## electronics

Fast-rise current pulses needed to check out thin-film digital computer memories are discharged into stripline. Heavy metal arc at bottom is a Helmholtz coil. See p 79


# Creative Microwave Technology MOOOON 

Published by microwave and power tube division, raytheon company, waltham 54, mass., vol. 2. No. 4

## RAYTHEON KLYSTRON CLOCKS 62,000 HOURS OF SERVICE

--tube retired after seven years of continuous operation

We don't send out 62,000-hour warranties; however, you can expect unusual performance from Raytheon klystrons. Take the tube cited above -- the QK-531 -- a 6,575$6,875 \mathrm{mc}$ reflex klystron which we conservatively warrant for 7,500 hours. As the local oscillator in the Houstonia, Missouri, link of the Panhandle Eastern Pipeline Company's $400-\mathrm{mile}$ microwave system, the tube performed a major function in relaying up to ten channels of information between the Odessa and Boonville stations.
How is this kind of performance built into a tube? Advanced manufacturing techniques and rigorous quality control is the answer.

If you need low-power coverage of government, studio link and common carrier frequency bands, look into the characteristics of Raytheon's complete line of klystrons.


Homer Marrs of Motorola presents gold-plated klystron trophy to F. J. McElhatton, Panhandle East ern Pipeline Co. J. A. Fowler, Supervisor of Communications for panhandle, is at the left. Prized klystron, the Raytheon QK-531, performed for 62,000 hours.


The QK-531 is particularly suited for local oscillator service in microwave receivers. It is useful, also, as a local oscillator in microwave spectrum analyzers, as a pulse generator for testing circuit response and as a frequency modulated source in microwave relay links.


Close control of product quality and costs at every state of production is responsible, in part, for Raytheon's success in meeting industry and government specifications. Every step of assembly is spot checked by inspectors, each with 10 years or more experience in microwave tube production.

## Excellence in Electronics

You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Company, Waltham 54, Massachusetts. In Canada: E. Waterloo, Ontario.

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Amplifier rack panel. . . $10.5^{\circ h} h, 19^{\prime \prime} \mathrm{w}, 28^{\prime \prime} \mathrm{d}$ Power supply rack panel
$12.25^{\prime \prime}$ h, $19^{\prime \prime}$ w, $20^{\circ} 0$


Specifications / Model 116 Amplifier
Pass band. . . . . . . . . . . . . . . . . . 4-32 Mc Pulse power output . . . . . 100 kw (nominal) Power gain ................ 24 db (nominal) input impedance . . . . . . . . . . . . . . 50 ohms Output impedance . . . . . . . . . . . . . 50 ohms Maximum duty factor , . . . . . . . . . . . . . . 02 Maximum pulse width . . . . . . $2000 \mu \mathrm{sec}$ Prime power . . . . . . . . . . . $230 \mathrm{v}, 3 \phi, 60 \mathrm{cps}$ Dimensions :
2 cabinets, each . . . . . . $64^{*}$ h, $49^{\circ} \mathrm{w}, 32^{*} \mathrm{~d}$

Frequency-independent high power transmitting systems are now possible for the first time with this new line of amplifiers. Available in output power levels from 10 watts to 100 kilowatts, G/A's amplifiers offer power gains up to 24 db over 16:1 frequency bands in the hf range. These performance characteristics are ideal for system applications in ECM, propagation research and ionospheric radar where fast frequency change over extreme band widths without retuning is essential. They are already incorporated in a complete G/A-developed ionosphere sounder system - a good example of the company's capability in high power radio equipment. Related system "building blocks" from Granger Associates include wide-band antennas, baluns, multicouplers, T/R switches... special hardware conceived and produced by men who understand its purpose. Thorough knowledge of theory and application backed by design experience: that's the type of system capability offered by G/A. Send for further technical information, or inquire TTGT POWWR about our engineering staff openings. FROM GRANGER ASSOCIATES


## New LAMBDA

# Regulated Power Supplies 5 and 10 AMP 0-34 VDC 

## CONVECTION COOLED



## - Convection cooled-no internal blowers to wear out

## - Guaranteed for a full 5 years

- Ambient temperature $50^{\circ} \mathrm{C}$


## - Excess ambient thermal protection

- Special, high purity foil, hermetically sealed long. life electrolytic capacitors
- Hermetically sealed trans. former designed to MIL-T-27A


## - Remote sensing and DC vernier

## New LAMBDA LA Series Condensed Data

## DC OUTPUT:

(Regulated for line and load)

| MODEL | voltage rangel | Current range ${ }^{2}$ | PRICE |
| :---: | :---: | :---: | :---: |
| LA50-03A | 0-34 VDC | 0. 5A | \$395 |
| LA50-03AM | 0.34 VDC | 0. 5A | \$425 |
| LA100-03A | 0.34 VDC | 0-10A | \$510 |
| LA100.03AM | 0-34 VDC | 0.10 A | \$540 |

1 The output voltoge for eoch model is completely covered in four steps by selector switches plus vernier contral ond is obtoined by summotion of voltoge steps ond continuously vorioble $D C$ vernier as follows:

MODEL
VOLTAGE STEPS
LA $50-03 \mathrm{~A}$, LA $50.03 \mathrm{AM}-2,4,8,16$ and 0.4 volt vernier LA100-03A, LA100-03AM-2, 4, 8, 16 and $0-4$ volt vernier 2 Current roiing opplies over entire output voltoge ronge
Regulation: Line: Better than 0.15 per cent or 20 millivolts (whichever is greater).
Load: Belter than 0.15 per cent or 20 millivolts (whichever is greater).

## Transient

Response:

## Ripple

and Noise: Less than 1 millivolt rms with either terminal grounded.
AC INPUT:
$100-130 \mathrm{VAC}, 60 \pm 0.3$ cycle. This frequency band amply covers standard commercial power lines in the United States and Canada.

## OVERLOAD PROTECTION:

Electrical:
Magnetic circuit breaker front panel mounted. Special transistor circuitry provides independent protection against transistor complement overload. Fuses provide internal failure protection. Unit cannot be injured by short circuit or overload.

## REMOTE SENSING:

Provision is made for remote sensing to minimize effect of power output leads on DC regulation, output impedance and tran. sient response.

## PHYSICAL DATA:

Size: $\quad$ LA 50-03A. . $311^{\prime \prime} \mathrm{H} \times 19^{\prime \prime} \mathrm{W} \times 143 / 8^{\prime \prime} \mathrm{D}$
Panel Finish: Black ripple enamel (standard). Special finishes available to customers specifications at moderate surcharge. Quotation upon request.

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WHAT PRICE UHF TELEVISION? Federal Communications Commipsion says about $\$ 2$ million. This is the amount FCC has asked Congress to appropriate for what may be a conclusive test of this broadcast service. Latest plan is to set up an experimental uhf station in New York City (the antenna to go on the Empire State Building) and try to decide finafly whether or not uhf is a "feasible medium." Much is at stake. Other spectrum users have long been looking at the block of uhf space and putting on pressure in attempts to get it. Broadcast people say appropriation of $\$ 2$ million for the test is fairly certain. Political people, however, remind that nothing is certain "on the Hill" until it's signed. Associate Editor Emma has been speaking with broadcasters and politicians. To learn what they have to say, see p 32 .

ENGINEER RECRUITMENT. The pattern of engineer recruiting by electronics firms is changing for many reasons. The story on $p 40$ by Market Research Editor De Jongh points out the type of engineers inlustry employers are looking for today, and the shifts in engineers' job $\$$ ttitudes. The article also brings to light a number of important trendssuch as growing interest in sales and marketing organizations-and new factors in winning military contracts.

## Coming In Our June 10 Issue

CHARACTER GENERATOR. As reported recently in ElECTRONICs (p 11, April 29), a solid-state character generator has been developed by CBS Labs for use in data processing systems. In our next issue, J. K. Moore and M. Kronenberg of CBS Labs in Stamford, Conn., describe the circuits in the generator, which uses a high-speed parallel-to-serial converter to achieve high video signal frequencies from relatively slowspeed cores.

The present developmental model produces characters at a rate of 5,000 a second with graphic arts-quality resolution. According to the authors, the basic techniques may be used to construct equipment capable of writing at rates as high as 250,000 characters a second, although at a sacrifice of character quality.

PLASMA PROPULSION. Development of plasma propulsion systems for space vehicles requires instruments for measuring such factors as thrust and condition of the ejected mass. Next week, J. J. Peajson of Republic Aviation Corp. in Farmingdale, N. Y., describes the instrumentation being used to conduct research on the pinch propulsion system described in our July 31, 1959, issue ( $p$ 11). Particular emphasis is placed on the high-speed streak camera-a tool widely used in plasma research.

IMPEDANCE MATCHING. Transmitting antenna towers usually differ from each other enough to require special feeder matching and antenna tuning networks. Next week's reference sheet provides a convenient method of calculating the circuit elements for tuning an antenna. A. Horvath of Laboratorio De Radio-Ingenieria in Quito, Ecuador, shows how graphical methods can be applied to obtain the proper circuit elements.


OUTSTANDING COMBINATION OF ACCURACY, REIIability and stability with tow temperature coefficients
Molded Filmistors are being used with excellent results where stability cannot be achieved with conventional composition resistors and for applications where low controlled temperature coefficient, low noise level, good stability under load and negligible voltage coefficient are required. They also offer lower selfinductance and distributed capacitance -approach precision wirewound resistors in reliability and stability despite their small size.

## sUPERIOR RESISTANCE ELEMENT

The Filmistor element is achieved by
the pyrolytic decomposition of hydrocarbon gas depositing an ultra-thin film of pure carbon on a smooth ceramic rod. Silver-to-silver low-contact resistance, low-noise end terminations are used.
TOUGH MOLDED SHELL ASSURES ALL-ROUND PROTEC. TION AGAINST MECHANICAL DAMAGE AND HUMIDITY Rated at $1 / 8$ through 2 volts, Sprague Type 405E, 406E, 407E, 408E and 409 E resistors are housed in a molded shell so tough that humidity performance characteristics are far beyond the humidity life and stability of coatedtype carbon-film resistors. They also have improved load life and better insulation resistance than the older construction. $\star ~ \star ~ \star ~ \star ~ \star ~ \star ~ \star ~$


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## Chops time from 20 hours to 30 minutes drilling and notching Silicon Carbide waveguide inserts

PROBLEM: Drill two $.062^{\prime \prime} \pm .001$ holes to a depth of $.187 \pm .002$, and produce a notch $.375 \pm .001$ wide $\times .250 \pm .001$ deep $\times 1^{\prime \prime}$ long with no internal radius allowed on the end of silicon carbide sticks. The pieces are for use as dummy loads in high frequency waveguides. Previously, the holes were cut with carbide drills and the notch produced with diamond wheels.
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## COMMENT

## Standards and Pronunciation

Mr. Angell's inquiry and your comment (Backtalk, p 128, Apr. 1) on pronunciation of the newly accepted prefixes for orders of magnitude was read and digested with a sigh of relief.

My usage of the terms was handled with confidence throughout the month of April. Challenges to my use of the prefixes were rapidly countered with reference to your campaign for their usage and subsequent guide to their correct pronunciation. Needless to say, some conferences went astray of the intended objective over this disputed subject.

Then at the end of April I was alarmed to find an article in another publication regarding adoption of the new prefixes and pointing out pronunciations opposing your previous treatment. For the present I am forced to return to micketmouses and kilomegs.
Take me to the Leader.
Frank Fogelman

## Aeromarine

San Diego, Calif.

Your answer to Mr. Angell's letter jolted me. The pronunciations which you give are all in disagreement with the National Bureay of Standards, which commented on the pronunciation in their Bulletin. In three cases, you differ from Websters: didn't you look them up?

Tera is from the Greek teras, a monster. NBS prefers tee-ra, but Websters Unabridged gives terra in compounds.

Giga is not derived from mathematical parlance, but from the Latin gigas, a giant. The first syllable rhymes with pie. not jig. Websters does not give the second even as an alternate.

Nano is from the Greek wanos, a dwarf. Nay-no is given as preferred and nan-no as an approved second choice. Spanish has nothing to do with it.

Pico may come ultimately from the Latin. through the French pic, a point. In the rare words, Websters gives specifically the word picofarad, defined as a micromicrofarad, with pronunciation given as pie-ko and no second choice. I was


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Q connectors are available as straight and right angle plugs, panel receptacles (with "O" ring seal) and cable receptacles in 8 insert arrangements in 6 sizes. Efficient, low-force requirenient knife blade contacts are silver plated, shells are O.D. finished aluminum. Sandwichtype sealed inserts are Orlon-filled diallyl phthalate.
The new Q connectors join amphenol's complete line of ground equipment connectors-89 series "GSE" and 164 series Signal Corps power and audio types. Complete catalog information on Q, 89 and 164 seriesconnectors is available for your immediate use!

## AMPHENOL CONNECTOR DIVISION

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9

## Detection to Projection in Less than a Second

Large-screen display of radar signals can be recorded and projected in less than a second. This advanced technique in information display is an example of one application of the new thermoplastic recording system developed by General Electric.

The grainless, thermoplastic film eliminates processing delays and permits, with higher resolution, much greater enlargement than is practical with high-speed photographic film. Target delineation is also significantly improved by optical filtering used to increase the signal-to-noise ratio.

Now undergoing final development in General Electric's Electronics Laboratory, the "thermoplastic display" is expected to find maximum application in the high-speed radar systems of the future.

## Progress/s Our Most Important Product GENERAL ( ك 6

## DEFENSE ELECTRONICS DIVISION

HEAVY MILITARY ELECTRONICS DEPARTMENT SYRACUSE, NEW YORK


## BALLANTINE Model 300-G SENSTIVE ELECTRONIC VOLTMETER

- Top accuracy of $1 \%$ over entire meter scale from 1 mv to 250 v and over the band of 20 cps to 20 kc . Better than $2 \%$ to 1,000 volts and for the wider band of 10 cps to 250 kc .
- High input impedance: 2 megohms shunted by 15 pf, except 25 pf on lowest voltage range.
- Long life: Several thousands of hours of operation without servicing or recalibration.
- Does not require stabilized input voltage. Less than $1 / 2 \%$ change in indication with power supply change from 105 v to 125 v .
- Five inch, mirror-backed, easy-to-read meter. Only two scales with mirror between. One is 1 to 10 for volts, and the second is 0 to 20 for decibels.
Also available in 19 inch relay rack Model 300 G-S2 at $\$ 325$.

Write for brochure giving many more details.

## ELECTRONICS NEWSLETTER

## Defense Contracts Seek <br> Research Breakthroughs

MISSILES AND SPACE continue to account for much of the government money spent in electronics, with new R\&D areas opening in guidance and componentry.

- Big item: $\$ 84$-million contract to General Motors' AC Spark Plug division for research on inertial guidance for USAF's Titan ballistic missile. Titan currently uses radio command guidance; later squadrons will use the nonjammable inertial systems.
- Contract for research and development on high-reliability components for the Minuteman ballistic missile goes to Motorola. The subcontract (from Autonetics, prime for the Minuteman's WS133A inertial system) is for $\$ 1,-$ 272,000 , will investigate mesa transistors to find structures with failure rates of 0.0007 percent per thousand hours or better. Autonetics has embarked on a program to improve component reliability by a factor of about 100 , so that the Minuteman can be safely left alone, for months or years if necessary, but fired when needed.
- North American Aviation copped the $\$ 9.1$-million contract to build the Sugar Grove, W. Va., radiotelescope reflector. The $600-\mathrm{ft}$ dia dish, which will be the largest movable structure in the world, will rise taller than a 60 -story building and cover an area of more than seven acres.


## New System Assists Air, Space Navigation

NAVIGATION for hypersonic or space craft may be aided by a computerdirected map-projection system now under development at IBM's Owego, N. Y., laboratories.

The system as it exists thus far projects a highly accurate circular map of an area 400 miles in diameter $(125,000 \mathrm{sq} \mathrm{mi})$ on a $7 \frac{1}{2}$-in. screen. Glass hemisphere with detailed map of half the earth on its inside surface is illuminated by a small beam of light so that a small circular portion appears on a translucent screen. Associated computer
circuitry positions the map so that a pinpoint of light indicates craft position over the ground.

## Japan Reopens <br> Export Quotas

Japan's Ministry of International Trade \& Industry is expected to reopen transistor-radio exports this week under official controls. The action reverses the drastic step taken May 10 to halt all export licensing for the small sets.

Trading firms will be granted licenses first, with subsequent allocation of quotas for manufacturers. MITI is taking interim measures to license firms whose export applications were filed prior to the May 10 cutoff date.

Meanwhile, Japan's Electronic Industries Association announces that the boom in tv receiver sales has passed its peak, with inventories in March standing at 130,000 , more than double January's figure.

## Data Transceiver Handles 2,400 Bits a Second

BINARY DATA transceiver that allows computers to talk to each other at 2,400 bits per second over ordinary commercial telephone lines has been developed by Stromberg-Carlson division of General Dynamics. The transceivers use solid-state circuits throughout, can accept polar or im-pulse-type binary informaiton.

Serial trains of pulses are shaped by the equipment and used to modulate a subcarrier. According to S-C engineers, the modulation method used minimizes errors due to impulse noise, phase distortion, and frequency translation.

## Transistor Tv <br> Uses 19 -in. Tube

BIG-SCREEN transistorized television with a rechargeable battery is being produced by Motorola. Dubbed Astronaut, the 19-in.-screen set contains 23 transistors, 12 diodes and a silver-cadmium cell.

A 19AEP4 picture tube with 114-
deg deflection is used; this is similar to a 19XP4 tube with the gun structure modified for transistor operation. Filament power requirements are 12.6 v at 150 ma . The gun is modified to permit low $G_{\text {: }}$ voltage ( 100 v ) without increasing spot size or defocusing the picture.

## Cosmic Rays Guide Soviet Spacecraft

TECHNICAL DETAILS of the USSR's "spaceship," launched May 16, are beginning to leak out of the Soviet Union. E. Fyodorov of the USSR Academy of Sciences says the new ship is testing out systems for: regenerating oxygen supply, maintaining temperature within prescribed limits, enabling crewmen to take food under conditions of weightlessness, protecting crew and gear against excess strain in takeoff, and ejecting the pressurized cabin capsule from the mothership for reentry.

Astronavigation expert N. Varvarov states that the near-circular orbit achieved by the ship "is attainable in either of two ways: using cosmic rays or exploiting earth gravity." In the first case, he says, cosmic-ray counters are oriented parallel to the earth-tangent; slight deviations from selected orientation cause sharp changes in count, which are used to control stabilizing instruments and correcting engines.

## Cambodia Expands Broadcasting Activity

RED CHINA is giving a $50-\mathrm{Kw}$ shortwave broadcasting station to the Cambodian government. A personal gift from Chou En-Lai to Cambodia's Prince Norodom Sihanouk, the station will be built near the capital, Phnom Penh, starting in August.

Meantime, the government of the small Asian nation is asking for bids on a television station to serve the capital. It will be the first in the country, will cost about $\$ 370,000$ ( 13 million riels). Bids close on June 20 ; specs are available from the Cambodian Embassy.

## LAMINATED PLASTICS what they are, where they can be used

Taylor laminated plastics, also known as reinforced plastics, are thermoset-ting-type materials formed by impregnating paper, cotton cloth, asbestos, glass cloth, nylon or other base materials with synthetic resins and fusing them into sheets, rods, tubes and special shapes under heat and pressure. These materials exhibit a valuable combination of characteristics, including high electrical insulation resistance, structural strength, strength-to-weight ratio, and resistance to chemical reaction; also adaptability to fabricating operations.
Types of laminated plastics made by Taylor There are four basic types of Taylor laminated plastics commonly specified and used throughout industry today. They are as follows:


Phenoiic Iaminates. Paper, cotton fabric or mat, asbestos, glass cloth or nylon bases impregnated with phenol formaldehyde resins. These provide strength and rigidity, dimensional stability, resistance to heat. chemical resistance, and good dielectric characteristics. Some Taylor grades are excellent basic materials for gears, cams, pinions, bearings and other mechanical applications. Others are widely used in terminal boards, switchgear, circuit breakers, switches, electrical appliances and motors. Also in radios, television equipment and other electronic devices; and in missiles as nose cones, exhaust nozzles, and combustion chamber liners.


Melamine Laminates. Glass cloth or cotton fabric impregnated with melamine formaldehyde resin. Taylor melamine laminates have superior mechanical strength and are especially desirable for their arc-resistant qualities. Good flame and heat resistance, good resistance to the corrosive effects of alkalis and most other common solvents, besides other favorable characteristics. Typical applications include arc barriers, switchboard panels, and circuit-breaker parts in electrical installations.


Silicone Laminates. Continuous-filament woven glass fabric impregnated with a silicone resin. These laminates combine high heat resistance (up to $500^{\circ} \mathrm{F}$. continuous) with excellent electrical and mechanical properties. They are primarily used in high-temperature electrical applications and high-frequency radio equipment.
Epoxy Laminates. Continuous-filament woven glass fabric or paper impregnated with epoxy resin. Glassfabric grades are designed for use in applications requiring high humidityresistance, good chemical resistance,

and strength retention at elevated temperatures. Paper grades are used under high-humidity conditions where resistance to acids and alkalis is required. Both grades are characterized by good dielectric strength, low dielectric losses, and high insulation resistance even following severe humidity conditions.

Recent technical advances in the bonding of various metallic and nonmetallic materials to laminated plastics have opened up new design opportunities. It is now possible to bond virtually any compatible material with a laminated plastic to form a composite which combines the advantages of both. One of the first composite materials was a copper-clad laminate used for printed circuits. More recent composite laminates, usually manufactured to customer specification, include the following: Taylorite ${ }^{\text {² }}$ vulcanized fibre-clad, rubber-clad, asbestos-clad, aluminumclad, beryllium-copper-clad, stainless-steel-clad, magnesium-clad, and silverand gold-clad. Any one of these materials can be sandwiched between sheets of laminates, too, and can be molded to fit specific requirements.
Send for complete information about any or all of these Taylor laminates. And remember Taylor's new selection guide will simplify your problems in choosing the right laminate for your specific application. Taylor Fibre Co., Norristown 40, Pa.

# AVAILABLE NOW FROM TI 100:1 miniaturization with <br>  semiconductor networks 

Now-3 years ahead of industry's expectations Solfd Circuit semiconductor networks from Texas Instruments for many of your high-reliability miniaturized systems!
Solid Circuit networks are a major departure from conventional components because they integrate resistor, capacitor, diode, and transistor functions into a single high-purity semiconductor wafer. Protection and packaging of discrete elements is eliminated, and contacts between dissimilar materials are minimized, reducing element interconnections as much as $80 \%$. Fabrication steps have been reduced to one-tenth those required for the same circuit function using conventional components.

## SEMICONDUCTOR NETWORK CONCEPT

The concept of a semiconductor network is the relation of conductance paths in a semiconductor to the classical circuit elements, establishing an orderly design approach based on circuit knowledge. In this manner, semiconductor networks may be designed to perform the functions of a wide variety of existing circuits. Through the proper selection and shaping of semiconductor conductance paths, it is possible to realize such electronic functions as amplification, pulse formation, switching, attenuation, and rectification.

An assembly of 13 Solld Circuit networks, actual size, performs a full serial adder function, replacing 85 conventional components with a $100: 1$ size reduction. Weight: 1.5 gm . Volume: 0.02 cubic inch.


## *Trademark of TEXAS INSTRUMENTS INCORPORATED

Only a few process steps and time-proved TI mesa production techniques permit a high degree of process control in Solid Circuit network fabrication. The result of these facts: reliability is built into each Solid Circuit network.

If you need to reduce equipment size and weight-or to design a more complex system in the same size-investigate Solid Circuit networks for your missile, satellite, space vehicle, and other microelectronic programs. TI engineers are ready to custom design this concept to your requirements. Cnntact your nearest TI Sales Engineer today. The TI Type 502 Solid Circuit network is immediately available for your evaluation.


DC to 1 KMC
Attenuation: 1 to 20 db 50 Ohms

Connectors: Type $\mathrm{N}, \mathrm{Y}$ male, 1 female
High stability, low frequency sensitivity
Power Sensitivity: Less than .1 $\mathrm{db} / 10$ watts
Calibration Frequencies: $D C, 400$ $\mathrm{mc}, 750 \mathrm{mc}, 1000 \mathrm{mc}$
Finish: Stainless steel connettors; black anodized aluminum body


Complete specificotions upon request. Weinschel Fixed Cooxiol Attenuotors cover the frequency ronge of DC to 12.4 KMC. Write for complete cotalog.
Weinschel Engineering KENSINGTON. MARYLAND

## WASHINGTON OUTLOOK

Collapse of the Paris summit talks and renewal of international tensions make it certain that Congress will boost the new defense budget. Senate insiders talk about an increase of some $\$ 1.5$ billion. Before the summit failure, the House voted an appropriation running only $\$ 122$ million over the Administration's request, made some major overhauls in the spending plans.

So far the Administration is sticking to the line that the heightening of world tensions should have no impact on military spending, that the new defense budget was drafted under the assumption the summit conference would produce no easing in military requirements.

But in the Pentagon background, the professionals are already beating the drums for more money. Gen. Thomas White, the Air Force chief of staff, for instance, told the Senate Appropriations Committee the latest turn in U.S.-Soviet relations justifies a two-squadron increase for the Atlas ICBM program.

Some Washington officials caution against any dramatic boost in defense spending, argue that such action would spur a new round of hostile measures by the Russians. Their point is this: U.S. deterrent power is already solid and the Russians respect this might.

But political reaction runs the other way. The outlook is for increased funds to be voted for a wide variety of projects.

The House has already approved extra money for Polaris submarines, the Minuteman ICBM, an airborne bomber alert, military satellites, transport aircraft, and modernization of Army equipment.

But these increases were offset by cutting the Bomarc-B missile and a super aircraft carrier and by a hefty $\$ 400$-million cut in general procurement funds.

As things shape up now, the Senate will probably restore the funds cut out, increase even further the projects accelerated by the House, and vote extra money for the Air Force's gutted B-70 program.

LICENSING OF COMMUNITY ANTENNA SYSTEMS has been killed for this session of Congress, under heavy lobbying by some operators. With backing of a number of western senators, they argued that it would be unnecessary government regulation of private business. They also objected to being licensed when other forms of broadcast relay, by boosters or translators, are not.

Broadcasters are eager to get community antennas brought under FCC control. They are particularly worried about western cities with only one station, which may have a hard time surviving if community antennas bring in several competing channels from distant cities.

The bill was sent back to committee by a 39-38 vote after two days of hot debate. The House Commerce Committee immediately announced it will go ahead with hearings on licensing of vhf-tv boosters-already passed by the Senate.
UNION ORGANIZING among professional engineers was dealt a blow when Western Electric Company engineers rejected labor union representation.

Loss of the election may, in the long run, boost the efforts of production unions to sign new professional members.

The election was held among 51 Western Electric units in 14 states and 20 locations abroad. It was the largest election ever conducted among professional employees by the National Labor Relations Board.

Out of 6,750 professional engineers eligible to vote, 3,970 voted against representation by the union, 2,603 voted in favor.

## Measure dc currents

 0.3 ma to 1 ampere
## with

## No Breaking of Leads No DC Connection No Circuit Loading



428A CLIP-ON

## We've changed our name to

 The Bendix Corporation

To reflect our dynamic growth in such fields as electronics, missiles and space, automotive, weapons systems, computers, machine tools, instrumentation, nuclear technology, hydraulics, meteorology, electrical, marine and others, we dropped "Aviation" from our corporate name on June 1, 1960. We do not wish to convey the impression that our products and skills are limited to the aviation field alone, although aviation products accounted for billings of $\$ 388,700,000$ in 1959.

Today Bendix -through 25 divisions and 16 subsidiary and affiliate companies around the world serves many fields.

Our success in the rapidly expanding age of aviation has long obscured the fact that the Bendix automobile starter drive was the company's first major product. Bendix introduced the type of four-wheel brakes that over the years has been used on most makes of cars. Bendix also pioneered automotive power brakes and power steering. Our automotive business in 1959 totaled $\$ 114,300,000$.

A notable trend in Bendix' recent history is the utilization of electronics in many of our major fields of activity. These range from automobile radios to aircraft and industrial communications and automatic flight controls . . . from electronic computers and data processing to numerical tape control systems for machine tools . . . and from transistors and ship-toshore telephones to sonic cleaning and undersea sonar detection equipment. Approximately $40 \%$ of Bendix products are electronic, including air defense radar which today guards 25 million square miles.

Missile and space equipment
A thousand

accounted for $\$ 103,000,000$ of our total business of $\$ 689,692,312$ in 1959 . In addition to being the prime contractor for two important missiles, Talos and Eagle, we are also a supplier of components and sub-systems for most U. S. missiles. Bendix is likewise taking an active part in Project Mercury and in satellite communications. The first is the program to puty a man into space. The second will mark a new era in communications by using a satellite in orbit as a relay station for global radio messages.

Bendix also has a growing and diversified, nuclear program. Since 1949 we have operated the Kansas City Division for the Atomic Energy Commission It is a large manufacturing organization employing 7,500 people engaged in the atomic weapons program. We also supplied control mechanisms for nuclear submarines and nuclear industrial power plants, and we are playing a part in developing the newest U. S. atomic power plants for aircraft, missiles and space vehicles.

Thus, as we drop "Aviation" from our corporate name, but not from our programs, we face a tomorrow where the range of our opportunities is broadening at a breathtaking rate.
diversified products

## Reliability in volume...



## a new pattern in semiconductor

 progress...

## SHOCKLEY TRANSISTOR JOINS CLEVITE

In keeping with its program of advancement in semiconductors, Clevite has acquired the Shockley Transistor Corporation of Palo Alto, California.

Dr. William Shockley, noted solid state physicist and co-winner of the 1956 Nobel Prize for his work in the development of the transistor, joins Clevite, together with his research and development organization.

## NEW PRODUCTS

In addition to Clevite Transistor's broad line of diodes and transistors, the corporation now offers to the industry Shockley devices which represent new advances in the semiconductor art. The Shockley 4 -layer diode is a nearly ideal switch for pulse generation, pulse counting and high
power switching in such applications as computers, telephone and control circuits. A new plant in Palo Alto, California, is underway to fill the growing demand for these new devices.

## NEW PLANTS

Besides the new plant for the Shockley organization in California, Clevite Transistor is nearing completion of its new $\$ 4,000,000$ Waltham, Massachusetts facility which will employ 2,000 people. The present Waltham plant will continue as a supplementary operation. Clevite's overseas operation, Intermetall G.m.b.H., now employs 1,000 people in a new plant at Freiburg, West Germany to serve the European market.

To.find out more about our progress and our products, urite:

A division of CLEEVITE

## NEW ELECTRO INSTRUMENTS

 HIGH-SPEED, ALL-ELECTRONIC, Analog-To-Digital CONVERTERS 1000 measurements per second!Transistorized circuitry, one millisecond conversion rate, one megohm input impedance, automatic polarity, one digit sensitivity and resolution


#### Abstract

These new 7000 Series High-Speed, Analog-To-Digital Converters and Digital Voltmeters accept both positive and negative input voltages and produce binary coded decimal descriptions of their magnitude and polarity. This determination is arrived at by the successive approximation method. Bits are sampled as a function of an internal clock and are successively tried and accepted or rejected. Encoding time is always a fixed millisecond. Output can be applied directly to indicators for visual readout and also to auxiliary devices for controlling entry into recorders and computing systems. The constant encoding time and programmed ranging features make the 7000 Series ideal for systems applications.


Ask your EI Sales Engineer for complete specifications.

[^0]

# At The Ramo-Wooldridge Laboratories... integrated programs of research \& development of electronic systems and components. 

The new Ramo-Wooldridge Laboratories in Canoga Park provide an environment for creative work in an academic setting. Here, scientists and engineers seek solutions to the technological problems of today. The Ramo-Wooldridge research and development philosophy places major emphasis on the imaginative contributions of the members of the technical staff. There are outstanding opportunities for scientists and engineers. Write Dr. Richard C. Potter, Head, Technical Staff Development, Department 21-F.

THE RAMO-WOOLDRIDGE LABORATORIES
8433 FALLBROOK AVENUE, CANOGA PARK, CALIFORNIA


An electron device permits scientists to study the behavior of charged dust particles held in suspension.

## Hughes, Nippon Electric Form Company

Hughes Aircraft and Nippon Electric in a joint disclosure announce establishment of a new firm called Japan Aviotronics. The new company, which will manufacture and overhaul fire-control systems, has been provided with a $\$ \frac{1}{2}$ million capitalization by the two parent firms. In addition to its work in fire-control systems. the new Japanese company will produce Hughes' line of aviation instruments, as well as germanium and silicon diodes.

Trygon Electronics, Inc., Roosevelt, L. I., N. Y., reports the venture capital firm of Payson \& Trask, N. Y., has invested $\$ 75,000$ in it. The company designs and manufactures a line of precision regulated power supplies for laboratory systems and automatic checkout applications. The Long Island company markets more than 150 different power supply models on a nationwide basis.

## Electralab Printed Electronics

 Corp., Needham Heights, Mass., announces acquisition of the assets of Minitron, Inc., Encinitas, Calif., printed-circuit manufacturer. Acquisition is through a cash and stock transaction. The Minitron operation will be merged with EPEC, subsidiary of Farrington Mfg., thus establishing the company on the west coast. The Massachusetts company was formed in 1959 by the merger of Printed Electronics Corp., Natick, Mass., and Farrington's Electralab, Inc.Lockheed Electronics Co., Los Angeles, reports cash purchase of Waldale Research Co.. Pasadena, Calif., for an undisclosed amount. Formerly a wholly-owned subsidiary of Consolidated Metal Products Co., Albany, N. Y., Waldale manufactures load cells, strain gages, position transducers and force gages for military and industrial applications.

