## electronics

Using transistor sound-level meter at London Airport (below), p 64
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there is the transtarmer even twice the size of the DOI and DI-Y series which has as much as 1 10th the power handling ability ... which can equal the efficiencs or equal the response range. And none 10 approach the reliability of the DO-T and DIT anits (proved so, but exceet ing MIL-T-27A grade 4).

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Anchored Leads Printed Circuit Use Suited to clip Mourting.
> up to 10 times greater twice as good at low end reduced $80 \%$ up to $30 \%$ better compare DCR hermetically sealed to MLL-T-27A. completely metal cased. will withstand 10 pound pull test (soider melting) plastic insulated leads lise Augat \# $6009-8 \mathrm{~A}$ clip
transformers pictured actual size





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## HOW TO SCRIBE

## A "PERFECT" CIRCLE

## IN OUTER SPACE

## Bell Laboratories guidance system achieves unprecedented accuracy in steering Tiros weather satellite into orbit

Equipped with TV cameras, tape recorders, solar cells and antennas, the world's most advanced weather satellite, the NASA Tiros I, had to be placed in a precisely circular orbit at a specified altitude to do its job well.

The "shot" was a virtual bull's-eye. The mean altitude was within one mile of that planned. And

the deviation from this mean was less than $1 / 2$ per cent, making it the most-nearly-perfect circular orbit ever achieved with a space vehicle by either the United States or Russia.

The dependability and accuracy of Bell Laboratories' ground-controlled Command Guidance System has been proven before-in the successful test flights of the Air Force Titan intercontinental ballistic missile, and in last year's Air Force Thor-Able re-entry test shots from which the first nose-cone recoveries were made at ICBM distance. Now, with Tiros, the system contributes to a dramatic nonmilitary project. Other uses are in the offing.

This achievement in precise guidance again illustrates the versatility of Bell Laboratories' research and development capabilities-directed primarily toward improving your Bell telephone service.
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The Microminiature Kernel ATE-34 Adjustoroid ${ }^{\text {fr }}$ and a New Line
of Miniature Encapsulated Adjustoroids

Newest addition to the Burnell Adjustoroid line is the microminiature Kernel ${ }^{(\pi)}$ ATE-34 and the miniature ATE-11, ATE-0 and ATE-4. One of the unique features of these new Adjustoroids is a flush slotted head providing for ease of adjustment and economy in height.

The new microminiature Kernel ATE-34 Adjustoroid and the miniature ATE-11, ATE-0 and ATE-4 are variable over a $10 \%$ range of their inductance. Fully encapsulated, they will withstand high acceleration, shock and vibration environments. All of the above meet MIL-T specifications, 27 Grade 4 Class R and MIL-E 15305 A. Write for Stock Sheet AT-34.

|  | Length/ Dio. | Hgi. | Wi. | Usoful Freq. Range | Mox, 0 | Mox. L. in hys |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| ATE-0 | $11 / 16^{\prime \prime}$ | 1" | $11 / 2 \mathrm{az}$ | 1 kc to 20 kc | 10 kc | 5 hys |
| ATE. 4 | 15/16" | $13110^{\prime \prime}$ | 3.5 or. | 1 kc to 16 kc | 6 kc | 15 hys |
| ATE. 6 | 11/16" | 1 " | $11 / 2 \mathrm{oz}$. | 10 ks to 100 ks | 30 kc | . 75 hys |
| ATE. 10 | $15 / 16^{\prime \prime}$ | $13 / 16^{\prime \prime}$ | . 1 oz . | 3 kc to 50 kc | 20 kc | . 75 hys |
| ATE-11 | 1/4" | $13 / 16^{\prime \prime}$ | . 75 oz. | 2 kc to 25 kc | 15 kc | 5 hys |
| ATE-12 | 3/4" | $13 / 16^{11}$ | . 75 oz. | 15 kc to 150 kc | 60 kc | 1 hy |
| ATE-34 | 27/44 | 21/32" | . 1 oz . | 3 kc to 30 kc | 55 kc | 1 hy |

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STRATOSCOPE I. Our lead technical article this week points up the increasingly important role of electronics in helping astronomers and other scientists study our environment. Stratoscope I made four flights last summer. In all of them the tv system functioned in such a manner as to enable the telescope to be focused well within the theoretical focus tolerance. The tv equipment, which is described by L. E. Flory, G. W. Gray, J. M. Morgan and W. S. Pike of RCA Laboratories, also assisted astronomers in finding sunspots and other areas of interest on the sun's surface.

According to the authors, the balloon camera took more than 400 photographs on the second flight that were superior in quality to any similar photographs ever taken before by a telescope. Use of the tv system greatly increased the yield of useful pictures, one of which is shown on p 51.

MINNESOTA. There are more than 100 electronics companies in Minnesota, 90 percent of them in the Twin Cities area.

This state, once known mainly for agriculture and flour milling, experienced its first major industrial growth with the rise of iron mining in the northern regions. Later, as activity declined in the Mesabi range, and as high-grade ores became depleted, a new industry came into being -the electronics industry.

State officials were quick to recognize the growth potential in our industry. To learn more about electronics in Minnesota, Associate Editor Emma has been traveling in the region, speaking with executives, engineers and businessmen. His search led to a personal interview with Gov. Orville L. Freeman, as you'll read on p 30.

## Coming In Our June 24 Issue

MICROWAVE. Some of the most intensive research effort in our industry lies in the growing field of microwave technology. To bring you up to date on the latest developments in this important subject, next/week Electronics presents a special report on microwave equipment and applications. Authored by Associate Editors Carter and Solomon, the report describes the state of the art in antennas, generators and amplifiers, components and test equipment.

You'll read about the new broadband microwave antennas, electronbeam and solid-state generators, r-f semiconductor switches and the applications of microwaves to communications and radar. You'll find out where we stand in the trend toward broader bandwidth, higher power and lower noise. You won't want to miss this roundup, which is the product of comprehensive surveys and interviews held over the past /several months.

FURTHERMORE. The variety of interesting feature material scheduled to appear next week includes: a sonar pinger system for use in positioning underwater cameras by H. E. Edgerton of MIT; an attachment for converting oscilloscopes for fast-pulse sampling by J. J. Amodei of RCA; a discussion on measuring tape flutter and wow by J. T. Mullin of Minnesota Mining and Manufacturing Co.; and tunnel diode logic circuits by W. F. Chow of GE.


Now! Just two tubular capacitor types cover nearly all Entertainment Electronics

Low cost . . . superior performance . . . you get both with Sprague DIFILM ${ }^{\star}$ Capacitors: Black Beauty ${ }^{*}$ Molded Tubulars and Orange-Drop ${ }^{*}$ Dipped Capacitors.

And when it comes to humidity resistance, tests prove them to be outstandingly better than any comparable molded, ceramic-case, or dipped unit made!
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- Difilm Black Beauty Molded Tubular Capacitors, Type 160P and 161P, are the best capacitors money can buy for entertainment or commercial electronics. The duplex dielectric makes them the best inside ... their molded phenolic case makes them the best outside.

Difilm Orange-Drop Capacitors are the undisputed choice where economy and physical size are the keynote and where performance standards are slightly less than those of DIFILM Black Beauties. Smaller in size, Orange-Drops are also big space-savers. Radial leads are neatly crimped for printed wiring board insertion.
Take your pick-Black Beauty or Orange-Drop -and you're sure to get the best in performance at the lowest cost. If a-c peaks are involved, such as in line bypass, buffer, or vibrator power supply, Black Beauty mineral oil impregnated capacitors, Types 73P and 184P, are unsurpassed. Black Beauties are also available with stabilized Halowax impregnation where negative temperature coefficient of capacitance is required.

> Complete data on all types is given in Engineering Bulletins (No. 2025 for Difilm Black Beauties; No. 2004 for for Diflm Orange-Drops; No. 2010 for Black Beauties with mineral oil or wax impregnation) available from Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachuselts.

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## Excellent Coverage

. . . Your fine magazine is much appreciated for the excellent coverage it provides of new circuit techniques and components, particularly in solid-state devices and circuits.

Could you survey in a coming issue the recent advances in highpower high-frequency transistors using the mesa structure? I am sure that such an article would be of wide interest and assistance. . . .

Thomas M. Conrad
Flight Electronics
Wayne, Penna.
Under advisement.

## Japanese Production Workers

I was very much interested in your article on Tatsuko and Kayoko ("Japanese Production Workers: A Closeup," p 36, Apr. 1). However, it seems to me that there must be a typographical error in the last sentence, which reads "Besides which, about 30 million yen ( $\$ 833$,000 ) a month went toward operating the schools, a hospital, etc., for employees."

I assume you were also talking about the Totsuka plant of Hitachi in Yokohama. If so, the annual cost of these fringe benefits for the 3,500 employees in the Totsuka plant would run about $\$ 11$ million a year, or $\$ 3,000$ per employee. As the average annual pay to each employee is something less than $\$ 600$, the comparison is rather incredible.

It may be that the $\$ 10$ million for schools, etc., refers to the total Hitachi operation, including its 20 odd production facilities. . . .

Robert C. Sprague
Sprague Electric Co.
North Adams, Mass.
Needled by the doubt reader Sprague planted in our heads, we contacted Hitachi in Yokohama. Manager Kubo of the Totsuka plant confirmed that the plant provided 30 million yen worth of benefits for its 3,500 employees, added "of course, this doesn't mean that that much is spent; it's extremely difficult to figure out exactly what the expenditures actually amount to."

The figure undoubtedly is a budgeted maximum rather than a recorded outlay. Our error lay in making it seem a money-spent figure.

## Electronics in Japan

The study "Electronics in Japan" (p 53, May 27) is the best analysis of the subject that has ever appeared in a commercial publication. It paints a clear picture of the "key to Japan's future."

It was unfortunate that the typesetter misprinted KLD for KDD ( p 85) and had proofreading troubles on p 95 . However, these did not bother me as much as Malaysia (p 95) and Andrew Bell (p 89).

The report makes clear the facts of a heretofore misunderstood industry and helps erase a misconception about a very ambitious country.

## Roy K. Nishida

Highland Park, N. J.

Malaysia, according to several authorities available to us, describes the island group off southeast Asia in the Pacific and Indian Oceans stretching from Sumatra to Timor, and can be extended to mean the country inhabited by the Malay race-these islands plus the Malay and Indochina peninsulas and the Philippines. This extended meaning is what we meant. But how we ever mixed up Scottish educator Andrew Bell with the Alexander Bell who was A. G. Bell's grandfather and the groundbreaker in the science of phonetics we'll never be able to tell.

## Fine Job

You people did a fine job of editing my article "Insuring Stability in Time-Delay Multivibrators," p 73, Apr. 8. I was pleasantly surprised to find that none of the content had been lost. Congratulations on a fine publication. . . .
paul E. Harris
Syracuse University Researich
Corporation
Syracuse, N. Y.

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** Meets all requirements of MIL-C-55057 and MIL-C-21720A including dimensions.

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## B

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The 布 160B-a new 15 MC oscilloscope built to exacting MIL specifications; most versatile oscilloscope ever offered.


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## MEPtary quaity - Using premium components throughout, the 160 B is

 designed to meet the highest standards of ruggedness, accuracy and dependability. It follows MIL-E-16400B for shock, vibration, humidity and temperature. Premium features include high stability tube-transistor circuits, regulated dc filament voltages, power transistors in efficient heat sinks, circuits on translucent epoxy-glass, simplified layout.
## EaSy 10 OOEFQt - Model 160B control array is traditional and logical.

 No special training is required to operate the 160 B . Your set-up time and measurements are simplified with improved preset triggering and an automatic beam-finder. The first means that one preset adjustment insures optimum triggering for almost all conditions (even signals down to 2 mm deflection). The second means that with the press of one button the beam is instantly located and "held" until you center your trace.
## SPEC|FICATIONS

SWEEP GENERATOR:
Internal Sweep: 24 ranges, $0.1 \mu \mathrm{sec} / \mathrm{cm}$ to $5 \mathrm{sec} / \mathrm{cm}$; vernier to $15 \mathrm{sec} / \mathrm{cm}$
Magnification: 7 ranges, to $0.02 \mu \mathrm{sec} / \mathrm{cm}$
Triggering: 2 mm minimum, internal, power line or vertical input signal. External $0.5 \vee$ peak to peak
Trigger Point: Going voltage, -30 ta +30 v
Sowtooth Output: -50 to +50 v
Gate Output: 50 v pulse
HORIZONTAL AMPLIFIER:
Bandwidth: de to 1 MC
Sensitivity: 7 ranges, $0.1 \mathrm{v} / \mathrm{cm}$ to $10 \mathrm{v} / \mathrm{cm}$; vernier to $25 \mathrm{v} / \mathrm{cm}$
Input Impedance: 1 megohm, 30 pf shunt
CALIBRATOR:
Type: 1,000 cycle square wave, $1 \mu \mathrm{sec}$ rise, decay time Voltage: 9 ranges $\pm 3 \%, 0.2 \mathrm{mv}$ to 100 v peak to peak Current: 5 ma peak to peak, $\pm 3 \%$

CATHODE RAY TUBE:
Type: 5AMP mono-accelerator, flat face, P1, P2, P7, P11 screen; $5,000 \times$ accelerating potential
Deflection Sensitivity: 20 v approx.; intensity modulation 20 v pulse to blank
PRICE: 1608 Oscilloscope, $\$ 1,850.00$
(4) 162A PLUG-IN AMPLIFIER

Sensitivity Range: (Each channel) $0.2 \mathrm{v} / \mathrm{cm}$ to $50 \mathrm{v} / \mathrm{cm}, 10$ ranges, $0.02 \mathrm{v} / \mathrm{cm}$ to $20 \mathrm{v} / \mathrm{cm}$. Accuracy $\pm 5 \%$
Pass Band: Dc coupled, de to $14 \mathrm{MC}, 0.025 \mu \mathrm{sec}$ rise time Ac coupled, 2 cps to 14 MC
Differential Input: Both attenuators may be switched to one chan. nel and adjusted separately. Common Mode Rejection at least 40 db at max sens.; at least 30 db with attenuators
PRICE: 162A Plug•In Amplifier, $\$ 350.00$ Data subject to change without notice. Prices f.o.b. factory.

INSULATION RESISTANCE, Greater than 30,000 megohm-microfarads at $25^{\circ} \mathrm{C}$, but need not exceed 30,000 megohms
DISSIPATION FACTOR. Less than $1 \%$ when meas ured at or referred to 1000 CPS - tempera ture of $25^{\circ} \mathrm{C}$.
VOLTAGE RANGE. Available in 100, 200, 400 and 600 VDC.

ACCELERATED LIFE TEST. 250 hours at $+100^{\circ} \mathrm{G}$ and $125 \%$ of rated voltage.
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TEMPERATURE RANGE. Full rated voltage from $-55^{\circ} \mathrm{C}$ to $+100^{\circ} \mathrm{C}$, to $+125^{\circ} \mathrm{C}$ with $50 \%$ derating.
TYPICAL SIZES-SHOWING THICKNESS•WIDTH•LENGTH

| cap. | 100 volts |  |  |  |  | 200 volts |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| In mfos. | 1 |  | w |  | 1 | $T$ |  | w |  | 1 |
| . 01 | $1 \pm 6$ | $\times$ | . 203 | $\times$ | ' | 125 | * | $3^{8-}$ | * | \% |
| . 1 | . 250 | * | . 359 | x | \%. | 250 | $\times$ | . 359 | $\times$ | 1. |
| . 33 | . 296 | $\times$ | . 484 | $\times$ | 14. | 328 | $\times$ | . 500 | * | \%, |
| . 47 | . 359 | $\times$ | 546 | $\times$ | " | . 343 | $\times$ | . 625 | $\times$ | \% |
| . 68 | . 343 | x | . 515 | x | '50 | . 421 | * | . 750 | $\times$ | \% |


| cap. IN MFDS | T | ${ }_{\text {laters }}$ |  |  |  | T | 200 Volts | TS |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1.00 | . 421 | $\times$ | 593 | * | 15. | 453 | 687 | * 11/4 |
| 2.00 | 406 | $\times$ | . 718 | $\times$ | $1{ }^{1}$ | 453 | - 734 | $\times 15$ |
| 1.00 | . 453 | $\times$ | . 765 | $\times$ | 1, | 546 | -. 903 | $\times 12$ |
| 4.00 | . 500 | $\times$ | . 890 | $\times$ | 1\% | 850 | $\times 1015$ | $\times 18$ |
| 5.00 | . 484 | $\times$ | . 843 | $\times$ | $1{ }^{1}$ | . 625 | - 1250 | $\times 1 \%$ |

Gapacitance Change v.. Temperature
Insulation Resistance ve. Temperature


Write for literature on these NEW, "space-saving" types
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## ELECTRONICS NEWSLETTER

Study Contract Seeks ICBM "Signature"

department of defense is pushing a program to find out how radar and other devices can more easily recognize the "signature" of an intercontinental ballistic missile-a basic need for putting target acquisition under high-speed machine control. Up to now, radars have relied on recognition of target characteristics by human operators; even the ballistic-missile earlywarning system can't reliably sort out a lofting missile from other echoes.

Dubbed PRESS (Pacific Range Electromagnetic Signature Study), the Army-supervised program, supported by Advanced Research Projects Agency, will catalog ICBM characteristics (specifically, traits of missiles carrying nuclear warheads), and design electronic gear to search for and recognize these characteristics. Recent award: RCA study contract to arrive at design specifications for a "data-handling and computer complex which will assimilate and process all data acquired on project PRESS," in the words of RCA defense electronics chief A. L. Malcarney.

RCA is also working on Tradex (target resolution and discrimination experiment), part of the PRESS project, described as a "long - range ultra - sophisticated tracking radar."

## Cable to Connect

## Britain and Sweden

work Started last Friday on the laying of a 500 -mile submarine cable between the United Kingdom and Sweden. New two-way link, which will come into operation in October, runs between Gothenburg, Sweden, and Marske, near Middleborough, England. It will carry sixty telephone circuits and should take the load off the Anglo-Dutch cables over which most U. K.Swedish telephone traffic passes.
Standard Telephones \& Cables (part of ITT) is putting in the 28 repeaters, the polyethelene-dielectric cable and the repeater super-
visory and terminal equipment. Telegraph Construction \& Maintenance Co. is supplying the landline links, and Westinghouse Brake \& Signal Co. built the submerged repeater power-feeding equipment. Total cost will be $\$ 4.2$-million.

## NASA Contracts for Design of Ion Engine

EXPERIMENTAL ION ENGINE will be built by Hughes Aircraft under a National Aeronautics \& Space Administration contract now in negotiation. Designing and testing the engine will cost "more than \$500,000, " according to NASA estimates, and will take a year.

Engine will use a cesium stream, ionized upon passing between hot tungsten electrodes and focused electronically. Cylindrical engine will attain jet speeds of over 100,000 mph , develop 0.01 lb of thrust, measure 8 in . long by 4 in . dia.

## Atlas Guidance System Measures Earth Rotation

PRECISION of a giant centrifuge and components of the inertial guidance system built for USAF's Atlas missile by American Bosch Arma were recently used by Arma engineers to measure the rotation of the earth for the first time by inertial means.

Inertial technique employed the accelerometer of the Atlas system and an extremely precise calibration centrifuge, normally used to calibrate the accelerometers at high values of acceleration.
By spinning the centrifuge in the same direction as the earth's rotation, and then in the opposite direction, researchers were able to use the accelerometer to sense the small rate effect introduced by the earth's motion.

## Sound-Ranging Techniques Locate Missile Impact

"SPLASH NET" in use on the Atlantic Missile Test Range impact area,
near Ascension Island off the coast of Africa, is a missile-impact locating system (MILS) developed for Navy by Bell Laboratories. System was installed by Western Electric, is used for detecting and locating the sound of a reentry vehicle as it strikes the ocean's surface.

Impact creates noise signals which are picked up by a chain of six hydrophones, precisely surveyed into position on the ocean floor. Time variations of received acoustic wavefront are used for hyperbolic ranging on the impact point, as in the sound-ranging techniques employed for artillery counterbattery and countermortar intelligence work.

## Space Age Spurring <br> Hawaiian Electronics

Hawair's Department of Economic Development reports a rapid expansion of electronics work in the islands. Recent state survey indicated that 10 different employers in Hawaii would hire an additional 134 technicians or engineers right now if they could find them. Part of the increased employment demand comes from four space-tracking stations located in the islands.

Five years ago, the department notes, there were only a few dozen electronics technicians and engineers in the Territory; now that it's a state, there are at least 550, and by 1963 it is predicted there will be 1,160 .

## NTSC Color Standard <br> Clears Last Japanese Hurdle

Japan's Electrowave Control Council last week formally okayed the U. S. National Television Standards Committee color-tv standard, suggested as official Japan standard by both Ministry of International Trade \& Industry and, last December, by Postal Minister Haruhiko Uetake.

Council's okay is the last visible knot in the bureaucratic tangle that has delayed color TV in Japan.


## RCA Ferrite line now offers a choice of memory cores with faster switching times or reduced power requirements

RCA's new memory core 227M1 (XF-4138) with $0.7 \mu \mathrm{sec}$ switching time, now opens up a wide choice of design possibilities for military and commercial computers. With the announcement of this new core, RCA now offers:

- 227M1 (XF-4138) for fast switching
- 226M1 (XF-4028) for reduced power requirements with increased operating margins
- 224M1 (XF-3018H) for standard coincident-current memory applications
See chart for comparative operating characteristics. These
cores are part of RCA's comprehensive line of ferrite cores, transfluxors, and other magnetic memory and switching devices.


## Systems Engineering Service

Your local RCA Field Representative is prepared to furnish a completely coordinated service, including transistor, ferrite, and memory-systems application assistance. Call him today. For technical literature on RCA Ferrite cores and memory devices, write RCA Commercial Engineering, Section F-19-NN-3, Somerville, N. J.

| NOMINAL OPERATING CHARACTERISTICS AT $25^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  | Resp | ponse |
| Type | New Feature | Size | Full Driving Current (Im) (ma) | Partial Write Current (lpw) (ma) | ```Pulse Rise Time (t) (\mu sec)``` | ```\}\begin{array}{c}{\mathrm{ Switching}}\\{\mathrm{ Time }}\\{(\mp@subsup{t}{5}{\prime})}\\{(\mu\textrm{sec})}``` | "Undis- turbed $1 "$ $\left(\mathrm{UV} \mathrm{V}_{1}\right)$ $(\mathrm{mv})$ | "Dis. turbed $0^{\prime \prime}$ $\left(\mathrm{dV} \mathrm{V}_{2}\right)$ (mv) |
| $\begin{gathered} 226 \mathrm{MI} \\ (\mathrm{XF}-4028) \end{gathered}$ | Lower Drive | .050"x 0307 x . $015{ }^{\prime \prime}$ | 400 | 200 | 0.2 | 0.95 | 85 | 10 |
| $(\times F-3018 \mathrm{H})$ | Present Standard | .050 ${ }^{\prime \prime} \times .030^{\prime \prime} x .015^{\prime \prime}$ | 500 | 250 | 0.2 | 0.95 | 75 | 8.5 |
| $\begin{gathered} 227 \mathrm{MI} \\ (\mathrm{XF}-4138) \end{gathered}$ | Faster Switching | .050" $x .030^{\prime \prime} \times .015^{\prime \prime}$ | 500 | 250 | 0.2 | 0.70 | 105 | 13 |

ANOTHER WAY RCA SERVES YOU THROUGH ELECTRONICS
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## WASHINGTON OUTLOOK

EFFORTS to alter government patent rights in defense contracts will get nowhere this year. Failure of such efforts may spur establishment next year of a special Congressional committee to look into patents.

The only legislation moving is a bill to restore private patent rights in contracts let by National Aeronautics \& Space Administration. It has been cleared for House vote; but even if it passes, the Senate will bury it.

A Senate patent subcommittee has studied and reported on the patent practices of various government agencies. Its summary report on De fense Department practices will be finished late this year. But patent problems cut across several committees, including Armed Services, Space, Judiciary and Small Business. Senator Russell Long (D., La.), chairman of the Small Business subcommittee on monopoly, may propose a special committee next year to work out uniform federal patent policy.

Long feels that patents developed out of defense research contracts should be made available to all comers. He has several times complained that big contractors are strengthening their domination of industry through cornering such patents, particularly in technologically oriented industries like electronics.
FEDERAL COMMUNICATIONS COMMISSION has virtually written off chances of getting any vhf television channels away from the Defense Department for establishment of more civilian stations. FCC had offered to swap some unused uhf channels for the more popular vhf space.

Negotiations between the Commission and the Pentagon have reached a stalemate, and a report expected within the next few weeks will eand the effort. FCC chairman Frederick C. Ford recently told a Senate subcommittee the outlook was "bleak." Admiral Arleigh Burke, Chief of Naval Operations, says shifting of military radio-tv frequencies would be expensive in terms of new equipment, and "a blow to defense readiness."

Failure of the negotiations will spur other efforts to expand civilian $t v$. The Senate will consider legislation requiring that all new tv sets be able to receive uhf broadcasts as well as vhf, so that broadcasters will be more willing to start stations in the higher bands. A renewed effort can also be expected to squeeze new stations into cities with only one or two tv outlets by reducing required mileage separation between stations.

ARMY'S ORDER for France's SS-11 antitank guided missiles will be filled by a U.S. producer. Nord Aviation, which developed the SS-11, has informed the Pentagon that a recent West German army order for 25,000 missiles will tie up its production facilities in France.

The Pentagon now has a choice of either allowing Nord to license a U.S. producer directly, or asking Nord to cede the license to the Army, which in turn would hold open competition for a domestic manufacturer. Nord prefers the first alternative, is reported to have selected Geniral Electric to produce the missile.

Nord has already sold an earlier antitank missile, the SS-10, to the Army; it had a range of about a mile, was produced in France. Range of the SS-11 is about two miles. Army is meanwhile evaluating other foreign designs for antitank missiles.
GOVERNMENT OFFICIALS are studying a proposal to set up a new federal agency to act as a central clearinghouse on electronic data-processing for all federal bureaus.

The proposed agency would not only buy machines and furnish dataprocessing services for agencies which have no computer facilities, but also provide programming and other management services to agericies which own machines.


RHEEM OFFERS THE INDUSTRY'S broadest line of silicon diodes


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## FREE GYRO

A highly reliable, two-degree-of-f reedom instrument utilizing AC synchro transmitters at each gimbal axis. Designed to operate under the most severe missile conditions, this grro has AC torquers mounted at each gimbal axis to permit command positioning or slaving of spin axis to desired reference position; each torquer capable of producing a precession rate of $360 \%$ minute with 12.5 watts/phase power input.

## typical

CHARACTERISTICS \#O2315
Environmental Capabilities Temperature Range:
(operative): $-54^{\circ} \mathrm{C}$ to $+71^{\circ} \mathrm{C}$
(non-operative): $-65^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$ Altitude: Unlimited
Vibration: $10 \mathrm{~g}, 10-2000 \mathrm{cps}$

## Pickoffs

Excitation:
$26 \mathrm{~V}, 400 \mathrm{cps}$, single phase
Output (sinusoidal):
$11.8 \mathrm{~V} \pm 5 \%$ max
Error from E.Z.: 10 min. max.
Motor
Excitation:
$115 \mathrm{~V}, 400 \mathrm{cps}$, three phase
Speed: 23,500 RPM
Momentum:
$2.25 \times 10^{6} \mathrm{gm} \mathrm{cm} \mathrm{cm}^{2} / \mathrm{sec}$.
Caging and Preset Provision (Electrically energized torquer type) Excitation: 115 V max./phase
Excitation: 22.8 dyne $\mathrm{cm} /$ Volt $^{2}$

Performance Characteristics Free Drlft:
$5^{\circ}$ minute each axis
Runup Time:
1 minute max.
Torquing Rate:
$360^{\circ}$, min. (intermittent) $40^{\circ} / \mathrm{min}$. (continuous)
Write for complete data.

## BASIC <br> BUILDING BLOCKS <br> FROM KEARFOTT



## SIZE II

 SYNCHRONOUS MOTORFeaturing pull out torque efficiency of $50 \%$ nominal with 3.4 watts input and 3 watts pull out power, this synchronous motor represents a major achievement in terms of performance for a unit of this extremely small size. Additional advantages made possible by Kearfott's unique design include resistance to environmental extremes, light weight construction and low unit cost. This motor and its variations are available in production quantities.

## TYPICAL

CHARACTERISTICS R172
Excitation: Phase 1 Phase 2 Voltage $40 \mathrm{~V} \quad 40 \mathrm{~V}$ Frequency 400 CPS 400 CPS Power $\quad 2.3$ Watts 2.3 Watts Current $\quad 0.157$ Amps 0.157 Amps

## Performance:

Synchronous Speed 8000 RPM Stall Torque 0.2 In .02. Pull Out Torque $\quad 0.35 \mathrm{In} .0 z$. Pull In Torque 0.15 In .0 z .

