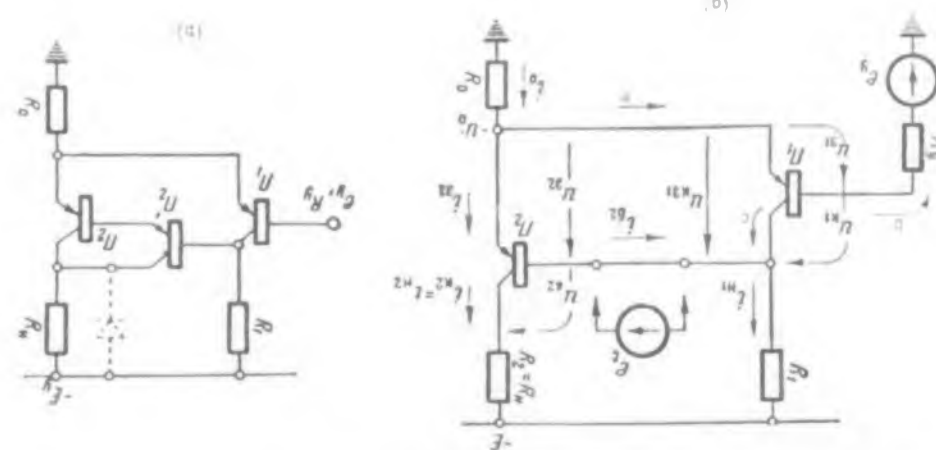


Fig. 1. Principle diagram of contactless relay: a—using two transistors; b—with three transistors.

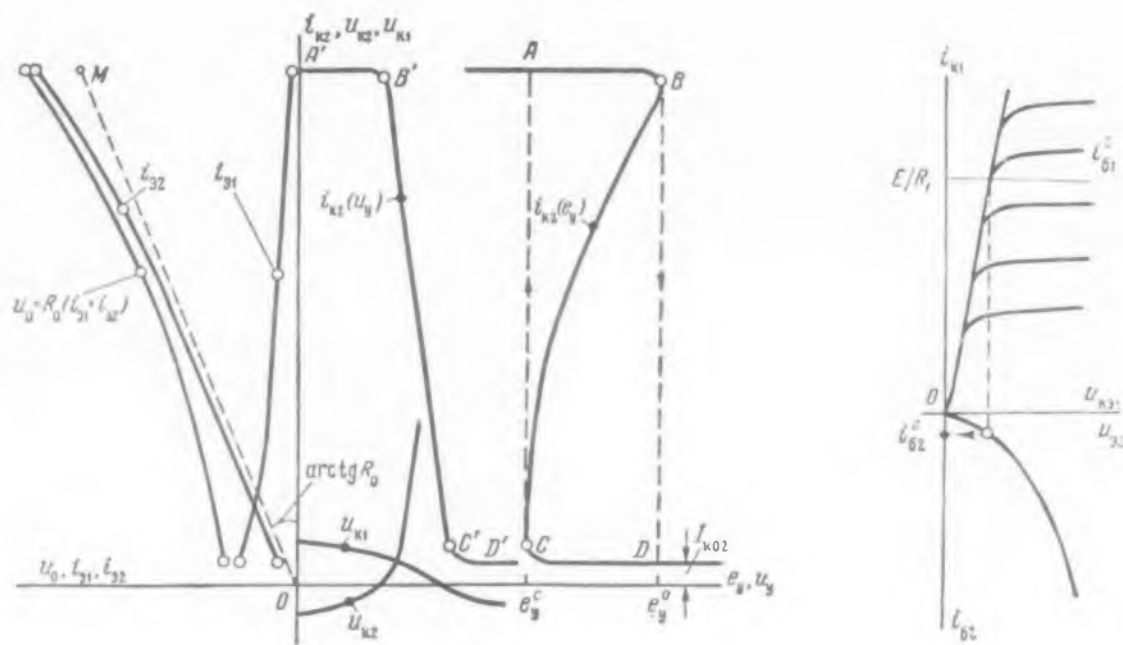


Fig. 2. Qualitative characteristics of the circuit of Fig. 1.



Fig. 3. Block diagram of exponential detector: 1—broadband high-pass filter; 2—nonlinear element; 3—narrow-band lowpass filter.

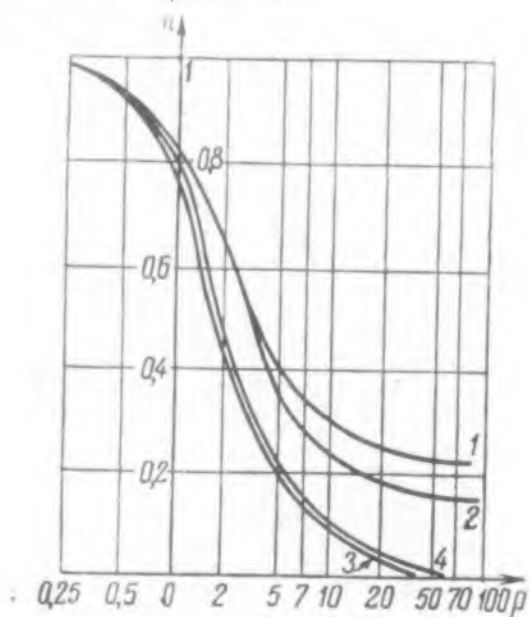


Fig. 4. S/R of exponential detector.

whereas in a linear or square-law detector (3 and 4, Fig. 4) the ratio goes to zero.

Transients in an AFC System With Diode-Phantastron Control Circuit, Resulting from a Change in the Signal Frequency, by M. V. Zerova, EC 11/58, 18-28. 7 figs.