North Electric Co., Galion, O., an-
nounces acquisition of control of Power Equipment Co. in the same city. North manufactures telecommunications and automatic control equipment. Power produces power supplies for computers and other electronic-electrical applications. North will acquire approximately 90 percent of the 600,000 outstanding shares of Power, according to company officials. They add that at the purchase price of $\$ 7.50$ a share, this represents an investment of slightly more than $\$ 4$ million. Combined gross sales of the affiliated companies is reported in excess of $\$ 31$ million.

Litton Industries reports purchase of Servomechanisms (Canada) Ltd., Toronto. The Canadian company, formerly a subsidiary of Servomechanisms, Inc., Los Angeles, develops and makes electronic equipment for airborne systems. Plans call for special emphasis on advanced systems, including inertial guidance equipment for the Lockheed CF-104 fighter-bomber for the RCAF.

## 25 MOST ACTIVE STOCKS

|  | WEEK ENDING MAY 20 |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | SHARES <br> (IN 100's) | HIGH | LOW | CLOSE |
| Avco Corp | 2,043 | 145/8 | 123/8 | 131/2 |
| Int\| Tel \& Tel | 2,026 | 45 | 411/4 | 441/8 |
| Raytheon | 1,886 | 481/2 | 411/2 | 435/8 |
| Gen Inst | 1,848 | 38 | 333/8 | 345/8 |
| Lear Inc | 1,576 | 20 | 161/8 | 175/8 |
| Sperry Rand | 1,348 | 247/8 | 231/4 | 235/8 |
| Univ Controls | 1,288 | 161/4 | 131/2 | 161/4 |
| Gen Transistor | 1,221 | 261/2 | 2036 | 243/8 |
| Collins Radio | 1,145 | 62 | 545/8 | 571/8 |
| RCA | 1,115 | 771/2 | 75 | 751/4 |
| Eltronic Ind | 1,105 | 156 | 11/8 | 15/8 |
| Litton Ind | 1,042 | $863 / 4$ | $771 / 2$ | 813/4 |
| Standard Coil Prod | 1,034 | 163/4 | 141/2 | 16 |
| Ampex | 1,008 | 373/8 | 341/2 | 351/8 |
| Varian Assoc | 992 | 56\% | 513/4 | $521 / 2$ |
| Westinghouse | 773 | 581/4 | 54 | $563 / 4$ |
| Gen Electric | 695 | 911/4 | 873/4 | 901/4 |
| Transitron | 690 | 507/8 | 45\% | 461/8 |
| Amer Bosch Arma | 638 | 241/2 | 211/8 | 221/8 |
| Compudyne | 604 | 1378 | 101/8 | 121/4 |
| Burroughs | 595 | 371/4 | 351/8 | 363/6 |
| Barnes Engn'rg | 555 | 483/8 | 39 | 453/4 |
| Reeves Sndcrft | 551 | 95/8 | $81 / 8$ | 81/2 |
| Siegler Corp | 551 | 41 | $381 / 4$ | $381 / 2$ |
| Amphenol Borg | 505 | 491/2 | 441/2 | $461 / 2$ |

The above figures represent sales of electronics Stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for Electronics by Ira Haupt \& Co., investment

Another of a series of files on precision products by ALINCO


## DIFFERENTIAL DC AMPLIFIER Model 516

- WIDE FREQuency RESPONSE
- high output
- totally transistorized

Designed to meet a need for a flexible general-purposedifferential dc amplifier, the ALINCO Model 516 is a solid state wide band instrument. Chopper stabilized, the Model 516 features low noise of 14 microvolts rms over the full bandwidth. It has a common mode rejection of 130 db at dc and 90 db at 60 cps . The gain factor is continuously variable from $10-2000$ with an accuracy of $0.5 \%$;overload recovery time is less than 1 second and the chopper intermodulation $0.1 \%$. Maximum output is 80 ma at 10 v . The amplifier can faithfully reproduce signals from dc to 40 kc . Available as a single channel portable unit, or in an 8 channel module for rack mounting. Size: $21 / 8^{\prime \prime} \times 7^{\prime \prime} \mathrm{x}$ $18 \frac{1}{4} 4^{\prime \prime}$. Is ideally suited for driving high frequency galvanometers from a low level source such as resistance strain gages and thermocouples.
For additional information on the Model 516 amplifier or for the answer to a specific amplifier requirement, write:


Allegany Instrument Company, Inc. Dept. A , 1091 Wills Mountain Cumberland, Maryland Regional Sales Offices: Palo Alto, Calif. - WashingIon, D. C.

## TaMpuay doMPLETE PANEL METER

BAR-RING TYPE MOVEMENTS (Exclusively Triplett)

- Self Shielded
- Not affected by magnetic panels ar substantially by stray magnetic fields.
- More Torque
- Lower Terminal Resistance
- Faster Response
- Exceedingly Rugged and Accurate
- All Case Sizes





 or $167, \mathrm{P}$

 Dip 361


Rectangular Flush Mounting $\left(2^{3 / 0^{\prime \prime}}\right)$ Model DC 227-T, AC 237-S, RF 247 - $T$


Rectangular Flush Mounting (4 \%/a") Model: DC $420-\mathrm{PL}, \mathrm{AC} 430$-PL, RF $440 . \mathrm{PL}$


Rectangular Flush Mounting ( $2^{\left.19 / 22_{2}\right)}$
Model: DC 227-PL. AC 237.PL,
RF 247 -PL


Rectangular Flush Mounting ( $6^{\prime \prime}$ ) Model: DC 626, AC 636 , RF 646


Meativiuler Mrelt M ovasiny (30) Dy 1012

## LINE FULLY MEETS YOUR NEEDS

The name TRIPLETT has been on instruments of our manufacture for more than 55 years, and is regarded as a symbol of customer satisfaction to industrials and distributors in all parts of the world. Our instruments can be built to customer
specifications or provided from our large stocks of standard ranges in hundreds of sizes and types. We also carry in stock many semi-finished movements which can be converted readily to special customer needs.


Beathanguiler Mlachi Mowntrole (4)w




Model 420-U Unimeter 41/2" with mirror scale



Model 354 Relay


Tilting Case Portable Model: 325 (DC), 335 (AC)


Model 234 Unimeter Stand



Nedel 420 VU Exentor
Type A Scel.

MMalded Cese 4.7Fteme Partilles
Medet 625 (DC), 635 (AC).

# Computer Sales to Quadruple by ' 65 



COMPUTER MANUFACTURERS look for a sharp rise over the next five years in sales of digital computers to industrial, commercial and non-military government markets.

Sales estimates for 1965 range between $\$ 1.8$ billion and $\$ 2$ billion. Estimates for 1960 sales vary from $\$ 0.4$ billion to $\$ 0.5$ billion.

Because of the variety of ways in which computer sales are compiled, estimates are meaningful only after definition. Above figures represent factory value of computers leaving manufacturers' plants and without regard to method of sales. Service center computers are included, as well as value of auxiliary input and output equipment.

Current forecasts are much higher than those made a year ago. Big reason for the increased optimism is the number of new applications and new markets opening up.

One manufacturer figures cumulative five-year purchases of computers by banks for use with magnetic ink check handling systems will total $\$ 0.8$ billion to $\$ 1.2$ billion. This is equivalent to one-third to one-half of the total check handling equipment market. Bank computer boom is expected to start shortly, with first orders coming from big banks.

Another new major market is computers for process control and production scheduling. Also usually in this group are computers for air traffic control. Today sales total only a few million dollars. By 1965 sales are expected to be between $\$ 300$ million and $\$ 400$ million.

Sales of computers for control and production scheduling could be much higher than predicted. Deci-
sion to purchase is based on such factors as more efficient use of productive capacity and materials, rather than labor saving. Market is limited by computer sellers' ability to demonstrate worthwhile efficiency improvements and is not tied to the number of people employed.

Computers for use in service centers are expected to appear prominently in tomorrow's sales picture. Says one manufacturer: "We can't measure it, but we are confident that it is a real big market."

By the end of the decade, sales of computers for information retrieval and for many applications not even known today are expected to be significant.

Some persons anticipate annual computer sales will be as high as $\$ 3$ or $\$ 4$ billion by 1970 .

Japanese 1959 electronics production set record of $\$ 936$ million, almost twice 1958 output of $\$ 498$ million, BDSA reports.

Leading items produced last year were: tv receivers- $\$ 335$ million, radio receivers- $\$ 157$ million, receiving tubes- $\$ 72$ million, picture tubes- 59 million and tran-sistors- $\$ 45$ million.



RCA's entire line of Silicon and Germanium Transistors and Silicon Rectifiers is now as close as your telephone and can be obtained at factory low prices in quantities up to 999. The new "Drift Field" types...Thyristors, exciting new bi-stable switching transistors...the High Power, Intermediate Power and Medium Power Silicon Transistors featuring exceptionally low-saturation resistance...are just a few examples of the rapidly expanding line of RCA Semiconductor Products you can now quickly and conveniently order from your nearby RCA Semiconductor Distributor. And don't forget these extra benefits a call to your RCA SEMICONDUCTOR DISTRIBUTOR will bring to you:

- Prompt delivery of the latest RCA types for your evaluation
- Orders filled from factory.fresh stock
- Up.to-date, practical product information
- Valuable technical assistance when you need it
- "One-stop" service on your orders
- Specialists who understand your problems and your electronic needs

The Most Trusted Name in Electronics radio corporation of america

## WHAT'S WRONG WITH THIS TELEGRAPH SIGNAL?

## ... and how do you find out without interrupting traffic?

The answer to the second question is Radiation's TDMS-Telegraph Distortion Measurement System-a compact, self-contained unit for on-line testing, analysis and monitoring of telegraph and data transmission links.

The TDMS detects, measures and analyzes signal distortion on a continuous basis, alerts even a non-technical operator that a circuit is deteriorating. Thus pinpointed, the malfunction (a badly-tuned receiver in a radio link, for example) can often be corrected with little or no circuit downtime.

For detailed information on the TDMS, write for Bulletin RAD EL-6 to Radiation Inc., Melbourne, Fla.

WHAT'S WRONG WITH THE SIGNAL SHOWN ABDVE? Character (letter R) shows a split 4th element, a result of poorly adjusted transmitting equipment. Spiral trace disploy on Telescon CRT (at left) indicates the presence, and analyzes the noture of characteristic distortion.
the electronics field also relies on radiation for...
RAOIPLEX-50-channel low-level multiplexer with broad data pracessing applications. Features rugged solidstate circuitry, almast unlimited programming flexibility, unique modular construction for compactness and exceptional ease of operation and maintenance.

RAOICOROER-Multistylus recorder provides high-speed instantaneous readout for wide range of data acquisition or processing systems. Eliminates necessity of electronicaliy translating complete data, thereby reduces computer work loads.
TELEMETRY TRANSMITTER-Model 3115 is a ruggedized 215-260 MC unit with extremely linear FM output under the most severe environmental conditions. With its record of outstanding performance in many missile progroms, Model 3115 is specified by leading missile manufacturers.

RADIATMON
INGORPORATED

## IN MINIATURE

# SILICON <br> CONTROLLED 

## FROM SOLID STATE

## For control circuit application in the 10 to 1250 ma output current range

## - HIGH SENSITIVITY

only 2 mA input to control one ampere (continuous) at $100^{\circ} \mathrm{C}$.

- HIGH TEMPERATURE stable operation to $150^{\circ} \mathrm{C}$.
- LOW LEAKAGE 10 ufA cutoff current at full voltage.
- SIMPLIFIED MOUNTING
no need for insulating hardware stud is electrically isolated.


These devices offer significant circuit advantages in that they are specifically designed for operation in the 10 to 1250 mA current range. It is no longer necessary to derate higher power units, with attendant losses in efficiency.
The miniature SCR combines a current rating of 1 ampere at $100^{\circ} \mathrm{C}$ with extremely small size. It fatres high peak recurrent and surge current ratings. Switching efficiency up to $98 \%$ is practical. High gain, low loss control of loads up to 300 watts can now be achieved along with significant miniaturizaton. The internally insulated junction eliminates the need for external mica washers. Assembly is therefore simplified and reliability improved.
The miniature SCR is useful in applications such as AC and DC static switching, proportioning control, D.C. to D.C. converters, servo motor driving, squib firing, protective circuits, and related applications.
Encapsulated in the unique SSPI cold welded copper case, the SCR offers a high degree of mechanical ruggedness and long term reliability.


## Has every form of silver for your electronics applications

Silver, in many forms and alloys, is a necessity in the electronics and electrical industries. To meet this need on a high quality level, Handy \& Harman manufactures powder, flake, paint, paste, sheet, strip, wire, etc., for printed circuits, wiring, resistors, condensers, thermistors, contacts, printed terminal strips on glass, ceramics, plastic laminates, etc.

Another "At Your Service" Division of the Handy \& Harman Silver Supermarket is our Research and Engineering Department. Always ready to help you with any problem or project you may have involving silver for any application.

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We have five Technical Bulletins giving engineering data on the properties and forms of Handy \& Harman Silver Alloys. We would like you to have any or all of those that
particularly interest you. Your request, by number, will receive prompt attention.
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Silver-Copper Alloys alletin A-1
-Copper Alloys . . . . . . . . . . . . . . . . . . . . . Bulletin A-2
Silver-Magnesium-Nickel . . . . . . . . . . . . . . . . . Bulletin A-3
Silver Conductive Coatings . . . . . . . . . . . . . . Bulletin A-4
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## Your No. 1 Source of Supply and Authority on Precious Metal Alloys <br>  <br> HANDY \& HARMAN

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| Specifications | Low Voltage |  |  | High Voltage |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{gathered} \text { Model } \\ \text { PS4305M } \end{gathered}$ | $\begin{gathered} \text { Model } \\ \text { PS4315M } \end{gathered}$ | $\begin{gathered} \text { Model } \\ \text { PS } 4330 \mathrm{M} \end{gathered}$ | $\begin{gathered} \text { Model } \\ \text { PS4221M } \end{gathered}$ | $\begin{gathered} \text { Model } \\ \text { PS4231M } \end{gathered}$ | $\begin{gathered} \text { Model } \\ \text { PS4222M } \end{gathered}$ | $\begin{gathered} \text { Model } \\ \text { PS4232M } \end{gathered}$ |
| Voltage Range (VDC) | 0.36 | 0.36 | 0-36 | $30-210$ | 120-330 | 30-210 | 120-330 |
| Current Range (Amps) | 0.5 | 0.15 | $0-30$ | $0 \cdot .1$ | 0.1 | 0-1.5 | 0-1.5 |
| Regulation Against $\pm 10 \%$ Line change 0 to full load | $\begin{array}{r} .025 \% \\ .05 \% \end{array}$ | $\begin{array}{r} .025 \% \\ .05 \% \\ \hline \end{array}$ | $\begin{array}{r} .025 \% \\ .05 \% \\ \hline \end{array}$ | $\begin{aligned} & 0.1 \% \\ & 0.1 \% \end{aligned}$ | $\begin{aligned} & 0.1 \% \\ & 0.1 \% \end{aligned}$ | $\begin{aligned} & 0.1 \% \\ & 0.1 \% \end{aligned}$ | $0.1 \%$ <br> $0.1 \%$ |
| Impedance (Ohms) DC to 100KC | . 1 | . 02 | . 02 | . 4 | . 4 | . 2 | . 2 |
| Ripple (RMS) in Millivolts | 1 | 1 | 1 | 2 | 3 | 2 | 3 |
| Panel Height | 51/4" | $51 / 4^{\prime \prime}$ | 83/4" | $51 / 4^{\prime \prime}$ | 51/4" | 51/4" | $51 / 4^{\prime \prime}$ |
| Price (See Notes) | \$545 | \$890 | \$1190 | \$555 | \$620 | \$580 | \$645 |
|  | Note 1: If meters not desired deduct $\$ 30$ and drop " $M$ " from model number. <br> Note 2: If fixed output desired ( $\pm 5$ volts) deduct $\$ 40$ and add " $F$ " to model number followed by nominal output voltage desired. |  |  |  |  |  |  |

Write for complete specifications

## Specify power sources by

 POWER SOURCES, INC.BURLINGTON, MASSACHUSETTS

## Better Environmental Design



## SILAGTIL' <br> SICICONE FUETER

## Cushions Electronic

 Packages at -90 to 250CWhere environmental conditions are extreme, or fluctuate from one extreme to another, specify resilient Silastic to protect sensitive components. Silastic, the Dow Corning silicone rubber, is not affected by temperatures from - 90 to 250 C ( -130 to 500 F ), nor by rapid thermal cycling. It retains its excellent dielectric and physical properties . . . resists the effects of ozone, storage, moisture, corona.

For these reasons, Silastic was selected by engineers of the Emerson Electric Manufacturing Company, St. Louis, for several parts of the electronics package shown. Part of the fire control system on Convair B-58 Mach 2 bombers, this unit must function at -65 F . . . continue to function dependably despite vibration and operating temperatures up to 350 F around the miniature tubes. A molding of heat resistant Silastic holds the tubes gently but firmly to protect them from vibration and shock. Silastic grommets, feed-throughs, and connector insulation are also part of the package. In any climate and under any environments, Silastic gives required protection to Emerson's assemblies.


Wire That STRETCHES
Like a stretch-to-fit sock, this snappy new product extends itself to meet your needs. Available with insulation of Silastic, it is called Stretch Wire, and is manufactured by the Stretch Wire Corporation.
Stretch Wire elongates to $165 \%$ of its original length . . . then springs back. It has already proven itself in missile and ordnance electronics, withstanding launchings at speeds of 1000 fps and inertia loads of 800 G's. Because of the properties of Silastic, the insulating sheath remains elastic under the temperature extremes encountered. and technical service on silicones.


## ...silicones provide lasting protection



## Laminate Parries Lightning Thrust

Long range HF communication systems employing probetype antennas are now safe from lightning strikes with the new Aircraft Lightning Arrester made by Joslyn Manufacturing and Supply Company, Chicago.
Key component: a 0.0625 inch thick slotted silicone-glass laminate part that serves as retainer and insulator for 15 phosphor bronze spring elements. Made of Dow Corning silicone resins and glass cloth, this part enables the arrester to safely discharge lightning strokes with a peak current of 100,000 amperes and 200 coulombs charge. The silicone laminate is strong, resists moisture, vibration and fungus growth, and is inexpensive to fabricate. Electric strength is . . . obviously . . . excellent.

CIRCLE 290 ON READER SERVICE CARD

## 997 Varnish Ups Power, Cuts Weight

When designing transformers to operate at high temperatures in standby control power supplies for submarine nuclear reactors, Milro Controls Co. faced three major musts: maximum power output for minimum weight; great resistance to moisture; ample overload protection.
Impregnating with Dow Corning 997 Varnish, and using silicone insulating components, proved to be the right answer on all three counts. This silicone varnish withstands operating temperatures up to $250 \mathrm{C} .$. provides superior protection against all the well-known enemies of electronic and electrical equipment. Each of the new Milro power supplies contains three compact, light-weight transformers, impregnated with 997.

CIRCLE 292 ON READER SERVICE CARD


## New Gel Gives "View-Through" Protection

Poured as a liquid, transparent Dow Corning Dielectric Gel fills all voids, then sets up to form a heat stable gel. Dielectric strength is excellent; stress on components almost nil. Potted components and circuitry remain clearly visible . . . can be checked by eye. Probes can be inserted for instrument checks . . . the gel re-seals itself when probes are removed. Individual components can be removed and replaced.
Dielectric Gel enabled CBS Laboratories to meet stringent reliability requirements on its Photoscan power supplies. Despite high temperatures, high voltages, and high vibration levels in this remarkably small unit, Dielectric Gel prevents arcing. Components are spaced less than $1 / 4^{\prime \prime}$ apart, yet output voltages run from 1,000 to 25,000 volts!

CIRCLE 291 ON READER SERVICE CARD


## Far-Reaching $\$ 2$ Million

FCC proposes to locate a uhf television station in New York City. Experiment could brighten uhf's future


Empire State Building tower may see a uhf-tv antenna added to these vhf arrays, if Congress grants the money

PLANS TO SPEND $\$ 2$ million to find out conclusively whether or not uhf television can be rejuvenated are now being considered in Washington.

The plan is credited to FCC Commissioner R. E. Lee. Other commissioners supported his $\$ 2,250,000$ idea and the request was presented to Congress.

Late last month the House Appropriations Committee gave it the green light after trimming the figure to an even $\$ 2$ million. The proposal is before the Senate Appropriations Committee as ElecTRONICS goes to press.

## Funds By July?

Hopes in Washington are high that approval will be granted. At least two senators on the committee have past records favorable to the project. Sen. Magnuson (D-W ash.) has often urged FCC to conduct more of its own research and not to rely on industry. Sen. Pastore (DR.I.) has, in the past, shown himself to favor uhf. Presidential approval, if granted, would mean funds by July of this year.

If approval is given, Commission researchers will be drawn from industry on a contract basis similar to the type of research contracts awarded by the military. Commissioners feel the tests would be a one-time affair and are reluctant to increase FCC payrolls on a permanent basis to get the technical people they will need.

Plans call for setting up the experiments in New York City, with transmissions coming from the Empire State Building. Building officials say room can be found for the antenna.

Commissioners have resisted suggestions that experiments be tried in some city already having an active uhf station. Typical of their thinking is the statement by Commissioner T. A. M. Craven before the House Appropriations Committee: "If it (uhf-tv) works in New York, the chances are it will work any place else in the country."

## Uhf-Tv Study Planned

The suggestion that Pittsburgh's educational uhf station be used was flatly turned down.

At first, some Representatives balked at the idea of financing the project with government funds. A question put to Commissioner Lee during the hearings was: "Is there any reason why the industry should not pay for the cost?"

Lee's answer was: "On this particular problem, the reason for setting up of TASO-(Television Allocations Study Organization) which has 104 men from industry, largely the same group that developed color standards-was to help us on this very problem (uhf-tv) This was one of the objectives. By reason of the fear of antitrust implications, the final result from this industry committee did not give us the answers that we expected to get."
Although figures have not been fixed, FCC has a good idea how most of the money will be spent. Some funds will go for transmitting equipment. This would run to about $\$ 446,000$ if transmitters are leased, and might rise to $\$ 688,000$ if they are purchased outright. Informal talks have been held with General Electric and RCA on this, but FCC spokesmen say this does not rule out other possible suppliers.

Station construction will run to about $\$ 285,000$, according to Commission estimates. Operating costs are expected to be in the neighborhood of $\$ 200,000$.

## Receiver Development

According to W. C. Boese, chief of the FCC technical research division, receiver development will come to about $\$ 250,000$. He adds that there have been no discussions on receiver development with possible suppliers.

He did, however, tell ElecTronics that the Commission intends to explore new developments not now incorporated in home receivers. A strong possibility exists that some of the receivers might be

European. Mentioned in this connection are Valvo, N.S.F., Siemens \& Halske, and Philips.

Actual production of 100 receivers for use in the study project is planned. The special-purpose sets are expected to cost about $\$ 195,000$, with the tab for installation and observation to be in the neighborhood of $\$ 86,000$.

Commission spokesmen feel there are enough commercially available uhf receivers in the New York City area to fill in any additional observation requirements that may arise.
Highly interested in the project is New York's station WNYC, a municipally operated installation.

This station holds the construction permit for uhf channel 31.

From talks with station manager Seymour Siegel, Electronics learns that many sources of program material are interested in participating in the study. He feels community interest will run high, due to the belief there are a number of vhf-uhf sets in the New York City area.

He points out that the number of master antennas on multiple dwellings in the city will make provisions for uhf reception simpler for a greater number of people than would be possible in nonurban areas.

## A Key to 10KMc Tunnel Diode?



PACKAGED miniaturized tunnel diodes capable of oscillating at 4,000 Mc are now available with 10,000 Mc units a distinct possibility, say officials at Sylvania Electric Products, Inc., manufacturer and marketer of the diodes.

The company indicates the increased frequency range results from two factors: A unique etching process and a low inductance packaging technique.

The photograph shows an enlarged cross-sectional view of the packaged diode which is used in
microwave stripline and cavity applications. Scientists at General Telephone and Electronics Laboratories Inc., where the device was developed, designed the case for operation up to 10 Gc . They believe that once some contact problems are solved, 10 Gc tunnel diodes will be a reality.

Other manufacturers are working on the packaging problem. Some hint that they will not employ new packages until industrywide standards have been established.

Our instruments, 40 to 30,000 cycles, are used extensively by industry and on government projects where enduring accuracy and maximum durability are required. Your inquiries on related products are invited.

## PRECISION FORK OSCILLATOR UNITS

## TYPE 2003

Size 1 1/2" dia. $x 4^{1 \text { I/ " }}{ }^{\prime \prime}$ H. Wght. 8 oz. Frequencies: 200 to 4000 cycles
Accuracies:-
Type 2003 ( $\pm .02 \%$ at $-65^{\circ}$ to $85^{\circ} \mathrm{C}$ )
Type R2003 ( $\pm .002 \%$ at $15^{\circ}$ to $35^{\circ} \mathrm{C}$ )
Type W2003 ( $\pm .005 \%$ at $-65^{\circ}$ to $85^{\circ} \mathrm{C}$ ) Double triode and 5 pigtail parts required. Input, Tube heater voltage and $B$ voltage Output, approx. 5 V into 200,000 ohms

## TYPE 2007-6

TRANSISTORIZED, Silicon Type Size 1 1/2" dia. x $31 / 2^{\prime \prime}$ H. Wght. 7 ozs.
Frequencies: 360 to 1000 cycles
Accuracies:
2007-6 $\left( \pm .02 \%\right.$ at $-50^{\circ}$ to $+85^{\circ} \mathrm{C}$ R2007-6 ( $\pm .002 \%$ at $+15^{\circ}$ to $+35^{\circ} \mathrm{C}$ W2007-6 ( $\pm .005 \%$ at $-65^{\circ}$ to $+85^{\circ} \mathrm{C}$
Input: 10 to 30 Volts, D. C., at 6 ma . Oútput: Multitap, 75 to 100,000 ohms

## TYPE 2001-2

Size $33 / 4^{\prime \prime} x 4^{1 / 2 "} \times 6^{\prime \prime} H$., Wght. 26 oz.
Frequencies: 200 to 3000 cycles
Accuracy: $\pm .001 \%$ at $20^{\circ}$ to $30^{\circ} \mathrm{C}$
Output: 5 V . at 250,000 ohms
Input: Heater voltage, 6.3-12-28
B voltage, 100 to 300 V ., at 5 to 10 ma .

ACCESSORY UNITS FOR 2001-2
L-For low frequencies
multi-vibrator type, 40-200 cy.
D-For low frequencies counter type, $40-200 \mathrm{cy}$.
H-For high fregs, up to 30 KC .
M-Power Amplifier, 2W output.
P-Power supply.


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c.
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z

## TYPE 2005A

Size $8^{\prime \prime} x 8^{\prime \prime} x 7^{1 / 4 \prime}$ High Weight, 14 lbs.
Freq̧uencies:
50 to 400 cycles (Specify)
Accuracy:
$\pm .001 \%$ from $20^{\circ}$ to $30^{\circ} \mathrm{C}$
Output, 10 Watts at 115 V
Input, 115 V . ( 50 to 400 cy .)

## PRECISION FREQUENCY-STANDARDS



TYPE 2121A

## Size

$83 / 44^{\prime \prime} \times 19^{\prime \prime}$ panel
Weight, 25 lbs.
Output: 115 V
60 cycles, 10 Watt
Accuracy:
$\pm .001 \% 20^{\circ}$ to $30^{\circ} \mathrm{C}$


Input,
115 V ( 50 to 400 cy .)

## TYPE 2IIIC

Size, with cover $10^{\prime \prime} \times 17^{\prime \prime} \times 9^{\prime \prime} H$.

Panel model $10^{\prime \prime} \times 19^{\prime \prime} \times 8^{3 / 4_{1}^{\prime \prime}} \mathrm{H}$. Weight, 25 lbs. Frequencies: 50 to 1000 cy . Accuracy:
( $\pm .002 \%$ at $15^{\circ}$ to $35^{\circ} \mathrm{C}$ )


Output: $115 \mathrm{~V}, 75 \mathrm{~W}$.
Input: $115 \mathrm{~V}, 50$ to 75 cy .
When requesting information, please specify type number

# OZALID NEWSLETTER 

NEW IDEAS TO HELP YOU WITH ENGINEERING REPRODUCTION AND DRAFTING


A simple sponge with new Duratrace is your quickest way to renew soiled drawings.

## New washable, scrubbable Duratrace ${ }^{\oplus}$ gives you indestructible masters you can sponge new!

If ever there was a drafting film that "is forever," Duratrace is it. New Ozalid Duratrace, when used with modern plastic pencils, can be wiped clean and thereby restored to new condition at the sweep of a sponge. Drawings, originally done in regular pencil or India ink, can also be cleaned, although a bit more care might be necessary.

Just combine this cleanability with
the fact that Duratrace never yellows or ghosts, and you've got a winner that's hard to match on any count. And how about this? Duratrace either exceeds or equals any other tracing material as far as dimensional stability is concerned!

Want even more? Just check Duratrace on acceptability of a pencil image! Never has a drafting film equaled New Ozalid Duratrace on
pencil acceptability. But the proof is really in the doing. There are intangibles that exist between a draftsman and his materials that are hard to fully describe. Only your own experience with Duratrace can completely convince you. We think that Duratrace has a certain "feel" that makes it a delight and a joy to work with. Hundreds of draftsmen agree with us. Why not try Duratrace today? Someday, someone might improve on this. Bet we'll be the ones to do it. On every count, doesn't it make sense to try Duratrace?

## If you like 'em stacked for speed...

Just check our Ozalid Streamliner 200 Direct Copy Machine.

Fast? A neat 14 feet per minute. Perfect for medium-sized operations and easy feeding.

Wide? A roomy 42 inches that takes four $81 / 2 \times 11$ sheets in a row, does them as fast as smaller machines do a single sheet.

And the new close-up controls of the 200 cuts operator fatigue; means anyone can learn to operate it in minutes.

New stacking system cuts work time considerably while the new cooling system means greater comfort for everyone in the office.

But these are just the basic facts of operation. How about versatility? The Streamliner 200 is specifically designed as a double-duty unit equally suitable for both engineering and general office work.

Just invest in one Streamliner 200 and get both an engineering and an office unit in one. You get the benefits of engineering speeds and width in your technical work plus a super high-efficiency unit for office copying and order invoicing.

One last plug. The Streamliner 200 costs a lot less than you would imagine. It costs less to operate and virtually nothing to maintain. Sold? Just contact your local Ozalid representative for a demonstration.


New styles from world's largest manufacturer of children's dresses arrive at fashion show fast . . . delivered by AIR EXPRESS

## "Cinderella" is first to market with Air Express

These youngsters are about to model the latest collection of "Cinderella" frocks for the junior set. This debut of new creations by Rosenau Brothers is the "Paris showing" of the children's market. New fashions often must bow at buyers' showings thousands of miles from the Philadelphia factoryjust hours after the last stitch was sewn-or lose a big order. That's why Cinderella takes no chances-ships by AIR EXPRESS regularly. Only lowcost AIR EXPRESS assures overnight delivery coast to coast. These advantages could tielp you, too! Call AIR EXPRESS and be FIRST TO MARKET...FIRST TO SELL.

## AIR EXPRESS

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One last plug. The Streamliner 200 costs a lot less than you would imagine. It costs less to operate and virtually nothing to maintain. Sold? Just contact your local Ozalid representative for a demonstration.

## ICBM HARD BASE:

This mammoth excavation, somewhere in the United States, will soon be a "hard base"-an almost invulnerable underground launch site for the Air Force titan Intercontinental Ballistic Missile.

It is an important element in the United States Air Force Strategic Air Command's mission-to prevent war.

The job of this titan hard baseand the others like it-is to insure that we will have such devastating retaliatory power, even under concentrated nuclear attack, that no enemy will consider war.

Bases such as this cannot be built overnight. It is a credit to the foresight of our military planners that the bases will be operational concurrent with the TITAN ICBMs now in production at Martin-Denver and undergoing advanced tests at Cape Canaveral.



New styles from world's largest manufacturer of children's dresses arrive at fashion show fast . . . delivered by AIR EXPRESS

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These youngsters are about to model the latest collection of "Cinderella" frocks for the junior set. This debut of new creations by Rosenau Brothers is the "Paris showing" of the children's market. New fashions often must bow at buyers' showings thousands of miles from the Philadelphia factoryjust hours after the last stitch was sewn-or lose a big order. That's why Cinderella takes no chances - ships by AIR EXPRESS regularly. Only lowcost AIr EXPRESS assures overnight delivery coast to coast. These advantages could help you, too! Call AIR EXPRESS and be FIRST TO MARKET... FIRST TO SELL.

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## MIL-R-94B Style RVO $1 / 2^{\prime \prime}$ Dia. $3 / 4$ Watt VARIABLE RESISTOR

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## UNIQUE CARBON-CERAMIC ELEMENT Helps 1 Control Do 2 Jobs:

Surpass MIL-R-94B Style RV6 stability under military environmental conditions including moisture resistance and thermal cycling.
Provide full $3 / 4$ watt power rating @ $70^{\circ} \mathrm{C}$ with derating to zero at $150^{\circ} \mathrm{C}$ on most values $(25 \%$ to $50 \%$ better than MIL-R-94B Style RV6) for higher load and temperature applications. Result of efficient ceramic-to-metal heat sink.

