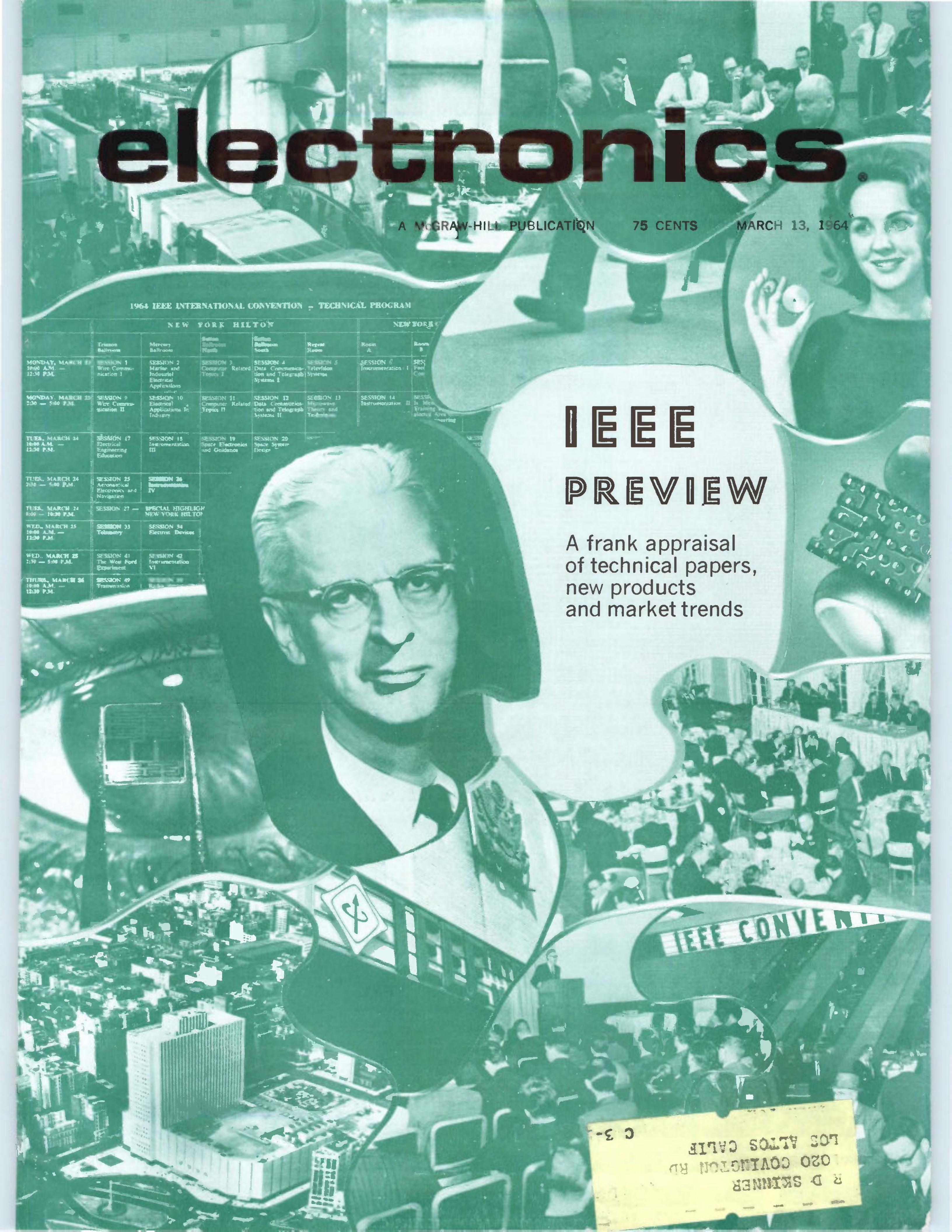
electronics

A McGRAW-HILL PUBLICATION 75 CENTS MARCH 13, 1964



IEEE PREVIEW

A frank appraisal of technical papers, new products and market trends

MARCH 13, 1964

electronics

A McGRAW-HILL PUBLICATION 75 CENTS

Contents continued

electronics

March 13, 1964 Vol. 37, No. 11

Published weekly, with Electronics Buyers' Guide as part of the subscription, by McGraw-Hill, Inc. Founder: James H. McGraw (1860-1948).

SUBSCRIPTIONS: Available only by paid subscription. Publisher reserves the right to refuse non-qualified subscriptions. Subscriptions to Electronics solicited only from those actively engaged in the field of the publication. Position and company connection must be indicated on subscription orders forwarded to address shown below. Subscription rates for individuals in the field of the publication: U. S. and possessions and Canada $6 one year, $9 two years, $12 three years (single copies 75¢). All other countries $20 one year (single copies $1.50).

EXECUTIVE, EDITORIAL, CIRCULATION and ADVERTISING OFFICES: McGraw-Hill Building, 330 West 42nd Street, New York, N. Y., 10036. Telephone Area Code 212. 971-3333. Teletype TWX N. Y. 212-640-4646. Cable McGrawhill, N. Y. Printed in Albany, N. Y. Second class postage paid at Albany, N. Y. Title reg. ® in U. S. Patent Office.

SUBSCRIBERS: Please address all correspondence regarding subscriptions, change of address notices, and subscription orders to Fulfillment Manager, Electronics, P. O. Box 430 Hightstown, N. J., 08520. Change of address notices should be sent promptly; provide old as well as new address; include zip code or postal zone number if any. If possible, attach address label from recent issue. Please allow one month for change of address to become effective.

POSTMASTER: Please send Form 3579 to Fulfillment Manager, Electronics, P. O. Box 430, Hightstown, N. J., 08520.

Audit Bureau of Circulation

Associated Business Publications

Contents continued

DEPARTMENTS

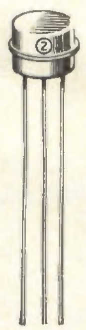
db db db db $$$$$$

FOR MAXIMUM GAIN AT MINIMUM COST...

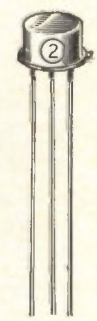
You can't beat

MADT*

Communications Transistors



Check this 200 mc Performance*			
Type No.	**Case**	**Power Gain**	**Noise Figure**
2N1742	TO-9	14db(min.)—19db(max.)	5.5db(max.)
2N2360	TO-12	14db(min.)—19db(max.)	5.5db(max.)
2N2398	TO-12	16db(min.)—22db(max.)	4.5db(max.)



******Tested in fixed matched, fixed neutralized, fixed biased functional circuits.*

MADT Communications Transistors are now available in volume from Sprague Electric.

For complete information on these and other MADT High-Performance Amplifier Transistors, write to Product Marketing Section, Transistor Division, Sprague Electric Company, Concord, N.H.

*TRADEMARK OF PHILCO CORP.

SPRAGUE COMPONENTS

TRANSISTORS
CAPACITORS
RESISTORS
MICROCIRCUITS
INTERFERENCE FILTERS
PULSE TRANSFORMERS
PIEZOELECTRIC CERAMICS
PULSE-FORMING NETWORKS
TOROIDAL INDUCTORS
ELECTRIC WAVE FILTERS
CERAMIC-BASE PRINTED NETWORKS
PACKAGED COMPONENT ASSEMBLIES
BOBBIN and TAPE WOUND MAGNETIC CORES
SILICON RECTIFIER GATE CONTROLS
FUNCTIONAL DIGITAL CIRCUITS

4ST-182-63

SPRAGUE®
THE MARK OF RELIABILITY

'Sprague' and '②' are registered trademarks of the Sprague Electric Co.

GET THE FULL STORY AT IEEE BOOTHS 2416 THRU 2426

SIX DIGITS!

to display full 300% overranging of the Dymec Integrating Digital Voltmeter

A new sixth digit is available on the world's first and finest integrating digital voltmeter, the DY-2401B... and here's what it gives you:

New convenience in taking advantage of the voltmeter's 300% overranging capability on the 100 millivolt, 1, 10 and 100 volt ranges. For example, you don't have to measure 3 volts on the 10 volt range, thereby losing a full decade of resolution. Measure it on the 1 volt range, taking advantage of the overranging feature. The sixth digit tells you the most significant figure.

Additionally, an optional autoranging feature is available with the 2401B, for your maximum measuring convenience and speed (only 34 milliseconds maximum range-change time).

The DY-2401B offers a broader measuring capability than any other digital voltmeter available. Guarded input and integrating operation permit measuring low level signals... even in the presence of high common mode and superimposed noise. Flip a switch and the voltmeter becomes a 300 kc frequency counter. All functions are programmable by contact closures to ground; BCD output is standard.

Accessory instruments include the DY-2411A Guarded Data Amplifier, which adds a 10 mv full scale range (again, with 300% overranging). The DY-2410B AC/Ohms Converter provides floated and guarded, broadband ac voltage and resistance measurements.

Ask your Dymec/Hewlett-Packard field engineer for a demonstration of the 2401B, now available with these new options: automatic ranging with or without the sixth digit, or the sixth digit with standard manual ranging.

DY-2401B	$3950
DY-2410B	$2250
DY-2411A	$1150

Data subject to change without notice. Prices f.o.b. factory.

Visit Dymec at IEEE, Booth 3416

DYMEC

A DIVISION OF HEWLETT-PACKARD COMPANY

dy

DEPT. E-1, 395 PAGE MILL ROAD, PALO ALTO, CALIFORNIA • PHONE (415) 326-1755 TWX 415-492-9363

89

Spring Tonic

IN TWO WEEKS, when the feet are weary and the head pounds from too much imbibing and too little sleep, a lot of people will again promise themselves never to attend another IEEE show and meeting. Engineers, salesmen, and exhibitors have been threatening to swear off it for years. Still, every year the annual event gets bigger and busier.

There's no question that it's become the worst mob scene at any technical event. An engineer has an awful time fighting his way through jammed aisles at New York's abysmally designed Coliseum to find a particular exhibit. When he's finally at his destination, he gets little or no chance to talk to a technically qualified booth attendant. At best, he may get a smile from a model whose charm far exceeds her technical knowledge.

The technical sessions aren't much more helpful. They've become an eight-ring circus (page 35). The eager visitor has to spread himself wafer-thin in order to attend a part of each meeting. Probably nobody will go to that much trouble, because few of the papers at the technical sessions are worth all that effort (page 39). Instead, many visitors will be diverted to the company-sponsored seminars being held in surrounding hotels—complete with lunch.

Still, this rat race continues to be a rallying point for the industry, and therefore deserves support. No other industry has such a stimulus. During February and part of March, engineers at hundreds of companies worked frantically to put the finishing touches to product designs that will be introduced and displayed. Some of these products would not have been ready until autumn without the deadline of the IEEE show to push them.

The show acts as a giant trade fair. If the visitor is energetic enough, he can manage a brief look at most of the new hardware in the industry—and much that's not so new but still useful. Seventy-five thousand potential customers are on hand, even if most of them can't get into any individual booth. Salesmen call on customers during the show, and a lot of orders are booked. It's also a good chance to see what the competition is doing.

For recruiters, the show is a happy hunting ground. For dissatisfied engineers, it is a hope of finding a way out of a blind or boring work alley.

For four days, New York is a giant electronics klatch. Gossip about commercial, technical and personnel events buzzes at restaurants, subways, and even hot-dog stands.

On balance, the advantages of the IEEE's annual confab outweigh its shortcomings. The electronics industry needs the event. Once a year is not too often to rekindle the enthusiasms of man and company.

COMMENT

PATENTS

Your *Newsletter* item, Patent Prices Going Up? (p 17, Feb. 21), should alert every independent inventor and small business to the devastating effect this bill, H. R. 8190, will have if passed by Congress.

Already frustrated by the inequities and discouragements to which our patent system has sunk during the past thirty or forty years, these little fellows, who have consistently come up with most of our great industry-founding inventions of the past, but who have now been reduced to about 40% of the total number of patentees, will assuredly be further decimated and forced to enter the inventive corrals of the large corporations where they are stripped of their creative rights and given only a living wage by their employment contracts. These sharply-increasing, proposed patent fees offer no obstacles at all to corporate industry, but they would surely lead to the extermination of independent and generally impoverished independent inventors who have somehow survived in this arid and inhospitable climate for technological creativity. . . .

The fountain head of our economy is invention, which must be encouraged in every possible way. Increased patenting fees and the frustrations of unrewarded employment contracts can only reduce still further our now relatively low patent output. This bill, now before Congress, should be strenuously opposed by every one interested in our country's future. If the Patent Office—the virtual Cinderella among U. S. agencies as to appropriations, yet the source of all our econmic wealth—needs increased funds to meet current needs, Congress should appropriate them, not kill the geese who lay the golden eggs of our prosperity by further bleeding of our creative citizenry, already in a hostile and extremely speculative climate. . . .

B. F. MIESSNER
Pres., Patent Equity Assoc.
and independent inventor

Miessner Inventions, Inc.
Miami Shores, Florida

• According to one of our patent-holding editors, there are very few independent inventors left. More important, the patent fees usually amount to less than ten percent of the search and legal fees, which are the big expense items.

Regardless of fees, the Patent Office itself offers no protection to the independent inventor who discovers that his patent is being infringed upon. Big corporations can afford to fight patent infringements, and tend to gain the most from the services offered by the Patent Office.

SELENIUM RECTIFIER

Some time ago we received reprints of your Family Tree of Semiconductors (p 45, April 26, 1963). We think it is a good idea to give information about semiconductors in this clear and handy way.

Nevertheless we take the liberty to make a comment. In your historical review you say that selenium rectifiers were developed in 1942. We think this is not right because the Süddeutsche Apparate Fabrik at Nürnberg introduced the first selenium rectifier already in 1930. This factory is a member of the International Telephone and Telegraph System.

M. KOSTER

Nederlandsche Standard Electric Mij. N. V.
The Hague, Netherlands

• According to an ITT engineer familiar with its history, the first selenium rectifier was made in 1928 by the Süddeutsche Apparate Fabrik. The process was taken to the French ITT affiliate in the early Thirties, then went several years later to the ITT English company. In 1938 the process was brought to the United States by ITT, which assembled selenium rectifiers from imported parts for a short time, before starting a production line.

SQUARE-ROOT COMPUTER

The article by H. H. Wieder entitled, Square-Root Computer Uses Hall Multiplier (p 30, Jan. 24) was very interesting and informative.

I would like to call your attention to an error that was probably a misprint. Following Eq. 3, the condition "for $(v_m/v_o) \gg 1$" should be changed to read "for $(v_m/v_o) \ll 1$" if eq. 2 is to be a good approximation to Eq. 3.

GARY L. BLANK

Minneapolis-Honeywell Regulator Company
St. Petersburg, Florida

New Miniature Wet Slug Tantalum Capacitor Offers Higher Ratings Per Unit Volume

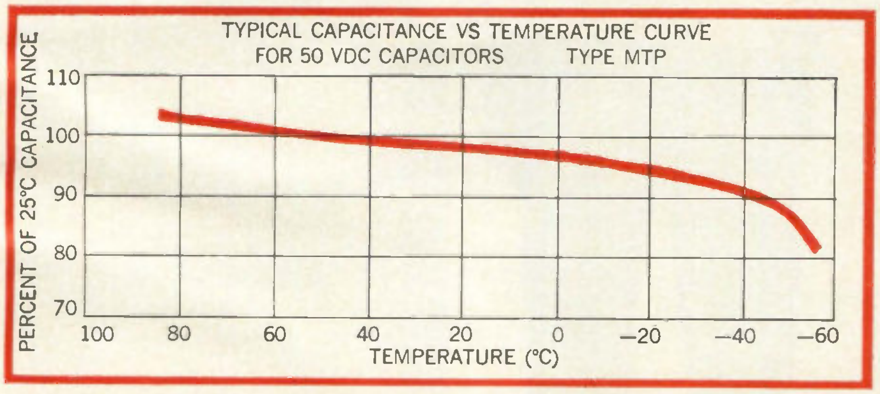
The new Mallory type MTP wet slug tantalum capacitor offers higher capacitance-voltage product than conventional wet, solid or foil MIL types. The MTP is an industrial version of an extremely high reliability capacitor developed by Mallory. It is available in ratings from 4 mfd., 50 WVDC to 450 mfd., 6 WVDC. It operates at ambients from −55°C to +85°C without derating, and comes in four case sizes . . . smallest is 0.115" diameter by 0.312" long, largest is 0.225" diameter by 0.764" long.

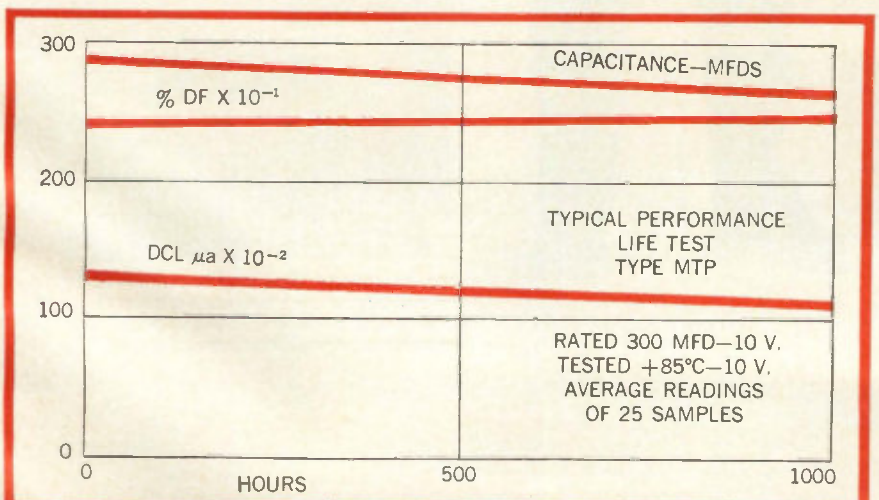
The MTP has good ability in withstanding vibration, shock, temperature cycling, immersion and moisture resistance. Life tests, quality control history and temperature stability tests indicate that the MTP has performance and reliability compatible with the most stringent specifications.

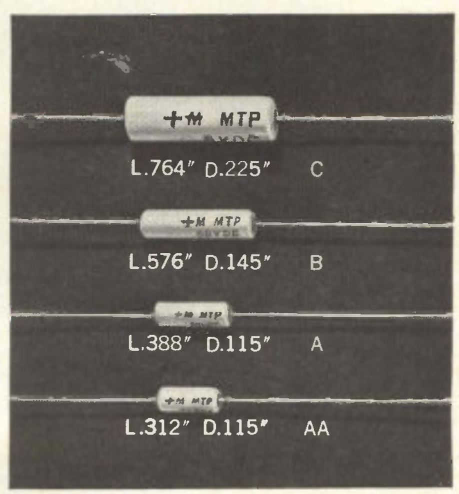
Size and reliability of this unit make it ideal for use in microminiature applications where discrete components are used in conjunction with thin film circuits. For complete data and prices, write or call Mallory Capacitor Company, Indianapolis 6, Indiana—a division of P. R. Mallory & Co. Inc.

STANDARD RATINGS

MFDS CAPACITANCE	RATED VOLTS	MAX. DCL @ 25°C.	MAX. DF @ 25°C.	CASE SIZE
4	50	2.5 μa	10%	AA
6.8	50	3 μa	15%	A
30	50	8 μa	20%	B
78	50	10 μa	20%	C
6	30	2.5 μa	12%	AA
10	30	3 μa	15%	A
45	30	8 μa	25%	B
120	30	10 μa	30%	C
60	20	7 μa	25%	B
80	15	6 μa	30%	B
200	15	8 μa	30%	C
120	10	5 μa	33%	B
300	10	7 μa	33%	C
180	6	5 μa	37%	B
450	6	6 μa	50%	C

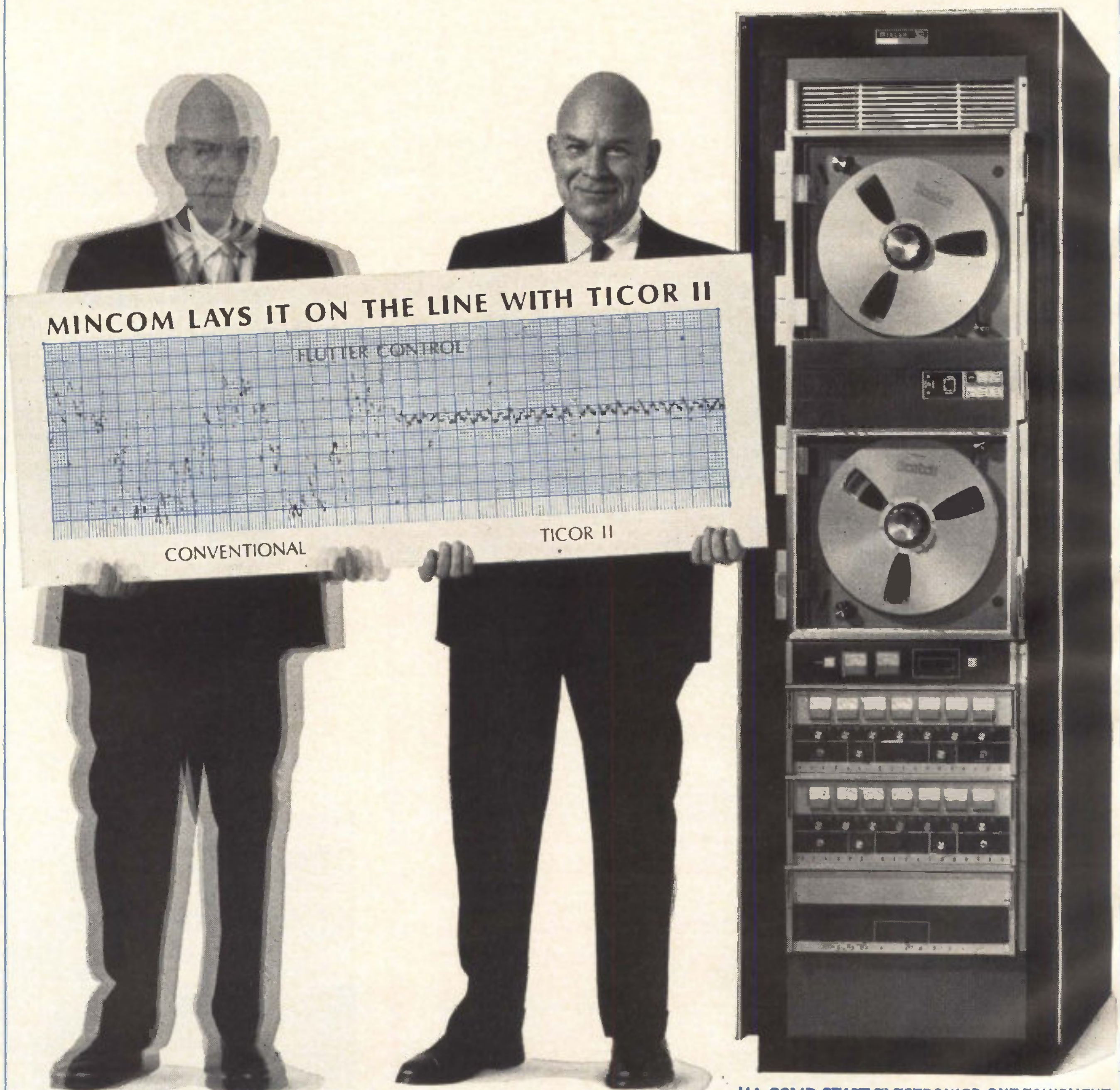






MALLORY

WET SLUG, FOIL AND SOLID TANTALUM CAPACITORS



ALL-SOLID-STATE ELECTRONICS, ONE EQUIPMENT RACK, SEVEN OR FOURTEEN TRACKS, RAPIDLY CONVERTIBLE FROM 1/2-INCH TO 1-INCH TAPE OPERATION, COMPLETELY RFI-SHIELDED.

NEW NEW

TICOR II

...expanding the capability of all data reduction centers to heights never envisioned before

After four years of research and extensive field testing, Mincom announces the TICOR II.

New in theory and design, this 1.5-mc magnetic tape recorder/reproducer is a unique approach to data handling. Mincom is ready to demonstrate that it will advance the performance of your present data reduction equipment to standards previously considered impossible—with the rugged reliability achieved by Mincom's longitudinal recording with fixed heads.

During the recording process (on any IRIG-compatible system), a reference signal is recorded on the tape and used during TICOR II playback to lock in the tape motion to the original time base. *Continuously, anywhere on the tape, TICOR II holds time-base correlation between events to a value of less than ± 0.5 μsec. Flutter components below 200 cps are virtually removed.*

New Applications

With TICOR II, on-line data reduction conditions can now be reproduced in the laboratory instead of operating under stringent field handicaps. Radar recording, single sideband, serial PCM and other systems crucially sensitive to time-base stability are now processed easily and dependably by TICOR II.

Time Correction

Advanced capability of the new system stems from a high-performance capstan assembly coupled to a double-loop frequency/phase-lock servo, providing the industry's most precise tape time base stability.

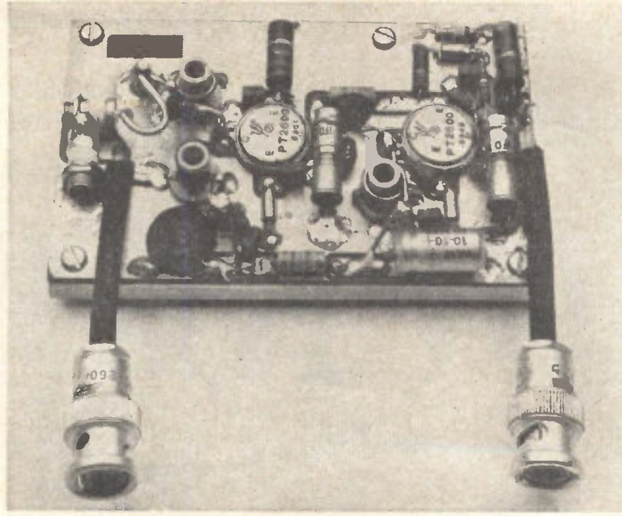
RFI Shielded

From the inception of the TICOR II program, control of radio frequency interference was a major consideration. New circuit design, mechanical packaging, and interface compatibility have been combined to make TICOR II completely RFI-shielded.

Write today for complete specifications.

Mincom Division 3M COMPANY

2049 South Barrington Avenue, Los Angeles, California • 320 Shaw Road, South San Francisco, California • 529 Pennsylvania Building, 425 13th Street, N.W., Washington, D.C. • 135 West 50th Street, New York, New York • Post Office Box 272, Fairborn, Ohio • 1230 Orange Avenue, Winter Park, Florida 2121 Santa Anna Avenue, Dallas, Texas • Eltron Engineering Sales, Inc., 246 Walnut Street, Newtonville, Massachusetts



TRANSISTOR amplifier to be shown by TRW Semiconductor gives 4-w output at 580 Mc. Transistor at left performs dual multiplier-amplifier function with high gain and efficiency without use of varactors

1964: The Year Microcircuits Grew Up

Sign at the IEEE Show will be catalog selling of broad product lines

NEW YORK — If you go to the IEEE Show March 23, you are going to see microcircuits and more microcircuits. You are going to see microcircuits whether you give a darn about them or not. Though they still can't touch conventional electronic components in all-around utility, microcircuits will shoulder their way into the IEEE Show spotlight. There will be too many of them this year to ignore.