One of the most important characteris-

tics of an afc system is its operating speed, for which purpose it is necessary to analyze the transients resulting from a sudden change in the frequency. A pulse afc system of this type is shown in Figs. 5 and 6.

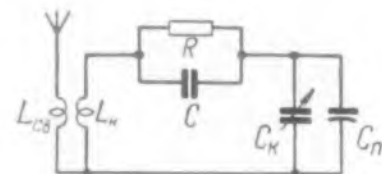


Fig. 5. Addition of frequency-dependent impedance to tank circuit.

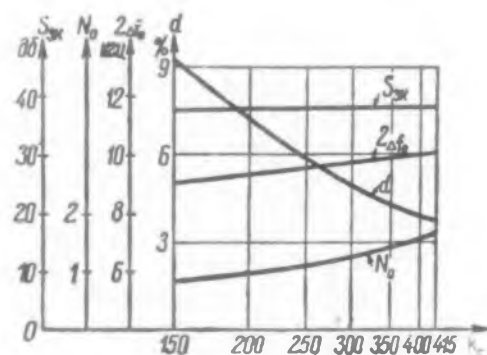


Fig. 6. Variation of bandwidth ($2\Delta f_0$), selectivity (S), attenuation (d) and transfer coefficient (N_0) in a receiver using a corrected tank circuit.

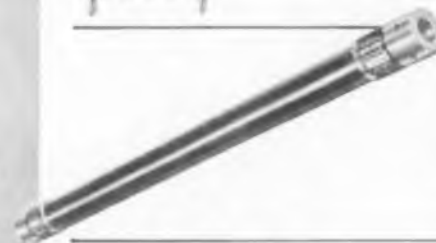
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RUSSIAN TRANSLATIONS

In this article both "underdamped" and "overdamped" transients are discussed quantitatively, and the relation is established between the speed of frequency control and the overshoot on the system parameters. The parameters involved are the pulse duration, the pause duration, the time constant of the charging circuit, the time constant of the discharging circuit, and the gain of the system.

Design of Receiver Input Circuits with Frequency-Dependent Impedance in the Tank Circuit by V. A. Borisov. EC 11/58, 29-35. 4 figs, 3 tables.

In most radio receivers with a single tank circuit the attenuation of the input circuit is determined essentially by the parameters of the tank-circuit coil and by the parameters of the antenna

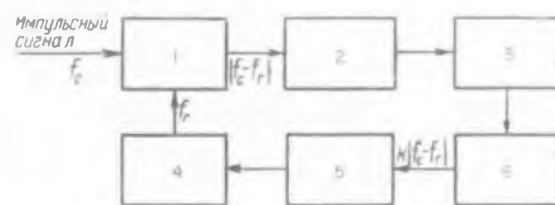


Fig. 7. Block diagram of afc system: 1—pulse signal; 2—i-f amp; 3—discriminator; 4—heterodyne; 5—control network; 6—video amp.

circuit. The result is that the bandwidth of the input circuit cannot be kept within a specified value over the entire tuning range. Introducing a frequency dependent impedance into the tank circuit (an RC network) improves the situation. A specific example, illustrated in the Fig. 7, is discussed in detail and the results are shown in Fig. 8.

Delay Lines with Lumped Parameters by V. F. Golyshko and K. A. Sil'vinskaya. EC 11/58, 69-76.

Delay lines are most frequently constructed in the form of low-pass filters, with a cut off frequency beyond the useful frequency band of the delay line. A method for designing such a delay line with lumped parameters is presented here along with the most economic circuit of one element of such a delay line. The parameters of the delay line are determined on the basis of best approximation of the group propagation time to a constant value within the specified interval. Reference is made to "Delay Networks Having Maximally Flat Characteristics" by W. E. Thom-

TUBE PROBLEM:

An amplifier manufacturer was plagued by noise, microphonics and hum that developed in the high gain stages of his amplifiers. Sonotone engineers were consulted on the problem.

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ELECTRONIC DESIGN • February 18, 1959

son (*Proceedings IEE*, No. 44, November 1949).

Contribution to the Analysis of Multiple-Frequency Bunching in a Reflex Klystron-Multiplier by V. S. Stal'makhov and A. F. Golubentsev. RE 10/58, 1243-1253. 5 figs.

The authors have investigated the possibility of exciting the resonator of a reflex klystron si-

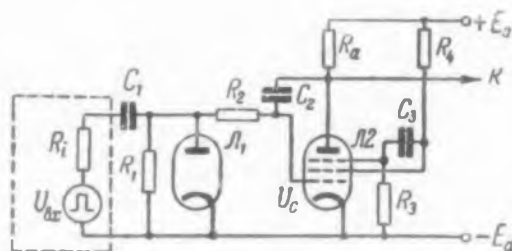


Fig. 8. Essential circuit elements of afc system.

multaneously at several natural frequencies. Problems connected with the analysis of the multifrequency bunching of the electron beam in the reflex klystron-multiplier are discussed for the general case of arbitrary frequency ratio. Expressions are obtained for the efficiency of the electron system and the working formulas are given for the calculation of the principal parameters of the multiplier in case of excitation at two frequencies.

KEY

The sources of the Russian articles and their dates of issue follow the authors' names. Here is the key to the names of the journals in which the articles originally appeared.