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- High insulation resistance.
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$\qquad$ your nearest CTS office today.

# Mass Engineer Recruitment Declines 

## Company hiring interest shifts to key men with industry reputations

MASS RECRUITMENT of electronics engineers by industry firms is on the way down, according to reports received by Electronics. In the past mass recruitment of engineers has been one of the peculiar characteristics of the electronics industry.

Current hiring interest is centered on the outstanding engineers with industry reputations. Other side of this coin is that firms are much less interested in acquiring run-of-the-mill applicants than formerly.

Typical comment follows:
"We have always been interested in acquiring really outstanding engineers as they add to our stature and ability to perform. But, our interest is particularly strong at this time because of the decline in production contracts and the increase in research and development work. The addition of mere numbers of engineers means little in our ability to handle an advanced R\&D contract, but the addition of one top-flight man can mean a lot."

Fact that industry firms have been stocking up on engineer capabilities in areas of talent shortage for several years was another frequently mentioned reason for the decline in mass-hiring efforts. Many firms have filled their needs for the moment.

Says one R\&D firm, "Our bank of engineer employees is full. We have enough to carry us through a year of expansion. We are not interested in acquiring new men except for the few exceptionally good men that happen to come our way."

Another company viewpoint is disillusionment with the effectiveness of mass-recruiting methods. A semiconductor manufacturer reports that in the past he went in for large-scale recruiting. But he found most of the applicants attracted were unusable in the company's operation. Time and money were wasted.

Also fitting into this picture are reports that electronics industry management is getting more sophisticated about management of costs and expenditures. A general
tightening up on loose and unproductive spending was reported.

However, company decisions are not the whole story. The engineer's attitude means a lot.

Employers told us engineers are not as easy to entice away from their jobs as formerly. Most experienced engineers are sitting pretty today, said one employment manager, and have relatively little interest in job switching.

There has been so much hiring in recent years that engineers who have wanted to work in special technical areas have been able to get into these areas. The ones who wanted to live in particular sections of the country have been able to make the shift. Having got what they wanted, they see little reason for moving at this time.

Potential engineer job applicants have also become disillusioned with mass-recruiting methods. Too often they have been exposed to appeals like, "Come to Utopia Land. It's a wonderful place to live." This appeal doesn't stir them the way it used to, says one recruiter.

Company efforts to build up
sales and management staff are also playing an important role in changing recruitment emphasis.

Sales engineers are in strong demand. There has been a tremendous increase in number of salesengineer job openings this year. In addition to sales engineers, industry firms have been recruiting many marketing managers, costs analysts, military economists, systems analysts, contract managers and market analysts.

Some companies have a limited amount of money they can spend on recruitment. There also are limits on company time and aftention that can be devoted to recruitment. As result, there has beer less company wherewithal left to devote to recruitment of engiqeers.

The drop in recruitment acfivity can be related in part to DOD policy changes since large part of the financial support of enginest recruitment comes from goverrment.

One manufacturer said that DOD officials are going over recruitment costs with a fine tooth comb and that contract disallowances for recruitment expenses are

## Tiros Orbited With Command Guidance



Engineers T. J. Grieser and D. R. Hagner of Bell Telephone Laboratories look over second-stage of USAF's Thor-Able missile used to launch NASA's Tiros weather satellites. BTL-Western Electric command guidance system developed for Titan ICBM guides Tiros into preselected circular orbit
increasing. If a firm's recruitment expenses are noticeably higher than a norm or average, the expenses are likely to be disallowed.

DOD attitude is that there has been no changes in the regulations covering recruitment costs. But, a DOD spokesman admits that contract officers may be taking a closer look at recruitment costs.

In a nutshell: DOD support practices may have had some influence on decline in recruitment activity; but they are not the major influence.

Perhaps more important than DOD financial support of recruitment is reported changes in methods of awarding contracts. Contracts are now being awarded to firms that already have engineers on hand. Firms that have to go out and hire engineers to fulfill contracts find themselves handicapped in winning awards in the first place.

Could a drop in engineer employment activity be a signal that industry sales are about to fall? This happened just prior to the 1957 1958 recession.
Queried on this point, electronics firms say business conditions have nothing to do with their change in attitude on engineer hiring. In fact, all firms reported that although their employment activity was dropping they were in the midst of expansion.

Only two negative business-activity factors turned up that may have had some effect on recruitment.

West Coast firms operating in aerodynamics have been particularly hard hit by contract cancellations. There have been some layoffs. Decline of engineer recruitment here has been more marked than elsewhere.

Also, monthly DOD expenditures for hardware and R\&D fell somewhat in early months of 1960 because of confusion about directions to be taken in the final budget for fiscal 1961. However, the monthly expenditure trend is on the way up, according to reports, and in some areas of military spending there is the problem of disposing of unspent funds before the end of fiscal 1959.

Reports from colleges indicate that there has been no effect on college recruitment. It is as strong this year as ever.


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Sealectro, and only Sealectro, goes the limit to assure you the best terminal-inplace. Sealectro maintains a complete customer-engineering service devoted solely to the purpose of guaranteeing you the very best terminations at the lowest possible costs.

## THE ONE AND ONLY "PRESS-FIT" TEFLON TERMINAL



Only Sealectro manufactures "Press-Fit" terminals. Proved in more installations than all other teflon-insulated type terminals combined, "Press-Fit" offers you the choice of over 1000 standard configurations, plus choice of 10 ElA colors, and complete design, development and manufacturing capabilities to meet any requirements

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The Helicop-Hut is a "flying" shelter for the missile age. Extremely versatile, it is light in weight, yet rugged in performance. But its best feature is its high reputation!
This high reputation through field-proven performance has made the HeliconHut the only shelter in mass production today. At Craig's Lawrence Plant, these shelters are produced at a rate of over 160 per month to house a multitude of electronic systems. Flight of the Army's Hawk missile shown above is coordinate by the Battery Control Center housed in a Craig Helicop-Hut. The military approved S-141()/G Helicop-Hut is the core of the Pentomic Army Communication System now in world wide use. Other Helicop-Huts house air traffic control sets, missile maintenance equipment, digital computers, and a host of complicated electronic systems. In fact, Craig Helicop-Huts have been assigned over 20 different Federal Nomenclatures for over 100 mobile systems.
Craig builds shelters that build their own reputations. And Craig engineers have the experience and knowhow to tie an entire system together.

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Sylvania announces a major breakthrough in TUNNEL DIODES ...featuring oscillation capabilities at unusually high frequencies ...

## 2 KMC MINIMUM with type D4115

## 3 KMC MINIMUM

 with type D415A
## 4 KMC MINIMUM <br> with type D4115B



- basic package design offers potential of 10 KMC operation
- ruggedness proved-withstands 500G1-millisecond shock test
- hermetic ceramic-to-metal seal-Sylvania tunnel units will pass MIL moisture tests

|  | 04115 | D4115A | D41158 |
| :---: | :---: | :---: | :---: |
| Measured Oscillation Freq. | 2 KMC min . | 3 KMC min . | 4 KMC min . |
| $I_{p}$ | 1.8 mA typ. | 1.7 mA typ. | 1.6 mA typ. |
|  | 5:1 min. | 5:1 min. | 5:1 min. |
| $\mathrm{V}_{\mathbf{v}}$..................................... | 350 mv typ. | 350 mV typ. | 350 mV typ. |
|  | 55 mV typ. | 55 mV typ. | 55 mV typ. |
| $\mathbf{R}_{\text {s . .................................... }}$ | 1 ohm typ. | 2 ohm typ. | $3 \mathrm{ohm} \mathrm{typ}$. |
| C ..................................... | $8 \mu \mu \mathrm{ftyp}$. | $6 \mu \mu \mathrm{f}$ typ. | $4 \mu \mu \mathrm{ftyp}$. |

Sylvania Tunnel Diodes are now available in limited quantities for engineering evaluation. Start your investigations of the exciting tunnel phenomenon with advance-design Sylvania units. For details on price and delivery, contact the Field Engineer at your nearest Sylvania Field Office.

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Measuring coil tests magnetic properties of passing sheet of steel. Technologist reads meter (center bachground) which indicates properties numerically


Television camera (upper center) looks inside model of an ore boat's hold as it pitches in simulated rough-sea roll. Rate and degree of load shift is transmitted to tv screen (right)

## NEW LABORATORIES PROVIDE

## More Electronics In Steel Research

ELECTRONICALLY-CONTROLLED steel mills are one aim of the new electromechanical laboratories opened recently at United States Steel's Research Center in Monroeville, Pa. Work is being done to place a mill's entire rolling schedule on a punch card. Research going on this week also involves projects ranging from problems in materials handling to the development of automatic control devices.


Infrared detectors (vertical cylinders in model) are used in measuring I-beams. Digital computing equipment (behind model) tabulates and notes measurements

Instrument centered on table above small blast furnace model records temperature changes in furnace. Miniature radiation devices on either side of furnace are being tested for measuring combustion chamber temperatures

## TAF TANTALUM FOIL ...polarized and

## ... for high working voltages in small case sizes

Complefe line of aluminum and tanfalum -lectrolytics, mofor sfart and run capacifors

# CAPACITORS non-polarized 

Here's a tantalum capacitor that's small in size but large in voltage handling capacity. Mallory TAF Tantalum Foil Capacitors are available in voltage ratings up to 150 WVDC in case sizes as small as ${ }^{3} / 16^{\prime \prime} \times 11 / 16^{\prime \prime}$. Available in polarized and nonpolarized designs, these capacitors are ideal for computers, airborne radar, control systems, and other applications requiring the reliability, stability, low leakage current, and long shelf-life of a quality tantalum foil capacitor.

TAF Plain (unetched) Foil Tantalum Capacitors operate over a temperature range of $-55^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$. Standard capacitance tolerance for all units is $\pm 20 \%$. TAF capacitors are designed to meet the electrical and environmental characteristics of military specification MIL-C-3965B. Capacitors may be ordered with or without Mylar* insulating sleeves.

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. . . immediate delivery on 16 different types!
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Write for complete technical data. For expert consultation on your circuit requirements, see a Mallory capacitor specialist. ${ }^{*}$ Registered tradomark-E. I. du Pont de Nemours \& Co., Inc.

TYPE TAF PLAIN TANTALUM FOIL CAPACITORS

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| :---: | :---: | :---: | :---: |
| $.5-10$ | $.25-5$ | $11 / 16$ | $3 / 16$ |
| 1.50 | 1.25 | $7 / 8$ | $9 / 32$ |
| 4.160 | $3.5-85$ | $17 / 16$ | $3 / 8$ |
| 8.350 | 7.170 | $21 / 8$ | $3 / 8$ |
| 20.440 | $10-250$ | $23 / 4$ | $3 / 8$ |

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## PRECISION ELECTRONIC TIME DELAY RELAYS

Since their original design and introduction almost four years ago, Tempo's miniature Time Delay Relays have been accepted as the standard of precision, performance and unquestioned reliability. Thousands have been specified and delivered for a wide range of critical timing applications - in many of the nation's major missile and space programs, for avionic and ground support systems, matic controls - Whereter altra-reliable timing under difficult environmental conditions.


SOLID STATE DESIGN
Tempo's Time Delay Relays contain no moving parts except the contacts of a balanced armature control relay. The actual time delay circuit function is accomplished by a unique Solid State 1 ming Module, developed and relay have by empo. on the accuracy of the time delay, Contact arrangements include 2PDT. 2 amp and Contact arrangements include 2 PDT. 2 amp and

FIXED OR ADJUSTABLE TIMING
Fixed time units are available with time delays from .020 sec . to 300 sec ., or longer on spe-cial-order types. In adjustable types, the minimum adjustment range is from .050 sec . to 1.00 sec. - the maximum is from 15.0 sec . to 300 sec. As many as eleven intermediate adjustment ranges are also available, each with a 20 to 1 spread. Adjustment is made by a simple, quick change of an external resistance value - no special calibration equipment or elab. orate procedures are required.

## TIMING ACTION

Units are available with time delay occurring between application of voltage and relay pult. in, or delay occurring between removal of control signal and relay drop-out.
ACCURACY RATINGS TO . $01 \%$
Standard types are available with accuracy ratings of $10 \%$, $5 \%$, or $3 \%$ of nominal time delay, guaranteed under any combination of conditions including:
emperature $\ldots . . .-55^{\circ} \mathrm{C}$ to $+125^{\circ} \mathrm{C}$
Input Voltage.......

Acceleration … . . . 20 g's, steady state Special-order types are available with guaranteed accuracy ratings of $1 \%$ or $.01 \%$

## WRITE FOR ENGINEERING CATALOGS

Tempo Engineering Bulletins 5903 (Fixed Timing) and 5905 (Adjustable Timing) contain all necessary technical, application and ordering data.

These service-proven units are engineered and produced in compliance with an exacting Quality Assurance Progralm, including functional testing of each unit under all combina. tions of rated temperature and voltage extremes.


TEMPO INSTRUMENT INCORPORATED 5 Commercial St., Hicksville, L. I., N. Y.

# Stereo Tests On the Way 

Federal Communications Commission will evaluate industry group's stereo f-m findings

Stage one of the long-awaited stereophonic broadcast tests is nearing the countdown. Field tests are slated to get started early this summer.

Testing, which will be conducted on stereophonic f-m systems only, will be made by Panel 5 of the National Stereophonic Radio Committee. Although the overall NSRC group was deactivated recently, (Electronics, p 63, Mar. 11), Panel 5 has been called on to perform the tests and submit its findings to the Federal Communications Commission which will establish standards.

The industry group has selected one test site and may spread its operations to two more. Station KDKA-FM, Pittsburgh, has been named as a firm test location. Two Boston stations, WCRB-FM and WBZ-FM may also be called on to aid in the study.

The testing method will include
the playing of seven two-minute selections chosen from musical recordings believed to typify the present state of stercophonic recording, according to Jean Caffieux, of EIA's engineering staff. A master reference tape containing this information will be used as a comparison standard for separation at high and low frequencies, for signal characteristics of the sounds of different instruments and for other qualities the group will be examining.

In charge of preparing the tapes is M. R. Schroeder of Bell Tele phone Laboratories.

According to R. L. Kaye, vic chairman of the subcommittee or transmission and receiving facili ties, some system plays already have been set up. In each case, system proponents will be offered the use of a basic f-m transmitter with the obligation to provide their own ancillary gear. In some cases

## Twin Cities Get Self-Service Post Office



Customer-operated system by Minnesota Electronic Co. sells stamps in three denominations, envelopes, cards. It totals purchases, changes bills
this may mean that system advocates will provide their own exciter systems, supply their own multiplex gear if desired, or make such other technical provisions as might be needed. One obvious stipulation is that functioning of the station transmitter for regular operation must not be jeopardized.
Systems proponents will supply their own stereo receivers, and broadcast signals will be checked both with these receivers and with standard types of monophonic receivers. Compatibility, from all indications, will be high on the list of desired characteristics.

## Systems Named

A broadcast member of NSRC's Transmitting and Receiving panel says a number of systems are slated to be tested. For reference purposes, these have been identified with numbers as follows: 1Crosby Laboratories; 2A-Calbest; 2B-Halstead; 3-Electric \& Musical Industries; 4-Zenith; 5A and 5B-General Electric. Although these are the systems for which plans have been made, it is possible that there may be changes as the tests progress. Actual testing will be conducted in station off-hours, probably in the time area after 11:00 p.m. and before 7:00 a.m.

According to Kaye, there has been some talk of the possible differences between daytime and nighttime transmission that may affect measurements, but NSRC testers do not feel this will be a substantial source of difficulty.

The tests will be set up by three subcommittees of Panel 5 bearing designations as follows: 5.1Transmitting and Receiving Facilities; 5.2-Specifications and Measurements; 5.3-Transmitting and Receiving Specifications.

Some of the men who will be working on these phases of testing are: A. C. Goodnow, R. L. Harmon, Westinghouse Broadcasting; R. L. Kaye, WCRB, Waltham, Mass; Daniel von Recklinhausen, H. H. Scott Co.; and J. Benjamin, BogenPresto, Paramus, N. J. All personnel involved in the testing are industry members. No FCC personnel will be involved in the data-gathering phase of the study.

Another in a series of thoughtful observations on the topic of Time

is the flight of Time, as they see who look back at $\boldsymbol{i t}^{\boldsymbol{n}}$
sENECA, Roman Philosophar, 5-65 AD

TEMPO INSTRUMENT INCORPORATED, HICKSVILLE, L.I., NEW YORK
DESIGN AND MANUFACTURE OF PRECISION ELECTRONIC TIMING DEVICES AND CONTROLS



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## Can a silicon rectifier solve your problem?

It might, if you have a problem in DC power sources. For example, some time ago C \& D needed a high efficiency, constant potential, current limiting DC power supply. Output had to be held within $\pm 1 \%$ over an AC input variation of $\pm$ $15 \%$. In addition, maintenance would have to be virtually nil.
The answer was found by using a silicon rectifier in combination with simplified components that became the heart of C \& D's AutoReg® charger. AutoReg chargers provide continuous, automatic, unattended charging of industrial storage batteries. With the exception of a timing circuit
there are no moving parts. There are no relays to adjust and practically no maintenance is required.

Now, C \& D has expanded facilities of the AutoReg plant to provide industry with similar DC sources, which incorporate silicon rectifiers and automatic regulation. Final form of these units can supply power in a range from milliwatts to megawatts, depending upon your requirements.

Companies with a problem in DC power sources should write, giving a general outline of their requirements, to: Vice President in Charge of Engineering

## AufoReg Power Sources

Manufacturers of Slyver Clod (®) Industrial Batteries - PLASTICELI * and MAncois (®) Batteries for Communications. Control, and Auxiliary Power - Producers of AufoReg © Silicon Chargers and AufoCal * Charger-Battery Combinations.
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# Moisture Control and the Stability of Transistor Parameters 

THE technology of semiconductors is in a large degree the technology of surfaces. The junction is a surface between two layers of semiconductor material. The contact is a surface between the semiconductor and a metal. And, finally, there is a surface between the semiconductor and its environment.

It is on these surfaces that most of the significant actions of the transistor take place, and it is the composition and structure of these surfaces which determine the character of these actions. Moisture can play havoc with surface stability, and ultimately with transistor reliability. Water is, in fact, the primary cause of surface stability problems in transistor production.

If the characteristics of germanium p-n-p alloy transistors are measured immediately after the final vacuum-bake, and again after the surface has been exposed to water vapor it will be found that: Alpha increases; junction breakdown voltage changes; and reverse current increases.

If the transistor is then put through another vacuum-bake, the original characteristics will be restored. Long exposures to water before baking, however, will result in irreversible changes.

Exactly what takes place on the surface is difficult to say, but certain changes do occur in the presence of water. Whether the water actually enters into the change or acts as a catalyst has not been determined. These surface changes have the net effect of altering various paths which a carrier can take.

It would seem that a ready means of overcoming the effect of water would be to hermetically seal the transistor immediately after the vacuum-bake.

This is done in practice, but it results merely in slowing the effect since the transistor is so small that very little water is required for the change to take place and the semiconductor materials have a strong affinity for water. Since it is a practical impossibility to exclude all water during this operation, the use of a hermetic seal alone is insufficient.

There seems to be no simple solution to the problem. Therefore, Tung-Sol subjects every transistor to a multi-level water-control process, which has proved extremely successful.

## Elimination of Moisture During Processing

In the final stages of production prior to encapsulation, Tung-Sol makes sure that surfaces are clean, stable and insensitive to water. First, the surface is etched to remove any impurities which might have
been produced during processing. The entire structure is washed in a bath of highly deionized water. The water is then blown off with pure dry air. Next the germanium is chemically treated to provide a surface which is relatively unaffected by water. And finally the transistor is placed in a vacuum oven and baked. The unit is now ready for encapsulation.

## Sealing Water Out

Three essential factors must be considered in sealing: the quality of the seal; the size of the working area; and, the effect of sealing on associated parts.

Seal Quality: The properties of water and the conditions of transistor usage require that the seal be perfect and at the same time rugged. Water in liquid form will enter through a hole as small as 2 x $10^{-3} \mathrm{~cm}$. Water vapor can enter through apertures approaching the diameter of the water molecule, less than $4 \AA$. The seal must also be strong enough to withstand the tough operating conditions of industrial and military equipment, without developing imperfections.

Size of the Working Area: Since the transistor is a miniature component, the case must be as small as practical. The size of the working area is limited, thus complicating the tooling problem.

The Effect on other Parts: In order to attain the seal, work must be performed on the case. Depending on the kind of work performed, mechanical and thermal stresses may be transmitted to the working parts of the transistor and alter their properties.

The Tung-Sol methods of sealing have overcome these serious problems. The seal is of the highest reliability, yet the processing is such that the size of the working area offers no barrier and the other working parts suffer no stress damage. The following is a capsule digest of Tung-Sol sealing methods:

Connection Leads: Kovar-hard glass seals are used to secure a tight glass to metal seal while providing the necessary electrical insulation without destroying the mechanical insulating properties of the case.


Case Sealing with Electronic Welding: The header is welded to the case by means of an extremely localized heat which is controlled electronically. (This method is more reliable than the previously used pressure fit technique in which the can was forced on to a tight fitting header. An uncertain seal resulted.)

Case Sealing
with Cold-Weld:


For larger transistors, a more practical seal is provided by the Cold-Weld technique, an exclusive Tung-Sol development. In this process the entire case is made of pure copper. Both the can and the header have matching flanges which are pinched together under pressure. The pressure joins the two pieces together in a true weld without the application of external heat.

## Controlling Water Inside the Case

When the transistor case is welded together, water is sealed out. On the other hand, any water that happens to be inside the case is sealed in. In fact there is usually enough water present to cause instability. To prevent the sealed-in water from affecting the semiconductor surface, Tung-Sol employs a "Molecular Sieve".
Molecular sieves, actually zeolite crystals, contain precisely arrayed networks of cavities. They have a great affinity for water molecules, absorbing them in preference to other substances. Under certain conditions molecular sieves reduce the amount of water in a gas or liquid to as low as four parts per million.
In Tung-Sol's transistors, the zeolites, in the form of a small pellet, are placed inside the transistor case. This pellet dries the can and draws off any water from the transistor.
Molecular sieves have a stronger affinity for water than conventional silicone oils and grease. They provide permanent absorption of water at all operating temperatures, and minimize the migration of ions.

## Tung-Sol Transistors

 and "Extra-Reliability"Moisture control is just part of the wide-ranging care that Tung-Sol takes of every semiconductor product, all aimed at bringing you the most reliable components. Every component is the product of manufacturing processes and quality control practices that have made Tung-Sol the name synonymous with the finest precision componentry.

Full report on moisture control is featured in the latest issue of the Tung-Sol technisal journal, The Laftice. Available on request.

## (5) TUNG-SOL

Tung-Sol Electric Inc., Newark 4, N.J.

## Standards Parley Starts June 22

TALKS on high-frequency standards and calibrations will highlight six technical sessions during the threeday 1960 Conference on Standards and Electronic Measurements to be held at Boulder, Colo.. June 22-24.

The conference is being sponsored by three major electronic groups: The National Bureau of Standards, The Institute of Radio Engineers and The American Institute of Electrical Engineers.

The technical sessions scheduled for Wednesday, June 22, are on current and future problems in standards and electronic measurements, morning session; frequency and time standards, afternoon session.

On Thursday, June 23, the morning session is on methods of measurement for materials, and the afternoon talks will be devoted to microwave standards and calibrations.

The final morning session of the conference, June 24 , will be concerned with $\mathrm{d}-\mathrm{c}$ and low-f requency standards and calibrations. Last afternoon session is on high frequency standards and calibrations.

During the final session, E. E. Aslan, FXR, Inc., Woodside, N. Y., will describe a new microwavemicrowatt power meter, which permits full scale measurements from 0.01 to 3 millwatts in six ranges over a 0.01 to $40-\mathrm{Kmc}$ frequency range.

## Solar Highway Alarm



Sun-powered call system shown by $H$. L. Hoffman, president of Hoffman Electronics, gives drivers choice of emergency service

Other conference highlights:
A technique for comparing phases of two microwave signals which uses amplitude modulation in one channel of a two-channel system will be described by G. E. Schafer, National Bureau of Standards.

New approach to the measurement of volume resistivity of semiconductor material during its manufacture will be discussed by J. R. Seifert and G. L. Allerton, Western Electric Co., Allentown, Pa.

## U. S. Is Leading In Space Data

CORONADO, CALIF.-Greater precision, more miniaturization and simplification of aircraft and missile flight test systems is forecast by Ralph H. Tripp, incoming president of the Instrument Society of America.
Tripp, assistant flight director at Grumman Aircraft, made these predictions at the sixth national flight test instrumentation symposium of the aeronautical division of the society here. More than 400 members attended the meeting. Members heard Rear Adm. Jack P. Monroe, Commander of the Pacific Missile Range, say the United States is far ahead of Russia in ballistic missile and satellite fields, trailing only in the deep space category.

He said U. S. scientists are receiving eight times the information Russia gets from its space program.
"Instruments represent the engineer when he isn't there," Thomas G. MacAnespie, measurement specialist for Martin, said. "And we'll have both manned and instrument flights for years to come."

MacAnespie said many aircraft firms, including his own, now are completely out of the manned airplane business and into missile work.

However, he said, the aeronautical and space industries division of ISA will continue to concentrate equally on high performance aircraft, commercial aircraft, missile and spacecraft problems.


## EIMAC CERAMIC TUBES DESIGNED FOR SPACE <br> WITH RUGGED NEW 26.5 VOLT HEATERS

Three extremely sturdy Eimac ceramic tetrodes have been specially designed for missile telemetry and airborne military communication systems-with rugged new 26.5 volt heaters.

In actual missile systems and current key projects, these tubes have passed severe tests with flying colors. And have dramatically proved that they can take it!

For your space age needs, investigate the many advantages of these pioneering Eimac tubes: the X578G, X578H and X578J. Write for complete information.

general characteristics eimac 26.5 volt ceramic tubes

| Tube | Eimac Tube <br> With Similar <br> Characteristics | Length | Diameter | Frequency <br> for Max. <br> Ratings | Max. <br> Plate-Diss. <br> Rating | Heater <br> Voltage |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| X578G | 4 CX 300 A | $2.5^{\prime \prime}$ | $1.65^{\prime \prime}$ | 500 mc | 300 watts | 26.5 |
| X578H | 4 CX 125 C | $2.5^{\prime \prime}$ | $1.25^{\prime \prime}$ | 500 mc | 125 watts | 26.5 |
| X578J | 4CN15A | $2.5^{\prime \prime}$ | $0.9^{\prime \prime}$ | 500 mc | $15^{*}$ watts | 26.5 |

*A nominal rating. May be increased by employing a suitable heat sink or liquid immersion.


Professional placement report for Electronics Engineers

## How the continuous need

 to improve the nation's space surveillance capabilities opens avenues for new engineering careersThe continuous need we are talking about at General Electric refers to the fact that future-generation missiles, satellites and deep space probes will require refined or entirely new detection techniques, including many that have not yet been conceived.

For example, it is anticipated that for every technical discipline now utilized in the detection field, at least one more must be found to apply within the next 10 -year-period.

With this in mind, General Electric is increasing its electronics engineering staff now working on advanced missile, satellite and deep-space-probe detection systems. Keeping pace with this expansion, the Company added a new building last year, and another will be ready for occupancy in a few months.

First clues to this trend were obvious in General Electric's well known "Golfball Study," published five years ago. This study compared the problem of missile detection to that of locating a golfball 200 miles away, using the most advanced techniques available in 1954. The problem no longer has such proportions, thanks to the creative imagination of dedicated General Electric engineering, scientific, and technical personnel responsible for designing and developing the unique surveillance sub-system of the Ballistic Missiles Early Warning System (BMEWS) which is receiving headline attention today.

Find out more about these creative and selfexpressive opportunities now open to qualified personnel in one of the most vital technologies of the space age.

## Immediate openings

 for qualified electronics engineersRADAR EQUIPMENT SYSTEMS SPECIALISTS capable of conceiving and directing the design of long-range radar systems. Desirable experience includes 3 to 10 years in at least one of the following: radar systems design, antenna systems, RF components. transmitters, radar receiver systems or radar data processing systems. Salary structure is fully equal to the professional requirements of the job.

ADVANCED SYSTEMS ENGINEERS capable of defining future defense and space detection problems including deep space-probe tracking. Also the ability to conceive and estallish the feasibility of optimum systems solutions to these problems-making use of the most advanced techniques and understandings. Also required is an ability to recognize the need for, and coordinate the development of, new techniques and the exploration of new phenomena. Experience requirements include a Bachelor degree plus a combination of advanced training and several years' experience in both the theoretical and practical aspects of detection systems engineering. A desire to work in the conceptual phase of systems design with the analytical ability required to evaluate and demonstrate the effectiveness of the proposed systems is essential.
FIELD OPERATIONS ENGINEERS for systems management teams to be deployed at complex radar systems installations of the BMEW'S type. Systems-oriented Electronics Engineers are needed who have the ability to assume responsibility for installation, checkout, and integration of major radar systems. Background in high-powered Klystron transmitters, low-noise receivers and digital data processing equipment is desirable. A Bachelor degree is required.

ADDRESS YOUR INQUIRY IT.I CONFIDENCE TO:
MR. JOSEPH WOOL, PROFESSIONAL PLACEMENT, DEPT. T-3 MISSILE DETECTION SYSTEMS SECTION HEAVY MILITARY ELECTRONICS DEPARTMENT GENERAL ELECTRIC COMPANY COURT STREET, SYRACUSE, NEW YORK

Qualified applicants will be invited to visit us in Syracuse at Company expense. Relocation assistance will be provided. 177-25

## Aerocom's Dual Automatic Radio Beacon

Reliability is built into every part of this dual 1000-watt aerophare unit. Ruggedly constructed and conservatively rated, it provides trouble-free unattended service, and at truly low operating and maintenance cost. It operates in the frequency range $200-415 \mathrm{kcs}$, using plug-in crystal for desired frequency.

Uses single phase power supply, nominal 220 volts, 50 or 60 cycles. Consists of two 1 kw transmitters with 2 keyers, automatic transfer unit and weatherproof antenna tuner. Each transmitter housed in separate fan ventilated rack cabinet, with controls in center rack cabinet.

Nominal carrier power is 1000 watts.

High level plate modulation of final amplifier is used, providing any desired level of modulation up to $100 \%$. P-T switch interrupts tone, permitting voice operation. Operates in ambient temperatures from $-35^{\circ} \mathrm{C}$ to $55^{\circ} \mathrm{C}$, humidity up to $95 \%$.

Standby transmitter is placed in operation when main transmitter suffers loss (or low level) of carrier power or modulation, or continuous ( 30 sec .) tone, or carrier frequency change of 5 kcs or more. Audible indication in monitoring receiver tells when standby transmitter is in operation.

Antenna may be either vertical tower or symmetrical T type.


## TRANSISTOR

$\checkmark$ testing matching


The Tektronix Type 575 TransistorCurve Tracer is a valuable production tool as well as an engineering instrument. The most intricate test procedures devised by engineers become high-speed operations by production personnel...through the use of a simple setup chart.

## Here's how it works:

1. The engineer devises the test procedure required to attain the desired end result.
2. The engineer designates the control settings for the Type 575 on the chart, and draw's a picture of the display, outlining the limits for acceptance or rejection. If desired, separate graticules for each test setup can be marked with colored lines or tapes.
3. The production-test facility takes over at this point and performs the test operation with speed and accuracy.

Operational curves displayed on the Type 575 provide information desirable even in relatively simple tests. A convenient switch makes it easy to check test setups against a standard, and to make direct comparisons. You'll be abead using the Type 575 in any lest procedure ubbere a meter reading is not entirely adequate.

Your Tekironix Field Engineer has a supply of the test set-up charts, and will be happy to help you with any phase of this operation. If you are not already acquainted with the performance characteristics of the Type 575, ask your Field Engineer for a demonstration.
Type 575 Transistor-Curve Tracer. . . . . . \$975
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## Tektronix, Inc.

P. O. Box 500 - Beaverton, Oregon

type 575 transistor-curve tracer

mansisto: a


COMPONENT: $2 N 700$ 151-027
testing: BETA SEGREGATION
procedure: USE SPEC/AL SOCKET WITH By.passed base lead

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## MEETINGS AHEAD

June 9-12: Society of Women Engineers, Annual Convention, Ben Franklin Hotel, Seattle, Wash.

June 10-26: British Exposition, Electrical And Electronic Equipment, Coliseum, N. Y. C.

June 12-15: American Nuclear Society, Annual, Palmer House, Chicago.

June 13-14: Radio Frequency Interference Symposium, IRE, Shoreham Hotel, Washington, D. C.

June 14-16: Railroad Communications, Assoc. of Amer. Railroads, Communications Section, Shera-ton-Cadillac Hotel, Detroit.

June 20-21: Broadcast and Tv Receivers, Chicago Spring Conf., IRE, Graemere Hotel, Chicago.

June 20-24: American Institute of Electrical Engineers, Summer General, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 22-24: Standards \& Electronic Measurements, NBS, AIEE, IRE, NBS Laboratories, Boulder, Colo.

June 23-24: Solid-State Electronics Workshop, IRE, ASEE, Purdue University, Lafayette, Ind.

June 26-29: New England Electronic Conf., ERA, the Salsams, Dixville Notch, N. H.

June 26-July 1: Materials Sciences, ASTM, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 27-29: Military Electronics, National Convention, PGME of IRE, Sheraton-Park Hotel, Washington, D. C.