Write for complete data.

## BASIC

 BUILDING BLOCKS

## FROM KEARFOTT

ROTARY
SWITCH
Kearfott's rotary switching devices for missile and aircraft systems are used to sequence or switch circuitry as a function of time or shaft position. Used in conjunction with sensitive relays or solid state switching techniques, high current loads can be handled. These switches consist primarily of shaft assembly and bearing mounted cylinder divided into conducting and non-conducting segments with continuous track for common input. Multiple conductor "broom" type brushes ride on each cylinder track while number of tracks and segmentation of each is function of the number of circuits and type of "onoff" sequencing required.

## TYPICAL

CHARACTERISTICS P1280-11A
Number of switching tracks: 2
Angular Segmentation (both referenced to $0^{\circ}$ start):

Track 1 - Non-conducting about
$0^{\circ}+50^{\circ}$
Track 2-Conducting $0^{\circ}-180^{\circ}$
Non-conducting $180^{\circ}-0^{\circ}$
Mechanical Accuracy of
Segmentation:
$\pm 1^{\circ}$ (better as required)
Starting and Running Torque: 0.1 oz.-in.

Current Capacity:
50 ma at $28 \mathrm{~V} /$ Brush (suitable for any sensitive relay or solid state switching circuits)

Write for complete data.

GENERAL PRECISION, INC.


AC Seeks and Solves the Significant-AC has earned an enviable reputation for scientific accomplishment with national defense projects such as AChiever inertial guidance systems. But AC is not limiting its goal to leadership in the international technological race. Utilizing scientific "fallout," $A C$ is also increasing its development of significant new commercial products. / This, too, is AC QUESTMANSHIP: the scientific quest for new ideas, methods, components and systems . . . to promote AC's many projects in guidance, navigation, control, detection and communication. / In the commercial field, AC is already producing communications systems, automotive controls and fuel controls for gas turbine engines. Some day they may even add such advanced projects as systems controls for "ground effect vehicles." According to Mr. B. H. Schwarze, AC Director of Commercial Engineering, 'the proper application of scientific 'fallout' to commercial products leads to diversified career opportunities." / You may qualify for our specially selected staff . . . if you have a B.S., M.S. or Ph.D. in the electronics, scientific, electrical or mechanical fields, plus related experience. If you are a "seeker and solver," write the Director of Scientific and Professional Employment, Mr. Robert Allen, Oak Creek Plant, 7929 So. Howell Ave., Milwaukee, Wisc.


Note the offset parabolic relay antennas mounted on the tropo and reflecting surface thith integral radomes protecting the base communications use - another indication of KENNEDY's all. around capabilities in the antenna art.
when you're thinking about

## TROPO-SCATTER ANTENNA SYSTEMS

... you should be talking to D. S. KENNEDY \& CO.

The KENNEDY antenna pictured, is but one model of the world's most complete line of tropo-scatter antennas, including 60 foot models of steel or aluminum, 28 foot aluminum, 28 foot transportable models plus 120 footers like the one pictured.

Erected by General Electric Company's Communication Products Department in the arctic, KENNEDY antennas like this were selected for the job for several reasons:

1. ENGINEERED FOR TOUGHEST ENVIRONMENT: Arctic winds often exceed hurricane force, and these tropo-scatter units will withstand winds of more than 180 mph when loaded with $6^{\prime \prime}$ of ice.
2. ENGINEERED FOR CONTINUOUS DUTY: Operating tolerances are strictly maintained. KENNEDY structural know-how keeps antennas accurate under wind or ice loads.
3. ENGINEERED TO ADVANCED CONCEPTS: KENNEDY antennas utilize offset feed systems, separately mounted feed towers and are designed for easy erection in the field.
4. BUILT-IN PRECISION: KENNEDY quality control and precision construction at the plant assures minimum field time and maximum performance.
5. COMPLETE SYSTEMS: Wave guides, feed horn, feed tower, and reflectors are integrated into a unit by KENNEDY. This saves time and improves the performance of all the components.
D. S. KENNEDY \& CO. has been associated with the design, manufacture, and erecting of the greatest variety of tropo. scatter antennas. That's why it will pay you to talk to them.

Kennedy gives you experience you can't buy elsewhere.

Antenna Division, Cohasset, Mass.
EVergreen 3-1200 Twx COH 311
Anchor Metals Division, Hurst, Texas
(Fort Worth) ATlas 4-2583

## A PROVEN INSTRUMENT



The Model 803 is the end result of more than six years of concentrated engineering effort in the Differential Voltmeter field. Excellent customer acceptance plus service records which reflect extreme reliability are evidence that this Voltmeter is truly a proven instrument.

## FEATURES

## DIRECT IN-LINE READOUT STANDARD CELL REFERENCE AUTOMATIC LIGHTED DECIMAL DC <br> AC

- Accuracy $0.05 \%$ of input voltage
- Four search ranges and four null sensitivities
- Infinite input resistance at null
- Accuracy $0.2 \%$ of input voltage
- Converter frequency response 30 CPS to 5 KC
- Measures RMS value of true sine wave


## GENERAL SPECIFICATIONS

Voltage Ranges: $A C-5,50$, and 500 V DC-0.5,5,50, and 500 V

Accuracy: AC- $\pm 0.2 \%$ from 0.5 to 500 VAC, 30 CPS to 5 KC
DC- $\pm 0.05 \%$ from 0.1 to 500 VOC $\pm 0.1 \%$ or $50 u v$, whichever is greater, below 0.1 V
Null Sensitivity AC-100V, $10 \mathrm{~V}, 1 \mathrm{~V}, 0.1 \mathrm{~V}$, and 0.01 V Ranges: $\quad D C-10 \mathrm{~V}, 1 \mathrm{~V}, 0.1 \mathrm{~V}$, and 0.01 V Max. Meter Resolution:
Input
Input
Impedance:

Dimensions:
50uv
AC-1 Megohm, 25uufd
OC-Infinite at null
Cabinet-93/4"W×13"Hx16"D Rack-19" $\mathrm{W} \times 83 / 4^{\prime \prime} \mathrm{H} \times 17-5 / 16^{\prime \prime} \mathrm{D}$

Weight: Cabinet-30 Ibs., Rack-33 Ibs.
Price: Cabinet- $\$ 875.00$, Rack- $\$ 895.00$

| $\boldsymbol{w}$ |  | MOD | 804 V | BOXES |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\stackrel{\square}{\bullet}$ | Madel No. | Division Ratio | Maximum Input | Total Resistance | Price |
| 0 | 80A-1 | 2:1 | 1 KV | 1 Megohm | \$ 60.00 |
| 0 | 80A-2 | 4:1 | 2 KV | 2 Megohms | \$ 70.00 |
| $\cdots$ | 80A-3 | 6:1 | 3 KV | 3 Megohms | \$ 80.00 |
| $\cup$ | 80A-4 | 8:1 | 4 KV | 4 Megohms | \$ 90.00 |
| $\cup$ | 80A-5 | 10:1 | 5 KV | 5 Megohms | \$100.00 |
| $<$ | 80A-6 | 2:1 | 1 KV | 10 Megohms | \$120.00 |

Prices and technical data subject to change without notice.

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The if 800 series differential voltmeters may be used to measure DC voltages in excess of 500 volts by utilizing an appropriate voltage divider (Volt Box). The division ratio of all models is accurate to $0.01 \%$ and long term stability is better than $0.01 \%$ per year. The approximate magnitude and the polarity of the unknown high voltage may be easily observed with the newly incorporated center zero panel meter.

## MANUFACTURING CO., INC.

P. O. BOX 7161

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## NOW AVAILABLE

## Rugged New Eimac $\mathbf{x} 77 \boldsymbol{8}$ Traveling Wave Tube.${ }^{-\quad}$ One Watt Output, 55-60 db Gain

Purchase orders are now heing accepted for Eimac's pioneering new high gain traveling wave tube, the X778.
Unique features of this advanced one watt CW traveling wave tube include its exceptionally wide frequency range -5.0 to 11.0 KMc ., small signal power gain of $55 \cdot 60 \mathrm{db}$, and light weight permanent magnet focusing.
Like all other Eimac ceramic-metal tubes, this TWT "can take it."
The X 778 was especially designed to operate under severe environmental conditions of shock, vibration, temperature variation and high altitude. Breakage is a thing of the past, resulting in greatly reduced tube replacement costs.
The Eimac X778 finds wide usage in electronic counter-measures, radar augmentors, data links - in any application where more than one tube would normally be required to cover the C and X bands. This means significant cost reduction and increased system reliability.
Contact R \& D Marketing Department for additional details and information on how this tube type may be modified for your requirements.

General Performance Characteristics
Eimac X778 Traveling Wave Tube


EITEL-MCCULLOUGH, INC. • San Carlos, Callfornia

# New Merger Plan Studied 

DIRECTORS of General Instrument Corp. and General Transistor reportedly have agreed in principle to merge. The merger would create an organization with indicated sales in the neighborhood of $\$ 60$ million. The proposed merger is subject to further investigation and to stockholder approval.

Midwest Technical Development Corp., Minneapolis investment company, reports private purchase of 12,000 shares of Telemeter Magnetics, Inc., Los Angeles. The L. A. firm produces magnetic cores and memory units for data processing equipment. At the end of 1959, TM reported sales of $\$ 4$,653,833 , up 53 percent over the previous year. Net income was \$158,072.

Waltham Precision Instruments, Waltham, Mass., announces signing an agreement to purchase the Boesch Manufacturing Co., Danbury, Conn. It's expected the acquisition will add more than $\$ 1$ million to Waltham's sales volume this year. Boesch manufactures toroidal coil winding equipment, controls and accessories.

Systron-Donner Corp., Oakland, Calif., reports a rise in earnings to $\$ 228,838$, or 40 cents a share on the 572,907 shares presently outstanding, for the six-month period ending Jan. 31, 1960. These figures represent earnings of Systron Corp., and Donner Scientific Co., as separate firms and show an increase of 43 percent over earnings of $\$ 159,283$, or 28 cents a share, for the corresponding period a year ago. The combined company makes electronic components for the Polaris and Hawk missile systems.

Vocaline Co. of America, Inc., Old Saybrook, Conn., reports highest sales and income in company history for 1959. Net sales showed a gain of 64 percent over 1958 to a total of $\$ 1,808,000$, according to C. T. Cooney, president.

Lear, Inc., Santa Monica, Calif., announces a rise in income equal to 48 cents a share for the first quarter of this year, as compared with 16 cents a share for the equivalent period in 1959. First quarter sales amounted to $\$ 22,-$ 818,337 in 1960, $\$ 17,222,656$ in 1959. Net earnings this year were $\$ 510,357$ for the first three months, as compared with $\$ 395,923$ a year ago. In addition, during the 1960 first quarter, the company realized a gain of $\$ 775,791$ from the sale of its LearCal division to Motorola in January.

Electronic Specialty Co., Los Angeles, reports net sales of $\$ 11$,001,827 for the fiscal year ended Mar. 31, 1960. In the previous fiscal year, this figure was $\$ 4,165,-$ 791. Per-share earnings this year came to 61 cents, compared with 25 cents the previous year. Net earnings after taxes (including non-recurring capital gains) were $\$ 331,115$. During the past fiscal year the company acquired the stock of Technicraft Labs., Inc., and Systems Labs. Corp.

## 25 MOST ACTIVE STOCKS

| Gen Tel 2 Elec | WEEK ENDING JUNE 3 |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | $\begin{aligned} & \text { SHARES } \\ & \text { (IN } 100 \text { 's) } \end{aligned}$ | HIGH | LOW | CLOSE |
|  | 5,454 | 344/8 | 301/2 | 307/ |
| Ampex | 1,841 | 381/2 | 33\%4 | 365\% |
| Sperry Rand | 1,762 | 251/4 | 237/ | 24 |
| Int'l Resistance | 1,628 | 371/2 | $311 / 4$ | 371/2 |
| Burroughs | 1,342 | 403/8 | 373/9 | 391/2 |
| Ger Inst | 1,237 | 431/8 | 371/8 | 381/4 |
| Collins Radia | 1,149 | 68\%8 | 621/4 | 631/2 |
| Int'l Tel \& Tel | 1,130 | 463/8 | 431/2 | 441/6 |
| Lear Inc | 987 | 20 | 183/2 | 191/2 |
| Du Mont Labs | 911 | 101/4 | 91/2 | 91/2 |
| RCA | 778 | 76\% | 741/2 | 751/6 |
| Avnet Electronics | 749 | 203/4 | 163/4 | 171/4 |
| Dynamics Corp Amer | - 749 | 127/8 | 10\%/ | 11\% |
| Siegier Corp | 699 | 43 | 38\%/8 | 38\% |
| Victoreen | 562 | 141/2 | 123\% | 125/8 |
| Philco Corp | 531 | 34\%/ | 3239 | 321/2 |
| Gen Electric | 526 | 911/4 | 883/4 | 901/4 |
| Edo Corp | 501 | 191/2 | 141/8 | 171/. |
| Aveo Corp | 487 | 133/4 | 13 | 13 |
| Raytheon | 470 | 441/8 | 411/4 | 413/4 |
| Zenith | 462 | 1197/ | 113 | 1131/2 |
| Fairchild Camera | 457 | 182 | 1573/4 | 1603/1 |
| Amphenal Borg | 441 | 533/4 | 475/8 | 501/2 |
| Barnes Engar'g | 430 | 57\% | 471/2 | 50 |
| Westinghouse | 421 | 603/4 | 591/8 | 601/8 |

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


## We Can Make Alumina Ceramic Parts in Sizes from Micromodules to Nose Cones

You are looking at the largest high alumina Isostatically formed ceramic part in the world. It is $125 /{ }^{\prime \prime}$ " outside diameter at the base and stands $40^{\prime \prime}$ high. This nose cone is the result of Coors research.

In my right hand you can just see one of the tiny micromodule wafers ( $.310^{\prime \prime}$ square x $.010^{\prime \prime}$ thick) from our current production.

If you need high strength alumina ceramic parts-large, miniature or in between, get in touch with us here in Golden or call the Coors regional sales manager nearest you.

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## Veeder-Root <br> R E A d 001 Bulletin

## New Electronic Counters provide

## simplified operation, automatic control

## for Original Equipment

Veeder-Root Electronic Predetermining Counters are now being used to improve machine efficiency by providing varying degrees of automatic control as original equipment.
These new electronic counters count electrical impulses. This makes them extremely versatile - and suited to design innovation - because these pulses can be supplied by photoheads, snap-action switches, mechanical contactors, impact and proximity switches, and the like. Photohead actuation alone has almost limitless application potential, and is ideal for high velocity, non-contact counting at any stage of a machine's operation.

The predetermining action - which actuates machine controls, signals, etc., - can run the extreme from a single stop motion, with only one bank of selector knobs all the way to multiple banks which are used to set up a series of stop motions, usually sequentially. There is no theoretical limit on the number of banks (or sequential stops) that can be provided. Counting speeds are available up to 5000 counts per second, and even higher in special applications. Instantaneous reset and automatic recycling are also valuable features.
Some of the many possible counter variations are shown below. Both the 1804 Series, Electronic, and 1601 Series, Electric, Counters are providing this type of control as original equipment on a variety of machines, from bacon slicers to plastic film extruding machines. Design and engineering assistance is available to help achieve maximum operating efficiency for your equipment.


This is a panel mounted Series 1804 Predetermining Counter designed to control operation of o bocom slicing machine. Top bank of knobs is preset to number of slices in each package, other set controly fotal number of units or packages.


These are a few of the variations in predetermining control available with the Veeder-Root Series 1601 Electric and 1804 Electronic Counters. (A) For measuring film footage; when number on top set of dials is reached machine is slowed down, then stops when lower number is

## Simplified Schematic of the Veeder-Root Series 1804 Electronic Counter



[^0]

## NEW SHAPES and NEW TOLERANCES in



## BR] custom made technical ceramics

Engineers with designs formerly considered too complex or impossible as to dimensional tolerances are invited to send sketches or blue prints.

Chances are that NOW they can be made in ALSIMAG.

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THERMAZIP is available in asbestos or fiberglass Zippertubing that offers insulation for pipes and cables as well as an abrasion-proof jacket. Jacket and insulation are applied in a single operation, so entire cost of thermazip application is less than some insulations alone!

THERMAZIP jacketing permits inspection and maintenance of cable or pipe by simply zipping open. After inspection is completed, thermazip can be zipped closed in a matter of seconds.

Send for name of nearest field representative and complete literature on Zippertubing insulating materials that will withstand extreme high or low temperatures!

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# THE Zippertubing ${ }^{\oplus}$ co. <br> 752 S. San Pedro St., Los Angeles 14. Calif. 

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## Our Industry to be Third Largest

THE ELECTRONICS INDUSTRY is growing so rapidly that it will be the nation's third largest manufacturing industry by 1965, says Harvey Riggs, president of International Electronic Research Corp. At that time, only the automobile and steel industries will exceed the electronics industry's sales volume of about $\$ 15$ to $\$ 16$ billion.

Today the electronics industry ranks fifth behind the aircraft and chemical industries, as well as steel and autos.

Zener diode sales volume is getting up in the big figures. Last year's total, about $\$ 11$ million, topped forecasts for the year, which looked for a \$9-million total.

Manufacturers of computer memory cores are highly confident about future sales because of mounting computer sales and increased use of core memories in computers. Manufacturers say about 200 to 225 million cores were sold last year and that unit sales total will multiply three times by 1965.

Sylvania looks for special tube sales to increase about 120 percent by 1965 , going from the present rate of $\$ 180$ million to $\$ 400$ million at the end of the five-year period. Firm's definition of special tubes is pretty much limited to microwave types and excludes broadcasting and power tubes. Company expects microwave tubes to benefit from rapidly growing sales of microwave equipment.

Pace of crystal filter sales quickens. Only two months ago it looked like total sales for 1960 would be about $\$ 1 \frac{1}{2}$ million. But indications today point to sales of $\$ 2$ to $\$ 3$ million by year's end. Hermes Electronics reports that its Crystal Filter division's sales for first four months of this year amounted to $\$ 1$ million, about three times the sales figure for same period last year.

Major applications for crystal filters include eight missile pro-
grams, radar systems, military receivers, transmitters and industrial mobile radio systems.

Numerical machine tools market is much on the minds of electronics industry market investigators looking into the many budding industrial fields. Electronic machine tools are getting a warm reception from manufacturers caught between rising labor costs and increasing competition from low-cost foreign manufacturers, according to reports.

All information we have received has been optimistic about future sales, with opinion variations limited only to the degree of optimism.

One estimate is that annual stales will mount from $\$ 21$ million in 1958 to $\$ 67$ million in 1962 . Study by a management group claims that 1959 sales doubled over the preceding year, and that this kind of increase will be recorded for setcral years.

Electronic Industries Association reports big increases in f-m and auto radio production in first three months of 1960 over the same period last year. F-m output is up 82 percent, while auto radio production is running 37 percent ahead of similar period a year ago.


## PANORAMIC PANADAPTORS give you continuous visual spectrum analysis of communications signals <br> - Detecting and investigating interference caused by splatter, harmonics, r.f. parasitics and multipath transmissions. <br> - Tuning aid for telemetry and SSB signals. <br> - Rapidly locating and identifying intermittent and irregular transmissions. <br> - Spotting inadvertent off-frequency transmissions. <br> - Band occupancy studies. <br> Interference analysis with Model SA-8b Panadaptor, <br>  Sidebands from AM channel $\# 3$ are seen to soill into band occupied by intermittent $C W$ channel $\# 2$.

Operating in conjunction with a communications receiver, the Panadaptor automatically scans the band around the frequency to which the receiver is tuned. Scan is adjustable from full sweep width capacity for observing overall band to reduced sweep widths for detailed narrow band signal analysis.
Panoromic Panadoptors are available in two models and 14 types, to operate with RF, VHF, and UHF receivers hoving standard IFs. Also ovailable are specially designed Panadaptors for use with receivers with non-standard IFs or other unusual properties.
PANORAMIC'S PANADAPTOR MODEL SA-8b is o professional-quality spectrum analyzer designed for convenience and exceptional versotility. Adjustable sweep width, sweep rote and IF bandwidth controls provide for optimum frequency resolution. Log, linear and power amplitude scales are precisely calibroted on a long persistence 5" CRT.

PANORAMIC'S PANADAPTOR MODEL SA-3 is a rugged, compact, easy to operate unit with a $3^{\prime \prime}$ CRT. Only three controls ore needed-sweep width, goin and center frequency.
Cabinet or rack mounting optional.

|  | Mode SA-8 |  |  |  | Mod¢ SA-3 |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{aligned} & \text { Type } \\ & \text { T-100 } \end{aligned}$ | Type T-200 | $\begin{aligned} & \text { Type } \\ & \text { T-1000 } \end{aligned}$ | $\begin{gathered} \text { Type } \\ \text { T-10,000 } \end{gathered}$ | $\begin{aligned} & \text { Type } \\ & \text { T. } 50 \end{aligned}$ | $\begin{aligned} & \text { Type } \\ & T-100 \end{aligned}$ | $\begin{aligned} & \text { Type } \\ & \text { T-200 } \end{aligned}$ | $\begin{aligned} & \text { Type } \\ & \text { T- } 1000 \end{aligned}$ | $\begin{gathered} \text { Type } \\ \text { T-1000 } \end{gathered}$ | $\begin{gathered} \text { Type } \\ \text { T-2000TD1 } \end{gathered}$ | $\begin{gathered} \text { Type } \\ \text { T-2000NC } \end{gathered}$ | $\begin{gathered} \text { Type } \\ \text { T-3000 } \end{gathered}$ | $\begin{gathered} \text { Type } \\ \text { T-3000С1 } \end{gathered}$ | $\begin{gathered} \text { Type } \\ \text { T-6000 } \end{gathered}$ |
| For receivers with | 455 ke or 500 kc (Specify) | 455ke | 5.25mc | 30 mc | 455 kc | 655ke or 500ke | 455 ke | 5.25 me | 10.2 mc or 10.7 me (Specify) | 30me | 30 me | 30 mc | 21.4me | 30 mc |
| Sweep Width | 0-100ke | 0-200ke | 0-1me | 0-10me | 2-50ke | 0-100ke | 0-200ke | 0-1me | 0-ime | 0-2me | $0-2 \mathrm{mc}$ | 0-3me | 0-3me | 0-6me |
| Direct Sensitivity(*) | $1000 \mu \mathrm{v}$ | $2000 \mu \mathrm{v}$ | $2000 \mu \mathrm{v}$ | $150 \mu \mathrm{v}$ | $200 \mu$ v | $200 \mu v$ | $200 \mu \mathrm{~V}$ | $200 \mu \mathrm{v}$ | $200 \mu \mathrm{~V}$ | $500 \mu \mathrm{v}$ | $10 \mu \mathrm{v}$ | 1 mv | $50 \mu \mathrm{~V}$ | 10mv |
| Sweep Rate | Sweep may be synch'd externally or to nower line or free running. |  |  |  | 30 sweeps per second, line synchronized ( 25 sweeps/sec with $50-\mathrm{eps}$ power line.) |  |  |  |  |  |  |  |  |  |
| Amplitude Scales | Linear (ealibrated from 0 to 1.0). <br> Logarithmic (from 0 db to -40 db ). Power. |  |  |  | Nominally linear |  |  |  |  |  |  |  |  |  |
| Resolution Capabilities. Depends upon sweep rate and sweep width | 50 cps to 4 kc Variable | 50 cpsto4kcariable | $\begin{aligned} & 200 \mathrm{eps} \\ & \text { to } \\ & 10 \mathrm{kc} \\ & \text { Variable } \end{aligned}$ | $\begin{gathered} \text { 9kc } \\ \text { to } \\ 80 \mathrm{kc} \\ \text { Variable } \end{gathered}$ | 2.5 kc | \| $3.4 \mathbf{k c}$ | /4.4kc |  |  |  | dth <br> 20kc | 25kc | 25ke | 50 kc |
|  |  |  |  |  | Approximately $20 \%$ improvement at $20 \%$ of full sweep width. |  |  |  |  |  |  |  |  |  |

* Direct sensitivity (Model SA-8b) is the maximum voltage at the center frequency required for a full scale deflection on the linear amplitude scale. Direct sensitivity (Model SA-3) is the maximum voltage at the center frequency required for $1 / 4$ inch deflection.
Panadaptors are available for most receivers. For best over-all response, the receiver type should be mentioned when inquiring about Panadaptors. Write today for detailed specifications bulletin. Also send for new Catalog Digest and ask to be put on the regular mailing list for The Panoramic Analyzer, featuring application data.


## telegraph and data transmission systems without interrupting traffic

Circuit downtime is lost time. Save it by diagnosing the trouble in communications links while they are operating. Radiation's new Telegraph Distortion Measuring and Monitoring System permits online testing and wave-form analysis of telegraph and data transmission circuits. Thus, the trouble in a deteriorating link can often be diagnosed and remedied without interrupting message traffic.

With miniaturized components for space saving compactness, the TDMS can replace most test equipment now required. This permits a reduction of test equipment costs and increases maintenance eff. ciency. Portability is achieved at the "push of a button."

For complete technical data on the TDMS and its many capabilties, write for Bulletin E-100B to Radiation Incorporated, Dept. EL-6, Melbourne, Fla.
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RADIPLEX 89-a 48-channel low-level multiplexer with broad data processing applications. Features rugged solid-state circuitry, almost unlimited programming flexibility, unique modular construction for compactness and exceptional ease of operation and maintenance.
RADICORDER-Multistylus recorder provides high-speed instantaneous readout for wide range of data acquisjfion or processing systems. Eliminates necessity of electronically translating complete data, thereby reduces computer work loads.
TELEMETRY TRANSMITTER-Model 3115 is a ruggedized $215-260$ MC unir with extremely linear FM output under the most severe environmental conditions. With its record of outstanding performance in many missile programs, Model 3115 is specified by leading missile manufacturers.

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## NEW MICROFILM PRINTER DOES WORK OF 25 MEN AT 1/2 THE COST!



TWENTY FIVE MEN plotting graphs at top speed could not keep up with Stromberg-Carlson's S-C 4020 High Speed Microfilm Printer. In a typical graph plotting application, the S-C 4020 can do the job better - at $\frac{1}{4}$ to $\frac{1 / 2}{2}$ the cost! And the S-C 4020 oan save you money in dozens of other important applications. It will accept the output - on-line or off-line - of most major computers and produce accurate, high-quality
recording on microfilm at rates of 15,000 plotting points or alphanumeric characters per second.

The S-C 4020 may be used for plotting graphs, drawing axes, drawing vectors or printing full pages of tabular data. Mathematical formulas used for design of mechanical components may be printed as drawings with significant dimensions superimposed on the design. Ship's hull equations, aircraft wing sections and
other critical design components requiring descriptive geometry may be graphically displayed. With an optional automatic processing camera, graphs or tabular data may be viewed on a special screen only 8 seconds after film exposure.
literature available: Learn the complete story of the S-C 4020. Write to Dept. A-51, Stromberg-Carl-son-San Diego, 1895 Hancock Street, San Diego, California.


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## New G-E CLAD-MOLY SHEET won't blister, flake or peel even if you heat it to $950^{\circ} \mathrm{C}$

G-E Clad-Moly is molybdenum sheet clad in either nickel or copper, developed by General Electric. It meets the needs of the electronic industry for a molybdenum sheet with good soldering characteristics. What's more, this cladding really sticks! Won't delaminate! Bonds like a single piece of metal!

Base material is General Electric HD Moly Sheet, a new, high ductility sheet of pure molybdenum. The G-E Clad-Moly Sheet retains all the favorable properties of molybdenum-like its coefficient of thermal expansion that's similar to silicon, and its high electrical conductivity.

Order G-E Clad-Moly Sheet in thicknesses of from 0.010 to 0.080 inches - in widths up to 4 inches. Specify copper or nickel cladding on one or both sides. (Cladding will be between 0.0005 and 0.001 inches thick.) Or you can special
order the cladding thickness up to $10 \%$ of total sheet thickness. WIDEST USE AT PRESENT-G-E Clad-Moly is ideal for disks in silicon power rectifiers (see disks in photo above). It gives them excellent soldering properties. But there's no limit to the possible uses of this new material. We'd like to work with you in tailoring just the right G-E Clad-Moly to your specific needs. General Electric Co., Lamp Metals and Components Dept. E-60, 21800 Tungsten Road, Cleveland 17, Ohio.

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## 

Spotlighted, above, is FXC's new Light Dependent Resistor, a "mighty mite" employed in the control of TV sets . . . organs . . . call systems . . . computers . . . automatic telephone exchanges . . . toys - and other applications calling for a change of circuit resistance as light intensity varies, even at relatively low levels. Smaller than a dime in diameter, the LDR has a resistance ratio in excess of 25,000 to 1 for a light intensity change from total darkness to 1,400 foot candles. Highly versatile, the LDR can be used with a light source to replace single, multi-pole or latching type relays or for gain limiting in amplifier circuits. It has an interminable service life and is exceptionally low in cost.