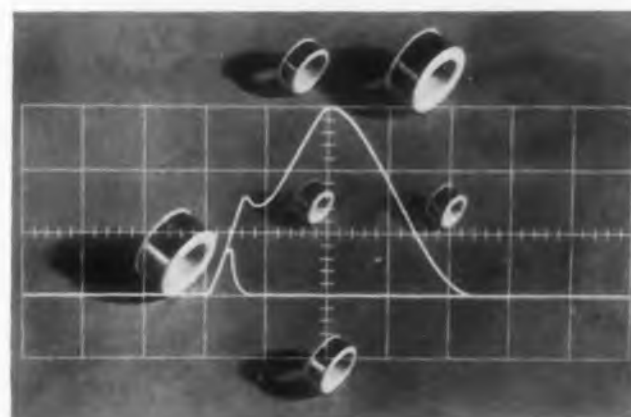
- AJ Acoustic Journal (*Akusticheskiy Zhurnal*)
- AT Automation and Telemechanics (*Avtomatika i Telemekhanika*)
- CJ Communications Journal (*Vestnik Svyazi*)
- EC Electrical Communications (*Elektrosvyaz*)
- IET Instruments and Experimental Techniques (*Pribori i Tekhnika Eksperimenta*)
- JTP Journal of Technical Physics (*Zhurnal Tekhnicheskoy Fiziki*)
- ME Measurement Engineering (*Izmeritel'naya Tekhnika*)
- R Radio
- RE Radio Engineering (*Radiotekhnika*)
- REE Radio Engineering and Electronics (*Radiotekhnika i Elektronika*)



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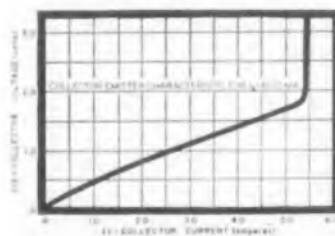
The Westinghouse Silicon Power Transistor pictured above is a highly efficient device which greatly increases the range of applications for transistors which must operate without high losses in the "true power range." Thanks to a remarkably low saturation resistance—less than .750 ohms at 2 amperes and .5 ohms at 5 amperes—these transistors possess very low internal dissipation, and can be efficiently used in applications where they must handle as much as 1000 watts. For example, as a DC switch, handling 750 watts (150 volts at 5 amps) the internal dissipation is about 9 watts, with an efficiency of better than 99%.

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There are a great many applications for which this new type of silicon power transistor is ideally suited. It will find use in inverters or converters (AC to AC; AC to DC; DC to AC; DC to DC), regulated power supplies, servo output, and other aircraft circuits, as well as in certain amplifiers and switching applications.

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GERMAN ABSTRACTS

E. Brenner

Transistor Q Multipliers

ACTIVE circuits which present negative driving point resistance can be used to raise the effective "Q" of coils at audio frequencies. Thus, the storage factor, Q, can be effectively multiplied by reducing the resistive losses. To obtain a stable multiplication factor, the negative resistance network must be stable particularly with respect to temperature. Transistor circuits which present a negative impedance, constant within 1% in a temperature range from -30 to +60 deg C can be devised.

If a resonant circuit is represented as the parallel combination of a capacitance C, inductance L, and conductance G then $Q = \omega_0 C/G$. If G is the sum of positive conductance G_p and negative conductance G_n then Q_0 is the Q for $G_n = 0$; a "Q-multiplication" factor q is defined as

$$q = \frac{Q}{Q_0} = \frac{G_p}{G_p + G_n} \quad (1)$$

Hence

$$\frac{\Delta G_n}{G_n} = \frac{\Delta Q}{(q-1)Q} \quad (2)$$

so that with $q = 11$, a one per cent change in the negative impedance element produces a ten per cent change in the effective Q.

A circuit which has the required temperature stability is shown in Fig. 1. It can be shown that a conductance

$$G_n \approx \frac{1-a}{a^2 R f}$$

is reflected into the tank circuit. (The approximation is valid if the output impedance of the transistor is neglected compared to its load.) Since a, the turns ratio of the tapped coil, exceeds unity, G_n is negative. Since G_n depends on a and Rf only, it is highly stable. Temperature dependence is introduced through the positive input conductance of the transistor G_i , which is part of G_p in Eq. 1.

In order to minimize the effect of G_i which is temperature dependent, it is necessary that $G_i \ll G_p$.

In that case

$$\frac{\Delta Q}{Q} = q \frac{G_i}{G_p} \cdot \frac{\Delta G_i}{G_i}$$

The small input admittance required can be achieved by means of Darlington's circuit, Fig 2, by the use of the lowest possible tank impedance level, and by connecting the transistor input terminal to another tap on the inductor.

A second negative resistance network which has the required temperature stability but requires complimentary transistors is the circuit of Karp.¹ This circuit can be used at all tank impedance levels.

Abstracted from an article by A. E. Bachmann, Archiv der Elektrischen Uebertragung, Vol. 12, No. 8, August 1958, pp 368-370.

Reference

1. Proc. Nat'l. Electr. Conf. 12, 1956, 469-480.

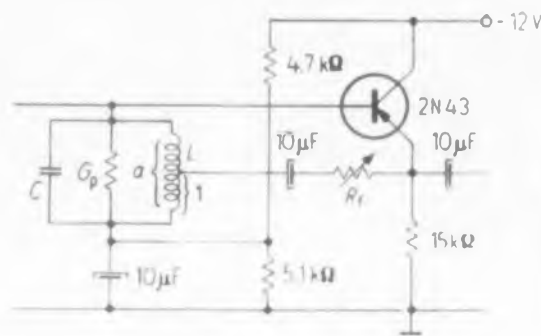


Fig. 1. Transistor feedback circuit.