Aug. 23-26: Western Electronic Show and Convention, WESCON, Memorial Sports Arena, Los Angeles.

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iN. phase Fundamental at zero speed. ..... 2MV
IN-phase Fundamental at zero speed... ..... 6 MV
Total harmonic. ..... 10 MV (RMS)
IN-phase axis error ..... IMV
Quadrature axis error ..... IMV
inearity -0 to 4000 RPM (percentageof voltage output at 3600 RPM)$- \pm .06 \%$
Variation in output gradient with variation in ..... $\pm 0.2 \%$
Variation in axis error with variation in
ambient temperature $\left(-55^{\circ} \mathrm{C} .10+80^{\circ} \mathrm{C}\right.$.)Variation in phase shift with variation in
ambient temperature $\left(-55^{\circ} \mathrm{C}\right.$. to $\left.+80^{\circ}\right)$ ..... $\pm 1^{\circ}$
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## List of contents

[^1] by Robert M. Bowie, Syivania Research Labs.
are answered.

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Electrical Limiting: Approximately $\pm 115 \%$ of full scale
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push button push button
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## electronics

June 8, 1960

FIG. 1-Parametron with inductance variable excitation (A), attendant voltage-frequency and oscillation region characteristics ( $B$ and $C$ ) and oscillation build-up waveforms (D)

(A)


# Parametron Computer Circuits 

## Discussion of characteristics and coupling of parametrons prefaces description of logic, register, adder, counter, translator and converter circuits

By KYOZO NAGAMORI,
Chief of the 4 th Laboratory,
Research Laboratories,
Nippon Electric Co, Ltd., Tokyo. Japan

Since the parametron was invented by Assistant Professor Goto ${ }^{1}$ of Tokyo University and was made public in July 1954, it has been investigated vigorously at various research institutes and laboratories. The device is now finding a wide field of application in electronic computers and various digital apparatus.

Oscillation frequency: The parametron utilizes a nonlinear reactance consisting of a resonant circuit made up of an inductance $L$ and a capacitance $C$. By causing either $L$ or $C$ to vary periodically, an oscillating current is produced in the resonant circuit.

Such a phenomenon is observed when the resonant frequency of the circuit (determined by the average value of $L(t)$ and $C$ or the average value of $C(t)$ and $L$ ) is made approximately equal to $f$, or $\frac{1}{2}$ of the
excitation frequency $2 f$, and when the frequency of the produced oscillation becomes exactly equal to $f$. Such a phenomenon is referred to as parametric oscillation.

As a method of excitation, either the inductance $L$ or the capacitance $C$ may be varied. With parametrons now in practical use, however, the parametric oscillation caused by varying the inductance has been exclusively adopted. This is a method of varying inductance by changing permeability thus utilizing the nonlinearity of magnetic materials.

An example of a circuit using inductance variation is shown in Fig. 1A. This circuit consists of primary windings in the same direction on two ferrite cores of toroidal form each 4 mm in external diameter, 2 mm in internal diameter and 1 mm in thickness, of secondary windings wound on the two ferrite cores in opposite directions to each other and of a capacitance $C$. In the primary windings, an excite current at a frequency of $2 f$ is superimposed on a d-c bias $I_{d-c}$.

Note that the excitation frequency used for parametrons now in use is about 2 Mc while the power consumption per parametron is of the order of several centiwatts. For the reduction of power consumption, various parametrons of improved form have been announced.

Oscillation region: It is desirable that the parametron resonant circuit be exactly tuned to one-half the excitation frequency. Even if the resonant circuit is slightly detuned, oscillations can still take place whose range varies with the intensity of excitation as well as with the characteristics of the magnetic core.

Figure 1B shows the variation of oscillation voltage as a function of excitation frequency. Hysteresis is observed at lower frequencies. The oscillating conditions between $f_{1}$ and $f_{2}$ are of two kinds, as will be discussed, representing the fundamental nature of parametrons used as logical elements.
To be more specific, let the phase of an oscillating condition be 0 phase, then the phase of the other
oscillating condition is $\pi$ phase which differs 180 degrees in phase from 0 phase. For this reason, the region between $f_{1}$ and $f_{2}$ is called the two-valued region.

The region between $f_{2}$ and $f_{3}$ can take a third condition, in which no oscillation can occur under a certain condition. This region is called the three-valued region.

Figure 1C illustrates the threshhold of oscillation with respect to the excitation frequency and the excitation current. It is evident from this figure that the parametron operates stably under sufficient excitation current.

Amplifying action: The oscillation phase is the phase of small oscillation at $f$ which was present in the resonant circuit prior to excitation. If a small oscillation of 0 phase is present prior to excitation, the 0 phase oscillation occurs; whereas, if a small oscillation of $\pi$ phase is present, the $\pi$ phase oscillation occurs. In this way the amplitude of oscillations which existed initially increases excitation progressively, the ratio of the small oscillation amplitude to the amplitude of the final oscillation reaching about 80 db . This phenomenon is called the amplifying action of the parametron.

Limiting action: Figure 1D shows the build-up process of the oscillation of a parametron. As will be evident, upon applying excitation the oscillation voltage increases exponentially. It is true that in theory the amplitude of oscillations should increase without limit, but actually it stabilizes at a definite amplitude because of the nonlinearity of the magnetic core. This action is referred to as the limiting action.

Phase quantizing action: The small input oscillation determining the oscillation phase of a parametron is not exactly in the 0 or $\pi$ phases. Even if a considerable phase difference is produced, the ultimately stabilized, phase invariably settles at either of two points differing in phase by 180 degrees. This property is called the phase quantizing or pull-in action.

Memory action: The oscillating condition of a parametron receiving excitation remains unchanged unless the excitation ceases thus becoming irrelevant to the input information. Therefore, the control of the oscillation phase under exci-


FIG. 2-Impedance ( $A$ ) and transformer ( $B$ and $C$ ) coupling, and time relation of excitation currents in three-rhythm excitation ( $D$ )
tation conditions is generally impossible except during the initial period of excitation. This property of holding information is called the memory action.

Coupling parametrons: A parametron can assume two oscillating conditions. Accordingly, it may be used as a two-valued logic element to correspond with the opening or closing of relay contacts.

Although the 0 and $\pi$ oscillation phases are made to correspond to 0 and 1 , respectively, for convenience of handling in logical algebra, they may be expressed as (+) and (-) or +1 and -1 . This can be done since the voltage in $\pi$ phase is assumed to be $+E$, that in 0 phase be-
comes $-E$.
The control of the oscillation phase of a parametron is performed by information given prior to excitation. Typical coupling methods are shown in Fig. 2A, B and C. Fig. 2A shows a case in which two parametrons are connected with an impedance $Z$ (normally a resistance); Fig. 2B and C show cases in which a coupling transformer is used. Each parametron furnishes information current to the primary winding (one-turn winding) of the transformer coupled with the succeeding parametron through the oscillation voltage stabilizing resistor $R$.

Three rhythm method: Since control resulting from input in-
formation is not possible, it is necessary to make the output of a parametron the nucleus for controlling the phase of another parametron coupled to the first. Control is achieved by making or breaking the excitation for the transmission of information.

The sequence of making or breaking excitation need only be such that directivity is given to the transmission of information. In general, parametrons are divided into three groups from view-point of excitation. Excitation period is shifted as shown in Fig. 2D.

Suppose that parametrons 101 and 102, parametron 201, and parametron 301, are subject to excitations I, II, and III in Fig. 2D, respectively. At time $t_{o}$, parametrons belonging to I (abbreviated I parametrons) are oscillating and information is delivered to the parametron at each side in the form of small oscillations. Since the output is devoid of directivity, information is delivered to parametron III via a coupling transformer.

At time $t_{i}$, parametron II starts oscillation in the same phase as the small oscillations from parametron I thus turning into the same phase as that of a parametron connected to the left-hand side. At time $t_{2}$, excitation of parametron $I$ is stopped and only parametron II is sustaining oscillation. Thus, information of parametron I has been transferred to parametron II.

In a similar manner, information is transmitted in succession to the right in accordance with the excitation periods of I, II, and III. $T$ and $f$, which equals $1 / T$, are called the information transmission time and the keying frequency, respectively. Keying frequency of parametrons now in use is from 10 to 30 Kc .

This excitation method is called the three-rhythm or normal excitation method. An excitation method not based on the abovementioned principle-for example excitation such as performed only when required-is called the abnormal excitation method.

Symbolic representation: Parametrons are normally represented by small circles as shown in Fig. 3A. The classification of excitations is expressd by a number of threedigit places, making 3 a model number (for instance 101, 401, and 701 are excitations for I) or simply
by notations I, II, and III.
Where the output of a parametron is fed to another parametron as a phase control signal of unit intensity, two small circles are connected by a solid line (positive coupling). To denote a coupling of $n$ (an integer) times the unit intensity, an $n$-fold coupling is used. To represent a coupling of phase reversal (negative coupling), the solid coupling line is intersected perpendicularly with a short line.

Parametrons which produce a standard phase of $\pi$ or 0 at all times are referred to as constant parametrons. To indicate that a signal input is impressed to a parametron from a constant parametron, the $\operatorname{sign}(+)$ or $(-)$ is written within a small circle so as to correspond to $\pi$ or 0 phase. Therefore, when constant information of $\pi$ phase $(+1)$ is given at unit intensity, an encircled + sign is written and an encircled - sign is written for constant information of 0 phase ( -1 ). In general, $n$ plus signs or $n$ minus signs are written within a small circle where constant information of $n$ times the unit intensity is impressed.

To discriminate between the input and output lines of parametrons, arrows are used. Black dots are sometimes used at the output sides, as shown in Fig. 3A, when the direction of transmission of information is clearly indicated. To branch information out, the connection shown in Fig. 3B is adopted. A schematic representation is shown in Fig. 3C.

(C)

FIG. 3-Symbolic representation of a parametron delay circuit ( $A$ ), and symbolic ( $B$ ) and schematic (C) representation of connections for branching information

Majority circuits: Where a number of inputs are given to one parametron, they are applied simultaneously to the input transformer as shown schematically in Fig. 4A. In this case, the small oscillation becomes the algebraic sum of the currents corresponding to the number of inputs, the oscillation phase being determined by this majority principle. Therefore, the number of inputs is restricted to an odd number.

In practice three inputs are used, by taking into consideration erroneous operation resulting from scattering in oscillation voltage. The maximum number of inputs is five.

AND circuit: The and circuit using a parametron is primarily intended for a case of two inputs. Two AND circuits are combined for a case of three or more inputs. In Fig. 4B, let 103 be a constant parametron for -1 . Then the output of 201 produces +1 only when both 101 and 102 information are +1 simultaneously. This condition is in accordance with the majority principle.

Let the information from 101 and 102 be $x$ and $y$. Then the output of the AND circuit becomes the product of $x$ and $y$ (logical product) which is represented as shown in Fig. 4C.
$O R$ circuit: In Fig. 4B, let 103 be a constant parametron of +1 . Then the output of 201 becomes +1 when either or both of 101 and 102 are +1 . Let the two lines of information be $x$ and $y$, then the output of the $O R$ circuit becomes the sum of $x$ and $y$, or $x+y$ (logical sum). This condition is represented as shown in Fig. 4D. In the same manner as in the case of the and circuit, the basic form of the $O R$ circuit is for the case of two lines of information.

NOT circuit: It is intended by using a parametron in the not circuit to reverse -1 ( 0 phase) to +1 ( $\pi$ phase) or +1 to -1 . This circuit is shown in Fig. 4E. By making the direction of the primary winding of the input transformer opposite to that of the positive coupling, information is available at 201 which is complemental to that at 101. The not circuit is expressed as shown in Fig. 4F, Not for information $x$ being expressed by $x^{\prime}$.

Reference phase: So far, an ex-
pression 0 phase or $\pi$ phase has been used for the phase information of a parametron. This is a relative mat-ter-that is, the phase is determined only by comparison to a phase which becomes the reference.

The reference phase is created by the circuit shown in Fig. 4G or a delay circuit in which three parametrons are connected in ring form. This delay circuit memorizes onebit of information.

Since this information is sustained at a constant value after the power switch has been thrown (that is, the excitation is not stopped), 0 or $\pi$ phase is considered the reference phase assuming the information is in 0 or $\pi$ phase. The constant parametron, as previously mentioned, corresponds to the present circuit. All constant information is furnished from the present circuit as a supply source.

Shift register: Figure 5A is a symbolic representation of a circuit called the serial-type register. Binary 4 -bit numbers are stored in succession in this register at a period of $4 T$. Since the input to $G$ is normally zero, the AND circuit 105 is closed. The contents of the register remain unchanged even if an information input is fed to the input $S$. Upon applying four pulses on the $G$ input terminal in order to rewrite the contents, the information from the $S$ input terminal enters the register through AND circuit 105 and or circuit 201 and, at the same time, the previous contents are erased by AND circuit 101.

Figure 5B and C shows a parallel type register circuit in which each digit place of a binary number is stored at a period of $T$. The and and $O$ circuits of Fig. 5B operate in a similar manner as in the case of the serial type register circuit of Fig. 5A. Upon sending one pulse to terminal $G$, the previous contents are erased and new information is written.

Figure 5C shows a circuit arrangement by which the method of writing in the input information has been changed. The principle of circuit operation is the same as that of Fig. 5B. A shift register circuit capable of shifting digit places is illustrated in Fig. 5D.

Note that a gating circuit for shifting has been attached although the basic circuit construction is the same as that shown in Fig. 5C. Each

(A)

(B)

(C)
(D)


(F)
(G)

FIG. 4-Schematic ( $A$ ) and symbolic ( $B$ ) diagrams of majority circuits, symbolic diagrams of AND ( $C$ ) and OR ( $D$ ) circuits, schematic ( $E$ ) and symbolic $(F)$ diagrams of NOT circuit and reference phase circuit $(G)$
time a pulse is applied to the $L S$ or $R S$ terminal in the figure, one digit place is shifted to the left or to the right.

Half adder: The principle of the half adder circuit is shown in Fig. 6A. Parametrons 101 and 102 constitute an or circuit for the sum of inputs $x$ and $y$ and an AND circuit, respectively. Parametron 102 produces carry-over, $C$, while parametron 201 produces the sum, $S$, by parametron 101 and an AND circuit for NOT for carry-over parametron 102.

Full adder: The principle of the full adder circuit is as shown in Table I. The parametron circuit meeting this requirement is shown in Fig. 6B. The operation of parametron 103 for performing carryover is the same as that of the majority circuit.

Parametron 102 operates on the majority principle as a result of the not for $x, y$, and $C$. The result of operation corresponds to borrow, $B$, when $y$ is subtracted from $x$. The output of parametron 201 is determined by the majority principle among not for carry $C_{o}, x$, and $B$, which is nothing but the sum $S$ to be derived.

Serial adder: Figure 6C illustrates what is commonly called the serial type adder circuit, each of the register circuits $A, B$ and $C$ in the figure constituting the serial type register circuit shown in Fig. 5A. This register circuit can store the necessary number of digit places if the number of delay circuits is increased in accordance with the number of digit places of numbers to be handled.

By applying one pulse to terminal $G_{1}$ at a time when bits of the final digit place of numbers stored in registers $A$ and $B$ are sent to 101 and 102 as inputs, the additional result of $x$ and $y$ reaches the input side of register $C$. Upon applying a pulse to terminal $G$, the sum of $x$ and $y$ enters register $C$ to be stored. In this case, the number of pulses sent to $G$, and $G$ must equal the number of digit places.

The carry-over produced in addi-


FIG. 5-Symbolic diagrams for serial-type ( $A$ ) and parallel-type (B) registers. Modification of input writing circuit for ( $B$ ) is shown in (C). Shift register is shoun in (D)

(c)


(D)

(f)

F1G. 6-Symbolic diagrams for half adder ( $A$ ), full adder ( $B$ ), serial adder (C), parallel adder ( $D$ ), and high-speed carry adder $(E)$ and for a multiplier ( $F$ )
tion is delayed by parametrons 301 and 103. On entering the adder the carry-over is added with a bit in the next high-digit place after a predetermined time interval. As a rule, register $C$ is used for the same purpose as register $A$ and is called the accumulator register. The time required for addition is $n T, n$ being the number of digit places.

Parallel adder: Figure 6D shows a parallel-type adder circuit which is constructed by connecting in parallel the same number of adder circuits, shown in Fig. 6B, as that of digit places. Carry is given as the third input to the upper digit place while the sum of $x$ and $y$ is available from terminals $S_{1}$ and $S_{4}$ simultaneously. The adding time is governed by the transmission time for carry. This time is $n / 3 T$ for the case of a binary $n$-bit number which is three times faster than the speed of the serial-type adder.
High-speed carry adder: As has been mentioned previously, the adding speed of the parallel-type adder is governed by the transmission speed of carry. Since the emphasis of the arithmetic circuits of a computer is placed on the adder, the entire computation speed is naturally governed by the speed of the adder.

Various contrivances have been made in order to increase the adding speed. Fig. 6E shows one example. Although the basic operation of this circuit is the same as that of Fig. 6D, carry-over is performed at an extremely high speed with this circuit. Addition of all numbers is done after the carry computation has been finished.

For the detection of carry, each
digit place is provided with a threeinput majority circuit. Thus, the carrying process for two-digit places is performed during one rhythm excitation time interval, $1 / 3 T$. As a result, the carrying operation for six-digit places progresses during one information transmission time interval, $T$, and the adding time becomes $n / 6 T$ resulting in a rapid increase in speed.
Multiplication: The multiplying operation consists of the adding operation and the repetition of shift. It can be performed by using the above mentioned adding circuits with an auxiliary register. In performing additions, however, carryover must progress perfectly. Since a considerable time interval is needed for multiplication, a method of adding to the next higher digit place is resorted to as a means for raising the multiplication speed.

This method must function without progressing the carry in each digit place which is produced in adding a multiplicand to a partial

TABLE I-Principle of Full Adder Circuit

| Input |  |  | Output |  | 102 | Co ${ }^{\prime}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $x$ | y | $\begin{aligned} & \text { Carry } \\ & \text { (C) } \end{aligned}$ | $\underset{(\mathbf{S})}{\text { Sum }}$ | $\begin{aligned} & \text { Carry } \\ & \text { (Co) } \end{aligned}$ | Borrow (B) | $\begin{aligned} & \text { NOT } \\ & \text { for } \\ & \mathrm{C}_{0} \end{aligned}$ |
|  | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 1 | 0 | 1 |  |
| 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| 0 | 1 | 1 | 0 | 1 | , | 0 |
| 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| 1 | , | 1 | 1 | 1 | 1 | 0 |

product in course of the multiplication process. Figure $6 F$ shows a binary 3 -bit multiplication circuit provided with such a function. Using this circuit, the same number of adders as the digit places is arranged with partial products being shifted to the right. Therefore, to add a carry-over to the next higher digit place, the carry must be returned to its own digit place.

Multiplicands $x_{1} \sim x_{3}$ are given in parallel and the and gating circuit is controlled by each bit of the multiplier $y$ introduced in serial, beginning with the lowest digit place. In this manner the addition of the partial product and the multiplier is carried out. The result of a multiplication is available serially. The time required for multiplication is $n T$ for an $n$-digit place number while the time required for completion of the entire multiplication process becomes $2 n T$.

Radix $N$ counter: Figure 7A shows a binary counter circuit for one digit place. The contents are changed each time an input pulse is applied to the input terminal $x$. When a change takes place from 1 to 0 , pulses are sent out from the output terminal $y$ as an output. This circuit corresponds to the flip-flop circuit comprising vacuum tubes.

To construct an $N$-binary counter circuit, it is only necessary to connect $n$ circuits of this type in cascade. Figure 7 B shows $2^{3}$ or the scale-of-eight counter circuits, one output pulse being obtained from the output terminal $y$ for each eight input pulse. To construct a radix $N$-counter circuit that is not expressed by $2^{\prime \prime}$, the computer must be preset to skip $2^{\prime \prime}-N$ pulses by using an $N$-binary counter circuit, assuming that $N=2^{n-1}<N<2^{n}$.

Figure 7C shows an example of the scale-of-seven counter circuits. By performing the internal feedback as shown by the heavy line with the above mentioned scale-ofeight counter circuits, digit 1 is preset by the output pulse. Therefore, one output pulse is sent out for each seven pulses.

Reversible counter: Figure 7D shows an example of the scale-ofeight subtraction circuits. The contents stored in the counter circuit are subtracted by one each time a pulse is sent to terminal $x$. The counter circuit used for both addition and subtraction is called the
reversible counter circuit. Scale-ofeight reversible circuits are illustrated in Fig. 7E.

This circuit is the same as that in Fig. 7B where the input applied to terminal $S$ is zero while the constant input is considered to have been reversed when the input is 1 . Therefore, the pulses sent to terminal $A$ are added to the counter contents and the number of pulses sent to terminal $S$ is substracted from the contents.

Code converter: A translating circuit made up of a diode matrix is commonly used for the code converter circuit. A description is now given referring to a circuit using a similar parametron circuit.

Figure 7 F shows a matrix translating circuit consisting of aND circuits. Each of the sixteen outputs correspond to binary four-bit numbers available from the parametrons which constitute the intersection points of a matrix. Although the coupling lines from $x$ or $y$ directions are made to pass through the parametrons for brevity in the figure, these are two-input and circuits. The 16 parametrons belong to the same excitation classification. This circuit is used as an address decoder for designating memory addresses of the memory device in a computer.

Figure 7G shows a decimal to binary translation circuit. The input information sent to each binary three-bit output parametron is determined by the algebraic sum of the induced voltages of toroidal magnetic cores assembled in matrix form. With these magnetic cores, it may be considered the direction of voltage induced in the secondary windings is encoded with respect to
all primary windings wound in the same direction.

The manner in which parametron 5 has been selected out of all the parametrons 0-7, for decimal numbers is also shown in Fig. 7G. In the secondary windings (in column direction) of all magnetic cores, information voltages are induced as shown (expressed by +1 and -1 ). The output parametrons initiate oscillations according to this information on the basis of the majority principle. In this case, the digit place for $2^{\circ}$ and $2^{2}$ become 1 ; that for 1 and $2^{1}$ becomes 0 . Thus, a binary number 5 (101) is available from the output parametron.

Input-output translation: The parametron receives an item of information in the form of a phase. For this reason, mutual translation between phase and voltage or phase and current becomes necessary where a parametron circuit is coupled with another system such as, for example, vacuum-tube, transistor, or relay circuits.

Since the simplest method of controlling the oscillation phase of a parametron is done externally, the input information is directly controlled as shown in Fig. 8A. Let 101 and 102 be constant parametrons of +1 . Then the output of 201 is 0 by a NOT input if switch $S$ is open; however, if switch $S$ is closed, 1 is sent out from 102 by a double coupling.

Figure 8B shows an example of the input conversion circuit utilizing the saturation characteristics of a magnetic core. Constant information is coupled to the conversion parametron through three transformers. The induced voltage pro-

(A)

(日)

(c)


(D)

(F)
(E)


FIG. 7.-Symbolic diagrams of radix $N(A)$, scale-of-eight (B), scale-of-seven ( $C$ ), scale-of-eight subtractive ( $D$ ) and scale-of-eight reversible $(E)$ counters, and of matrix ( $F$ ) and decimal-to-binary ( $G$ ) translators
duced by transformer $T_{1}$ is in opposite phase to the induced voltages produced by $T_{2}$ and $T_{3}$.

Transformers $T_{2}$ and $T_{\mathrm{z}}$ are so balanced that the circuit on the d-c side may not affect the parametron information. When $S$ is open (or control current is 0 ), coupling information produced by $T_{2}$ and $T_{3}$ is greater than that produced by $T_{y}$ Upon running a control current sufficient for the saturation of $T_{3}$ and $T_{s}$ after closing switch $S$, information produced by $T_{2}$ and $T_{3}$ is minimized. The conversion parametron initiates oscillations in phase opposite to a case in which the control current is zero.

Figure 8C illustrates an example of the circuit for converting pararietron information into a d-c signal. Suppose that in the figure the number of turns of signal windieg $n_{1}$ is equal to the number of turhs of the constant winding $n_{2}$ and they are wound in the same direction. Then a voltage is produced across the secondary winding of the transformer where the signal side and the constant information are in the same phase.

This voltage is rectified and amplified by a vacuum tube circuit. If a neon tube, relay or the like are inserted in the anode circuit, the phase information can be monitored or connected to other systems.

Figure 8D shows a circuit in which tubes are replaced with transistors. Circuit operation is exactly the same as in the above mentioned case.

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(A)

(c)


(D)

FIG. 8-Symbolic (A) and schematic ( $B$ ) diagrams of voltage-to-pheise converter, and for tube (C) and trinsistor (D) versions of phase-to-voltage converter

## MEASURING SWITCHING SPEED OF

## Magnetic Films

## Strip transmission line is used in measurement apparatus for determining polarity reversal time of thin magnetic films. Fast rise pulse is obtained from a charged coaxial cable



Thin magnetic film is being measured with the aid of a strip transmission line. The four resistors are symmetrically placed in such a way that voltage induced by air flux is essentially cancelled

## BY W. DIETRICH

and W. E. PROEBSTER,
International Business Machines Corp., Zurich, Switzerland

THIN MAGNETIC films have certain features that make them useful for storage and switching elements in electronic computers. The films have two stable states of magnetization and can be switched from one condition to the other in about one nanosecond. Another desirable characteristic is their small size, which is of value in miniaturization. Such films are about 0.1 micron thick; they are made of soft magnetic
material, preferably Permalloy with a composition of 80 percent nickel, 20 percent iron.

To provide a basis for circuit design, the switching behavior of the film has to be investigated. Special pulse equipment had to be developed because the reversal times involved are beyond the time resolution of conventional oscilloscopes using distributed amplifiers and the small signal amplitudes do not allow exact observation by a traveling wave oscilloscope.

The measurement equipment has to have an overall response time less than $0.5 \mu \mathrm{sec}$ to resolve the switching processes sufficiently. Sensitiv-
ity has to be at least $50 \mathrm{mv} / \mathrm{cm}$ deflection on the crt with adequate signal to noise ratio. The latter figure is based on a characteristic switching signal of a Permalloy film 0.1 micron thick and 0.5 cm in diameter; flux reversal in $2 \mu \mathrm{sec}$ induces about 0.5 v in a single turn loop.

Figure 1 shows the general principle of the pulse measurement equipment. Homogeneous fields of up to about 10 oersted, with fast rise times, have to be provided in the plane of the film. These magnetic fields are produced by the discharging current of a previously charged 50 -ohm coaxial cable into a short-circuited 50 -ohm strip-trans-

FIG. 1-Coaxial cable is discharged through contacts of mercury relay 50 times a second into strip transmission line. Resulting magnetic field at the thin film has the necessary fast rise time

mission line. The discharging switch is a special coaxial relay with mercury wetted contacts which show no contact chatter and low contact resistance. It is operated at 50 cps . The other end of the charging cable is terminated by a matching network which absorbs the reflected wave. Diode $D_{1}$ disconnects matching resistor $R_{m}$ from the cable during the charging time between pulse intervals. The R-C network compensates for the response time of the diode.

Two pairs of Helmholtz coils set up additional static magnetic fields and reset fields in the plane of the film. The earth's magnetic field is cancelled by a third pair of coils.

The stripline consists of two equal plates, about 5 cm long and 1.5 cm wide; width is determined by the maximum sample diameter, in this case about 1 cm . One end of the line is short-circuited to double the magnetic field caused by the reflected wave; the other end is connected to the charging cable. The line shows a characteristic impedance of 50 ohms, determined by the width of the plates and the distance of 0.1 in . between them. The maximum field amplitude is limited by the back-voltage of diode $D_{1}$, the power dissipation of the mercury relay and the geometry of the strip-
line. For the apparatus shown, the maximum charge is 600 v , which gives a field of 7.5 oe.

Two different kinds of striplines are used. The first stripline, Fig. 2 A , picks up the longitudinal flux change of a film under test, that is, the flux change in the direction of the driving pulse field. Pickup is accomplished by a wire 0.1 mm in diameter that is placed in the symmetry axis of the strip line. The inner end of this wire is terminated in four 200 ohm resistors symmetrically connected to the two plates of the line. Voltage induced by the air flux is practically cancelled by this arrangement. Some of the details can be seen in the photograph.

The second stripline, Fig. 2B, picks up the transverse magnetic flux change; this is the flux that is perpendicular to the driving field. A thin pickup wire of 20 micron diameter is placed normal to the long axis of the line and parallel to the plates. It is possible to connect one end of this wire directly to one plate of the stripline because no air flux is picked up. An additional small wire of 0.5 mm diameter above it acts like an electrostatic shield and reduces capacitive disturbance by a factor of three.

Distance between the film sample and the shorted end of the stripline

(A)

( $B$ )

(C)

FIG. 2-Shorted strip transmissi $n$ line with pickoff of longitudinal flax change in film under test ( $A$ ); piqcoff of transverse magnetic fux (B). Signal induced in unbalanced pickup from air flux is shown in (C), where each large division is 0.4 nsec
determines the time it takes the field at the film to increase to its final value. The distance should be small, and for the apparatus shown, rise time is about $0.1 \mu \mathrm{sec}$, whith is small compared to the switching time.

The picked up signal is fed lover a delay cable to a special sampling oscilloscope ${ }^{1}$. A minimum delay of $60 \mu \mathrm{sec}$ is necessary, because this is the delay between the trigger pulse and the strobing pulse of the sampling oscilloscope. For the signal delay cable a wide band cable, type RG-19U, is used; it has 3.5 db attenuation per 100 ft at $1,000 \mathrm{Mc}$. Such a small attenuation does not affect the time resolution of the sampling oscilloscope, which is about $0.35 \mu \mathrm{sec}$, while a 50 ohm cable, type RG-9U, for example, showed an increase of the overall response time by $0.2 \mu \mathrm{sec}$. The trigger pulse is derived at the matched end of the charging cable to avoid distortion of the front edge of the driving field pulse. Rise of the pulse field inside the stripline is illustrated by Fig. 2C, which shows the signal induced by the air flux in the longitudinal pickup. This pickup is matched unsymmetrically to one plate of the stripline only, and forms a loop of $0.27 \mathrm{~cm}^{2}$. Rise time is evidently equal to or smaller

FIG. 3-Electronic subtracter reduces system disturbances by a factor of 10 and holds the peak noise level to about s $m v$ at 4 oe pulse field. Sensitivity is about $50 \mathrm{mv} / \mathrm{cm}$

than the response time of the oscilloscope.

Disturbances caused by capacitive and remaining inductive coupling between stripline and pickup loop can be considerably reduced as they are periodic. In principle, the disturbing signal alone-produced by completely saturating the film while the drive pulse is applied-is subtracted from the disturbed switching signal. However, no complete storage of the two waveforms is necessary since sampling is used and subtracting is done point by point. The two waveforms are produced alternately and sampled for example at times $t_{0}, t_{0}+\Delta t, t_{0}+2$ $\Delta t$, where $t_{0}$ is the start time of the signal derived from the time base of the oscilliscope. Thus just one sample is stored and from it the second sample is subtracted. Figure 3 shows a simple electronic circuit for this purpose. This circuit reduces the disturbances of the setup by a factor of more than 10 and gives a sensitivity of about $30 \mathrm{mv} / \mathrm{cm}$ and a peak noise level of about 3 mv at 4 oe pulse field.

The remaining disturbances become smaller when the interval $\Delta t$ decreases. They should drop to zero for $\Delta t=0$, that is, when the signal and disturbances are sampled at the same time. Such a procedure would

(B)

(C)

FIG. 4-Switching of Permalloy film: longitudinal $(A)$ and transverse ( $B$ ) signals for coherent rotation. Each unit square in $(A)$ is 0.4 nsec wide by 0.6 v high; in ( $B$ ) each square is 0.4 nsec wide by $0 . s v$ high. Inverse switching time vs switching field $H$, is shown in (C). $H_{\text {. }}$ is applied parallel to the preferred axis, $H_{F}$ perpendicular thereto
also allow a reduction of the noise by sampling and integrating over a number of events.

It is known from low-frequency measurements ${ }^{2}$ that the flux reversal in a Permalloy film can be by pure rotation of the magnetization in the plane of the film when a suitable drive field is applied. The speed of this rotation has been estimated to be in the $\mu \mathrm{sec}$ region, when the drive field, or switching field, $H_{0}$, consists of a step pulse. Observation of the longitudinal and transverse output signals, $d M_{L} / d t$ and $d M_{F} / d t$, of a film under the same driving conditions allows determination of whether switching takes place by a pure rotation. For this, the point of the magnetization vector has to describe an exact circle in the $M_{r}-M_{L}$ plane during the reversal. The $1 /{ }^{T}$ versus $H_{s}$ curves in Fig. 4C indicate that films switch about 100 times faster than bulk material ${ }^{3}$.
Thanks are due to H. P. Schlaeppi and his group at the IBM research lab, Zurich, for providing the highspeed sampling oscilloscope.

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# Biasing Methods for Tunnel Diodes 

By RAY P. MURRAY,
Associate Prof. of Electronics, U. S. Naval Postgraduate School, Monterey, California

THERE ARE two main categories of d-c operation of the tunnel diode, and each is affected by the total series resistance in the circuit. In one category, the tunnel diode operates in the switching mode, and in the other category, the tunnel diode operates as an oscillator or amplifier.

For the switching mode, a highresistance circuit is used (Fig. 1). The resistance is high enough so that the load line intersects the diode characteristic in three places, one of which is unstable (point $B$ ). For bistable operation to result, it is necessary that $R_{s}>|r|$, where $|r|$ is defined as the least numerical value of the diode negative resistance. This value of $r$ corresponds to the steepest part of the negativeresistance portion of the diode's characteristic curve.