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(2) As a mulfi-pole relay.

(3) As a latching type relay.


# See Growth in Minnesota 

# Skilled manpower, expanding universities and favorable financial climate foster growth of the electronics industry in the state 

## By THOMAS EMMA,

Assoclate Editor
ST. PAUL, MINN.-An exclusive interview with Minnesota's Governor Orville L. Freeman by Electronics indicates the atmosphere of growth for electronics in this state.

The Governor cited as main growth factors the upturn in scientific and technical interest at the academic level, the availability of skilled and readily-trainable manpower and the state's central location.

When asked if any legislation is planned which would subsidize electronics firms, the answer was firmly negative. "We don't need that sort of thing," he said. "My faith for the growth of the electronics industry lies in the people that live here, not in handouts."

Freeman told Electronics he has always been interested in the electronics industry and recalled that prior to his election as governor he participated in many underwritings of electronics stock issues as a lawyer.

Electronics firms in the Twin Cities area tell Electronics they share the governor's optimism.

A recent survey by International Properties, Inc., developer of a scientific-industrial park in suburban Minneapolis, shows sales of electronics here in 1958 were about $\$ 500$ million. In 1959 , they rose to $\$ 600$ million. It's expected this year will see a climb to $\$ 700$ million.

Many electronics company executives in the St. Paul-Minneapolis region say a good measure of our industry's growth here may be attributed to starts many of today's key men got from major companies headquartered in the region.

Most frequently mentioned in this connection is Minneapolis Honeywell Regulator Co. Also cited is Minnesota Mining and Manufacturing, General Mills Mechanical division, and Remington Rand Univac division.

A sampling among engineers in local smaller companies rarely fails
to show up some alumni of the bigger firms.
The academic community is providing a continuously rising number of young engineers and technicians.

Athelstan Spilhaus, dean of the University of Minnesota's Institute of Technology said:
"The strength that exists in the Institute in the basic sciencesphysics, mathematics and chem-istry-and related engineering sciences, provides an important consideration to attract idea industries such as electronics."

In 1957 the Institute had 463 B.S. students, 74 M.S. students and 15 Ph.D.'s. In the fall of 1958 , there were 3,143 B.S. students, 323 M.S. students and 158 Ph.D.'s. At the same time, there were 1,275 pre-engineering enrollments in the state's 26 colleges.

A current survey by the First National Bank of Minneapolis lists more than 100 electronics companies in the state. The majority of these, according to local businessmen, received their initial financings here. The businessmen

## Rubber Test



Impact of steel ball on test material electronically measures energy absorption for Chevrolet designers
stress that banks in this region tend to be very cooperative.

The financial environment is further reflected in the activities of Midwest Technical Development Corp., Minneapolis. Founded two years ago by a group of industrialists, lawyers and academicians, the investment firm has holdings in 11 technically-oriented companies.

Total investment now held comes to more than $\$ 1$ million, and includes companies in California, New England, New York and Florida.

Although the majority of electronics companies in Minnesota are now situated in urban St. Paul and Minneapolis, there are signs the patterns of growth into suburbs followed in New England, California and Chicago will come about.

Mentioned by aides to Gov. Freeman are such suburbs as Bloomington, New Hope and Roseville. Plans now being made are expected |to spur the growth of industrial parks.

Several companies are already scouting out new locations in the suburbs. Typical among these is General Electronic Control, which will move its more than 300 employees, including those of its subsidiary, Minnesota Engineering Co., to a location in Bloomington.

## Japanese Company Signs Export Pact

токуо-Japan Victor announcés a four-month export contract with U. S. importer Delmonico International for $\$ 1.4$ million worth of consumer electronic products.

Contract covers 10,000 19-in. portables, $10,00023-\mathrm{in}$. portables, 10,0008 -in. transistor portables and 15,000 radio-tv-phonograph combinations featuring stereo high fidelity, 30,000 radios of various types and other items, such as tape recorders and electric organs,

Japan Victor expects to negptiate with Delmonico for further exports, including $21-\mathrm{in}$. color tv sets, in the period from October to March 1961.


RUM (Remote Underwater Manipulator), returning from Pacific floor, carries sonar, four tv cameras, mercury vapor lights - powered and transmitted via cable (right)

# Navy Gets New Deepsea Television 

Tv guides tank over sea bottom to explore, install and remove fixed sonar gear

NAVY NOW HAS a remote control workhorse designed to crawl around on the bottom of the sea- $20,000 \mathrm{ft}$ below the surface-to send back tv pictures as clear as a good home movie, assemble and install instrumentation, collect samples and specimens and bring back equipment in need of repair.

Called RUM, for Remote Underwater Manipulator, the vehicle consists of the basic hull and truck assembly of an Ontos tank upon which has been mounted a special electromechanical manipulator arm. The manipulator, which synthesizes the motion of the human arm, can lift objects weighing up to $5,000 \mathrm{lb}$.

The vehicle is linked to a mobile van on shore by a 5 -mile coaxial cable which carries tv signals and telemetering channels and relays 60 -cycle power for operation of the vehicle, cameras, mercury vapor lights and sonar.

RUM carries four cylindrical fully-transistorized tv cameras, each housed in $\frac{1}{2}$-in. steel casing capable of withstanding $10,000 \mathrm{psi}$ pressure. A 2-in., conical Lucite window is sealed to the front of the casing to protect the vidicon tube. Each camera ( 3 in. in diameter and 14 in. long) contains video pre-amplifier, horizontal and vertical
sweep, remote control, iris, focus, and sweep loss protective circuits.

Each camera is connected by double-jacketed, oil-insulated cable to a central control unit.

The control unit, also tube-shaped and mounted in $\frac{1}{2}-\mathrm{in}$. steel casing, contains the power supply for each of the four cameras, plus video switching and power amplifiers. Through the controi unit, any one of the four camera images can be selected for transmission to surface monitors, or the images of any two cameras for simultaneous three-dimensional transmission.

When the image of one camera is called for on the surface monitor, the picture is transmitted at the rate of 15 scans or frames per second. If a three-dimensional view is desired, the images of two cameras are intermittently transmitted at $7 \frac{1}{2}$ scans per second.

The system transmits either high or low resolution images. Low resolution transmission produces a horizontal scan of 3,750 cycles per second and a vertical scan of 15 , resulting in a 250 -line picture. In high resolution transmission, the horizontal sweep rate is changed to 2,000 cycles per second, and the vertical scan to $3 \frac{3}{4}$ sweeps per second to produce a 530 -line picture.

The phosphorized, long-persistence monitor screens are fitted with orange filters to prevent an image from fading during the splitsecond interruptions in signal transmission.

RUM got its feet wet for the first time recently in a test that took it 50 ft down and $2,000 \mathrm{ft}$ out from the shore at San Diego.

Development of the present breadboard model was sponsored by the Office of Naval Research. Work was directed by the Marine Physical Laboratory of the Scripps Institution of Oceanography of the University of California in cooperation with the Hudson Laboratories of Columbia University.

The manipulator was built by General Mills and the tv system by Orbitran, Inc., Lakeside, Calif.

ONR is interested in buying several production models designed by Jered Industries that would be lighter and more maneuverable. Hughes has submitted proposals for building a large three-bladed fixed-pitch rotor mounted on the vertical axis that would enable the vehicle to rise and descend while underwater, as well as move laterally.

Future models may well have commercial applications, ONR says.


When designs call for products in the field of electronics, the Guide solves problems in advance.

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## Mote fan mail for Mel Bondy? . . Not quite. Actually it's another memo from one of our field

 engineers outlining performance specifications and a list of potential applications for an electron tube that doesn't exist. But it's enough to start Mel Bondy on a concentrated survey that ends in the creation of a new industrial receiving tube.As head of our Receiving Tube Design Group, New Products Section, Mel's the man who translates tube concepts into wire, metal and glass. He also takes the prototypes of such revolutionary devices as the RCA nuvistor and prepares them for the commercial market. Whatever this preparation involves-investigation of materials, the modification of designs to meet applications requirements, determination of tube geometry-he always has a single goal in mind: the best possible tube for the job.
Mel's search for new tubes for any given function continually opens new circuit-design possibilities for you. It's your assurance that, whatever your special needs may be, we at the RCA Electron Tube Division will do our best to meet them.

## The Most Trusted Name in Electronics

 RADIO CORPORATION OF america[^1]
# British Show Features Industrial Controls 

## Digital building blocks allow designers to build systems straight from logic diagrams

LONDON-To a visitor who attended the previous exhibition, the third international Instrument Electronics and Automation Show here recently had a distinctly new flavor. Although instrumentation was still widely displayed, the emphasis was now all on industrial applications and controls. Examples:

- Modular building blocks using digital techniques allowing designers to build systems straight from the logic diagrams-this stopped a lot of the show visitors.
- Testing systems.
- Industrial instrumentation.
- Data-logging systems.

The 1960 show was the biggest to date; the last in 1958 was viewed by 54,000 people. This year over 500 firms exhibited, occupying 150 ,000 sq ft with their wares. This year, too, foreign participation increased with exhibitors from France, West Germany, Austria, Belgium and others plus-from the other side of the curtain-East Germany, Poland and Czechoslovakia. Next show is slated for 1962.

Two causes brought industrial applications well to the fore.

Firstly, specialized exhibitions coming later this year segregated out both business computers and machine tool control systems, since manufacturers were reluctant to release their new products ahead of these specialized shows.

Secondly, manufacturers feel that while instrument markets are now well served in Britain, there is, as one exhibitor put it to Electronics, "untapped gold in the industrial field if we can get the idea across to industrialists that increased industrial instrumentation means increased profits" (see Electronics, p 52, May 13).

Newest trend in the show was the introduction of digital building blocks, now being marketed by English Electric Company and Mullard Equipment among others.

In the systems, thermocouples are sequentially scanned and values outside the preset limits actuate alarm circuits. Electric typewriters
log normal temperatures, while strip printers record off-limit conditions. Visual and audible alarm panels register location and condition of abnormal points.

Both Mullard and English Electric systems are transistorized. The English Electric "Datapacs" are split into both asynchronous and synchronous units using diode gating and emitter-follower buffer amplifiers for the inverter. In the Mullard system similar units have been standardized into encapsulated 10 x $24 \times 54 \mathrm{~mm}$ packages.

One of the show stoppers was the simple ball-bearing tester developed by SFIM (Great Britain), where, in a $14 \times 13$-in. console, bearings are checked for minimum torque friction, starting torque and noise.

The bearing is placed on a spindle whose lower end carrier the noiselevel detector armature windings. A magnetic circuit concentric with the spindle provides a rotating field with speeds up to $24,000 \mathrm{rpm}$. On test, the bearing is subjected to a standard loading of 70 or 400 grams
by a load cylinder placed over the bearing.

Induced currents in the cylinder from the magnetic field cause rotation of the outer bearing race. Photocells detect the rotational speed, and dials indicate the bearing rpm, torque and noise level.

Testing cable looms by combining the actual point-to-point wiring with inspection in a system developed by White \& Riches cuts production costs and operator training times by 20 percent.

Automatic tape-testing unit developed by M. S. S. Recording Co. puts magnetic-tape dropouts on a statistical basis. On the tape under test, five tracks carry the same digital information; the sixth is used to control the mean level of the system. Outputs from the five tracks of the tape, which is run through at 100 in . per second, feed transistor counters to clock up the number of dropouts per track.

Marking the swing toward mpre and more specialized instruments for each industry is the Kenley paper moisture-content meter, deyel-

## Mobile Chamber Tests Missile Parts



Electronic controller-recorder programs temperatures of -100 to $200 \quad F$ to test missile components in Cook Electric's environmental unit
oped jointly by Baldwin Industrial Controls and the Paper \& Board Research Association. Paper web is passed over a capacitor pickup, with moisture variations sensed as changes in voltage output. Accuracies of 0.1 percent are claimed for the range of 2 to 15 percent moisture content.

## Data Logging

New data-logging systems are appearing on the British market, but as yet their sales future looks cloudy. Adding their wares alongside the already existing systems of firms like Panellit, Honeywell Controls, and the many aircraft firms hoping to sell in this field, were newcomers Kelvin \& Hughes Industrial and Plessey.

The Kelvin \& Hughes system uses a building-block approach to handle inputs in multiples of 30 with a five-point-per-second scanning rate. Feature of the system is its 0.1 -percent accuracy and high system sensitivity of 10 microvolts. Inputs are scanned on gold-plated stepping switches and fed via pinboard patch-panel programming units for span and zero corrections and high and low alarm limits to a decimal-to-binary diode matrix. Resultant binary signals are then measured on a digital voltmeter prior to printout on electric typewriters.

Plessey, through a recent tie-in agreement, is bringing to the British market Hagan process controls and data-handling systems. At present its main marketing target lies in the public utility and marine fields.

In the textile field, a new automatic warp-inspection system developed by Bruce Peebles \& Co. is now being fitted as standard equipment. A variable-sensitivity optical electronic system detects variations in yarn diameter and yarn faults.

From the same firm is a pinhole detector for steel strip. Using 3,500 cps fluorescent tubes as the illuminating source above the $1,700-\mathrm{ft}$ -per-second traveling steel strip, multiplier phototubes below the strip detect pinholes as small as 0.0005 in . under ideal conditions. Under industrial conditions normal detection is usually for 0.002 in. holes.


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## From missile cable to magnet wire ANACONDA OFFERS YOU A COMPLETE AND MANUFACTURE OF ELECTRICAL

Anaconda Wire and Cable Company manufactures the broadest line of wire and cable in the industry. A nationwide network of nine fully integrated plants offers cable capability marked by continuous research, product development and rigorous quality control. Some of the many complex cable constructions currently being manufactured by Anaconda are described below.


Umbilical Breakaway Cable. Anaconda designed and manufac. tured this 99 -conductor composite breakaway cable for the "Corporal" -one of America's first missiles.


Portable Power Cable. Designed for maximum durability and meets flame tests of the Bureau of Mines. Available with or without grounding wires, round or flat constructions.


Ground Support Cable (MIL-C-13777). Power and control cables for interconnecting units of complex weapons systems.


Launch Control Cable. Seventy-conductor, flexible copper strand, polyethylene insulation, tinned-copper braid shield, nylon jacket, planetary stranded, oil-, gas-, flame-, moisture-resistant over-all jacket.


Polaris Cable, Digital transmission and synchro resolver cable developed for the firing system of Polaris submarines. Withstands open-end hydrostatic pressure of 300 psig.


Nuclear Reactor Cable. Developed by Anaconda for U.S. Navy. In addition to its absolute watertight features withstands hightemperature operations in the order of 500 F .

Instrument Probe Cable. Miniature coaxial constructian. No. 40 Awg Evanohm resistance conductor, cellular polyethylene insulation, finned.copper braid shield, PVC jacket. Overall diameter $0.100^{\prime \prime}$.

## 323536

Radiation Resistant Satellite Cable. Four-conductor miniafure construction. Tinned-copper conductors, color-coded HYRAD [irradiated polyolefin] insulation, flame-retardant, $90 \%$ copper braid shield, irradiated HYRAD jacket overall.


THE COMPLEX ELECTRICAL NERVE SYSTEM of many of America's prime missiles, such as ATLAS TTTAN, POLAEIS, is composed of many specially designed cables built by Anaconda to strictest military specifications. This proven experience is ready to solve your most critical cable problems.

# SUUXRE FOR RESEARCH, DEVELLOPMENT, ano Elictronic wire ano cable 



THE TYPES OF ANACONDA WIRE AND CABLE range from the simplest bare wire to complex multi-conductor control, communication and power cables. And the range of applications from standard commercial installations such as this electronic data processing computer to the most exacting military requirements.


Computer Cable.
Multiconductor construction for interconnecting units. Conductors to MIL-W-16878, extruded nylon jacket over primary P.VC insulation, tinned-copper braid shield, color-coded PVC jacket over each pair, overall PVC jacket.

260C High Temperature Missile Cable. Silver-plated copper conductors, fused-wrapped Teffon insulation, flor-glass tape abrasion barrier, Teflon impregnated fiberglass inner braid, silver-plated copper braid shield $90 \%$ coverage, Teflon impregnated fiberglass outer braid, conductors cabled, Tefton impregnated fiberglass braid overall.

Quality Military Hook-up Wire. single and multiconductor shielded or nonshielded, PVC, Polyethylene, nylon, Teflon, HYRAO insulations, with plastic or braided jackets. Fully water-tested.


Communication Cable - High Reliability, Direct burial telephone cable specially designed for missile complexes. High-molecular-weight polyethylene insulation and jacket, codmium bronze tapes for shielding and mechanical protection.


High Frequency Cable, Custom designed to meet all industrial and military requirements. Flexible, shielded, coaxiol and triaxial cable as radio-frequency lines in radar and communications systems.


Power Cable. For generation, transmission, distribution and utiliza. tian of electric power. Paper, rubber, plastic, cambric insulation. Solid, gas-filled, oil-filled or pipe type. All voltages up to 345 KV .


Magnet Wire Round, square and rectangular magnet wire in any single or proctical cambinations of film or fibrous coverings. Epoxy, enomel, Formvar, nylon, cotton, paper, glass-fiber yarn. Sof derable Anoloc. 250C Silicane-Teflon. 500C Silotex-N.

For more information about any one of the product categories mentioned on these pages, write: The Anaconda Wire \& Cable Company, 25 Broadway, New York 4, New York.

ASK THE MAN FROM

I am interested in additional information on the following-
$\square$ Magnet Wire $\square$ Power Cable $\square$ Control Cable $\square$ Hook-up Wire
$\square$ High Frequency Cable $\square$ Communicatlon Cable $\square$ M/sslle Ceble
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## WIRE-WOUND... THE HARD WAY

 All current carried by a single fragile hair-like wire. Cutting any one turn causes no-warning, catastrophic failure-for 2,000 turns, 2,000 chances for element failure!Single bar contact wiper - one microscopic dust particle can cause an open - 1:1 odds on failure!
In one traverse wiper must make switch-like contacf to each turn for continuity - for 2,000 turns, 2,000 chances for opens!


## FILM POT... THE EASY WAY

Current carried by broad band of hard carbon film with an infinite number of current paths - ZERO probability of element failure!

Multiple fingered wiper - each finger with different natural frequency - odds on opens 1:16!

Wiper rides on continuous film, glass smooth, self-lubricating carbon - ZERO probability of opens!

Precision film potentiometers are inherently four million times more reliable than wire-wound types! Write for our Tech Note "Reliability Factors in Precision Potentiometers" for the whole story.



# Perfection <br> Wanted 

Minuteman needs components that will come to life at the press of a button after years underground

Individual trays protect parts from handling

EFFORTS to achieve greater component reliability are usually motivated by a specific need. Results from such painstaking work eventually benefit our entire industry.

Such a process is now going on at Autonetics div. of North American Aviation.

The need is to perfect component parts of the Minuteman ICBM's guidance and control system to reliability 50 to 100 times that possible in present missiles. Reason for this need is that Minuteman will be left unattended for months or years in bomb-proof, underground silos.

If launched, the missile must come to life at the press of a button and be capable of taking tremendous vibration, shock, acceleration and temperature extremes.

The company will spend $\$ 18$ million to find out why components fail and how to eliminate the causes. The results will make Minuteman more reliable and provide the industry with new ways to improve other end products.

The objects of all this attention and expense include transistors, capacitors, diodes and resistors. The investigation begins with the basic raw materials and follows through every production step.
"We are requiring suppliers to start with materials research on products and to keep accurate track of all units made throughout the manufacturing process," says William J. West, Autonetics chief, reliability and standards engineering.

To cut down on the amount of handling, where damage can occur, special sandwich-construction trays are used. In each tray as many as

200 transistors are placed. Here, they are protected from shock, dust and dampness. Each part has its serial number and punched card, showing performance in tests and leaving space for further testing results after delivery.

After tests at point of manufacture and upon receipt by the prime contractor, each tray goes into storage under low power. Some 90 days later, all parts are put through a final performance and rated. Stability of characteristics is a prime requirement for parts, due to the possibility of the Minuteman's lorigtime storage underground.

Of parts which have passed the test, about one-fifth go to even more extensive tests. Most of them must take 4,000 hours of what is called "life" tests to provide a better understanding of their wearout curve. A few components are subjected to destructive tests to speed up failure.

Malfunction of transistors recently led to a thorough investigation. The clue was a rising leakage of current, which indicated contamination in the transistor's sealed can. The component was uncased and the contamination found and traced back to the specific place on the production line where it was caused.

Another approach is simplification of design. The number of part types in guidance and flight control systems was reduced 66 percent.

Another example of design simplification is use of interchangeable plug-in packages. Gyros have been cut from three to two in the autonavigator.

Operating environments are controlled. The hydraulic equipment
is sealed. In the inertial navigation system, mechanical wear is reduced by avoiding metal-to-metal contact wherever possible.

Voltages are lowered-as are temperature and power require-ments-for longer component life. Transistors rated at five watts are used at two watts. This same principle of derating and operating at ideal temperature is applied to many components.

Motorola is supplying mesa transistors for Minuteman under a $\$ 1.272$-million subcontract. Specifications call for the semiconductors to meet a failure rate of 0.0007 percent per thousand hours operation.

This means that under usual testing concepts 136 million transistorhours with no failures must be accumulated. This is difficult since there are only 8,800 hours in a year.

Testing, the manufacturer says, is almost as difficult as the design and production of the transistor. The means of verification are mathematically designed life test experiments involving from 4,000 to 20,000 devices at one time.

Testing to determine this reliability will involve many advanced statistical methods, including response surface analysis and sequential life testing, and will largely be done with big computers.

Other subcontractors, Autonetics reports, are: Pacific Semiconductor, $\$ 1.2$ million for transistors and diodes; Fairchild Semiconductor, $\$ 1.5$ million for transistors; Transitron, $\$ 1.1$ million for transistors and diodes. Contracts with five other subs for capacitors and resistors are being negotiated.


Sprague-developed moss production and quality-contral techniques assure lowest passible cost consistent with utmast quality and reliability. Here too, complete fobrication focilities permit prompt production in a full, wide ronge of sizes and shapes.

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Driverless car maintains safe distance behind manned vehicle during test demonstration, showing . . .

## How Electronic Highway Works

> Wire loops, guidance cable and transistorized detector circuits used in test installation

FULL-SCALE electronic vehicle-guidance and warning system was demonstrated recently by RCA and General Motors. (See Electronics, p 71, Nov. 21, 1958)

A quarter-mile track on RCA's Sarnoff Research Center, Princeton, N.J., contains the test installation. Elements include a series of car-length rectangular wire loops and a continuous guidance cable buried just under the pavement, and a chain of transistorized detector circuits alongside the road.

## Distance and Speed

Passage of a car over a detector loop detunes the 100 or 300 Kc oscillator of which the loop is a part. The transistorized detector unit at roadside then generates two signals, which are fed to control equipment and then to a third embedded wire called a tail antenna.

The tail antenna links two detector loops in back of the car. This antenna radiates a pulse-width varying signal at 4.5 Kc for distance and a pulse-spaced signal at

8 Kc for speed information.
These signals are picked up by the next tail antenna to the rear snd retransmitted, but at a lower level and with the 4.5 Kc pulse-varying signal modified to indicate the addition of another car length between the lead car and any that might be following.

Thus a vehicle passing down the electronic highway generates a flying electronic tail behind it. A following vehicle wipes out the preceding tail and generates a new one of its own. The continuous guidance cable operates at 15 Kc with a current of 50 to 100 ma .

## Automatic Steering

In the recent demonstration at Princeton, specially equipped GM cars were steered automatically by signals from the cable, which also was used to transmit voice informa-tion-emergency instructions, traffic advisories-to the cars. The control signals from the detectors were used in several ways: in the specially equipped cars they operate
brakes and accelerator to maintain safe separation distance; in other cases, they can measure speed and activate speed warnings, count vehicle flow and operate traffic-light systems, and turn roadside illumination on and off.

One problem now being studied is use of the system on roads that are periodically shrouded by fog. Guidance lights installed in the roadbed would change color or pattern and thus give drivers enough information to speed up traffic.
The Nebraska Highway Department has been using the system for over two years in limited ways and is planning further installations. Because the speed and spacing information is instantly available, a special computer will be installed near Lincoln, Nebr., to program the lights of a particularly congested intersection.
It's estimated a road control system will cost between 5 and 10 percent of the total highway costs, depending on how many lanes are automated. Car controls may range from $\$ 200$ to $\$ 300$.
Also for Airports
RCA is providing similar vehicleguidance gear to Federal Aviation


Winthrop S. Pike, member of RCA technical staff, holds miniature version of detector package

Agency at its National Aviation Facilities Experimental Center in Atlantic City, N.J. FAA will test the feasibility of using the equipment for detection of aircraft position and movement on the airport as an aid to controllers in routing ground traffic.


Curtiss-Wright Relays have been proven time and again in high speed sled tests and component test equipment switching applications. Designed for missile, aircraft and complex industrial controls and instrumentation and pulse circuit applications, these pulse-triggered relays switch DC power to loads in microseconds. There are no moving parts . . . no RF radiation . . . and "On" resistance is constant. Models are available for high temperature service; also custom designs for special applications.

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## 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 cowinner 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, write:

## Data System Links Distant Computers

Magnetic tape equipment is employed for inventory control between facilities 650 miles apart
dallas-Two data communications networks have been put into operation by Collins Radio. The firm reports that speed on both systems is 300 characters a second.

One system uses a magnetic tape system for inventory control between the Signal Supply Agency's inventory-control point in Philadelphia and the Army Signal Depot at Lexington, Ky. Distance is 650 miles.
The other system sends missile design problems and answers on a punched-card system for Douglas Aircraft between Charlotte, N. C. and Santa Monica, Calif.
Each day a reel of tape from a Signal Corps computer at Lexington that has recorded the previous day's supply transactions is transmitted by telephone line to Philadelphia. A 2,400-ft reel representing about 25,000 transactions can be transmitted in about 2 hours. The data are fed to a larger computer that updates inventory records and produces summary reports.

The Douglas network allows engineers at the company's Charlotte plant to send missile design problems on punched cards 2,200 miles
over a telephone line to the company's computing center in Santa Monica and get answers back the next morning.

Design data relayed to Santa Monica for processing to IBM 704 and 709 computers include missile trajectory calculations, thermal analysis, stress analysis, guidance and control studies and test data reduction. Computing is done at night. Present card volume is about 20,000 a day. Full capacity is about 100,000 cards an 8 -hour shift, or 200 cards a minute in full-duplex operation.


System for Signal Corps inventory control links computers in Philadelphia, Pa., and Lexington, Ky. Reel holds 25,000 transactions

## Company Running Own Semiconductor School

WALTHAM, MASS.-Raytheon is combatting the shortage of semiconductor engineers by giving a series of in-depth, 13 -week courses.

Both new and veteran employees are being instructed.
More than 500 job applications were received in response to public announcements of the first series, now nearing completion. The second series of SET (Semiconductor Engineering Training) meetings starts late next month.
Lecture subjects include : chemistry and physics of semiconductor surfaces, circuit characterization and application of semiconductor devices, semiconductor and device physics, introduction to technical
analysis and principles of crystal growth and impurity control.

In addition to lectures and textbook readings, each course includes 10 laboratory experiments and three field demonstrations. Some of the equipment specified for experiments: oscilloscopes, thermocouple potentiometers, variable transformers, volt meters, milliammeters, multi-testers, square-wave generators, precision capacitors and audio oscillators.

Experiments call for such activities as measuring conductivity as a function of temperature, characteristics of the $p-n$ junction, graphing photoconductivity decay, recording and analyzing drift mobility.


## FAIRCHILD

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## IMPROVED FAIRCHILD 2N706

# SILICON LOGIC TRANSISTORS PRICED TO REPLACE GERMANIUM* *2N501A *2N559 *2N695 *2N705 *2N710 

Fairchild, mesa pioneer, announces further process breakthroughs effecting improved electrical performance and higher product yield for the Fairchild $2 N 706$. For YOU, this means:

IMPROVED PERFORMANCE Beta at $25^{\circ} \mathrm{C}$ is increased from 15 to a guaranteed 20 minimum; 500 mw dissipation at $100^{\circ} \mathrm{C}$ TC (from 300 mw ) is delivered; the new 2N706 is designed to meet Mil-S-19500B.
REDUCED PRICE Fairchild 2N706 silicon mesas are the inevitable replacement for germanium types in logic applications. The new Fairchild 2N706, priced down with high-performance germanium types, is $\$ 15$ (1-99) or $\$ 10$ ( $100-999$ ).
SUPERIOR RELIABILITY Fairchild's improved mesa process for the new 2N706 guarantees you new levels of reliability, backed by several million hours of reliability experience and Fairchild's $300^{\circ} \mathrm{C}$ stabilization on all units.
IMMEDIATE AVAILABILITY Available today from franchised Fairchild distributor stocks.