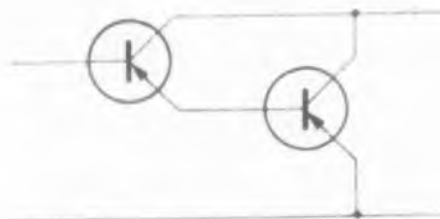


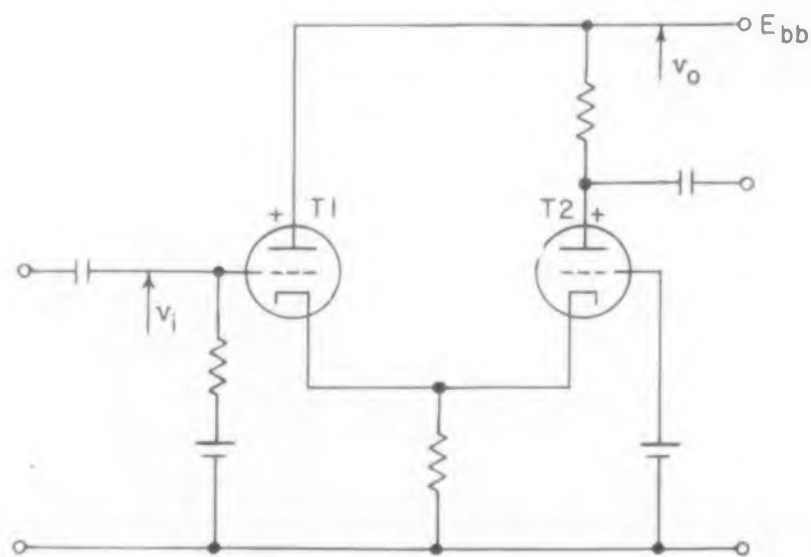
Fig. 2. "Darlington's" circuit.

Cathode Coupled Limiters

THE CATHODE coupled limiter shown in Fig. 1 is superior to the conventional diode, triode, or pentode circuit because its limiting action is independent of tube clamping effects. In each direction, the circuit is designed so that the limiting action is due to a cut-off. When the signal v_i is positive, clipping occurs due to cutoff in T_2 ; T_1 limits the negative swing of the signal. The signal swing between clipping levels can be as much as 35 db without grid current flow due to the cathode follower action in T_1 . Therefore, the circuit acts as a linear amplifier between clipping levels.

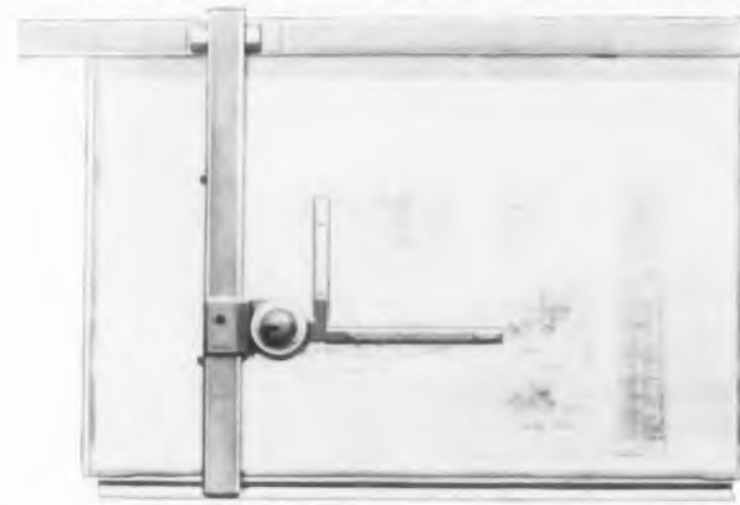
The design of the circuit is generally carried out using the static characteristics of the tube with straight line approximations.

Abstracted from an article by J. Schulz, Frequenz, Vol. 12, No. 4, April 1958, pp 114-117.



Cathode-coupled clipper.

DRAFTING TRENDS



The Universal Tracmaster drafting machine, currently being introduced by Post, is perfectly balanced for all board angles without protruding counterweights. The Tracmaster features extreme parallel accuracy, offering featherlight responses for easy operation, with the same overarm protractor head used on the famed Universal Boardmaster drafting machine

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The extremely rigid horizontal beam

rail you see across the top of the Tracmaster is mounted to the board by two brackets. Once mounted, there is never a need for adjustment. The machine's beams always stay straight.

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If space is a problem, you'll find the Tracmaster a perfect answer. There are no protruding arms or weights in the back, so the machine can be used close to walls or near other tables. You can actually put more tables in a given area using the Tracmaster on a Hamilton Auto Shift or L-Angle Table than you can with any other drafting combination. In fact, in all Post's years of experience in working to serve draftsmen engineers and designers, this combination of the Universal Tracmaster with modern Hamilton equipment offers by far the best opportunity to materially improve drafting efficiency.

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LETTERS

NEC Seeks Convention Cure

Dear Sir:

Your editorial, "Have Convention, Must Travel" (*ED*, Oct. 1, 1958) was read with a great deal of interest in this quarter. We fully appreciate the problem the engineer has with "convention congestion."

Today conventions are a necessary part of our industrial society. Like trade journals they are increasing in number because the theory behind them (to efficiently demonstrate new developments) is basic to our American free-enterprise economy. The convention that performs this service best will survive and grow while others die out.

National Electronics Conference in the enclosed news release (mailed recently to trade journals in the industry) has announced its intention to face this problem head on in an attempt to help not only the engineer but also the commercial exhibitor to realize more value from their precious time.

By necessity our announcement was in rather general terms: details will be announced at a later date. The big point we are striving to make now is that we are cognizant of this situation and as the nation's leading forum on electronics research, development, and application we feel a responsibility to do something about it.

We intend to rigorously research and amend our methods in an effort to bring forth a maximum number of truly significant technical papers to a maximum audience in a manner most conducive to comprehension by those in attendance. This we must do in order to provide full service to our sponsors.