Figure 2A shows another interesting example of the switching mode. Series resistor $R$ and the tunnel diode are considered as a single circuit element. Such a combination may be encountered in tunnel diode pulse circuits. If series resistor $R$ has a greater resistance than $|r|$, the composite diode-resistor circuit will produce the characteristic shown in Fig. 2B. Values of $V$. and $R$, determine whether the diode-resistor circuit will be bistable or monostable and also whether it may be triggered from one state to another by a negative and/or a positive pulse.

The second category of d-c operation biases the tunnel diode in the negative-resistance region, as shown in Fig. 3. For the d-c loadline analysis, it is convenient to represent the bias supply by its Thev-enin-circuit equivalent (Fig. 4A). Since $R$, is less than $|r|$, bistable operation will not result. By proper
choice of $V_{s}$, the operating point may be situated in the negativeresistance region of the diode characteristic. This type of operation is required for oscillator and amplifier applications.

Consider the circuit of Fig. 4B, which may be either an amplifier or oscillator. For simplicity, all of the circuit losses, such as that resulting from the load resistance, can be lumped into the series a-c resistance of the coil, $R_{\text {a-c }}$. For this circuit to function as either an amplifier or an oscillator, it is necessary that the sum of the d-c resistance of the coil and the bias supply resistance be less than $|r|$. In Fig. 4 B , this requirement means the coil must have a d-c resistance, $R_{\text {d-a }}$, that is less than 140 ohms.

To obtain oscillation, in addition to this d-c requirement it is necessary that the total series a-c resistance be negative, that is, the real component of the total series a-c impedance must be negative. In Fig. 4 B , this requirement means the a-c resistance of the coil, $R_{n-c}$, must be less than 140 ohms. In general, it is easy to meet both of these requirements.

To obtain amplification, in addition to the d-c requirement mentioned previously it is necessary that the total series a-c resistance be positive. In Fig. 4B, this requirement means the coil a-c resistance must be more than 140 ohms. Thus, adjustment of circuit impedance values is much more critical for amplifier operation than for oscillator operation.

In the preceding discussion on amplifier and oscillator operation, it was tacitly assumed that the frequency of operation was low enough to neglect the reactance associated with the tunnel diode; this assumption meant the negative resistance presented by the tunnel diode corresponds to that of the volt-ampere characteristic. However, as the frequency of operation is increased, the reactances of the diode reduce
its negative resistance until at some high frequency the net resistance shifts from negative to positive. This negative-resistance cutoff frequency, $f_{c}$, defines the upper useful frequency of the tunnel diode.

The total impedance of the tunnel diode (equivalent circuit shown in Fig. 4C) is $Z=j \omega L+(r)(1 / j \omega C) /$ $(r+1 / j \omega C)+R$ which becomes rationalized and written as

$$
\begin{align*}
Z= & \frac{\left(\omega^{2} C^{2} r^{2} R+R+r\right)}{\omega^{2} C^{2} r^{2}+1}+ \\
& j \frac{\left(\omega^{3} L C^{2} r^{2}+\omega L-r^{2} \omega C\right)}{\omega^{2} C^{2} r^{2}+1} \tag{1}
\end{align*}
$$

Equating the real and imaginary parts to zero gives the resistive cutoff frequency, $f_{o}$, and the selfresonant frequency, $f_{r}$, respectively.

$$
\begin{aligned}
& f_{c}=[1 / 2 \pi|r| C][(|r| / R)-1]^{1 / 2} \\
& f_{r}=[1 / 2 \pi|r| C]\left[\left(r^{2} C / L\right)-1\right]^{1 / 2}
\end{aligned}
$$

For a ZJ56A diode with clipped leads (typical values shown in Fig. $4 \mathrm{C}), f_{e}$ is 1.8 Gc and $f_{r}$ is 0.75 Gc . Since $f_{r}$ can be less than $f_{c}$, the resistance at the self-resonant frequency can be negative.

Thus high-frequency oscillations may result for low values of bias resistance $R_{2}$. If $L$ is reduced so that it is equal to or less than $R C|r|$, the device becomes short-circuit stable, that is, lower $L$ means higher $f_{c}$ and if $f_{r}$ exceeds $f_{e}$, $\omega^{2} C^{2} r^{2} R+R$ will exceed $|r|$, resulting in a positive resistance at $f_{r}$.

Let us consider a circuit in which this problem of high-frequency oscillations is encountered. The series resistance of the volt-ampere characteristic curve tracer shown in Fig. 5 is low enough to prevent switching. Yet there is a distinct possibility that oscillation may occur as the device is swept through its negative-resistance region. If oscillations do occur, they will be at a frequency determined by the lead inductance and capacitance acting in conjunction with the equivalent circuit of the diode. For proper operation, $R$, must not only be less than the low-frequency value of $|r|$ taken from the volt-ampere charac-

Here's how to determine the proper bias and the correct circuit impedances for operating the tunnel diode as a switch, amplifier or oscillator
teristic, but also greater than the absolute value of diode resistance computed from Eq. 1 at the possible frequency of oscillation. These requirements may not be difficult to meet unless the lead inductance and capacitance produce a sufficiently low resonant frequency to cause the high-frequency negative resistance to approach the low-frequency value. In this case, the circuit stability approaches zero; that is, if $R$, is too low, there is oscillation,
and if $R_{2}$ is too high, there is loss of the proper operating point because of switching.

Figure 6 shows two examples of faulty curve tracing by the curvetracing circuit of Fig. 5. In Fig. 6 A , switching occurs as the result of too high a series resistance. Here, Fig. 5 was modified by adding 500 ohms in series with the 75 -ohm resistor, thus producing a load-line resistance of about 400 ohms. In Fig. 6B, high-frequency oscillation
occurs because the revultant a-c circuit resistance is negative at the self-resonant frequency, $f_{c}$. Here, shunting tunnel diode $D_{1}$ with a 5 -pf capacitor lowered the resonant frequency, thus producing a negative a-c circuit resistance. Oscillations can also be produced by adding an $0.5-\mu \mathrm{h}$ inductance in series with tunnel diode $D_{1}$. For both A and B, the abscissa is 0.1 v per division and the ordinate is 0.2 ma per division.


FIG. 1-Biasing the tunnel diode for bistable operation. Curve shows normal tunnel diode functioning


FIG. 2-Circuit and characteristic considering tunnel diode and series resistance as single component


FIG. 3-Biasing the tunnel diode for amplifier or oscillator operation


FIG. 4-Approximate Thevenin equivalent for Fig. 3 A (A); tunnel-diode oscillator or amplifier circuit ( $B$ ); equivalent circuit of tunnel diode ( $C$ )


FIG. 5-Tunnel-diode-characteristic test circuit. Leads to tunnel diode must be short


FlG. 6-Switching caused by over-high series resistance ( $A$ ); oscillation resulting from a negative circuit resistance at self-resonant frequency (B)


Low frequency antennas with umbrella top hat: arrangement (A) shows apex angle 65 degrees


Arrangement (B) has angle apex of 44 degrees

By GEORGE J. MONSER and WALLACE D. SABIN,

Motorola Inc.,
Military Electronics Division,
Scottsdale, Arizona.

A SIMPLIFIED analysis is developed, in which it is shown that for maximum radiation efficiency for specified bandwidth, the ratio of the radiation resistance to antenna reactance slope at the operating frequency should be maximized. Test data supporting the theory is given for two base-feed radiators: a $\frac{1}{10}$ scale model evaluated at 1.5 Mc , and a 150 -foot unit evaluated at 150 Kc. While the test data is restricted to these two units, the basic precepts are general and can be applied to the design of any electrically short vertical radiator.

Radiation efficiency provides a convenient means for measuring the radiation capability of the antenna, since it relates the radiated power to the antenna input power. The


FIG. 1-Antenna equivalent circuit, upon which analysis is based (A), and simplified layout of scale-model antenna (B)

## Antenna Design for

Half-wave antennas, although efficient radiators, may be several miles long for very low frequency operation. Here are design criteria for electrically short antennas with
high radiation efficiency, plus data from test anternas
antenna must of course be suitably coupled to the transmitter, and coupler loss should be included in the definition.

For the arrangement illustrated in Fig. 1B, percentage radiation efficiency is given by

$$
\begin{equation*}
\eta_{R}=\frac{R_{a}}{R_{\text {loog }}} \times 100 \tag{1}
\end{equation*}
$$

Where: $R_{\text {a }}=$ antenna radiation resistance referred to the base (or driving point), $R_{\text {toop }}=R_{a}+R_{s}+$ $R_{1}+R_{1}+R, R_{g}=$ equivalent ground loss resistance, $R_{1}=$ equivalent base insulator loss resistance, $R_{1}=$ base tuning coil resistance, and $R$ $=$ broadbanding dissipative resistance.

Maximum efficiency occurs when $R_{\text {a }}$ is maximum and $R_{\text {toop }}$ minimum. A limit on the reduction of $R_{\text {Ioop }}$ is set by the required radiation bandwidth. Thus
$Q=\frac{f_{0}}{2 R_{\text {loop }}}\left|\frac{d X}{d f}\right|_{f_{0}}=\frac{f_{0}}{R_{\text {Loop }}}\left|\frac{d X_{s}}{d f}\right| f_{0}$
where $d X / d f \mid f_{0}=$ net reactance slope evaluated at $f_{\mathrm{o}}, d X_{n} / d f^{\prime} f_{0}=$ antenna reactance slope evaluated at $f_{0}$, and $f_{*}=$ frequency for which net reactance $X=Q$.

Substituting into Eq. 1

$$
V_{\mathbb{R}}=\left[\frac{R_{a}}{\left(\frac{f_{0}}{Q}\right)\left|\frac{d X_{a}}{d f}\right|_{f_{0}}}=\frac{R_{a}}{(B W)\left|\frac{d X_{a}}{d f}\right|_{f_{0}}}\right] \times 100
$$

Either quantity within the brackets may be used to calculate radiation efficiency. Equation 2 shows that for a particular bandwidth $(B W)$, a maximization of the $R_{e}\left|\frac{d X_{e}}{d f}\right|_{f_{0}} \quad$ ratio is required.

Radiation resistance provides a convenient concept for relating radiated power to the antenna driving current. For an electrically short monopole, the radiation re-


FIG. 2-Scale model impedance curves for range of top-loading coil reactances ( $A$ ); efficiency versus frequency for the $150-f t$ antenna with guy-wire top-hat (B); driving point resistance and reactance of $150-f t$ antenna versus frequency
for top-hat apex angle of 68 degrees ( $C$ )

## Maximum L-F Radiation

sistance (referred to the base) is $R_{a}=40 \pi^{2}(h / \lambda)$ )
Where $h=$ height of vertical radiator and $\lambda=$ wavelength expressed in same units as $h$.

Equation 3 can be extended to include the effect of top-loading.

For a short monopole, top-loaded with a nonradiating capacitive tophat', the radiation resistance becomes

$$
\begin{align*}
& R_{a}=1,978\left(\frac{h}{\lambda}\right)^{2} \\
& {\left[1-\frac{h}{h+b}+(1 / 4)\left(\frac{h}{h+b}\right)^{2}\right]} \tag{4}
\end{align*}
$$

Provided $(h+b)<0.1 \lambda$, where $h=$ length of vertical radiator, $b=$ equivalent additional vertical length resulting from the top-loading, $\lambda=$ wavelength expressed in same units as $h$.

For a short monopole, with a combined top-load consisting of a coil in series with the hat, no known simple expression exists for calculating radiation resistance. However, when the reactance of the toploading coil is much less than the reactance of the top-hat, the effect is analogous to increasing $b$ slightly in Eq. 4.

The reactance of the monopole (stub) is $X_{a}=-Z$. cot ( $2 \pi h / \lambda$ )
where $Z_{0}=60[\ln (h / p)-1]=$ characteristics impedance of the stub considered to be a transmission line, $h=$ antenna height, $\lambda=$ $c / f=$ wavelength in the same units
as $h, p=$ equivalent radius of stub in the same units as $h, c=$ speed of light, $f=$ frequency.

Under the following restrictions of $h / \lambda<0.1$ and $60<h / p<90$ the reactance equation becomes $X_{\text {u }}$ $=K_{A} / h f$ where $K_{A}=-Z_{n} c / 2 \pi=$ a constant. The antenna slope reactance is therefore

$$
\begin{equation*}
\frac{d X_{a}}{d f}=\frac{K_{a}}{h f^{2}} \tag{6}
\end{equation*}
$$

In similar fashion for the toploaded antenna

$$
\begin{equation*}
X_{a}^{\prime}=\frac{\beta K_{A}}{h f^{a}} \tag{7}
\end{equation*}
$$

Where $K_{A}, h$, and $f$ are as defined for equation (5), $\beta=$ coefficient due to top-loading, $a=$ exponent for the frequency term and $d X_{a}{ }^{\prime} / f=a K_{A} /$ $h f^{a+1}$

The exponent $a$ is close to unity for the capacitive top-hat. For combined top-loading, the exponent may approach 10 .

Several methods are available for controlling or modifying the performance of base-driven vertical antennas.

The following techniques are examples: (a) guy-wire capacitive top-loading, (b) flat-disk capacitive top-loading, (c) combined top-loading, where a coil is inserted between the top of the tower and the top-hat.

Figure 1B shows a sketch of the scale model antenna. In this figure, the umbrella or guy-wire top-hat length is specified for maximum radiation resistance. To establish
this length, tests similar to those performed by Smith and Johnson ${ }^{1}$ were conducted. The improvement in radiation capability was referenced to this configuration.

Observe in Fig. 1B, that if the apex angle approaches 90 degrees, the umbrella top-hat becomes electrically equivalent to a flat-top. The effect of increasing the apex angle has recently been reviewed in the literatures. To verify published data, two apex angles ( 44 and 63 degrees) were checked. Smeby ${ }^{2}$ showed in an earlier paper that the effect of top-hat current on useful radiation becomes less pronounced with larger apex angles and that a further reduction in the effect of top-hat current would be obtained by folding back the top-hat. For the Smith and Johnson antenna, he indicated that theoretically about 1 db improvement in radiation capability would result, if the top-hat was folded back.

Table I summarizes the results for the different arrangements investigated using the scale model antenna.

Additional insight into the performance characteristics listed in Table I may be had by observing Fig. 2A and Table II. Figure 2A shows the antenna input impedance components for the scale model plotted as a function of frequency. Three different top-loading coil impedances $\left(Z_{n}\right)$ are indicated. For $Z_{n}$

TABLE I-Efficiency Varies Widely With Antenna Configuration


TABLE II—Reactance Equations For Different Antenna Arrangements

| Antenna Identification | Reactance Equation | Equation Valid For Frequencies Between |
| :---: | :---: | :---: |
| Type 2 | $855 f_{m e}{ }^{-1.06}$ | 1-2 Mc |
| Type 7 | $700 f_{m c^{-1.08}}$ | $1-2 \mathrm{Mc}$ |
| Type 7 | $595 f_{m e}{ }^{-1.06}$ | 1-2 Mc |
| Top hat extended one section- <br> Apex angle $63^{\circ}$ |  |  |
| ${ }_{\text {Type } 7}{ }^{\text {Apex }}$ | $505 \mathrm{fmc}^{-1.08}$ | 1-2 Mc |
| Top hat extended two sections- |  |  |
| Type 8 | $700 \mathrm{f}_{\text {mc }}{ }^{-1.08}$ | 1-2 Mc |
| Type 3a | $740{ }^{7} \mathrm{f}_{\text {m }}{ }^{-1.6}$ | $1-1.5 \mathrm{Mc}$ |
| Type 3* | $1290 \mathrm{fme}_{\mathrm{c}}^{-3.4}$ | 1. $6-1.6 \mathrm{Mc}$ |
| Type ${ }^{\text {a }}$ | $19100 f_{\text {fme }}{ }^{\text {c-0.2 }}$ | 1.6-1.8 Mc |
| 1/10 scale model antenna5 foot radius disk top hat | $1110 f_{m e}{ }^{-1.09}$ | 1-2 Mc |

Type 2
Type 7
xtended one sectionType 7
Top hat extended two sectionspex angle $63^{\circ}$
Type ${ }^{\text {a }}$
Type 3*
/10 scale model antenna-

- $X_{n}=363$ ohms at 1.5 Mc (top loading coil)
$=0$, the unit is simply an umbrella top-loaded unit. Observe that with increased top-loading-coil reactance $X_{n}$, the input reactance decreases and the reactance slope at the operating frequency increases.

Table II summarizes the reactance data for a number of different top-loading conditions considered in Table I. In Table II, reactance curves similar to those shown in Fig. 2A were reduced to equation form over the range of interest. Observe that with the exception of the combined top-loading case, the reactance exponent is close to unity, so that the effect on radiation efficiency indicated by Eq. 2 is small. However, for combined top-loading, this is not the case. It was found that only about 1 db improvement in radiation efficiency over the type 2 unit could be obtained with this type of loading, even though the driving point antenna reactance could be greatly reduced.

The greatest improvement noted during the scale model tests was between the type 2 unit and the type 9 unit (see Table I), where a 2.4 -db improvement in radiation was measured. Accordingly, the 150-foot antenna performance was first measured as a type 2 unit, and then as a type 9 unit. The data was treated similarly to that outlined for the model, and the improvement in radiation efficiency was found to be about $2.8-\mathrm{db}$. This value was then checked by computing efficiency using Eq. 2. Figure 2B shows the results of this effort.

Figure 2C shows the final antenna design values. In this figure, driv-ing-point impedance components, radiation resistance, and $\mathbf{Q}$-static ( $X_{D P} / R_{D P}$ ) are sketched as a function of frequency.

Field test data presented in this article were obtained while performing work on Contract DA 36-039-SC-78020.

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F'G. 1-Multiplex transmitter (A), receiver ( $B$ ) and waveform of transmitted signal showing sync signal (C)

# Bilingual Multiplex 


#### Abstract

British multiplex system, using technique similar to our color tv system, is used for European bilingual broadcasts or conventional stereophonic transmissions


By NICK LANDON, London Bureau, McGraw-Hill World News
developed by Mullard Ltd., London, England, this twin-signal system can be used for bilingual broadcasts or other twin-signal purposes such as stereophonic transmissions. The system is basically an application of pulse-amplitude time multiplexing in which the bandwidth after multiplexing, but before transmitter modulation, is restricted to a logical minimum.

In the transmitter, a sampling generator operating at the multiplexing frequency of 32.5 Kc produces two sine waves out of phase. These are fed to two mixers (see Fig. 1A), to which the $A$ and $B$ audio signals are also supplied. The sampling sinusoids are half-wave rectified to produce two time-interlaced pulse trains, one amplitude modulated by $A$ and the other by $B$. To resolve $A$ and $B$ ambiguity at the receiver (Fig. 1B), a small amplitude sync signal at sampling frequency is introduced in with the pulse trains as shown in Fig. 1C. Other than this, the transmitter is conventional. The theoretical limit of crosstalk at the $A$ input into the
$B$ output (and vice-versa) is -45 db.

The f-m receiver is conventional up to the output of the detector. As shown in Fig. 2, the negative sync pulses are used to phase lock an oscillator at the multiplexing frequency. The oscillator output is rephased by + or -90 deg to gener-
ate the correct phase relationship for operating the decoder mixers. Outputs of the decoders are deemphasized and fed to their respective audio amplifiers.

When receiving a monophonic signal, outputs appear at both mixers. Stopping the oscillator improves the signal-to-noise ratio.


FIG. 2-Receiving system can operate on either multiplex or monophonic transmissions. For monophonic reception, oscillator should be inoperative


## Axis-Crossing

 Intervals
# System described may provide knowledge necessary for the design of weak signal detectors based on an axis-crossing interval principle. Digital output contains data useful in theoretical studies of noise 

FIG. 1-Quantity to be measured is shown in (A). Timing diagrams: initiate commands ( $B$ ), noise input ( $C$ ), interval gate from sampler (D), clock pulses ( $E$ ) and input to counter (F). Setup of measuring system (G)

## By A. J. RAINAL,

The Johns Hopkins University,
Radiation Laboratory, Baltimore, Md.
ONE of the outstanding unsolved problems in the mathematical theory of noise is the determination of the statistical distribution of time intervals between the axiscrossings of a random process. Usually one is interested in the distribution of the axis-crossing intervals when the axis is located at the level of the average value of the random process. Since the level of this average value is normally zero the term zero-crossing problem is often used to refer to the general problem.

In the literature there is a paucity of analytic solutions for this problem. S. O. Rice ${ }^{1}$ treated the case of a random Gaussian process and was able to determine the average number of zeros in a time $T$, and the probability of finding a zero (not necessarily the first) in an increment of time $\Delta t, t$ seconds after a
zero had occurred. Kohlenberg ${ }^{2}$ and Steinberg, Schultheiss, Worgrin, and Zweig ${ }^{\text {s }}$ derived expressions for the average of the square of the number of zeros in a time interval $T$. Other analytical results have been obtained by Mc Fadden ${ }^{4}{ }^{44}$, Kuznetsov, Stratonovich, and Tikhonov ${ }^{s}$ and Tikhonov ${ }^{\circ}$, but thus far no new results amenable to machine calculation have been obtained. In short, it must be concluded that mathematical difficulties seriously limit the understanding of the phenomenon gained by analytical means. Under such circumstances it is a natural motivation to turn to experiments for a further insight into the problem.

Most of the experimental work dealing with this problem was reported by G. M. White ${ }^{7}$, Favreau, Low, and Pfeffer ${ }^{\text {, }}$, and C. R. Gates ${ }^{\circ}$. In order to explore the problem further an instrument has been designed and tested at the Radiation Laboratory. It differs considerably from previous instruments, and the
measurement is digital rather than analog. This approach not only permits the instrument to work in conjunction with a digital computer but also allows a wider variety of statistical quantities to be computed directly from the data. Furthermore, the inherent stability of a digital system allows measurements to be made over periods of hours or even days if required.

The quantity measured is illustrated in Fig. 1A. A sample function from an ergodic random process is shown, (perhaps a noise voltage) and an arbitrary axis-crossing level is indicated. The basic problem is to measure all time intervals $\tau_{1}$. The particular set of $\tau_{1}$ 's shown are the time intervals between an axis-crossing with a positive slope and an axis-crossing with a negative slope. This will be denoted by $\tau_{+}$. . The system to be described has provisions for measuring any of the four possible time interval sets; $\tau_{+-}, \tau_{++}, \tau_{--}$and $\tau_{-+}$; at any arbitrary axis-crossing level.


FIG. 2-Interval sampler can handle four possible interval sets

(A)


FIG. :-Random phasing error (A) and uniform probability density funo-
tion

Instead of measuring successive time intervals of a sample function as shown in Fig. 1A, uncorrelated samples of time intervals are measured. However, since the process is ergodic, the statistics of these samples are equal to the statistics of successive time intervals. The method of measurement consists of opening and closing a gate at the proper times following initiate commands. The gate is used to determine the number of clock pulses counted by an electronic counter. The count in this electronic counter is a measure of the time interval and is recorded on tape by a digital printer. Similarly, punched cards, or punched tape which feeds directly into a digital computer, can serve as the recording medium.

The circuit which produces the necessary gate is called the axiscrossing interval sampler. A block diagram of the system and timing diagrams are shown in Fig. 1B to G. Clock pulses (Fig. 1E) are spaced 20 microseconds apart. Initiate
commands (Fig. 1B) are spaced 0.5 second apart to insure uncorrelated samples. The system operates with random processes which have axis-crossing intervals less than 100 microseconds with a probability less than 0.01 .
The function of the axis-crossing interval sampler is to produce a gate voltage whose width equals the desired axis-crossing interval. This is indicated in Fig. 1. A block diagram of the axis-crossing interval sampler is shown in Fig. 2. A cathode follower input offers a low impedance to the high gain amplitude limiter. This is necessary to minimize stray pick-up. A Philbrick K2-X operational amplifier is used as the amplitude limiter and inverter. This stage contains the axis-crossing level adjustment-a precision potentiometer calibrated at 0.1 volt per division.

With no input applied (manual reset position) the potentiometer is adjusted so that a neon indicator lamp at the output of the limiter
just lights. The potentiometer dial reading then represents the value corresponding to the zero crossing level when the input is applied. Since the potentiometer is calibrated at 0.1 volt per division the axis-crossing level may be raised ( + direction) or lowered ( - direction) by any desired amount. With the noise input applied (operate position) the output of the limiter is a train of randomly spaced pulses whose pulse durations equal the random time interval being measured.

This random pulse train is applied to a modified Schmitt circuit in order to produce narrow positive pulses at times corresponding to the axis-crossings for the four different cases. For example, the output indicated by ++ contains puises which occur at the times the noise voltage crosses the crossing level with a positive slope. An OFF position provided on the slope selector switch shuts off all pulse inputs. A symmetry adjustment in the modified Schmitt circuit is adjusted so that a neon indicator lamp at the ouput of the Schmitt circuit just lights while in the manual reset position.

The 60 -cycle line frequency is used to calibrate the spacing of the clock pulses. With the $6.3 \mathrm{v}, 60$ cycle filament voltage applied to the input (line calibrate position) and the slope selector switch in either the ++ or -- position, the spacing of the clock pulses is adjusted until the number $833 \pm 1$ count is consistently recorded. This represents a period of the 60 cps sine wave in units of $20 \mu$ seconds. Also, while in the line calibrate position, the zero axis-crossing level is digitally reset by re-adjusting the axiscrossing level potentiometer until the number $116 \pm 1$ count is consistently recorded in both the +and -+ slope selector positions.

Function of the remaining circuits are to produce the interval gate. In particular, it is the gate bistable (flip-flop) that produces the interval gate. Two other bistables, the reset and initiate bistables, are used for timing.

Consider the case when it is desirable to sample the time intervals between a positive going zero crossing and a negative going zero crossing. The primary function of the instrument is to produce an interval


FIG. 4-Neon lamps indicate state of bistables while scope output allows viewing interval gate
gate whose width equals the desired time interval. Initially the bistables are set such that the initiate bistable through gate $V_{ \pm}$prevents the input pulses from entering the reset bistable; the reset bistable via gate $V_{3}$ prevents inputs from entering the gate bistable and the gate bistable via gate $V_{\text {g }}$ prevents clock pulses from entering the output cathode follower.

To produce the desired interval gate, the axis-crossing level is set to the zero position, the slope selector is switched to the +- position, and an initiate command is applied. The initiate command reverses the state of the initiate bistable, and hence pulses are permitted to enter the reset bistable. However, because of the position of slope selector switch, only pulses occurring at times of negative slope crossings are permitted to enter. The first such pulse reverses the reset bistable, permitting pulses to enter the gate bistable.

Now, because of the slope selector switch position, pulses occurring at times of positive or negative slope crossings are allowed to enter. How-
ever, since the last axis-crossing occurred with a negative slope, this assures that the pulse entering the gate bistable corresponds to the desired slope sequence +- and not -+ . The first such pulse reverses the gate bistable, permitting clock pulses to enter the output cathode follower. This change in state is also used to reset the initiate bistable, preventing any more pulses from entering the reset bistable.

The second such pulse again reverses the state of the gate bistable (to its initial state). This prevents clock pulses from entering the output cathode follower. This change in state is also used to flip the reset bistable, preventing pulses from entering the gate bistable. The change in state is also used to command the digital printer to print the number stored in the electronic counter.

At this point the interval gate has been generated and all bistables are set to their initial states. That is, the system has completed a cycle. This same cycle is repeated for other initiate commands.

Inherent in the method used to
measure time is the error due to the random phasing of the clock pulses relative to the interval gate. The rms magnitude of this error can be computed. In Fig. 3A interval gate widths $\Delta \tau$ and $2 T-\Delta \tau$ can permit one pulse to be counted by the electronic counter. Hence, when one count is observed the true width of the interval gate $\tau$ is in the range $0<\tau<2 T$. Assume that the probability that $\tau$ has any value in the range $0<\tau<2 T$ is uniform. That is, any particular width in this range is equally likely to have produced the observed count. The form of this assumed uniform probability density function is shown in Fig. 3B. The variance of the distribution is

$$
\sigma^{2}(\tau)=E\left[(\tau-\bar{\tau})^{2}\right]=E\left(\tau^{2}\right)-\bar{\tau}^{2}
$$

where

$$
\begin{aligned}
& E\left(\tau^{2}\right)=1 / 2 T \int_{0}^{2 T} \tau^{2} d \tau=4 T^{2} / 3 \\
& \bar{\tau}=1 / 2 T \int_{0}^{2 T} \tau d \tau=T=\text { Average Value }
\end{aligned}
$$

## Hence

$$
\begin{aligned}
\sigma^{2}(\tau) & =T^{2} / 3 \text { and } \sigma(\tau)=T / \sqrt{3} \\
& =\text { rms enror }
\end{aligned}
$$



Fig. 5-Traces for - - (A) and $-+(B)$ slopes. Amplitude is $1 \mathrm{v/}$ div. sweep is $500 \mu_{\mu}$ sec/div. General shape of interval gate is shown in (C)

Therefore, when a certain count N is observed, one reports the width of the gate as NT with an rms error of $T / \sqrt{3}$. In the present design $T=$ $20 \mu$ seconds and the rms error inherent in the method used to measure time is approximately $12 \mu \mathrm{sec}$.

The complete schematic diagram of the axis-crossing interval sampler is shown in Fig. 4. A printing interval signal from the printer indicates the time interval in which the printer is printing. This signal is used to energize relay $K_{1}$, and hence $C_{1}$ is charged. After the printing interval, the relay is de-energized and the charge stored on the $C_{1}$ is used to reset the counter.

A summing device associated with the digital printer is used to compute the first moment of the probability density function. The reciprocal of this moment is useful for determining the average number of axis-crossings per second.

To determine the performance of the system under actual operating conditions, photographs (Fig. 5A and B) were taken of chopped oscilloscope traces. Each photograph shows a trace of the interval gate
produced by the axis-crossing interval sampler and a trace of the input. The interval gate has the general shape shown in Fig. 5C. The top of the interval gate determines the count stored in the electronic counter. Hence this should be used as a guide when determining the axis-crossing interval sampled in each photograph. The axiscrossing level is not related to the d-c level of the interval gate, nor is it coincident with the oscilloscope horizontal scale.

In a practical system the arbitrary axis-crossing level indicated in Fig. 1A has a nonzero width $\Delta v$. This nonzero width is due to the finite gain of the limiter. Because of finite gain the limiter characteristic has a finite slope in the neighborhood of the origin. The photographs in Fig. 5 indicate that $\lrcorner v$ is of the order of 0.1 volt. Since $\Delta v$ is independent of the amplitude of the noise voltage under investigation, its effects on the accuracy of the system can be made negligible by amplifying the input noise.

With a $10-\mathrm{Kc}$ sine wave input the measured zero crossing intervals agreed with the intervals as measured with a Tektronix 545 oscilloscope to within $\pm 1$ count. The numbers recorded by the system are correct to $\pm 1$ count.

White Gaussian noise was passed through a low pass filter having a 36 db /octave skirt and a cutoff frequency $f_{b}$ of 400 cps . With the slope selector switch in the +- position, 1,000 samples of the resulting zerocrossing intervals were automatically recorded. Figure 6 shows the probability density function of the normalized variable $\phi$ plotted from the recorded data. The experimental result compares favorably with a theoretical result derived by S .0 .

Rice ${ }^{2}$ for an ideal low pass filter. The theoretical result is known to be inaccurate for $\phi$ greater than about 7 because of certain assumptions in its derivation. More recently J. A. McFadden ${ }^{4}$ deduced an approximate theoretical result which extends Rice's result beyond $\phi=7$. The experimental result of Fig. 6 also compares favorably.

The author gratefully acknowledges the stimulating discussions with Dr. E. M. Glaser concerning the axis-crossing problem and the design of the system. Thanks are also due to Dr. J. M. Kopper for his advice and suggestions and to H. Snyder for the construction of the experimental equipment.

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FIG. 6-Distribution showing theoretical and experimental results

## DEMODULATORS FOR

# Linear Differential Transformers 

Some applications of linear variable differential transformers require demodulation of the a-c output. Demodulation techniques are summarized

By JOSEPH LIPSHUTZ and MARTIN ARONOW,
Schaevitz Engineering.
Pennsauken, N. J.

MOST BASIC METHODS of measuring force, weight, pressure and acceleration depend on measurement of deflection in an elastic member. The linear variable differential transformer (LVDT) is ideally suited for accurately converting such deflections to electrical voltage. However, LVDT output is a-c, whereas many commonly used control and indicating systems require a variable d-c signal. To convert this a-c output, d-c rectification or demodulation techniques are employed.

Demodulators useful in LVDT systems are classified as follows: simple rectification circuits or a-m demodulators; directionsensitive demodulators; synchronous or phase-sensitive demodulators; and multipurpose demodulators, such as demodulator regulators.

In conventional applications the two secondary windings of an LVDT are connected in a series opposing relationship. Thus, there is a core position for which the outputs of the two secondaries are equal and the resultant or differential output is substantially zero or null. In most linear variable differential transformers this null exists when the core is positioned in the center of the unit. When the core is moved in one direction away from the null position
the differential output increases linearly and is of a certain phase with regard to the primary. When the core is moved in the opposite direction the differential output again increases linearly and is 180 deg out of phase with the output obtained in the first direction. When operation is on one side of null only, the differential output resulting from core movement is similar to an amplitude-modulated signal. When operation is on both sides of the null position the output is not a conventional amplitude-modulated signal since a 180 deg phase shift takes place in the carrier each time the core crosses null.