In fact, this may be the last IEEE Show at which microcircuits enjoy the favored status of a brash, young product. They are growing up faster than the industry expected.

Demand has grown so in the last few months that even some of the most optimistic manufacturers are started. Production capacity is growing so fast that some firms are beginning to get edgy about the question of price cutting.

Barely a year ago, the prevailing opinion was that microcircuits would enjoy a long adolescence, growing to maturity under the comfortable pricing that custom production allows. At the 1963 Show, the sales message was primarily capability. This year, it will be capability, plus availability of proven units at competitive prices.

"You'll see a broadening of the product base and more and more evidence of getting into production," predicts Robert Noyce, general manager of Fairchild Semiconductor. Harry Knowles, manager of Westinghouse Electric's Molecular Electronics division, expects to see a lot more hard peddling of catalog microcircuits. "What was being talked about last year is now available off-the-shelf, and in quantities of thousands rather than ones and twos."

Applications Speedup — David A. Hill of Hughes Aircraft, chairman of the IEEE session 31 on microcircuits, cites the military's initial sizable support. Equipment development is entering a phase that once was not anticipated before 1970. Microcircuits are finding broad applications rather than a few highly specialized ones.

Like other observers, Hill sees no end or peak to technical development. With over 40 companies active in the field, enough new ideas become successful each month to keep the industry in ferment.

Commented D. A. Jenny, Hughes Semiconductor division manager: "I share . . . the opinion that by 1970 the market will be split 50-50 between microcircuits and discrete-component circuits."

Growth vs. Competition—Some expect high costs and competition soon to force the microcircuit business to amalgamate like the tube business did. Others see breathing room as long as the custom business remains large and the technology retains its bandwagon nature.

The key question appears to be capacity, and overcapacity. Some facilities could match now in mass production the estimated 500,000 microcircuits made in 1963. Norden division of United Aircraft, for one, says its new pilot line can make 50,000 circuits a month. At the show, Norden will be pushing its ability to deliver complex single-chip circuits like a 100-component 6-watt amplifier (booth 2130). Bendix Semiconductor, another company that was selling microcircuits internally, will

POOR MAN'S APPROACH

Cleveland Metal Specialties will show pseudo thin films and pseudo multilayer circuits for use with solid-state devices (booth 1914). Sales manager Sal Gross calls it the "poor man's approach" to microcircuits, less expensive versions that can be used now in commercial electronics equipment, as well as military.

Gross, who just completed an eight-week swing around the country, finds more "make" decisions now than he's seen in a long while. But, he says, the industry is very cost-conscious and the only way to get more business is to provide lower-cost, more sophisticated devices.

introduce its "mosaic" line of metal-oxide active integrated circuits (booth 2222).

But big military programs can gobble up enormous quantities. At the end of 1963, for example, Minuteman's schedule called for over 4,000 circuits a week from Texas Instruments, Westinghouse and RCA. TI expanded capacity 10 times during 1963, and was supplying more than 100 programs.

There is, says a Motorola spokesman, overcapacity now in conventional semiconductor devices, but not in advanced devices and integrated circuits. Whether overcapacity comes to integrated circuits depends on how fast equipment manufacturers adopt them, and upon the degree of standardization. R. J. Hanschen, marketing manager for TI's Semiconductor Components division makes a similar point, that the semiconductor components industry will follow the historical pattern of undercapacity for new devices and a tendency for overcapacity in production of mature devices.

Sylvania, which is tooling up for volume output, sees no oversupply as yet. But Sylvania people suspect that by June or July the industry will start feeling the squeeze of more production than sales. One large manufacturer says he is already producing more than he can sell, but feels this is temporary.

Computer Question — Microelectronics business is still mostly military. Producers are anxiously looking to commercial computer makers for a decision to use integrated circuits on a large scale.

Computermen have pointed out that integrated circuits are still too slow for high-speed computers. They face tough sledding unless cost is well below discrete components or hybrid thin-film circuits.

Among the cost predictions made by manufacturers: Fairchild's three-input gate could be sold now for $3 to $4 in quantities of 50,000; within the next few years, logic elements can cost less than $1; ultimately, integrated circuit cost should compare to present-day medium-speed transistors.

Price Cutting?—Manufacturers expect prices to drop on circuits that achieve standardization and high yield. But what they don't want is "another 2N404 situation"—the underpricing that hurt the transistor business.

But the general feeling is that microcircuits don't yet face transistor-type competition. In a fast-moving field, it's risky to try for the jackpot by tooling up to produce standard circuits automatically.

A Sylvania man, however, sees a steadily developing price pressure from military equipment manufacturers. "We have been selling only premium circuits," he says, "but now behind the scenes we're preparing lower-priced ones. So is everybody else."

Others expect demand to continue taxing manufacturing capability. One producer thinks microcircuits won't settle down to an established business routine for a year or two.

Discrete Semiconductors—Semiconductor device manufacturers at the Show will be selling capability, too. As E. J. Diebold, engineering v-p at International Rectifier and chairman of IEEE session 36 on semiconductor devices, puts it:

"The marketplace is forcing companies to grow up. They have to take a hard look at what they're making. They want to compete but this is not a matter of just cutting prices. Companies must make better devices to fill gaps and fulfill needs."

For instance, helping the push for higher power are these semiconductor devices:

- Silicon Transistor's STC-2500 series of 100-amp silicon transistors that can dissipate more than 300 watts (booth 1328).
- Clevite Semiconductor's 4TP-001 four-layer diode. It's a 500-amp, 500-volt switching device (booth 2616).
- Hoffman Electronics' silicon rectifiers that can switch up to 10 amp in 80-nsec. (booth 1227).
- Westinghouse Electric's integral heat sink SCR rated at 400 amp up to 800 volts (booth 1402).
- Transitron Electronics' high-power Biswitch, a five-layer device for a-c phase control that can handle up to 4.8 kw. Company sees a swiftly developing market in consumer appliances and industrial applications (booth 1811).

RCA will show its TA 2301 developmental silicon power transistor with collector-to-base and collector-to-emitter voltage rating of 300-v peak. It can go in class-A a-f amplifiers in line-operated, low-cost entertainment equipment (booth 1602).

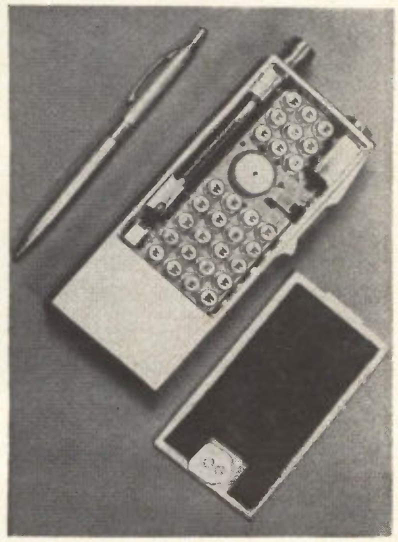
FET'S—Crystalonics will feature a field-effect transistor (FET) with leakage currents down to 0.1 nanoamp. The firm claims it is swamped with orders for this epitaxial switching device (booth 2112).

Crystalonics sees demand for FET's in general peaking by the end of 1964. "Now, and for the next six months, overcapacity situation continues. Engineers are afraid to design them in, don't know enough about them. Also, prices are much too high. Applications would open wide if they could sell for $5 to $10. In sonobuoys, for example, FET's could be used in quantities of 100,000 or more. Preamplifiers would be a big market, if volume sales could get prices down. We think this will be the year."

TRW Electronics expects to introduce its insulated-gate FET. They have obtained approximately 20 db of power gain at 105 Mc in a common-source neutralized amplifier. Device is considered ideal for front-end amplifiers. Noise figure is less than 3 db at 105 Mc (booth 2122).

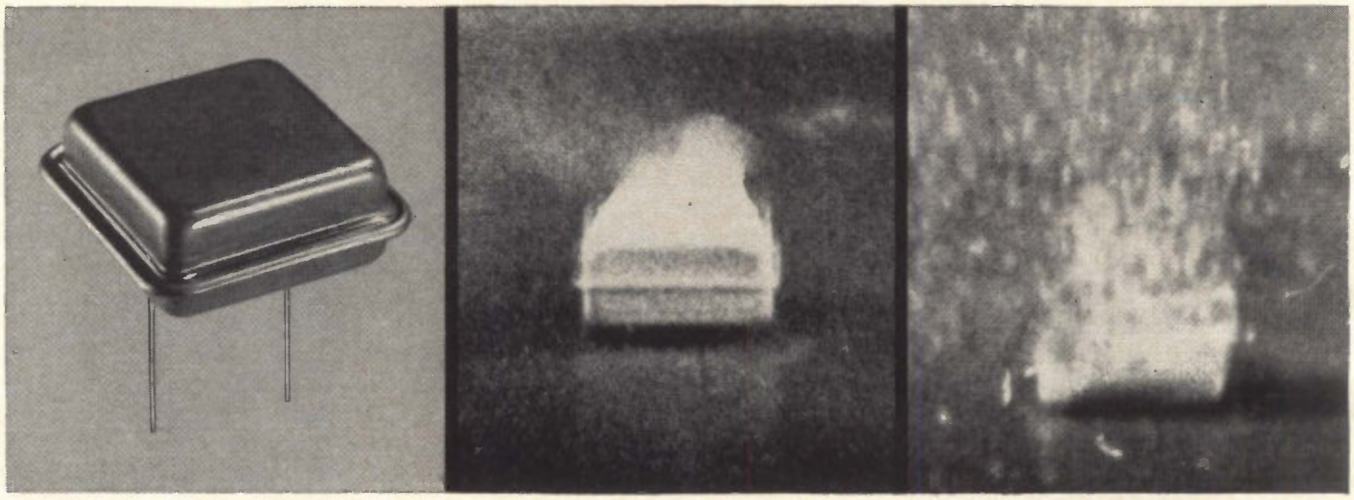
This type of device is arousing considerable industry interest. One reason is its potentially low manufacturing cost.

Micro Transceiver

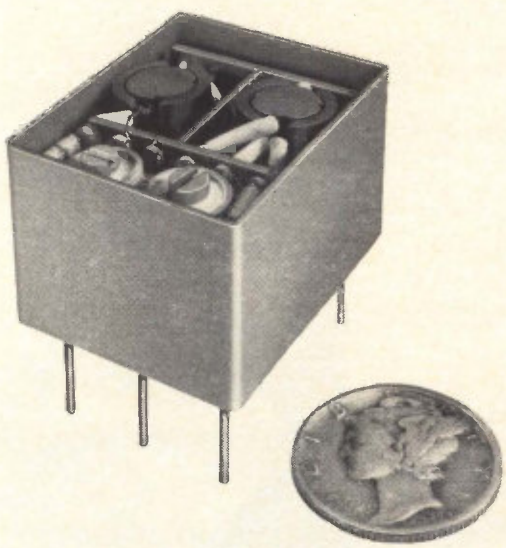


RESEARCH MODEL of a 120-Mc, a-m transmitter-receiver was built by Motorola for Air Force to demonstrate use of integrated circuits in vhf equipment. With case closed, it looks like regular transistor radio

HIGH RELIABILITY in Frequency Control Devices from Reeves-Hoffman's COLD WELD TECHNIQUE



EXPLOSION TESTS RUPTURE THE HOLDER, NOT THE SEAL
Explosion tests, designed to determine the reliability of the cold weld, consistently result in rupture of the holder, not the seal. Tests were photographed (as shown in center and right photos above) with a high speed movie camera at 3000 frames per second.



HIGH RELIABILITY, MINIATURE FILTER
is actually two units in one. Each can be used independently and is controlled by two crystals in cold-welded holders. Each has a center frequency in the 500 kc region. This filter, designed to customer requirements, has the following approximate characteristics: bandwidth at 3 db is 0.1% of center frequency—at 20 db, 0.3%—at 30 db, 0.5%.

Reeves-Hoffman's new cold welding process provides crystal holder seals with a leak rate reliability of more than 100,000 times better than the requirement of MIL Spec 3098. Elimination of solder, and attendant flux and heat, removes undesirable damping and corrosion . . . solve problems of thermal isolation. The result: substantial increases in the reliability and stability of crystal units, oscillators and filters . . . further opportunity for miniaturization . . . faster delivery . . . lower cost.

Cold-welded holders have enabled Reeves-Hoffman to produce precision crystals no larger than power transistors. These units are much more rugged, many times lighter, and much smaller than their glass-enclosed equivalents. As proof of their ability to withstand severe environmental conditions, Reeves-Hoffman crystal units in cold-welded holders are being used in the Mariner space probe that will soon be on its way to Mars.

Reeves-Hoffman production crystals, from 1 kc to 100 mc, are available in cold-welded holders for use in networks of your own manufacture, or as components of Reeves-Hoffman filters, oscillators or standards.

SEE COLD WELDING AT IEEE BOOTH 1202

REEVES-HOFFMAN
CARLISLE, PENNSYLVANIA
DIVISION OF DYNAMICS CORPORATION OF AMERICA

See these new Hewlett-Packard INSTRUMENTS

at IEEE

New York Coliseum
March 23-26, Third Floor

Hewlett-Packard
Dymec
F. L. Moseley
hp associates
Sanborn
Boonton Radio
Harrison Laboratories

superior instrumentation with an extra measure of quality!

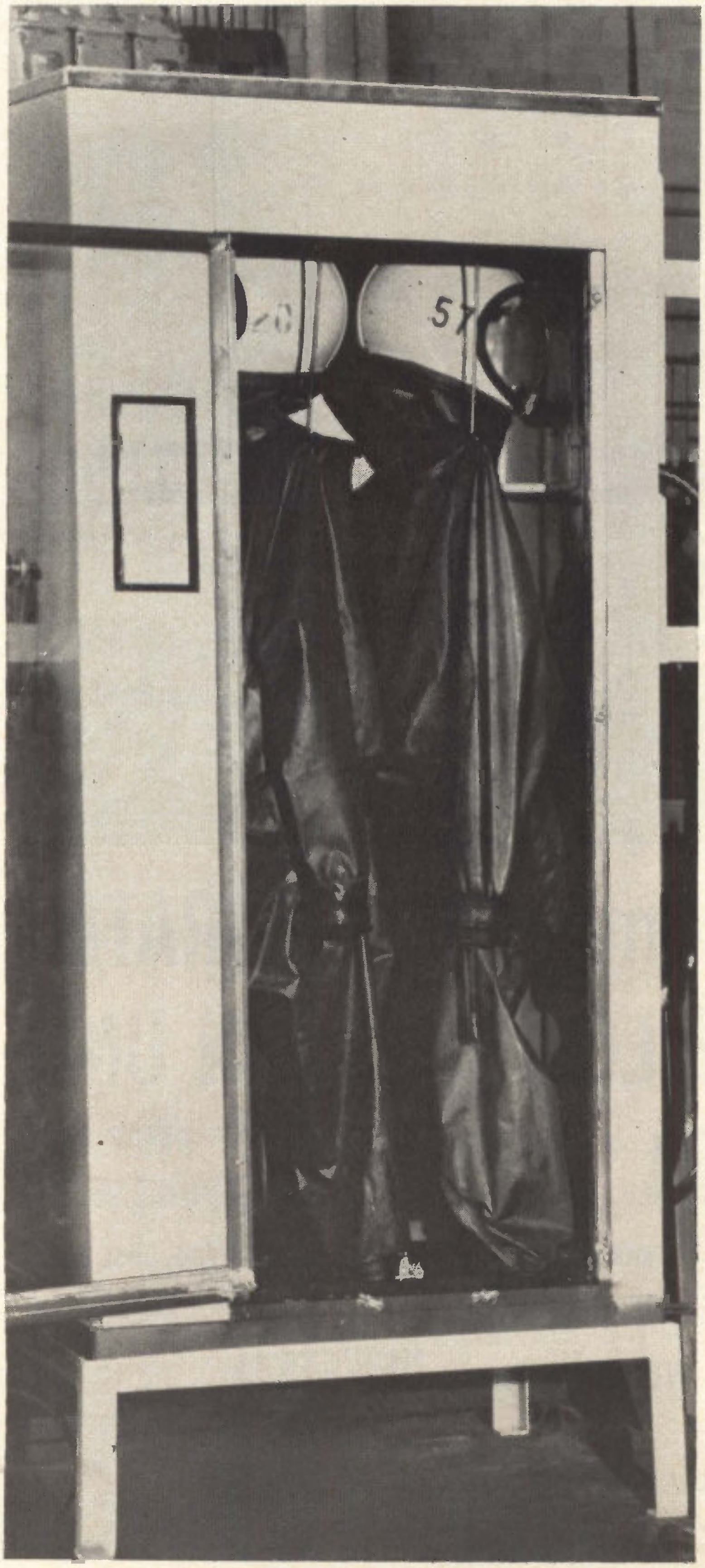
Amplifiers—pulse, video, power—hp 461, 462
DC Standard—supplies and measures precise dc voltages—hp 740A
Data Acquisition Systems—standard systems for low-level measurements—DY 2010, 2013 Series
Digital Voltmeters—plug-in versatility; 6-digit resolution—hp 3440A, DY 2401B
Electronic Counters—new 2.5 gc frequency range—hp 5245L and plug-ins
Frequency Standard—cesium beam stabilized oscillator—hp 5060A
Frequency Synthesizer—fast, programmable selection to 50 mc—hp 5100
Microwave—new semiconductors from hp associates
Oscillographic Recorders—solid state systems—Sanborn 7700 Series
Oscilloscopes—bandwidth to 4 gc; 4-trace viewing to 40 mc; new plug-in scope—hp 140A, 1754A
Power Calibrators—for peak power to 2000 mc—Boonton 8900B
Power Supplies—high power, high efficiency; versatile modular supplies—H-Labs 6200 Series
Quartz Oscillators—unprecedented spectral purity at 5 mc—hp 107A
Signal Sources—for critical applications to 4500 mc; new economy models—hp 8614B, 8616B
Strip Chart Recorders—solid state models for economy, reliability—Sanborn 7701A, Moseley 7100A, 7101A
Sweep Oscillators—new models extend coverage from 1 to 40 gc—hp 690 Series
Voltmeters—average reading, peak, rms—hp 3400A
X-Y Recorders—economy models, accessory equipment—Moseley 135C, 2D-4

HEWLETT PACKARD

For more information write Hewlett-Packard Company, Palo Alto, California 94304, Tel (415) 326-7000; Europe: 54 Route des Acacias, Geneva; Canada: 8270 Mayrand St., Montreal.

CIRCLE 13 ON READER SERVICE CARD

Here's how Martin Company saves $16,000/year cleaning safety suits for TITAN II!



PROBLEM: It used to be an expensive and time-consuming job for Martin Company's Canaveral Division to clean these critical safety garments. The suits protect TITAN II launch-stand personnel from toxic propellants during fueling and countdown. They must be cleaned after each wearing for toxicity and sanitation reasons. Formerly, Martin did this laboriously by hand with detergents at $6.35 per suit.

SOLUTION: An entirely new cleaning system based on FREON fluorocarbon solvents. FREON is an efficient *selective* solvent. It quickly removes toxic fuels or vapors, oil, grease and dirt from the suit while not affecting plastic or metal parts in any way.

To clean the suits, Martin uses FREON in a modified shower cabinet, fitted with several nozzles to drench 2 suits thoroughly—both inside and out. Since adopting this system, cleaning time per suit has been cut from 1½ hours to 5 minutes; cost, from $6.35 to $1.10. So in one year, with 3,600 safety suits cleaned, that's a saving of $16,000!

Martin also likes FREON because it is nonflammable, nonexplosive, and has very low toxicity—making it safe and easy for workers to handle. And—extremely important—contaminated FREON is easily purified for reuse over and over again.

• • • • •

Wherever *you* have a critical cleaning problem, components or assemblies, electronic, electrical or mechanical, it's quite possible FREON solvents could improve operations and cut costs. We'd be happy to discuss it with you! First step: send the coupon or Reader Service Card for our new cleaning booklet.

FREON®
solvents

DU PONT
REG. U.S. PAT. OFF.
Better Things for Better Living
. . . through Chemistry

MAIL COUPON FOR NEW BOOKLET ON CLEANING

E. I. du Pont de Nemours & Co. (Inc.)
FREON Products Division
N-2420E-3R, Wilmington 98, Delaware

Name________________ Title________

Company________________________

Address________________________

Please send new booklet on FREON solvents for precision cleaning. (Offer good in U.S.A. only.)

I am interested in cleaning________________

☐ I would like Du Pont to send a cleaning specialist.

Synchronous Satellite OK Sought

WASHINGTON — The Communications Satellite Corp. has requested FCC permission to operate an "Early Bird" synchronous satellite over the Atlantic in early 1965. The 240-channel satellite would provide interim communications to Europe while Comsat is perfecting its basic worldwide communications system that is expected to be in operation by 1967, with 1,200 channels by 1972.

Designed to last at least one year, Comsat is hopeful that the Early Bird may stay in service up to three years. Cost of putting the satellite into operation should run below $15 million. Comsat will spend close to $8 million for two satellites, plus material for a third. They will be furnished by Hughes Aircraft Co., developer of the Syncom synchronous satellites for NASA.

If all goes well, Comsat hopes its first satellite will not only provide experimental data but also turn a nice profit. AT&T has already indicated it is ready to lease 100 satellite communications circuits as soon as they are available for commercial use. European countries have also expressed interest in using the initial satellite service.

This will be the first synchronous satellite designed for commercial quality tv. It will have two 25-Mc channels. Proposed band center frequencies for use between Europe and North America are: Europe, transmit at 6,301.02 or 6330.67 Mc; receive at 4,160.75 or 4,170 Mc; North America, transmit at 6,389.97 or 6,404.79 Mc; receive at 4,081.00 or 4,100 Mc. Proposed radiated power is four watts. Radiation-resistent solar cells will generate 45 watts. Bandwidth and power are considerably greater than Syncom II.

Meanwhile, FCC set March 23 as the deadline for communications common carriers to file applications for the first stock issued. The Commission wants all communications common carriers, including some 3,000 telephone companies, to submit applications. Since December, 1962, 149 applications have been filed.

ZAP, You're Vaporized?

MASER OPTICS, INC., has delivered a laser rifle to Frankford Arsenal, Philadelphia. The rifle contains a standard pulsedruby laser head, plus an optical system, connected to a rifle butt. Maser Optics would not disclose Army's plans for the weapon, but it will probably be used—at least at this stage—for research and development.

At present output levels, the most damage the weapon could do would be to blind someone on the opposing forces—tankman, for example—and give you time to direct your fire before his could get into action. Or you could blind the artillery fire director, or an opposing rifleman. But at the present power level, you would have to get pretty close to him. And, if you can do that, you might just as well hit him over the head with a club.

The device is portable, plugging into a power pack, a battery power supply that can be carried on the back. Major advantage of the rifle is its portability which, at present, limits its power.

Maser Optics says that tests indicate a capability of continuous operation at rates in excess of one pulse every second. Current pulsing capability is once every 10 seconds. Output was given by the company as 2 to 5 joules.

A-11 Jet Plane—Tests, Not Production Now

THE A-11 MILITARY JET will lead ultimately to a new generation of military and commercial aircraft. But right now, despite tests of its capabilities as an advanced interceptor, the plane probably will not be ordered into production. Instead, it will be widely used as a flying test bed for advanced missile and fire-control systems, and for new electronic and photographic reconnaissance equipment. And it will prove a valuable research tool in the U.S. effort to develop a supersonic transport (SST) airliner.

The A-11 breakthrough in titanium metallurgy implies the U.S. leads the world in this important high-temperature technology and is closer than previously suspected to development of the SST. Operating the A-11 will also produce considerable technical information in subsystems and engine development, aerodynamics, and operating techniques. Although its avionics are secret, the U.S. obviously can build electronic gear to survive the heat generated by mach-3 flight.

A-11 was designed primarily to carry a heavy load of electronic and photographic spy equipment and is probably equipped with an astro-inertial guidance system for long-range navigation.

Rumor—and Facts—Put Fairchild in Computer Market

RUMOR is rampant this week that Fairchild Camera and Instrument Corp., by way of its two Palo Alto affiliates, Fairchild Semiconductor and Fairchild Space and Defense Systems, may be entering the computer market. The rumor was reinforced at the Solid State Circuits Conference last month when Fairchild's R. Rice, ex-IBM, delivered a paper describing a procedure for implementing a shift register, mentioned in the talk as "part of a large complex system." Rice is reportedly one of a small, but high-powered, group of computer design engineers at Fairchild.

Fairchild's Space and Defense Systems Div. is known already to be building a few computers. One is a navigational system presumably connected with Sperry's Loran-C system, for which Fairchild Semiconductor has just announced receipt of a near-$1 million contract for epitaxial flat-packaged micrologic elements.

Another rumor at the conference had Fairchild Space and Defense Systems working on a desk-type computer, intended to be programmed directly in English. Company is using Fairchild Semiconductor integrated circuits but reportedly is authorized to use any other competitor's products. Computer would be used by working engineers, many of whom are reluctant to wait their turn at a central computer, or to go through programmers before they can get computer time at central EDP facilities.

Is Hughes Dynamics Also Going Computer?

HUGHES Dynamics is doing just about everything in the computer business except selling commercial computers. The company recently acquired Consumer Credit Clearance (CCC), a credit reporting service said to be the nation's largest in unit volume, in order to develop capability in applying computer techniques to business management. Hughes insists that its only business —now and for the foreseeable future—is software, but says that they will manufacture peripheral hardware (input/output devices, for example), when necessary.

Hughes Dynamics aims to be a business system company doing over-all business problems-solving on a regular basis for smaller companies. It will not develop a program for a large company on a one-time basis unless there is some proprietary information to be gained.

Since its organization 18 months ago by the Hughes Tool Co., Hughes Dynamics has acquired three computer service companies in addition to CCC: Tellertron of Boston, Advanced Information, Systems, and Automated System International of Detroit. In addition, Hughes Dynamics has a ten-year option to acquire control of Dashew Business Machines of Los Angeles.

Navy Will Update Message Handling

CAPE (Communication Automated Processing Equipment) is the study contract awarded ITT-Federal Laboratories for automating communications message handling, aboard Navy ships. Company spokesmen can say only that the study will include the use of computer simulation programs to assist in evolving the best configurations for the future system.

Navy spokesmen say the project has "the greatest possible breadth of scope." They indicate that a whole family of systems will be considered, including all existing naval communications techniques — both ship-to-ship and ship-to-shore. Industry observers believe that broadband systems with data handling will be included.

NSF Lures Women With $24,950

WOMEN ENGINEERS and scientists are being sought for the profession by the National Science Foundation, which has allotted $24,950 for the first international conference on women engineers and scientists to be held in New York in June. Dr. Dorothy Simon, vice president of Avco Corp., will be chairman of a committee that will administer $8,320 in overseas travel and aid grants for women attending the conference. The government hopes to develop the largely untapped pool of female talent in science and engineering.