Joseph H. Enenbach, President
Arthur H. Streich, General Manager
National Electronics Conference, Inc.
Chicago, Ill.

► Readers who have ideas on how to better run a conference the size of NEC might pass their suggestions on to Messrs. Enenbach and Streich. (Send us a carbon copy—we like to know if these requests for reader action ever materialize.) The benefits of a discussion type program for smaller conventions all touched on an editorial in the

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1. Any number may be installed in series to form a multi-digit counter.
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SODECO 1TD ten or twenty-five impulse/sec. counters are compact (7/8" x 1 1/2" x 4 3/8"), rugged units suitable for flush mounting. The large, easy to read numbers are 5/32" wide and 13/32" high. Power requirements are low—permitting their installation in electronic circuits. Their cost is reasonable, too.

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5 amperes 125/250 volts a.c.
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CIRCLE 522 ON READER-SERVICE CARD

January 21 issue of *ELECTRONIC DESIGN*. It seems to us some of these benefits might be possible at a large convention if speakers were set up in a room to be available to all questioners after the formal presentation. Any comments?

Reaction to Readouts

Dear Sir:

I am very much interested in the article, Comparing Illuminated In-Line Readouts (*ED*, Nov. 26, p.24). In offering the following comments, I wish to emphasize that I am not attempting to start a controversy on the subject of digital versus analog presentation. As a matter of fact, you are undoubtedly aware that the controversy on the comparison of the two presentations is part of history and not of recent vintage.

Your article flatly states that digital presentation has the following three advantages over the analog method.

1. Elimination of human estimating error. This may be true, but practically everyone with whom I have discussed the subject and who is considered an authority in the use of instruments in laboratories, control rooms, and manufacturing operations, feels quite strongly that they are able to read analog dials more accurately than they can read digital dials. I suspect the difference of opinion stems from the fact that the men who are doing the actual reading become accustomed to seeing the position of the pointer on the analog dials of the given groups of instruments with which they constantly work. We have noticed through years of observation that they do this with amazing accuracy. Perhaps to the casual user of instruments, the digital dial can be read more accurately, but I think in the long run the wishes of the men who use the instruments most should be served first.

2. Speed in observing data. Actual tests conducted by reading experts, as well as some tests that were made at Wright Field during the war, proved that the positions of pointers on dials are read much more rapidly than are digital dials. To illustrate this fact, you might try this simple experiment. Set a digital clock and a rotating pointer clock to the same time. Ask several different people what the time was after flashing the digital clock for a fraction of a second and then the rotating pointer clock for the same amount of time. I have seen this experiment tried on dozens of people, and almost invariably the rotating pointer clock was read with reasonable accuracy while the digital dial was not read.

3. Reduce fatigue of human operator. Some tests I recently heard about proved the contrary. Apparently more mental effort is involved in

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For specific information on the new AGASTAT relay for your application, write to Dept. A30-224

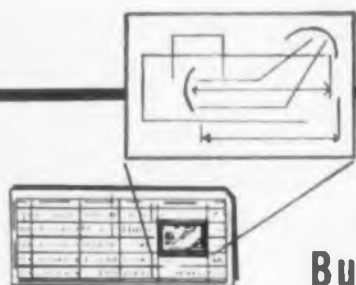
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LETTERS

recognizing the indication of a series of numerals than that of the angle of rotating pointers.

Let me conclude by saying that I am writing to you primarily because there are many authoritative instrument people among major users, who would disagree with your article on the basis of actual experience and factual tests.

(Name withheld by request)

► According to our human factors engineering friends (who will not be pinned down without thoroughly analyzing what information the operator needs), a direct reading meter is best if the operator must read an exact numerical value and if the indicator is stationary at the time the reading is made. If the indicator is moving (faster than 2 digits per sec) a moving pointer is probably best. The human factors experts say a moving pointer is best (less fatiguing) if the operator is looking for approximate or qualitative values.

Importance of Octal Math

Dear Sir:

I was very pleased to see my article, "Calculating with Octal Mathematics" in the December 10 issue of ELECTRONIC DESIGN.

You neglected, however, to include a very important point which I feel should be of considerable interest to your readers. This is that the reason for using octal mathematics in preparing computer problems is that it can be converted to binary notation by inspection. All that is necessary is to write each octal digit as its binary equivalent to yield the binary equivalent of the octal numbers. Similarly, by dividing a binary number into groups of three digits beginning at the right and writing each group as an octal digit the octal equivalent of a binary number is obtained. I would appreciate your calling this fact to the attention of your readers.

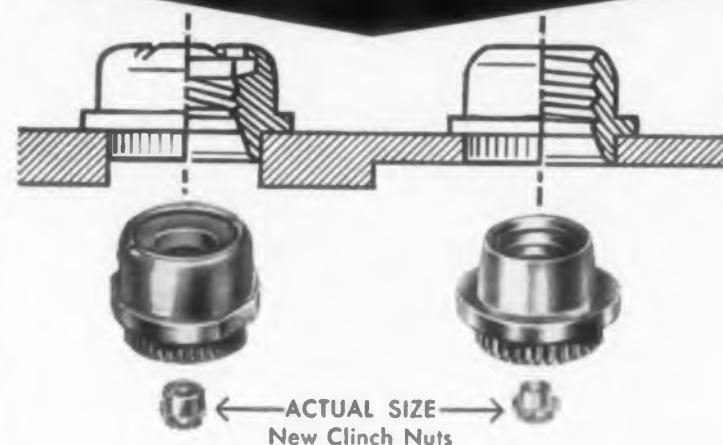
Roger T. Stevens
Senior Engineer
Electronics Systems, Inc.
105 Chauncy Street
Boston 11, Mass.