When operation is on one side of null only, simple a-m demodulation techniques may be applied.

The main advantages of the simple demodulation circuits shown in Fig. 1A, B and C are as follows: they are the simplest form of demodulator; they may be used in conjunction with a linear variable differential transformer whose center, or tie point, is not brought out as an external connection; the secondary to primary phase shifts have no effect on the d-c output. Their disadvantages are: output lacks directional sense when operating on both sides of null; since the diodes are called upon to rectify a signal which varies in the range of zero to several millivolts or volts, non-linearities are introduced based on the nonlinear curve of commercially available diodes.

This method of demodulation is useful when linearity is not of importance and also when the LVDT is to be operated in a single direction range which starts at a point removed from the null point.

Direction-sensitive demodulators (Fig. 1D and 1E) are demodulators which maintain the sense of direction of the core movement. In general, depending on the polarization of the diodes, the d-c output voltage on one side of the null position will be negative while on the other side it will be positive.

Some of the advantages of this method are: the output maintains the directional sense of core motion; the circuits are relatively simple; because rectification of each secondary output takes place, the diodes usually operate above their threshold level and do not introduce nonlinearities; phase shifts do not appreciably affect the linearity.

Some disadvantages are: to maintain the symmetry of the circuit, the load 'must be balanced or ungrounded; the mixing of the two secondary rectified outputs into one d-c output, which is based on the resistive mixing principle, causes large output power losses; in certain differential transformers, due to space savings, the output of each secondary at the end of the travel range may be appreciably below the threshold level of the diodes so that nonlinearities are introduced into the d-c output.

These direction-sensitive de-

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New Universal Transistor Sockets for use with the ten transistor bases illustrated and five base types. Casting is mica-filled phenolic (MFE).
Contacts are beryllium copper, gold plated. Contacts may be used with either one or two sided 1/16" p. w. boards.

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## TYPE 1

No. 24419


Cose E3-25


## TYPE 2

$0407{ }^{-102}$

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TRANSISTOR SOCKET FOR CONVENTIONAL WIRING


## POWER TRANSISTOR SOCKETS:



No. 24324


WITH INTEGRAL EYELETS


No. 22831


No. 24246

There are three laminated type sockets; 22831,24324 and 24860 . No. 22831 is elongated in shape, top plate is of $1 / 64^{\prime \prime}$ chocolate colored XP Bakelite, bottom plate is of 3/64" chocolate colored XP Bakelite: both vacuum wax impregnated. The contacts are of brass, cadmium plated.
No. 24324 is rectangular in shape. Top and bottom plates are of natural XP Bakelite, vacuum wax impregnated. Contacts are of brass, cadmium plated. Formed thread for $6-20$ screw. . 104/.110 dia. hole in C R steel plate. Provides easy attachment to a heat sink.
No. 24860 is identical with 24324 except it is equipped with integral eyelets for easy assembly to chassis.
No. 24246 is a molded socket with gen. eral purpose Bakelite casting. Contacts are phosphor bronze, cadmium plated. The above transistor sockets may be used with the following RETMA BASE designations:

| E | $3-14$ | E $3-42$ |
| :--- | :--- | :--- | :--- |
| E $3-15$ | E $3-43$ |  |
| E $3-25$ | E $3-44$ |  |
| E $3-32$ | E $3-51$ |  |
| E $3-38$ | E $3-53$ |  |
| E $3-39$ | E $4-13$ |  |

E 4-24
E 4-31
E 4-43
E 4-52
ET-103-D


No. 24872

For use with transistors designed to the triangular base layout . $2^{\prime \prime} \times .1^{\prime \prime}$ (JETEC-30) contact centers, as well as the three contact in-line $1.048 \times .192$ contact centers). This socket was originally designed for the all transistor TV set; however, its future applications are many; industrial communications, test equipment, bread board circuits, etc.
This design features an exceptional subminiature contact designed for the absolute minimum in intermittent failures, and an all molded monoblock construction with mounting holes provided as part of the casting. Assemblies are available in G. P. Black and low loss Mica-filled Phenolic.

The drawing shows five contacts but any number can be omitted to meet your particular contact layout... Contacts are of Phosphor bronze, Cadmium plated .0001 (P24).

Centrally located plants at Chicago, Illinois; Shelbyville, Indiana;
City of Industry, California;
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modulation techniques are used extensively with LVDT's and give very good results when operated with most conventional units. Care must be taken, however, not to overload the circuit.

Synchronous or phase-sensitive demodulators (Fig. 1F, 1G, 1 H ) exploit the basic principles of a phase detector, synchronous demodulator, or phase comparator. These circuits are based on the idea of rectifying an artificially created difference voltage rather than the signal itself. Since the diodes are used to rectify the difference signal by proper selection of the reference voltage, the rectification takes place at voltage values well above the threshold values of the diodes.

This type of demodulator (Fig. 1F) has the disadvantage of being sensitive not only to amplitude changes but also to phase variations of the signal versus the reference voltage.

Thus, with differential transformers designed for long travel, performance may be seriously impaired. To overcome the difficulties introduced by differential transformer phase shifts, a modified circuit has been devised. This circuit (Fig. 1G, 1H) causes the reference voltage phase to shift simultaneously with the signal voltage so that the relative phase angle between the two voltages remains constant. Some of the advantages of this method are: an unbalanced load can be used; nonlinearities in the d-c output due to demodulation are eliminated even with long-travel linear variable differential transformers and differential transformers having inherent phase shifts over their range; these circuits can be used for any linear variable differential transformer. Some disadvantages: complexity; wattage consumed by the special transformers is a power loss.

This method may be used when simpler circuits do not operate satisfactorily. It is used in standard demodulators due to its universality and applicability to most types of linear variable differential transformers.
Multipurpose demodulators are more than a-c to d-c conversion circuits. They may incorporate voltage regulation, signal amplification, etc. In conjunction with the demodulation, and as an integral part of it, a feed-back signal is used to control the input signal to the linear variable differential transformer. The closed-loop network compensates for errors due to line voltage variations, frequency fluctuations, temperature and load changes.

Acknowledgment is made to all the members of the Schaevitz Engineering staff who participated in the development and evaluation of these demodulator circuits.


FIG. 1-Simple demodulation circuits $(A),(B)$ and $(C)$; direction-sensitive demodulators ( $D$ ) and ( $E$ ); and symchronous or phase-sensitive demodulators $(F),(G)$ and $(H)$


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to A similar CENTRALAB 4-stage amplifier received the Certificate of Excellence in the 1959 Miniaturization Awards Competition, sponsored by Miniature Precision Bearings, Inc., Keene, New Hampshire.


# Thermoelectric Generator Delivers 5 Kw 

THERMOELECTRIC generator built by Westinghouse for BuShips delivers 5 Kw by direct conversion of heat into electricity without major moving parts. It is claimed to be 50 times more powerful than any previously described thermoelectric power plant.

The generator is the largest unit so far developed under à joint Army, Air Force and Navy thermoelectric power program coordinated by the Navy's Bureau of Ships. It is an experimental unit intended for evaluation of power generating materials and fabrication techniques which have been produced under a Navy-sponsored thermoelectric materials research program. New materials developed by this program in the last three years have tripled the efficiency with which heat may be directly converted to electricity. This high rate of progress supports Navy hopes for an early achievement of practical thermoelectric generators of considerably larger size.

To secure maximum flexibility in design, the generator is built up from thermoelectric assemblies, or modules, which can be arranged electrically to give a wide range of output voltages and currents. These combinations range from 10 volts at 500 amperes to 120 volts at about 42 amperes. This modular construction also gives versatility in physical design, permitting the generator to be built as two identical sub-generators which are connected together to give the full power output, or which can be used independently of one another as separate 2,500-watt power plants.

The thermoelectric portion of each 2,500-watt sub-generator resembles a hollow cylinder about 30 inches in diameter and 30 inches high. The thermoelectric modules form the walls of the cylinder, their hot inner surfaces exposed to the flame of burning kerosene; their outer surfaces are cooled by water piped to them. Heat flows through the thermoelectric materials from their hot to cold faces, and elec-


Testing of one of two 2,500-w subgenerators making up thermoelectric power plant developed for Bureau of Ships, U. S. Navy
tricity is generated in the process. The only moving parts in the entire 5,000 -watt unit are those in the pumps for the cooling water and for the kerosene fuel burners. Both are operated by electric motors which receive their power from the electrical output of the generator itself.

Six different thermoelectric materials are used in the new generator, including both broad-band and narrow-band semiconductor materials. Such bands describe the spread in energy which the conducting charges can have. Both p-type and n-type materials are used; they are fabricated into individual thermocouples, which are then electrically connected in series to form the thermoelectric modules. The modules can then be interconnected in a variety of ways to give the desired output voltages.

Thermoelectric materials differ widely in their ability to withstand high temperatures, and each has a rather limited temperature range over which it operates most effectively. For this reason, in each thermocouple, different thermoelectric materials are combined in a series arrangement from hot to cold, so that each material operates in that region of temperatures at
which it performs best. The heat flowing through a high-temperature thermoelectric material is passed on to a material that has maximum performance at intermediate temperatures, and so on.

By exploiting this technique, the new generator operates at temperatures as high as $1,200 \mathrm{~F}$ while its cool side is at about 50 F . No single thermoelectric material could span this range of temperatures by itself. This thermoelectric generator was designed to operate with maximum quietness. The modular construction gives it flexibility as a prototype that can be easily tested, studied, evaluated and improved.

## Pins Discharge Airborne R-F Static

Precipitation static may be eliminated from airborne radio and navigation equipment by a device developed by Stanford Research Instituke. This static develops when aircraft pass through snow or clouds of ice particles. The device permits corona discharges but prevents the generated noise from reaching the radio antennas

When ice crystals of snow or clouds rebound from the aircraft, electrons are removed from the crystals and remain on the purface of the aircraft. Each impaqt leaves a minute negative charge. The cumulative effect of millions of such impacts causes the aircraft to be charged to a voltage so high that corona discharges occur at wing tips and other sharp extremities.

The corona discharges oecur as a series of short pulses, eadh transmitting a broad band of frequencies. The waves generated by the pulses travel about the aircraft, guided by the metallic surfaces, and enter the radio antennas. The resulting precipitation static is often severe enough to impair functioning of radio receivers and navigation equipment.

To prevent the airplane from

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New from Krohn-Hite: this unique combination of power and bandwidth! The Model DCA-10 direct-coupled amplifier allows you to increase power of all sources from dc to one megacycle, without the bother of changing amplifiers or bandswitching!

The DCA-10's low distortion ( $0.1 \%$ ) makes it the perfect complement for low-distortion, quality oscillators - for unexcelled performance over the entire frequency range.

Output - to 300 volts peak to peak, to 600 milliamperes peak to peak. Frequency response is flat, within one db , from dc to 1 mc . Stability is excellent for both output DC level and gain.

The Model DCA-10 direct-coupled amplifier provides high, distor-tion-free power over the entire range, from sub-sonic into radiofrequencies. 20 watts of push-pull power can be obtained from two DCA-10's cascaded. If this high-quality, flexible amplifier can fill a need for you, write for full information.

Other Krohn-Hite amplifiers include the direct-coupled 50 watt DCA-50, and the ultra-low distortion ( $0.005 \%$ ) 50 watt UF-101A. Also. Krohn-Hite Oscillators, Filters and Power Supplies. KROHN-HITE CORPORATION

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becoming charged when flying through solid-particle precipitation is impossible. It is also impossible to prevent the noise-producing corona discharges from occurring.

The discharge devices use a sharp tungsten pin supported by a resistively coated plastic cement for attachment at all points on the aircraft at which the discharges occur.

A typical discharge device consists of a nylon rod with the tung sten pin crosswise through it at about an inch from the outer end The nylon rod is coated with paint having the proper electrical resistance.

The static dischargers are also effective in carrying off charge created by jet engine exhausts. While this is generally less than that from precipitation, it is troublesome because it is worse during throttle changes during landing-when good radio communication is critical.

Precipitation static has been under study by SRI for the U. S. Air Force. A study of application of this static-elimination measure on military aircraft is being made. Service tests on commercial Boeing 707 jet planes are being made by Qantas Airways. It is planned that these dischargers will be standard equipment on future Boeing 707 jets.

## Precision Thermometry For Low Temperatures

national Bureau of Standards is expanding its low-temperature research program in an attempt to provide higher-precision thernometry in the range from 90 down to 20 K ( -183 to -253 C ), and toprovide a calibration service for secondary thermometers from 20 lown to 2 K . The measurement of low temperatures is growing in importance because of recent advances in cryogenic techniques, and because physicists and chemists need a practicable and reliable working scale when determining specific heats, thermal conductivities and other fundamental properties of materials at these temperatures.

Although there is no international agreement on a practical temperature scale below 90 K , a gas thermometer may be used to make
measurements on the thermodynamic temperature scale in this region. The inherent difficulties of this thermometer, however, make it impractical for use in a regular calibration service. When stable platinum resistance thermometers were developed to operate in this range some years ago, the Bureau was able to establish a provisional scale from 90 down to 11 K .

In preliminary research toward making absolute temperature determinations from 20 down to 2 K , the Bureau studied changes in the velocity of sound in helium gas as a function of temperature in the region of 4.2 K . An acoustical interferometer was used for the first velocity measurements, and temperatures derived from the velocity of sound were compared with the temperatures associated with the vapor pressure of the liquid helium bath surrounding the instrument.

Recent Bureau investigations show that a nearly constant-temperature liquid helium bath can be achieved and associated with an extremely reproducible vapor pressure. The bath consists of a few liters of liquid helium in an ordinary metallic liquid-helium storage Dewar of 15 or 20 liters capacity. The vapor pressure of the liquid is controlled very accurately and liquid helium evaporates at a rate of about 300 cu cm per day. This technique will be of considerable help in determining the accuracy of temperatures derived from sound velocity measurements, because a better comparison will be possible between temperatures derived from vapor pressure and those derived from sound velocity.

When used in the constant-temperature liquid helium bath, carbon resistors displayed remarkable reproducibility of electrical resistance (resistances equivalent to temperatures ranging from a millidegree to a few tenths of a millidegree) versus helium vapor pressure in the range of 2 to 4 K , even when the resistors had been cycled between 300 and 4 K . Several sources indicate that germanium resistors also exhibit excellent reproducibilities. Thus, both carbon and germanium resistors appear to be promising sources of secondary thermometers for use at low temperatures.


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New from Krohn-Hite: this variable-frequency, 50 watt ac power source, with the long-desired specifications of less than $0.01 \%$ amplitude stability and $0.1 \%$ harmonic distortion! The LDS-1500 offers a continuously variable wide range of voltage and current up to 1500 volts, and up to 12 amps , at any frequency from 20 cps to 20 kc .

The short-term stability and low distortion now makes it possible for you to calibrate conventional indicating ac voltmeters and ammeters, and digital meters to lab standards, yourself!
As a general-purpose variable frequency source of distortion-free, highly stable power, the LDS-1500 has many applications. Distortion measurements at high power levels of precision resolvers, inductors, gyro motors and other electro-magnetic components can now be made with greater accuracy and ease.
The 50 watt power output of the LDS-1500 is ample to supply test benches, for quality control testing at unusual frequencies.
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# Micron-Sized Vacuum Tubes 

## ENCAPSULATED IN A SOLID BLOCK

VERY SMALL INDEED might be a reply to a proposed construction described by Ken Shoulders of Stanford Research Institute. ${ }^{\text {' }}$

Shoulders has taken a long look into some of the effects found in the world of microelectronics, and has re-examined the electronic effects found in conventional vacuum tubes. This unfettered approach was taken in an attempt to attain advances that do not seem possible with present systems.

This report on microelectronic components, interconnections, and system fabrication, delivered at the recent Western Joint Computer Conference, is a sound and original approach to the investigation of components for microelectronic data processing systems.

This approach is based on the examination of electron emission into a tiny vacuum bubble that is encapsulated in a solid block, or in effect, a micron-sized electron tube that can be self-formed in a block of solid material.

Although this is a simulated device at this stage, the actual details have been worked out for a new component that seems well suited for microelectronic system requirements and fabrication methods. This component is based upon the quantum mechanical tunneling of electrons into a vacuum; has an estimated switching time of $10^{-10}$ seconds, seems adaptable to selfforming manufacturing methods giving component uniformity, and what is important promises immunity to temperature variations between 4 K and somewhere within the red heat range.
Ionizing radiation does not effect the cathode properties or other metal electrodes until the dielectric has been severely damaged. The choice of dielectrics for this device is very wide, but materials like aluminum oxide or beryllium oxide, in film form, would be chosen because of their stable characteristics under bombardment. Mechanical


FIG. 1-Tunnel effect vacuum tetrode is intended for use in interconnected arrays having up to $10^{1 \prime}$ components per eu in.
forces would not likely effect this microscopic device either unless a physical crack resulted in the materials.

Complete details of the findings will be published soon in a report to be issued by the Information Systems Branch of the Office of Naval Research under Contract Nonr 2887 (00). The look was taken at electron emission of conventional vacuum tubes to consider the negligible transit time lag and absence of bothersome space charge effects because of high fields.
To help understand this component, called the tunnel effect vacuum tetrode, the operation of this device may be divided into two parts, namely obtaining electron emission, and using these emitted electrons. Figure 1 shows one configuration proposed.

Cathode properties have been investigated and there is agreement that the current density can be $10^{7}$
amps per square centimeter with only very small space charge effects. The current from this source can be varied over seven powers of 10 by a change in field of 2 to 1 at the cathode, implying high gain possibilities. Tests at $10,000 \mathrm{mc}$ have verified that there is no detectable deviation from the d-c emission characteristics.

The variation of grid voltage would cause the necessary field change at the cathode and measured velocity distribution of 0.14 electron volts shows that this is not a noisy source.

The intention is to form an array of small tips superimposed on the cathode shown in Fig. 1. These tips, a few hundred angstrom units in diameter, will provide emission below 100 v when applied to the screen grid or anode. The cathode is nominally 3,000 A units wide.

Electron optical considerations dictate how the emitted electrons are to be used. A positive control grid would be used normally, but this would not draw appreciable current because it is located out of the electron path between cathode and anode. Negative grids are possible if they are smooth or have high enough work function to prevent emission. It is desirable to collect the electrons at a low plate potential, thus avoiding unnecessary heating. Potentials as low as a few volts seem possible because the field strength would be sufficient to allow the collection of electron current densities of greater than $10,000 \mathrm{amps}$ per square centimeter without adverse spacecharge effects.

During this mode of operation, the screen grid would remain at some level near $100-\mathrm{v}$ acting as a bias to help cause field emission, but not collecting an appreciable current.
The upper limit in switching speed for this device would be set by the allowable power dissipation. Using an anode voltage of 10 v , a


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Precise resistance measurement is possible using 0-41 and 0-51 four- and 5-digit Ohmmeters, powered by C-1 or C-2 Control Units.
Multiple input channels may be sampled rapidly and accurately with the Model MS-2, a single unit for scanning up to 100 points, or the MS-1, AS-1 MasterAuxiliary combination for scanning up to 1000 points with multiples of one, two, four or five-wire inputs.

Voltage ratio measurements are made with the R-41 and R-51 4 and 5-digit models operating only as Ratiometers or with the VR-41 and VR-51 models, which operate both as Ratiometers and Voltmeters. Measurements can be permanently recorded with the addition of a PC-Series Printer Control Unit, providing input for any quality printer on the market.
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Also available-Low Capacitance Bridge Model 1342: $0.002 \mu \mu \mathrm{~F}$ to $1,111 \mu \mu \mathrm{~F}$; 3-terminal transformer ratio-arm bridge designed for precision measurement of extremely low capacitance.
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current of 100 microamps, a capacity of $10^{-18}$ farad, then this one-micron-sized device would show a switching time constant of $10^{-10}$ secs for a power density of $10^{5}$ watts per square centimeter, which is well within the allowed value for a micro-sized single component.

A completed machine composed of tunnel-effect elements could have a max input power of 100 wattsas determined by heating considerations. The one milliwatt of input per device would allow $10^{5}$ devices to operate simultaneously with a $10^{-10}$ second switching time which gives a bit rate of $10^{13}$ per second.

The transit time for electrons would be about $10^{-18}$ seconds, and this would seem to remove the need for complicated traveling wave devices to obtain high frequency gain.

The fabrication method to make these devices was described in this paper. Vacuum deposition methods were used to obtain starting materials. The fabrication methods provide for vacuum encapsulation with no more difficulties than filling in unused space in a solid-state system.

Converting a small open cavity into a small closed vacuum cavity can be done as easily as filling voids in one layer so as to smooth the surface, before proceeding to the next layer.

Since complete vacuum tunnel effect devices do not exist, detailed electrical characteristics do not exist. But Shoulders points out that there are many things to guide one toward the eventual circuits.

These vacuum tunnel effect devices are intended for use in interconnected arrays having as many as $10^{11}$ components per cubic inch, and not as individual devices.

## REFERENCE

(1) K, R. Shoulders, On Micrielectronic Components, Interconnections, and System Fabrication, Stanford Research Institute, Menlo Park, California. Work supported by the Information Systems Branch of the Offlce of Naval Research on Contract Nonr 2887 (00), supported by the Air Force on
Contract AF $19(604)-6114$ and the Signal Contract AF 19(604)-6114 and the Sign
Corp on Contract DA 36-039-SC-84526.

## Quartz-to-Metal Seals

QUARTZ is an excellent material for windows for high-frequency vacuum tubes because it is a low-loss dielectric with a low dielectric con-
stant. Being a glass rather than a crystalline substance, quartz is vac-uum-tight at smaller wall thickness -further reducing capacitive loading of waveguides.

Quartz has a high transparency for infrared and ultra-violet radiation and can now be extensively used in photo cells, lamps and waveguide devices. An outstanding property of quartz is its great thermal shock stability. Quartz is particularly suited for use in the envelopes of television camera tubes and is capable of withstanding electron bombardment and exposure to $x$-rays and other atomic radiation without receiving any appreciable discoloration or radiation damagemaking it ideally suited for atomic installations. In addition, quartz is able to withstand exposure to extremely high electric field strengths before breakdown occurs.

At Eitel-McCullough, Inc., San Carlos, California, a successful quartz-to-metal sealing technique has been perfected that makes it possible to produce quartz-to-metal seals which are vacuum tight and physically strong. Developed by Oskar Heil, discoverer of the principle of velocity modulation, this technique renders quartz the ideal substance for use in vacuum-windows for high-frequency microwave tubes.

## Phenolic Laminate

A NEW PAPER-bASE phenolic laminate which provides flame retardance with excellent cold punching characteristics at nearly half the cost of epoxy-paper laminates is announced by National Vulcanized Fibre Co., Wilmington, Delaware.

The base stock, PHENOLITE XXXPC476, meets NEMA Standards and Underwriters' Laboratories test for flame resistance, and is available in two copper-clad forms: (-1) with standard adhesive bonding made primarily for commercial radio and tv applications: and (-2) made primarily for computer printed circuits and military applications requiring plating from alkali solutions. Samples will be shipped promptly if material thickness and copper thickness are specified.

During preflight checkout, ground power supplies must be meticulously monitored to avoid limping undervoltage, crippling overvoltage.

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## Electron Beam Zone Refines Single Crystals

SINGLE CRYSTAL RODS of silicon, silicon carbide and other high-temperature compound semiconductors, as well as refractory metals, can be purified and grown in electron beam vertical zone refiners, according to MRC Manufacturing Corp., Yonkers, N. Y.

A refiner, producing zone temperatures of $6,000 \mathrm{~F}$, was recently demonstrated by the firm. The machine can also be used to weld dissimilar refractory metals and for high-temperature vacuum outgassing. Sharply-bent rods of tungsten, molybdenum and molybdenum welded to columbium were shown to indicate the cold-working properties of refined materials.

The demonstration model had a glass bell jar. Production machines will have a water-cooled stainless steel bell jar and will handle rods up to 18 inches long and is inch in diameter. Future high power versions will be able to handle rods


Production model of electron beam zone refiner will have steel bell jar


Horizontal tilting indium refiner with traveling radiant heat sources
to 1 inch in diameter.
Operating principles are similar to those used in other electron beam equipment. However, the electron source-a tungsten loop-is housed in a scanner which rings the rod and focuses the beam into a narrow zone (Fig. 1). Height of the zone varies according to the rod material. The molten zone is about 1 mm in tantalum and 2 mm in molybdenum rod. The zone tends to spread in materials with high conductance.

The scanner is motor-driven up a screw parallel to the rod. A typical maximum travel speed is 1 inch a minute for purifying $k$-inch tungsten rod. Return is automatic and up to 16 passes can be preset in a programmer. As with other vertical zone refiners, impurities (except those removed by the vacuum system) are collected near the top of the rod.

Rods are held at top and bottom


FIG. 1-Basic setup of zone refiner. Supports are not shown


FIG. 2-Polished collars focus heat on indium ingot, prevent "puddling"
in a V-groove closed by a springloaded clip. This permits rod expansion, preventing twisting. The distance between holders can be adjusted by a reversible motor, which allows portions of the rod to be thinned or thickened by stretching or compressing the zone. Normally, a crystal with a regular rod shape is grown, since the filament control circuit is self-modulating.

Procedures for welding and starting a crystal are similar. One rod is placed in the bottom holder and the other rod is placed in the top holder and centered on the bottom rod. After the vacuum is drawn, the scanner is placed oper the joint and the weld made. If a crystal is to be grown, the bottom rod is topped by a seed.

Operating vacuum range is $5 \times$ $10^{-4}$ to $5 \times 10^{-6} \mathrm{~mm} \mathrm{Hg}$. The latter gives better outgassing. Some difficulties are encountered, however, in processing materials with low vapor pressures. Too poor a vacuum results in the characteristic blue discharge around the scanner. A diffusion pump with a liquid nitrogen trap is used. Typical heam power consumption is 100 watto for a $\frac{1}{8}$-inch rod of tantalum. The power supply is rated at $5 \mathrm{Kv}, 500 \mathrm{ma}$ d-c.

Other equipment shown by MRC included horizontal tilt-type (a slight tilt keeps crystal thichness uniform) zone refiners with $r$ - $f$ and radiant heating. One, designed for refining indium, focuses the optput of 2 radiant heat sources thyough a slot (Fig. 2). This was reported to overcome the "puddling" which occurs when indium is heated in too wide a zone.

## Extruded Waveguide <br> Has Integral Flange

CONTOUR EXTRUDED aluminum tubing is being considered for waveguide components made by Western Electric Company at its Kearney, N. J. works. It would simplify the



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$\star+85^{\circ} \mathrm{C} \&+125^{\circ} \mathrm{C}$ OPERATION

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Write foday for complete technical information to ...

## AEROVOX OORRORATION <br> NEW EEDFORD, NASSAOHUSETTE


(especially if you're a transistor driving a relay)

If you've been toying with the idea of using a transistor circuit to drive a relay, here are some facts of life that may save you grief later on. The watchword is bistable operation - particularly with regard to the transistor.

What can make a mess of an otherwise compact, cool, low standby-power transistor is a driving circuit that leaves the little pill neither saturated nor cut off. The transistor is then very apt to become an unstable, variable gain amplifier, when it should be taking a firm stand in favor of either "on" or "off". The thing to do is design the input circuit properly so that it is responsible for the transfer from one stable state to the other. (The Schmitt trigger circuit is an excellent for instance.)

Once you've got the transistor operating as a flip-flop and not as an amplifier, a good relay to use is a bistable type. Then the relay simply monitors the condition of the driving circuit, and success is practically around the comer (maybe). Magnetic latching relays are just such switches and they have the added advantage of needing no standby power. Naturally, we have all sorts and kinds which all carry the designation "Form Zzzzz."

You won't be completely out of the woods, however, until you've given some thought to (a) operating speed and (b) nature of the transistor load. As for the former, you may be on the verge of transistorizing a tube-relay circuit and wonder why, all else being equal, the relay will operate slower from transistors. Although the transistor will do all sorts of wonderful things on less power, one thing it won't do on less power is hurry the relay. The remedy is adding some external resistance and raising the source voltage - or lowering the impedance of the relay. As for the load the transistor must switch, it is well to remember that if it's inductive (and a relay coil is) and the energy cannot be safely dissipated in the transistor, you'd better find another outlet. The lack of "arc suppression" in transistor circuits, when needed, may not produce juicy blue sparks but the result is the same - quite rapidly.

Some of our application engineers are notoriously bistable, and depending on which state they are in when they hear from you, will undoubtedly send you either ( + ) circuit design ideas (based on the use of a Sigma relay) or ( - ) some zzzzz-inducing printed material on bistable applications. Zatisfaction guaranteed.


SIGMA INSTRUMENTS, INC.
62 Pearl Street, So. Braintree 85, Mass.


Fig. 1-Conventional tubing (top) requires soldered flanges and bushings. Extruded section (bottom) is machined
production of components requiring short lengths of waveguide and may improve transmission efficiency.

Tubing, for use in the $4,000-\mathrm{Mc}$ microwave band, is extruded in lengths with heavy contoured walls. After the tubing is drawn to the critical inside dimensions, it is cut into sections of the desired lengths.

Flanges are made by machining an annular undercut near each end of the section. The contoured sections remaining on the end become the flanges, as in Fig. 1.

Advantages indicated by the method are: reduction in the number of parts handled, elimination of soldering and flux cleanup problems and better internal finish than drawn thin-wall tubing provides. The heavy wall does not require a bushing for tuner-plug mounting.

## Water Drop, Light Check Fit of Parts

FIT of mating glass parts can be accurately determined by methods known as the water drop and fringe pattern method. In the former, a

## announcing

 reliable
## diffused <br>  silicon

 diodes
$\mathbf{A}-$ dumet, $\quad \mathbf{B}$ - platinum, $\quad \mathbf{C}$ - gold, $\quad \mathbf{D}-$ difflused region,
Active portion and consequently the capacitance of these diodes are minimized by etching away all but a small diffused section. Rugged construction provides resistance to shock and vibration exceeding MIL-STD. 202A.

## More reliable products through Advanced Engineering

Advance-engineered diffusion techniques are now applied to CBS silicon diodes. Fast switching . . . high conductance . . . high temperatures . . . high voltage . . . low capacitance . . . and low reverse current are achieved.
The diffusion technique offers many other advantages over the alloying method: Close process control of all parameters, great uniformity, and high reverse voltage for a given resistivity through the graded junction. Hermetic sealing of miniature glass package also contributes to the exceptional life.
Now you can have proven CBS reliability in diffused silicon diodes. Watch for further announcements on this growing CBS silicon line.

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Note the two major classifications particularly designed for computers in missiles, rockets, airborne and industrial equipment. Typical applications include switching, pulse, flip-flop, modulator, demodulator, discriminator, clamping, gating and detector circuits. Write for complete technical Bulletins E-373 and E-374.

FAST RECOVERY TYPES

| Type | Min. Rev. Voltage (a) $100 \mu A$ | Min. Forward Current |  | Maximum Reverse Current |  |  |  | Reverse Recovery Characteristics* |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | (a) $22^{\circ} \mathrm{C}$ |  | (93) $100^{\circ} \mathrm{C}$ |  |  |  |
|  |  | $\begin{gathered} I_{F} \\ (\mathrm{~mA}) \end{gathered}$ | $\underset{\text { (volts) }}{\mathrm{E}_{\mathrm{F}}}$ | $\begin{gathered} \mathrm{Im}_{\mathrm{m}} \\ (\mu \mathrm{~A} \end{gathered}$ | $\underset{\text { (volts) }}{E_{R}}$ | $\begin{gathered} \mathrm{l}_{\mathrm{R}} \\ (\mu \mathrm{~A}) \end{gathered}$ | $\underset{E_{R}}{(\text { volts) }}$ | $\begin{gathered} \text { Zrec } \\ \text { (Kohms) } \end{gathered}$ | $\begin{gathered} t \\ (\mu \mathrm{Sec}) \end{gathered}$ |
| 1M625 | -35 | 4 | 1.5 | 1 | -20 | 30 | -20 | 400 | 1.0 |
| 1N628 | -50 | 4 | 1.5 | 1 | -35 | 30 | -35 | 400 | 1.0 |
| 1N627 | -100 | 4 | 1.5 | 1 | -75 | 30 | -75 | 400 | 1.0 |
| 1N828 | -150 | 4 | 1.5 | 1 | -125 | 30 | -125 | 400 | 1.0 |
| 1N829 | -200 | 4 | 1.5 | 1 | -175 | 30 | -175 | 400 | 1.0 |

*JEDEC 14.5-1 (Modified IBM-Y reverse recovery circuit with:
$\boldsymbol{i}_{\mathrm{F}}=30 \mathrm{~mA}, \mathrm{E}_{\mathrm{a}}=-35 \mathrm{~V}, \mathrm{R}_{\mathrm{L}}=2 \mathrm{~K}$ ohms.)
HIGH CONDUCTANCE TYPES

| Type | Min. Rev. Voltage (volts) | Max. Fwd. Voltage (volts) | Maximum Reverse Current |  |  |  | Max. Avg. Fwd. Current |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | (1) $25^{\circ} \mathrm{C}$ |  | (a) $150^{\circ} \mathrm{C}$ |  |  |  |
|  |  |  | $\begin{gathered} \binom{\mathrm{J}_{\mathrm{R}}}{\mu \mathrm{~A}} \end{gathered}$ | $\begin{gathered} \mathrm{E}_{\mathrm{R}} \text { (volts) } \end{gathered}$ | $\begin{gathered} \mathrm{Inf}_{n} \\ (\mu \mathrm{~A} \end{gathered}$ | $\underset{\mathrm{E}_{\mathrm{R}}}{\text { (volts) }^{2}}$ | ${ }_{(\mathrm{mA})}^{25^{\circ} \mathrm{C}}$ | $\prod_{(\mathrm{mA})}^{150^{\circ} \mathrm{C}}$ |
| 1N482 | -40 | 1.1 | 0.25 | -30 | 30 | -30 | 100 | 25 |
| 1N483 | -80 | 1.1 | 0.25 | -60 | 30 | -60 | 100 | 25 |
| 1N484 | -150 | 1.1 | 0.25 | -125 | 30 | -125 | 100 | 25 |
| 1N485 | -200 | 1.1 | 0.25 | -175 | 30 | -175 | 100 | 25 |

CBS ELECTRONICS, Semiconductor Operations • A Division of Columbia Broadcasting System, Inc,
Sales Offices: Lowell, Mass., 900 Chelmsford St., GLen view 4-0446 - Newark, N. J., 231 Johnson Ave., TAlbert 4-2450 - Melrose Park, Ill., 1990 N. Mannheim Rd., EStebrook 9-2100 - Los Angeles, Calif., 2120 S. Garfield Ave., RAymond 3-9081 - Allanta, Ga., Cary Chapman \& Co., 672 Whitehall St., JAckson 4-7388 Minneapolis, Minn., The Heimann Co. 1711 Hawthorne Ave。FEderal 2-5457 - Toronto, Onh., Canadian General Electric Co., Ltd., LEnnox 4-6311


Virtually no maintenance (supplies can't be damaged even by direct short circuit of output) ; long life; extremely fast response; transient-free, ripple-free output; and wide input frequency tolerance-these are just a few of the major features you get in Sorensen Q and QR Series transistorized supplies.