MEETINGS AHEAD

NUMERICAL CONTROL SOCIETY MEETING, NCS; Hotel Commodore, New York, N. Y., **March 19-20.**

IEEE INTERNATIONAL CONVENTION, IEEE; Coliseum and New York Hilton Hotel, New York, N. Y., **March 23-26.**

RADIO TECHNICAL COMMISSION FOR MARINE SERVICES MEETING, RTCMS; Boston, Mass., **March 31-April 2.**

JOINT COMPUTER CONFERENCE, British Computer Society, IRE, IEE; Edinburgh, Scotland, **March 31-April 3.**

SYMPOSIUM ON ENGINEERING ASPECTS OF MAGNETOHYDRODYNAMICS, IEEE, MIT; Massachusetts Institute of Technology, Cambridge, Mass., **April 1-2.**

NAB ANNUAL CONVENTION, National Association of Broadcasters; Conrad Hilton Hotel, Chicago, **April 5-8.**

NONLINEAR MAGNETICS INTERNATIONAL CONFERENCE, IEEE; Shoreham Hotel, Washington, D.C., **April 6-8.**

CLEVELAND ELECTRONICS CONFERENCE, IEEE, ISA, Cleveland Physics Society, Western Reserve University, Case Institute of Technology; Public Hall, Cleveland, Ohio, **April 7-9.**

MEASUREMENT AND CONTROL INSTRUMENTATION SYMPOSIUM, ISA; Hotel Floridian, Tampa, Fla., **April 8-10.**

SMPTE TECHNICAL CONFERENCE, Society of Motion Picture and Television Engineers; Ambassador Hotel, Los Angeles, **April 12-17.**

MICROELECTRONICS SYMPOSIUM, IEEE: Chase Park Plaza Hotel, St. Louis, Mo., **April 13-15.**

FLIGHT TEST INSTRUMENTATION INTERNATIONAL SYMPOSIUM, College of Aeronautics, Cranfield, Bedfordshire, England, **April 13-16.**

AEROSPACE ELECTRO-TECHNOLOGY, INTERNATIONAL CONFERENCE AND EXHIBIT, IEEE, AES, SAE, ASME, ASM, ASVACE; Westward Ho Hotel, Phoenix, Ariz., **April 19-25.**

ADVANCE REPORT

CONSUMER ELECTRONICS *Technical Session at the National Electronics Conference, Oct. 19-21, McCormick Place, Chicago, Ill.; IEEE PTG's on Audio, Broadcast and Television Receivers, and Electron Devices. March 30 is deadline for submitting abstracts to James F. Novak, 6601 S. Laramie Ave., Chicago, Ill. 60638.*

Common Market, Common Patent

BRUSSELS—The six member governments of the European Economic Community now have in their hands a report—already adopted by subcabinet representatives of the six—that points the way to a European patent and a possible change in U.S.-European patent relations.

The report pins down the fundamental problems that the governments must solve before the final text of a draft convention can be hammered out. Some of the problems—mostly political—to be wrangled out at ministers meetings are:

- Scope—Should the European patent be limited to EEC countries or opened up to others?
- Rights of third country nationals—Should anyone be eligible to file for a European patent or should applications be limited to nationals of contracting states?
- Compulsory licensing—Should mandatory licensing be left up to the individual governments? The majority of the six want a clause that would make licensing mandatory for anyone who hadn't exploited his European-patented invention within three years.
- Administration—Where should the patent office be located? What sort of authority should control it? What international court should judge validity disputes? (The six are agreed that infringement suits should be handled by national courts.)

As for the patent itself, the experts, in their draft convention, combined the best features of the two patent systems now in use in the EEC—the "examination" and the "registration" systems.

In the draft convention's two-step process, an inventor would first get a provisional patent, essentially a "registration" backed up by a summary "newness" search. The provisional patent would lapse after five years. To turn the five-year patent into a full-fledged twenty-year patent would require a full-fledged examination. The deferred examinations are expected to prevent the enormous backlog that swamps U.S., German, and British patent offices. Besides, experts' studies revealed that 60 percent of patents become worthless after six years.

Satellites To Probe Ionosphere, Test Laser

NEXT WEEK, two more satellite launches are planned. One will be the Topside Sounder, whose mission is to help improve world-wide communications by collecting data on the ionosphere. The other will make the long-postponed test of a laser for space tracking.

The 97-lb Ionosphere Explorer satellite (S-48) is part of a joint program by Canada, Great Britain and the U.S.

Density and thickness of the ionospheric layer will be determined by transmitting radar pulses at 1.5 to 7.2 Mc into the ionosphere, and measuring the round-trip transit time. Data will be transmitted to ground on a 136 to 137-Mc carrier.

The laser will be tested by NASA's S-66 Polar Ionosphere Beacon Satellite. The satellite will have a reflector array at its base to catch a ruby-laser beam. Signals reflected back to ground will be amplified by a photomultiplier tube. Round-trip time will give distance of the satellite.

Systems Will Process Raw Radar Data

FIRST of four radar video data processors built for the FAA by Burroughs were to be shipped to the National Avionics Facility Experimental Center (NAFEC) today. The equipment is used to convert raw radar and beacon video into digital "words" that can be transmitted over telephone lines. The microwave relay links now used to transmit the raw rata typically cost $360,000 for a long-range radar 90 miles from a control center. The data-processors fit into the FAA's plan to automate air-traffic control routine. They can be used to feed whatever computer the FAA picks.

IN BRIEF

COMPUTER with multiple typewriter outputs, each batting out a "personal" letter, is being tested in Washington for a "high public figure" who likes to have correspondence answered promptly — and with a personal look—even when the volume is in the thousands.

ZENITH President Joe Wright announced last week that the company will sell tv sets using rectangular 25-inch color tubes during the latter half of 1964 for $75 to $100 extra. Zenith hopes to sell 300,000 color sets in 1964—or 30 percent of the expected 1 to 1.2-million market.

JAPAN Broadcasting Corp. is developing a bandwidth-compression method to permit satellite transmission of television of commercial quality in 1.5 Mc.

SYLVANIA has doubled its production of color-tv picture tubes since the first of the year.

WASHINGTON University, St. Louis, will be the new site for the computer technology center in the biomedical sciences, recently phased out at MIT (p 17, Feb. 21, 1964).

COMPONENTS for what is said to be a practical optical radar are being tested at Sperry Rand's Electro-Optics Group. The three-laser, optical-heterodyne system operates at a 1.06-micron wavelength and combines power, narrow bandwidth, phase stability and narrow beam angle. Sperry engineers say this combination will give laser radars greater range and sensitivity than existing optical systems.

PALO ALTO—Granger Associates will install the first operational ionosphere sounders under two contracts — totalling $1.5 million — from Air Force Communications Service. Previous work on ionosphere sounders has consisted of research and feasibility studies using experimental transmissions. Granger will engineer, furnish and install sounders, antennas and display devices at Air Force locations in Pacific and Atlantic operational zones. Work should be finished by the first of May.

FIRST National Cash system to link reservation-recording machines directly to a computer is now in use by Pacific Southwest Airlines. An NCR 315 computer handles inquiries.

Project Definitions Will Precede All Big DOD Contracts

The Defense Department is taking two steps to clarify and simplify contracting procedure:

- After a two-year test, it will incorporate a "project definition" phase in planning for major projects with development costs over $25 million, or expected production costs of $100 million or more.
- On April 20, the Pentagon will begin a pilot test of Project 60, to determine the feasibility of consolidating Army, Navy, Air Force and Defense Supply Agency offices which administer contracts. The test will be conducted in the Philadelphia region.

The "project definition" phase is a period of time set aside for precise planning of engineering, management, schedules and cost factors before commitment to a full-scale development program. A McNamara brainchild, the new phase is aimed at lessening chances of a project being cancelled once it is begun, by establishing firm, realistic specs, schedules and costs. It is also hoped that with high precision at an earlier stage, the trend toward fixed-price contracts, and away from cost-plus contracts, will be speeded.

Hoffa's Conviction May End Teamsters' Electronics Drive

Labor organizing will see wholesale changes if James R. Hoffa is ousted as head of the Teamsters Union. Hoffa's departure is being freely predicted in the wake of his conviction in Chattanooga last week on charges of jury tampering.

Many Teamster leaders badly want their union taken back into the AFL-CIO fold, but AFL-CIO says no, so long as Hoffa is chief. The Teamsters Union was expelled from the AFL-CIO in 1957. The Teamsters would have to quit raids on other AFL-CIO affiliates in the communications field, and membership drives in electronics would end. Where Teamsters have tried to move into nonunion territory, they would be likely to turn the activity over to a union with a greater claim to jurisdiction, such as the Communications Workers.

Tax Men Tightening Rules Affecting Engineering Firms

Internal Revenue Service is expected, within a matter of weeks, to set final rules restricting or prohibiting the use of corporate organization for federal tax purposes by engineers, and other professionals. Engineering firms organized as corporations, rather than partnerships, would thus lose some of the important tax advantages they now enjoy, particularly in the building of pension funds.

In IRS hearings last week on the proposed regulation, architects and engineers both opposed the new criteria that IRS suggests. Although IRS may make some amendments, it is expected to tighten up its regulations along much the same lines as it has proposed.

Congress Shakes Up Cooperative Weapons Program

Several projects for the cooperative development or use of weapons by the U. S. and its allies are in trouble:

- Congress has cut the appropriation for R&D on the Mobile Medium Range Ballistic Missile (which the U. S. is developing principally for use by NATO members) from $110 to $40 million. Congress specifies that spending of the remaining money be concentrated on development of stellar-inertial guidance.
- The House Armed Services Committee is pressuring the Defense Department to reexamine whether the U. S. should continue to participate with Britain and West Germany in development of a vertical takeoff and landing aircraft. The committee questions why this investment should be made when a number of promising aircraft of this type are being developed in the U. S.
- And the Army has stopped procurement of the Canadian-built Caribou I logistics aircraft. Whether the follow-on Caribou II, soon to undergo tests, will be bought is undecided.

CIRCLE 21 ON READER SERVICE CARD→

Why Do Tigers Wag Their Tails?

When you see a Flying Tiger Swing-tail-44 with its tail out of joint, you see the biggest cargo-loading threshold in captivity. Tiger's straight-in loading swallows your freight safely, economically, speedily. We call it "one-gulp" loading.

The Tiger's 6′9″ high cargo hold is over two boxcar-lengths deep. If we can't get your outsize shipment on board, nobody can. Sideloaders just aren't of the same stripe when it comes to handling single units of large size.

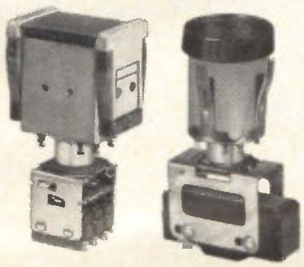
Flying Tigers is the Airfreight Specialist that gets whatever you've got—or want—in, up, down and off according to your schedule.

For big, or little, airfreight shipments, track us down. This is the way your problems end, not with a whimper but a roar.

first in airfreight with airfreight first **FLYING TIGER LINE**

FLYING TIGER LINE AIRFREIGHT SPECIALISTS

"Series 5" Pushbutton Switches: Sealed, modular construction. Momentary or alternate action, with or without magnetic coil. Modules include dry circuit gold-contact, 25 amp. capacity, subminiature, hermetically-sealed and multi-circuit assemblies. Size shown: 3.90" x 1.0". **Catalog 68**



"Series 2" Modular Lighted Pushbutton Switches: Round or rectangular operator units. Maintained, momentary or magnetic pull-in action. Variety of color screens. 20 switch modules. Size: 3" x 1¼" x 1". **Catalog 67**

"50PB" Lighted Pushbutton Switches: Round, square or hex buttons in 5 colors. Momentary or alternate action. Variety of circuitry Size: 2.85" x .78" x .66". **Data Sheet 133**

"TS" Bushing-mounted Toggle Switches: Sealed lever and keyed bushing. Multi-circuit switching. 1 and 2 pole. Size: 2.24" x 1.13" x .63". Rating: 15 amps ind., 25 amps res., 30 vdc; 10 amps ind. and 15 amps res., 125 vac. **Catalog 73**

"AT" Subminiature Toggle Switch Assemblies: Weight and space savers. Available with up to eight SPDT switching units. Gold or silver contacts. Regular solder, turret or double-turret terminals. Size shown: 1.36" x .80" x .38". **Catalog 73**

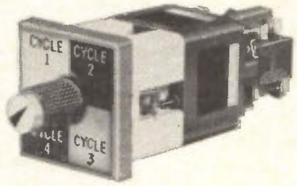
"1RM" Multi-pole Rotary Switches: 15 amp. capacity, up to eight switching units. Two-position switches are standard—up to eight positions available. Gold-contact and hermetically-sealed assemblies available. Size: shown: 2.5" x 1.6" x 1.5". **Data Sheet 202**

"E6"-"V6" Enclosed Switches: "E6" side-mount, "V6" flange-mount, easy wiring, rugged. With or without plunger boots. Variety of actuators. Rating: 15 amps, 125, 250 or 480 vac; ½ amp, 125 vdc; ¼ amp, 250 vdc. Size shown: 3.04" x 2.80" x 1.0". **Catalog 83**

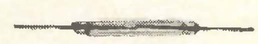
"TL" Pull-to-unlock Toggle Switch: Requires definite pull of lever to change positions. Several locking combinations. Available in 1, 2 or 4 poles. Sealed. Size: 2.7" x 1.12" x .62". Rating: 15 amps ind. and 20 amps res., 30 vdc; 10 amps ind. and 15 amps res., 115 vac. **Catalog 73**

Pre-engineered Electronic Switch-circuit Packages: Eliminate need for custom circuits. Size shown: 3.22" x 1.04" x .75". **Data Sheets 150, 177 and 194**

"ET" Environment-proof Magnetic Hold-in Switches: Built-in solenoid permits conversion from momentary to maintained contact and remote electrical release. Sealed. SPDT or DPDT. 2- or 3-position. Size: 2.91" x 1.0". Rating: 2.5 amps ind. and 4 amps res., 28 vdc. **Catalog 73**



Coordinated Manual Control: Combines lighted legend display and heavy duty or electronic duty contact blocks in compact, sealed assembly. Units available—pushbutton, rotary selector, selector-push, and indicator only. Variety of color-coded displays, up to seven lines of legend. Requires only 2⁵⁄₁₆" x 2⁵⁄₁₆" panel front space. **Catalog 69**



1CS1 Reed Switch: For dry circuit applications requiring long life, low power actuation. Consists of low reluctance metal reeds, hermetically sealed in inert gas filled glass tube. Actuated by permanent magnet or magnetic coil. Size: .105" diameter x 1.5". Rating: .100 amp, 120 vac; .125 amp, 32 vdc. **Data Sheet 214**

Mercury Switches: Offer reliability in contaminated atmospheres. Many sizes, capacities, and operating characteristics. Hermetically sealed glass tube. Enclosed switch shown: 1.88" x .53" diameter. **Catalog 90**

PLUS help like this...

Experienced design and quality control engineers provide reliable answers to any space-age design problems you might have.

Qualified field engineers, fully seasoned in the design and application of switches, are available to your design team at a moment's notice.

SEE OUR EXHIBIT BOOTHS 2511, 2513 IEEE SHOW MARCH 23-26 • NEW YORK COLISEUM

H HONEYWELL

MICRO SWITCH

FREEPORT, ILLINOIS 61033

A DIVISION OF HONEYWELL

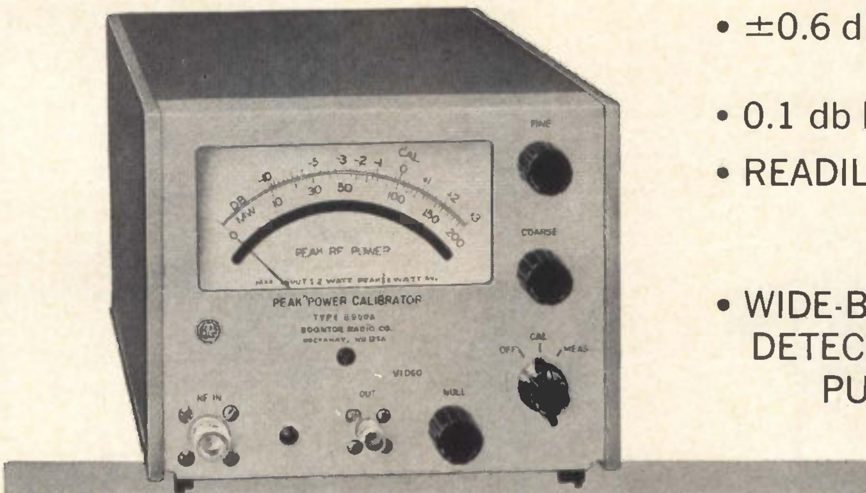
IN CANADA: HONEYWELL CONTROLS LIMITED, TORONTO 17, ONTARIO

HONEYWELL INTERNATIONAL—SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD. MANUFACTURING IN UNITED STATES, UNITED KINGDOM, CANADA, NETHERLANDS, GERMANY, FRANCE, JAPAN.

MEASURE **PEAK POWER**

INDEPENDENT OF DUTY CYCLE

50 - 2000 MC



- ±0.6 db ABSOLUTE ACCURACY
- 0.1 db PRECISION
- READILY STANDARDIZED WITH EXTERNAL BOLOMETER
- WIDE-BAND (7 Mc.) DETECTOR OUTPUT FOR PULSE MONITORING

The Type 8900-B Peak Power Calibrator provides a convenient means for measuring the peak RF power of pulses in the range from 50 to 2000 MC. The power level is read out directly on the panel meter and is completely independent of repetition rate and pulse width (>0.25 μsec). The instrument consists of a precision terminated input circuit, diode detector, DC reference supply, meter and a chopped video output system.

In operation, the RF signal is applied to the input circuit, which, through a power splitter, feeds the diode detector. The demodulated diode output and the output of the DC reference supply are simultaneously fed to the video output through a mechanical chopper.

In making a measurement, a suitable external oscilloscope is connected to the video output and the DC reference voltage is adjusted so that it is exactly equal to the peak value of the demodulated pulse. The level of the required DC reference voltage is then indicated on the panel meter, calibrated to read peak RF power. The diode is operated in a biased condition for maximum stability of calibration. Provision is made, however, for readily standardizing the instrument against an external bolometer or calorimeter by simply connecting to the input circuit in place of a standard termination.

The Peak Power Calibrator is completely self-contained and housed in a modular cabinet which may be readily rack mounted.

SPECIFICATIONS

RADIO FREQUENCY MEASUREMENT CHARACTERISTICS:

RF RANGE: 50 to 2000 MC
RF POWER RANGE: 200 mw* peak f.s.
*May be readily increased through use of external attenuators or directional couplers.
RF POWER ACCURACY: ± 1.5 db*
*±0.6 db with custom calibration curve.
RF POWER PRECISION: 0.1 db
RF PULSE WIDTH: >0.25 μsec
RF REPETITION RATE: 1.5 MC max.
RF IMPEDANCE: 50 ohms
RF VSWR: <1.25

MONITOR OUTPUT:

LEVEL: 0.2 volt for 20 mw. input.
IMPEDANCE: 150 ohms nominal.
BANDWIDTH: >7 MC.

PHYSICAL CHARACTERISTICS:

MOUNTING: Cabinet for bench use; readily adaptable for 19" rack mounting.
FINISH: Gray engraved panel; green cabinet (Other finishes available on special order).
DIMENSIONS: Height: 6⅛", Width: 7¾", Depth: 11"
WEIGHT: Net: 10 lbs.

POWER REQUIREMENTS:

8900-B: 105-125/210-250 volts, 50-60 cps

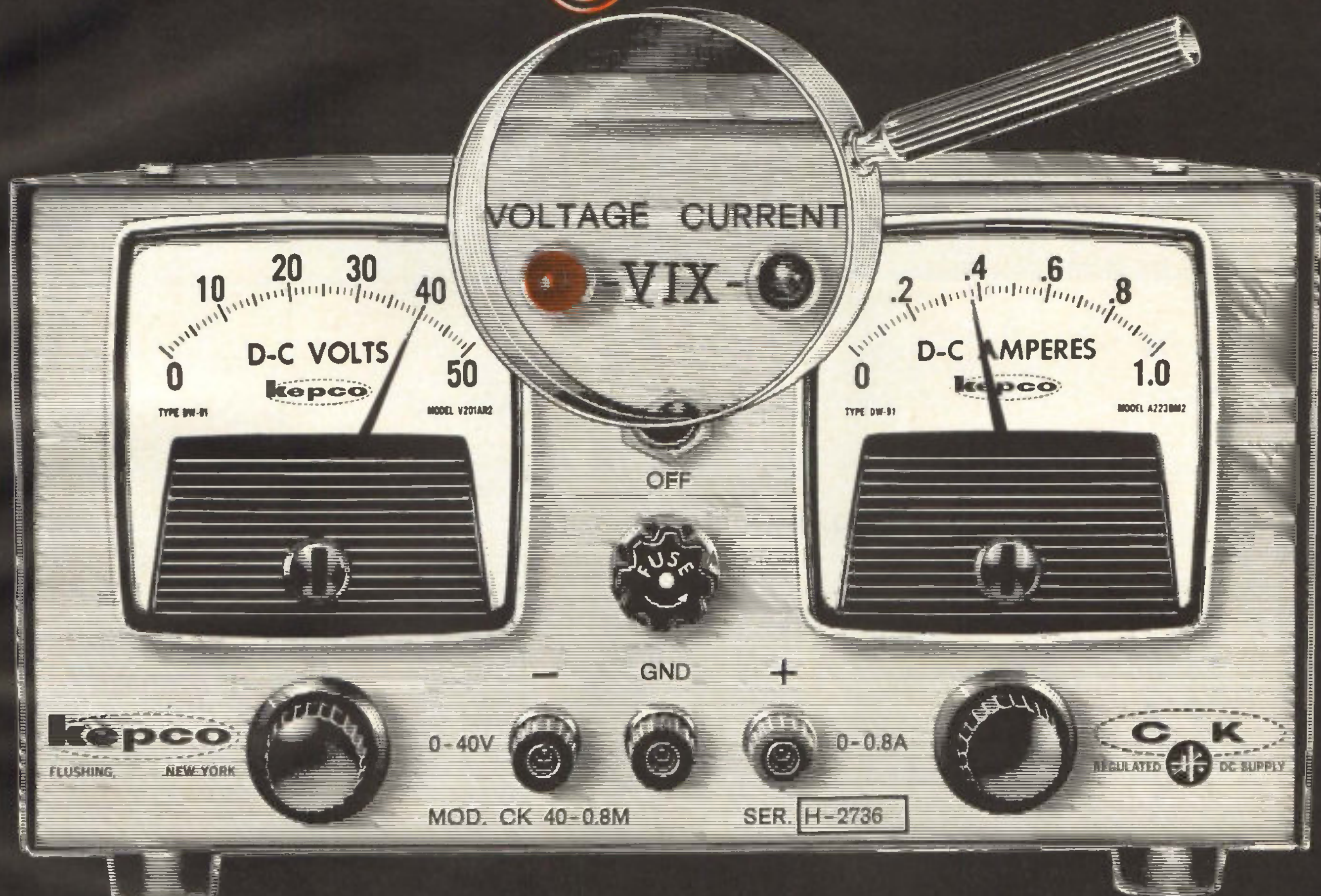
PRICE:

8900-B: $485.00—F.O.B. Rockaway, N. J.
Custom Calibration Curve: $75.00

SEE OUR EXHIBIT AT THE IEEE SHOW BOOTHS 3401-3403

BOONTON RADIO COMPANY
A Division of Hewlett-Packard Company
GREEN POND ROAD, ROCKAWAY, NEW JERSEY
Tel. 627-6400 (Area Code 201) TWX: 201-627-3912 Cable Address: Boonraco

NEW! MODE INDICATORS FOR VOLTAGE/CURRENT REGULATED POWER SUPPLIES



KEPCO TIME-SAVING VIX* INDICATORS

Kepco voltage/current regulated power supplies in the CK series now come equipped with voltage/current mode indicators called "VIX".* Time saving and added utility are provided by these indicators which show at a glance whether the power supply is in its voltage regulating mode or its current regulating mode. This indication is especially useful in the Kepco CK Models since they have extremely sharp cross-over characteristics.

*VOLTAGE/CURRENT CROSSOVER INDICATORS

NEW CK SERIES (REGULATED DC SUPPLY)

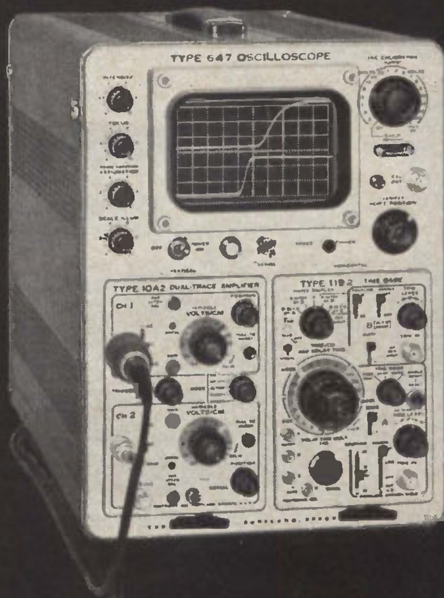
0.01% REGULATION and STABILITY

DC OUTPUT RANGE VOLTS	AMPS	MODEL	PRICE
0–2	0–8	CK 2–8M	$330.00
0–8	0–5	CK 8-5M	330.00
0–18	0–3	CK 18-3M	290.00
0–36	0–1.5	CK 36-1.5M	290.00
0–40	0–0.8	CK 40-0.8M	255.00
0–60	0–0.5	CK 60-0.5M	290.00

Send for complete data on Kepco CK Models featuring NEW "VIX" Indicators.

kepco Inc. ®

131-38 SANFORD AVE. • FLUSHING 52, N.Y.
(212) IN 1-7000 • TWX# 212 539-6623
Cable Address: KEPCOPOWER, NEWYORK



DC-TO-50 MC, 10 MV/CM

Solid-State Oscilloscope

for accurate, reliable measurements . . . even in difficult environments.

The type 647 Oscilloscope and plug-in units add new convenience to display and measurement of high sensitivity, wide-band, dual trace applications.

Adaptable and versatile, the oscilloscope retains accuracy, within stated specifications, *under extensive temperature variations . . fluctuating line voltages . . difficult conditions.*

TEMPERATURE

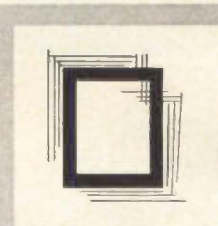
Non-Operating —55°C to +75°C. Operating —30°C to +65°C.

SHOCK

Non-Operating 20 G's max, 2 shocks, each direction, along each of 3 major axes.

HUMIDITY

Non-Operating meets Mil-Std-202B, Method 106A, except freezing, vibration, through 5 cycles (120 hours).



VIBRATION

Non-Operating or Operating 0.025" pk-pk, 10-55-10 cycles, (4 G's max), 1 min cycles, 15 min each major axis.

ALTITUDE

Non-Operating 50,000 ft. Operating 15,000 ft. 50-to-400 cps line freq.

Type 647 Features

with 10A2 and 11B2 Plug-In Units

- 100 v—130 v line voltage. No calibration changes with line fluctuations. 50-to-400 cps line frequency. Low power—185 watts, approximately. Convection cooled—no fan needed.
- Dual-trace operation. 10 mv/cm sensitivity. Dc-to->50 Mc passband. Less than 7-nsec risetime.
- 6-cm by 10-cm display area. Internal, no-parallax graticule. Controllable graticule illumination. 14-kv accelerating potential.
- Bright line automatic triggering. ÷10 external trigger attenuator, (on main time-base triggering). 'Ground' input positions on each vertical channel.
- 2 time bases, independent triggering. Sweep rates to 0.1 μsec/cm. 10X sweep magnifier.
- Sweep delay 50 sec to 1 μsec. Single-sweep operation. Wideband (>50 Mc) triggering. External horizontal input.
- 1-kc voltage calibrator, (crystal controlled). Pushbutton trace finder. Dc-coupled Z-axis amplifier. Current-probe calibrator.