RATINGS AND CHARACTERISTICS $\left(25^{\circ} \mathrm{C}\right)$ - NEW FAIRCHILD $2 N 706$ DIFFUSED SILICON MESA TRANSISTOR

| SYMBOL | Characteristics | Rating | min. | TrP. | max. | TEST CONDITIONS |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| ${ }^{\text {cbo }}{ }^{\circ}$ | Collector to base voltage | 25 v |  |  |  |  |  |
| $V_{\text {EBO }}$ | Emitter to base voltage | 3 v . | , |  |  |  |  |
|  | Total dissipation, $100^{\circ} \mathrm{C}{ }^{5} \mathrm{C}$ | 500 mw |  |  |  |  |  |
|  | Total dissipation, $100^{\circ} \mathrm{C}$ free air ambient | 150 mw |  |  |  |  |  |
| $h_{\text {he }}$ | D.C. pulse current gain |  | 20 |  |  | ${ }^{1} \mathrm{C}=10 \mathrm{~mA}$ | $\mathrm{v}_{\mathrm{C}}=1.0 \mathrm{v}$, |
| $V_{\text {BE (SAT) }}$ | Base saturation voltage |  |  |  | 0.9 | ${ }^{1} \mathrm{C}=10 \mathrm{~mA}$ | $1_{B}=1 \mathrm{~mA}$ |
| $V_{\text {CE (SAT) }}$ | Collector saturation voltage |  |  | 0.3 | 0.6 | $I_{C}=10 \mathrm{~mA}$ | $1_{B}=1 \mathrm{~mA}$ |
| $h_{\text {fe }}$ | Small signal current gain at $\mathrm{f}=100 \mathrm{mc}$ |  | 2 | 4 |  | $\mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}$ | $v_{C}=15 v$ |
| $\mathrm{C}_{\mathrm{ob}}$ | Collector capacitance (140Kc) |  |  | 3.5 pf | 6 pf | $\mathrm{I}_{\mathrm{E}}=0 \mathrm{~mA}$ | $\mathrm{V}_{\mathrm{CB}}=10 \mathrm{v}$ |
| $\tau_{s}$ | Charge storage time constant |  |  | $16 \mathrm{~m} \mu \mathrm{~s}$ | $60 \mathrm{~m} \mu \mathrm{~s}$ | $\begin{aligned} & \mathrm{c}_{\mathrm{c}}^{c}=10 \mathrm{~mA} \\ & \mathrm{c}_{\mathrm{B} 1}=\mathrm{I}_{\mathrm{B} 2}=10 \mathrm{~mA} \end{aligned}$ | $\begin{aligned} & v_{C C}=10 v \\ & R_{L}=1 \mathrm{~K} \Omega \end{aligned}$ |



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No. 8208-_2 conductors: 18 AWG $7 \times 27$ copper tinned
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No. 8738-2 conductors: 22 AWG solid
.015" ins. . $130^{\prime \prime}$ nom. dia.
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## HICKORY BRAND Electronic Wires and Cables

## MEETINGS AHEAD

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, Cola.

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

June 26-29: New England Eletronic Conf., ERA, the Balsamis, 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.

June 27-July 7: Automatic Control, International Conf. of IFAC, AACC, ISA, ASME, AIEE, IRE, AIChE, Moscow, Russia, contact: R. Oldenburger, Purdue Univ., Lafayette, Ind.

July 4-7: British Computer Society Conf., Leeds University, Sun Pavilion, Harrogate, Yorkshire, England.

July 21-27: Medical Electronics, International Conf., Inst. of Electrical Engineers, Olympia, London.

Aug. 8-11: American Astronautical Society, Western National, Olympic Hotel, Seattle, Wash.

Aug. 9-12: American Institute of Electrical Engineers, Pacific General, San Diego, Calif.

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

Oct. 10-12: National Electronics Conf., Hotel Sherman, Chicago.

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# Television System For Stratoscope I 

Unconventional slow-scan tv chain assists astronomers in finding sunspots with balloon-borne optical telescope

By L. E. FLORY, G. W. GRAY, J. M. MORGAN and W. S. PIKE

David Sarnoff Research Center,
RCA Laboratories, Princeton, N. J.


Television system sent aloft with Stratoscope I increases yield of useful solar photographs obtained

THE STRATOSCOPE I television system is a special-purpose slow-scan tv chain consisting of a balloonborne camera and transmitter, and a ground receiving station. The Stratoscope itself is a telescope used for high-altitude solar photography: When aloft, it is remotely operated by radio command signals transmitted from the ground.

About two hours are required for the balloon to reach operating altitude. at which time the equipment is turned on automatically. Servos then orient the telescope in azimuth and elevation so that it sees the sun.

When the telescope comes to thermal equilibrium, the active part of the flight begins. An automatic film camera on the telescope starts exposing one frame each second and the tv camera is turned on permitting the astronomer at the ground control point to aim and focus the telescope by viewing a monitor screen.
Since the electrical and mechani-
cal design of the tv system had to be integrated carefully with the telescope, a number of problems arose that required solutions and techniques different from those normally encountered in commercial broadcast practice. Resolution of the tv system was to be equal to normal studio practice and a range of 150 miles had to be attainable.

Existing mechanical shutters in the telescope and film camera were arranged to expose the film once a second with an exposure time of about $\mathbf{1 . 5}$ millisecond. It seemed logical to relate the tv frame rate directly to the mechanical system, thus a vertical scanner frequency of one cps was adopted. Horizontal scanning rate followed naturally from this-a 500 -line resolution requiring a $500-\mathrm{cps}$ horizontal scan. To avoid carrying a sync generator, interlace was not used.

An advantage of the low frame rate is that lower bandwidth and transmitter power are required
with a bandwidth of 200 Kc being adequate. Calculation showed that an f-m transmitter with 200 Kc deviation (modulation index $=1$ ) and a power of 0.8 watt would be ample under ideal conditions with the receiver and antennas to be used. The conservative approach of providing 10 watts was adopted.
A block diagram of the balloonborne equipment is shown in Fig. IA. Light entering the telescope is imaged at the film gate of the film camera and the faceplate of the tv pickup tube by an optical system consisting of a primary 12 -inch parabolic mirror and a number of subsidiary mirrors and lenses. Exposure time and rate are controlled by a rotary shutter operating at one rev/sec, which illuminates both film and tv cameras for 1.5 millisecond once a second. A beam splitter following this shutter apportions the light between the tv and film cameras.

An additional rotary shutter is
installed in the path to the tv camera to permit only every third exposure to reach the vidicon. This technique reduces image blurring caused by the storage properties of the vidicon obtained at the low scanning rate.

Vertical sawtooth and blanking signals for the camera are generated by an electronic vertical sweep circuit driven from a cam-operated blanking microswitch on the onerev per sec shaft of the film camera. The microswitch is phased with the shutter system so that the latter illuminates the vidicon during the vertical retrace. Horizontal scanning and blanking signals are generated by circuits in the camera.

Video output of the tv camera is applied through a control box to a 2 -watt commercial f-m telemetry transmitter operating at 225.7 Mc . This unit excites a 10 -watt pushpull amplifier which feeds the antenna.

Considerations influencing efficient radiation of tv signals are: the telemetering transmitter operates on a frequency only two megacycles removed from the tv system; since the orientation of the entire balloon with respect to the receiving station changes during flight, the airborne antenna must be omnidirectional in azimuth; and since the telescope tube traverses in elevation during flight and is several wavelengths long at the telemetry and tv frequencies, the antenna must be located to minimize any anomalies in its directional pattern.

A four-element antenna designed to meet these requirements is shown in Fig. 2. The east-west pair of unipoles are interconnected by cables such that the currents in the east antenna lag behind those in the west by 180 degrees. The northsouth are similarly connected. If an extra 90 -deg. phase shift is introduced into east-west pair, the antenna pattern will be omnidirectional in azimuth.

The antenna is similar to the turnstile array often used in tv broadcasting in so far as its feed arrangements are concerned; that is, it must be fed from two correctly phased sources. This requirement is met with the bridge or rat race type diplexer. All power produced by both transmitters is radiated and a failure of either transmitter does not affect the other.

A quarter-wave unipole installed in the center of the ground plane energizes the command receiver in the balloon which operates on 138.38 Mc. It can be shown that the field from the balloon transmitters at the location of this receiving antenna is zero because of the way in which the transmitting unipoles are phased. The 138.38 Mc receiver is thus immune to interference from the balloon transmitters.

A block diagram of the ground station tv equipment is shown in Fig. 1B. Signals from the balloon are picked up on a pair of stacked Yagi antennas having a gain of about 15 db over an isotropic source. A $200-\mathrm{Mc}$ high-pass. filter is provided at the receiver input to ensure that no spurious signals are picked up from the command and communication transmitters also located at the station.

The incoming signal from the balloon tv system on 225.7 Mc is applied to a commercial f-m telemetry receiver which has a bandwidth of about 0.5 Mc and a noise figure of about 6 db . Receiver output (about 8 volts peak-to-peak) is applied to a distribution amplifier which provides three isolated outputs for the three monitors so that a defect in one will not disable the others. The distribution amplifier also uses high-frequency boost to improve system response at the upper video frequencies.

Since the balloon-borne equipment is inaccessible, much attention was paid to thorough stabilization of all circuits. Vidicon target voltage and video black level controls are extended to the ground by the telemetry and command radio circuits for use during flight. All other controls are preset at launch and require no further adjustment.

A simplified circuit diagram of the camera is shown in Fig. 3. Signals from the vidicon target are applied first to a CK5703 triode. Voltage gain of this stage is about 0.9 but it serves as a comparatively noise-free impedance converter between the high output impedance of the vidicon and the low input impedance of the following transistor amplifier.

To obtain maximum stability, an unconventional method of controlling the vidicon beam current was adopted. A 510 -kilohm resistor is placed in the vidicon cathode and
grid $G_{1}$ is returned to the regulated -24 volt supply. Beam control is achieved by variation of the $G$, voltage so that $d$-c beam current is degeneratively stabilized until it requires no adjustment.

Transistors $Q_{1}, Q_{2}$, and $Q_{s}$ make up a direct-coupled negative feedback amplifier with a flat overall voltage gain of about 300 . A network interconnecting the emitters of $Q_{1}$ and $Q_{3}$ controls the ratio of a-c to d-c feedback, thus controlling the stability and frequency response of the amplifier. Conventional high peaking is used to offset the droop in high frequency response caused by the high load impedance seen by the vidicon. The high peaker consists of the compensated voltage divider following $Q_{8}$. The one-kilohm resistive element of the high peaker is also used as a preset video gain control.

The gain control is followed by a direct-coupled feedback amplifier consisting of $Q_{1}$ and $Q_{5}$ and having a gain of about 10 . Note that base potential of the input transistor is stabilized by a Zener diode.

Transistor $Q_{\text {t }}$ is a keyed clamp which clamps the base of $Q_{8}$ to a potential set by the remotely controlled black level potentiometer at the start of each horizontal line. Clamp pulses are from the horizontal rate generator. The video signal is amplified by $Q_{s}$ and a large pedestal at both horizontal and vertical frequencies is added to it in the collector circuit of $Q$, by $Q_{i}$. Transistor $Q_{i}$ is driven with a mixed blanking signal from the vertical and horizontal rate generators.

Diode $D_{1}$ coupling $Q_{s}$ to $Q_{s}$ opens during each blanking pulse, thus clipping out most of the added pedestal and providing a composite signal to $Q_{\text {, }}$ that has a clean baseline during blanking. Since the black level potentiometer indirectly controls the potential at the collector of $Q_{Q}$, the amount of pedestal not clipped out by $D_{1}$ can be adjusted.

A fixed amount of mixed blanking is added to the signal in the collector circuit of $Q_{B}$ to serve as sync in the ground equipment. Transistor $Q_{0}$ is directly coupled to $Q_{10}$ driving the video line to the transmitter. Emitter load for $Q_{10}$ is a $3,000-\mathrm{ohm}$ resistor in the transmitter.


FIG. 1-Optical and tv portion of balloon-borne equipment (A). During all four fights made to date, tv equipment has functioned satisfactorily, enabling telescope to be focused well within theoretical focus tolerance. Also shown is television portion of ground station (B). Note: the 188-Mc command transmitter for operating airborne focusing and pointing equipment, and the 7-Mc communications transmitter for maintaining communication with balloon tracking crew, are not shown


F1G. 2-Antenna system for Stratoscope I. Long unipoles service $t v$ and telemetry transmitters, short unipole feeds command receiver


Photograph of sun taken at altitude of 80,000 feet. Large circular sunspot (dark area) is about 5,000 miles in diameter. Note detail of solar granulations surrounding spot

Vertical deflection for the vidicon is provided by transistors $Q_{11}$ through $Q_{15}$ A switch on the onerev per sec shaft in the film camera drive train is the starting point for the vertical deflection. At the instant vertical flyback is initiated, the upper contact of the switch opens and the lower closes. The switch stays in this position for about 50 millisec.

When the switch operates, $Q_{11}$ conducts, discharging capacitor $C_{1}$. This action corresponds to vertical flyback. At the conclusion of the
flyback, $Q_{11}$ turns off and $C_{1}$ recharges through constant current transistor $Q_{13}$. The linear sawtooth generated across $C_{1}$ is amplified by transistors $Q_{18}$ through $Q_{15}$ and applied to the vertical defiection coils.

The horizontal rate generator consists of transistors $Q_{1 s}$ and $Q_{18}$ connected as a stabilized multivibrator circuit. The two coupling time constants of the multivibrator are made individually adjustable, one being about five times longer than the other. The longer adjusts the horizontal frequency, the
shorter adjusts the length of horizontal flyback and blanking.

Output from the multivibrator is applied to a sawtooth generator similar to that in the vertical deflection circuit except the discharge device is a diode. Transistor $Q_{z}$ is the constant current charging device. The sawtooth produced is amplified by $Q_{s n}$ and $Q_{s 1}$ and applied to the horizontal deflection coils.

Mixed blanking is produced in transistors $Q_{11}$ and $Q_{15}$. Horizontal and vertical pulses are applied to the base of $Q_{10}$ through a diode clip-


FIG. 3-Airborne tv camera circuit. Plug-in wiring boards are used to permit ready replacement and servicing. Power is supplied by load-acid storage cells. All critical voltages are regulated and high voltages for vidicon and transmitter are produced by d-c to d-c chopper-type converters
per network to ensure that both horizontal and vertical pulses are of the same amplitude. Transistors $Q_{18}$ and $Q_{17}$ distribute mixed blanking at low impedance and correct amplitude to circuits requiring it, including the vidicon cathode.

Principal item of interest in the ground station tv equipment is the monitor shown in Fig. 4. Video signals from the distribution amplifier are applied to the sync separator and to the video amplifier. Sync separation takes place primarily in $Q_{1}$. The video signal has positive going sync which drives the base of $Q_{1}$ into conduction on each sync tip, thus building up a bias on the base such that only the sync tips are am-
plified, the video signal being below cutoff. Transistor $Q_{3}$ further clips the video signal, again in the direction to amplify only the sync pulse tips. The clean sync is next applied to $Q_{3}$ where it is inverted and amplified. At the collector of $Q_{3}$ the signal splits, vertical pulses being selected by integration at $Q_{1}$ and horizontal pulses being selected by differentiation at $Q_{13}$.

Vertical sync pulses from $Q$, are applied to the vertical oscillator. Vertical sawtooth is generated in $Q_{7}$ and $Q_{8} ; Q_{7}$ is a constant current charging transistor and $Q_{8}$ an emitter follower. Time base capacitor $C_{1}$ is discharged by diode $D_{1}$.

The sawtooth from $Q_{s}$ is applied
through $Q_{9}$ to $Q_{10}$. The collector load of $Q_{10}$ is half of the center tapped vertical deflection winding. The emitter currents of both $Q_{10}$ and $Q_{11}$ are sampled by a common 33 -ohm resistor $R_{1}$. Since $Q_{\text {: }}$ drives the opposite side of the centertapped yoke winding, any unbalance in the currents flowing in $Q_{10}$ and $Q_{11}$ will cause a signal to appear across $R_{1}$ which is amplified by $Q_{13}$ and fed back to $Q_{11}$ in the correct polarity to reduce the unbalance.

Horizontal sync from $Q_{13}$ is applied to a phase splitter which drives a balanced phase detector. A reference sawtooth is also supplied to the phase detector from the horizontal deflection system


FIG. 4-Ground station monitoring circuit. Type 7ABP14 kincscopes are used in all threc monitors. Monitor deflection yoke is wound on a laminated core as a motor stator. Vertical windings consist of four identical windings connected in series; horizontal windings are similarly arranged
through $Q_{1 s}$. D-c output of the phase detector is applied through $Q_{15}$ and $Q_{17}$ to the horizontal oscillator to control its frequency. The phase detector output varies the voltage applied to one end of the horizontal hold control to keep the oscillator locked to the incoming signal.

Pulses from the horizontal oscillator are applied to the sawtooth generator. Capacitor $C_{2}$ is discharged by $Q_{s o}$ during the flyback and recharged through constantcurrent transistor $Q_{n}$. The sawtooth is fed through $Q_{\text {en }}$ and $Q_{m}$ to the horizontal deflection amplifier.

The important difference between the horizontal and vertical output
stages is the load impedance for the higher horizontal frequency. The yoke looks inductive with the result that a large pulse is generated across it during the flyback. Dissipation of the transistor driving one-half of the yoke is much higher than that of the transistor driving the other half because of the asymmetry of the signal due to the pulse caused by yoke inductance. Thus $Q_{z s}$ and $Q_{n 0}$ are used in parallel to drive one side. Transistors $Q_{3 s}$ and $Q_{2 s}$ are connected as a direct-coupled feedback amplifier with a gain of about 10. Output of $Q_{29}$ is a-c coupled to $Q_{s o}$ with large capacitor $C_{3}$; d-c restoration is provided at this point to keep the base of $Q_{30}$ from swing-
ing positive. Emitter follower $Q_{\mathrm{a}}$ delivers about a 40 -volt peak-topeak signal to the kinescope grid.

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# Automatic Surveying System Measures Runway Roughness 

Lightbeam projector and profile measuring device are used to record runway profile variations every 6 inches. At peak speed of 15 measurements a second, dynamic accuracy exceeds $1 / 4$ inch

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an automatic surveying device has been developed that surpasses by a factor of at least 10 the speed of any previously known system. This equipment, which will be used to survey Air Force runways, measures and records profile variations at intervals of six inches. At the peak speed of 15 measurements a second, dynamic accuracy will be better than $\$$ inch.

Data obtained from these surveys will be used to improve designs of landing gear and to determine the magnitude of stresses induced in airframes during taxiing.

The surveying system consists of the lightbeam projector and profile measuring device shown in the photograph. Principle of operation is similar to that of conventional rod and transit surveying equipment. The projector, which replaces the transit, projects a highly collimated lightbeam down the runway and establishes a stable reference from which measurements are made. The measuring instrument, which replaces the rod, is towed down the runway and senses the position of the light. Equipment mounted on the profile measuring device measures and records the distance between the runway surface and the lightbeam centerline.

The lightbeam projector is shown


FIG. 1-Circuits record distance between runway and center of lightbeam
in its normal operating position in the foreground of the photograph. The projector light source is a $100-$ watt zirconium crater are lamp, whose image is focused on a $0.01-$ inch pinhole which becomes a virtual light source for the collimator. Because the image is larger than the pinhole, the focus of the collimator becomes independent of the random wandering of the crater within the lamp.

Mounted directly in front of the pinhole is a slotted disk chopper which modulates the light at a frequency of $1,080 \mathrm{cps}$, thereby enabling it to be distinguished from ambient sunlight. This modulation also simplifies the electronic circuits by obviating the need for d-c amplification.

The measuring device consists of two major subsystems: the beamsensing system and the measuring and recording system. Block diagram of the profile measuring device is shown in Fig. 1.

In operation, the collimated lightbeam enters the sensing head which contains a bank of 10 photocells mounted behind a ground glass diffusing plate. These photocells are connected to give six outputs whose magnitudes depend upon the position at which the lightbeam strikes the diffusing plate. These output voltages are applied to the input of the servo detector chassis where they are amplified, filtered and


Automatic surveying equipment consists of profle measuring device at left and lightbeam projector in foreground


FIG. 2-Servo detector gonerates d-e voltages proportional to vertical and horizontal positions of sensing head
added as shown in Fig. 2.
This process gives two d-c output voltages: one proportional to the vertical position of the optical sensing head (with respect to the lightbeam), and the other proportional to its horizontal position. The vertical position signal is amplified and drives the servo motor which positions the head. The servo system is stabilized by a tachometer.

The horizontal-position signal drives a microammeter which indicates to the operator the position of the head in the lightbeam. The
operator can also hear through his headphones a $1,080-\mathrm{cps}$ note whenever the sensor is in the beam.

Mounted on the sensing head is a shaft-to-digital converter. This device is geared to the profile follower wheel in such a way that its shaft rotation is proportional to the distance between the runway surface and the lightbeam. The output of the digitizer is an 11-bit binary word which is applied to the input of the digital coupling unit. (See Fig. 3A.)
Upon receiving a command from
the odometer switch, the coupling unit reads a word out of the digitizer and stores this word in its memory, which consists of a bank of 11 relays. The coupling unit then proceeds to read out this information to the punch in the form of two sequential six-bit binary words (11 information bits and a parity bit). During this readout period of 67 milliseconds, the coupling unit is controlled by synchronizing pulses received from the punch at a rate of 120 pulses a second.

Figure 3B shows one of the 11
information channels. The output from the digitizer is either a -3 or a -21 -volt signal, depending upon whether a binary ONE or zERO is present. This signal is applied to one input of an and circuit. Upon receiving a command signal, switch 1 closes, causing the one-shot multivibrator to generate a pulse of about 3 milliseconds duration. This pulse is passed through an emitter follower and applied to the second input of all 11 AND circuits.

When the pulse is received by the and circuit, a similar pulse appears at the output if a binary ONE is present on the other input. This pulse is then passed through a pulse inverter and produces a posi-+ive-going spike of about one microsecond duration.

The one-microsecond spike will be generated only if a binary ONE is present at the input of the and circuit when the read pulse appears; if a binary zERO should
change to a ONE during the one microsecond that the read pulse is present, a pulse will appear at the output of the and circuit but the rise time of this pulse will be too slow to trigger the pulse inverter. Therefore, the digitizer is read in about a microsecond, and the results are accurate even when the digitizer output is changing rapidly.

The output spike from the pulse inverter triggers a flip-flop circuit whose output is connected directly to the grid of a parallel-connected 12AU7. The load on this tube is a 4PDT relay with mercury wetted contacts which was selected for fast, chatter-free operation. Of the four contacts, one is used for a latch, two for a parity circuit and the fourth for a register.

During the 67 milliseconds the word is being read onto the tape, the register is disabled by ungrounding the 12AU7 cathodes and


FIG. s-Measuring and recording system (A) contains 11 information channels, one of which is shown in (B)
by electrically latching the relays. This disabling makes the circuit insensitive to the electrical noise generated by the punch.

The synchronizing circuit consists of seven relays; the first six operate sequentially, the seventh serves as a latch on the odometer switch. When the odometer switch closes, the seventh relay is actuated and latched, and the timing contacts on the punch are energized. These contacts close alternately at a $60-\mathrm{cps}$ rate and drive the chain of six relays, each of which latches itself through one of its own contacts and is energized through a contact of the preceding relay. Sequential operation is thereby assured. Because each relay is driven through a diode, it can be electrically latched without actuating the other relays connected to the same bus.

The synchronous operation proceeds as follows. First, the 11-bit word is read into the register. Then the tape is advanced and the first line ( 6 bits) is punched. Next, the tape is advanced and the read circuit is switched to the second six bits.

Then the second line ( 6 bits) is read and the tape advance circuit is disabled. Finally the entire circuit is disabled.

Another feature is that if the seventh relay ever closes the entire reading sequence must occur regardless of how long the command switch remains closed. Furthermore, once the sequence has been completed, the odometer switch must open to reset the circuit before another word can be read. This feature makes the device insensitive to towing speed, except that when the top speed of 15 words a second is exceeded, the excess words will not be printed at all.

As a check on system accuracy, a 600 -foot section of roadway was surveyed by conventional rod and transit techniques as well as by the automatic system. A comparison of the 2,400 readings so obtained showed that 84 percent differed by less than 0.2 inch, and that the greatest error ever encountered did not exceed 0.5 inch.

This development was carried out under Air Force Contract No. AF 33 (616)-6512.


FIG. 1-If input pulse exceeds bias at A, flip-flop is triggered and potential at $B$ is driven negatively


FIG. 2-Control flip-flop formed by $Q_{1}$ and $Q_{3} ; Q_{1}$ is the integrator

# Novel Design Peak Voltmeter 


#### Abstract

Auxiliary flip-flop compares input pulse with voltage already on integrating capacitor. Flip-flop then automatically adjusts capacitor charge to match peak voltage of input


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The difference between this circuit and conventional peak reading detectors is that in this circuit the storage capacitor is charged during a substantial part of the interpulse interval; in conventional circuits the storage capacitor is charged at the peak of the input voltage waveform. If the d-c loading of the storage capacitor is several hundred thousand ohms or less, and if the duty ratio is low, it becomes difficult to supply sufficient current at the voltage peaks to fully charge the storage capacitor.

In the circuit under discussion the peak input voltage is compared with the charge on the storage capacitor. If the input voltage exceeds the voltage on the storage capacitor a monostable multivibrator is set to increase the charge on the storage capacitor. If the peak pulse voltage is less than the voltage on the storage capacitor the charging current is reversed and the storage capacitor is charged in the opposite direction. Figure 1 is a block diagram of the peak voltmeter. The monostable multivibrator is designed to switch to its unstable condition
whenever its input is driven more than a few tenths of a volt positive. Furthermore it should stay in the unstable (on) condition for a substantial portion of the interpulse interval.

Consider the circuit to show zero reading, and a train of positive pulses applied to the input terminal. The d-c level at point $A$ will be zero since there is no charge on capacitor $C_{z}$, and point $B$ is at zero volts. The positive input pulse will drive point $A$ above ground, and the multivibrator will turn ON. When the multivibrator turns on point $C$ goes to plus 5 volts, and current flows into $R_{z}$ of the integrator. In response to the current flow in $R_{2}$ point $B$ of the integrator moves in a negative direction. When the unstable period of the monostable multivibrator has elapsed the multivibrator will switch to the OFF state and point $C$ will fall to minus 3 volts; current flow out of $R_{2}$ will cause point $B$ to move in a positive direction. The d-c level of point $A$ is established through $R_{1}$ at the voltage of point $B$.

If the next positive pulse applied to the input terminal exceeds the negative d-c level established on point $A$, point $A$ is driven positive with respect to ground and the monostable multivibrator is once
again turned on. The integrating circuit again integrates current flow into $R_{2}$ for the duration of the period of the multivibrator, and point $B$ travels further negative. Ultimately point $B$ is brought to a negative voltage slightly in excess of the positive peak pulse voltage and the multivibrator is not turned on by the pulse (providing its amplitude has not increased). Capacitor $C_{2}$ then charges in the opposite direction until point $B$ is no longer more negative than the positive peak excursions of the input and the multivibrator is turned 0 N for one or more cycles. Hence point $B$ oscillates with small amplitude about the peak pulse voltage.

Figure 2 is a schematic diagram of the circuit. Transistors $Q_{1}$ and $Q_{2}$ form the monostable multivibrator which controls the integrating circuit. The monostable feature is provided by the capacitively coupled feedback path involving capacitor $C_{3}$. The function of diode $D_{3}$ is to provide a low resistance path for the rapid discharge of capacitor $C_{3}$. Point $C$ is the output of the monostable multivibrator. Transistor $Q_{3}$ is a simple d-c amplifier integrating circuit. Its function is to accumulate and store the d-c voltage level that is compared with the input pulse.

# Broadband Log-Periodic Antennas 


#### Abstract

These antennas can operate over a $10: 1$ frequency bandwidth while a range of antenna configurations confer important directional characteristics.


Representative types of antennas are presented in this short survey


FIG. 1-Versatile log-periodic antenna is capable of horizontal, vertical and circular polarization (A), basic three-element array ( $B$ ), iteration of the basic three element array (C), geometry of the log-periodic antenna (D)

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The log-periodic antenna concept, originated by DuHamel, Isbell and their colleagues at the University of Illinois, is a remarkably flexible design approach for good antenna performance over wide frequency bands. Omnidirectional, bidirectional and unidirectional configurations are available that have good patterns and vswr characteristics, and constant performance over frequency ranges up to 10:1. Some designs permit remote selection of polarization. Circularly polarized strutcures are also practical. Applications include monitoring and signal interception, direction finding, satellite tracking, radio astronomy and h-f communications.