They're ideal for critical applications like powering computer circuits, straingauge bridges, or low-level instrument circuits.
Q Series Supplies: Offered in 15 models with nominal output voltages of 6 , $12,28 \mathrm{vdc}$ (adjustable $2: 1$, approximately) and up to 220 watts power capacity. Models available for either $\pm 0.25 \%$ or $\pm 0.05 \%$ voltage regulation (combined line and load). Available in either cabinet or $19^{\prime \prime}$ rack-mounting styles ( 15 and 25 W models can also be provided for dual rack mounting on a single panel).
QR Series Supplies: Feature wide-range adjustable output voltage-zero to rated voltage, continuously, with COARSE and FINE front-panel controls. Two standard models: $0-36 \mathrm{vdc}, 4 \mathrm{amps}$ max., or $0-75 \mathrm{vdc}, 2 \mathrm{amps}$ max. Output is regulated to within $\pm(0.02 \%+1 \mathrm{mv})$. Output voltmeter and ammeter. Units are available for cabinet or rack-panel ( $19^{\prime \prime} \times 51 /{ }^{\prime \prime}$ ) mounting.

Get complete specs on these outstanding power supplies. Ask your Sorensen representative or write: Sorensen \& Company, Richards Ave., South Norwalk, Connecticut.


[^2]: New Sorensen catalog! Just off the press! 32 . page catalog of : more than 400 : supplies plus val-- uable application : data. Write for : your copy today.
drop of water is placed on one surface and the concentration or spread of the drop indicates the character of the mismatch or fit. In the fringe pattern method, the mating parts are placed under a monochromatic helium light source and observed through a microscope. The number of fringes along the circumference of the surfaces indicates the fit.


FIG 1-Water drop method of checking stem-to-bulb fit
(A)

(B)

(D)

(C)




FIG. 2-Fringe pattern methoa of checking fit

Chatham Electronics, a division of Tung-Sol Electric Inc., Livingston, N. J. uses the methods to judge lapping (water drop, Fig. 1) and polishing (fringe pattern, Fig. 2) of the mating edges of bulbs and button stems made for polyoptic tube sealing as previously reported. Standard stems are used to check bulbs and vice-versa. Fig. 1A shows bulb too large or stem too small; Fig. 1B, bulb too small or stem too large; Fig. 1C, button curvature greater than bulb curvature, and Fig. 1D, good fit. Fig. 2A shows a perfect fit; Fig. 2B, good fit; Fig. 2C, acceptable fit; Fig. 2D, bad fit; Fig. 2E, particle between the surfaces, and Fig. 2F, bad fit, out-of-round.
...the widest line lets you make the wisest choice


Clecomatic* No. 10 Series Screwdriver-Nut-Runner: These are the tools that enable you to set torque to the most critical specifications . . . then forget it. Torque is positively maintained by a no-drift locking device. A long wearing, non-friction clutch is quickly adjusted when torque change is desired. This is the only torque control air tool that starts and stops automatically! Operator merely engages the screw with bit, the tool starts. When torque is reached, the tool stops. Motor operates only during rundown. Less air is used. Wear is reduced. There is no quality let-down at the end of a shift because control is in the tool. This tool has little impact, is shorter, and weighs less than competitive tools. No. 10 Clecomatic Screw-driver-Nut-Runners are available in pistol grip or straight handles in speeds


## AIR TOOLS

from 400 to 2,900 r.p.m. Reversible or non-reversible.

Clecomatic Right Angle Nut-Runners: You get uniform tightness in every nut or bolt rundown with a Clecomatic 14 or 16 Series Nut-Runner. Torque is preset. When specified foot pounds are reached, air is automatically shut-off at the driving spindle. The hazardous, tiring torque kick usually found in tools of this type is substantially reduced, your operators can produce more without extra effort. As for maintenance, there's practically none. Cleco's non-friction clutch operates for very long periods, completely maintenance free. Torque adjustment is made externally, no need to disassemble the tool. Clecomatic Nut-Runners are
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## New On The Market



## Ceramic Circuit Board

SIZES TO 18 SQ IN.

Ceramic printed circuits in sizes up to 18 sq in. are in production by Mitronics, Inc., 1290 Central Ave., Hillside, N. Y.

The high alumina bodies with molymanganese circuits screened on, can be subjected to temperatures up to $1,800 \mathrm{~F}$ without failure and will withstand equally exacting humidity and corrosive environment. The boards can be hermetically sealed to either or both faces. Sizes range from 0.125 in . square by 0.000 in. thick to 3 in . by 6 in . by 0.060 in .

The printed circuits are composed of high alumina bases ( 96 percent)
and metal circuits which are a composition of molybdenum and manganese. This circuit is then protected with an electroplated coating of nickel or copper which serves as a base for hard or soft solder assembly techniques. Some of the materials that can be applied to the plated circuit include silver, gold, copper and various brazing alloys.

Through additional manufacturing refinements, through-plated holes can be provided and mechanical tolerances closely held. Pattern configurations can be screened on to within $\pm 0.005 \mathrm{in}$.

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## Image Orthicon

## FIELD-MESH TYPE

PORTHOLING and edge effect are said to be reduced by the field-mesh image orthicon type GL-7293 developed by General Electric, Schenectady, N. Y.

The field mesh improves beam
landing by creating a more uniform electric field in back of the target. This minimizes landing and shading errors, reduces geometric distortion and provides sharper. transition from black to white with-
out spurious effect.
The GL-7293 is interchangeable, electrically and physically, with the 5820. The tube is designed primarily for studio use, and for outdoor pickup where light levels are adequate.

Using a glass target, the tube has a photocathode identical to that of the 5820. Spectral response is close to that of the human eye.

The tube is available in sample quantities at a user price of $\$ 1,300$. It will carry a 500 -hour warranty.

CIRCLE 302 ON READER SERVICE CARD


## Silicon Rectifiers

## 2,200 V PEAK INVERSE

SINGLE unit silicon power rectifiers with peak inverse voltages of 2,200 volts and current ratings from 200 ma through 10 amperes, are now being manufactured by Britton Electronics Corporation, 19 Warren Pl., Mount Vernon, N. Y. These diffused junction rectifiers eliminate the need for a series connection of lower voltage multiple units to achieve a piv of 2,200 volts.

CIRCLE 303 ON READER SERVICE CARD


## Digital Clocks

## TIME FOR RECORDERS

TIME of day information can be added to recorded data by two digital clocks available from HewlettPackard, 275 Page Mill Rd., Palo Alto, Calif.

The digital clocks, models 570A and 571 B , can be mounted in the left-hand side of the Hewlett-Packard 560 A and 561 B digital recorders, respectively. The clocks fit into


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WEST VIRGINIA
Chemcity Electronic Distributors Beckley
either cabinet or rack-mount digital recorders.
The clocks indicate time to 23 hours, 59 minutes and 59 seconds (12-hour clocks are available on special order). Display is by longlife, in-line indicator tubes. All time digits are available for printing.
In one operating mode, digital counters or other external equipment control the print rate, time being printed simultaneously with
other data. In the second mode the digital clocks control the timing of readings. A front panel control selects reading rates of 1 per second, 6 per minute, 1 per minute, 6 per hour or 1 per hour.

The model 570 A is priced at $\$ 1,050.00$-current availability approximately 15 weeks. The Model 571B is priced at $\$ 950$-current availability approximately 15 weeks.

CIRCLE 304 ON READER SERVICE CARD


Circuit Analyzer
HANDLES 140 WIRES

COMPLEX aircraft electrical circuits can be checked out with a circuit analyzer produced by Rohr Aircraft Corp., Chula Vista, Calif.

The analyzer can be produced to handle circuits varying in complexity from 35 wires to 140 -in increments of 35 wires. On special order it will be possible to vary the size of the case slightly to handle still more complex circuits. The analyzer can test for short and open circuits simultaneously. It not only defines the nature of the trouble but also tells where in the circuit the trouble spot is located.

Under normal usage one man can operate the analyzer. It will

## Manganese Battery

## LONG LIFE, LOW DRAIN

an alkaline dry cell that gives exceptionally long life both in highdrain and in low-drain service has been announced by Mallory Battery Co., 13,000 Athens Ave., Cleveland, Ohio. The alkaline man-
check out any combination of series and parallel wires, with a switch on the front panel to adjust sensitivity from 1 through 100 megohms to cover any application.

Available power is 1,000 volts. However, the analyzer can be produced to give any degree of sensitivity desired and functional test voltages can be incorporated where required.

The unit comes in a steel case. It weighs less than 40 pounds, and is just a little over a cubic foot in size.

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ganese battery is applicable to high-current duty in battery-operated phonographs as well as in lowcurrent uses such as portable radios. Shelf life is two years without serious loss of capacity.

The penlite size cell delivers up to 1,800 milliampere hours on continuous low-drain service, and approxi-
mately 2,000 milliampere hours at intermittent low drain. It can supply short-time currents up to 7 amperes for photoflash service.

Pricing between zinc-carbon and mercury batteries of identical size.

CIRCLE 306 ON READER SERVICE CARD


## Miniature Fan

## 3 IN. DIAMETER

A miniature vaneaxial fan with a nonstall characteristic has been designed to deliver air at high pres $\dagger$ sure for cooling tightly packed electronic components and other related applications in missiles, submarines and aircraft. The fan is a product of IMC Magnetics Corp., Westbury, N. Y. The unit eliminates the dip in the pressure-flow curve inherent in many vaneaxials. The new nonstall blade provides a steadily ascending pressure without interruption. Thus the unit can be used at any air flow in its range without producing stall effect.

Designated model BC 1607V-1, the unit measures 3 in. overall diameter and $2 \frac{5}{8} \mathrm{in}$. length. Desigp features are: $115 \mathrm{v}, 400 \mathrm{cps}$, single phase, weight 15 oz . Design options include: (1) $115 / 200 \mathrm{v}$ a-c 3 phase, (2) $310-1,100 \mathrm{cps}$, single phase sine wave or square wave, (3) " h slip" altitude varying speed motors.

CIRCLE 307 ON READER SERVICE CARD

## H-F Transistor <br> OPERATES AT HIGH POWER

CURRENT gain of 45 at 1 ampere de is achieved at 4 to 6 Mc with the 2N1660 silicon transistor developed by Raytheon Co., Semiconductar Division, Needham, Mass.

The 2N1660 has a power output of 85 watts and operates within a temperature range of minus 65 to 200 deg C. Applications of the new npn diffused transistor include

# Experience is the optimum test for Energy Storage Capacitors... 

## time-proven Sangamo Type DCM Electrolytic Capacitors exceed operating requirements of practically every application



Sangamo was the first capacitor manufacturer to produce and establish standards in the manufacture of electrolytic energy storage capacitors. Since 1949, design and manufacturing techniques have been developed to such a scientific degree that Sangamo is still regarded as the leader in the field with the Type DCM. The timeproven characteristics of the DCM more than meet normal requirements of operating temperature, equivalent series resistance and life expectancy. Those techniques mean, too, that maximum capacity can be put in the smallest case size consistent with good engineering practice and performance reliability.

Occasionally applications call for energy-storage capacitors to meet special requirements - including higher temperature, and higher ripple current. Sangamo is uniquely qualified and equipped to engineer and produce to the most exacting specifications. We would appreciate the opportunity of supplying your future needs.

Complete data on capacitance and voltage combinations on Type DCM Capacitors is detailed in Sangamo's Engineering Catalog 2231. Contact your Sangamo Representative, or write us for your copy.

| Maximum Capacity in Mfds Vs Case Size in Inches |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { Rated } \\ & \text { voltoge } \end{aligned}$ | $\begin{gathered} \text { Surge } \\ \text { Voltage } \end{gathered}$ | $\begin{aligned} & \mathrm{D}=1-7 / 16 \\ & \mathrm{l}=4-1 / 2 \end{aligned}$ | $\begin{aligned} & D=1-13 / 16 \\ & i=4-1 / 2 \end{aligned}$ | $\begin{aligned} & D=2-1 / 16 \\ & L=4-1 / 2 \end{aligned}$ | $\begin{aligned} & \mathrm{D}=2-1 / 16 \\ & \mathrm{I}=6 \end{aligned}$ | $\begin{aligned} & \mathrm{D}=2-9 / 16 \\ & \mathrm{i}=4-1 / 2 \end{aligned}$ | $\begin{aligned} & D=3-1 / 16 \\ & 1=4-1 / 2 \end{aligned}$ | ${ }^{\mathrm{D}=3-1 / 16} \mathrm{l}=6$ |
| 5 | 8 | 14,750 | 25,500 | 33,000 | 48,750 | 55,500 | 85,000 | 125,000 |
| 10 | 15 | 10,500 | 18,500 | 23,500 | 35,000 | 40,000 | 60,000 | 90,000 |
| 15 | 20 | 8,000 | 14,000 | 18,000 | 26,500 | 33,300 | 46,000 | 68,500 |
| 20 | 30 | 6,650 | 11,700 | 14,750 | 22,000 | 27,000 | 38,000 | 56,500 |
| 30 | 40. | 5,100 | 9,000 | 11,400 | 16,900 | 19,000 | 29,000 | 43,000 |
| 35 | 50 | 4,000 | 7,000 | 9,100 | 13,500 | 15,400 | 23,500 | 34,800 |
| 40 | 50 | 4,000 | 7,000 | 9,100 | 13,500 | 15,400 | 23,500 | 34,800 |
| 50 | 75 | 2,650 | 4,765 | 5,900 | 8,800 | 10,000 | 15,300 | 22,500 |
| 75 | 100 | 1,350 | 2,400 | 3,000 | 4,500 | 5,400 | 7,750 | 11,450 |
| 100 | 135 | 1,000 | 1,790 | 2,250 | 3,350 | 4,000 | 5,750 | 8,500 |
| 150 | 185 | 720 | 1,250 | 1,600 | 2,400 | 2,800 | 4,000 | 6,000 |
| 200 | 250 | 500 | 900 | 1,100 | 1,650 | 2,000 | 2,750 | 6,000 |
| 250 | 300 | 390 | 690 | 880 | 1,300 | 1,550 | 2,200 | - |
| 300 | 350 | 275 | 490 | 620 | 900 | 1,000 | 1,500 |  |
| 350 | 400 | 190 | 350 | 440 | 650 | 775 | 1,100 | - |
| 400 | 475 | 170 | 300 | 380 | 570 | 680 | , 975 |  |
| 450 | 525 | 150 | 260 | 340 | 500 | 600 | 850 | - |

NOTE: Cose dimensions include insulating sleeve.
Subtract $1 / 16^{\prime \prime}$ from diomefer ond $3 / 8^{\prime \prime}$
from length for overall dimensions of un-
insulated case.
SC-60-4

## THREE KLEIN PLIERS

## to make electrical wiring easier



Here are three newly engineered Klein Pliers which will solve difficult problems in the wiring of electronic assemblies. Catalog 103-A describes these and scores of other pliers in the complete Klein line. If you wire electronic assemblies, write for a copy.

## All-PURPOSE ELECTRONIC PLIER

Potent ponding
Shear blade culs flush and holds clipped end of wire
Requires no sharpening; will at hard or soft wire. Smooth, continuous action prevents shock which may damage resistors. For bare wire up to 18 gauge.
No. 260.6-length $63 /{ }^{\prime \prime}$
No. 260-6C -with coil spring that holds jaws open

## NEEDLE-NOSE PLIER Patent pending

Similar to No. 260.6 but nose has been slimmed down to permit use in confined areas.
No. 261-6-length $6 \%$ "
No. 261-6C-with coil spring to hold jaws open

## LONG-NOSE PLIER-KNIFE AT TIP

Pat. Na. 2,848,724
Jaws behind blade hold clipped wire end firmly
A shear-cutting plier that will cut hard or soft wire. Blade is af the tip of the plier. Supplied with coil spring to keep jaws apart.



Foreign Distributor: International Standard Electric Corp., New York

power oscillators, power amplifiers, regulated power supplies and computer core drivers.

Simultaneously Raytheon announced four other silicon power transistors, the $2 \mathrm{~N} 389,2 \mathrm{~N} 424$, 2N1470 and 2N1657. The 2N389 and 2 N 424 require only 1.5 volts to drive a 1.5 -ampere collector current level.

The 2N1470 features low collector leakage current, low saturation voltage and an alpha cutoff of 1 Mc. The 2N1657 is the 2N1470 in the square power-transistor shell.

CIRCLE 308 ON READER SERVICE CARD


## Contact Protectors

EXTENDS LIFE 100 X
DESIGNED to prevent destructive arcing due to inductive voltage surges at contact points, new protective units that will extend contact life up to 100 times, have been developed by Radio Receptor Company (Selenium Division), subsidiary of General Instrument Corporation, 240 Wythe Ave, Brooklyn, N. Y. The protectors are available with pigtail leads, in encapsulated or tabular construction. The units will serve all relays operating up to 40 times per second and which draw up to 200 ma operating current at 130 v a-c or 250 ma at 154 v d-c. Ratings are based on an ambient temperature of 35 C .

Assemblies encased in phenolic tubing have a maximum width of號 in. with length ranging from E to 18 in. max. Plastic encapsulated assemblies have a maximun length of 0.380 in ., widths ranging from 0.340 in . to 0.380 in .

## CIRCLE 309 ON READER SERVICE CARD

## Frequency Reference

FOR AIRCRAFT, MISSILES
DEVELOPMENT of a small, highly stable frequency reference that can


Longer recording time because of higher tape packing density at all six speeds - from 3 hours and 12 minutes at $62.5 \mathrm{kc}-71 / 2 \mathrm{ips}$, to 12 minutes recording $1 \mathrm{mc}-120 \mathrm{ips}$. That's only one advantage of the new Mincom Model CM-100 Magnetic Tape Instrumentation Recorder/Reproducer. Read on: CM-100, an analog system, does the work of two systems by storing both analog and pulse data simultaneously and with equal facility. Also: One-rack compactness, no belt changes, all-dynamic braking, seven 1 mc tracks on $1 / 2$-inch tape, built-in calibration, IRIG compatibility, only twelve moving parts with four easy adjustments. Interested? Write today for brochure.

```
\(62.5 \mathrm{KC}-71 / 2 \mathrm{IPS}-192 \mathrm{MIN} \cdot 100 \mathrm{KC}-12 \mathrm{IPS}-120 \mathrm{MIN} \cdot 125 \mathrm{KC}-15 \mathrm{IPS}-96 \mathrm{MIN} \cdot 250 \mathrm{KC}-30 \mathrm{IPS}-4 B \mathrm{MIN} \cdot 500 \mathrm{KC}-60 \mathrm{IPS}-24 \mathrm{MIN}\)
``` 1 MC- 120 1PS- 12 MIN


\section*{LIGHTWEIGHT IRON PROVIDES HIGH-SPEED SOLDERING WHERE OTHER IRONS CAN'T REACH}

For electronic, instrument, and communication equipment production lines, and for maintenancewhere hard-to-reach joints must be soldered in a hurry-General Electric's Lightweight Soldering Iron offers the ideal solution.

It weighs only \(81 / 2\) ounces, and handles like a pencil. A thin shank and small tip sizes let you solder in tight places where regular-size irons won't go. Rated 120 volts, 60 watts, the iron features extremely fast heat recovery to provide reliable, uniform solderjoints in seconds.

Want more information? Contact your General Electric distributor or nearby G-E Apparatus Sales Office, or write Section 758-02, General Electric Co., Schenectady 5, N. Y.

ELECTRIC


Miami plant of the Stanley Works
Metal fabricating, machining, plastic control manufacturers, heat treating plants - they're all here to serve the electronics and aircraft and missile manufacturers of America.
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Write: D. Richard Welsh, Director
DADE COUNTY DEVELOPMENT DEPARTMENT
345 Northeast 2nd Avenue - Miami 32, Florida

f \(\mathbb{P}\) Industrial Electronic Engineers, Inc. 5528 Vineland Avenue, North Hotlywood, California
meet the timing and frequency control requirements in aircraft and missiles has been announced by Armec Corp., 195 West Hills Road, Huntington Station, N. Y. Design is based on a cruciform plate resonator; the unit is stable under shock, vibration and acceleration. Since no stabilizing oven is needed, the unit requires neither heater power nor warmup time.

Measuring \(\underset{j}{5} \mathrm{in}\). high by \(1 \frac{1}{2} \mathrm{in}\). square and weighing 2 oz , the Chronodyne resonator is offered in models to meet frequency requirements from 250 to \(2,500 \mathrm{cps}\). All models meet accuracy specifications under 5 g peak vibration at operating frequency and up to 20 g at lower frequencies. They can withstand shocks of 50 g for 11 milliseconds and 10 g steady acceleration, without isolation mounting.

The frequency reference is available with accuracy ratings of either plus or minus 0.025 percent or plus or minus 0.05 percent, both over an ambient temperature range of -40 C to +80 C .

CIRCLE 310 ON READER SERVICE CARD


\section*{V-R Power Supply}

\section*{BANTAM SIZE}

MATTHEW LABORATORIES, 3344 Ft. Independence St., New York 63, N. Y. Model UVS-100 bantam size voltage regulated power supply is designed for the powering of solid state equipment. It is transistor and Zener diode regulated, measures 4.75 in . wide by 4.5 in . high by 6.25 in . deep while providing 4 to 36 v at 500 ma . Regulation is better than 1 percent against line and load and ripple less than 5 mv . The output, continuously monitored by a voltmeter and milliammeter, is isolated from input line and chassis ground. A back terminal block, in parallel with the output binding

THE SHORTEST PULSE ON RECORD...


GENERATED BY THE NEW Amperex \({ }^{\circ}\) TYPE 7093 K-BAND MAGNETRON

The 7093 permits the design of an extremely compact, short range radar system providing resolution of 4 meters at 1000 yards and a minimum range of only a few yards. NOTEWORTHY FEATURES OF THE AMPEREX TYPE 7093 Frequency Range: \(34,512-35,208 \mathrm{Mc}\).

Power Output: 25 KW
Pulse Length: 0.02 microseconds
Rise Time: 600 KV per microsecond
Weight: 4.2 lbs .
Cathode: Philips dispenser-type
Immediately available in production quantities.
Illustration above is a direct line-conversion from an unretouched radarscope photo of Schiphol Airport, Amsterdam Netherlands. Range- 1500 meters. 1 jeep traveling down runway at 55 mph .2 slow moving vehicles and people walking.


AMPEREX ELECTRONIC CORPORATION
230 Duffy Avenue, Hicksville, Long island, New York


\section*{accuracy} on all

\section*{ranges}

For the first time, accuracy of \(\pm 1\) percent is now available in multi-range Panel-Mounting Electronic Voltmeters (PMEV's)

Metronix offers two such instruments: Model 300-1 for DC measurements and Model 311-1 for AC measurements.


Model 311-1
These instruments, like all Metronix PMEV's, also offer these familiar advantages:
- Continuous monitoring of critical parameters
- Minimum panel space-no larger than the meter itself
- Maximum reliability
- Easy adaptability to special needs

Call, wire or write for data sheets. We welcome inquiries on special voltage monitoring problems.

METRONIX, inc.
a subsidiary of Assembly Products, lac. Chesterland, Ohio

Telephone: HAmilton 3-4440
posts, allows rear connection when the UVS-100 is relay rack mounted. Supply is priced at \(\$ 99.50\).

CIRCLE 316 ON READER SERVICE CARD


\section*{Power Rectifiers}

\section*{TWO NEW STYLES}

Syntron co., 241 Lexington Ave., Homer City, Pa. Styles ES-21 and ET-21 silicon power rectifiers have peak forward voltages of 1.5 v maximum at 25 amperes. Peak inverse current is 5.0 ma at 100 C and a thermal drop of \(2.75 \mathrm{C} / \mathrm{w}\) maximum. Temperature range is -35 C to +120 C (case) and -35 C to +150 C (junction). Mounting torque for style ES-21 is 50 in.-lb maximum and for the ET-21 it is 300 in.-lb maximum. Overall length for \(\mathrm{ES}-21\) is \(1 \frac{8}{\frac{8}{16}} \mathrm{in}\). maximum and ET-21 is \(1 \frac{1}{18}\) in. maximum. Piv ranges from 100 to 400 v in 100 v steps.
CIRCLE 317 ON READER SERVICE CARD


\section*{Broadband Coax Mixer \\ PRINTED CIRCUIT TYPE}

PREMIER INSTRUMENT CORP., 33 New Broad St., Port Chester, N. Y., is producing a printed circuit broadband coax mixer which utilizes a replaceable printed circuit diode. The PC-Mix is a compact, low noise figure mixer with local oscillator level adjustment. It is capable of withstanding severe vibration and shock and is available in frequency ranges of 250 Mc to \(\mathbf{8 , 0 0 0}\)


You'll find our Series RL \& RLP Latching Relays are made best to perform best, with an added plus: they are available either OPEN or PLUG-IN. Both types feature gold flashed load contacts, providing reliability when switching extremely low amperage circuits, as well as completely eliminating contact oxidation prior to use. Operational reliability is assured through the use of a \(100 \%\) checkout before shipment. Series RL Plug-in relays are thoroughly checked for continuity through the use of a punched card testing unit.

The Series RL \& RLP are mechanical latch units which require only a momentary pulse for operation, thereby eliminating current drain and chatter.

SPECIFICATIONS:
Contact Ratings: 10 amps . non-conductive Contact Arrangement: up to 6 PDT (open Type) up to 5 PDT (plug-in Type)

For more information about the Series RL \& RLP Latch Relay circle the reader service number below. However, if you want a copy of our complete catalogue, send your request to our new address as shown below.


\section*{LINE ELECTRIC COMPANY}

241 River Street, Orange, N. J.
AFFILIATE - INDUSTRIAL TIMER CORPORATION

Mc in five basic units. Some of the essential features are: a signal vswr of 2:1 maximum; L-0 vswr of \(1.5: 1\) maximum; a better than 9 db noise figure; and single or balanced mixing.

CIRCLE 318 ON READER SERVICE CARD


\section*{Trimmer Potentiometer HORIZONTALLY MOUNTED}

MAUREY INSTRUMENT CORP., 7924 South Exchange Ave., Chicago 17, Ill., announces the modular 50M60 printed circuit, horizontally mounted, single turn trimmer. Adjustment is made from front of panel. Setting is pin-pointed on indexed dial face. Single turn assures fast trimming. Unit is light in weight, occupies less area on p-c board, fits 0.1 in . grid, is adaptable to dip and splash soldering, and is of sealed construction. Resistance values range from 25 ohms to 50,000 ohms.

CIRCLE 319 ON READER SERVICE CARD


\section*{Servo System}

VARYING RESPONSE TIME
LING-ALTEC ELECTRONICS, INC., 1515 South Manchester, Anaheim, Calif. The S-14 servo system offers control accuracy of less than 3 percent variation in controlled level for system resonances up to 50 db and has a varying response time. The reaction time is less than 5 cycles for 90 percent correction of 10 db gain


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Thermoplastic insulation type MW 1000 volt\(80^{\circ} \mathrm{C}\), military specifications Mil-W-76A. In 30 color combinations. Fungus-proof. Resistant to acids, alkalis, oil, flame and moisture.
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\section*{wide-range REGATRON \({ }^{\circ}\) POWER SUPPLIES}

\section*{... for}
laboratories with varied requirements

Wide-range REGATRON Laboratory Power Supplies: available in \(0-300,600\), or 1000 volts dc continuously variable, \(0-500,600\), 1000 , or 1500 ma . . . load regulation to \(0.01 \%\) or 0.05 V , negligible ripple . . . also 6.3 V ac and regulated dc bias outputs. For all the reasons why leading laboratories prefer REGATRONS send for Bulletin 422

Model 219B (pictured above)
Main output: 0 to \(600 \mathrm{~V} \mathrm{dc}, 0\) to 1000 ma .
Load regulation: \(0.01 \%\) or 0.05 V . Ripple: 0.0005 V .
Also regulated \(0-150 \mathrm{~V}\) dc bias supply and 6.3 V ac CT output, ten-turn control, calibrated dial with 3 volt vernier, modulation input. PRICE: \(\$ 675\) F. O. B. Eatontown, N. J.

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MEASUREMENTS
COMPANY. INCORPORATEO EATONTOWN . NEW JERSEY
reduction-less than 5 sec to correct within 10 percent a 10 db gain expansion at 5 cps decreasing with increasing frequency to 50 millisec at 5 Kc .
CIRCLE 320 ON READER SERVICE CARD


\section*{Silicon Rectifiers}

\section*{JAN MILITARY TYPE}

COLUMBUS ELECTRONICS CORP., 1010 Saw Mill River Rd., Yonkers, N. Y. has available silicon rectifiers produced by the double diffusion proc ess. They are supplied in the her metically sealed, axial lead top hat design, JAN series 1N538, 1N54 and 1 N547. They are also produce in the hermetically sealed, \(\frac{7}{18}\) in. stud design, JAN series 1 N253, 1N254, 1 N255 and 1N256. These units provide highest reliability in performance, meeting the electrical, mechanical and environmental requirements of specification MIL E-1.

CIRCLE 321 ON READER SERVICE CARE


\section*{Chatter Monitor \\ FOR CONTACTS}

COPLAN ELECTRONICS, 939 Galloway, Pacific Palisades, Calif., has announced the improved model CCM 1 A contact chatter monitor. Designed specifically for the production testing of relays for chatter or for intermittent contacts in connectors, commutators, etc., it may be operated by unskilled personnel If the contact under test exhibits
an undesired opening (or closing) in excess of a selected time interval, a warning light will indicate this condition at the conclusion of the test. The time interval is variable from 10 to \(100 \mu \mathrm{sec}\).

CIRCLE 322 ON READER SERVICE CARD


\section*{Precision Resistor CARBON FILM}

ELECTRA MFG. C0., 4051 Broadway, Kansas City, Mo. New resistor measures only 0.250 in . in length and 0.093 in . in diameter. It is rated \(1 / 10\) th watt at 125 C , maximum rated voltage is 250 v and the resistance range is 10 ohms to 300 K . The minute component has a high temperature, impact and moisture resistant coating, sturdy No. 22 leads and silver plated compression caps. For applications requiring extra protection against mechanical abuse and other similar hazards, the new resistor is available with an extra molded plastic jacket. With this extra jacket the resistor body measures 0.260 in . in length and 0.125 in. in diameter.

CIRCLE 323 ON READER SERVICE CARD


Servoed Indicator

\section*{RELIABLE, ACCURATE}

Kearfott division, general preciSION INC., 1150 McBride Ave., Little Falls, N. J., announces the T860511 N servoed ground speed and drift angle indicator. Containing a variable gain preamplifier, this hermetically sealed unit operates in conjunction with a Kearfott A470801 power supply and servo amplifier


\section*{COMPLETE RESPONSIBILITY}
for design, fabrication \& construction
of rotating antennas. For information contact the

\author{
Blaw-Knox Equipment Division, Pittsburgh 38, Pennsylvania
}


ANTENNAS


ARMAG \({ }^{*}\) PROTECTED DYNACOR \({ }^{\text {® }}\) BOBBIN CORES AT NO EXTRA COST!
Tough-as-tortoise-shell Armag armor is an exclusive Dynacor development. It is a thin, non-metallic laminated jacket for bobbin cores that replaces the defects of nylon materials and polyester tape with very definite advantages -and, you pay no premium for Armag extra protection.

Tough Armag is suitable for use with normal encapsulation techniques on both ceramic and stainless steel bobbins. It withstands \(180^{\circ} \mathrm{C}\) without deteriora-tion-is completely compatible with poured potted compoundshas no abrasive effect on copper wire during winding-fabricates easily to close-tolerance dimen-sions-inner layer is compressible to assure tight fit on bobbin-does not shrink, age or discolor.

Write for Engineering Bulletins DN 1500 , DN 1000 A, DN 1003 for complete performance and specification data covering the wide range of Dynacor low cost Standard, Special and Custom Bobbin Cores-all available with Armag non-metallic armor.
-trademark
package. Designed to operate under severe environmental extremes specified in MIL-E-5422 and MIL-E-5272C, the unit features numerals, letters, and pointers which are luminescent fluorescent in accordance with MIL-L-25142.