Type 647 Oscilloscope . . . . (without plug-ins)	$1225
Type 10A2 Dual-Trace Unit	$675
Type 11B2 Time-Base Unit	$825
2 P6008 Probes	$ 70

U. S. Sales Prices f.o.b. Beaverton, Oregon

Dual-trace display shows input and output pulses of an amplifier at 10 nsec/cm—with trigger source from channel 2 only, for convenient and accurate time relationship between traces. Upper trace is amplifier output. Lower trace is applied step function.

FOR MORE INFORMATION—OR TO ARRANGE A DEMONSTRATION—PLEASE CALL YOUR TEKTRONIX FIELD ENGINEER.

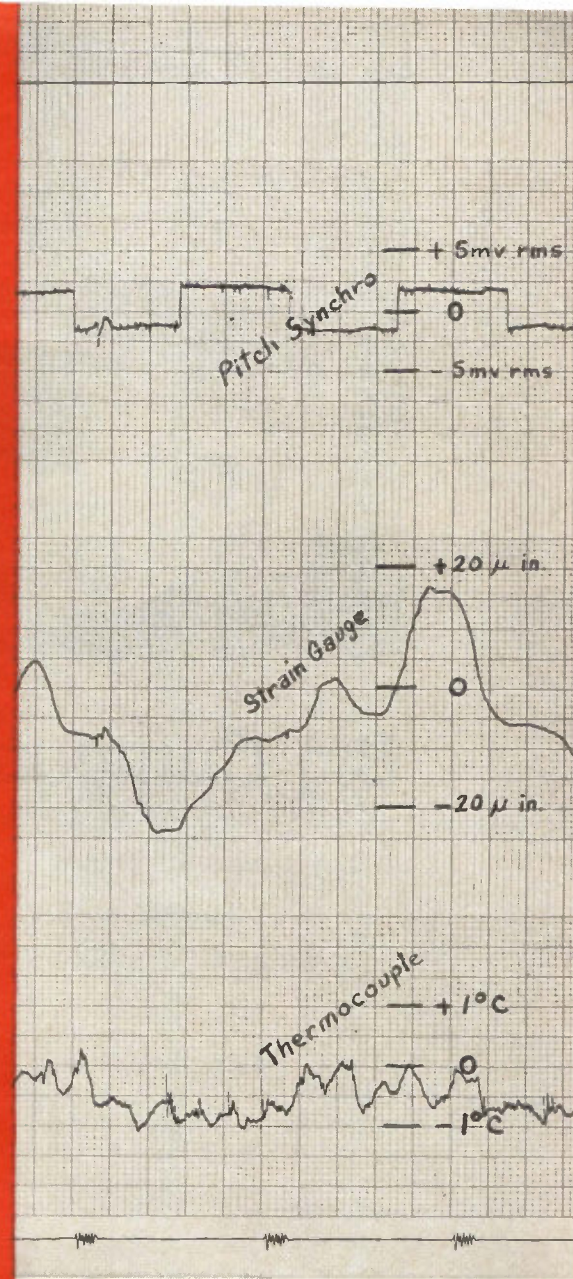
Tektronix, Inc. / *P.O. BOX 500 • BEAVERTON, OREGON 97005 • Phone: (Area Code 503) Mitchell 4-0161 • Telex: 036-691*
TWX: 503-291-6805 • Cable: TEKTRONIX • OVERSEAS DISTRIBUTORS IN 25 COUNTRIES
TEKTRONIX FIELD OFFICES in principal cities in United States. Consult Telephone Directory
Tektronix Australia Pty., Ltd., Melbourne; Sydney • Tektronix Canada Ltd., Montreal; Toronto
Tektronix International A.G., Zug, Switzerland • Tektronix Ltd., Guernsey, C. I. • Tektronix U. K. Ltd., Harpenden, Herts

ticklish signals?

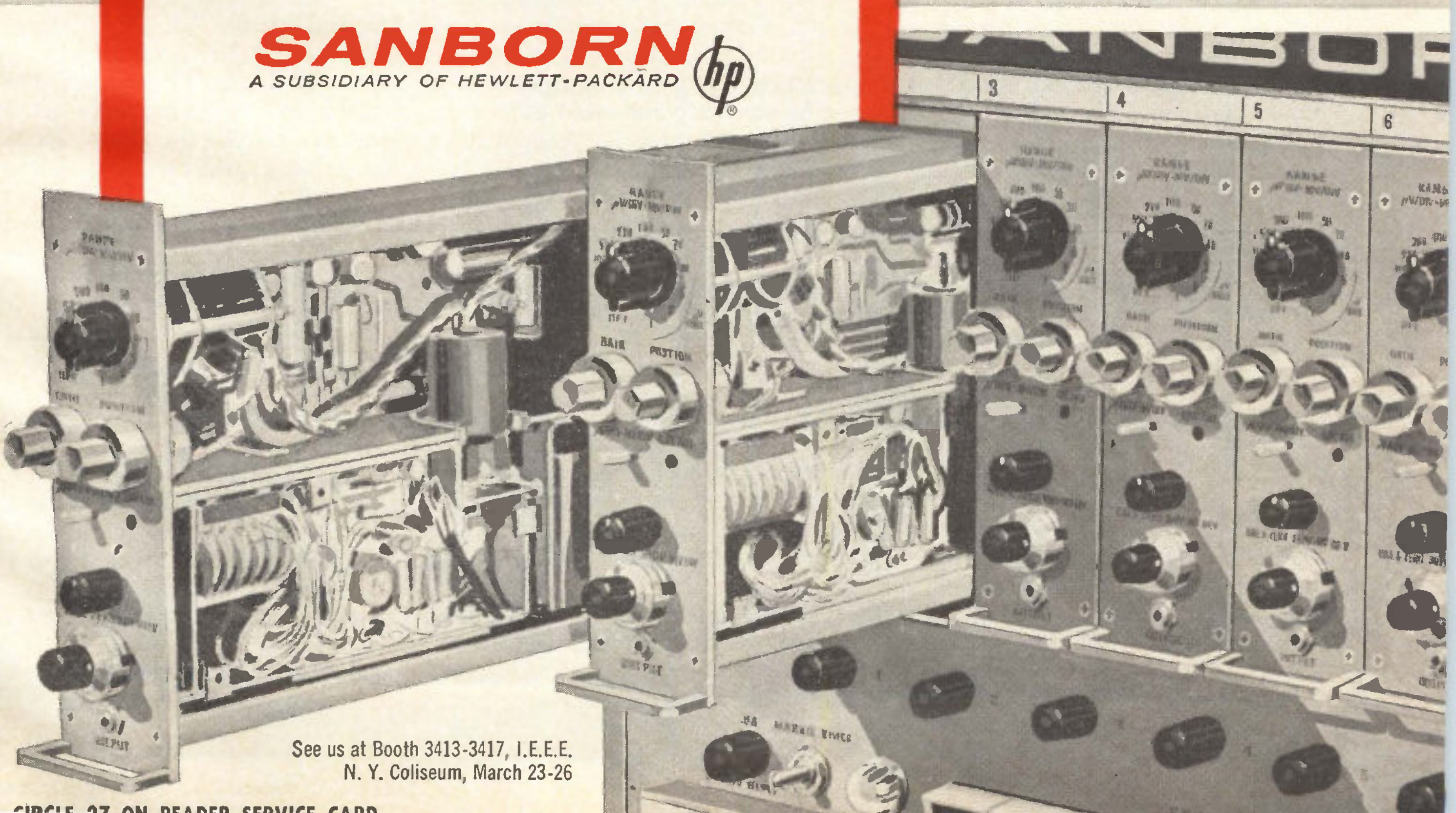
PUT THEM ON PAPER WITH EASE WITH THIS NEW SOLID STATE OSCILLOGRAPH

Now you can precisely measure and record a greater variety of AC and DC variables — over wider dynamic ranges and with more signal-conditioning capabilities at your command — with this new Sanborn 7700 Series 6- and 8-channel oscillograph. A choice of highly developed plug-in preamplifiers (eight in 7″ x 19″ of panel space) gives you recording capabilities such as: 1 μv/div. to 250 volts full scale in a single preamp, which also has multi-range, calibrated zero suppression built in . . . phase-sensitive demodulation of in-phase or 180° out-of-phase floating signals, 60 cps to 40 KC, with calibrated or uncalibrated adjustable phase shifting . . . carrier signal recording from 10 μv/div. and with calibrated zero suppression and cal. factor.

The all-solid-state circuits in this new system also mean cooler operation with less power than tube circuits . . . easy servicing of modular circuits on accessible plug-in cards . . . simpler, smaller power supplies with integral AC excitation . . . and generally improved drift, gain stability, noise and linearity characteristics. Combine these advantages with the proven and widely-used Sanborn *heated stylus*-Permapaper® recording method: true rectangular coordinate writing with *higher* resolution at slow chart speeds, *no* spills or smears, *greater* environmental immunity, *no* priming or constant attention needed. Call your HP field engineering office for complete specs — or write Sanborn Company, Industrial Division, Waltham, Mass. 02154

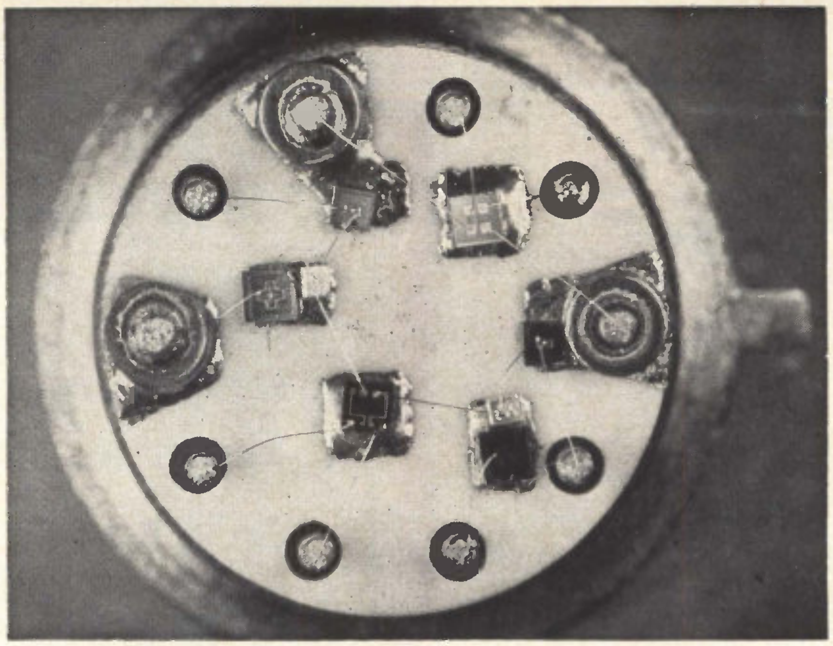


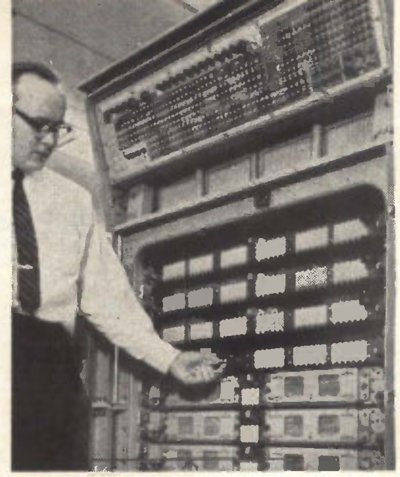
SANBORN
A SUBSIDIARY OF HEWLETT-PACKARD



See us at Booth 3413-3417, I.E.E.E.
N. Y. Coliseum, March 23-26

CIRCLE 27 ON READER SERVICE CARD





COMPUTER built for Navy has a volume of 60 cubic feet

HYBRID circuit combines integrated and discrete components in transistor can

Big Computer Goes in Small Package

Company claims its micro system is as speedy as the large commercial computers

ST. PAUL, MINN. — Univac reported last week that it has delivered to Navy a computer that has eight times the speed and four times the memory capacity of its conventionally fabricated predecessor of the same size.

Size was reduced by adopting a hybrid form of microelectronics, combining integrated-circuit and discrete components in transistor cans that are mounted on interchangeable printed-circut cards. Packed inside a Motorola type TO-5 10-pin transistor can, for example, are two inverters with matched transistors, integrated diodes and silicon resistors.

The design, which also includes a ferrite-core memory and two thin-film memories, resulted from a contract to develop high-density hybrid microcircuitry, awarded Univac by Navy Bureau of Ships. Another of the computers will be delivered to Navy in June.

The computer, designated the CP-667, is a successor to the CP-642A, which Navy now uses aboard ships. Completely compatible operation enables direct use of many operational programs already written by the Navy and other users for the CP-642A and B. Anticipated reliability of the new computer is over 1,000 hours between failures.

During a final 30-hour endurance test, the computer performed 54 billion instructions at the rate of 30 million a minute. It was designed to handle both scientific problems and real-time problems. Univac says that because of its capacity and speed, it will be ideal for real-time control applications.

Univac claims the new computer can match the speed and memory of any of the big commercial computers presently available.

Size and Speed—The CP-667 measures about 3 feet square by 6 feet high. Volume is 60 cubic feet. This includes the memories, input-output circuits and blower-cooling system. The cabinet is the type with button-

Secretary-Sized Computer Debut

NEW YORK—SCM Corp. has stepped into the very-low-priced computer field with a secretary-sized computer that sells for about $8,000 less than its nearest competitor. With the program on tape, any girl can operate it with a little training, the company says.

Both the computer and a document-writer, also introduced last week, use eight-channel punched paper tape and edge-punched cards. Because the SCM perforators punch their own sprocket holes, information can be punched on the edge of memos, letters and other documents. Some competing equipment requires prepunched sprocket holes in the documents.

The document-writing part of the system, called the Typetronic 2816, sells separately for $4,295. A solid-state system, its prints repetitive data at 10 characters a second and can be programmed to punch data on tape or cards for later use.

The complete computer, called the Typetronic 7816, will be sold in six models costing $11,900 to $14,500. It has transistor plug-in modules and a one-track magnetic disk. It adds, subtracts and transfers data in 8 to 18 milliseconds, and multiplies in 700 to 1,500 msec. There are nine registers, seven of them accumulators. Word length is usually 10 digits, but working registers can range up to 22 digits.

By comparison, Friden's desk-sized 6010 is much faster, but costs $19,750.

up doors that Navy prefers.

The new computer accepts and presents data at 12 times the rate of its predecessor. Using 16 input and 16 output channels simultaneously, information is transferred at 500 thousand words (about 18 million bits) a second under control of a thin-film memory.

Typical instruction times are 2 microseconds for add or subtract and 18 microsec for multiply or divide.

Memories — The ferrite-core internal memory consists of two banks, each with a capacity of 65,536 words of 36 bits each. Cycle time of each bank is 2 microsec, but time overlapping of the banks halves the word-time to 1 microsec, Univac says.

A 256-word thin-film control memory stores and retrieves information in 400 nanosec. Working with the high-speed memory, it can perform 500,000 additions a second. The memory controls the input and output data transfer, the storage of 120 index registers for modification of memory operand address, two real-time clocks, and eight accumulators for temporary storage of arithmetic results.

A 64-word nondestructive film memory automatically initiates operations by reading instructions from external devices. Wired-in programs start operation by reading programs stored on magnetic tape, drums, paper tape and disc files. The nondestructive memory can also store critical information. It automatically recovers from a catastrophic failure, such as temporary loss of power.

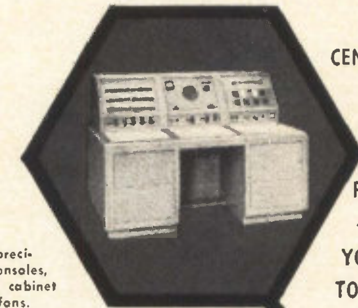
COMPUTER housing doubles as desk

WRITE TODAY FOR COMPLETE TECHNICAL AND ENGINEERING DATA

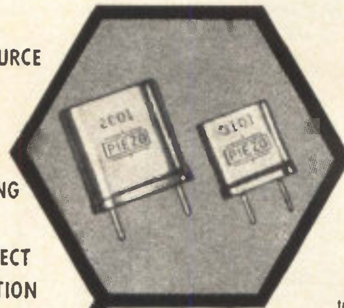
ONE CALL FOR ALL

of these Quality Electronic Components

ONE
CENTRAL SOURCE
SPEEDS
UP
YOUR
PURCHASING
— SPEEDS
YOUR PROJECT
TO COMPLETION

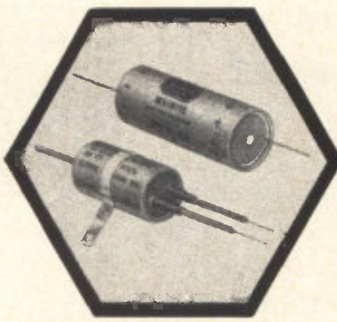


A complete line of precision-built standard—consoles, racks, chassis panels, cabinet slides, blowers, and fans.
PREMIER METAL PRODUCTS CO., INC.
Bronx, New York

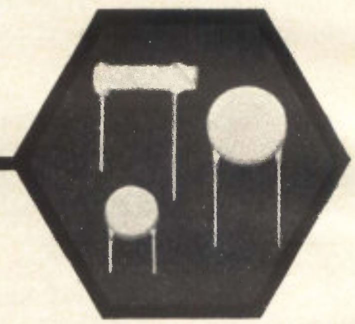


Manufacturers of quartz crystals for frequency control oscillators and amplifiers.
PIEZO CRYSTAL CO.
Carlisle, Pa.

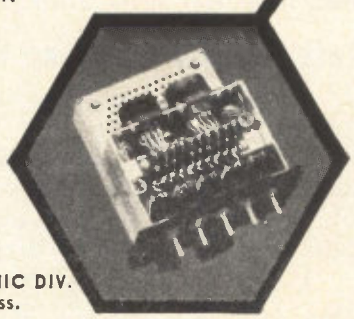
RENWELL
INDUSTRIES, INC.
and
CONSOLIDATED
SUBSIDIARIES



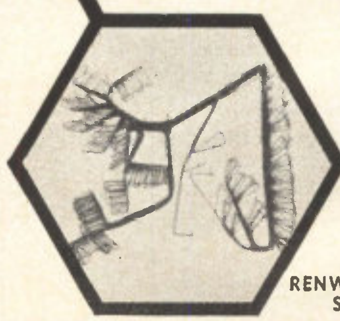
A complete line of: capacitive micromodule elements; paper, plastic film, metallized, tantalum, and electrolytic capacitors; R.F. interference filters.
ASTRON DIVISION
East Newark,
New Jersey



Ceramic disc and molded tubular capacitors employing the latest equipment and techniques.
SKOTTIE ELECTRONICS, INC.
Peckville, Pa.



Manufacturers of custom electronic assemblies to commercial or military specifications.
RENWELL ELECTRONIC DIV.
So. Hadley Falls, Mass.



Specialists in the custom manufacture of precision: electronic assemblies, wiring harnesses, cable assemblies.
RENWELL ELECTRONIC DIV.
So. Hadley Falls, Mass.

RENWELL INDUSTRIES SALES DIVISION

755 New Ludlow Road, South Hadley Falls, Mass.
Tel., 413-536-1800

REPRESENTATIVES

● N. Y. C.-Westchester County
For Premier and Renwell Only:
David Sonkin Associates
10 Fisk Place
Mount Vernon, N. Y.
Tel. 914-668-9809

For Astron and Skottie Only:
Henry Abbott
3939 Wicks Avenue
Seaford, N. Y.
Tel. 516-781-5256

● Northern New Jersey
Jack Gordon
167 Fort Lee Road
Leonia, New Jersey
Tel.: 201-482-7800

● Upper New York State
Naylor Electric Co., Inc.
1718 Erie Boulevard, East
Syracuse, N. Y.
Tel. 315-471-9183

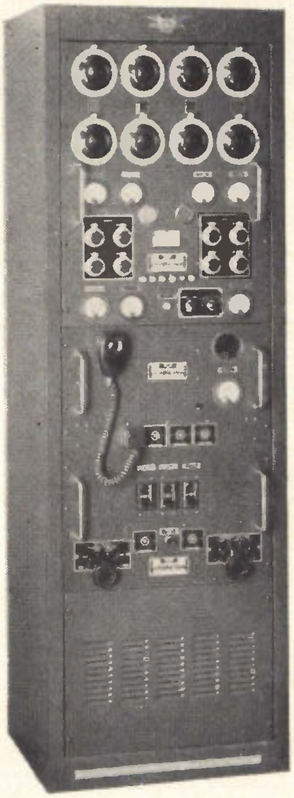
● L. I. (Nassau & Suffolk County)
J. L. Brown
64 Meadow Street
Garden City, New York
Tel.: 516-741-3046

● Conn.-West. Mass.-Vermont
C. G. Wilcox
P. O. Box 448
Thompsonville, Conn.
Tel.: 413-733-1871

● Eastern Pa., Southern New Jersey, Delaware, Maryland, Washington, D. C., Virginia

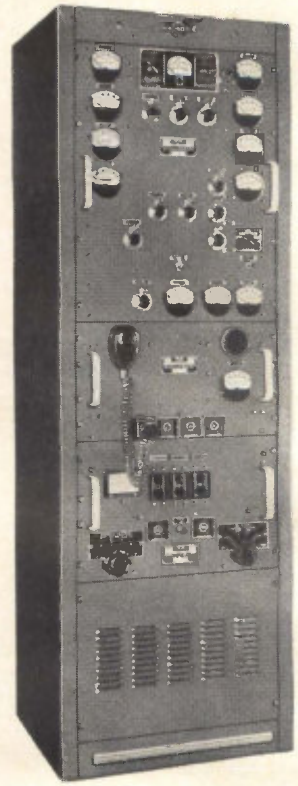
Samuel A. Jeffries, Inc.
105 Forrest Avenue
Narberth, Pa. 215-664-8500

Renwell presents New Products in Electronics at I.E.E.E. Booths 2833-2835



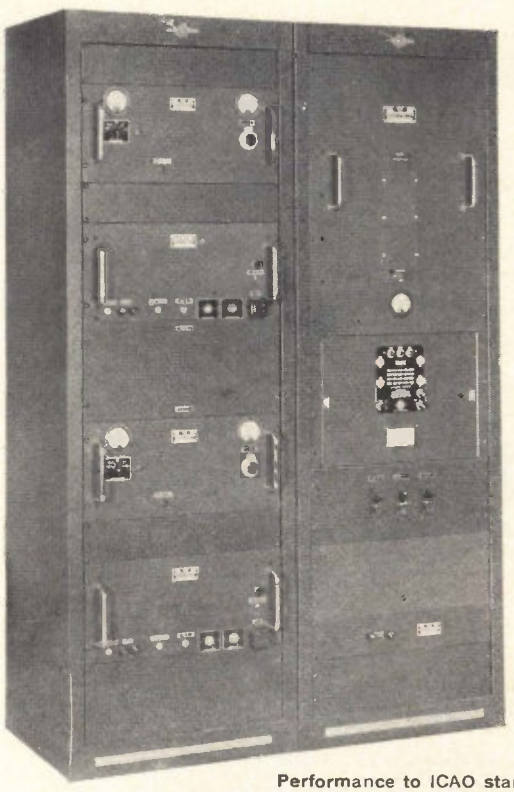
VERSATILE, DEPENDABLE COMMUNICATIONS EQUIPMENT BY

AEROCOM



A versatile stable rugged H.F. transmitter for A-1, A-3, FSK communications. Designed for point-to-point, ground to air, operating on 4 crystal controlled frequencies in band range 2-24 mcs. 1000 watts carrier power. Also available in 100 or 350 watt models. FCC Type accepted.

A VHF transmitter extensively used in extended range and satellite command services. Nominal output of 1000 watts in frequency range of 118-153 mcs. Can be remote controlled. FCC Type accepted. Also available in 200 watt and 50 watt models.



Model 85 — VHF Receiver. Low noise figure, single conversion, crystal controlled and very stable. Receiver covers frequency range 108-154 mcs. Also available, Model 77 for H.F.

Model 10LA—For more communications power AEROCOM 10LA linear amplifier used with your SSB transceiver will provide 1000 watts PEP for continuous service. Housed in cabinet that can be used as stand for exciter. Four non simultaneous channels cover band 2-22 mcs.

This dual package type ND Beacon operates in range 200 - 500 kcs. Intended for unattended service. It consists of 2—100 watt transmitters, 2 keyers, transfer unit and antenna tuner. Available in 50, 400, 1000 and 3000 watt models. FCC Type accepted.

Performance to ICAO standards. All AEROCOM equipment is ruggedly constructed to give long trouble-free service. Additional information on request.

WORLD WIDE AER -O- COM **SINCE 1946**

Complete technical data available on request

FCC Type Accepted for Aviation Service

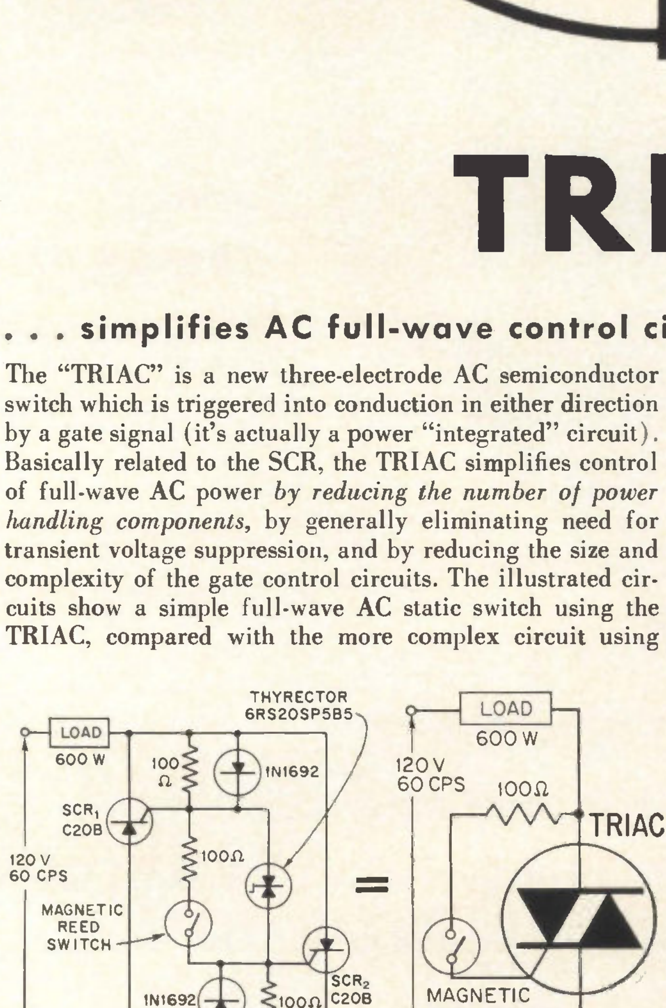
3090 S. W. 37th Avenue — Miami 33, Florida

TRIAC

. . . simplifies AC full-wave control circuits . . . reduces circuit size and cost

The "TRIAC" is a new three-electrode AC semiconductor switch which is triggered into conduction in either direction by a gate signal (it's actually a power "integrated" circuit). Basically related to the SCR, the TRIAC simplifies control of full-wave AC power *by reducing the number of power handling components,* by generally eliminating need for transient voltage suppression, and by reducing the size and complexity of the gate control circuits. The illustrated circuits show a simple full-wave AC static switch using the TRIAC, compared with the more complex circuit using multiple SCR's necessary to perform the same function.