Logarithmically periodic antennas achieve wideband properties by geometric iteration. Consider the simple combination of driven dipole, parasitic reflector and direction of Fig. 1B. This combination radiates a unidirectional beam in the direction of the arrow, with the field polarized in the plane of the elements. With a proper choice of element lengths and spacing, the vswr and gain can be made reasonably constant over a frequency band of $\pm 10$ percent. When the antenna is driven at frequencies which are well outside these limits, however, the resonant character of the self and mutual impedances, and the space phasing which accounts for the directivity, result in rapid deterioration of performance. The vswr increases, the gain decreases, and undesirable secondary lobes appear. If additional elements are added, as in Fig. 1C, and the feed arrangement is appropriate, much
wider band performance is obtainable. DuHamel and Isbell arranged these additional elements so that the significant dimensions increased in a logarithmic fashion from one end of the array to the other, and such that the ratio of element length to spacing was constant. It is apparent that this amounts to iterating the basic 3 element array, so that the final array can be regarded as a superposition of 3 -element arrays, differing from one another only by a constant geometric scaling factor.

The usual log-periodic factors can be expressed in terms of the parameters defined in Fig. 1.
$X_{n}=\left(X_{n+1} X_{n-1}\right)^{1 / 2}=X_{n+1} / \sigma=\sigma X_{n-1}$
$R_{n}=\left(R_{n+1} R_{n-1}\right)^{1 / 2}=R_{n+1} / \sigma=\sigma R_{n-1} \quad$ (2) where $\sigma$ is a constant that is less than unity.

Research on antennas structures of this type has shown that it is possible to design for any of a wide range of performance parameters while retaining characteristic wideband features. The most significant design parameters are $\sigma$, as defined above, $d$, the taper angle, and, in arrays of log-periodic elements, $\Psi$, the angle between the axis of the elements in the array.

The log-periodic structure has a characteristic phase behavior that permits its application to circularly polarized and omnidirectional rerequirements. This frequency-independent phase shift capability is directly related to the behavior of the structure when it is regarded as a delay line supporting a transmission line mode.

From the wide band performance and simplicity of phasing, gains up

FlG. 2-Antenna can be vertically or horizontally polarized by remote switching (A); polar diagram of top antenna (B). The h-f antenna radiates a low-elevation-angle beam (C); polar diagram of h-f antenna (D)

(A)

(C)


# Built-in Test System For 


(B)

(C)

(D)

FIG. 1-Comparator network (A) has two available channels; either one or both may be used. Multivibrator pulses (B); normal pulse amplitudes (C); reduced pulse amplitudes (D)

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TESTING the battery control center (BCC) of the Hawk Weapons System is a formidable job. The automatic fault-finding system to be described makes this job easier.

The BCC is of modular construction, and has a full set of operational spares stocked at each site. Missilemen replace faulty modules as required, returning the defective modules to depots.

Each module of the BCC is monitored by comparator networks. A test set monitors a matrix of the comparator outputs and when it gets an indication of a fault, begins to scan comparator outputs until it locates the faulty module.

Testing a module to evaluate its operational state requires that a standard set of input signals must be supplied, and that, with the

[^2]standard inputs applied, the outputs be checked against a set of standard outputs.

Assuming that the standard set of inputs is applied, there remains the problem of checking the outputs. The comparator checks the output signals of the modules. This device reduces the performance of each module to a single d-c test voltage of the go/no-go type with a minimum of complexity.

Since outputs of one module become the inputs of another, logical analysis is performed on the d-c test signals of the various modules. This logic locates the faulty module in cases of multiple failure symptoms and allows the system to supply most of its own test signals, thus saving considerable extra test equipment.

The comparator (Fig. 1A) is a miniature encapsulated plug-in unit (7-pin miniature basing). It is used with externally supplied reference voltages and allows continuous monitoring of the performance of two independent periodic
electronic signals, such as pulses, gates, sweeps, and causes an alarm to be actuated when either signal falls below a preset reference level.

The comparator consists of two independent peak detection-comparison networks. Outputs of each of the dual comparison networks are coupled together through an and coincidence circuit to form a single normalized output. Channel 1 and channel 2 are identical. In describing the operation, channel 1 will be referred to.

The signal to be compared, input No. 1 , is a-c coupled through $C_{1}-R_{1}$, whose time constant is many times larger than the width of the widest gate to be handled. Diode $D_{1}$ is a d-c restorer that restores the level of the a-c coupled input to the value of the negative reference voltage at input 1 , which is derived from an external source. The restored signal charges $C_{2}$ through $D_{2}$. The time constant of $C_{a}$ and paralleled resistors $R_{2}$ and $R_{3}$, which constitute the discharge path for $C_{2}$, is much greater than the period of the in-

# Automatic Fault Detection 

## COMPLEX MISSILE-CONTROL SYSTEM BUILT INTO THE SYSTEM'S MODULES

put signals so that the voltage across $C_{0}$ is a relatively good peak detection of the input. The voltage across $C$. represents the comparison of the peak amplitude of the input and the magnitude of the negative reference voltage. If the peak amplitude of the input is greater than the magnitude of the reference, $C_{2}$ will be charged positively with respect to ground; if the peak amplitude of the input should be less than the magnitude of the reference, $C_{z}$ will be charged negatively with respect to ground.

The output is normally terminated in 1 megohm to ground. When $C_{s}$ is charged positively, parallel diodes $D_{3}$ and $D_{4}$ are back biased, and the output is at ground potential (through 1 megohm). Should $C_{z}$ not be charged above ground, as would be caused by a decrease in amplitude of the input signal, then parallel diodes $D_{3}, D_{4}$ are forward biased. They conduct through the path of the terminating resistor and parallel resistors $R_{\mathrm{s}}, R_{\mathrm{i},}$ and the output falls below ground by an amount proportional to the difference between the inputsignal peak amplitude and the magnitude of the negative reference voltage.

Thus, the output has two principal states. One state, at ground, corresponds to normal operation of the monitored circuits; the other state, below ground, corresponds to a malfunction or performance deterioration. A typical fail level is -1 volt, or more, in the negative direction; 0 volts is normal.

Regardless of the amplitude or shape of the waveform that is compared, or the level at which the input is judged to cause malfunction, the output of the comparator is zero volts for normal operation and minus 1 volt for malfunction. The effect is to normalize any input so that the output state is at either of two predetermined levels. The normalizing is accomplished by
supplying a negative reference for each input waveform and by d-c restoring each input signal to the reference level. So that the output be at ground, $C_{2}$ must be charged positively, regardless of input wave, shape and amplitude. The setting of reference voltage establishes the level from which $C_{8}$ is charged. By setting this level externally, all waveforms can provide the same normalized output levels of 0 and -1 volt.

Channel 2 operates exactly as does channel 1. Except for the output circuit, the channels operate independently of each other.

The voltage across $C_{2}$ to ground represents the comparison of peak amplitude of input No. 1 and the magnitude of reference No. 1; the voltage across $C$, to ground represents the comparison of input No. 2 and the reference No. 2. The comparison voltage of channel 1 is coupled to the output through diodes $D_{3}$ and $D_{4}$; the comparison voltage of channel 2 is coupled to the output through diodes $D_{i}$ and $D_{8}$. Diode combinations $D_{i}, D_{4}$ and $D_{i}, D_{k}$, together with the terminating 1 -megohm resistor form an AND coincidence circuit. Both sets of diodes must be back biased ( $C_{2}$ and $C_{1}$ must be both charged above
ground) for the output to be at zero volts. Should either pair of diodes conduct in the forward direction the output will be negative.

When only one signal is to be monitored, either channel of the comparator may be used; both channels are used when two signals are to be monitored. If three or more signals must be monitored, the number of comparators may be increased as necessary, since each comparator unit has only two channels. When more than one unit is employed, the outputs must all be connected together; only one terminating resistor is needed regardless of how many comparators are used. Should any one signal out of many that are being monitored degrade below a certain preset limit, the output will be in the fail state.

The comparator is primarily an amplitude comparison device. However, if a parameter such as rise time is deemed critical then a simple high-pass R-C filter placed at the input of the comparator will permit an approximate measurement by sampling high frequency components of the signal. Similarly, a simple low-pass filter will permit measurements of flatness of the tops of rectangular pulses.

Use of the comparator to check


FIG. 2-Simple serics module (A); complex series module (B). Parallel modules shown are simple (C) and modified (D) arrangements


FIG. 3-Mixer circuit modified for use with comparator

FlG. 4-Simplified diagram of test set. Step relay $K_{1}$ is in the home position
the output of a multivibrator, a typical output signal, is shown by the waveshapes of Fig. 1B, 1C and 1D. Input time constant $C_{1} R_{1}$ (Fig. 1A) is many times larger than $T 2$, Fig. 1B. Output time constant of $C_{\mathrm{g}}\left(R_{2}, R_{3}\right)$ in Fig. 1A is many times larger than $T_{1}$ in Fig. 1B. Figures 1C and 1D show the waveforms at points $A, B$ and the output of Fig. 1 A for the cases of normal and reduced (failure) amplitudes. This multivibrator-circuit example assumes that 30 v is the threshold of unacceptability. By proper choice of time constants $C_{1} R_{1}$ and $C_{2}\left(R_{2}\right.$, $R_{3}$ ), comparator parameters can be made universal for an entire system. Only one type comparator is stocked for the Hawk BCC.

Typical series connected circuit modules are shown in Fig. 2A. These modules can be quickly checked for failure location by monitoring the outputs with a comparator ( $C N$ ) channel for each output signal. One comparator channel is required for Fig. 2A and three comparator channels (two comparators) are required for Fig. 2B.

The parallel-logic module of Fig. 2 C is slightly more complicated to handle than the series type. If the comparator is placed at the output of the module, as shown in Fig. 2C, the output of the comparator may not be a true reading of the operation of the whole module. The comparator is a peak detecting device so the signal from any one

channel is able to saturate the comparator. In the condition where the comparator is saturated by the signal from one channel, a failure in the other channel will be undetected. If the mixed signals are redundant, this condition may be acceptable. However, if the signals are not redundant and are both essential, the configuration of Fig. 2D may be used to isolate the signals before mixing. This requires the use of two additional comparator channels to check each signal before they are mixed. Note that Fig. 2D requires two additional mixing diodes; if either of these diodes short, the conditions of Fig. 2C prevail. If the diodes open, system operation may be degraded in some cases.

The configuration of Fig. 2D is not particularly desirable. It is often possible to generate a synthetic sampling signal for the comparators such that the operation of both circuits may be checked in a manner that will not degrade system performance. An example of this is shown in Fig. 3. Here small plate resistors ( $R_{1}$ and $R_{2}$ ) have been inserted to obtain a sampling pulse for the comparators. These resistors do not affect circuit operation and provide independent sampling pulses for each comparator. The two resistors fail safe; that is, if they open or short, failure will be shown by the comparators.

The comparator network may be used in sufficient numbers to reduce
the performance indication of a module to a single d-c voltage. The problem remains of how to locate the malfunctioning module. Previous discussion has shown that monitoring the outputs of modules is sufficient to determine their operating state if the inputs are known. To save on test equipment, it was further noted that the equipment was capable of providing many of its own test signals if suitable logic was applied. The basic question that must be answered concerning the validity of a failure signal is: Has a given module failed, or does it merely appear to be faulty because it is lacking one or more correct inputs?

Figure 4 shows a simplified diagram of the test set used to isolate a malfunctioning module of the Hawk BCC.

When a malfunction occurs, the tester, which consists of stepping relay $K_{1}$ and control circuits, is started by applying the start signal. The stepping relay always starts from the position shown, its home position; before it can leave its home position, it must pass a series of self tests. The starting signal, which is the nominal level of a test signal in the failure state, is applied through the off-normal switch to skip relay $K_{\underline{g}}$ and stop relay $K_{8}$. Step relay $K_{1}$ is energized through series-connected contacts of $K_{2}$ and $K_{3}$. Both $K_{2}$ and $K_{3}$ must be operated to start the test sequence. If either is faulty, the
analyzer designates itself failing.
Assuming the analyzer is acceptable, energizing $K_{1}$ causes it to advance one step, releasing the cam-operated off-normal switch. The series-connected contacts on $K_{2}$ and $K_{s}$ then lose control of $K_{1}$. The start signal is also removed when the off-normal switch drops out. After the step relay leaves home, operation of stop relay $K_{8}$ deenergizes the step relay, halting it. The stop bank of $K_{1}$, which controls the stop relay, is wired to the test signals of the modules that are scanned; therefore, the stop relay tends to stop the test sequence whenever a bad test signal is located. However, the skip circuit is wired so that a normally open contact on $K_{3}$ is in parallel with a normally closed contact on the stop relay, in the step-relay drive circuit. If $K_{q}$ is energized, $K_{1}$ will be energized regardless of the state of $K_{3}$, causing the test sequence to continue. To the positions of the skip banks of $K_{1}$, are applied the input test signals of the modules driving the module whose test signals are applied to the stop bank.

The purpose of the skip bank is to cause the test sequence to continue until a module is located which has an acceptable set of input signals and a faulty set of output signals. The skip circuit makes the logic of the test sequence combinational since there is always information present concerning the state of the driving modules. The number of skip banks needed is equal to the number of inputs of the module with the greatest number of inputs.

The stop bank is wired as it would be for the hypothetical system of Fig. 5. In this example, two skip banks are sufficient since no
module has more than two inputs. A positive signal, representing the failure condition, into block $B$ would energize $K_{3}$ when $K_{1}$ stepped into position 2; $K_{1}$ would therefore be stepped to position 3. If there were no inputs, an absence of inputs indicating the correct-functioning condition, into blocks $A$ and $D$, relay $K_{2}$ would not be energized and $K_{1}$ would stop at position 2.

The skip logic is not acceptable when feedback paths, such as the one between modules $G$ and $H$ in Fig. 5, are present. In this case, the test set would be unable to designate either module as a failure, since, if there is a failure in the loop, both modules will show apparent failure and both are capable of inhibiting each other. There are three possible solutions to this problem.

If the feedback path is one of packaging location of circuits rather than one of a true feedback loop, relocating the circuits to obtain a series connected logic flow will solve this problem.
If the circuits cannot be relocated, the various test signals may be expanded so that a test signal will not include a whole module, but only a portion needed to establish a straight line flow.

If the feedback path is a true feedback path, the designer can choose one of these options: the feedback loop can be opened with suitable programming and each module can be located on an open loop response basis; check the modules on a closed-loop basis and make any failure indications and ensuing repairs on a matched-pair basis.

The skip banks of Fig. 4 are wired for the example of Fig. 5; the wiring for modules $G$ and $H$ is


FIG. 5-This is the system being tested by test set of Fig. 4


Sound level meter being displayed in Trafalgar Square, London. Nelson's Column and St. Martin's in the Fields are in the background

# Transistorized 

This article traces the development of a transistorized sound level meter. Special attention is given to the evolution of the high input impedance circuit

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THE BASIC INSTRUMENT for noise measurements is the sound level meter. It consists of a microphone, amplifier, frequency-response-determining elements called weighting networks and an indicating meter. The sound level meter measures the weighted sound pressure level in decibels with reference to 0.0002 dyne per $\mathrm{cm}^{2}$. Performance characteristics have been standardized in a number of countries, the most widely used specifications being American ${ }^{1}$ and German ${ }^{2}$. These are substantially similar and a committee of the International Electrotechnical Commission (IEC) is working on a combined international standard.

For general use a compact and portable sound level meter is required so that the advantages of transistors are particularly attractive. Their low power consumption allows lightweight batteries to give many hours of operation; small size and absence of microphonics are especially desirable for a portable equipment.

However the use of transistors in a sound level meter creates a number of difficult design problems. The amplifier must have a low noise level and provide a suitable input impedance for a high-grade microphone. The gain must be unaffected by normal variations in battery voltage and environmental factors such as temperature. Stable impedance levels between amplifier stages are necessary for proper functioning of attenuators and weighting networks and a wide dynamic range is required to cope with the high peak-to-mean values of many noise waveforms.

The first design consideration is the choice of microphone. A flat frequency response, stable sensitivity and omnidirectional characteristics are required. With transistor circuits, since a low-impedance transducer provides optimum sig-nal-to-noise ratio, a moving-coil microphone might be desirable. However the frequency response of the low-priced hi-fi units is too irregular, while the precision-grade
moving-coil microphones are too expensive and too bulky for the gen-eral-purpose sound level meter.

Modern capacitor microphones provide extremely good performance but are expensive and because of their low self-capacitance require an extremely high input impedance. The inherent noise of transistor circuits is excessive at these exceptionally high impedances.

High-grade piezoelectric crystal microphones are widely used in portable sound level meters because of their relatively low cost, high sensitivity and reasonably good frequency response. The self-capacitance is much higher than for capacitor microphones so that they can be used with high input impedance transistor circuits.

A block diagram of the transicy torized sound level meter is showp in Fig. 1. A compensated dia phragm, high-capacitance crystal microphone is connected through a voltage attenuator to a high input impedance transistor circuit. An insert resistor ( $R_{1}$ ) is connected in

## Sound Level Meter

series with the microphone to aid in calibration. The signal is then amplified by four amplifier stages and finally applied to a meter rectifier circuit. The amplifiers feature stable low output and input impedances. Weighting networks, a current attenuator and a preset gain control are connected between successive stages. The two attenuators are operated by a single sound-level range control to provide eleven steps of 10 db . The current attenuator between the second and third amplifier stages operates at low levels to improve the signal-to-noise ratio. At high levels the voltage attenuator following the microphone becomes effective to prevent overload of the input stage. The three weighting networks are designed to the IEC draft specification and, as will be seen from Fig. 2, these are a compromise between the American and German standards. An advantage of the IEC curves is that they are based on the response of simple resistance-capacitance networks and, since the curves are to some extent arbitrary, the changes are not significant.

Standard 600-ohm filters can be inserted between the high input impedance circuit and the first amplifier so that a frequency analysis can be carried out using the main amplifier and meter circuits. The dynamic range is such that a signal may be passed through a filter in the presence of a masking signal of up to $50-\mathrm{db}$ greater amplitude without overloading any stages in the amplifier. An output jack enables the amplified signal to be monitored, for example with headphones or a cathode-ray oscilloscope.

The most vital problem in the development of the transistorized sound level meter was the design of a suitable high input impedance circuit, which is essential for proper operation of the crystal microphone. Transistors are inherently low input impedance devices when compared with tubes. High input impedances may be obtained with transistors by three basic methods: use of a high-value series resistance at the input of a voltage amplifier of relatively low input impedance; positive feedback methods; and negative feedback methods.

Use of a high-value series resistance gives a stable input impedance but the voltage transfer of the system depends on the amplifier used. In applications where the voltage gain stability is more important than an accurate value of input impedance, this method is not economical in terms of the number of transistors and associated components necessary to achieve a given performance. Another disadvantage is that no reduction in circuit noise is obtained by negative feedback through the impedance of the source. Simple positive feedback arrangements lead to stability difficulties so that negative feedback methods for increasing the input impedance were investigated.

Consider an amplifier having an input resistance $R$, a voltage gain $G$ and a phase change of 180 deg throughout the working frequency range (Fig. 3A). If the voltage across the output terminals $B-C$ is $V_{0}$ then the voltage across the normal input terminals $A-C$ will be $V_{o} / G$. If a signal $V_{1}$ is applied between $A$ and $B$, that is, between the normal input and output terminals,


FIG. 1-Complete diagram of the transistorized sound level meter. With transistors, the effect of vibration and high-intensity sound levels is negligible

FIG. 2-Overall response characteristics of sound level meters (weighting curves)

FIG. 3-Block circuit for increasing input impedance by negative feedback (A); and circuits showing the evolution of the high input impedance circuit: (B), (C) and (D)


$V_{1}=V_{0}+V_{0} / G$ or $V_{0}=V_{1} /(1+$ $1 / G$ ). If $G$ is large, $V_{0}$ closely approximates $V_{1}$ and the voltage transfer is nearly unity even for relatively large changes of $G$.

The input impedance viewed from the terminals $A$ and $B$ is given by $R_{\mathrm{tn}}=V_{1} /$ Input Current $=V_{1} /\left(V_{0} /\right.$ $G R)=G R(1+1 / G)$. From this it will be noted that when $G$ is large, the effective input impedance is close to the product of the normal amplifier gain and the normal input impedance.

One form of such a circuit is shown in Fig. 3B. This employs two transistors, $Q_{1}$ and $Q_{\text {., }}$, the first with grounded collector and the second with grounded emitter. A disadvantage of this circuit is that neither side of the input is common with
$Q_{1}$ is operated under conditions of low collector voltage and current to minimize $1 / f$ semiconductor noise. In addition r-f alloy-type transistors such as the XA112 give less noise in this circuit than the lowpower audio transistors used for all other stages. Further reduction of noise, particularly at the higher frequencies, is obtained from negative feedback through the relatively high self-capacitance of the crystal microphone.

Because transistor parameters are sensitive to temperature, special circuit techniques are required to achieve the necessary high performance for the sound level meter. After investigation of several circuits, the configuration of Fig. 4A was chosen as the most suitable for


FIG. 4-Simple amplifier configuration with stable gain (A); and meter circuit with close approximation to true rms indication (B)
the power supply. The circuit may be rear ranged ${ }^{3}$ to overcome this difficulty. The first step is shown in Fig. 3C. The collector supply for $Q_{1}$ is derived from the collector voltage of $Q_{s}$ through decoupling components $R_{\mathrm{s}}$ and $C_{\text {. }}$. The a-c conditions of the circuit are unchanged except for slight loading of $R$, by $R_{5}$.

By interchanging the battery and $R_{\mathrm{s}}$, the common terminal $B$ of input and output circuits becomes connected directly to one side of the battery supply. The output signal can then be connected directly to subsequent stages using the same battery supply.

The final circuit arrangement (Fig. 3D) may be regarded as a compound grounded-collector stage with the collector, emitter load and bias resistor of $Q_{1}$ boot-strapped;
the present application. This provides the low input and output impedances required for the current attenuators, weighting networks and filter jacks, together with a stable gain for variations of transistor parameters and thus for temperature and supply voltage variations.

In Fig. 4A, $R_{\mathrm{t}}$ is large compared with the input resistance of $Q_{3}$ in the grounded-base configuration and $R_{4}$ is much smaller than the output resistance of $Q_{3}$. Since the current transfer is close to unity, voltage gain of $Q_{3}$ is close to $R_{m} / R_{11}$. Two grounded collector transistors, $Q_{3}$ and $Q_{s,}$, are used as impedance converters to make the output impedance of the complete stage small compared with the next stage.

A forward-biased silicon diode, $D_{1}$, provides the low impedance sup-
ply of about 0.7 v for the base-emitter circuit of $Q_{s}$ without a separate battery.

For maximum independence of transistor parameters, $R_{a}$ should be large and $R_{s}$ small, whereas for maximum voltage gain the converse is required. With $R_{1}=680$ ohms and $R_{s}=15,000$ ohms, the voltage gain is about 25 db . A gross variation of $\beta Q_{3}$ of 50 -percent results in only about 2 -percent change in gain. Similarly a 50-percent change of $r_{e}$ gives only a 4-percent change of voltage gain.

All the amplifier stages are similar to Fig. 4A except the last ( $A_{4}$ in Fig. 1) where one of the grounded-collector transistors is omitted since the impedance of the meter circuit is relatively large.

The meter rectifier circuit is shown in Fig. 4B. For wideband noise of the type commonly encountered in sound level measurements, an indication proportional to the rms value is desirable. This meter circuit provides a two-segment linear approximation to the squarelaw characteristic necessary for true rms indication. This is because the charge on capacitor $\mathrm{C}_{3}$ offsets the normal linear charaeteristic of an average-law rectifier from the origin.

Power supplies consist of three small self-contained $9-\mathrm{v}$ batteries with a life of about 60 hours. Two in series provide an 18 -v supply for the last two amplifier stages; the third 9-v supply is used for the rest of the circuit.

Sound level range of the equipment is 24 to 140 db with the standardized frequency response of 32 cps to 8 Kc . The main factor determining the effect of temperature on the overall calibration is the crystal microphone, which has a temperature coefficient of 0.1 db per $\operatorname{deg} C$. The gain of the complete circuit is within 0.2 db over the temperature range 0 to 40 deg C and within 0.5 db when the voltage of all three batteries falls from 9 v to an end point of 6 v .

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[^3]
# Graphical Solution For Twin-T Networks 

# Charts normalized for frequency provide a rapid solution to twin-T network parameters. 

Data is plotted for three values of notch
for terminating resistance ratios of $10,000: 1$ to $1: 1$

By DONALD R. BOCAST, Director, Loyola Laboratories, Los Angeles, Calif.

INTEREST in the parallel-T R-C network in recent years has led to a number of papers on application and design. Earlier work was generally restricted to the assumption of zero source resistance and infinite load resistance but recent articles by $J$. Oono ${ }^{1}$ and L. G. Cowles ${ }^{2}$ have removed this restriction. The solution worked out by J. Oono, although straightforward, still involves a sizeable amount of computation for each solution. The graphs presented in this article make it easy to determine network-component values for frequency-rejection filters. These graphs are normalized for termination resistances and frequency. They provide a rapid method of determining the component values of a parallel-T network for a range of terminating resistance ratios from 0.0001 to 1 .

Figure 1 shows the circuit for which the graphs were constructed. The following expressions are those given by J. Oono, with the exception that $r_{1}$ is defined as the smaller terminating resistance and $r_{z}$ as the larger,


F1G. 1-Parallel-T R-C network
instead of as source and load resistance. This definition applies regardless of the direction of signal flow.

The primary defining equations are given in the following text

$$
\begin{align*}
\frac{R_{1}}{R} & =\frac{C}{C_{1}}  \tag{1}\\
R_{1} & =k R, C_{1}=C / k \\
R_{2} & =\frac{R k}{\mu^{2}(1+k)}, C_{2}=\frac{C(1+k)}{\mu^{2} k}  \tag{3}\\
\mu & =2 \pi f_{0} R C  \tag{4}\\
R & =x r_{1}  \tag{6}\\
n & =\frac{r_{1}}{r_{2}}
\end{align*}
$$

The quantities $k, \mu$ and $x$ are intermediate computational values which are functions of $M$ and $n$. Loss at the extreme frequencies away from the notch region is represented by $m$. The rejection frequency is represented by $f_{0}$.

If both sides of Eq. 5 are di-
vided by $r_{\mathrm{n}}$, then a can be defined as

$$
\begin{equation*}
\alpha \equiv \frac{R}{r_{2}}=\frac{x r_{1}}{r_{2}} \tag{7}
\end{equation*}
$$

From Eq. 2 and 3, $a_{1}$ and $a_{2}$ can be defined in the same way as

$$
\begin{gather*}
\alpha_{1} \equiv \frac{R_{1}}{r_{2}}=\frac{k R}{r_{2}}  \tag{8}\\
\alpha_{2} \neq \frac{R_{2}}{r_{2}}=\frac{k}{\mu^{2}(1+k)} \times \frac{R}{r_{2}} \tag{9}
\end{gather*}
$$

These $a$ 's are the normalized resistance values for the network.

Normalized capacitive reactances are used in the graphs instead of capacitance. Inverting Eq. 2 and dividing both side by $2 \pi f$ 。

$$
\begin{equation*}
\frac{1}{2 \pi f_{0} C_{1}}=\frac{1}{2 \pi f_{0} C} \times k \tag{10}
\end{equation*}
$$

or

$$
\begin{equation*}
X_{1}=X k \tag{11}
\end{equation*}
$$

From Eq. 4 it is shown that

$$
\begin{equation*}
X=\frac{R}{\mu} \tag{12}
\end{equation*}
$$

which, after dividing both sides by $r_{\mathrm{E}}$, allows $\beta$ to be defined as

$$
\begin{equation*}
\beta=\frac{X}{r_{2}}=\frac{R}{r_{2}} \tag{13}
\end{equation*}
$$

Following the same procedure,

## ELECTRONICS REFERENCE SHEET



FIG. 8-Normalized values for $R$ and $X$ are plotted as $a$ and $\beta$

the other two normalized reactances can be defined as

$$
\begin{gather*}
\beta_{1} \cong \frac{X_{1}}{r_{2}}=\frac{k x}{r_{2}}  \tag{14}\\
\beta_{2} \equiv \frac{X_{2}}{r_{2}}=\frac{\mu^{2} k}{(1+k)} \times \frac{x}{r_{2}} . \tag{15}
\end{gather*}
$$

The values of $\alpha$ and $\beta$ are plotted versus $n$ in Fig. 2, 3 and 4 for several values of notch width, $\Delta$. All the intermediate computational equations are functions of $M$ and $n$ and since

$$
\begin{equation*}
M=1+n+2 \sqrt{n} \Delta /\left(\Delta^{2}-4\right)^{1 / 2} \tag{16}
\end{equation*}
$$ the final equations can be expressed in terms of $n$ and $\Delta$. Equation 16 is derived to give the minimum insertion loss at extreme frequencies for a prescribed $\Delta$, where $\Delta$ must be greater than 2. Notch width $\Delta$ is defined as

$$
\begin{align*}
\Delta & =\left(f_{2}-f_{1}\right) / f_{0}  \tag{17}\\
f_{1} f_{2} & =f_{0}{ }^{2} \tag{18}
\end{align*}
$$

( $f_{2}$ always greater than $f_{1}$ ) where $f_{1}$ and $f_{z}$ are the frequencies for which

$$
\begin{equation*}
\frac{E_{2}}{E_{\mathrm{i}}}=\frac{1}{M \sqrt{2}} \tag{19}
\end{equation*}
$$

This is equivalent to 3 db (voltage) down from the response at extreme frequencies.