CIRCLE 324 ON READER SERVICE CARD


\section*{Waveguide Switches}

\section*{broadband operation}

FXR, Inc., 26-12 Borough Place, Woodside 77, N. Y. Series 641 waveguide switches are designed to be operated manually or driven electrically by a 28 v d-c solenoid actuator. They feature low vswr, excellent isolation and high power capacity. A milled aluminum rotor mounted on precision ball bearings assure a long and trouble-free life. Switches cover the frequency ranges from 3,950 to \(40,000 \mathrm{Mc}\) and each switch operates over the full waveguide bandwidth. Maximum vswr is 1.10 . Minimum isolation is 60 db for frequencies from 3,950 to \(26,500 \mathrm{Mc}\) and 50 db from 26,500 to \(40,000 \mathrm{Mc}\).

CIRCLE 325 ON READER SERVICE CARD


\section*{Banana Plug Resistor}

EIGHT STANDARD SIZES
CONSOLIDATED RESISTANCE CO. OF america, inc., 44 Prospect St., Yonkers, N. Y., has available banana


\section*{Electrical Engineering}

\section*{Science}

Just Published. Introduces the field of electrical engineering in terms of the basic concepts of electricity and magne-tism-applies these concepts in dereloping fundamentals of energy conversionand circuit theory-and of network analysis. tegrated treatment of network analysis. Helps you quickly solve electrical engl neering problenanical systems, diode logic as electronechanical systems, dion of percircuits, instrumentation, design of permanent magnet structures, and many both of Princeton Cniversity. 525 pp . 357 lllus., \(\$ 9.50\)

\section*{Resistance and Resistors}

Just l'ubllwhed. This practical reference thoroughly treats the most frequently used component in electronic circuitry the resistor. It analyzes the basic aspects of resistor-the materials used in its manu-resistor-the materials used in its manuwith each type, and applications. ComWith each type, and applications. Comprehensive tables include most manuone common table. Thus a design or components engineer can tell at a glance exactly what is available. By Charles \(\mathbf{L}\). Wellard, Technical Director, systems Division, Clifton Preclalon Prodtucts Co. 264 pp.. \(6 \times 9,82\) llus., \(\$ 8.50\)

\section*{Two-way Radio}

Complete guide to two-way radio-from its practical uses to technical information on both \(A M\) and \(F M\) transmitters and recelvers, circuits, selective calling methods, antennas, power supplies, installation, and servicing. Covers digital pulse, codes, power sources, transmitter tuning, phase-shift modulators, splitchannel operation, and other topics. Describes such recent developments as synchronous \(A M\) and single sideband. By A. Intel, A veo IIf. Co., Crosley Div. 304 pp., 283 flus., \(\$ 9.50\)

\section*{Introduction to}

\section*{Matrix Analysis}

Just Published. Clearly treats the basic flelds in the analysis of matrices-symmetric matrices and quadratic forms, matrices and differential equations, and positive matrices and their use in probability theory and mathematical economics. Each section includes mathematical, physical, and economic background of the particular matrix theory. There are special chapters on dynanic programming and stochastic matrices. By \(R\). Bellman, The KANI) Corp. 331 pp, , \(\$ 10.00\)

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plug resistors in 8 standard sizes from to 2 w power dissipation. General type is noninductively wirewound; also carbon and metal film. Tolerance is 1 percent through 0.005 percent absolute; stability, through 0.001 percent; temperature coefficient, through 5 ppm per deg C absolute; impregnation, hermetic seal in epoxy resin; MIL specs, applicable sections of MIL-R93B and MILR9444; standard plug spacing, ${ }^{\frac{3}{4}}$ in. and also ${ }_{3}^{3} \mathrm{in}$. Plugs are silver plated and jacks are gold plated. Price: approximately $\$ 2$ each in 0.1 percent tolerance and lots of 100 pieces.

CIRCLE 326 ON READER SERVICE CARD


## Power Supply

## FOR CAPACITOR AGING

nje corp., 20 Boright Ave., Kenilworth, N. J. Model CS-58TRM72B power supply is designed especially for electrolytic capacitor forming and aging. It is rated at 2 to 300 v d-c; 0.6 to 30 amperes, and exhibits excellent regulation and ripple characteristics. The transistordriven magnetic-amplifier circuitry contributes to high reliability and versatility. In operation, the unit is current-limited and voltage-regulated. The preselected current is maintained during the initial charging interval to within $\pm 2$ percent. The voltage rises in proportion to the increasing load impedance until it reaches the pre-

Scientific objectivity characterizes the examination of natural forces in the experimental laboratories at Los Alamos.


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## Personnel Director

Division 80.53


## WHAT'S UP IN WASHINGTON?



Powerful individuals in Congress, The Pentagon, the State Department and elsewhere can influence the business plans of scores of electronics manufacturers.
electronics reports on policy makers who influence decisions on guided missiles, basic scientific research, government communications policy and many other sensitive subjects.

The highlights are summed up in 3 minutes reading time. More detailed reports on particularly important subjects are specially edited for quick and easy reading.
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## FIND WHAT YOU NEED IN... electronics

selected level. The voltage is then maintained within $\pm 0.5$ percent. Ripple will not exceed 0.2 v rms .

CIRCLE 327 ON READER SERVICE CARD


## Portable Counter <br> FOUR DISPLAY UNITS

aErotronic associates, inc., P. 0. Box 367, Contoocook, N. H. Model 1301P portable counter has been designed for making measurements in the audio range from 1 cps to 20 Kc . It contains four multivibrator type display units. Associated with these are input and gating amplifiers and a 1.0 sec gate generator. The gate generator derives its time base from the 60 cycle line. An automatic reset feature is included. Price is $\$ 375$.

CIRCLE 328 ON READER SERVICE CARD


## Transformer

## CONSTANT VOLTAGE

FREED TRANSFORMER CO., INC., 1718 Weirfield St., Brooklyn 27, N. Y., offers a sine wave ( 7 percent distortion) constant voltage transformer in 60 and 400 cycle units. With a line variation of 95 v to 130 v , output of this unit will remain constant to within $\pm 1 \frac{1}{2}$ percent. Unit has a current-limiting feature which prevents excessive fault currents. It can replace nonregulating transformers in step-up or step-down

## In research...

A Model 906 Honeywell Visicorder wrote this record of pressure fluctuations . . "buzz" . . for engineers at the NASA Lewis Flight-Propulsion Laboratory in Cleveland. "Buzz" is an unsteady variation in the pressure and airflow characteristics of a supersonic aircraft or missile inlet. These Visicorder studies defined the buzz-free operating limits of the inlet, and provided the designers with structural load information in case the inlet were inadvertently caused to operate on buzz during flight. This load information is vital, for inlet buzz can result in fluctuating structural loads of the order of 1000 psf... loads which could cause structural failure of the inlet and loss of the airplane. Visicorder records such as this have played an important role in the de. sign of inlet control systems.


## these are records of leadership

## In medicine...

This directly-recorded Visicorder chart has told the scientists of the U. S. Public Health Service Occupational Health Program an important story about uneven alveolar ventilation in the human lung during a single breath of oxygen. In these lung function tests, the Visicorder measured anatomic dead space and abnormalities in the distribution of inspired gas in the alveoli of the lungs. The subject, under test, inhaled $100 \%$ oxygen to dilute nitrogen in the lungs. The Visicorder recorded the volume and the nitrogen percent of the exhalation. In these and in hundreds of other scientific and industrial applications, Visicorders are bringing about new advances in product design, computing, control, rocketry, nucleonics and production.
For information on applying the unlimited usefulness of the Visicorder to your specific problems, phone your wearest Honeyuell Industrial Sales Office.

The Honeywell Visicorder provides instantly-readable, high-sensitivity data at frequencies from DC 105000 CPS.
There are models with 8, 14, or 36-channel capacities.



Visicorder records 2/3 actual size.

## Honeywell

H Industrial Products Groupp
service are eliminated because the unit has no renewable parts. It can be hermetically sealed for military application at elevated temperatures.

CIRCLE 329 ON READER SERVICE CARD

## Tubular Relay

## HIGH RELIABILITY

Wheelock signals, inc., Long Branch, N. J., announces a newly developed model of the series 120 tubular relay. The armature of the relay is the only moving part in the component. The simplicity of design creates a very high degree of reliability in performance. Hermetically sealed and dry nitrogen filled, the relay is constructed for high vibration and shock immunity. Specifications for vibration are $15 \mathrm{~g}, 10$ to $2,000 \mathrm{cps}$, and for shock, 30 g deenergized, 100 g ener-gized-no contact opening. The life is more than 200 million mechanical operations.

CIRCLE 330 ON READER SERVICE CARD

## ... When there's NO SUBSTITUTE for PRECISION TIMING

When the emphasis is on accuracy in timing, the wise choice is STANDARD precision elapsed time indicators. Units are synchronous motor driven. . . electric clutch controlled
 by manual or automatic switch or output of electronic tubes . . . available with manual or electric zero reset, a-c or d-c clutch.

| Model | Scale <br> Divisions | Totalizes | Aceurocy |
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| S.100 | $1 / 5 \mathrm{sec}$. | 6000 sec. | $\pm .1 \mathrm{sec}$. |
| $S .60$ | $1 / 5 \mathrm{sec}$. | 60 min. | $\pm .1 \mathrm{sec}$. |
| $S M .60$ | $1 / 100 \mathrm{~min}$. | 60 min. | $\pm .002 \mathrm{~min}$. |
| S .10 | $1 / 10 \mathrm{sec}$. | 1000 sec. | $\pm .02 \mathrm{sec}$. |
| S .6 | $1 / 1000 \mathrm{~min}$. | 10 min. | $\pm .0002 \mathrm{~min}$. |
| S .1 | $1 / 100 \mathrm{sec}$. | 60 sec. | $\pm .01 \mathrm{sec}$. |
| MST | $1 / 1000 \mathrm{sec}$. | .360 sec. | $\pm .001 \mathrm{sec}$. |
| MST. 500 | $1 / 1000 \mathrm{sec}$. | 30 sec. | $\pm .002 \mathrm{sec}$. |

## THE STANDARD ELECTRIC TIME COMPANY <br> 89 LOGAN STREET, SPRINGFIEID, MASSACHUSETTS

tion to special applications; cabinet and rack mount models; 5-in. chart; price $\$ 320$.

CIRCLE 331 ON READER SERVICE CARD


## Isolation Amplifier

$$
\text { OPERATES }-55 \text { TO } 125 \mathrm{C}
$$

CONTROL TECHNOLOGY CO., INC., 1186 Broadway, New York 1, N. Y. Model 250 isolation amplifier measures 1 by 1 by $1 \frac{1}{2} \mathrm{in}$. high. Input impedance is 200,000 ohms and output impedance is 640 ohms. Gain of amplifier is unity. Isolated input and isolated output make the unit ideal for computer, servo and automation applications. Amplifier uses silicon transistors and operates on standard $28 \mathrm{v} \mathrm{d}-\mathrm{c}$ power. Internal signal limiting prevents overdrive or phase shift for high input signals. Operates from - 55 C to 125 C and under MIL-E-5272 environmentals. Models also available with an input impedance of 1 megohm or 5 megohms.

CIRCLE 332 ON READER SERVICE CARD


## Snap-Action Switch

PULSE-PRODUCING
micro switch, Freeport, Ill. Catalog 1PD1 switch is designed for industrial applications where momentary opening and/or closing of a circuit is necessary. It is especially useful for controlling pneumatic valves where permanent-duty solenoids are not used. The entire pulse operation occurs as the plunger is depressed; no switching action takes place on the plunger return stroke. Mechanical characteristics include


Look to Eastern Industries for the advanced pressurization/dehydration packs required by the avionic and ground support systems of tomorrow. Whenever a precisely controlled flow of dehydrated air is required, Eastern design and production experience team up to create compact, lightweight, reliable subsystems. Characteristics and performance range of existing units:
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Smaller packs feature replaceable chemical dehydrator elements - the larger subsystems are available with automatic reactivating dehydrators.

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1000 N. Olive St., Anaheim, California Branch: 437 Fifth Ave., New York, N.Y.
0.150 -in. maximum pretravel ; 0.600 in. minimum total plunger travel, 4-lb operating force and $8-\mathrm{lb}$ full overtravel force. Pulse length is adjustable from 0.030 to 0.450 in .; the adjustable plunger can be extended 0.750 in. Electrical characteristics of the spdt sealed switch are 10 am peres at 125,250 , or 480 va a ; $\frac{1}{2}$ ampere at $125 \mathrm{v} \mathrm{d-c}$; 1 ampere at 250 v d-c.

CIRCLE 333 ON READER SERVICE CARD

## Button Capacitors

## SILVERED MICA

SANGAMO ELECTRIC CO., Springfield, Ill., announces a new group of high-temperature silvered mica Button capacitors that are especially designed for continuous operation in the wide temperature range of -55 C to +230 C . These capacitors are rated at 200 wvde in capacitance ratings from 50 to $4,775 \mu \mu$. They have been developed for use where the application calls for low distributed inductance and reliable performance characteristics in a high temperature environment.

CIRCLE 334 ON READER SERVICE CARD


## D-C Power Supply <br> RUGGEDIZED UNIT

PERKIN ENGINEERING CORP., 345 Kansas St., El Segundo, Calif. Model M-1348 ruggedized, weatherproof d-c power supply for missile ground support has an output of 2432 v at 100 amperes. It has magnetic amplifier regulation with no vacuum tubes or moving or delicate parts. Silicon rectifiers provide resistance to high temperatures and adverse, environmental conditions. Regulation is $\pm 0.5$ percent line and load combined. Ripple is $\frac{1}{2}$ percent rms based on an a-c input of 208,230 , or $460 \mathrm{v} \pm 5$ percent (re-

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connectable), 3 -phase, 60 cps . Unit is provided with remote sensing and meets various MIL specs for adverse environments, fungus, and ruggedness.


## Module Oscilloscopes

RECTANGULAR TUBES
JAMES MILLER MFG. CO., INC., 50 Exchange St., Malden, Mass. A new series of compact module oscilloscopes using the 3UP1 $2 \frac{1}{8} \mathrm{in}$. by $1_{18} \frac{9}{8} \mathrm{in}$. and the 3 XP1 3 in . by $1 \frac{1}{2}$ in. rectangular tubes has been released. The scopes take up a panel space of only 3 in . by 5 in . for the No. $90912-\mathrm{R}$ and 3 in . by 6 in . for the No. 90913.

CIRCLE 335 ON READER SERVICE CARD


## Tiny Switch

## ENVIRONMENT-FREE

micro Switch, Freeport, Ill. Measuring just 0.616 by 0.6 by 0.316 in . and weighing only 0.2 oz , the sealed 1XE1 switch combines miniaturization with reliability for mobile, marine, aircraft and railway applications. Switch mechanism and extending leadwires are embedded in an epoxy resin inside a treated corrosion-resistant aluminum housing. An elastomer seal around the plunger prevents dust, dirt or moisture from getting inside. The spdt switch will operate in ambient temperatures ranging from -65 to 230 $F$. Electrical rating is 4 amperes inductive 28 v d-c; 5 amperes at


The coil shown above is a $1 / 32$ " residual I.D. toroid being wound by machine on Boesch's new Model MW400 MINITOR. It's the smallest machine-wound coil ever made (only half as large as the smallest previously available), and it can only be wound on MINITOR!
This achievement reflects a completely new, unique method of coil winding perfected by Boesch. The wire is loaded inside a hollow, round cross-section shuttle, and the winding is spun out. A single loading of this unique shuttle is usually enough to wind several coils.

MINITOR handles wire sizes from \#36 to \#50 AWG, and winds up to 500 turns per minute. Maximum finished coil size is $z_{4}^{\prime \prime}$.
Shuttles for MINITOR are loaded by a Boesch PW-100 Loader. This machine can service as many as 20 winding machines, and it can load needles for hand winding as well.

If you now own a Boesch SM series machine, you can convert it to MINITOR operation economically by buying a $400-200$ Head, a 400-300 Core Rotating Assembly, and the PW-100 Loader.

WRITE TO US TODAY for complete specifications, delivery schedules and prices on MINITOR.


## Professional Opportunities Are Available For

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UPTON, LONG ISLAND, N. Y.


115/230-v 60-cycle a-c. Leadwires available in $1-, 3-, 6-$ and $12-\mathrm{ft}$ lengths.

CIRCLE 336 ON READER SERVICE CARD


## Tunnel Diodes

FOR REFERENCE ELEMENT general electric co., Syracuse, N. Y. Types 1N2941 and 1N2969 germanium tunnel diodes are designed for use as circuit reference elements. The 1 N2969 has a typical peak point current of 2.2 ma ; the $1 \mathrm{~N} 2941,4.7 \mathrm{ma}$. This rating is held to a variation of no more than 10 percent in both diodes. Both have typical peak to valley current ratios of 8 to 1 . The 1 N2941 has a total capacity of $30 \mu \mu \mathrm{f}$; the $1 \mathrm{~N} 2969,20$ $\mu \mu \mathrm{f}$. Both have typical peak point voltages of 55 mv , typical valley point voltages of 350 mv , and typical forward peak point current voltages of 500 mv . They are rated for operation over an ambient temperature range from -55 C to +100 C . Units are housed in the standard small transistor package TO-18.

CIRCLE 337 ON READER SERVICE CARD


Oscilloscope
NULL-READOUT
analab instrument corp., 30 Canfield Road, Cedar Grove, N. J. A null balance technique introduces new standards of accuracy and speed for measuring analog data directly from the screen of the type $1100 / 700$ oscilloscope. To avoid the
usual reading errors from the crt screen, the Analab null-readout system incorporates an anti-parallax scale, equivalent to a mirror-backed scale on a meter. With the type 700 dual-channel plug-in, incorporating 1 percent null-readout potentiometers for measuring amplitude on the two signal channels as well as sweep time, the null readout system is said to be the fastest method for making direct, repeatable, accurate measurements without interpolation.

CIRCLE 338 ON READER SERVICE CARD

## Wire-Wound Pots <br> miniaturized

Waters mpg., inc., Wayland, Mass. Designed for bushing-type mounting, the APS $\frac{1}{2}$ pot requires up to 25 percent less space behind panel than pots having identical specifications. It is available with terminals, wire leads or p-c pins. Case length is $\frac{3}{} \mathrm{in}$. It is used in industrial and military equipment where utmost in reliability and performance is required. The WPS $\frac{1}{2}$, a precision version of the APS $\frac{1}{2}$, is equipped with servo-type mounting. Center taps, special shafts and pilots are available on request. Both pots are capable of dissipating 2 watts continuously.

CIRCLE 339 ON READER SERVICE CARD


## Voltage Calibrator

## TRANSISTORIZED

Kay electric co., 14 Maple Ave., Pine Brook, N. J. The Megavolter is a fully transistorized r-f voltage calibrator for use in obtaining voltage calibrations of r-f signal generators and vtvm's. The lightweight, compact unit can be used right on the production line, without the aid of expensive and delicate external voltage standards, to obtain readings of 1 percent accuracy to 10 Mc ;


For years, Lapp has been a major supplier of stand-off insulators to radio, television and electronics industries. Wide knowledge of electrical porcelain application, combined with excellent engineering and production facilities, makes possible design and manufacture of units to almost any performance specification. The insulators shown on this page are representative of catalog items-usually available from stock-and certain examples of special stand-offs. The ceramic used is the same porcelain and steatite of which larger Lapp radio and transmission insulators are made. Hardware is brass or bronze; brush nickel plating is standard.

Write for Bulletin 301 with complete description and specification data. Lapp Insulator Co., Inc., Radio



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POLYVAR has properties fully equal to those of Formvar for wire insulation, plus easy solderability, greater thermal stability, and lower moisture absorption.

In AWG sizes 15 through 40. May we send you complete details on Acme POLYVAR? If convenient, please describe your need.

2 percent accuracy to 50 Mc ; 3 per cent accuracy to 200 Mc and measure from 1 mv to 1 v rms from 1 Kc to 200 Mc . Time consuming and expensive trips to the standards laboratory are thereby eliminated.

CIRCLE 340 ON READER SERVICE CARD


Mesa Transistors

## AMPLIFIER TYPE

mOTOROLA INC., Semiconductor Products Division, 5005 E. McDowell Road, Phoenix, Ariz. The 2N1561 and 2N1562 mesa transistors, capable of producing $\frac{1}{2} \mathrm{w}$ power at 160 Mc , are intended as high power output amplifiers for vhf applications and can be used in two-way pocket radios, sonobuoy transmitters, telemetering devices for missiles, aircraft radio communications equipment, air'sea rescue radio transmitters and similar devices. Designed with collector current capability of 500 ma , the cold-welded copper package of these units insures very low internal temperature gradients. With a heat sink, they will dissipate up to 3 w at 25 C case temperature. Both meet MII.-S-19500.

CIRCLE 341 ON READER SERVICE CARD


## Chassis Slides

## EFFICIENT LATCHING

ELECTRO-PACK, inc., 11505 Jefferson Blvd., Culver City, Calif., announces a complete line of electronic chassis
slides that cannot over-ride the latching mechanism, no matter how fast the chassis is withdrawn from the cabinet. An internal latch locking system eliminates scoring on the slides, and does not throw slides out of alignment. All sections are interlocked for safety. Sliding action is non-binding, due to a unique all-radius bearing action. Chassis locks positively in the extended position. Unit is thin-engineered to mount standard $17-\mathrm{in}$. wide chassis in standard electronic cabinets, with a $17{ }^{3} \mathrm{in}$. clear opening. Height of the cabinet section is only $2{ }^{\frac{7}{6}}$ in. The Glide-Slide is rated to carry 220 lb in extended position, and will take over 3 g's during drop test in closed position.

CIRCLE 342 ON READER SERVICE CARD


## H-V Power Supply MINIATURIZED

film Capacitors, inc., 3400 Park Ave., New York 52, N. Y. Model PS-12-S has an output of 12 Kv at 1 ma . It is designed to operate at 115 v a-c, 60 or 400 cycle input at 1 ma continuous and 1.75 ma peak current. Ripple is 0.75 percent at rated current and regulation from no load to full load is 7 percent. Output voltage is variable from zero to rated output, by varying the input voltage. The supply utilizes selenium rectifiers which assures long life and elminates the danger of tube breakage. Unit is housed in a CP70 container $3 \frac{3}{4} \mathrm{in}$. by 4 最 in. by $6 \frac{1}{2} \mathrm{in}$. high. It can be mounted easily with brackets. Screw type solder seal terminals are used to prevent oil leakage and to make for simple connections.

CIRCLE 343 ON READER SERVICE CARD


The 40 liter/second Vaclon $₫$ High Vacuum Pump, emphasized above, is just one of a great variety of Varian Vaclon Pump sizes available from stock. These include $1 / 2,1,5,40$, $100,140,280,1000,3000,5000$ and 10,000 liter/second capacities. Other sizes available on custom order.
All these pumps give extremely clean vacuums to below $10^{-10} \mathrm{~mm} \mathrm{Hg}$, have no moving parts or fluids, and operate without attention or service.
The Vacion High Vacuum Pump is a fully electronic device and is a Varian "First." Unique both in principle and advantages, it has been accepted as an efficient, reliable laboratory and production tool by industries throughout the world. A comprehensive brochure and technical data sheets are available by writing Vacuum Products Division.


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## Literature of

ROTARY SWITCH Circuit Controls Co., A Division of Genge Industries, Inc., 1500 E. Colorado St., Glendale 5, Calif. Two-color, four page brochure describes a small size, light-weight rotary switch which completes up to 100,000 contacts per minute with no bounce.

CIRCLE 350 ON READER SERVICE CARI

POWER SUPPLIES Mid-Eastern Electronics, Inc., 32 Commerce St., Springfield, N. J., offers a new bulletin on the company's ME series of transistorized power supplies, featuring 26 standard units.

CIRCLE 351 ON READER SERVICE CARD

SILICONES Dow Corning Corp., Midland, Mich. An up-to-the-minute summary of the forms, properties and applications of the company's silicone products is contained in a 16 -page brochure.

CIRCLE 352 ON READER SERVICE CARD
DELAY LINES Cornell-Dubilier Electric Corp., 4144 Glencoe Ave., Venice, Calif. A new brochure, "Delay Lines-Basic Design Considerations," gives the design engineer the information he needs to calculate the circuit parameters and size of the delay line which will meet the requirements.

CIRCLE 353 ON READER SERVICE CARD
ROTARY TRIMMER CAPACITORS Corning Glass Works, Bradford, Pa., has published a data sheet describing standard, split bushing and precision rotary trimmer capacitors especially applicable to h-f tuned circuits. The sheet-CE-4.00-should be requested on company letterhead.

## IMPULSE COUNTING DEVICES

 Landis \& Gyr, Inc., 45 West 45th St., New York 36, N. Y. A new and revised general bulletin describing all Sodeco electric impulse coinnting devices is announced.CIRCLE 354 ON READER SERVIG CARD

## SAMPLING OSCILLOGFAPHY

Hewlett-Packard Co., 275 Page Mill
Road, Palo Alto, Calif. Eight-page
Application Note No. 36 describes
a method for pulse analysis of ultra-

## the Week

fast circuits. It traces the history of the sampling technique and its recent application to oscilloscopes, extending their usefulness into a higher portion of the frequency spectrum.

CIRCLE 355 ON READER SERVICE CARD
TEMPERATURE CONTROLS Assembly Products, Inc., Chesterland, Ohio. Simple and inherently stable temperature control packages, known as Simplytrols and applicable to a wide variety of industrial processes, are described in a 12-page bulletin 108 .

CIRCLE 356 ON READER SERVICE CARD
PULSE WIDTH SELECTION Hammarlund Mfg. Co., Inc., 460 W . 34th St., New York 1, N. Y. A technical brochure explaining the operations and applications of the comcompany's pulse width selection systems is available.

CIRCLE 357 ON READER SERVICE CARD
DIELECTRIC TEST BRIDGE Rohde \& Schwarz, 111 Lexington Ave., Passaic, N. J. A four-page, two-color bulletin presents detailed information on the type VKB dielectric test bridge which measures dissipation factors and capacitances of any kind of capacitors between $10 \mu \mu \mathrm{f}$ and $1 \mu \mathrm{f}$.

CIRCLE 358 ON READER SERVICE CARD
VARIABLE TRANSFORMERS Ohmite Mfg. Co., 3681 Howard St., Skokie, Ill. Bulletin 151 describes a new line of "v.t." brand variable transformers for low voltage applications such as transistorized power supplies, plating-bath power supplies, etc.

CIRCLE 359 ON READER SERVICE CARD
CORE TESTER Digital Equipment Corp., Maynard, Mass. Fourpage folder describes type 2101 automatic memary core tester designed for production-line testing of ferrite magnetic memory cores.

CIRCLE 360 ON READER SERVICE CARD
TOROIDS AND FILTERS Barker \& Williamson, Inc., Bristol, Pa. A four-page illustrated catalog lists various toroid types and shows typical performance curves.

CIRCLE 361 ON READER SERVICE CARD

Millions of tiny parts are made from shaped, special alloy wire

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Tons of beryllium copper, bronze and other special non-ferous alloy wire today provide millions of tiny formed parts for industry.
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65 Pavilion Avenue Providence 5, Rhode Island


## Swanson: first, a one-tube radio

ELECTRONIC countermeasures could well tip the balance between survival and destruction.

Countermeasures are not new to Elston H. Swanson, president of Instruments for Industry, Inc., Hicksville, N. Y. While only 9 , he countered a parental prohibition against listening to the 1932 election returns by building a one-tube radio, regenerative receiver type, which he hid under his bed and listened to half the night. He had bought the tube from a neighborhood repair shop and fashioned the rest from his father's old crystal sets.

Now, the company he heads develops and produces equipment to befuddle and render ineffective a foe's electronic gear. This highly sophisticated branch of electronics is pretty well hidden under security wraps, but among IFI's developments is a portable unit which places a "ceiling of safety" over men in the field to guard them from ballistic attack.

After graduating from the Illinois Institute of Technology 16 years ago, Swanson headed east to Long Island. He filled three increasingly better jobs in the area's burgeoning electronics industry, then led the group which in 1953 formed what is now known as IFI. In 1954, he bought all the company stock.

IFI's sales have boomed from $\$ 400,000$ in 1954 to more than $\$ 2.5$
million annually-and are expected to top $\$ 3$ million this year. The company "went public" last year.

Despite demands of business, Swanson finds time, as do others on his staff, to take an active part in industrial, educational and community affairs, for his theory is that "no business enterprise can be an island unto itself."

He founded, and was first president of, the Long Island Electronics Manufacturers' Council, created to expand opportunities for industry on the island. He is shown above with a plaque recently presented to him by the LIEMC in appreciation of his services.

He is also a director of Adelphi Research Center, which was developed as a hub of basic research and education on the island.

A flying enthusiast, Swanson pilots a twin-engine plane on business trips. Sharing in his many in-terests-such as photography, ham radio and raising rare tropical fish -are his two children and wife.

Swanson is a licensed professional engineer in New York, a member of Eta Kappa Nu (electrical engineering honor society), Tau Beta Pi, and the Institute of Radio Engineers. He now is chairman of the Long Island Chapter of the Young Presidents' Organization, made up of those who, before reaching 40, become presidents of com-
panies doing more than $\$ 1$ million in business a year.

He attributes IFI's success to the scientific knowledge and productive and management capabilities of those around him, and says: "Any successful executive surrounds himself with such people."


Vaughan Moves to SIE
As V-P, Marketing
SOUTHWESTERN INDUSTRIAL ELECtronics co., Houston, Texas, a division of Dresser Industries, Inc., has announced the appointment of Robert 0 . Vaughan as vice president, marketing.

Vaughan moves into the SIE position from his former post as western regional manager of government operations for Dresser Industries, Inc.

## Announce Formation Of New Company

A NEW electronics company, Embree Electronics Corp., was recently set up in West Hartford, Conn.
New firm, headed by John M. Embree, will manufacture computer components for the electronic control of machinery and processes.

Embree, a management staff engineer in the electronics field, says his company expects to market a line of products related to electronic analog computers starting this month.

Company is engaged in research, design and manufacture of its com-


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Write for Bulletin JSH \# 62


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puters, used to solve mathematical equations to predict the behavior of dynamic systems and to furnish data for successful operation of automatic reactor controls, submarine maneuvering controls, missile guidance systems and controls for in + dustrial and chemical processes.


## General Transistor

 Promotes Stanleyalan g. stanley has been advanced to assistant director of research at General Transistor Corp., Jamaica, N. Y. The announcement was made by Bernard Jacobs, vice president and director of research.
"In his new position," he stated, "Stanley will assist in the administration of our greatly expanded research facilities in New York."

With General Transistor since October 1959, Stanley previously headed the microminiaturization program at Philco Corporation Research Laboratories.

## Handicapped Group Forms New Facility

AN ELECTRONICS production unit manned entirely by specially selected handicapped people was recently established by the Institute for the Crippled and Disabled in New York City.

The new facility is functioning as part of the Institute's industrial rehabilitation service.

Initially, approximately 6,000 sq ft of floor space in the workshop has been assigned to the new unit.

The unit specializes in making cables and harnesses, wiring, soldering, and assembling light electron-

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## do you know what's expected from

semi-conductor materials?

There were more than a dozen articles on semiconductor materials in electronics in recent months. Each was specially edited to give you all key facts, ideas or trends-and there's more coming! Accurate electronics' reporting tells you what's happening now... what's $e x$ pected in materials and components. Don't miss dozens of articles on basic subjects edited to keep you informed, help make your research, development, sales and marketing plans pay off. It pays to subscribe to electronics (or renew). Fill in box on Reader Service Card now. Easy to use. Postage free.

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At full capacity, the unit will provide sheltered employment to 110 handicapped persons.


## John Lesser Heads Up Successor Company

FORMATION of Bodnar Products Corp., as successor to the Plastics Division of Bodnar Industries, Inc., has been announced by A. S. Bodnar, chairman of the board.
John Lesser has been elected president of the new organization. He formerly served as production manager of The Multi-Metal Co., vice president and general manager of Photo Chemical Products of California, Inc., and assistant chief exccutive officer of Karp Metal Products. Prior to assuming the helm at Bodnar Products Corp., Lesser served as executive vice president of the Karp-Lesser Co., consulting engineers. He is a senior member of IRE.
The new company, situated in New Rochelle, N. Y., will continue to develop, manufacture and market illuminated panels and other plastic products for the aircraft and electronics industries. The approval and listing on Q PL 7788, which pertains to the manufacture of plastic lighting plate to conform with military specification MIL-P7788 and 7788 A , has been transferred to Bodnar Products Corp.
B. J. Bodnar will serve as vicepresident and Walter Jacoves as secretary-treasurer.


For a decade, Schomandl KG of Munich has led in frequency synthesis. Their ND5 Frequency Decade with accessory Precision Decade is the workhorse of the line.
Phase-locked steps produce and measure discrete frequencies with crystalstandard accuracy at 1 -kc/s intervals from $50 \mathrm{c} / \mathrm{s}$ to $31 \mathrm{Mc} / \mathrm{s}$. Precision Decade adds $100-\mathrm{c} / \mathrm{s}$ intervals, with fine tuning to any intermediate frequency $\pm 0.1 \mathrm{c} / \mathrm{s}$.
Optional - extension to $1200 \mathrm{Mc} / \mathrm{s}$;
CRT for Lissajous comparisons; strip recording of sense and amount of frequency deviation with related variables.
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[^1]:    "Television Allocations Problems" by E. W. Allen, Federal Communications Commission
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