If you're interested in applications such as static power switching, temperature controls, lamp dimming, motor speed controls, and many others, you should look into the TRIAC, available in compact and rugged stud or press fit housings. You'll also be interested in the new DIAC (diode AC switch) to trigger the TRIAC and SCR's. See your G-E Semiconductor Products District Sales Manager today, or write Rectifier Components Department, Section 16C125, General Electric Company, Auburn, New York.



TRIAC Specifications

Breakover Voltage, V_{BR}	± 200 volts min.
Load Current, I_L	5 amps rms AC max. at stud temperature = 80°C, full conduction (600 watts load)
Gate Triggering Requirements	
V_G	± 3 volts, $T_J = 25°C$
I_G	± 50 milliamperes, $T_J = 25°C$

GENERAL ELECTRIC

Your Four Days in March: How to Make the Most of Them

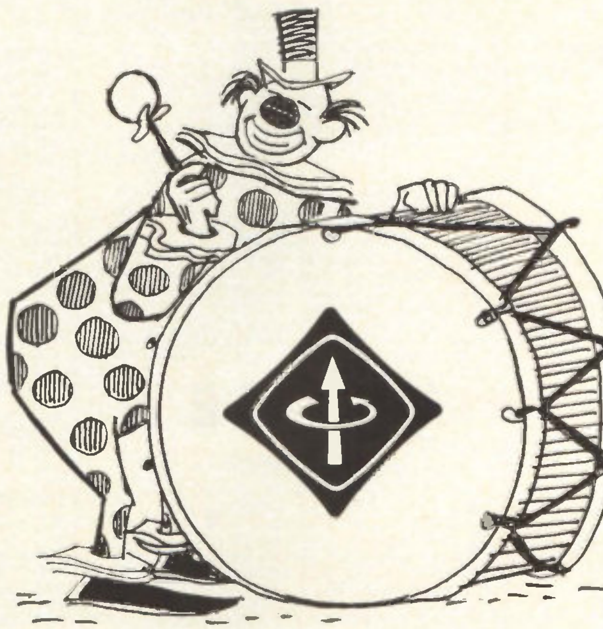
IEEE PREVIEW

This year's IEEE Convention will encompass 320 technical papers of varying degrees of merit and of specialization. Here is a rundown of papers that seem to point out emerging directions for our industry and a list of half a hundred noteworthy presentations

THE GREATEST SHOW ON EARTH—the Ringling Brothers-Barnum and Bailey Circus—has three rings, plus assorted clowns and tight-rope walkers—as well as a menagerie of 130 foreign and domestic animals.

This month the electronics industry will have an even bigger circus of its own. The Institute of Electrical and Electronics Engineers Second International Convention has eight simultaneous technical sessions, assorted committee meetings, and a trade show of 1,000 exhibitors.

An engineer attending the convention has a colossal task deciding which of the 320 technical papers in 64 sessions to hear, which exhibits to visit and how to participate in some of the professional activities of the four-day meeting. From this maze of frenetic offerings, technical session organizers believe about fifty papers promise to be really significant (see panel). They range from esoteric developments in advanced technology to mundane but interesting new trends in entertainment.



THE GREATEST SHOW ON EARTH

Advanced Technology—Recent developments in microwave technology have renewed interest in transmitting substantial quantities of electric power efficiently without wires. A continuous-wave Amplitron tube has generated 400 kilowatts with 70 percent efficiency. Power-transfer systems consisting of transmitting and receiving waveguides and antennas have operated with efficiencies slightly over 50 percent at both 8-mm and 10-cm wavelengths. The 10-cm system worked over a distance of 25 feet. And a close-spaced thermionic diode has provided 500 watts of d-c output at 200 volts with 50-percent efficiency. An experimental microwave power-transmission system has operated over a distance of 25 feet with 25-percent overall efficiency. It used a c-w magnetron operating at 2,450 Mc, a 9.5 ft diameter ellipsoidal transmitting antenna and a horn-type receiving antenna with a 19-in. aperture. (See paper No. 13.2.)

A super-energy accelerator far exceeding the capabilities of the 33-billion-electronvolt accelerator at Brookhaven National Laboratory will be discussed. The new machine could deliver either 200 or 1,000 billion electronvolts depending upon whether its sponsors want to pay half a billion dollars or go for broke with a cool billion. The chamber of the new machine would be five to ten times as long as the half-mile track of the Brookhaven machine. It would take seven to eight years to build. The giant machine would push to new limits the technology of high-power switching, controls and computers, multi-megawatt power sources, advanced power tubes and 20-Mc r-f and harmonic generators. (See paper No. 22.5).

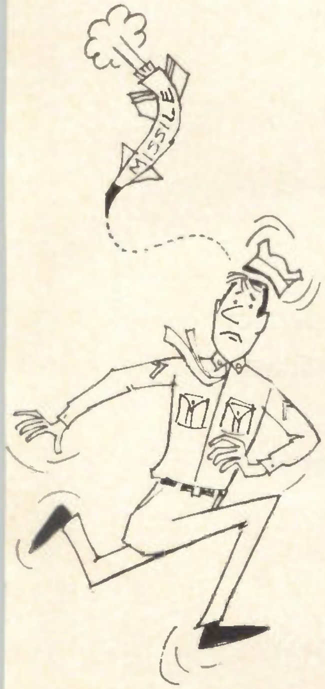
Session No. 55 on Human Factors deals with

64 SESSIONS TO HEAR

"quickening". This is a relatively new technique in human engineering which allows the human operator of a system to see the effect of a control action he might take before he takes it. One paper, 55.1, will show the application of quickening to a remotely controlled lunar surface vehicle and will have wide relevance to space exploration generally. Paper 55.4 will discuss the technique as used in the control of a tandem-propeller submarine. This new type of undersea craft has raised several knotty control problems. Its operation is described as "trying to fly a helicopter by instruments when blindfolded". Another paper, 55.3, will take a broad-front approach to man-machine systems design and in this paper the quickening techniques will play a relatively minor role.

Military Electronics—Microwave doppler radars, like those used by police departments to clock speeding vehicles, suffer from one serious limitation. This limitation is resolution of targets. If two vehicles are intercepted by the beam at one time, the radar set shows both of their velocities and also their sum and difference velocities.

Optical doppler radar has a much finer spatial resolving power and does not suffer from this limitation. However, conventional optical doppler radar requires a very wide bandwidth to



MILITARY

320 TECHNICAL PAPERS

PAPERS TO HEAR AT THE CONVENTION

SPACE

19.1 Experimental Investigation of Simulated Space Particulate Radiation Effects on Microelectronics, Emanuel Rind, F.R. Bryant, NASA Langley Res. Center, Langley Sta., Hampton, Va.

19.4 Optimization of Malfunction Sensing & Decision Systems for Space Vehicles, E.S. Joline, R.L. Smith, Information & Communications div., Sperry Gyroscope Co., Div Sperry Rand Corp., Great Neck, N.Y.

20.2 Effects of Rain on Transmission Performance of a Satellite Communications System, D. Gibble, Bell Tel Labs, Murray Hill, N.J.

20.3 Coded Division Multiplex System, A.B. Glenn, Defense Electronic Products, Systems Engineering, Evaluation & Res. Bldg., 127-310, RCA, Moorestown, N.J.

33.1 The design of Signals for Space Communications & Tracking, E.J. Baghdady, K.W. Kruse, ADCOM Inc., 808 Memorial Dr., Cambridge, 39, Mass.

33.2 Design of an instrumentation System for a Large Booster, V.V. Patton, R.W. Sjostrom, Wm. E. Smull, Mail A-172, Martin Co., Denver 1, Colo.

33.4 Telemetry Encoder for International Satellite S-52/UK-2, J.W. Adolphsen, A.B. Malinowski, NASA, Goddard Space Flight Center, Greenbelt, Md.

COMPUTERS

3.1 Tunnel Diode Memory, M.M. Kaufman, L. Dillon, G. Ammon, Electronic Data Processing Div., RCA, Camden 2, N.J.

3.3 High Speed Threshold Logic A/D Converter with Error Correction, D.S. Schover, Mark Stein, Hallicrafters Co., 4401 W. 5th Ave., Chicago, Ill.

11.2 Design of a Digital Waveform Identifier, E.J. Farrell, R.R. Lachenmayer, G.F. Marette, UNIVAC, Div. of Sperry Rand Corp., Univac Park, St. Paul, Minn.

21.4 Communications Swtiching and Telephone Charging of a Hotel Accounting System, J.C. Sieglinger, N.Y. Telephone Co., 140 West St., N.Y. 7, N.Y.

21.5 Data Processing Features of a Hotel Accounting System, W. Wilson, IBM Eastern Region Hqrs., 425 Park Avenue, N.Y.

60.2 The Timing Problem in Digital Communication—A Survey, B.K. Kinariwala, Bell Telephone Labs., Murray Hill, N.J.

CONSUMER

47.4 Proposed Articulation Rating for Loudspeakers, H.E. Allen, Jensen Mfg. Co., 6601 S. Laramie Ave., Chicago, Ill.

51.1 The RCA Victor "Dynagroove" System, H.F. Olsen, RCA Labs, Princeton, N.J.

51.2 An X-Field Micro-Gap Head for High Density Magnetic Recording, Marvin Camras, IIT Res. Inst., Technology Center, 10 W. 35th St., Chicago 16, Ill.

INDUSTRIAL

2.1 Diesel-Electric Machinery Installation with Centralized Control for Oceanographic Survey Ship, D.W. Drews, Westinghouse Electric Corp., East Pittsburgh, Pa.

2.2 A Marine Standard for Intrinsic Safety, J. M. Dorsey, U.S. Coast Guard, Merchant Marine Technical Div., Electrical Branch, Washington 25, D.C.

5.4 Design of Video Security Systems for Pay-Tv, Ira Kamen, Teleglobe Pay-Tv System, Inc., 400 Madison Ave., New York 17, N.Y.

10.1 Power Distribution Systems for High Speed Computers, J.W. Martin, Simpson Electric Co., 5200 W. Kinzie St., Chicago, Ill.

25.1 The Precision VOR System, A.B. Winick, Bureau of R&D, FAA, Washington 25, D.C. and E.R. Hollm, Airborne Instruments Lab., Div., Cutler-Hammer, Deer Park, L.I., N.Y.

INSTRUMENTATION

6.2 The Design of Linear Thermistor Networks, M. Sapoff, R.M. Oppenheim, Victory Engineering Corp., 128 Springfield Ave., Springfield, N.J.

6.3 Bendix Star Tracker Photomultiplier Tube, D. Ceckowski, Res. Labs Div., Bendix Corp., Southfield, Mich.; W. Polye, Eclipse Pioneer Div., Bendix Corp., Teterboro, N.J.; W. Wilcock, Instrument Technology Section, Dept. of Physics, Imperial College, London, England.

42.1 The Compensated Current Comparator; A New Reference Standard for Current Transformer Calibrations in Industry, N.L. Kusters, W.J.M. Moore, Radio and Electrical Engineering Div., National Research Council of Canada, Ottawa, Canada

42.2 Calibration of a Kelvin-Varley Voltage Divider, A.F. Dunn, National Research Council, Div. of Applied Physics, Ottawa 2, Ontario, Canada

42.4 The Application of Electronics to Instruments for Standards and Calibration, Peter Richman, Rotek Instrument Corp., 11 Galen St., Watertown 72, Mass.

ADVANCED TECHNOLOGY

7.1 Automatic Analog Solution of Algebraic Equations and Plotting of Root Loci by Generalized Mitrovic's Method, P. Kokotovic, System Analysis Div., Inst., "Milhailo Pupin", Belgrade, Yugoslavia and D.D. Siljak, Univ. of Belgrade, Belgrade, Yugoslavia

13.2 Experiments in the Transportation of Energy by Microwave Beam, W.C. Brown, Raytheon Co., Spencer Lab., Burlington, Mass.

22.5 Super Energy Accelerators, Lloyd Smith, Univ. of California, Lawrence Radiation Lab., Berkeley, Calif.

23.1 Information Theoretic Aspects of Feedback Control Systems, J.L. Barnes, Univ. of California, Los Angeles, Calif.

30.1 A Computer-Simulated Learning Control System, M.D. Waltz, K.S. Fu, Control & Info. Systems Lab., School of EE, Purdue Univ, Lafayette, Ind.

55.3 Analytical Methods in the Study of Man-Machine Systems, Miss B.L. Perry, H.P. Birmingham, U. S. Naval Res. Lab, Washington ,D.C.

55.4 Peripheral Augmentation of Range Perception in Pictorial Displays, H. G. Sperling, R.C. McLane, D.A. Anderson, Minneapolis-Honeywell, Minneapolis, Minn.

56.3 Electric Field Suspension of Inertial Masses, R.C. Staats, Precision Inertial Components, Minneapolis-Honeywell, Minneapolis, Minn.

56.5 Generation of Millimeter Waves by Means of the Doppler Effect, C.C.T. Wang, M.D. Birkis, Ultramicrowave Group, Dept. of EE, Univ. of Illinois, Urbana, Ill.

64.4 Ultrasonic Convective Cooling, J.E. McCormick, T.W. Walsh, Rome Air Development Center Griffis AFB, Rome, N.Y.

MILITARY

63.2 New Klystrons for Modern Multimegawatt Radars, A. Jorge, L. Singer, Sperry Gyroscope Co., Div. Sperry Rand Corp., Great Neck, N.Y.

63.4 A High Resolution, Microwave Modulated Optical Doppler Radar, R.B. Hankin, Halicrafters Co., Res. & Dev. div., 4401 W. 5th Ave., Chicago, Ill., and A.C. Todd, Illinois Inst. of Technology, 3300 Federal St., Chicago, Ill.

SOLID STATE

31.2 A General-Purpose Ceramic-Base Thin-Film Microcircuit Amplifier, Manfred Kahn, Sprague Electric Co., Engineering Labs., North Adams, Mass.

31.4 A Universal Logic Function Wafer, E.F. Uber, A.J. Domenico, Electronic Sciences Lab., Lockheed Missiles & Space Co., Palo Alto, Calif.

36.4 The TRIAC Gate Controlled Silicon AC Power Switch, E.K. Howell, Rectifier Components Dept., GE Co., Auburn, N.Y.

COMMUNICATIONS

1.2 192-Channel Time Division Multiplex PCM Communication System by Pulse Distribution Transmission, Hiroki Yoshine, Central Res. Lab., Hitachi, Ltd., Kokubunji-machi, Kitatama-gun, Tokyo, Japan

4.4 Error-Correcting Data Transmission System with Block-by-Block Synchronous Operation Over Telephone Channels, F. Schreiber, E. Lukas, P. Bocker, Siemens & Halske AG, Munich, Germany

28.6 A Low-Speed Magnetic Memory Device, Weichien Chow, ITT Kellogg, Telecommunications div., 6650 S. Cicero Ave., Chicago 38, Ill.

35.1 Communication Operations with Syncom II, T.R. Gleason, W.T. Tobias, R.G. Keyes, Test Operations Dept., U.S. Army Satellite Communications Agency, Ft. Monmouth, N.J.

35.4 Some Preliminary Results of Multiple Access Experiments with Syncom and Telstar II, V.G. Robatino, US etc (same as above)

35.5 Results of Syncom Communications Experiments, George Silverman, J.W. Lockett, J.C. Cittadino, (same as above)

39.1 An Introduction to Random-Access, Discrete-Address Systems, C.H. Dawson, Stanford Res. Inst., Menlo Pk., Calif.

39.2 Propagation Measurements for a Frequency Time Coded Pulse Communications System, J. Lomax, W. Bedsole, Martin Co., Orlando, Fla.

41.6 Experimental Belt as a Communications Medium, I.L. Lebow, P.R. Droulhet, Jr., W.B. Smith, Ferenc Nagy, Jr., Lincoln Lab., MIT, Lexington 73, Mass.

45.3 Design of the Conical Log-Spiral Antennas, J.D. Dyson, Univ. of Illinois, Urbana, Ill.

50.2 Air to Undersea Communication with Magnetic Dipoles, S.H. Durrani, Communication Prods Depf. GE Co., Mountain View Rd., Lynchburg, Va.

54.3 A Beam Waveguide Using Reflectors as Phase Correctors, J.E. Dengenford, M.D. Sirkis, Ultramicrowave Group, Elec. Engrg., Res. Lab., Univ. of Illinois, Urbana, Ill., and W.H. Steir, Bell Tel Labs, Holmdel, N.J.

54.4 Phase Characteristics of Spiral Antennas for Interferometer Applications, M.S. Wheeler, Air Arm Div., Westinghouse Electric Corp., Baltimore, Md.

62.2 Linear Array Synthesis, M.T. Ma, Electronics Lab., GE, Syracuse, N.Y.

62.3 An Equivalence Theory Between Elliptical and Circular Arrays, Y.T. Lo, H.C. Hsuan, Dept. of EE, Univ. of Illinois, Urbana, Ill.

measure any appreciable change in the vehicle's velocity and also requires almost perfect spatial coherence of the echo signal—something extremely difficult to achieve in practice. But when the optical signal is modulated by a microwave signal, the advantage of high beam resolving power is retained and there is sufficient doppler frequency shift in the microwave sidebands to determine velocity over a wide range. The optical source can be noncoherent.

Such an optical radar using microwave modulation is described in paper 63.4. The optical radar has an additional feature: it uses a dynamic crossed-field electron multiplier (DCFEM) to achieve efficient optical detection, frequency conversion and amplification of the received signal. The DCFEM is a wide-bandwidth high-gain multiplier phototube has been designed to use a microwave electric field in the multiplier section instead of the usual static electric field. When the incoming optical beam is modulated at a microwave frequency near that of the microwave electric field, the output frequency of the DCFEM is the difference between the two microwave frequencies. And, of course, if the modulation frequency is the same as the field frequency, the difference frequency is then the doppler frequency and yields the desired measure of vehicle velocity. The optical radar project is in the proposal stage and could be produced for military uses either in the air or on the ground.

Now on station as part of our Atlantic Missile Range are the Advanced Range Instrumentation Ships or ARIS. They use Sperry's Integrated Instrumentation Radar (IIR). This radar can capture target signatures at three distinct frequencies in the L, C and X radar bands (roughly 1,000, 5,000 and 10,000 Mc). Designers working in the high-power microwave field can now get a close look at the multimegawatt klystrons used in the ARIS ships. Paper 63.2 describes these tubes and covers significant achievements in increased power output, energy per pulse and bandwidth; and reduction of distortion and spurious outputs.

Solid State—Main attraction for solid-state engineers will be Session 27, a Tuesday evening symposium entitled Molecular Magic. Pat Haggerty, president of Texas Instruments, will be moderator as five industry experts survey the state of the integrated-circuit art. A similar session last year drew 2,000 people. C. L. Hogan, general manager of Motorola's Semiconductor Products Division, will describe several types of circuit. Harry Knowles, manager of Westinghouse Electric's Molecular Electronics Division, will delve into the research and development aspects of microelectronics. Three panelists will probe the expected impact of microelectronics on the user: Bob Noyce, general manager of Fairchild's Semiconductor Division; L. C. Maier, general manager of GE's Semiconductor Division; and J. E. Brown, engineering vice president of Zenith Radio.

Two representative types of the thin-film hybrid microcircuits recently in the news will be featured in papers 31.1 and 31.2. The first is a ceramic-base thin-film amplifier that can perform any of ten functions depending upon the interconnection board on which it is mounted. The circuit consists electrically of three linear amplifiers affording gains of 40, 60 and 80 decibels; two pulse amplifiers; and an oscillator and limiter. Any of the linear amplifiers can be connected as an inverter and either pulse amplifier can be a mixer. Physically the circuit consists of two 1-by-0.4-in. ceramic substrates, one of which carries encased transistors and input biasing networks while the other carries resistors, capacitors and diodes for feedback.

FLYING BLINDFOLDED

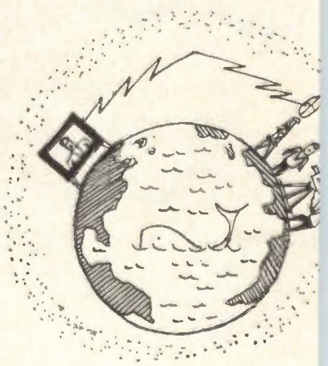
The second microcircuit to be described is a universal logic function wafer using titanium thin films. The thin-film circuit components have high yield and uniformity and are used with chip transistors to make up NAND/NOR logic elements.

A new discrete solid-state component, the Triac, is still in the development stage but it could become a contender for all present applications of silicon controlled rectifiers in a-c applications. The Triac is a gate-controlled silicon a-c power switch. (See paper No. 36.4.)

Communications—The old familiar name Institute of Radio Engineers is no more, but communications still remains close to the heart of IEEE activity. And the convention will provide a forum to discuss the results of several radical new communications techniques. Session 41 will hear the results of the West Ford experiment in which a belt of tiny copper dipoles was placed in orbit around the earth to provide reliable long-range microwave communications. As a result of the experiment, engineers believe that continuous global communications can be provided by two orbiting dipole belts, one placed in a polar orbit and one in an equatorial orbit. And despite strong criticism from astronomers both here and abroad before the dipoles were launched, radio astronomy telescopes suffered no interference from the metallic fuzz. One problem, however, has arisen: dispersion of the dipoles in space has caused a good deal of radio-signal scattering—enough so that the rate of sending digital information by bouncing it off the dipoles had to be reduced from 20,000 bits per second when the dipoles were packed in a single dense cloud to only 50 bits per second after the cloud had spread out into an earth-girdling belt.

HUMAN ENGINEERING

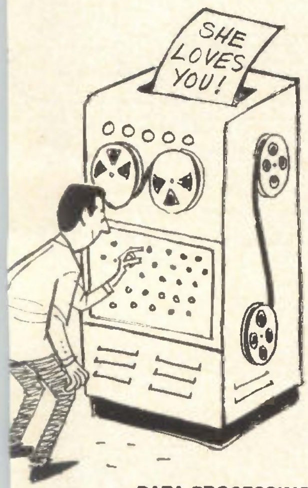
Syncom, Telstar and Relay will be scrutinized during Session 35, along with other communications satellites yet unlaunched. Some of the results of satellite tests to be given may already be known to a few engineers but the preliminary results of multiple-access experiments with Syncom and Telstar II promise to



WEST FORD EXPERIMENT

make the session worth attending.

Session 39 will offer the nonspecialist a chance to catch up with a recent and interesting turn of the communications wheel—RADAS or random-access discrete-address systems. Paper 39.2 will present some propagation measurements made on pulse communications signals that are coded in both frequency and time—a promising RADAS technique.



DATA PROCESSING

Other communications sessions serve up a mixed bag with many papers of interest to both specialist and nonspecialist. A 192-channel multiplex system for telephone use is to be described by a Japanese engineer who claims it will reduce equipment cost per channel by 50 percent. The system will use pulse-code modulation (paper No. 1.2). A telephone development from Germany (paper No. 4.4) provides for error correction. Information is divided into blocks for transmission. At the end of each block a feedback signal is sent telling whether the transmission is error free and whether another block should be sent or the first block repeated.

A low-speed magnetic memory device (paper No. 28.6) for inexpensive communications computers. Access times are long in the order of seconds and readout in milliseconds.

Air-to-undersea communication will become increasingly important in three-dimensional submarine-hunting operations and paper 50.2 presents a theoretical treatment of the subject. The author derives an expression for the range of satisfactory communications.

For antenna engineers, paper No. 54.4 describes spiral antennas used in the interferometer that will enable Gemini astronauts to conduct rendezvous and docking in space. Another paper, 54.3, describes a beam waveguide that uses appropriately shaped metal reflectors instead of dielectric lenses to correct phasing without introducing undue power losses.

GEMINI RENDEZVOUS

Space—Jam-proof satellite communications is an objective of the coded division multiplex (CDM) system. The system is reputed to be ideal for secure communications—both military and civilian. Paper 20.3 analyzes the CDM system showing error probability as a function of gain, number of channels, channel capacity, output power, ratio of jamming power to desired power, and transmitted bandwidth.

Here's a problem for space-system designers: how to place unified signals for telemetry, tracking, guidance and command on a single carrier for use with communications satellites, scientific satellites or deep-space probes. Paper No. 33.1 proposes a solution and discusses trade-offs among tight tracking accuracy, restricted signal bandwidth and problems of jamming, noise cost, and reliability. Although no single unified system is ideal, optimal trade-offs can furnish the best signal characteristics for a given application.

A new telemetry system carries low-level signals from the Titan II booster 125 ft to the launching-pad instrumentation unit. The system uses a system in which 196 low-level data channels are sampled and sent directly by pcm/f-m (pulse-code modulation/frequency-modulation) while 16 continuous channels are sent by f-m/f-m. Previously there had to be a d-c amplifier aboard for each low-level instrumentation channel (paper No. 33.2). Another instrumentation paper (19.4) describes the READI or Rocket Engine Analyzer and Decision Instrumentation System. The system will detect malfunctions in a rocket's propulsion system and take remedial action in real time.

One paper on environmental conditions (19.1) discusses the effects of radiation on microelectronics. So far the authors have delved into the effects of 22, 40, 128 and 440 Mev protons. They plan to investigate the effects of 100 to 600 Mev protons, 500 kev to 10 Mev electrons as well as x-rays, neutrons and other radiation. Another environmental paper looks at raindrops and how they affect satellite communications.

Conclusion — Communications systems must have a better margin of carrier power over noise power because rainfall does indeed reduce signal-to-noise ratio. In fact, a thin film of rain water on the outside of the big radome at Andover, Maine caused noticeable signal attenuation (paper No. 20.2).

Data Processing—Computermen are prominent once again on the IEEE program. Three engineers will give a look at the tunnel-diode memory for Project Lightning. This memory operates in the gigacycle range and will be part, presumably, of the Redman computer being built to do cryptanalysis for the Dept. of Defense (paper No. 3.1).

A new analog-to-digital converter corrects its own errors. It decomposes the analog quantity by taking the highest order digit first then the rest in order. It encodes the digits and compares their encoded values with the input analog values after passing the encoded value through a digital-to-analog coverter. The converter also uses the pre-set error technique in which a known error is introduced into the encoder so that low thresholds can be handled without having to worry about the absolute precision of the encoder (paper No. 3.3).

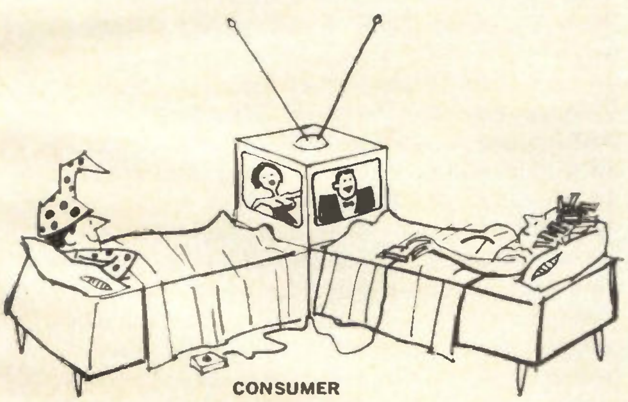
Sonarmen have long sought a way to distinguish among natural undersea noises, sonar returns from natural objects and the desired signals—sonar returns from man-made objects. Paper 11.2 tells how a library of known patterns stored in magnetic cores, on a drum or even on tape could be compared with sonar returns on a real-time basis.