The Case of The Inverted Exponent

Dear Sir:

May we call your attention to apparent errors appearing in the article "A Logarithmic Pulse

New ESNA miniatures flush mount in thin stock



When space requirements are tight, one of these two new ESNA miniature clinch nuts may be just what you're looking for! They are easily flush mounted in sheet as thin as .030".

Type NCFM clinch nut for temperatures up to 350°F, has special nylon locking insert which will not gall screws or create the cadmium flaking so damaging to electrical circuitry. Type LHCFM is an all-metal nut with an elliptical crown locking device capable of withstanding up to 550°F.

Detailed dimensional drawings on these two new miniature nuts, plus full data covering necessary installation tools are now available. Write Elastic Stop Nut Corporation of America, Dept. S8-257, 2330 Vauxhall Road, Union, N. J.



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Breakdown voltage between contacts, at sea level, mated with printed board 1200 volts DC.
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1725 State St., Racine, Wisconsin

Amplifier" (pg. 96-7) of ELECTRONIC DESIGN for October 29, 1958. Eq. (1) in the article reads

$$I = I_s (\epsilon^{qV/KT} - 1)$$

The exponent is inverted causing errors in the equations which follow.

Eq. (1) should read:

$$I = I_s (\epsilon^{qV/KT} - 1)$$

and, solving for V, assuming I is much greater than I_s , eq. (3) should read:

$$V = K_1 \ln I - K_2$$

Carrying through the negative sign preceding K_2 , results in K_4 of eq. (4):

$$K_4 = -(K_2 + K_1 \ln R)$$

Thus, the paragraph immediately following eq. (4) now reads correctly.

We believe these suggested changes to be correct. However, the article's interest and usefulness remain relatively unimpaired.

E. Leonard,

H. Click

Reconnaissance Systems Dept.

Airborne Instruments Laboratory

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Dear Sir:

Many design engineers derate the power dissipation of electronic components to achieve reliability and long life of the component. A common practice is to derate to a given percentage of the component manufacturer's power rating. The result of this derating is that the component internal temperature is a given percentage of the way from the ambient temperature towards the rated maximum temperature. This gives a new maximum internal temperature rating which depends on the ambient being designed for, rather than a consistent maximum internal temperature.

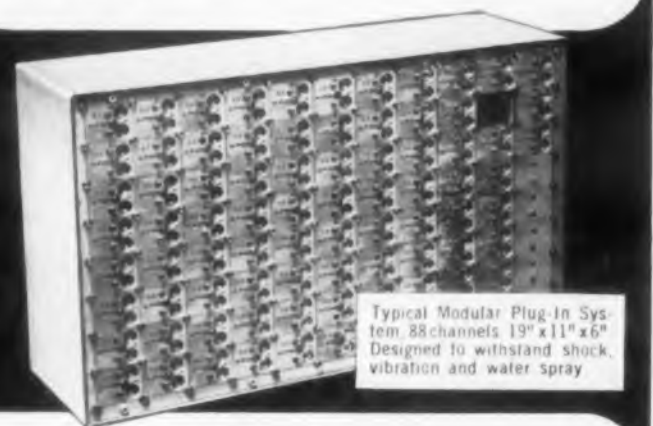
This point is best illustrated by an example where the ambient temperature is close to the maximum rated temperature. Consider a germanium transistor rated by the manufacturer for power dissipation derated linearly to zero at 85 deg C. Applying half the rated power seems to be conservative design practice. But is it? A circuit design to operate in a 25 deg C ambient will have a junction temperature of 55 deg C, while one designed to operate in a 65 deg C ambient will have a junction temperature of 75 deg C.

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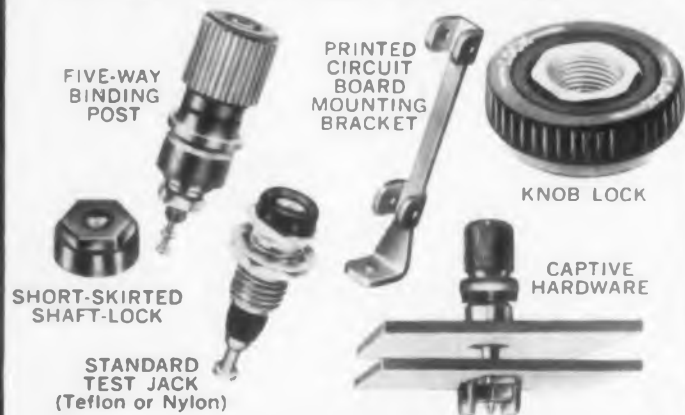
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LETTERS

practice is inconsistent. Worse yet, it may lead to a false sense of security, where the engineer believes he has made a reliable and conservative design when in fact he has not, and the fact may not show up until after many hours of life testing, if life testing is ever performed at all.

A more consistent derating method would be as follows: If you don't believe the manufacturer's internal temperature rating, rerate the temperature yourself as you see fit. Then calculate your own dissipation ratings based on that temperature and use them consistently.

Nathan O. Sokal
Senior Engineer
Di/An Controls, Inc.
Boston, Mass.

We Stand Corrected

Dear Sir:

Our group was pleased to note the prominence with which you have described our pulsed plasma accelerator in the "Behind the News" lead article of your October 29, 1958, issue. There are, however, one or two errors which we would like to correct.