Use of the charts can best be illustrated by an example. A filter is required to work from

|  | $\Delta=2.05$ | $\Delta=3.0$ | $\Delta=10.0$ |
| :---: | :---: | :---: | :---: |
| $\alpha$ | 0.44 | 0.32 | 0.32 |
| $\alpha_{1}$ | 2.49 | 0.53 | 0.33 |
| $\alpha_{2}$ | 0.038 | 0.29 | 3.92 |
| $\beta$ | 0.14 | 0.38 | 1.56 |
| $\beta_{1}$ | 0.78 | 0.61 | 1.62 |
| $\beta_{2}$ | 1.18 | 0.16 | 0.033 |
| R | 440 | 320 | 320 |
| $R_{1}$ | 2,490 | 530 | 330 |
| $R_{2}$ | 38 | 290 | 3,920 |
| X | 140 | 380 | 1,560 |
| $X_{1}$ | 780 | 640 | 1,620 |
| $X_{2}$ | 1,180 | 160 | 33 |
| C | 0.14 | 0.052 | 0.013 |
| $C_{1}$ | 0.026 | 0.031 | 0.012 |
| $C_{2}$ | 0.017 | 0.121 | 0.61 |

(a) $R, R_{1}, R_{2}$ are in ohms, $C, C_{1}, C_{2}$ in $\mu f$

FIG. s-Normalized values for $R_{1}$ and $X_{1}$, plotted as $a_{1}$ and $\beta_{1}$


## Superconductivity in Metals and Alloys

Superconductivity - the absence of electrical resistance at very low temperatures -is one of the most challenging of physical phenomena. Its appeal is almost universal; its application seems almost unlimited.

It has been suggested for use in frictionless bearings, motors, amplifiers, electromagnets, gyroscopes and electron-beam apparatus. IBM is concerned with still another possibility: the application of superconductivity to computer devices.

Scientists at IBM Research have demonstrated, with a thin-film superconducting device capable of switching in a few millimicroseconds, that computers of the future may be limited in their operating speeds only by the speed of light. Whether or not
a metal is a superconductor depends on many things: its structure, its valence, and the presence and position of alien atoms, missing atoms or electrons. The operation of superconducting devices depends upon the fact that a magnetic field will drive a superconductor into the normal (resistive) state.

A superconductor placed in a magnetic field develops a surface current which shields out any external magnetic field to a characteristic penetration depth. Since this penetration depth is comparable to the film thickness used in making superconducting devices, the penetration depth is an important property.

Superconducting alloys, with their in-
herent normal-state resistivity, offer promise for superior devices. Alloying can change the penetration depth, the electron density, and the ease by which a superconductor can be switched from one state to another.

Work is under way to outline the part played by impurities and structural defects in determining superconductivity. This work has already shown that microscopic homogeneity is a prerequisite of well-defined superconductive behavior. From such work may come devices that will make it possible to operate miniature computers at extremely high speeds.

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FIG. 4-Normalized values for $R_{2}$ and $X_{2}$, plotted as $a_{2}$ and $\beta_{2}$


FIG. 5-Response for $r_{1}=100$ ohms, $r_{2}=1,000$ ohms and $f_{0}=8,000$
a 100 -ohm source into a $1,000-$ ohm load with a rejection frequency of $8,000 \mathrm{cps}$. Here $r_{1}=$ $100, r_{2}=1,000$ and $n=r_{1} / r_{z}=$ 0.1.

The normalized values of the components ( $a, a_{1}, a_{3}, \beta, \beta_{1}$, and $\beta_{2}$ ) are obtained from the graphs of Fig. 2, 3, and 4. Values for the example for three different notch widths are given in Table I. To obtain the values of the components in ohms multiply the normalized values by $r_{2}$. Results of this multiplication are also given in Table I, as well as the capacitance as found from a reactance chart. Figure 5 shows the results of the data of Table I. The output voltages have been normalized to one volt generator open circuit terminal voltage. The 3 db points are indicated by their respective $\Delta s$, which show the defined bandwidths of each curve.

The extreme frequency insertion loss is given by the output impedance divided by the sum $r_{1}+R_{1}+R_{2}+r_{2}$; the output impedance being either $r_{1}$ or $r_{2}$, whichever is appropriate. Although the data of Fig. 5 had the generator inserted in the $100-\mathrm{ohm}$ leg, the generator may be inserted in either of the terminating resistances. The shape of the curve is independent of the direction of the signal through the network. The insertion loss, however, is a function of the direction. If the generator in the example had been put in the 1,000 -ohm leg instead of the 100 -ohm leg, the measured data would have had the same shape curves for the different $\Delta$ 's but the output voltages at all frequencies would have been reduced by 90 percent.

The above curves determine component values for input/output ratios from 0.0001 to 0.1 .

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(2) L. G. Cowles, The Parallel-T Resistance Capacitance Network, Proc IRF, 40, p 1712, Dec. 1952.

FIRST SILICON MESA in The To-36 CASE BROADENS E VERAGE THIS ORDINATED ICON LINE

milar to $=D E C$ -3 Case

N 1487
$\checkmark 1488$
$\uparrow 1489$

- 1490


EDEC -8 Case

N1483 N1484 1485

EDEC O-5 Case

- 1479


# RCA Anoounces Four Naw Silicon Mesa Power Transistors in the Popular T0-36 Case 

Available immediately in quantity...four new NPN Diffused-Junction Types... 2N1511, 2 N1512, 2 N1513, 2 N1514 - electrically equivalent to $2 N 1487,1488,1489,1490$ respectively - utilize the industry-preferred JEDEC TO- 36 single ended stud package with cold-weld seal - Designed for a wide variety of military and industrial applications

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Low saturation-resistance characteristics with high collectorcurrent and voltage ratings.
Wider application in military and industrial equipment-in power switching circuits, oscillator, regulator and pulse-amplifier circuits.
- The dependability of the cold-weld seal, proved by RCA through years of experience.
- Coordinated line of 16 RCA Silicon Power Transistors. These four new RCA transistors together with the 12 RCA Silicon Power Transistors shown in the accompanying table provide the designer of Industrial and Military equipment with a comprehensive selection of types to fit his specific needs.

| ELECTRICAL CHARACTERISTICS <br> Minimum and Maximum Values at Case Temperature $=25^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { RCA } \\ & \text { Type } \end{aligned}$ | Min. <br> Veex twolts | $\begin{gathered} \text { Min } \\ v_{c \in 0} \\ \text { volts } \end{gathered}$ | $\left(\begin{array}{c} \text { Max. } \\ I_{6} \\ (\operatorname{crap}) \end{array}\right.$ |  | Max. Saturation Resistance ohms | Mfe | Max. Dissipation Walts |  |
|  |  |  |  |  |  |  | $\begin{aligned} & 25^{\circ} \mathrm{C} \\ & \text { Case } \end{aligned}$ | $\begin{aligned} & 100^{\circ} \mathrm{C} \\ & \text { Case } \end{aligned}$ |
| $\left\lvert\, \begin{aligned} & 2 N 1514 \\ & 2 N 1513 \\ & 2 N 1512 \\ & 2 N 1512 \end{aligned}\right.$ | $\begin{array}{r} 100 \\ 60 \\ 100 \\ 60 \end{array}$ | $\begin{aligned} & \$ 5 \\ & 40 \\ & \$ 5 \\ & 40 \end{aligned}$ | $\begin{aligned} & 6 \\ & 6 \\ & 6 \\ & 6 \end{aligned}$ | $V_{\mathrm{Ce}}=30 \mathrm{v}$ 25 25 25 25 | $\begin{gathered} I_{c}=1.5 \\ 0.67 \mathrm{mp} \\ 0.67 \\ 2.00 \\ 2.00 \end{gathered}$ | $\begin{gathered} \mathrm{I}_{6}=1.5 \mathrm{mp} \\ 25.75 \\ 25.75 \\ 10.50 \\ 10.50 \end{gathered}$ | $\begin{aligned} & 60 \\ & 60 \\ & 60 \\ & 60 \\ & \hline \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \\ & \hline \end{aligned}$ |
| $\begin{aligned} & 2 N 1490 \\ & 2 N 1489 \\ & 2 N 1488 \\ & 2 N 1487 \end{aligned}$ | $\begin{array}{r} 100 \\ 60 \\ 100 \\ 60 \\ \hline \end{array}$ | $\begin{aligned} & \mathbf{5 S} \\ & 40 \\ & \mathbf{5 S} \\ & 40 \end{aligned}$ | $\begin{aligned} & 6 \\ & 6 \\ & 6 \\ & 6 \end{aligned}$ | $V_{\text {ea }}=30 \mathrm{r}$ 25 25 25 25 | $\begin{gathered} l_{e}=1,5 \mathrm{omp} \\ 0.67 \\ 0.67 \\ 2.00 \\ 2.00 \end{gathered}$ | $\begin{gathered} I_{C}=1.5 \mathrm{~mm} \\ 25-75 \\ 25.75 \\ 10.50 \\ 10-50 \end{gathered}$ | $\begin{aligned} & 60 \\ & 60 \\ & 60 \\ & 60 \end{aligned}$ | $\begin{aligned} & 30 \\ & 30 \\ & 30 \\ & 30 \end{aligned}$ |
| $\begin{aligned} & 2 \mathrm{~N} 1486 \\ & 2 \mathrm{Nl} 485 \\ & 2 \mathrm{Nl} 484 \\ & 2 \mathrm{~N} / 483 \end{aligned}$ | $\begin{array}{r} 100 \\ 60 \\ 100 \\ 60 \\ \hline \end{array}$ | $\begin{aligned} & \mathbf{5 5} \\ & 40 \\ & \mathbf{5 5} \\ & 40 \\ & \hline \end{aligned}$ | $\begin{aligned} & 3 \\ & 3 \\ & 3 \\ & 3 \\ & \hline \end{aligned}$ | $V \mathrm{Ca}=30 \mathrm{y}$ 15 15 15 15 | $\begin{gathered} \hline I_{C}=0.75 \mathrm{amo} \\ 1.00 \\ 1.00 \\ 2.67 \\ 2.67 \\ \hline \end{gathered}$ | $\begin{array}{\|c\|} \hline{ }^{1} C=0.75 \\ 35-1000 \\ 35-100 \\ 15.75 \\ 15.75 \\ \hline \end{array}$ | $\begin{aligned} & 15 \\ & 15 \\ & 15 \\ & 15 \end{aligned}$ | $\begin{aligned} & 7.5 \\ & 7.5 \\ & 7.5 \\ & 7.5 \\ & \hline \end{aligned}$ |
| $\begin{aligned} & 2 \mathrm{~N} 1482 \\ & 2 \mathrm{~N} 1481 \\ & 2 \mathrm{~N} 1480 \\ & 2 \mathrm{Nl} 49 \mathrm{a} \end{aligned}$ | $\begin{array}{r} 100 \\ 60 \\ 100 \\ 60 \\ \hline \end{array}$ | $\begin{aligned} & 55 \\ & 40 \\ & 55 \\ & 40 \end{aligned}$ | $\begin{aligned} & 1.5 \\ & 1.5 \\ & 1.5 \\ & 1.5 \\ & \hline \end{aligned}$ | Ves $=30-$ 10 10 10 10 | $\begin{gathered} \mathrm{I}_{\mathrm{C}}=0.2 \mathrm{mp} \\ 7 \\ 7 \\ 7 \\ 7 \end{gathered}$ | $\begin{array}{\|c\|c\|} \hline \mathbf{c}=0.2 \mathrm{amo} \\ 35-100 \\ 35-100 \\ 15-75 \\ 15.75 \end{array}$ | $\begin{aligned} & 4 \\ & 4 \\ & 4 \end{aligned}$ | $\begin{aligned} & 2 \\ & 2 \\ & 2 \\ & 2 \end{aligned}$ |

Call your RCA representative today for complete information. For additional technical data write to RCA Semicondf̈ctor and Materials Division, Commercial Engineering. Section F-19-NN, Somerville, N. J.

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# Frequency Selection for Air-Lane Markers 

national Bureau of Standards, at the request of the Federal Aviation Agency, is studying automatic computation methods for determining the best possible operating frequencies for radio transmitters used as "road markers" on air lanes.

A network of such transmitters marks routes between cities in the United States by sending out signals to assist pilots in flying a straight-line course. The rapid expansion of commercial and military air operations makes it necessary to add a substantial number of new transmitters to this network each year. The locations of these transmitters are determined by technical and economic considerations. However, the choice of carrier frequencies constitutes a difficult combinatorial problem. Efforts to solve this problem are being carried out by L. Joel, G. M. Galler, and A. J. Goldman of the Bureau's Applied Mathematics Division.

The difficulties of frequency selection stem from the fact that transmitters with identical or neighboring carrier frequencies must be spaced widely enough to prevent signal interference. Furthermore, this must be accomplished within the range of 100 discrete frequencies assigned to FAA. However, not only is the "interference radius" of a transmitter large (approximately three times the radius its signal serves) but the number of transmitters in existence is already considerable and is increasing rapidly. For these reasons, assigning a frequency to a new transmitter without introducing any interference requires a laborious examination of many "old" transmitters.

Such an assignment may in fact be impossible without changing the frequency of one or more old transmitters. This in turn may create new interferences in the system and require alteration of the frequencies of still more transmitters. The insertion of a new transmitter into the network has sometimes required frequency changes at as many as 11


Typical station for broadcasting direction and distance information to pilots
old transmitters. Such changes are expensive and disturb the smooth operation of the system, since pilots must be informed of and become accustomed to the alterations. An additional requirement introduced into frequency assignment is therefore the limitation of the number of changes.

As the frequencies and transmitters (old and new) are finite in number, there are only a finite number of ways in which frequencies can be assigned throughout the network. This means that in principle the problem could be solved by examining all such network-wide assignments, rejecting those which lead to interference, and then selecting from the remainder, one which assigns the original frequencies to the largest number of old transmitters. This procedure is impractical because the number of cases to be examined, though finite, is so enormous (exceeding $10^{2000}$ ) that the investigation could not be carried out in a reasonable time even on the most rapid electronic computer. What is needed is a systematic pro-
cedure rather than an exhaustive one.

The Bureau's efforts toward such a procedure can be roughly divided into two categories, which may be called ad hoc methods and model construction. The preliminary direction of the ad hoc activities was suggested by the fact that many new transmitters require changing at most one old transmitter. As a temporary aid to the FAA and an introduction to the general problem, a routine has been written to make such "easy" frequency assignments when possible.

The major activity in the model construction area has been the examination of a formulation which reduces the frequency assignment problem to the maximization of a sum. Computational methods and computer codes, although not immediately applicable in this instance, are available for this general type of problem, and efforts are being made to adapt them for frequency selection.

The computer program developed on an individual or ad hoc basis

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| MODEL | D.C OUTPUT |  |
| :--- | :--- | :--- |
| NUMBER | VOLTS | AMPS |
|  |  |  |
| TO60-15 | 0.60 | 0.15 |
| T036-30 | 0.35 | 0.30 |
| T032-30 | 0.32 | 0.30 |
| T014-30 | 0.14 | 0.30 |
| T07-30 | 0.7 | 0.30 |

Brief Specifications (all models)
REGULATION, LINE OR LOAD: $0.03 \%$ or 0.01 v
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## 50 watts from dc to 500 kc with this

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NEW from Krohn-Hite: this unique combination of high power and bandwidth! The Model DCA-50 offers you the convenience of 50 -watt amplification of all sources from dc to one-half megacycle, without the bother of changing amplifiers or bandswitching!

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depending upon whether the old transmitter $T$ does or does not have the frequency $f$, then the expression $\Sigma X^{\circ}{ }_{r T} X_{r t}$ (where the sum is over old transmitters only) represents the number of old transmitters left unchanged by the variable assignments denoted by the $\boldsymbol{X}_{r r}$ 's. The variables should therefore be chosen to maximize this sum, subject to the constraints described.

The maximization of a linear function subject to linear equation and inequality constraints is the typical problem of a fairly new branch of applied mathematics known as linear programming. Several computational methods and computer codes are already available for the solution of such linear programs. However, these standard codes are not usable for the frequency selection problem because their limitations are greatly exceeded by the numbers of variables (about 250,000 ) and constraint conditions (about $1,200,000$ ) involved. Nevertheless, there is reason to believe that this difficulty can eventually be overcome by exploiting the special nature of the constraints to modify the standard linear programming codes.

## Russian Photoelectric Blood Pressure Meter

JACKETED steel needle, connected at its base to a thin diaphragm, is inserted in a blood vessel for precise measurement of blood pressure, according to Tass. In this Russian device the oscillations of the needle on the diaphragm are translated by a photoconductor into signals which are read out on a meter.

The unit, designed by J. Moskalenko of the Institute for Evolutionary Physiology in Leningrad, uses a flashlight battery for power. The size of a cigarette pack, it weighs 400 grams ( 14 ounces).

The device eliminates the outside influences which affect the taking of blood pressure by external means, according to the report, and can also be used to measure spinal fluid pressure. It is claimed that the unit can be connected to an electrocardiograph, a myograph or an oscillograph, for making a permanent record.


## with this new low-distortion

## ac power source!

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!
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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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# Ceramic Gyro for Space Guidance 

the challenge to create the perfect gyroscope still exists and research and development work in this area is being pushed by many companies. Several months ago, Minneapolis - Honeywell disclosed that it had proven the feasibility of an electrically-suspended gy roscope, an entirely new concept in which the gyro rotor is suspended electrically in a vacuum. And the company has a major program underway to bring this new form of gyroscope into actual production.

Recently Honeywell announced the production of a gas bearing gyro that considerably reduces drift caused by the ball bearings by using a ceramic material, aluminum oxide, in the spin motor and gimbal constructions. In stability tests of the ceramic, Honeywell subjected the material to temperatures ranging from -85 to $1,500 \mathrm{~F}$ and the alumina retained its original dimensions within two millionths of an inch.

Previous gyroscopes have used ball bearings which, Honeywell pointed out are relatively unstable and subject to wear.

The ceramic bearings in the new gyro are lubricated by a film of gas, only 25 millionths of an inch thick. The film of gas, while virtually friction free, is under pressure that is stiffer than the steel ball bearings that it replaces. At the same time vibration, or bearing noise, is decreased by a ratio of 30 to 1 .

Although the principle of the gas bearing is not new, previous models, without ceramics have been severely limited due to the size and bearing wear caused by starting and stopping.

Honeywell's new gyro is only 2.817 inches long and 2 inches in diameter and weighs only half a pound. In tests its super-hard ceramic bearings have undergone many thousands of starts and stops without detectable wear.

In a floated integrating gyro, the input rates are converted by the gyroscopic element into gimbal torques. These torques are time-


The bell-shaped part in the cavity of the gyro is the aluminum oxide spip motor. Its interior spins at 24,000 revolutions per minute suspended in film of helium gas only 25 millionths of an inch thick. Ceramic construction improves unwanted balance torque
integrated into gimbal displacements which may be read off directly by a pickoff.

A practical mechanization of the floated gyro principle results in a gyroscopic element, spinmotor, sealed within a cylindrical gimbal supported by a medium that obtains near friction free support.

Two categories of unwanted torques confront the gyro designer. The first is friction-torque that tends to mask off some lower level gyroscopic torques to limit the angular rate threshold capability of the gyro. Second is an unbalance torque that comes from other than gyroscopic action and is erroneously measured as an angular motion.

Present production floated gyros with gimbal floation suspension greatly reduces friction torque. Flotation of the gimbal weight to better than 99 percent has reduced friction to the order of a million times less than ball bearings. Advanced developments in externally pressurized air suspension. hydrostatic fluid gimbal supports, magnetic suspension or electrostatic suspensions are within reach to im-
prove this area several orders of magnitude further.

It is in the area of unbalanced torque that comes from other than gyroscopic action and is erroneously measured as an angular motion, that the ceramic gas bearing spin motor significantly improves.

Unwanted torques may come from gimbal unbalance, electromagnetic reactions of pickoffs and torque generators, elastic restraint of the flex leads supplying power for the spin motor, or from the complex responses of the gyro under vibration inputs.

The ceramic gas bearing gyro has proved to be the solution to torques resulting from movement of the ball retainers and shifts of the balls in the raceway, mechanical hysteresis effects due to material damping and ball slippage, and stress and strain of the balls under angular motions of the gyro which cause deformations that change the balance of the gyro.

In the new gyro, the troublesome balls and retainers are eliminated, viscous damping is substituted for hysteresis damping, and deforma-


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Today, Hydro-Aire offers you special skills in the development of solid state components to help you solve your systems problems. The Hydro-Aire Electronics Division has been created, staffed and tooled to provide flexibility in design, on-time delivery and reliable performance. These capabilities are now producing precise answers for project engineers at Martin, Boeing, Space Technology Laboratories, General Electric, Litton Industries, Magnavox, Autonetics, and many others.
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Qualified Electronics Engineers are invited to investigate opportunities at Hydro-Aire by contacting Mr. Harold Giesecke.



Stepping devices from A. W. Haydon Co. can do wonderful things to pulses ... with pulses... and for pulses. For instance, one precision gated stepping switch acts as a pulse divider for a random or variable pulse source-or as a frequency divider if the pulse source is constant. Another works in conjunction with pulses, supplying single or multiple switch closures with an accuracy virtually equal to that of the pulse source itself. Still a third will count a predetermined number of pulses, rotate a stepper switch, return the counter to 000, and cut off the pulse source. ■ The remote positioning device illustrated is but one of A. W. Haydon Company's fancy steppers. Here a precision gated stepper switch has been coupled to a synchro transformer. Similarly, precise angular positioning of rotary components such as potentiometers, dials and indicators can be controlled. Based only on the number of pulses received (not incremental changes in voltage or phase angle), it will hold a set position whether power is on or off, and will home the synchro to the zero reference on demand-ready to accept another setting. All A. W. Haydon Co. stepper motors are all-electric-no ratchets, linkage, contacts or other mechanical crutches are used. Their power consumption is low, accuracy is extremely high. a Send for technical brochure SP9.1 and find out more about pulse driven steppers and their application.

tions due to thermal expansion disappear.

New ceramics, with their high modulus of elasticity, exhibit very good thermal stability and low longterm creep.

Contamination has always been critical in the manufacture of floated gyros. With extremely small clearances in the gas bearing spin motor, one-micron dust particles cannot be tolerated. Ceramic parts can be cleaned with acid which dissolves everything but the ceramic allowing improved cleaning and assembly techniques.

## Reports on Thin-Films

A-SERIES OF papers on thin-films, reflecting work in this area conducted by $I B M$, have been gathered together in a special issue of the IBM Journal of Research and Development, Apr. 1960.

Many of these papers are concerned with problems of film fabrication and structural effects. These papers cover ultra-high deposition rates for producing pure films, agglomeration in superconducting films, epitaxially grown films and the determination of crystallite size by x-ray diffraction.

Other papers in the issue deal with attenuation of magnetic fields by superconducting films, magnetic domain wall structures, the effect of film edges on device characteristics, and a theoretical calculation of anisotropic surface scattering of conduction electrons.

## New Cooling Techniques

Well-established refrigeration techniques, as well as experimental ones will be investigated at Battelle Memorial Institute, Columbus, Ohio under a broad-range program that will cover Peltier cooling units, high-speed centrifugal compressors, and the Stirling and azeotropic cycles.

The one-year study, authorized by the Air Research and Development Command's Rome Air Development Center has been launched with an extensive literature and patent search.

The Battelle staff will, where pos-
sible, enlist the aid of industrial organizations and other groups working on advanced cooling techniques.

## Cathode Bowing

a new cathode base metal for electron tubes composed of a clad sandwich of two metals, one on the surface having the desired thermionic properties and the other a core metal of high hot strength, has been found to greatly improve microphonics and resistance to cathode bowing under severe shock.
This metal consists of the type 499 nickel cathode alloy clad on both sides of a core of INCONEL in the percentages of 20-60-20.
W. T. Millis, of General Electric's Receiving Tube Dept., Owensboro, Kentucky, pointed out that this composite form of base metal has made it possible to improve one of the serious problems of the hot cathode in receiving tubes, namely that of cathode bowing. It has also made it possible to produce a combination with hot strength and the desired thermionic properties acting independently. Other desirable properties, those of low thermal conduction and reduced expansion, are attainable.

## Teflon-Glass Laminate

a laminate that combines the chemical and electrical properties of TEFLON and the physical and mechanical properties of glass cloth, is available from Mica Insulator, Div. of Minnesota Mining \& Mfg. Co., Schenectady, N. Y.

The new high-temperature laminate is manufactured from teflon resin and a fine weave, 0.002 glass fabric.

In addition, techniques and adhesives have been perfected that make it possible to bond one- or two-ounce copper foil to one or both sides of this laminate. These laminates, called CuClad Lamicoid No. 6098, are ideal for high-temperature ( 200 C ) printed circuits and also microwave applications.

The copper surface is extremely smooth and free from imperfections, and arc-overs.

## 0 Bendix Craftsmanship at work for you

## IMPROVED SUBMINIATURE XENON TETRODE THYRATRON

APPLICATIONS: Counters, grid control rectifiers, gyro erection systems, missile systems, automatic flight control systems, and other control circuits requiring utmost degree of reliability.
ADVANTAGES: Freedom from early failure . . . long service life . . . uniform operating characteristics... ability to withstand severe shock and vibration.
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The TD-17 is but one of many electron tubes designed and built by Bendix Red Bank for special-purpose applications. For full information on the TD-17, or on other tubes for other uses, write ELECTRON TUBE PRODUCTS, RED bank division, the bendix corporation, eatonTOWN, NEW JERSEY.


MECHANICAL DATA
Base... Button: Subminiature 8-pin long or short leads Envelope .............................. T 3 (8-1)
Bulb Length (Mox.) ........ . . . . . . . . . . 1.375 .
Diameter (Max.) .............................. 0.400 in.
Mounting Position, . . . . . . . . . . . . . . . . . . . . Any
Altitude Roting (Max.) . . . . . . . . . . . . . . . $80,000 \mathrm{ff}$.
Bulb Temperature (Max.). . . . . . . . . . . . . . . $125^{\circ} \mathrm{C}$.
Ambient Temperature (Min.)............... . $-55^{\circ} \mathrm{C}$.
Cathode. . . . . . . . . . . . . . . . . . Coated Unipotential

## ELECTRICAL RATINGS

| Heater Voltage | 6.3 Volts |
| :---: | :---: |
| Heater Current | 0.15 Amperes |
| Peak Plate lnverse Voltage | 500 Voits |
| Peak Forward Plate Voltage | 500 Volts |
| Maximum Negative Grid 1 Voltage. | -200 Voits |
| Maximum Negative Grid 2 Voltage . | - 100 Volts |
| Maximum Average Cothode Current. | 16 madc |
| Maximum Peak Cathode Current | 100 mA |
| Heoter-Cathode Voltage: Moximum | +25 Vde |
|  | $-100 \mathrm{Vds}$ |

ELECTRON TUBE PRODUCTS

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# P-C Masters Drafted on Film with Light 

PRINTED CIRCUIT master negatives or positives are prepared directly on film without drafting or camera work, by a 1:1 process recently developed by MacNutt Electronic Design Co., a subsidiary of MacNutt Electric Co., New York, N. Y. Masters can be prepared from accurate layouts or breadboard sketches.

A Mylar-based film called KalMac, made for the process by Kalvar Corp., New Orleans, La., is used. It is sensitive to ultraviolet light of about 4,000 Angstrom units and can be exposed to normal light for 4 to 5 hours before development. Once exposed it is developed by heat and is then stabilized by subjecting it to normal light for a few minutes. The film is reported to have a resolution of 500 lines per millimeter under controlled conditions.

Positives of circuits can be prepared in entirety on a single piece of film. However, the preferred method is to prepare positives of pad areas, finger connectors and conductor lines and overlay these to prepare a composite negative. The


FIG. 1-Cross section of image master which exposes pads
circular revolving pallet


FIG. 2-Pallet is disk of clear plastic revolving over grid


FIG. s-Film is developed by heated roller


Setting $X$ and $Y$ coordinates (tabulated in advance) with vernier dials


Inserting image master. Ultraviolet light source is in housing at right
pad positive serves as a working guide. The composite method also permits such standard features as connector patterns and title blocks to be prepared in advance as negatives or tracings.