Last June, the New York Hilton hotel installed a two-part electronic accounting system. One part only tallies the guest's telephone charges. The second part adds these to other charges for meals, drinks, room and the like to compute the guest's daily bill (papers No. 21.4 and 21.5).

Paper 60.2 tackles the problem of timing in digital communications. In a regenerative digital system of any kind the signals must be retimed to restore the pulses to their assigned time slots. This paper discusses how timing jitter arises, how it can be controlled and how the signals can effectively be retimed.

Consumer—Soon a loudspeaker rating system may be standardized and adopted by EIA. The standards will represent a compromise between those affording the best performance in reproducing music and those affording the best performance in reproducing speech. The proposed articulation rating system for loudspeakers to be described in paper 47.4 will allow a more meaningful figure to be assigned to a loudspeaker in that its loudness will be considered within the context of its intended use.

Paper 51.2 describes an X-field micro-gap head for high-density magnetic tape recording. This development will permit recording heads even smaller than those now in use to reproduce low-frequency signals without distortion and without erasing high frequencies by use of too high a bias field.

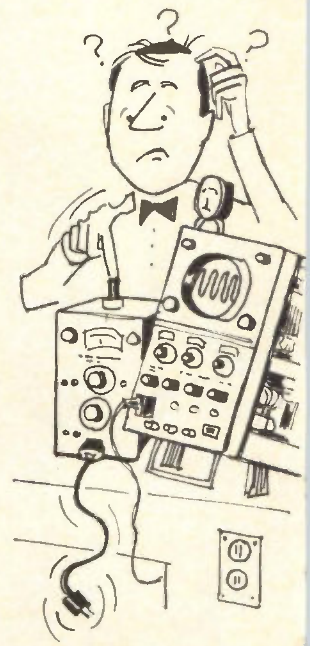


CONSUMER

Industrial—One active field of industrial automation concerns the control of merchant shipping. Paper 2.1 deals with the centralized control of a ship while adherence by designers to the standards proposed in paper 2.2 could open up a new field for marine automation—namely, the use of control equipment within volatile-liquid spaces aboard tankers.

Security systems for pay-television must insure that only paying subscribers receive the program being sold. The systems must also comply with certain FCC standards and with Bell System practices. Paper 5.4 will show how advanced solid-state centralized metering equipment and a novel approach to the multiplexing of encoded signals combine to provide secure and reliable operation.

In the design of today's high-speed computer systems, even power-distribution lines must be considered a part of the circuit and an approach to these design problems is given in paper 10.1. Paper 25.1 castigates the existing vhr omnirange system of air navigation for its poor accuracy and outlines what needs to be done to improve it.



INSTRUMENTATION

Instrumentation—These sessions deal with incremental advances in the state of the art rather than any major breakthroughs. Of interest are: a current comparator possessing unusually high accuracy with construction details given (paper No. 42.1); a new easier method of calibrating the popular Kelvin-Varley bridge that agrees with theory better than the existing method (paper No. 42.2); and the ways and means of converting existing test instruments into secondary or even primary standards (paper No. 42.4).

Paper 6.2 gives some design equations useful when designing thermistors into bridge circuits while paper 6.3 discusses a multiplier phototube for use in an image dissector. The tube is smaller and more efficient than present-day tubes.

AFTER THE BALL

How They Picked the Technical Program

Critics say the IEEE technical program is too big and too dull. Here is the way it was put together. Next year's program may be even bigger—what lessons can we learn from this one?

TEN DAYS FROM NOW the Second International Convention of the Institute of Electrical and Electronics Engineers will open in the New York Hilton Hotel and New York Coliseum.

It will present the most comprehensive technical program ever and the biggest. But will the quality of the program match its size?

The technical sessions are an eight-ring circus

EIGHT SIMULTANEOUS TECHNICAL SESSIONS

OVER 1,000 EXHIBITIONS TO SEE

in themselves with a trade show of over 1,000 exhibitors and innumerable peripheral events all vying for the engineer's time. How can he make the best use of his time during the show? Might it be by staying home and not attending at all?

The convention is only as good as its technical program and its technical program is only as good as the papers that make it up. Therefore, ELECTRONICS took a close, hard look at the way that these papers are selected and what engineers close to the selection process really think about it.

How Selection Works—This year the IEEE set up a brand new procedure for selecting the technical papers to be presented at its International Convention.

Responsibility is centralized in the Technical Program Committee (TPC) chaired by Professor Ferdinand Hamburger, Jr., Chairman of the Electrical Engineering Department at The Johns Hopkins University in Baltimore and Director of its Radiation Laboratory.

The TPC consists of ten members (see panel) each well-known and respected in the engineering community. Each TPC member was assigned one area of interest and each of the 64 technical sessions of the convention was, in turn, assigned to one of 10 areas of interest.

The TPC members had to get knowledgeable engineers and scientists to review papers and also to select session chairmen and session organizers. Each prospective author was required to designate to which field of interest his paper belonged at the same time he submitted the abstract and summary of his proposed paper for consideration by the TPC. He also had to answer the question: What is new or significant about your contribution? From these basic inputs, the TPC put together the IEEE technical program.

Was It Selective Enough? This year 62 percent of the papers submitted were accepted—about the same percentage of acceptances as last year. But the program will be about 20 percent longer—in part, to compensate for demise of the AIEE Winter General Meeting. About 320 papers are on the program.

Too many papers? "Not at all," says Professor Hamburger. "This year we could have included twice as many papers. And there was a clamor for some 150 sessions."

Yet an overview of the rejected papers would lead one to disagree with Hamburger's observation. At least half of the papers rejected reportedly would not have been acceptable to any IEEE group or section.

According to Professor Hamburger, the IEEE made a conscious effort to upgrade technical papers and aimed for top-quality papers of a broad nature, feeling that highly specialized papers belonged to highly specialized conferences. However, the number of invited papers this year is almost insignificant and members submitting papers purely on speculation can seldom be expected to anticipate the broad, general needs of the profession at large.

Professional Integration—"The technique for selecting papers is an experiment this year," says Professor Hamburger. "It is an attempt to find a solution to the problem of how to integrate contributions from former members of the old AIEE and IRE." However, selection of papers was still, in fact, somewhat influenced by the constituent society to which the author formerly belonged.

Although the Professional Technical Groups (successors in most cases to IRE Professional Groups) had little if anything to do directly with papers selection, many papers already selected by former AIEE Technical Committees did find their way on to the program. Furthermore, the TPC was said to have been placed under some pressure to accept a number of papers in the power field so that manufacturers of power-generating and transmitting equipment on exhibit for the first time this year at the

---

Areas of interest and responsible Technical-Program Committeemen

1) **BASIC SCIENCES**
Harold Chestnut, Senior Control Engineer, General Electric Co., One River Road, Schenectady, N. Y.

2) **POWER**
L. M. Olmsted, Senior Editor, Electrical World, 330 West 42nd Street, New York, New York 10036

3) **INDUSTRY**
R. H. Whaley, Manager—Electrical Engineering Dept., E. I. Lily & Company, 640 South Alabama Street, Indianapolis, Indiana

4) **COMMUNICATIONS**
L. G. Abraham, Director—Transmission Engineering Planning Center, Bell Telephone Labs, Murray Hill, New Jersey

5) **SYSTEMS**
E. F. Cook, Major General (Ret.) U. S. Army, Deputy Chief Signal Officer, Pentagon, Washington 25, D. C.

6) **COMPUTERS**
A. L. Samuel, Director—Research Communications, IBM Research Center, Box 218, Yorktown Heights, New York

7) **INSTRUMENTATION**
D. B. Sinclair, President, General Radio Co., Baker Avenue, West Concord, Mass.

8) **MATERIALS**
Gustave Shapiro, Chief—Engineering Electronics Section, National Bureau of Standards, Washington 25, D. C.

9) **BIOMEDICAL**
E. F. MacNichol, Jr. Associate Prof.—Biophysics, Johns Hopkins University, Baltimore 18, Maryland

10) **PROFESSIONAL ACTIVITIES**
G. E. Moore Manager—Graduate Student Training, Educational Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

IEEE Show might have adequate representation of their particular subject-matter on the technical program.

Inside The TPC—Even the men who selected the papers are not really sure about their quality. Gustave Shapiro of the National Bureau of Standards is the TPC member responsible for Area 8: Materials, Components and Production Processes. In mid-February he said, "An accurate assessment of papers presented at the sessions would not be meaningful. The actual paper can be different from the abstract. This is one of the curses of all sessions and no symposium is different in this regard."

Shapiro favors reducing the number of technical sessions and the number of presentations and squeezing the bad papers out. "But bad papers can get in. We ask what about the author? Does he have a good reputation? Sometimes papers can be chosen based on past performance of the author. But then too, an author who has given one good paper in the past can coast on that reputation for a long time."

Bad papers . . . even gag papers can get in as happened once at WESCON. The authors were well known. The subject sounded reasonable enough to the selection committee. The subject was one of wide application . . . carbon resistors . . . and the paper described them masterfully. But then dogs have slipped into the *Social Register* too.

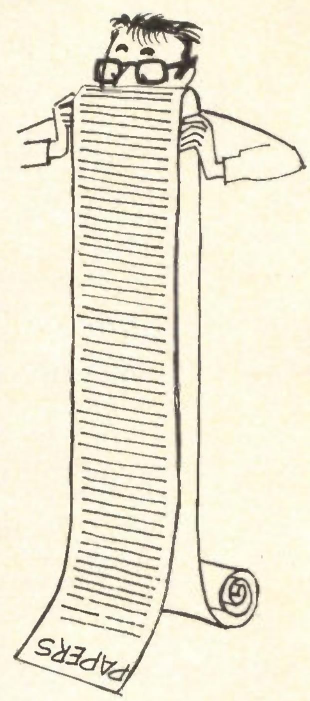
Even good papers can be kept out by mistake. Professor Hamburger reports that this year a paper on information storage theory was rejected. The authors protested; they insisted their contribution was important and demanded an explanation of why it was rejected. After an investigation by IEEE headquarters staff, the authors were found to be correct. But the paper had been submitted to the wrong selection committee—the computer group. The paper was immediately referred to another committee—the basic-science people dealing with information theory—and was written into the program at the last minute.

Criticism—Selection of papers by the TPC has been roundly criticized this year, especially by many session chairmen and organizers, some of whom, by mid-February, claimed they had not seen even abstracts of the papers to be presented at their sessions. See panel for verbatim comments.

There is also some feeling that the TPC cannot react as fast as was done in former years when, for example, one author called the committee only four days before the convention to say he was prepared to deliver a paper of vital importance. The chairman said that if the paper had merit it would get through. The paper was accepted and the author sat up the following nights writing it.

For years now the IEEE has chafed under criticism of its technical program. It has, in fact, been suggested that the only reason for having a technical program at all is to shield revenue from the IEEE Show from claims by the Internal Revenue Service. This year's international convention will present the longest technical program ever and will, for the first time, include contributions from both the AIEE and IRE sides of the house. The method of selecting papers has been drastically overhauled and not without an angry chorus of dissension. Nevertheless the members of the Technical Program Committee are eminently well qualified for their task. But not until next fortnight, when the last speaker shall have left the podium will we be truly able to assess the technical merit of the second IEEE International Convention.

BAD PAPERS SQUEEZED OUT



TOO MANY PAPERS

WHAT SESSION CHAIRMEN AND ORGANIZERS THINK OF THE PROGRAM

. . . The specialist must go to the specialist's meeting. Meetings like IEEE are good for survey papers of interest to nonspecialists but they should contain new material not just rehashes of what has been presented at other meetings. I would not go 2,000 miles to attend the IEEE Convention.

. . . I'm not enthusiastic about the bulk of the papers to be given. Even my own paper will not have wide interest. It represents an interesting solution to a problem that may never come up again.

. . . I did not pick the topics of my session so I am at a disadvantage chairing the session without having had any voice in the selection.

. . . Authors do not make the effort required to get the best into their papers. The technical sessions are not too well integrated. One paper in my session doesn't belong there; it should have been assigned to another session. Many authors submit papers just to get a week off in New York.

. . . The level of papers is up. There have been more submissions and less available space hence screening is better.

. . . Papers are spotty and do not represent a fair cross-section of the field since they are too few. The IEEE system of paper selection is defective since the session organizer has no final authority over the papers which will be included in the session.

. . . All papers look very interesting and the caliber of the people presenting them should assure a very high quality session.

. . . The papers are not in any way significant and there aren't any that stand out over the others. The IEEE is a very poor platform for papers. The papers are generally very low caliber. The show is a trade meeting—go to the trade show and don't bother with the papers.

. . . The whole session is interesting. All papers represent either an extension of the state of the art or are at least front-line thinking.

METAL BASE TRANSISTOR Pushes Back the Frequency Barrier

A transistor made of a metal film sandwich looks promising in amplifier and oscillator designs for microwave applications. It has better frequency characteristics, up to 100 Gc, and even interesting resistance to radiation

By **DONOVAN V. GEPPERT** and **ROBERT A. MUELLER**
Physical Electronics Laboratory, Stanford Research Institute, Menlo Park, Calif.

LIMITATIONS on high-frequency transistor performance (assuming optimum design for microwave units), include the effective transit time of minority carriers, base resistance, and collector capacitance. A useful figure of merit for a h-f transistor is the maximum frequency of oscillation, f_{max}. This is the frequency at which the gain drops to unity, and is given by $f_{max} \cong 1/4\pi(a_o/r'_b\ C_c\ \tau_{ec})^{1/2}$, where a_o is common-base current gain, r'_b is base resistance, C_c is collector capacitance, and τ_{ec} is the effective emitter-to-collector transit time. The latter is given by $\tau_{ec} = \tau_e + \tau_b + \tau_c$, where τ_e is emitter charging time, given by the product of emitter capacitance and emitter resistance, τ_b is base transit time, and τ_c is the collector attenuation time. There are two conflicting terms in the first equation, since if the base is made thicker to reduce base resistance (r'_b), transit time (τ_{ec}) increases. Thus, there is an optimum base thickness for best high-frequency performance.

Several proposals have been made recently for new types of transistors to overcome some of the frequency limitations of conventional *p-n* junction bipolar devices. Moll[1] recently made a comparison of proposed structures and has shown that best high-frequency performance should be attainable with a metal-base transistor using a Schottky emitter and collector. This device was first described by Geppert[2], and subsequently by Atalla and Kahng[3].

Metal-Base Transistor — The new device consists of a thin metal film sandwiched between two *n*-type semiconductors as shown in Fig. 2A. It resembles a conventional *npn* transistor in many respects. The energy diagram for the metal-base transistor is compared with that for a conventional-*npn* unit in Fig. 2B and 2C, respectively. Both cases show zero bias voltage.

The comparison between the metal-base transistor and the conventional *npn* device should not, however, be carried too far, since the physics of the two differ. In the

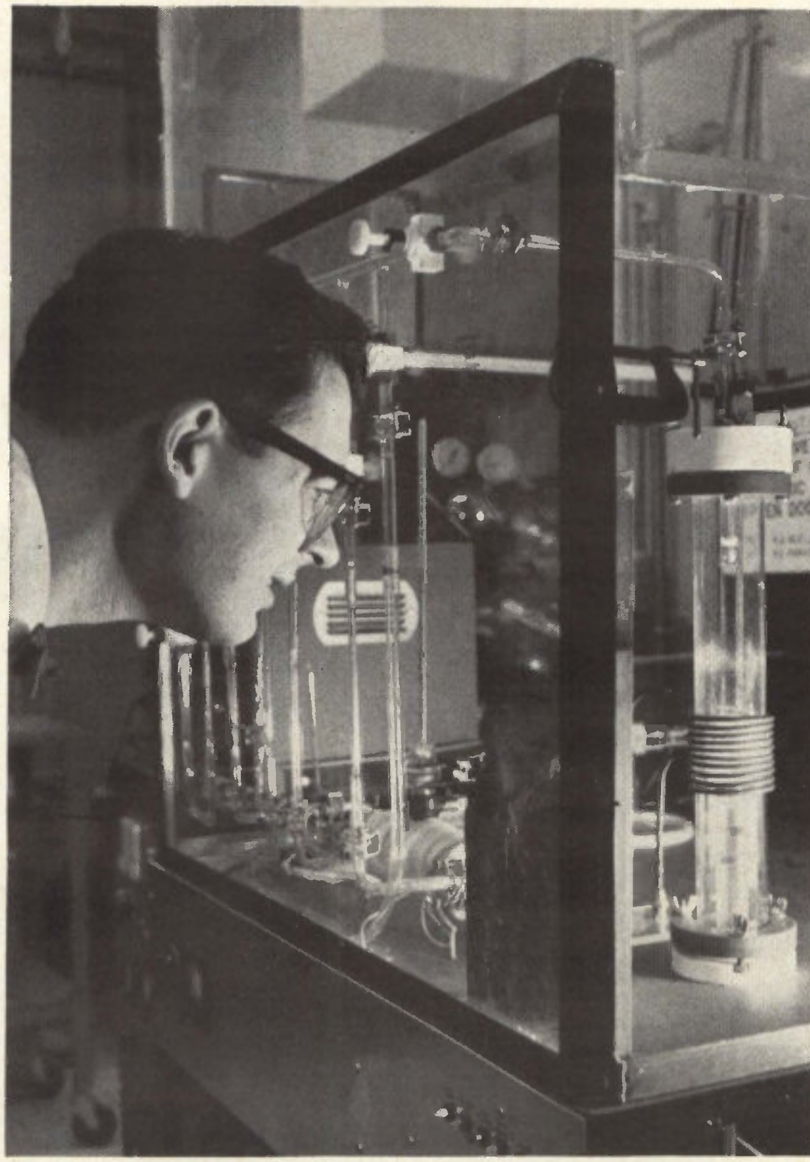
SOLID-STATE FREQUENCY LIMITATIONS

While the maximum operating frequency of conventional bipolar junction transistors has been steadily increasing, the rate of improvement has steadily declined. Earliest devices were limited to a frequency in kilocycles and present transistors are capable of operation near or slightly above 1 Gc.

In grown-junction units, frequency limitations can be attributed to large junction capacitance and high base resistance. With alloy-junction techniques, junction capacitance and base resistance are reduced, but high-frequency performance is degraded due to the large phase shift associated with diffusion of the minority carriers across the relatively thick and nonplanar base region. The surface-barrier transistor, diffusion techniques, MADT designs and finally the development of epitaxial devices, all represent frequency improvements in the state of the art. Moreover, dimension reductions of unit active regions and packaging advances also raise maximum operating frequency.

Many researchers feel that even with the latest advances, we have reached a point where further improvement of junction transistors will diminish, even with improved materials and continued size reductions.

In this article, the author describes a technique for developing new metal-base transistors that are now being designed for 10 Gc, and eventually may reach 100 Gc. This suggests that present-day microwave devices may soon encounter stiff competition



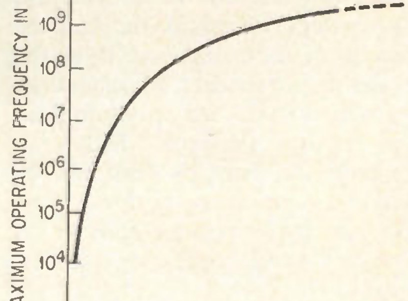
HYBRID vapor-vacuum system used in the fabrication of the metal-base transistor

npn device, electrons are injected into the base from the emitter, and some hole injection from base to emitter also takes place. The ratio of electron to hole current is made high by doping the emitter more heavily than the base, and also by using a relatively thin base region to cause a large diffusion gradient for electrons in the base region.

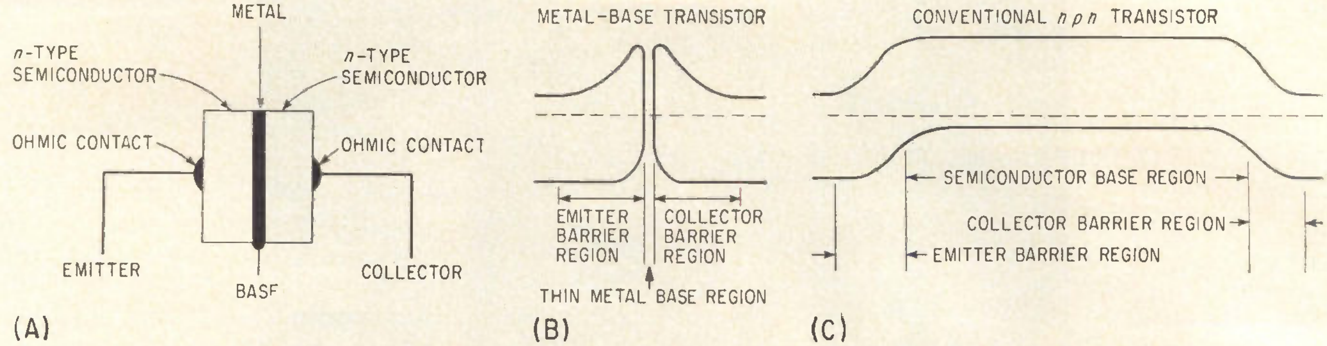
In the metal-base transistor, electrons are injected from the emitter into the base, and some hole injection from base to emitter also occurs. However, in the latter case, the electron current is not diffusion limited as in the *npn* device, but rather obeys a thermionic-emission law. Consequently, emitter injection efficiency is independent of base thickness, and depends only upon emitter doping, barrier height, and the diffusion length for holes in the emitter region. Analysis of this situation shows that high injection efficiencies can be achieved.

In the *npn d*evice, the electrons injected from emitter to base are minority carriers that diffuse to the collector because of a diffusion gradient in that direction. (In the drift transistor, the carriers are also assisted by the built-in electric field.) A few minority-carrier electrons recombine with holes in the body of the base region prior to reaching the collector; the number of these depends upon minority-carrier lifetime, or diffusion length. Surface recombination also can contribute significantly to minority-carrier loss. The mean kinetic energy of electrons injected into the base is low, since they are only slightly above the bottom of the conduction band.

In the metal-base transistor, electrons injected from the emitter into the base are very energetic. The mean kinetic energy of these hot electrons is relatively large, being on the order of 6 to 10 electron volts. Through collisions with the lattice and other electrons, their en-



GRAPH showing the increase in transistor maximum-operating frequency vs time illustrates how the rate of improvement has been declining—Fig. 1



CONSTRUCTION of the metal-base transistor (A), comparison between energy diagrams of the new device (B) and a conventional npn structure (C)—Fig. 2

ergy is gradually decreased as they travel through the metal base. If the metal is not too thick, a large percentage arrive at the collector barrier with little or no energy loss, and fall into the collector-barrier region where they are swept into the collector-body area by the field. Electron-phonon losses are serious because they randomize the momentum of the electrons; to be collected, the hot electrons at the collector barrier must be incident almost perpendicularly.

Thus, the emitter-injection process and the base-transport mechanism are different for *npn* and metal-base transistors. In other respects, the two devices are similar.

Referring to the equations demonstrates why the Schottky-emitter metal-base transistor has good high-frequency performance. First, base transit time is negligibly small. For metal-base film thicknesses on the order of 100 angstrom units, τ_b is on the order of 10^{-14} second. Thus, τ_{ec} is reduced as compared to *npn* junction transistors (τ_e and τ_c being comparable for the metal-base and *npn* devices). Second, the base resistance of the metal-base transistor is about two orders of magnitude lower than values for optimum junction-transistor designs. Thus, f_{max} is about 10 times as high for the metal-base transistor as for a junction device, having comparable geometry and operating current density.

Noise—The noise figure is important because it is anticipated that a major application of metal-base transistors will be in the front end of microwave receivers where klystrons and travelling-wave tubes are now used. At the present, there is little information on the subject, and further research is needed.

Other Advantages—In addition to considerably - improved frequency response, the metal-base transistor possesses other important advantages over conventional junction devices. One of these is anticipated radiation resistance. Whereas bipolar amplifiers require single-crystal material that has high crystalline perfection (particularly for the critical base region) the metal-base transistor can be fabricated from polycrystalline material, as described in the literature[4] and indicated by our own work. One approach[4] in use is directed towards an all-evaporated structure suitable for incorporation into integrated circuits, whereas our efforts are directed primarily towards high-frequency operation.

Research—Research and development have led to a metal-base transistor with several advantages over other known configurations.

Initial experimental devices used a copper base on germanium with a point-contact germanium emitter.[2] This configuration proved capable of a power gain of about 10 db, limited mainly by the high emitter resistance of the device. To overcome this, research has been directed towards a large-area emitter device. Gold was selected for the base film because the mean-free path of hot electrons in gold is higher than in any other metal tested.[5]

Gold-silicon diodes were fabricated and shown to be suitable for base-collector barriers. Emitters of evaporated CdS were used to fabricate triode structures, but barrier and temperature considerations as well as the diffusion of gold into CdS fostered an investigation into higher-temperature fabrication techniques and more highly refractory materials.

Vapor plating of refractory metals is a standard method for depositing metal films, and since this was compatible with the epitaxial growth of silicon, it provided a reasonable approach to a metal-base transistor. Several metals were deposited on silicon with the greatest attention given to the refractory group. Of these, molybdenum looked most promising.[7,8] Work was undertaken to determine the mean free path of hot electrons in molybdenum, and because of the results, plus the compatibility of silicon and molybdenum, the silicon-molybdenum-silicon approach to the metal-base transistor was pursued.

There is essentially no diffusion of molybdenum into silicon below 800°C.[6] At higher temperatures, a compound forms that has been shown to be molybdenum-disilicide by electron diffraction.

This silicide formation limits the temperature of vapor phase reaction for the molybdenum chloride and silicon chlorides used for the base and emitter to approximately 750°C.

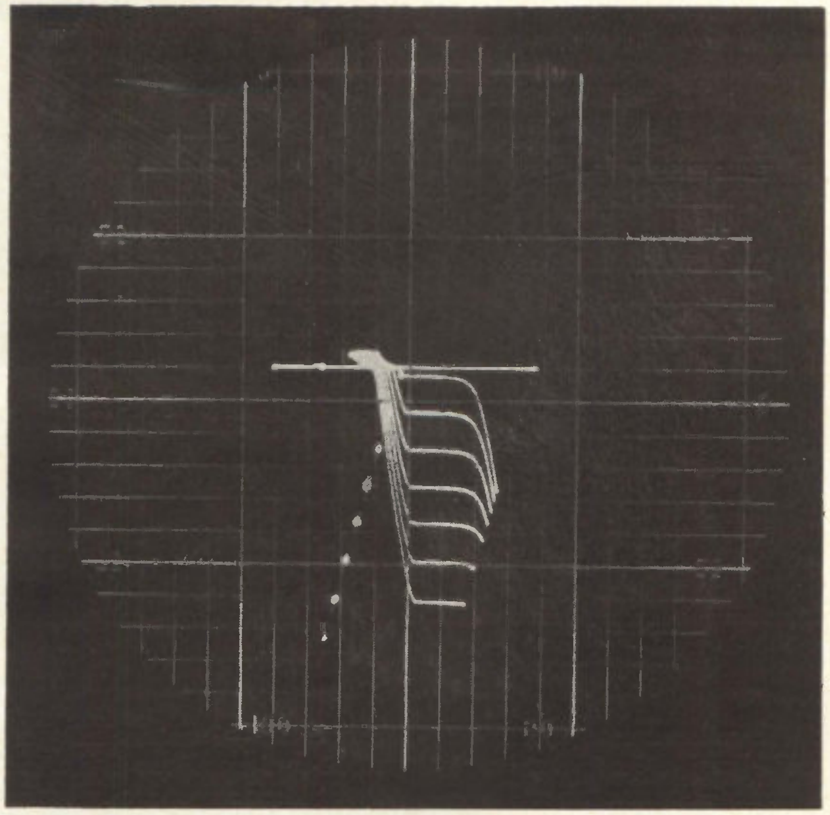
There may be other combinations of metals and semiconductors that have advantages over the silicon-molybdenum-silicon structure, such as silicon carbide for the emitter and possibly refractory metals other than molybdenum for the base region. For the present, however, the structure now used will continue to be optimized.