First, the power supply which Mr. Bernard Gorowitz used with the equipment in the Dallas exhibit was capable of delivering only 1250 w rather than 100 kw, with voltages up to 2500 v, as mentioned in the article. Although peak currents of the order of 500 amps are delivered in each discharge cycle of the ringing circuit, it is not necessary for this amount of current to pass in the discharge, as is certainly well known by anyone who has ever used a gaseous discharge tube. It is advantageous, however, to make this peak current as high as possible, thus explaining the use of the capacitor storage of energy, inasmuch as the magnetic driving force depends on the current in the discharge portion of the cycle; the higher the current, the higher the magnetic field, and consequently the higher the repelling force. We are somewhat ashamed to admit that the force measured with a ballistic pendulum is not the 0.303 oz mentioned, but rather with this particular type of magnetic field coupling more like 0.03 oz.

Boyd W. Harned, Physicist
Aerophysics Operation
General Electric Co.
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► The higher power mentioned may be necessary to get large thrusts.



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MEETINGS

Calendar of Events

February

25-26 Midwest Industrial Radioisotopes Conf., Manhattan, Kansas

March

2-6 Western Joint Computer Conference (IRE, AIEE, ACM), San Francisco, Calif.

5-6 Flight Propulsion Meeting, Inst. of Aeronautical Sciences, Cleveland, Ohio

5-7 2nd Western Space Age Conference, Los Angeles, Calif.

9-12 Aviation Conference (ASME), Los Angeles, Calif.

14-15 Southwestern Society of Nuclear Medicine, 4th Annual, New Orleans, La.

16-20 National Meeting AICE, Atlantic City, N.J.

16-20 Annual Conference National Assoc. Corrosion Engineers, Chicago, Ill.

17-21 8th Electrical Engineers' Exhibition, London, England

18-20 Electronic Industries Assoc. Conf., Washington, D.C.

23-26 IRE National Convention, New York, N.Y.

24-27 General Meeting American Meteorological Soc., Chicago, Ill.

26 15th Annual Quality Control Clinic, Rochester, N.Y.

27-28 Michigan Academy of Sciences, East Lansing, Mich.

29-2 21st Annual Instruments and Regulators Conf. (ASME), Cleveland, Ohio

30-1 Electrical Industry Show, Chicago, Ill.

31-2 21st Annual American Power Conference, Chicago, Ill.

31-2 9th Symposium on Millimeter Waves (IRE), New York, N.Y.

April

1-29 World Meteorological Organization, 3rd Session of Congress, Geneva, Switzerland

2-3 Electrically Exploded Wires Conference, Boston, Mass.

2-4 Association for Computing Machinery, Cleveland, Ohio

5-10 5th Nuclear Congress, Cleveland, Ohio

6-7 3rd Annual Astronautics Symposium (AFOSR), Washington, D.C.

13-15 Hydraulics Conference (ASME), Ann Arbor, Mich.

13-17 29th Annual National Packaging Conference (AMA), Chicago, Ill.

14-15 Electrical Heating Conference (AIEE), Philadelphia, Pa.

14-15 Conference on Industrial Instrumentation and Control, Chicago, Ill.

16-18 Southwestern IRE Regional Conference, Dallas, Tex.

16-30 Engineering, Marine, Welding, and Nuclear Energy Exhibition, London, England

17 Current Developments in the Production of High Vacuum Symposium, London, England

18-22 27th ASTE, Milwaukee, Wisc.

20-21 Techniques in Electronic Instrumentation (IRE), Philadelphia, Pa.

21-22 Technical Conference on Electronic Data Processing (IRE), Cincinnati, Ohio



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May

- 4-6 National Aeronautical Electronics Conference (IRE), Dayton, Ohio
- 5-7 URSI Spring Meeting (URSI, PGI, PGIT, PGGT), Washington, D.C.
- 5-7 7th National Conference on Electro-Magnetic Relays, Stillwater, Okla.
- 6-8 Joint Electronics Components Conference (IRE, AIEE, EIA, WCEMA), Philadelphia, Pa.*
- 6-8 7th Regional Technical Conference and Trade Show (IRE), Albuquerque, N. Mex.
- 11-13 National Symposium (PGMT-IRE), Boston, Mass.
- 18-20 Electronics Parts Distributors Show, Chicago, Ill.*
- 25-27 National Telemetry Conference (IAS, ISA, AIEE, ARS), Denver, Colo.*
- 25-29 International Convention on Transistors and Associated Semi-Conductor Devices, London, England*

June

- 1-3 National Symposium on Microwave Theory and Techniques (IRE), Cambridge, Mass.
- 3-5 Armed Forces Communications and Electronics Association, Annual Meeting, Washington, D.C.
- 4-5 Third National Conference on Production Techniques (IRE), San Mateo, Calif.
- 8-11 Semi-annual meeting, American Rocket Society, San Diego, Calif.
- 16-18 Symposium on Advances in Information Theory (IRE), Los Angeles, Calif.
- 29-1 National Convention on Military Electronics (IRE), Washington, D.C.

Joint Electronic Components Conference, May 6-8
Benjamin Franklin Hotel, Philadelphia, Pa. Sponsors: IRE, EIA, AIEE, WCEMA. Theme: New Concepts for Space Age. Papers to be presented on the following general categories: components and application in space vehicles; micro-miniaturization; mechanism of failure (operation) of components; new techniques for electronic filtering, tuning, and switching; components for military, industrial, and home appliance applications; and radiation effects. Contact *Gen. E. R. Petzing, AGEP Secretariat, Univ. of Pennsylvania, 200 South 33 St., Philadelphia 4, Pa.* for more information.

Electronic Parts Distributors Show, May 18-20
Conrad Hilton Hotel, Chicago, Ill. An expanded educational program for distributors designed to bring further benefits to the industry will be a special highlight of the show.