Patterns are built up by beaming light from a focusing type of ultraviolet lamp (Sylvania type DFA, 150-watt) through image masters. Fig. 1 shows construction of a pad image master. Other image masters are used for line segments, groups of pads, characters, and so on. The image masters are carried in a holder which is positioned over the film by a coordinate type of plotting table. MacNutt uses a Haag-Streit Coordinatograph (Aero Service Corp., Philadelphia, Pa.), which gives an accuracy of 0.001 on nor-
mal-sized masters. The table's accuracy is 0.0015 inch in 4 feet of length and the image masters are accurate to a few ten-thousandths of an inch. The Coordinatograph's standard prick punch is replaced by the image master holder. Both holder and image masters have mating reference flats which align with the X or Y axis.

## Pattern Layout

The operator places a sheet of film on a revolving pallet (Fig. 2) and takes any designated standard location as the 0-0 point. Crosshairs are exposed here and at an oldnumbered standard coordinate.

All pad locations are exposed on the first film. Coordinates for the pad centers are figured in advance from a layout or other instructions. Or, the operator can place a $1: 1$ sketch under the film, correcting for standard pad spacing as he goes.

The pad image master is stainless steel, containing a glass lens (Fig. 1). The pad hole is represented by a hole, ultrasonicallydrilled and fitted with a pin. The pin contacts the film to ensure exact proximity of the lens. The light source is housed in a casting which swings over the image master. The light is cycled by a foot-pedal-oper-


## NEW WESTON PANEL METERS PROVIDE THREE IMPORTANT DESIGN ADVANTAGES...

## - Exclusive magnetic shielding

- Sustained accuracy - up to $\pm 0.5 \%$


## - Ranges tailored for special applications

Long-term accuracy and reliability are special features of Weston's new line of panel instruments. Accuracy -in Model 1761 -is up to $\pm 0.5 \%$ of full scale deflection when supplied with knife edge pointer and mirror scale.
Exclusive CORMAG ${ }^{\bar{ब}}$ self-shielded mechanisms are used in both Models 1751 and 1761. The meters may be mounted on magnetic or non-magnetic panels without special adjustments . . . are immune to the effects of stray fields and nearby instruments. Housed in dust and moistureresistant Bakelite cases with glass windows, they are supplied in a wide variety of standard ranges.
Special range meters with conventional magnetic construction are available where higher current sensitivity, lower resistance, special ballistic characteristics and controlled scale distribution are required.

Call your Weston representative for details, or write for Catalogs 01-109 and 01-110-which contain technical information on this new line of precision panel meters. Weston Instruments Division, Daystrom, Inc., Newark 12, New Jersey. International Sales Division, 100 Empire Street, Newark 12, New Jersey.
In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ontario.


Standard instruments: Black Lance pointer, easy ta read black markings on while dial, $100^{\circ}$ are. Model 1751-Size: Rectangular-4.66" $\times 4.20^{\prime \prime}$; $4^{\prime \prime}$ long scale. Accuracy: $\pm 2 \%$ full deflection as DC instrument. Model 1761-Size: Rectangular $-5.75^{\prime \prime} \times 4.62^{\prime \prime} ; 4.5^{\prime \prime}$ lang scole. Both models ovailable as: DC ammeters, milliammetors, microammeters, voltmeters ( $1000 \Omega /$ volt).

## FIRST TMONGS FIRST!

FOR IMPROVED THERMAL DESIGN, there is no substitute for effectively cooling, extending useful life and increasing tube reliability than with IERC Heat-dissipating Electron Tube Shields.

The right time to "plan in" IERC's Heat-dissipating Electron Tube Shield components in your thermal design and packaging is at the start-however, it's never too late to improve reliability, insure proper tube cooling and protection from shock and vibration with widely-used, MIL-approved IERC shields.


New 1960 Subminiature Tube Shield Catalog gives you a complete shouing of IERC's diversified line, thermal design and application tips, dimensional and specification data - available on request.


INTERNATIONAL ELECTRONIC RESEARCH CORPORATION 135 West Magnolia Boulevard, Burbank, California
ated timer. A snap action switch in the lamp housing prevents inadvertent exposure when the lamp is not in exposure position. A spring, working against cams on the housing post, assures positive positioning of the lamp.

Pads for both sides of a doublesided board can be exposed on the same film. The same positive can then be used in preparing the 2 pairs of conductor and connector overlays and the final negative, assuring registration of both sides of the board.


Light source is locked into alignment with image master


After all pads are exposed, the sheet is still clear. It is developed by passing it against a roller heated to 250 F . The film is transported by a flexible belt to prevent strain and distortion (Fig. 3). Until the film is stabilized (exposure to normal light for 10 minutes or fluorescent light at a distance of 5 inches for 3 minutes) it can be reexposed and redeveloped, permiting last-minute checking and additions.

A similar procedure is used to make the conductor positive. The pad positive and the grid lines below the revolving pallet are used to align the slotted image masters. Finger connector patterns can be prepared in advance and used as guides. or can be exposed on a fresh sheet of film. Title blocks and characters can be exposed on a


Examining pad locations on developed film


Image masters for crosshairs, pad and conductor
separate sheet, added to any positive, or added as a tracing in the composite. Crosshairs are placed at the standard position on each sheet to facilitate alignment of the composite.

All the positives are then aligned over a fresh sheet of film and taped in position. The composite is exposed by a mercury vapor lamp, on a light table, or by any other source with sufficient ultraviolet light. The composite is a negative which can be reproduced by any standard type of reproduction. Proofs of the masters can be prepared by exposing photographers' proof paper through the composite.

The Coordinatograph's standard instruments can be used to check the accuracy of any of the positives or the negative. If alterations in the master are desired at any time, they can be made by preparing a fresh positive of only the area to be changed. The unwanted area of a master positive or the overlay positive is eradicated (chemically, by scraping away the surface or by cutting out the unwanted area with a razor blade). The reworked overlays are aligned and used to expose a new master negative.

Several additional techniques are under evaluation. One would use a pantograph to reduce $3: 1$ and $4: 1$ layouts to $1: 1$ positives. The pantograph stylus would be guided by indentations (for pads), V-groove grids (for lines), French curves and characters scribed in clear plastic plates placed on top of the original layout.

For reliable switching of low-level as well as power loads. Style 6Á will operate at coil power levels below most larger current-sensitive relays in its general class, yet easily switches load currents of 2 amps resistive and higher at 26.5 VDC or 115 VAC. Contact arrangement to DPDT. Unique construction permits flexible wiring and a variety of schematics. Withstands 50 G shock and 20 G vibration to 2000 cycles.

Meets applicable portions of specifications MIL-R-5757C and MIL-R-25018 (USAF) Class B, Type II, Grade 3 .

Call Or Write For Additional Information

## PRICE ELECTRIC

 CORPORATION
## New On The Market



## Microwave Triodes

METAL-CERAMIC

TWo miniature microwave triodes, the GL-7391 and the GL-7644, have been developed by General Electric's Power Tube Department, Schenectady, New York.
Both tubes are of rugged metalceramic construction, with the metal gold-flashed to minimize r-f losses. Both have identical outer dimensions (one inch long), and both weigh one-sixth ounce.

Type GL-7391, for Class C service, can be applied in microwave communications, beacons, radar and navigation equipment, especially where there are limitations on size, weight and power supply. In such applications, the tube can be used as a local oscillator, i-f amplifier, power amplifier, as a pump for parametric amplifier and for a number of other Class C purposes. In typical performance as an oscillator, operation at $5,400 \mathrm{Mc}$, the GL-7391 produces 65 milliwatts of power. Greater power levels are possible at lower frequencies. Onehalf watt c-w oscillator power is expected at 500 Mc . The GL-7391, which can withstand severe en-

## Silver-Zine Battery WITHSTANDS SHOCK

A SILVER-ZINC battery with high environmental resistance has been announced by Cook Batteries, a subsidiary of Telecomputing Corp., 3850 Olive St., Denver 7, Colorado. Chief application of the battery is in missile auxiliary power units.

The activation system of the model P81A battery employs gas
vironmental conditions is available in production quantities at an original equipment manufacturer price of $\$ 55$.

The GL-7644 radar tube features high gain, broad bandwidth and low noise in addition to physical and electrical ruggedness. It can withstand random spike voltages and excessive r-f exposure and has been tested at maximum spike pulses equivalent to a positive seven-volt video pulse applied for 15 microseconds at a repetition rate of 70 pulses per second.

Higher peak voltages and peak powers can be tolerated for shorter pulse widths.

Operation in a bandwidth of 7.5 Mc, the GL-7644 has a gain of 18.5 db and a noise figure of 4.3 db under matched conditions at 450 Mc. Mechanically and electrically. the GL-7644 is interchangeable with the GL-6299 and carries a 1,000-hour operational warranty. Original equipment manufacturer price is $\$ 49.50$, available in production quantities.

CIRCLE 301 ON READER SERVICE CARD
generated by a solid propellant with a controlled burning time. A gas pressure operated piston forces the electrolyte through a rupture diaphragm into the cells, producing full current within one second.

The battery provides an average current of 80 amp at 28 volts, with a maximum current of 250 amp . Discharge time is 3 minutes at 80 amperes. Voltage regulation is controlled to within 5 percent of the
battery's nominal output.
The entire activator and cell system is hermetically sealed against leakage and contamination. Activating signal is a 28 -volt signal at 2 amp. The unit will activate and operate in any position.

The battery will withstand 30 g vibration, 10 g acceleration and 50 g shock along all three major axes. Temperature resistance is from 60 $\operatorname{deg} \mathrm{F}$ to 100 deg F ambient; special models have ratings from -65 deg $F$ to +165 deg $F$.

CIRCLE 302 ON READER SERVICE CARD

## Stacked Resistors

HAVE BUSHING TERMINALS
SERIES 400 R-stack resistors featuring screw-mounted, bushing-terminated resistance elements have been announced by Consolidated Resistance Co. of America, Inc., 44 Prospect Street, Yonkers, New York. Typical applications include: multisection voltage dividers; adjustable resistances with ohmic readout; resistance standards; trimmer resistances; and miniature resistance decades.


Tap-off lug terminals are available and may be inserted as required between respective R -stock bushings. In final assembly R-stacks may be also soldered together if permanent connection is preferred. R-stacks are available in decimal kit values (stack-kits) and/or to specification.

General specifications are as $\mathrm{f} \$ 1$ llows: the resistors are noninductively wire wound (also carbon \& metal film), they have a tolerance of 1 percent through 0.005 percent absolute, their stability is 0.001 pdr cent, and they have a temperature coefficient of $5 \mathrm{ppm} / \mathrm{deg} \mathrm{C}$. Hermetically sealed in epoxy resin, the

## form

 the Miniature Trimmer America Knows Best!

Whether your circuit requirements call for performance in or out of this world, you can rely on JFD miniature trimmers. Tens of thousands in daily use under severe operating conditions on land, under sea and in space best tell their story of outstanding reliability.
The reasons why JFD precision piston trimmers are preferred make sense. They deliver maximum capacitance range in a minimum size...offer exceptional stability... High Q.... - even under conditions of severe shock, vibration and acceleration. The adjusting shaft of the miniature capacitors is self-contained within the capacitor permitting tuning without changing the size of the unit. In short, the design meets the most demanding requirements of the missile age electronics.
The popular model VC20G above is only one of the complete family of JFD miniature and subminiature trimmers. More than 200 models are available from stock. JFD also manufactures trimmers in cuantities to meet special needs - plus a wide variety of fixed metalized inductors, LC tuners, fixed and variable, distributed and lumped constant delay lines, pulse forming networks and diplexers.

## features

1. Compactness - (More capacitance per cubic inch).
2. Tuning sensitivity -(multi-turn adjustment).
3. Tuning linearity - (no reversals).
4. Stability-(Glass and invar $\pm 100 \mathrm{PPM} /{ }^{\circ} \mathrm{C}$ ), (Quartz and invar construction has zero temperature coefficient).
5. Anti-backlash design - smooth uniform tuning adjustment.
6. Low loss and low inductance for high frequency use.
7. No de-rating up to $125^{\circ} \mathrm{C}$ for glass dielectric $\left(150^{\circ} \mathrm{C}\right.$ for (quartz).
8. Shock and vibration resistant.
9. Special alloy plating gives 50 hour salt spray resistance.
10. Gold plating over special alloy for R.F. conductivity and freedom from silver migration.
11. High Q.-low dissipation factor.
12. Positive mechanical stops at both ends of adjustment.
13. Available in either glass or quartz dieleetric.
14. Sealed interior construction locks out all atmospheric effects in Sealcap series.

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15 JFD International
15 Moore Street. New York. N. Y.
resistors come in one-half and onewatt sizes, and satisfy MIL Specs MIL-R93B and MIL-R944.

The resistors are made to order with regular delivery in 4 weeks.

Special delivery service of 48 hours or one week on request. Price is approximately $\$ 2.50$ each in 0.05 percent tolerance and lots of 100 .

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## Wire Connector

SELF-STRIPPING

DEVELOPMENT of a self-stripping communication wire connector, for the telephone, communications and signaling industries, has been announced by Minnesota Mining and Manufacturing Co., 900 Bush Ave., St. Paul, Minnesota.

The Scotchlok brand electrical connector, type UR, splices, insulates and moisture-seals in two steps, saving up to one-half the time required for conventional twist and sleeve splices.

The connector accommodates any 2 or 3 wire combination of No. 19 to No. 26 Awg solid or No. 20 to No. 26 Awg stranded wire, and handles all common types of insulation, including plastic, rubber, enamel and Teflon. The resulting splice has an average pullout resistance equal to about 95 percent of
wire breaking strength.
In use, wires are inserted into the connector and secured by squeezing a button into the connector sleeve. As the button is depressed, the connector element strips the insulation and grips the conductors, providing a strong mechanical, electrical joint. A thermoplastic sleeve insulates and protects the splice, and silicone grease moisture-seals the joint.

Visual inspection of the connection through the transparent sleeve, and the flush position of the red button when fully depressed, insure complete splices. Splices made with the connector on cable up to 400-pair in size will fit into splice cases and enclosures currently in use.

CIRCLE 304 ON READER SERVICE CARD


Flight Recorder MONITORS 65 VARIABLES

ENGINEERING model of a magnetictape flight-performance recorder with flexible playback capability for
use in airline operations and maintenance programs has been demonstrated by Minneapolis-Honeywell

Regulator Company, Minneapolis, Minnesota. The device monitors as many as 65 different variables. Playback can be accomplished through the use of an aircraft instrument type display, a Visicorder, digital counter and printer, or large-scale digital computer.

The flight recorder meets the standard established by FAA requirements for incident analysis. Also, it will record up to 60 data inputs more than the FAA requirements at a sampling rate of one a minute. It has an audio channel that makes it possible for pilot inflight observations and comments to be recorded along with the performance data.

The flight recorder consists of three major components. The electronic circuits, heading repeater, time clock, and pressure-sensitive transducers are in a $\frac{1}{2}$ ATR chassis. The recording tape deck and its shock and temperature-protective materials are housed in a full-ATRsize chassis. The vertical accelerometer is mounted on a bracket for installation in a center-of-gravity location relative to the airframe.

The recorder monitors altitude, air speed, heading, vertical acceleration and time once each second. The additional 60 conditions that can be monitored once a minute are selected by the user.

A standard instrument for data reproduction has also been developed for processing and display of recorded information on the ground. This instrument contains pushbutton data channel selection and the basic playback channel electronics.

The flexible playback capability makes the flight recorder practical for both large and small airlines The new flight recorder will sell for less than $\$ 10,000$, and will be avail able initially to airlines in Decem ber.

CIRCLE 305 ON READER SERVICE CARD

## 3-Axis Accelerometer POTENTIOMETER OUTPUT

SMALL 3-axis accelerometer with pq tentiometer output is being produced for missile applications by Humphrey, Inc., 2805 Canon St., San Diego, Calif. This single accelerometer provides information on linear acceleration along three


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different axes. Total weight of the unit is about one-half pound; it is approximately $2 \frac{1}{2}$ inches in diameter and 2 inches long.

The company also manufactures a 2 -axis linear accelerometer. Total weight of this unit is four-tenths of a pound; it is about 21 inches in diameter and $1 \frac{1}{2}$ inches in length.

Both accelerometers can be furnished in hermetically sealed cases. They will withstand minus 65 deg F to 180 deg F while operating, relative humidity 100 percent, unlimited altitude, shock of 75 g for 6 milliseconds on any axis and acceleration of 75 g on any axis.

CIRCLE 306 ON READER SERVICE CARD


## Silicon Mesa Switch

HIGH-SPEED GUARANTEED
an ULTRA-HIGH speed guaranteed silicon mesa switcher, the 2N706A, is now commercially available from Texas Instruments Incorporated, Semiconductor - Components Div., P. O. Box 312, Dallas, Texas. Specific uses for the switch include such circuits as computer logic, flip-flops, binary counters, trigger generators and electronic switches.

The 2N706A is an improved version of the 2 N 706 . It is an $n p n$ silicon mesa switch designed for saturated circuits. Along with the 2N706A, the company has announced the 2 N 753 which is a highgain version of the same transistor.

The 2N706A guaranteed features include: $d-c$ beta ranges of 20 to 60 ; lower $T_{s}$ (charge storage time constant) of 25 nanoseconds maximum; output capacitance from 6 pf to 5 pf ; turn-on time ( $T_{o n}$ ) of 40 nanoseconds maximum; turn-off time ( $T_{\text {off }}$ ) of 75 nanoseconds maximum; minimum $B V_{\text {CRB }}$ of 15 volts at a sustaining current of 10 ma ; and maximum $I_{C B R}\left(R_{B E}=100 \mathrm{~K}\right)$ of $10 \mu \mathrm{~A}$ at 20 volts $V_{C E}$ (which gives a practical switch off test).

The 2 N 706 A is available in quan-


## TWO NEW CBS FRAME-GRID WIDEBAND PENTODES

Exclusive new CBS E280F/7722 and 7721 sharp-cutoff, 9 -pin miniature pentodes offer you the highest ratings ever for gainbandwidth product. The premium quality tubes make possible new high levels of performance in i-f and video stages of industrial and instrumentation equipment. You benefit from fewer stages, fewer tubes, fewer passive components, and fewer interconnections . . . due to the many advantages of true frame-grid construction.

Order from your local sales office or Manufacturers Warehousing Distributor. Get technical bulletins T-1006 and T-1007. Ask about other CBS frame-grid types. Watch for many new announcements on the rapidly expanding CBS industrial tube line.

ELECTRICAL CHARACTERISTICS

|  | $\begin{gathered} \text { E280F/ } \\ 7722 \end{gathered}$ | 7721 |
| :---: | :---: | :---: |
| Plate supply voltage | 190 | 190 volts |
| Grid supply voltage | +8 | + 10 volts |
| Cathode bias resistor | 370 | 400 ohms |
| Plate current | 20 | 22 ma |
| Screen-grid current | 6 | 6 ma |
| Transconductance | 26,000 | 35,000 $\mu$ mhos |
| $\mathrm{C}_{\mathrm{g}-\mathrm{p}}$ | . 035 | . $035 \mu \mathrm{mi}$ |
| $\mathrm{Cin}^{\text {a }}$ | 9.3 | 10 н 1 |
| Cout | 2.1 | $2 \mu \mu \mathrm{f}$ |
| Gain-bandwidth product | 362 | 465 |
| Input resistance, 100 mc | 1400 | 1000 ohms |

## OTHER NEW CBS INDUSTRIAL

TUBES... NOW AVAILABLEI

## ECC88/6DJ8

E88CC/6922
PCC88 7018
EF86 '6267
E182CC 7119
E182CC, 711
E83F, 6689
E81L/6686
E235L
E84L
High-gain, low-noise, Irame-grid twin triode Reliable version of ECC88/6DJ8
7 -volt version of ECC88/60J8
Low-noise audio preamplifier pentode
Reliable high-perveance computer twin triode
Reliable, 10,000 -hour wide-band pentode
Reliable, 10,000 -hour wide-band output pentode Reliable, 10,000 -hour switching power pentode Reliable version of EL84 (6BQ5) audio power pentode Reliable, 10,000 -hour industrial power pentode

Write for Chart E-378 on CBS Industrial Tubes.


## CBS ELECTRONICS <br> Danvers, Massachusetts

A Division of Columbia Broadcasting System, Inc.
Sales Offices: Danvers, Mass., 100 Endicott St., SPring 4-2360 - Newark, N. J., 231 Johnson A ve., TAlbot 4-2450. Melrose Park, Ill., 1990 N. Mannheim Rd., LStebrook 9-2100. Los Angeles, Calif., 2120 N. 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.

## THERMISTORS



## Now-Kidde experience sets the standard for quality and performance!

Kidde experience. For more than ten years, Kidde has manufactured thermistors for use in sensitive aircraft fire detectors. Now, by using the experience gained in this demanding field, Kidde makes available a complete selection of thermistor components for general use.
Kidde performance. First developed to meet the rigid specifications of the military, Kidde thermistors have been proven in performance. In temperature control, compensation, time delay or voltage regulation, you can be sure of the stabilized characteristics and high temperature capabilities of Kidde thermistors.
Kidde quality. By utilizing unique automated manufacturing techniques in the production of thermistors, Kidde can now offer the utmost in thermistor uniformity and quality at the lowest possible price. And, in addition to a wide off-the-shelf selection, Kidde also offers engineering help in the application of thermistors toward the solution of special problems. For more details on Kidde thermistors, and their application to special problems, write today.


ELECTRONICS DEPARTMENT
Kidde Aero-Space Division
Walter Kidde \& Company, Inc., 650 Brighton Road, Clifton, N.J. CIRCLE 40 ON READER SERVICE CARD

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tities up to 999 from TI distributors and large production quantities through TF sales offices.

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## Integrating Tachometer <br> FEATURES HIGH OUTPUT

A MINIATURE motor-integrating tachometer providing high output and torque-to-inertia ratio has been developed by Eclipse-Pioneer Division of The Bendix Corp., Teterboro, N. J. The unit is for use in electrical analog computers and velocity regulation systems, where instant response and accurate linear proportionality of voltage to angular velocity are demanded over a wide temperature range.

The size 10 unit, 0.937 inch in diameter, features a scale factor up to 2.5 volts per $1,000 \mathrm{rpm}$, with a linearity from 0 to $3,600 \mathrm{rpm}$ of plus or minus 0.12 percent. It has a rotor moment of inertia of 3 $\mathrm{gm}-\mathrm{cm}^{2}$ and an acceleration at stall of $9,500 \mathrm{rad}$ per $\mathrm{sec}^{2}$. It operates over a temperature range of minus 55 deg C to plus 125 deg C .

The tachometer is available separately or with any of a wide range of gearheads for speed reduction and torque amplification.

CIRCLE 308 ON READER SERVICE CARD


## Timing Device

## PRESET CYCLE

industrial electronics, inc., 4730 Earlham Dr., Indianapolis 27, Ind. New preset cycle timer is designed for use in triggering or cycle operation of external equipment. The cycle interval can be preset for any period from 15 minutes up to 2 hr and 15 minutes, in increments of 15 minutes. At the completion of each interval a set of contacts (spdt) operate and remain actuated for up to 15 sec depending upon

## another firstl

MOLCOTE metallized ceramic coating
for
use with
all types
of hard solders!


Here's a firmly bonded metal-to-ceramic coated surface to which a metal or metallized ceramic may be hard soldered up to $2200^{\circ} \mathrm{F}$ ! Its versatility permits use in a wide latitude of high temperature assembly manipulation, and its extreme refractory qualities defy the attack of solders of the copper-silver, silver, and pure copper types. No expensive preliminary processing is required. Molcote's solder bonds are exceptionally strong to the point of fracture! Like to know more? Bulletin 1155 contains all the facts. Write for a copy!


## frenchtown

 PORCELAINCOMPANY Frenchtown, New Jersey
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What useable discoveries are being made on the frontiers of electronic knowledge? Here are a few selected at random: directive long-range sonar transducer . . . high-speed ferrite memory and logic element . . . space-probe telemetry system ... master preamplifier for X-band radar. You can never tell when one is going your way. This is just ONE of the reasons why you should subscribe to electronics (or renew your subscription). Fill in box on Reader Service Card. free.

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electronics


> -Arnold transistorized, regulated power inverter drives A.C. gyros and motors from a battery line, with high efficiency

These units have all the advantages of square-wave output inverters-and none of the drawbacks. The sinusoidal output creates no excess heat. There is no loss of efficiency because the transistors are operated as saturated switching elements. Hence unit will handle up to 40 volt-amps without addled transistor heating. Battery drain is minimized.
ANTI-HUNTING EFFECT. A unique circuit eliminates the tendency of A.C. gyro spin motors to hunt when near synchronous speed.
REGULATION. Unit incorporates shortcircuit and overvoltage (spike) protection. It is fully encapsulated and hermetically sealed. Available with $\mathrm{A} / \mathrm{N}$ connectors, wire-lead pigtail, and solder-lead terminals as standard.

| Input Voltage: | 24,26 or 28 VDC |
| :---: | :---: |
| Output Voltage: | 115 VAC • Other voltages available |
| Output Frequency: | 400 cps . other frequencies available. |
| Output Power: | 40 volt-amps |
| Temperature Range: | $-55^{\circ} \mathrm{C}$ to $+71^{\circ} \mathrm{C}$ |
| Size: | $21 / 2^{\prime \prime} \times 4^{\prime \prime} \times 21 / 2^{\prime \prime}$ high |
| Weight: | 32 0z. complete |
| Environment: | Designed to meet MIL-E-5272B. |
| Write for complete data on |  |
|  | Model 591-J |



## ARNOLD MAGNETICS CORPORATION

 6050 W. Jefferson Blvd. Los Angeles 16, Calif. VErmont 7.5313the setting of an OnTime control. At the same time other contacts (dpdt) change position and remain changed until the next interval is completed. Unit will recycle at the predetermined rate continuously.

CIRCLE 320 ON READER SERVICE CARD


## Video Amplifiers <br> MODULAR TYPE

the daven co., Livingston, N. J., anounces the VA series plug-in and rack-mounted modular amplifiers for color and black-and-white video distribution. Two typical examples of the units: Type VA-P-101 video distribution amplifier was developed for systems requiring a simple one input, one output unity-gain unit. Eight of these amplifiers plug into a shelf $8^{3} \mathrm{in}$. high which mounts in a standard relay rack. The VA-P-102 sync adding amplifier simply plugs into one of the positions, when sync adding is required, allowing the addition of one sync to one or any number of the remaining seven VA-P-101 units.

CIRCLE 321 ON READER SERVICE CARD


## Transistor Holders

TEFLON INSULATED
sealectro corp., 139 Hoyt St., Mamaroneck, N. Y. The TC-300 series of Teflon insulated holders have been designed specifically for threelead transistors and embody the Press-Fit technique for fast and economical chassis insertions. The extra long terminal acts as a heat sink permitting soldering of the transistor in place with greatly reduced danger of damage to the transistor elements. Holders are available in the nine EIA colors

Time-Sharing Problem?

IDL
MAY HAVE A SOLUTION -

Your data handling system, whether RF carrier or wire transmission line, may require time-sharing to increase its capacity and efficiency. $)$
J In the past, the advantages of motor driven switches used for multiplexing were outweighed by their disadvantages. They were smaller, lighter and simpler but, because of high contact resistance, bounce and short life, they contaminated data.
Then IDL introduced multifingered brushes traveling on the inner periphery of cylindrical sections to minimize resistance and bounce and extend trouble-free life to hundreds of hours. These concepts have been successfully applied to missiles in sampling 900 data points per second for more than 500 hours without signal contamination even in the milli-volt signal level ranges.

For example, Switch No. 500660 is a complete unit within a compact case, available at reasonable cost and capable of sampling up to 180 transducers. It combines 2 poles of 30 data channels with 2 poles of 60. data channels, each operating at 5 rps .


Forfurthertnfor. mation, uertitefor Technical Bulletin No. 500660; or let u propose a solution to your Time-Sharing
Problem.

LOPMENT LABORATGRIES incorporated
Subsidiary of Royal Mickee Carporation

51 MECHANIC STREET, ATTLEBORO, MASS.
plus white for color-coded assemblies.

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## Silicon Transistor

## MESA TYPE

NATIONAL SEMICONDUCTOR CORP., Danbury, Conn. Type 2N752 is a general purpose npn silicon mesa transistor for all small signal applications to 200 Mc. Designed for vhf amplifiers and oscillators and video and i-f amplifiers, the device is recommended for applications requiring high reliability under severe environmental conditions. It has high gain at frequencies up to 200 Mc and at collector-emitter currents up to 100 ma . Device dissipation is 300 mw in free air. Minimum collector to emitter of 45 v , and emitter to base of 8 v is guaranteed. Leakage current is only 5 $\mu \mathrm{a}$ at +150 C , and collector-base capacitance only 5 pf.