With the vapor-plated emitter approach, a selective etch is required that will etch Si but not Mo. Several etches that should fulfill this requirement are presently under investigation.

Another approach that shows promise utilizes an evaporated silicon-emitter region. The Si can be deposited only where desired by masking during the Si evaporation, thus obviating the necessity of selective etching.

The system in use was constructed to explore both these and other methods of fabricating a metal-base transistor.

The research models of the metal-base transistor produced so far have shown great promise. The base collector breakdown occurs at about 10 volts as shown in Fig. 3, but this and the low alpha are not serious detriments in low-level microwave amplifiers, which are the primary projected use of this device.

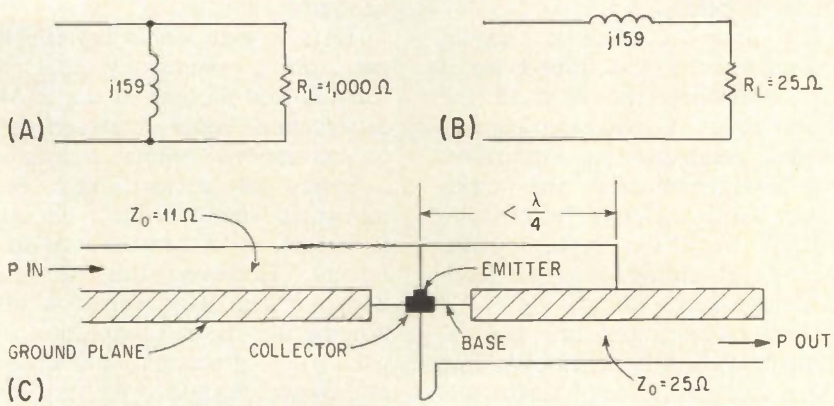


COMMON emitter characteristics of the MBT, where scales are 5 volts-per-division horizontal, and 2-ma-per-division vertical—Fig. 3

Design For 10 Gc—At present, efforts are directed at a broadband microwave amplifier utilizing a metal-base transistor in a grounded-base configuration, where the transistor has the following parameters: r_e is 2 ohms (achieved at a current density of about 3×10^3 amp/cm^2); r_b is 1 ohm; r_c is negligibly high; C_e is 1 pf (for an area of 0.5 $\times$ 10^{-5}/cm^2 and forward biased); C_c is 0.1 pf (for an area of 10^{-5} cm^2 and back bias of about 6 v); and α is 0.9 at 10 Gc.

The collector load must be inductive to tune out the collector capacitance as shown in Fig. 4A.

At 10 Gc, the reactance of C_c is 159 ohms. To achieve the desired bandwidth of 1 Gc, the Q of the output circuit must be less than 10. Choose $R_L = 1{,}000$ ohms. An alternative equivalent of Fig. 4A is the series arrangement of Fig. 4B, wherein r_L is 25 ohms. This is a good characteristic impedance for a strip-line microwave circuit and suggests its use with a small inductance in series with the collector load.



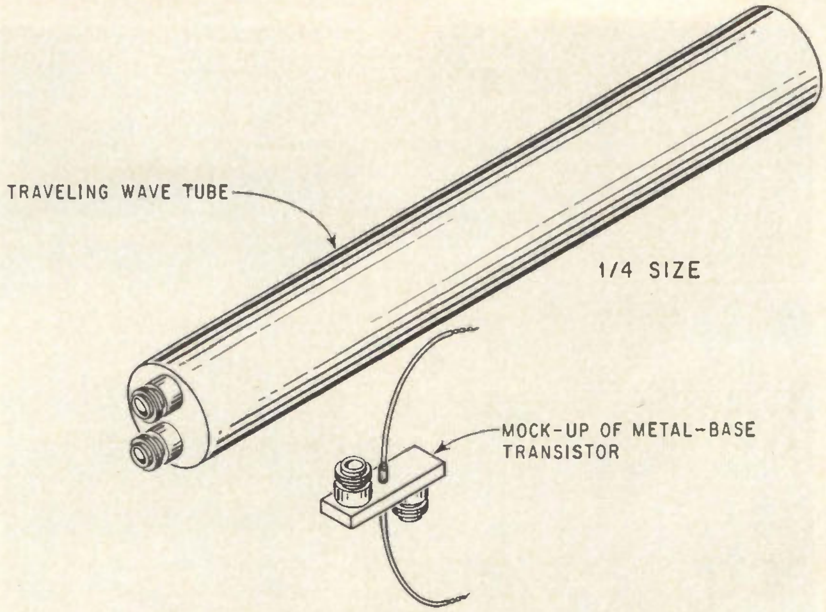
COLLECTOR load must be inductive to cancel capacitance at 10 Gc (A), alternative load circuit for a strip-line amplifier application (B), and actual strip-line circuit (C)—Fig. 4

The power gain of this amplifier is 25.2 db neglecting circuit losses. This calculation assumes negligible phase shift associated with α, permitting 5.2 db of circuit losses over and above the desired 20-db gain.

The grounded-base configuration is recommended because of the natural match achieved between the geometry of the device and the electromagnetic field pattern realized in a strip-line or waveguide circuit. Figure 7 illustrates a convenient arrangement and suggests the type of encapsulation required.

The input impedance of the transistor is $3.65 + j5.18$ ohms. By shunting the input with a capacitive reactance of 7.75 ohms, a resistive input impedance of 11 ohms is achieved at a Q of about 2. The input circuit is very broadband under these conditions. Figure 4C shows a short-circuited line longer than $\lambda/4$ paralleling the emitter input; this length should be adjusted to present $-j7.75$ ohms to the input for tuning.

The small hairpin loop in series



SIZE comparison between a metal-base transistor and a typical traveling-wave tube—Fig. 5

with the collector lead as shown is a simple way to achieve the $j159$-ohm series inductive reactance required to tune out the collector capacitance. The d-c isolation and biasing provisions are not shown, but these should not present any serious problems.

The base connection should preferably be a flat, round metal plate contacting the hole in the ground plane. A good electrical and thermal connection is desirable. With this arrangement, the output circuit is completely electrically shielded from the input circuit, thereby preventing external feedback difficulties.

The 11-ohm input line can be readily matched to a 25-ohm line with a taper or a step transformer, thus making the over-all input and output impedances equal.

The same general design can be readily adapted to coaxial or waveguide circuits.

Fabrication—Reproducibility of the metal-base transistor is not known as yet because fabrication parameters are not yet fully optimized. This has prevented making many identical runs as required for a statistically meaningful reproducibility analysis.

Tests to date would indicate but not show conclusively that the stability and lifetime of the Si-Mo-Si structures equal or exceed those of conventional bipolar transistors.

Scores of devices have been fabricated simultaneously on large Si wafers, as in conventional technology. However, this technique does not lend itself well to a solution of the special connection and packaging problems inherent in microwave designs. We are currently fabricating six devices simultaneously, each device being deposited on the two-mil tip of a tapered metal pin shaped like an old-fashioned phonograph needle. A base flange and a collector wire and pin are attached and the device is mounted in a strip-line circuit of the type shown in Fig. 4C, using the collector circuit of Fig. 4B. This technique is undoubtedly more expensive than the multiple-device technique on a single wafer generally employed for conventional devices. However, the metal-base transistor is designed to be competitive with other microwave amplifiers such as traveling wave tubes, rather than with low-frequency transistors of conventional design, and in the microwave area, the metal-base transistor should be highly competitive on a manufacturing cost basis. An artist's sketch of the complete metal-base transistor microwave amplifier package compared with a traveling-wave-tube package, both designed for broadband amplification at 10 Gc appears in Fig. 5. This design is nearing completion in the laboratory, and it is hoped that initial microwave-performance measurements can be made within two or three months.

At frequencies higher than about 10 Gc, the strip-line circuits become impractical, and it is necessary to use waveguides. Eventually, with good design, it should be possible to fabricate amplifiers and oscillators in the 50-to 100-Gc range. This will take more time however, just as the full frequency potentialities of conventional bipolar junction transistors required a reasonable development time.

Development work on the metal-base transistor performed at Stanford Research Institute has been partially sponsored by Sprague Electric Company, North Adams, Massachusetts.

The authors thank R. E. Parker for his assistance in the construction of equipment and devices.

REFERENCES

(1) J. L. Moll, "Comparison of Hot Electron and Related Amplifiers," *IEEE Trans. on Elec. Devices*, ED-10, p. 299, September 1963.
(2) D. V. Geppert, "A Metal-Base Transistor," *Proc. IRE*, 50, p. 127, June 1962. Also, "The Metal-Base Transistor," presented at the Solid State Devices Research Conference, Durham, New Hampshire, July 9-11, 1962.
(3) M. M. Atalla and D. Kahng, "A New Hot Electron Triode Structure," presented at the Solid State Devices Research Conference, Durham, New Hampshire, July 9-11, 1962.
(4) J. P. Spratt, "Metal Oxide Amplifier," Final Report, Signal Corps Contract No. DA-36-039-SC-90715, 30 June 1963.
(5) C. R. Crowell, W. G. Spitzer, L. E. Howarth, and E. E. LaBate, "Attenuation Length Measurement of Hot Electrons in Metal Films," *Phys. Rev.* 127, p. 2006 (1962).
(6) G. V. Samsonov, Silicides and their Uses in Engineering, (English translation), Foreign Technology Div. AFSC, WPAFB, Dayton, Ohio, January 29, 1962.
(7) J. J. Casey, R. R. Garnache, J. Lindmayer, and J. L. Sprague, "Characteristics of Metal-Base Transistor Structures," presented at the Electrochemical Society Meeting, April, 1963 (Paper No. 100) (To be published).
(8) J. L. Sprague, J. Lindmayer, R. Garnache, and J. J. Casey, Rept. on 23rd Annual Conference Physical Electronics (MIT) March 20-22, 1963, pp. 210-219.

MAPPING THE SKY IN UV

Present cosmological theories hold that stars were formed by condensation of interstellar gas and dust. Now interstellar atoms absorb radiation only in the far ultraviolet and they exhibit a lot of dispersion. Thus the primary mission of the third OAO flight will be to measure these ultraviolet lines—to map the sky in the ultraviolet region.

The third OAO will weigh 3,600 lb. It will be the largest orbiting lab to be launched in the current generation of satellites. It will follow a 500-mile-high orbit—below the Van Allen radiation belt but high enough to minimize external disturbances due to torques.

The spacecraft will be pointed to an accuracy of one mil of arc but the electronic systems will control data-gathering instruments to about a micron

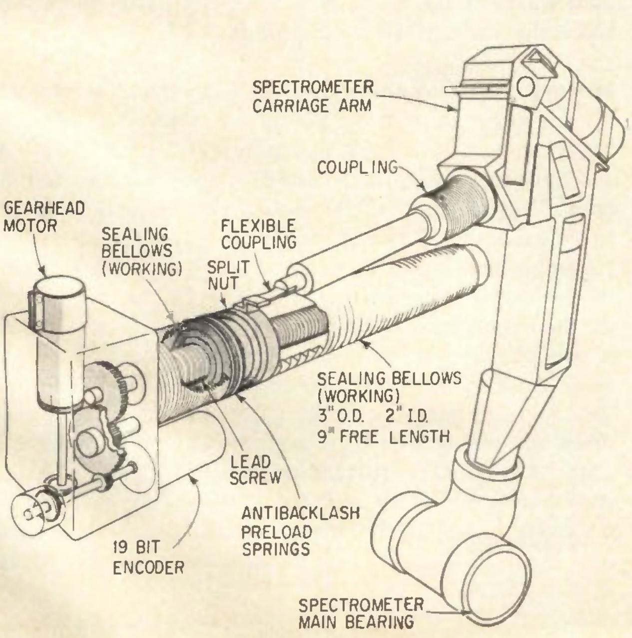
Drive-Brake Circuit Positions Ultraviolet Spectrometer in Spacecraft

Prearranged or instantaneous commands control movement of instrument in three search modes: scan, slew and sweep

By THOMAS CALLAHAN and ARTHUR VUOZZO
Sylvania Electronic Systems, Div. of Sylvania Electric Products, Needham, Mass.

THE THIRD OAO (Orbiting Astronomical Observatory) satellite scheduled for launch in 1966 is instrumented to obtain ultraviolet absorption of the intergalactic gas clouds. A Princeton 32-inch astronomical telescope, with a high-resolution spectrometer, will use electronics by Sylvania Electronic Systems, a division of Sylvania Electric Products Inc. for control and data gathering. (p 28 Feb 28 1964.)

The spectrometer has two independent detector carriages and their positions are controlled by the experimenter's commands from the ground. The position of each carriage is measured to a resolution of 1.5 microns. Necessary electronics includes a programmer and a drive-brake control circuit for the carriage motors.



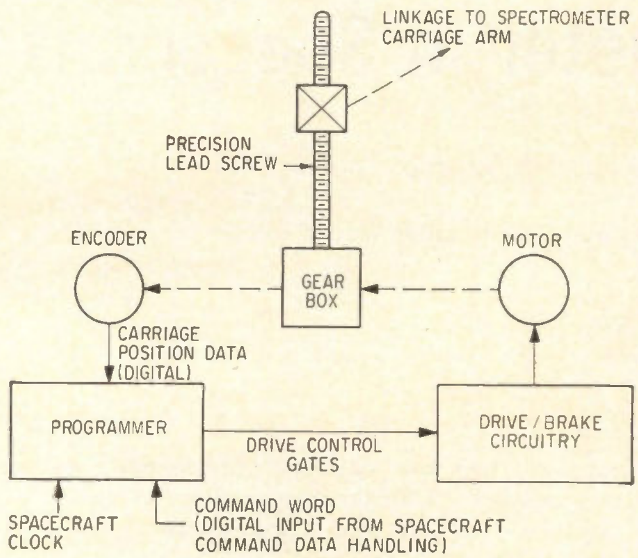
SPECTROMETER MECHANISM is hermetically sealed to prevent common failures of moving parts in space systems. A nonreversing drive limitation is common in accurate lead screw drives used in industry and scientific instrumentation. This digital control system and damping scheme provides an unusual solution—Fig. 1

Position Sensor—The position-determining element for each carriage is a precision lead screw, heavily preloaded by a split nut to minimize backlash (Fig 1). A drive motor and a 19-bit shaft-position encoder are geared to each lead screw. Carriage position is measured indirectly by sensing the position of the lead screw with the encoder. Since the geartrain and split-nut lead screw have a large mechanical hysteresis, reversing of the drive motor cannot be allowed during an operating cycle. Because of this limitation, overtravel cannot be allowed and the system must be heavily over-damped to achieve the desired positioning accuracy.

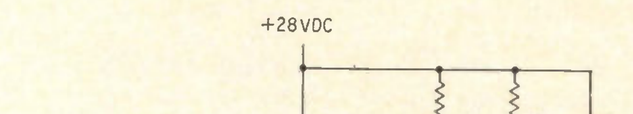
Motor—Perhaps the most important single component in the design of this mechanism is the motor. Electrical efficiency, torque, and physical considerations leads to a final choice of a size-8 two-phase, 5-watt, 400-cycle hysteresis-synchronous type gear-head motor and an off/on drive as opposed to a more conventional linear servo technique.

A specified readout resolution of 1.5 microns requires added inertia damping because there is an overshoot of 30 microns when full motor power is applied during the entire operating increment, (96 microns of carriage travel). A dynamic brake circuit triggered at the end of each drive cycle involves the application of a large current pulse to the motor windings for approximately 40 milliseconds. The frictional load (40-160 inch ounces at the lead screw) added to the dynamic braking provides sufficient damping to limit overtravel to approximately 1.0 micron.

Control Loop—The programmer accepts digital commands from the spacecraft command data handling and implements these commands as a function of time and carriage position (Fig. 2). The programmer is a digital program generator which executes pre-programmed routines and the experimenter's commands from Earth to two carriage drives; the telescope focus drive, and the main data-gathering portion of the instrument. The carriage-drive sections of the programmer consist of a 14-bit presettable counter, several flip-flops to hold decoded commands, and the associated control logic.



CONTROL LOOP accepts digital commands from Earth or the memory store of the spacecraft—Fig. 2



SIMPLIFIED DRIVE-BRAKE CIRCUIT uses 400-cycle square waves triggered by ON and START command signals appearing as sine wave current impulses in the resonant circuit formed by the secondary of T_2 and C_1. The brake gate command allows brake current to flow through the motor winding to stop the carriage within 1 micron—Fig. 3

Carriage Operation—The carriages may be operated in several modes as commanded by the experimenter. These modes are slew, scan and sweep.

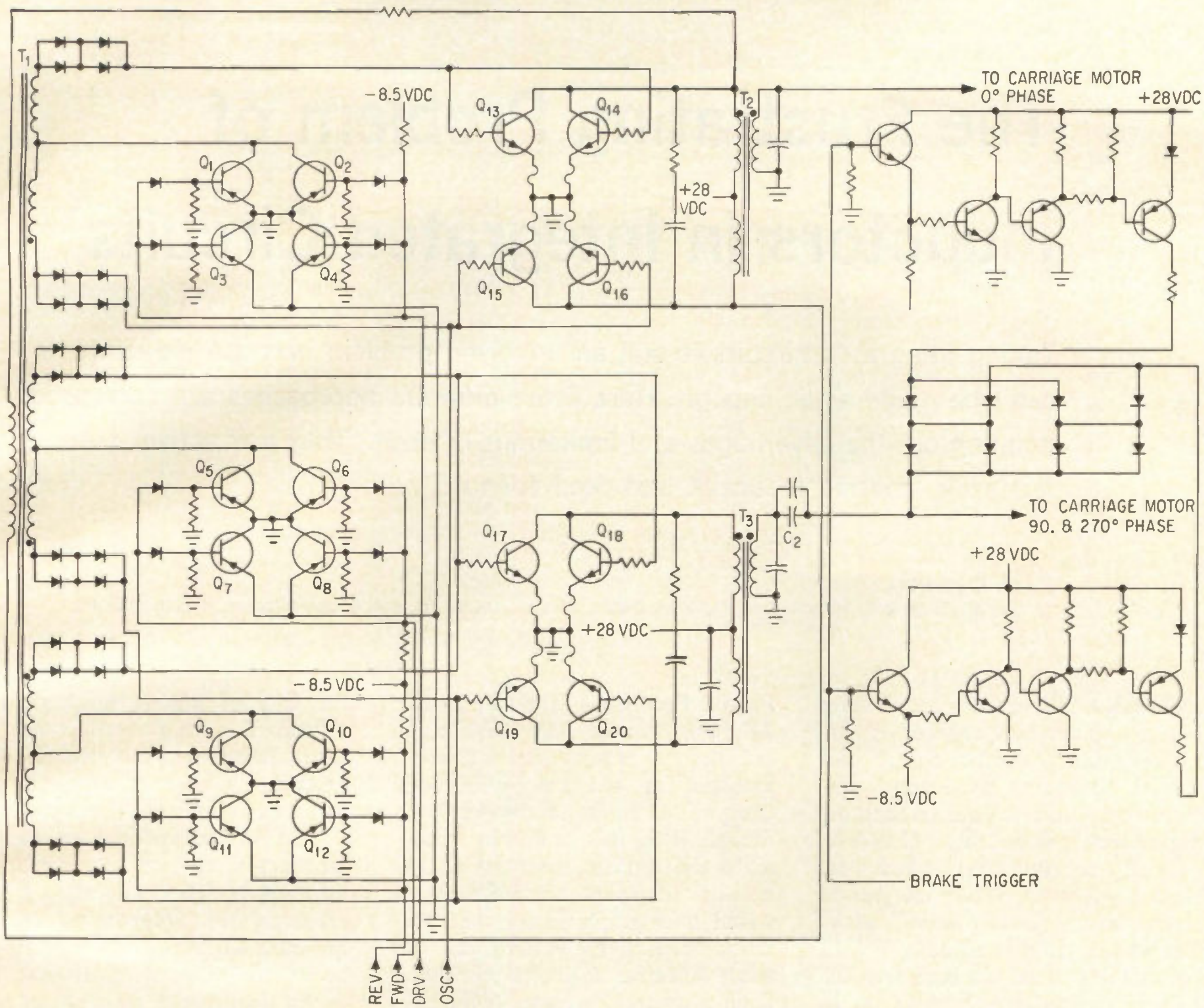
The slew command, as received from the experimenter, commands the carriage to move in a specified direction, a specified number of 12 micron increments. This command is executed by storing the specified number in the 14-bit counter and decrementing this count once for each 12 microns of carriage travel seen by the encoder. When the counter reaches the zero state the drive is halted.

The scan command causes the carriage to move in 12 or 96 micron increments over its full range of travel with a 15-second data-taking pause between each increment. This sequence is established by sensing 12 or 96 micron carriage steps seen by the encoder, and counting seconds (in the 14-bit register) under the control of the spacecraft clocks.

The sweep command causes the carriage to move in 12 micron intervals forward for 15 increments with a 15-second data-taking pause between each increment. The drive is then reversed for 18 increments, and driven forward for 3 increments to remove mechanical backlash. The sweep is repeated to allow for additional samplings of the same spectral region.

Programmer—Outputs from the programmer to the drive/brake circuits include the drive-forward and drive-reverse gates, the start trigger and the brake gate. The drive gates are the direct outputs of control flip-flops in the programmer. The start trigger coincides with the leading edge of the drive gates, has a duration of a few milliseconds, and shock excites the drive oscillator to insure a positive start. The brake gate starts at the trailing edge of the drive gates and has a duration of 40 milliseconds.

Drive-Brake Circuit—An operating cycle is started by the programmer by gating ON transistor Q^1 and applying a start trigger to excite Q_3 (see Fig 3). A stable oscillation quickly builds up with the switching core (T_1) acting as the 400-cycle frequency determining element. Transistors Q_2 and Q_3 act as saturated choppers and a square wave is applied to the primary of the output transformer T_2. The current waveform in the secondary of the transformer is a sine wave which provides drive to the motor. The end of a carriage drive cycle is commanded by removing the drive gate and applying the brake gate. This effectively disables the power oscillator and allows approximately 1 amp of d-c brake current to flow through Q_6 to the motor winding. This reduces coasting time of the motor from about 1.5 seconds to 30 microseconds in time and from 30 microns to 1 micron in distance traveled by the carrriage.



FINAL VERSION of drive-brake circuit. Master oscillator core T_1 is common to two power stages. Motor direction is controlled by reversing the phase of the drive to one power stage by C_2. Double redundancy is provided by quad configuration of power oscillator transistors Q_1 to Q_{12} and fuses in emitter circuits of power transistors Q_{13} to Q_{20}—Fig. 4

Reliability—To achieve maximum reliability in the motor drive system an approach illustrated in Fig. 4 is adopted. All semiconductors in the oscillator-drive section are in a series-parallel configuration (quad). This is advantageous because a failure in one transistor would not disable the entire circuit. A short in transistor Q_1 would pass all the current through this leg and divide it between Q_3 and Q_4 (depending on their match). If Q_1 opened, then transistor Q_2 must carry the full load, however, each transistor in the quad has been designed to carry the increased current. Note that various combinations of two open transistors or of open and shorted transistors are possible without rendering the circuit inoperative.

Instead of quading the power drive transistors, fuses were used in series with each parallel transistor (the use of fuses in these stages is possible since the current levels are high). Fuses are used here for economic reasons and power considerations. If a short occurs in one of the transistors the fuse blows, opening this leg, and its parallel transistor carries the full load. The benefit of a quad with maximum efficiency, and reliability, is realized. The fuses are micro-miniature, solid-state current limiters with one-piece ceramic elements (Microelectron type P400).

Conversion Efficiency — Electrical conversion efficiency of the circuit (28 v d-c to two-phase 26-v a-c, 400-cycle sine wave) is approximately 85 percent. The major factor in achieving this electrical efficiency with this drive system is the design of the output transformers (T_2 and T_3). Since they are nonlinear (a square-wave input yields a sine-wave output) they cannot be analyzed by the usual equivalent circuit techniques. Electrical conversion efficiency is highly sensitive to the turns ratio and to the value of the capacitor across the secondary. A capacitor in series with the secondary is then set to obtain the proper 90-degree phase separation in the motor windings.

These transformers have loosely coupled secondary windings with shunt resonance capacitors. Energy is absorbed from the square-wave input of the saturated transistors and fed out as a sine wave.

The authors acknowledge the help of the Newton Engineering Corp. (transformer design) and the Perkin Elmer Corp. (gearing and mechanism design).

The Frustrating Problem of Inductors in Integrated Circuits

Tuning integrated circuits is still an unsolved problem because inductors can't be made small enough. Here three different approaches are compared, pointing out the advantages and limitations of each. They are: active feedback, passive feedback and feed forward nets

By **W. E. NEWELL**
Fellow Engineer, Information Devices Dept., Westinghouse Research Laboratories, Pittsburgh, Pa.

INTEGRATED circuits are coming of age and are now capable of performing many of the digital and linear functions previously performed by conventional circuits using discrete components. However, one of the functions which has stubbornly resisted full integration is frequency-selective amplification. The source of the difficulty lies in the fact that it has not been possible to miniaturize high-Q inductors to the point where they are consistent in size with other integrated components. When a capacitor is miniaturized by scaling down all of its dimensions, the capacitance decreases proportionately but the quality factor remains constant at constant frequency. On the other hand, when an inductor[1] is similarly miniaturized, the Q decreases as the square of the scaling factor. Therefore major improvements in material properties are necessary before high-Q *LC* tuning networks can be integrated.

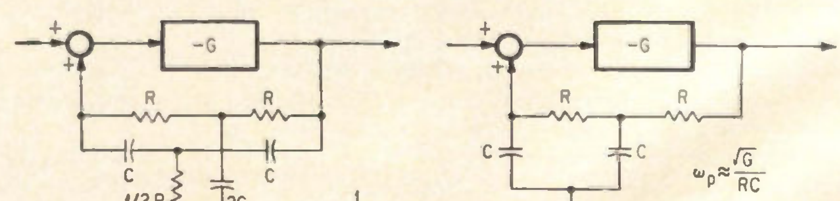
Many solutions to these tuning problems have been suggested. The purpose of this article is to show that each of these approaches falls into one of three categories. The advantages and disadvantages of each category are illustrated by typical examples. Elimination of the unpromising categories then points the way in which future work must be directed towards the solution of the tuning problem.