National Telemetry Conference, May 25-27
Brown Palace and Cosmopolitan Hotel, Denver, Colo. Sponsored annually by the American Rocket Society, IAS, AIEE, and ISA. Theme: Investigation of Space. Twelve sessions are tentatively scheduled for the meeting including such

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subjects as: Special Telemetry Techniques for Satellites and Space Vehicles; Sub-miniaturization; Telemetry of Bio-Medical Information from Man in Space; Transistorization and Data Processing. For information contact *Ralph Schmidt, AVCO Mfg. Co., 201 Lowell St., Wilmington, Mass.*

International Convention on Transistors and Associated Semi-Conductor Devices, May 25-29

To be held in London, this convention has been organized by the radio and telecommunication section of Britain's Institution of Electrical Engineers to mark the 10th anniversary of the transistor. It will be the most comprehensive ever held on transistors and will cover design, manufacture, basic theory, characteristics, measurements, applications, and equivalent circuits. To provide the widest possible interest, the International Transistor Exhibition will be held at the same time. For details contact *Industrial & Trade Fairs Ltd., Drury House, Russell Street, London, W.C. 2.*

Paper Deadlines

March 1: Call for papers for possible publication in the July issue of *IRE Transactions (PGME)*. Theme of issue will be "Simulation in Electronics," the subject being treated both as a research tool and as applied to training devices. Information from *Dr. J. G. Brantley, Jr., Radiation Lab Instrument Div., Orlando, Fla.*

March 1: Deadline for abstracts and rough drafts of outlines of papers to be presented at the first congress of **International Federation of Automatic Control** in Moscow in 1960. **July 15:** Deadline for completed papers. Agenda to cover three main areas: Theory; Components and Measurement; and Applications. Contact *W. E. Vannah, American Automatic Control Council, 330 West 42 St., New York 36, N.Y.*

May 1: Deadline for papers to be presented at **WESCON**, Aug. 18-21 to be held in San Francisco, Calif. Required are 100-200 word abstracts, together with complete texts or detailed summaries which should be sent to *Dr. Karl R. Spangenberg, WESCON, 60 West 41st Ave., San Mateo, Calif.*

June 22: Deadline for final manuscripts to be presented at the **4th Annual Magnetic Amplifiers Conference**, Sept. 23-25, in Washington, D.C. Contact *F. G. Timmel, 4601 Forest Park Ave., Baltimore 7, Md.*

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- Applied Mechanics
- Optical and Infra-Red Equipment Engineering
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ELECTRONIC DESIGN • February 18, 1959

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in confidence to Mr. E. A. Smith
Section 2-C*



DEFENSE SYSTEMS DEPARTMENT
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Qualifications: Bachelor's or advanced degree in E.E. or Aeronautical. At least 2 years' experience in systems analysis. Additional experience desired in development of military devices—servomechanisms, radar or computers.

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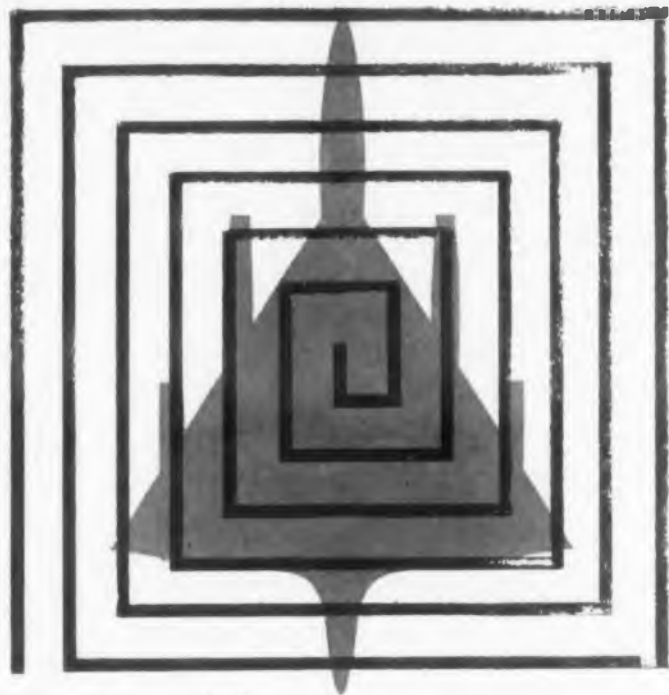
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Westinghouse Electric Corp., Electronic Tube Div.	184
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Whitso, Inc.	144
Zem Mfg. Co.	156

THIS
TUBE
THRIVES
ON
HIGH
VOLTAGE!



RCA-1B3-GT is designer-preferred...features heavy-duty filament...challenges filament burnout

Preferred Tube Type 1B3-GT is favored by design engineers for high-voltage rectifier service in TV sets. What makes it so good? How was RCA able to make it better?

A redesigned filament of larger wire with a larger coil diameter offers cooler operation. A smoother and lighter coating to assure uniform emission is applied to the filament by means of a special technique. The life of the filament is further safeguarded by a chemically treated anode support which assures a tight bond between it and the glass envelope and prevents leaks that would burn out the filament.

The glass envelope of the RCA-1B3-GT

has benefited, too, from improved techniques. Hydrogen firing of the envelope enables it to withstand electron bombardment and therefore reduces strain effects. In addition, contamination and resultant low emission are eliminated by supersonic washing of the anode and getter shield.

That's why the RCA-1B3-GT is a "champion" with high voltages. Your RCA Field Representative has the complete Preferred Tube Types story. See him soon.

If picture tubes are your interest, consider RCA here, too, for RCA picture tubes are engineered for long dependable performance. A word to your RCA Representative will bring you full information.



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