CIRCLE 323 ON READER SERVICE CARD


## D-C Power Supply SHIPBOARD TYPE

PERKIN ENGINEERING CORP., 345 Kansas St., El Segundo, Calif., has available a general-purpose Navy shipboard power supply with a d-c output of $28 \mathrm{v} \pm 10$ percent at 50 amperes and featuring automatic current limiting. ACL comes into operation at above 50 amperes and limits the current to a safe value in the model M-1217A. Regulation for line and load changes and adjustment of the output voltage level are accomplished by means of a magnetic amplifier regulator controlled by a transistorized pre-amp which uses a silicon Zener diode as a reference element. Line and load regulation at 28 v nominal output setting is $\pm 5$ percent. Regulation is also $\pm 5$ percent for line and load

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## New SHIFT REGISTERS by General Electric

 CUSTOM DESIGNED from 0 to $700 \mathrm{kc} / \mathrm{s}$Catalog components or devices oftentimes do not truly fit design needs. General Electric, working directly from your specifications, custom designs the new Voltage Controlled Shift Register for any frequency between 70 and 700 kc . Within a matter of days, first prototypes will be shipped. VCSR's deliver far higher shift rates than core-diode registers, with considerably less power dissipation. For shift speeds below $100 \mathrm{kc} / \mathrm{s}$, custom designed corediode registers are also a part of this General Electric service.

G-E Shift Registers can be designed within these parameters:
Shift Pulse Power: . . . . . . . . . . . . . . . . . as low as . 001 watts per ke
Shift Pulse Voltage: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 5 to 50
Signal Voltage: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 3 to 25
Signal-to-Noise Ratio: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . $15: 1$
Temperature: . . . . . . . . . . . . . . . . . . . . . . . . . . $-65^{\circ} \mathrm{C}$ to $+125^{\circ} \mathrm{C}$
For complete information write to Defense Industries Sales, Section 227-20G

DEFENSE ELECTRONICS DIVISION
HEAVY MILITARY ELECTRONICS DEPARTMENT, SYRACUSE, N. Y.

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Box 101, 330 West 42nd Street New York 36, New York
changes from no load to full load. The a-c input is $440 \mathrm{v}, 3$-phase, 60 cps. Ripple is 2 percent rms.

## Miniature Switch OVERTRAVEL PLUNGER

the milli-switch corp., Gladwyne, Pa., has introduced a miniature switch with overtravel plunger for cam actuation in rotary applications. Designated B-2PD, the switch has electrical and environmental characteristics which meet the requirements of MS-25085. It is available with drilled single or double turret terminals. Switch is $25 / 32$ in. long, $\ddagger$ in. thick and 0.871 in. high. Specifications include overtravel of 0.060 in . minimum, pretravel of 0.015 in . maximum and operating force of 10 oz maximum. Return force is 1 oz minimum and movement differential 0.001 in . maximum.

CIRCLE 324 ON READER SERVICE CARD


Test Probes, Jumpers "GRIP-TIP" SERIES
electro-Laminates, inc., 77 Florida St., Farmingdale, L. I., N. Y. The Grip-Tip series test connectors and jumpers offer a quick, positive connection onto hard-to-reach wires, solder lugs, terminal pins or chassis elements. The test probes can reach down into elements that are only 0.187 in . apart or into close areas where spring-type clips cannot fit. The red or black, long, slim, white striped handles permit deep probing and easy identification. The jumper series, for positive temporary connection of components, are available in high voltage ( $5,000 \mathrm{v}$ wire) or low voltage ( $1,000 \mathrm{v}$ wire)

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${ }^{\text {IN }}$ THE electronics BUYERS' GUIDE
models. They eliminate haywire lashups and are completely insulated for hot circuit work.
CIRCLE 325 ON READER SERVICE CARD


## Coaxial Load

## FOR RADAR SYSTEMS

bomac laboratories, inc., Salem Road, Beverly, Mass. Developed for use with balanced duplexers in radar systems, this coaxial lead in 15 in. 50 ohm EIA line, can dissipate an average power of 20 w at 20 Kw peak. Over a range of $400-450 \mathrm{Mc}$, it presents maximum vswr of 1.2. Designed as an expendable component, it is being sold at a relatively low price.

CIRCLE 326 ON READER SERVICE CARD


## R-F Power Amplifier

## KLYSTRON TYPE

SIERRA ELECTRONIC CORP., 3885 Bohannon Drive, Menlo Park, Calif., has developed a new 2-Kw r-f klystron power amplifier designed for both military and industrial applications. Four VA-856 klystron tubes are used to give the model 210 A amplifier a range of 7,125 to $8,500 \mathrm{Mc}$. It has a gain in excess of 40 db when operated as a broadband amplifier. Typical applications include high power point-to-point communications, tropospheric scatter, and other microwave communi-


## NOW! 2-30 mc PLUG-IN ELEMENTS

An insertion type instrument used to measure forward or reflected power in coaxial transmission lines in the frequency range 2 to 1000 mc . Directional selectivity is accomplished by fingertip rotation of element to point arrow in direction of power to be measured. Calibration charts or full scale meter adjustments are not needed for this direct reading instrument.
The lightweight and portable Model 43 may be used on mobile or fixed equipment. It is recommended for accurate measurement of forward or reflected power...transmission line loss... insertion loss of components, such as filters, connectors, switches, relays, etc. ... antenna matching work ... continuous monitoring of transmitter output and...VSWR in complete systems in operation.

## S PECIIFICATIONS

Each model 43 Directional Watt. meter is made up of a line section, an indicating meter and plug.in measuring elements all contained in an aluminum case. ELEMENTS: Available in the combinations of power and frequency ranges listed below:
FREQUENCY RANGE: 10 to 1000 Watts in six ranges. $(2.30 \mathrm{mc})(25.60 \mathrm{mc})$ $(50.125 \mathrm{mc})(100-250 \mathrm{mc})(200-500 \mathrm{mc})$ ( $400 \cdot 1000 \mathrm{mc}$ )
POWER RANGE: 10 to 1000 Watts in seven ranges: (10W) (25W) (50W) (100W) (250W) (500W) (1000W).

ACCURACY: $\pm 5 \%$ of full scale
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QUICK - CHANGE CONNECTORS:
Two Type "N" FEMALE connectors which mate with (UG/21) Male " N " are sup. plied UNLESS ORDER SPECIFIES OTHER CONNECTORS. Other available quickchange connectors are Male or Female "BNC." "LC,"' "LT," "HN," "C," Male " $N$ " and Female "UHF."
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DIMENSIONS: 7" x 4" x $3^{\prime \prime}$
BULLETIN $\$ 4360$ Sent on Request.

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RF Switches


## ELECTRONIC CORP.

CHurchill 8-1200
30303 Aurora Road, Cleveland 39, Ohio Western Representative:

## North Atlantic Series RB500 Ratio Boxes



With any of North Atlantic's RB500 Ratio Boxes you can now measure voltage ratios about zero and unity-without disrupting test set-ups.
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Effective series impedance:
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Long life, heavy duty switches
Name your ratio measurement and its probable there's a North Atlantic Ratio Box to meet them - precisely. Write for complete data in Bulletin 11 M

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 ...a complete line of complex voltage ratiometers...ratio test sets... phase angle voltmeters[^4]cations systems. Maximum bandwidths at the $\frac{1}{2}$ power points are 15 Mc , staggered tuned, and 10 Mc synchronously tuned. Amplifier measures 84 in . high, $44 \frac{1}{2} \mathrm{in}$. wide and 27 in . deep.

CIRCLE 327 ON READER SERVICE CARD


## Sensitive Relay

## MICROMINIATURE

hi-G, inc., Bradley Field, Windsor Locks, Conn. The hermetically sealed BC microminiature sensitive d-c relay, dpdt, is capable of withstanding 20 g to $2,000 \mathrm{cps}$ vibration, shock 50 g standard or better, temperature range -65 to +125 $\mathrm{C}, 40 \mathrm{mw}$ at pull-in at 25 C , rated from dry circuit conditions to 2 amperes at 32 v d-c, 100,000 operations minimum. Size, 0.4 by 0.8 by 1.275 ; header styles-hook, plug-in, $1 \frac{1}{2} \mathrm{in}$. or 3 in . leads; enclosuresplain, side strap, top stud, side stud and bracket.

CIRCLE 328 ON READER SERVICE CARD


## Voltage Regulator <br> MAGNETIC TYPE

voi-shan electronics, 13259 Sherman Way, North Hollywood, Calif. Operating over a temperature range of -65 to +125 C , this magnetic voltage regulator provides a highly regulated voltage output for airborne and ground applications. Input voltage range is 115 v a-c or 28 v d-c, with frequencies of 60 cps, or 360 to $1,000 \mathrm{cps}$. Output voltage is 5 to 400 v a-c with regulation held to $\pm 1$ percent during

Electromechanical
Components and Systems Capability


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One of a wide variety of temperature control systems developed and produced by AiResearch, this magamp temperature control system is used on the DC-8. It modulates hot $\mathrm{j} \delta \mathrm{t}$ engine bleed air down from $660^{\circ} \mathrm{F}$. to $450^{\circ} \mathrm{F}$. for the low pressure pneumatic system serving the air conditioning, refrigeration and ice protection sul)systems.

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 Los Angeles 45, Californiainput and load variations of 50 to 100 percent. Power handling from 5 to 500 va, with shock, vibration, and altitude conforming to MIL-'「5422C. Physical size, weight, and shape are held to a minimum through use of high efficiency magnetic cores and advanced packaging techniques.

CIRCLE 329 ON READER SERVICE CARD


Snap-Action Switch

## BIFURCATED CONTACTS

MICRO SWITCH, Freeport, Ill. Bifurcated gold contacts-for increased switch reliability and stabilized contact resistance in data processing, radar and radio circuits -are a feature of a new subminiature snap-action switch. Used in dry (extremely low-energy) circuits, these gold contacts offer low resistance with greater life and reliability characteristics in millivolt and milliampere circuits. The bifurcated contacts (two contact surfaces in each position) move with a wiping action to clean the surfaces with every cycle. Electrical rating of the spdt switch is 5 am peres at 30 v d-c. Switch weight is 0.006 lb , operating force 3 to 5 oz, dimensions $\frac{2}{2}$ by $\frac{1}{2}$ by $\frac{3}{4} \mathrm{in}$.

CIRCLE 330 ON READER SERVICE CARD


Time Code Generator
all-SOLID STATE
ELECTRONIC ENGINEERING CO. OF California, 1601 East Chestnut


This portable instrument in one complete package enables you to measure both frequency and frequency deviations in the maintenance of mobile communications systems.

As optional equipment the FM-7 Frequency Meter can be combined with the new DM-3 Deviation Meter as illustrated. The DM-3 is a dual-range deviation meter with 15 kc and 7.5 kc full scales.

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WOODSIDE. DARTMOUTH. N. S. 2005 Mackay St., Montreal. Que. 3077 Bathurst St., Toronto, Ont.
Corporation Housc, 160 Laurier West. Ottawa, Ont.

Ave., Santa Ana, Calif. Time correlation of data recorded by various instrumentation devices using the proposed IRIG code is now possible with the model ZA-810 time code generator. The code ( 36 -bit, 100 pps ) is the same as that now proposed for a world-wide timing system. The ZA-810 has the accuracy and stability ( 3 parts in $10^{8}$ ) equivalent to a secondary standard. The two outputs of the unit are in d-c level shift form and modulated $1,000 \mathrm{cps}$ carrier. The 36 -bit code indicates time-of-day and day-of-year and is read out once per sec at a 100 pps rate. Unit employs a leap year switch to provide for the extra day every four years for long duration timing programs. Provision is also made for WWV synchronization. Digital circuitry in the ZA-810 is accomplished with EECO plug-in circuits. Price of the unit is $\$ 11,180$.

CIRCLE 331 ON READER SERVICE CARD


## Spectrum Analyzer

SINGLE SIDEBAND
PANORAMIC RADIO PRODUCTS. INC., 520 S. Fulton Ave., Mrt. Vernon, N. Y. Motorized tuning, increased frequency range ( $100 \mathrm{cps}-40$ Mc), and a more versatile 2 -tone audio generator are 3 new design features in the model SSB-3a single sideband spectrum analyzer that speed a wider variety of ssb and a-m transmitter and receiver tests. Five preset modes of operation (with preset sweep rate, gain and optimized resolution at preset sweep widths of $150,500,2,000$, 10,000 and $30,000 \mathrm{cps}$ ), as well as continuously adjustable settings of each, full 60 db dynamic range and exceptional selectivity are among the features retained in the improved model. The motorized tuning frequency control permits


The new Keithley Model 415 micromicroammeter offers high speed of response, accuracy, and zero suppression.

A speed of response of less than 600 milliseconds to $90 \%$ of final value at $10^{-12}$ ampere is possible where external circuit capacity is $50 \mu \mu \mathrm{f}$. Accuracy is $\pm 2 \%$ of full scale on $10^{-3}$ through $10^{-8}$ ranges and $\pm 3 \%$ on ranges below. Zero suppression permits full scale display of one per cent variations of a signal.

The 415 is ideal for use with ion chambers, ionization gages, gas chromatography, mass spectrometry.


Response to a current step of $10^{-12}$ amp Input capacity is $35 \mu \mu \mathrm{f}$. One major horizontal division equals 200 milliseconds

## SPECIFICATIONS

Ranges: $10^{-12}, 3 \times 10^{-12}, 10^{-11}, 3 \times 10^{-11}$, etc. to $10^{-3}$ ampere f.s.
Accuracy: $\pm 2 \%$ f.s. $10^{-8}$ thru $10^{-8} \mathrm{amp}$; $\pm 3 \%$ f.s. $3 \times 10^{-9}$ thru $10^{-12} \mathrm{amp}$.

Zero Drift: Below $2 \%$ of f.s. per day. Input: Grid current below $5 \times 10^{-14} \mathrm{amp}$.
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Price: Model 415 . . . . . . . . $\$ 750.00$
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CIRCLE 332 ON READER SERVICE CARD


Klystron Amplifier broadband tube

LITTON INDUSTRIES, 960 Industrial Road, San Carlos, Calif. The L3270 broadband klystron amplifier tube is capable of providing over 2 megawatts of peak r-f power with a 100 Mc bandwidth at L-band. It features flat bandpass and linear phase shift characteristics over the 100 Mc bandwidth centered at 1,300 Mc as well as a minimum gain of 30 db . The characteristics of this klystron tube make it well suited for application as the output stage of sophisticated radar systems, particularly where frequency diversity or precisely shaped pulses are required.

CIRCLE 333 ON READER SERVICE CARD


Encapsulated Chokes
TWO TYPES AVAILABLE
MAGNETIC PRODUCTS DIVISION, Stanwyck Winding Co., Inc., P. O. Box 70, Newburgh, N. Y., announces two types of encapsulated chokes containing Ferroxcube ferrite shielding beads and having large values of r-f reactance and

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IN
THE electronics
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## Literature of

ACCELEROMETERS Columbia Research Laboratories, MacDade Blvd. and Bullens Lane, Woodlyn, Pa. Technical bulletin T-101 describes miniature, subminiature and heavy duty accelerometers for both laboratory and in-flight shock and vibration studies.

CIRCLE 380 ON READER SERVICE CARD
METAL PROCESSING Consolidated Reactive Metals, Inc., 115 Hoyt St., Mamaroneck, N. Y., has available a pamphlet which, among other things, describes the many types of mechanical operations which the company can perform on reactive and precious metals to convert them into wire, sheet and special shapes of use in electronic and nuclear fields.

CIRCLE 381 ON READER SERVICE CARD
SILICONES Dow Corning Corp., Midland, Mich. A 12 -page engineering guide explains how various physical forms of silicones contribute to reliability, miniaturization, modularization and environmental protection; increase serviceability over wide extremes of temperature; and aid value engineering.

CIRCLE 382 ON READER SERVICE CARD
DYNAMIC DIGITAL SYSTEM Instron Engineering Corp., 2500 Washington St., Canton, Mass. Brochure 8 illustrates, describes and gives specifications for a new $d y$ namic digital readout system.

CIRCLE 383 ON READER SERVICE CARD
VOLTAGE DIVIDERS Gertsch Products, Inc., 3211 S. LaCienega Blvd., Los Angeles 16, Calif. Fourpage, 2-color brochure gives detailed technical data on a line of subminia ture, coaxial ratio transformers. Units described are designed for use where minimum panel space and extreme light weight are required.

CIRCLE 384 ON READER SERVICE CARD
POTENTIOMETERS Bourns, Inc., 6135 Magnolia Ave., Riverside, Calif., has available the fourpage summary brochure No. 5 on Trimpot and Trimit leadscrew actuated potentiometers. Designed for quick reference, the brochure summarizes key information on 16

## the Week

standard models including resistances, terminal types, power ratings, operating temperatures, and dimensions.
CIRCLE 385 ON READER SERVICE CARD
MAGNETIC TAPE TRANSPORTS Minneapolis-Honeywell Regulator Co., 10721 Hanna St., Beltsville, Md. Bulletin DS3170A contains complete specifications, application information and features of the series 3170 magnetic tape transports.

CIRCLE 386 ON READER SERVICE CARD
MICROWAVE SYSTEM Adler Electronics, Inc., One LeFevre Lane, New Rochelle, N. Y., has available an 8 -page brochure describing the RT-3A heterodyne repeater which is designed for reliable unattended tv and communications relaying in the 2,000 Mc frequency range.

CIRCLE 387 ON READER SERVICE CARD
D-C CAPACITORS Aerovox Corp., New Bedford. Mass., has available new bulletins containing complete physical and electrical characteristics of its line of metal-cased, hermetically sealed, d-c oil-impregnated capacitors.

CIRCLE 388 ON READER SERVICE CARD
POWER TRANSISTORS Silicon Transistor Corp., Carle Place, L. I., N. Y. Bulletin 11-109, containing technical data for the types 2 N 389 and 2 N 424 high power silicon transistors, is now available.

CIRCLE 389 ON READER SERVICE CARD
A-C VOLTMETERS Flow Corp., 85 Mystic St., Arlington, Mass. Bulletin 59 compares the relative merits of seven basic types of a-c voltage measuring devices, describes some of the properties of random signals and discusses their importance, and outlines several necessary design features to obtain accurate random signal power measurements.

CIRCLE 390 ON READER SERVICE CARD
COMPONENTS M. Swedgal, 258 Broadway, New York 7, N. Y., has available a products brochure dealing with a line of precision-built variable condensers and drives.

CIRCLE 391 ON READER SERVICE CARD

MEMO TO:

## SILICON DEVICE MANUFACTURERS

FROM:
GRACE ELECTRONIC CHEMICALS, INC.
(supplier of ultra high purity Silicon)

## SUBJECT: <br> HIGHER DEVICE YIELDS!

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## Radiation Incorporated: a vision

two young engineers, Homer R. Denius and George S. Shaw, watched intently as the first missile rose from the sandy dunes of Cape Canaveral more than 10 years ago. They also observed vast man-made changes being wrought on the palmetto flats where the nation's largest missile test center now stands.

With the rapid development of missiles, and emergence of space exploration from the infant stage, Denius and Shaw saw the obvious need for support electronics. Perhaps it was in this locale that the vision of Radiation Incorporated crystallized. Denius, then 35, was vice president and director of engineering for Melpar, Inc., Va., and Shaw was his project engineer.

In 1950, the two men left for Melbourne, Fla., just a short distance from the Cape, where they formed Radiation Incorporated, to specialize in advanced electronics. From obscure beginnings in a rented building at the decommissioned Naval Air Training Station, the company has grown into a $\$ 14$ million operation with modern plant facilities in both Florida and California.

Denius and Shaw are quick to credit their highly-talented engineers and management personnel for the rapid strides made in 10 years. With record employment at 1,660 , over half of whom are engineers or technicians, the firm has begun a facilities expansion program. The first portion, completed
at Palm Bay, Fla., includes a new administration building and three $22,000 \mathrm{sq} \mathrm{ft}$ engineering modulesthe heart of a proposed multi-million-dollar electronics complex.

The company is still proceeding in the direction set by its founders. The team's first piece of business was a study contract from the U.S. Air Force on ways to present mis-sile-readiness information. This was followed soon after by a production contract for telemetry equipment.

Today, Radiation is regarded as a leader in pulse code modulation (pcm) telemetry. It has also expanded its areas of activity to include antenna systems, data acquisition and processing equipment, specialized missile telemetry components, and a number of defense electronic products marketed commercially.

With multi-million-dollar contracts to provide pcm telemetry for two of the nation's prime missile programs-Minuteman and Titan -Radiation has assumed a sizable role in space-age electronics. Data handling installations utilizing the pcm concept have been completed for Holloman's sled test program, Thiokol's solid propellant test facility, General Electric's Engine Test Center, and Johns Hopkins' Applied Physics Laboratory, as well as other government agencies and missile contractors, the company says.

Denius and Shaw believe in keep-
ing ahead of today's fast-moving technology. Emphasis has constantly been placed on imaginative research and intensive development of new techniques and systems. "We must originate new concepts not merely combine old ones," saj the founders.

Presently, the company is completing the communications-tracking antenna network for Project Courier, the Army's space satellite global communications system. The firm designed and constructed the TLM-18 missile tracking-telemetry antennas used on the Atlantic and Pacific test ranges. These highgain $60-\mathrm{ft}$ antennas utilize advanced technology developed to meet the rigorous requirements of fast, accurate tracking. "Radiquad" antennas for Project Score and the feed for Jodrell Bank's huge "dish" were also developed and built by the company.

Standing in front of the company's new electronics facilities at Palm Bay, Fla., Denius (left) and Shaw are enthusiastic about "the growing technology of space satellite communications."


## Telechrome Appoints Defense Products Mgr.

walter a. kirsch has joined Tele chrome Mfg. Corp., Amityville N. Y., as defense products manager and assistant to the vice president and director of sales, H. Charles Riker.

Telechrome designs and produces industrial automation systems, aero-space electronics components, and television broadcasting and testing equipment. The company recently acquired Hammarlund Mfg. Co., producer of radio receiv-

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## TOROIDAL COIL WINDER- <br> ers and transmitters. <br> Kirsch, a sales engineer for the Servo Corp. of America for the past year, previously was associated with Fairchild Camera and Instrument Co. for three years as superintendent of electrical assembly and manufacture on the SAGE project. <br> Dickson Organizes New Company

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DON DICKSON, who recently resigned his position as product manager of the Diode Department of Motorola Semiconductor Division, has announced the formation of Dickson Electronics Corp., in Scottsdale, Ariz. He will serve as president.

Dickson says the initial efforts of the new firm will be centered upon the development and production of diffused junction silicon Zener diodes and rectifiers. In particular, it will seek business from those companies which require large quantities of Zener diodes and rectifiers custom made to their own specifications.

In the new venture, Dickson has been joined by Walter Gray and Dalton Knauss.

Gray, named vice president and treasurer, was formerly manager of purchasing at Motorola Semiconductor Products Division.

Knaluss, formerly electronics section head at Motorola, will serve as chief engineer of the new firm.


## Promote Harrington

 To General Managerrobert J. harrington has been named general manager of ITI Electronics Inc., according to an announcement made by Horace Atwood, Jr., president of the Clifton, N. J., firm.

Harrington was formerly sales

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manager of ITI. In his new position he will be responsible for all manufacturing operations of this 13 year old firm.

Prior to joining ITI in 1948, Harrington was treasurer of American Time Corp., Springfield, Mass.


Appoint H. R. Austin ACF Lab Manager
the appointment of Howard R. Austin as manager of the communications laboratory of the electronics division of ACF Industries, Inc., has been announced.

Austin, who joined ACF Electronics from Motorola, Inc., of Chicago, will make his headquarters in the division's Electro-Physics Laboratory in Bladensburg, Md.

## Levinson Joins <br> Vitramon R\&D

SOLOMON LEVINSON, physical chemist formerly associated with Rockefeller Institute and several New York electronic firms, has joined the research staff of Vitramon, Inc., Bridgeport, Conn., manufacturer of solid-state porcelain and microminiature ceramic capacitors.

Levinson is expected to play a key role in the firm's unfolding program of research and development in the field of solid-state electronic devices. His work there will consist basically of the evaluation of existing materials and the development of new materials possessing requisite properties useful to the creation of tinier, more compact and versatile electronic components. The program is operating under the personal direction of Barton L. Weller, president and inventor of the "Vitramon" solidstate porcelain capacitor.

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To discuss these or other openings, write Mr. James C. Burg, Dept. 664B, Aeronautical Division, 1433 Stinson Blvd., Minneapolis 13, Minn.

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## H.R. 9996

AT THE PRESENT TIME federal law prohibits reimporting of goods originally purchased by the United States Government and then sold overseas, unless the Secretary of Commerce "determines that such importation . . . would relieve domestic shortages or otherwise be beneficial to the economy ..."


House Bill H.R. 9996 proposes to change all this, and would permit such reimportation except where the Secretary of Commerce determines that such reimportation would be injurious to the economy.

Following World War II the electronics industry saw millions of dollars worth of surplus components and equipment reimported and "dumped" on the market. Fortunately, the market was at that time so busy turning out long-delayed new products that the sale of the surplus items cannot, in retrospect, be said to have harmed the industry materially.

There are two sides to the present-day problem of surplus, and neither the surplus broker nor the distributors of new products can be said to be impartial in their opinions, but--let's not holler before we're sure we'll be hurt. Surplus components sold overseas aren't disappearing into thin air. They are being trans-shipped to other countries and assembled there, contributing to the lower prices of electronic equipment which is then often exported into our domestic market. Or competing with us in other markets the world over.

So, before we attack H.R. 9996, the phrase "injurious to the economy of the United States" must be considered in the light of the overall economy . . . not just yours . . . or ours.


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For more information about Daven's new Packaged Assembly Service, write today.

# RCA Vidicon tubes operate successfully in Tiros weather satellite and in Redstone target damage assessment cameras 

A new era in the application of television techniques opened on April 1st, when Tiros began sending back to earth its cloud-cover pictures. These pictures, produced by RCA Vidicons, are giving man his first "star's eye" view of his world and its weather. Not only do the vidicons promise to revolutionize the science of meteorology, but they open up new prospects for the exploration of the moon and solar system via vidicon-equipped TV cameras.
Another historic "first" was achieved by an RCA vidicon on March 15, when a TV-camera capsule was ejected in flight from a Redstone missile, and sent back pictures of the missile's impact. The camera, like the ones used in Tiros, utilized an extremely slow scan, permitting the transmission of high-quality pictures over a very narrow bandwidth.

It is no accident that RCA was chosen to supply the vidicons for these critical tasks. Long the leader in camera tube development, RCA currently manufactures four standard vidicon types: RCA-7038, for broadcast use; RCA-7735, for industrial use-featuring extremely high sensitivity ; RCA-7262-A, a short, low-heater-power version of the RCA-7735; and the RCA-7263, a short, low-heater-power type, which is environmentalized for military applications. All feature the high resolution capability, high uniformity and broad spectral response that have become identified with RCA vidicons.
For complete information about RCA's vidicon line or about special adaptations to meet unusual requirements, get in touch with: Marketing Manager, RCA Industrial Tube Products, Lancaster, Pa.

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[^3]:    (1) American Standards Association Specffcation Z24.3-1944, Sound Level Meters for Measurement of Noise and Other Sounds.
    (2) German Standard DIN 5045 .
    (3) British Patent Application $16981 / 59$
    (4) H. アoucke, A Novel RMS-Value Rectifier With Reduced Waveform Error, Archiv der Electrischen Ubertragung, p 267, July 1950.

[^4]:    

    NORTH ATI,ANTIC industries, inc.
    A. Terminal Drive, Plainview, L. I. N. Y. OVerbrook 1-8600

[^5]:    * See advertisement in the June, 1959 Mid-Month ELECTRONICS BUYERS GUIDE for complete line of products or services.

[^6]:    RCA ELECTRON TUBE DIVISION - FIELD OFFICES ...GOVERNMENT SALES: HARRISON, N. J., 415 S. 5th Street, HUmboldt 5-3900 - DAYTON 2. OHIO, 224 N. Wilkinson St., BAIdwin 6-2366 - WASHINGTON 7, D.C., 1725 " 'K'" SP., N.W., FEderol 7 -8500 - INDUSTRIAL PRODUCTS SALES: DETROIT 2, MICHIGAN, 714 Now Center Building, TRinity 5.5800. NEWARK 2, N. J., 744 Brood St., HUmbald 5-3900. CHICAGO 54, ILLINOIS, Suite 1154 , Merchandise Mart PLAZA, Whitehall 4.2900 . LOS ANGELES 22, CALIF., 6355 E. Washingtan Blvd., RAymand 3-8361 - BURLINGAME, CALIF., 1838 EI Camina Real, OXford 7.1620