Passive Feedback—The well-known *LC* tank circuit will serve as a standard of comparison and is an example of the passive-feedback category of tuning networks. Although it is not ordinarily recognized that the selectivity of an *LC* network depends on feedback, a signal flow graph shows the similarity between these networks and other selective feedback networks. Such networks become frequency-selective when at some frequency the loop gain approaches unity. In the case of passive feedback networks, this requires the use of nearly lossless reactive elements. For example, passive *RC* networks can never have sharp selectivity.

Selective networks using passive feedback have two very important advantages. They are simple in that relatively few components are required and the component tolerances are relatively uncritical. A useful quantitative measure of how critical the tolerances are may be obtained from the sensitivities[2] of

COMPARISON OF NETWORK TUNERS

Active feedback does not provide an attractive solution to the problem of tuning integrated-circuits because of the tight component tolerances needed. Feedforward also is not attractive because of circuit complexity. The most promising tuners would be passive LC circuits and piezoelectric resonators which, although not necessarily integrated, are at least compatible in size with integrated networks



SELECTIVE tuners use parallel T feedback network (A) and reactance-tube circuit (B)—Fig. 1

Q with respect to the various components x_i, where

$$S_{xi}^{Q} \equiv \frac{x_i}{Q} \quad \frac{\partial Q}{\partial x_i} \approx -2Q \text{ Im } S_{xi}^{sp}$$

Here s_p is the dominant pole causing selectivity, and the sensitivities S_{xi} may be evaluated from the characteristic equation of the network. A total Q sensitivity for the network, Σ_Q, may then be defined by

$$\Sigma_Q \equiv \Sigma_i \left| S_{xi}^{Q} \right| \approx 2Q\, \Sigma_i \left| \text{Im } S_{xi}^{sp} \right|$$

Σ_Q may be interpreted as follows. If every element in the network changes by 1 percent in a direction such that the effects are additive, the Q will change by Σ_Q percent. Conversely, if Q is to be held within a tolerance of $\pm\,\theta$ percent, component tolerances of the order of (θ/Σ_Q) percent are required.

When the sensitivities of Q with respect to the *L, C,* and *R* of a tank circuit are evaluated and summed, it is found that

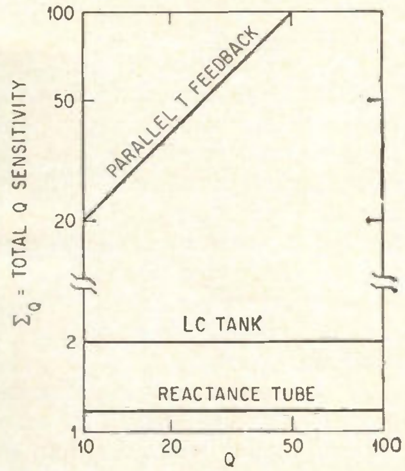
$$\Sigma_Q = 2$$

Since it is impossible for a passive network to be self-oscillatory, this value of Σ_Q is relatively small and in particular it is independent of Q. Therefore *LC* tuning networks are well behaved and are the ideal tuning method wherever they can be used.

Active Feedback—Numerous circuits for obtaining frequency-selectivity without using inductance have been discussed in the literature[3] and are commonly used at low frequencies where the alternative is to use a bulky inductor. Most of these circuits use an *RC* feedback network around one or more active elements. As before, selectivity results when the loop gain approaches unity, but now the active elements are necessary to cancel most of the signal losses in the *RC* network. Because of the delicate balance which must be maintained, selective active feedback networks are inherently very sensitive to component tolerances. If a component drifts slightly in one direction, selectivity is lost, while a drift in the other direction causes loss of the desired bandwidth and then self-oscillation.

A typical network of this type uses an *RC* null circuit in the feedback path, such as the parallel T, as shown in Fig. 1. The total sensitivity for this circuit is $\Sigma_Q = 2Q$, where the sensitivity of Q with respect to the amplifier gain, *G*, has not been included in the summation. The reason for this omission is that S_G^Q may be made arbitrarily small if *G* is made large enough. However the total sensitivity cannot be reduced. Since Σ_Q is proportional to Q, the attainment of higher Q (with the same percentage tolerance on Q) always necessitates tighter tolerances on the components. For example, to achieve a Q of 50 within ± 10 percent, component tolerances of the order of 0.1 percent are required over the entire range of operating conditions. Such tolerances on integrated circuits are completely unreasonable in the foreseeable future.

Similar conclusions hold for all other networks using an active feedback loop to obtain selectivity (other null circuits and phase shifters,[3] negative impedance converters, negative resistance devices,[4]) with one notable exception. Second-order feedback networks, such as the bridged T or the two-section phase shifter shown in Fig. 2, are unconditionally stable if connected around an amplifier having no excess phase shift. Under these circumstances Σ_Q is again independent of Q as it is for an *LC* tank circuit. The circuit shown in Fig. 2 is that of the well known reactance tube, and gives $\Sigma_Q = 7/6$ where, in this case, S_G^Q cannot be reduced and has been included in the summation. The disadvantage of these circuits is that very high gain is required for useful Q. For Fig. 2, $G \approx 9Q^2$ so that a

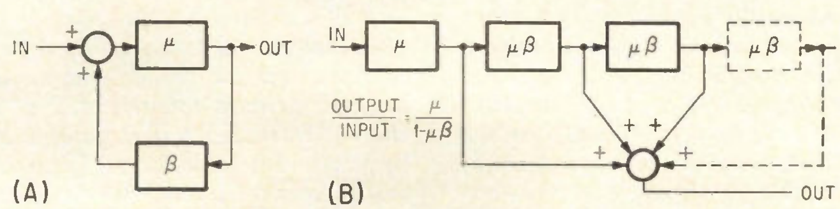


TYPICAL selective feedback networks illustrate the tolerance-sensitivity problem—Fig. 2

Q of 50 would require a gain of about 87 db. The high gain requirement, together with the low phase shift, have thus far made a transistorized reactance tube impractical for building an integrated tuning network. However, the development of high-gain, high-input-impedance field-effect transistors could change the future prospects of this circuit.

The seriousness of the tolerance sensitivity problem for most high-Q active feedback networks is shown in Fig. 3 in which the values of Σ_Q are plotted as functions of Q. The graph for parallel-T feedback, although not the minimum that is possible,[5] is representative since it is the slope which poses the major problem.

Feed-Forward Networks — The unique feature of a feedback network is that the same network is used to process the signal an infinite number of times. The price which is paid for this feature is the inherent possibility of self-oscillation. However, any feedback network may be



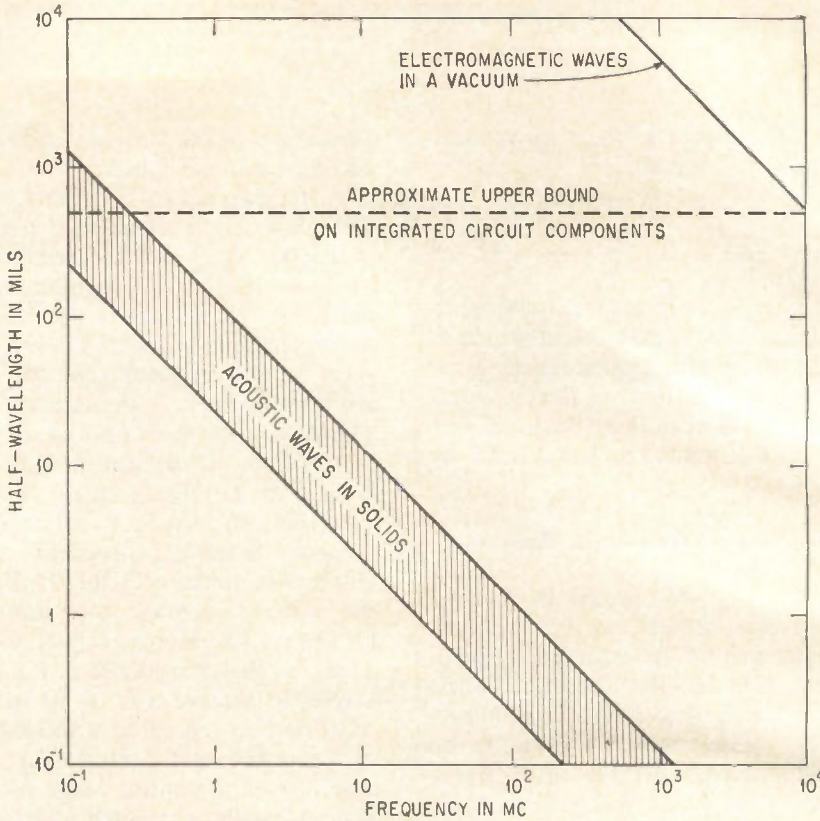
FEEDBACK network (A) and its equivalent feedforward network (B) present problems of complexity—Fig. 3

replaced by an equivalent feedforward network consisting of an infinite chain of identical stages, where the output is obtained by summing the outputs of the individual stages as shown in Fig. 4.

The question now arises: can a selective feedback network be satisfactorily approximated by a finite feedforward network, and if so, how many stages are required? The anticipated advantage is that a finite feedforward network cannot become self-oscillatory, and therefore the extreme tolerance sensitivity of a selective feedback network can be avoided.

As with the active feedback approach to tuning, there are many specific circuits which fall into the feedforward category. Some are ordinary linear networks or devices[6] while others use sampling techniques,[7, 8] and each differs from the others in details. The common disadvantage of these networks is not one of stability and tolerances but one of complexity. No high-Q feedforward network is known which promises to be economically feasible in integrated form.

As an example, consider the case where each stage consists of a lossless delay line. This network is the electrical analog of a diffraction-grating monochromator. Then $\mu(s) = e^{-\tau s}$ and $\beta = 1$ where τ is the delay in each section. The fundamental passband is centered at $1/\tau$ cycles per second, but other passbands occur at multiples of this frequency. It can be shown that the approximate Q for a large number of stages, N, is then given by $Q \approx 9N/8$. Therefore about 45 sections of delay line, together with the appropriate summing network, would be necessary for a Q of 50. Aside from the difficulty of trying to integrate a nearly lossless delay line, it is very unlikely that this much complexity can be justified in the accomplishment of such a simple function.



COMPARISON of half-wavelength of electromagnetic and acoustic waves favors the latter—Fig. 4

Looking Ahead—Assuming that an economically feasible solution to the integrated circuit tuning problem will eventually be found, it is unlikely that it will be either an active feedback network (because of the required tolerances) or a feedforward network (because of complexity). The remaining alternative is a passive tuning network, that is, a classical *LC* circuit or its electromechanical analog, an acoustic resonator. Although the investigation of integrated tuning networks over the past five years appears to have returned to its starting point, the present situation differs in at least two important respects. There is a fuller awareness that there is no mystical easy solution to the problem and the hard facts of life force the acceptance of a compromise solution as better than no solution. In this light, hybrid circuits that are not completely integrated become more attractive.

For frequencies of 50 Mc or more, relatively little inductance is required for tuning and it may yet be possible to develop a satisfactory inductor of compatible size. Piezoelectric devices also show great promise. These devices exhibit a resonance when the controlling dimension is of the order of an acoustic half-wavelength.

If 500 mils is taken as an upper limit for the size of an economical integrated circuit component, Fig. 5 shows that resonant acoustic devices lie below this limit for all frequencies greater than about 100 kc. The analogous electrically resonant traveling wave structure would be larger by a factor of about 10^5. The necessity of special mountings for these devices to prevent acoustic coupling has been a serious disadvantage, but this difficulty may not be insurmountable. Therefore the solution to the tuning problem, although not attained, has at least been circumscribed.

REFERENCES

(1) A. Rand, Inductor Size vs. Q: A Dimensional Analysis, IEEE Trans. on Comp. Parts, Vol. 10, p 31, March 1963.
(2) W. E. Newell, Selectivity and Sensitivity in Functional Blocks, Proc. IRE, Vol. 50, p 2517; Dec. 1962.
(3) S. W. Punnett, Audio Frequency Selective Amplifiers, Jour. Brit. IRE, Vol. 10, p 39, Feb. 1950; T. E. Price, G. Bradshaw, C. H. Taylor, A Tunable Solid-Circuit Filter Suitable for an I.F. Amplifier, Electronic Engineering, Vol. 35, p 806, Dec. 1963; G. Herskowitz, R. Wydrum, Jr., Design of Distributed RC Feedback Networks for Bandpass Amplifiers, Semiconductor Products, Vol. 7, p 13, Jan. 1964.
(4) H. G. Dill, Inductive Semiconductor Elements and Their Application in Bandpass Amplifiers, IRE Trans. on Mil. Elect., Vol. 5, p 239, July 1961.
(5) W. E. Newell, A Frequency-Selective RC Feedback Network with Relatively Low Component Tolerance Sensitivity, to be published, Jour. of Electronics & Control.
(6) S. N. Levine and J. J. Sein, Semiconductor Bandpass Filters, 1961 IRE Intnl. Conv. Rec., pt. 6, p 133.
(7) W. R. LePage, C. R. Cahn, J. S. Brown, Analysis of a Comb Filter Using Synchronously Commutated Capacitors Trans. AIEE, Vol. 72, pt. I, p 63, March 1953.
(8) A. Campora, B. Rabinovici, C. A. Renton, Generation of Band-Pass Filters by Switching Techniques, Proc. IEEE, Vol. 51, p 256, Jan. 1963.

PROBLEM SOLVING PRECISION SWITCHES AND CONTROLS

LICON®

this...

The Licon type 16 "Double-Break" Subminiature Switch

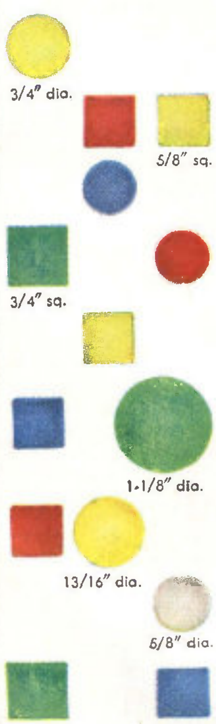
makes these...

Licon type 01 lighted pushbutton Switches

MOMENTARY CONTACT

MAINTAINED CONTACT

INDICATOR UNITS



reliable

The most reliable* indicator and manual switching components you can use . . . in a wide selection of
- all new buttons
- colors
- legends
- mountings
- circuitries
- solenoid held
- environment free

Send for facts catalog and list of distributors. Request sample/demonstration on your letterhead.

*20 million mechanical cycles

itw LICON
DIVISION ILLINOIS TOOL WORKS INC.
6615 W. IRVING PARK ROAD • CHICAGO, ILLINOIS 60634

IN CANADA: CANADA ILLINOIS TOOLS LTD. • 67 SCARSDALE ROAD • DON MILLS, ONTARIO, CANADA

TRYGON Half Racks

Model HR40-5A

New higher amp models available:

Model	Volt	Amps	Regulation	Ripple	Price
HR20-1.5*	0-20	0-1.5	0.01% line 0.05% load	0.25 mv	$164
HR40-750*	0-40	0-0.75		0.15 mv	$149
HR20-5A	0-20	0-5	0.01% line 0.01% load	0.5 mv	$299
NEW HR20-10A	0-20	0-10			$379
HR40-2.5A	0-40	0-2.5			$299
HR40-5A	0-40	0-5			$349
HR60-2.5A	0-60	0-2.5			$379
NEW HR60-5A	0-60	0-5			$449

*Single Meter Units

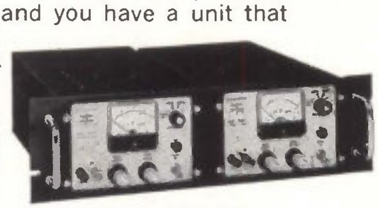
. . . the most versatile power supplies going!

In the lab—you'll find you can't beat a Trygon Half Rack for versatility and low cost! Want constant voltage with adjustable current limiting? You've got it! Want constant current with adjustable voltage limiting? You've got it! Want to select voltage and current with a remote control? You've got this too!

But check the features at the right—and the prices—for yourself. And remember—every Trygon power supply, large or small, goes through the same test procedures before shipment. Each is aged—burned in; each is subjected to stability runs. Each must pass shock and vibration tests—your assurance of long, trouble free performance along with versatility.

In a system—you merely take off the Half Rack dust cover, reverse it, add an inexpensive Trygon adapter, and you have a unit that slides right into a rack. What's more, you can place two Half Racks in a 19" rack width, occupying only 5¼" of panel height.

For complete specs—on the Half Rack Series as well as our catalog showing the complete line of over 100 Trygon Power Supplies, write to us today. Address: Dept. E-7.



Two Trygon HR20-1.5's, rack-mounted side by side.

FEATURES

- **CONSTANT VOLTAGE OPERATION** with adjustable current limiting.
- **CONSTANT CURRENT OPERATION** with adjustable voltage limiting.
- **COMPLETE RANGE REMOTE PROGRAMMING** furnishes voltage and current selection from a remote control.
- **REMOTE SENSING** provides rated regulation at the load, available at both front and rear terminals.
- **HIGH RESOLUTION** for setting current and voltage is provided by coarse and fine adjustments for both (4 controls).
- **AUTOMATIC OVERVOLTAGE PROTECTION**—Trygon's unique overvoltage protection is available as an option.

TRYGON ELECTRONICS INC.
111 Pleasant Avenue Roosevelt, L.I., N.Y.
(516) FReeport 8-2800 TWX (516) 868-7508

The Two Faces of Will Copp

With a soft voice and tough rules, he runs the IEEE Show

By **PEGGY JACKSON**, Staff Writer

NEW YORK—The largest and most successful trade show in industry was brought to its present stature by a man who considers himself a "scullery maid" and is too modest —or too politically astute—to take credit for his creation.

When William C. Copp joined the Institute of Radio Engineers in 1941 as an advertising salesman, the exhibit portion of the annual IRE Convention was run by one of its 10,000 members, without pay. In 1945, Will Copp signed a contract to manage the exhibit as well as sell advertising. He has been doing it ever since, and he, according to an associate, has been "amply compensated."

Under Copp's tutelage, the electronic extravaganza has grown from about 150 exhibitors and 10,000 attendees in 1945 to this year's expected 1,000 exhibitors and 72,000 attendees. It has outgrown, successively, New York's Hotel Astor, Hotel Commodore, Grand Central Palace, Kingsbridge Armory and, this year, the New York Coliseum. The electrical equipment manufacturers will exhibit their wares in the New York Hilton and, Copp laments, "I wanted to sell 150 booths in the Hilton but I'm only going to sell a little over 100."

Copp attributes the growth of the IEEE show to the growth of the entire electronics industry. But nearly everyone having anything to do with the show agrees that it is equally—if not more—attributable to Will Copp. Other industries have grown. But there is only one IEEE show. As one associate remarked: "He has been a victim of circumstances; and he took advantage of them."

Copp's own ability to "take advantage of them" is enhanced by his relationship with the IEEE. They hire him to run the show and he runs it. In a cooperative undertaking of 1,000 competing companies there must be a final authority. Although the Exhibits Advisory Committee, of which Copp is a member but not chairman, has nominal authority, the committee recognizes the advantages of Copp's 19 years of successful experience.

Many of the fruits of these 19 years are condensed into a two-page bulletin—blue this year—that is mailed to each of the exhibitors well before the show. Under the heading "Purpose and Rules," the bulletin, in 29 explicit paragraphs, lists rules that no ingenuity on the part of enterprising exhibitors can circumvent. Some call them "arbitrary," but everyone agrees that they are the same for every exhibitor. These rules, as well as furnishing guidelines for the IEEE show, furnish fuel for much of the controversy surrounding Will Copp.

Objections, But Vague—He is called "the most expert show manager in the United States" by the man who hired him and, variously, "a tough, businesslike guy," "tops," and "a very diplomatic fellow" by some of the people he's worked with. Copp's admirers back up their adjectives with anecdotes and examples. They talk about his 24-hour working days at show time, his willingness to "pitch in" with even the most menial phase of the operation. The most obvious example they cite is, of course, the success of the show.

Copp's detractors are either unwilling or unable to reveal the basis for their opinions. One exhibitor, complaining of Copp's "cavalier attitude" toward exhibitors, said he could not think of a single instance in which Copp had been unfair, and refused to substantiate his opinion with an incident or example. One cannot help reaching the conclusion that a grievance afraid of print is not a legitimate grievance and that, to him, a "cavalier attitude" describes a man who, in the words of an associate, "stands for no monkey business at the show."

Copp thinks of himself as "one of the littlest people in the world" and insists that his only "power" is "the power of being right."

A devout Christian Scientist, Copp attributes his power of being right to his close relationship with "the man upstairs." Using words and phrases that would sound at best corny—at worst, insincere—in the mouths of most of the people with whom he deals, he talks about praying at crucial moments during each show. He attributes the 9,600 attendance at the 1956 show—when New York was paralyzed by an 18-inch snowfall—to Divine intervention.

Profit-Making—In talking to Copp about his work, one could almost forget that William C. Copp & Associates, Inc., is a profit-making organization. But it is. Sales in 1962 were reportedly over $800,000. Copp will not discuss seriously his own earnings, although he is apparently aware of criticism that he "makes a fortune" on the IEEE show. "I have 49 gold-plated Cadillacs; and you can quote me."

No one will talk about the financial picture of the IEEE show itself, though IEEE officials smilingly admit it "breaks even." Consensus of industry observers, however, is that it does much better than that.

Brotherhood—Copp himself, in a soft, hypnotic voice, discusses the IEEE show in terms of the dignity and brotherhood of man. He runs the show with an eye to both.

It is not dignified—nor, says Copp, is it good salesmanship—to have "cheesecake" competing with products. It is not in keeping with the "brotherhood of man" to collect Company A's literature in an envelope that advertises Company B. The advertising manager of a long-time exhibiting company admits that "a lot of people don't like to be regulated. But," he adds, "they need some guidance and some regulation and Copp gives it to them."

The regulations are explicit. No exhibit, for example, can be higher than 8 feet. No equipment can produce noise louder than 6 db above the existing sound level. A manufacturer who wishes to show an 8-ft, 1-inch antenna, or a piece of equipment that operates at 7 db above sound level, might find it difficult to observe the rule. But in Copp, says one associate, "the exhibitors run up against a fellow who isn't afraid to say 'you go by the rules or out you go.'"

Exhibitors who have tangled with Copp might be pleased to know that there is one rule he has never made, although he would like to: "I'm an absolute dry and those liquor stands on the floor really burn me up."

Copp's near-missionary attitude toward his work is startlingly represented on three walls of his reception room by murals in which the various activities of William C. Copp are depicted in a realistic style that is strangely out of phase with the abstractions that decorate most corporate headquarters.

Above the section representing the IEEE show is written: "A trade show is the cooperative effort of a brotherhood of business men demonstrating the bright hope of better products."

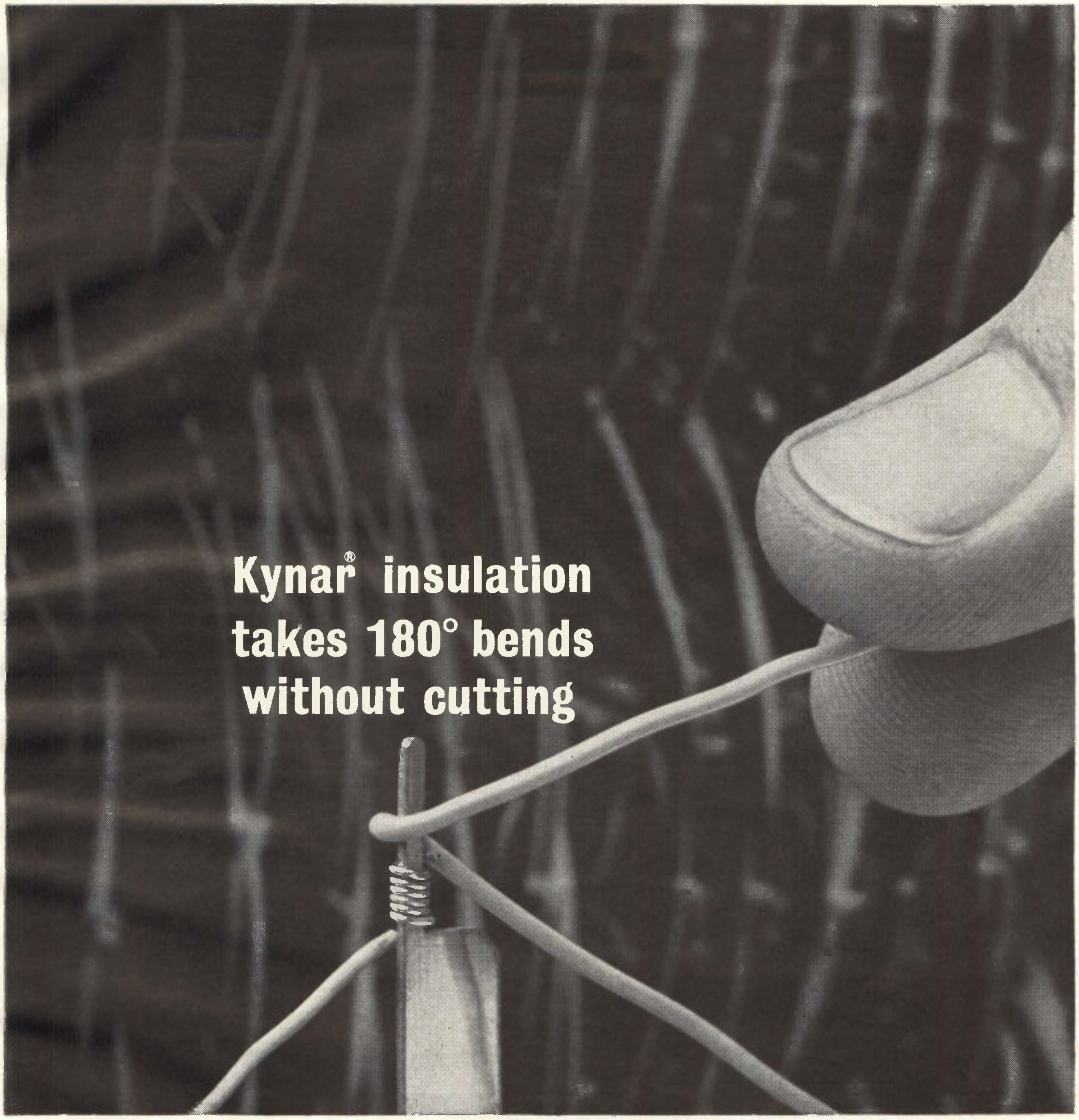
Copp is almost embarrassingly earnest when he speaks about his belief in this doctrine. To him, the IEEE show is a "brotherhood of exhibitors exhibiting side by side." He is equally earnest in seeing his own position as that of a "scullery maid" in the IEEE organization.

Humility—His humility emerges when he says "this show is coordinated and put together by one of the littlest people in the world. The glory isn't mine; it belongs to 1,000 exhibitors. I'm a presenter of ideas. They're the originators. I never had an original idea in my life."

Some of the exhibitors feel anything but "glorified" after an encounter with Will Copp; but Copp's ability is recognized by all who know him, even if the recognition sometimes takes the form of a teeth-gritting admission.

The man who causes the teeth-gritting wears many hats. As President of William C. Copp & Associates, Inc., he runs the IEEE show as Advertising and Exhibits Manager and does the same job—with the same title—for the Armed Forces Communications and Electronics Association. As President of Copp Publications, Inc., he publishes two trade magazines: *Law and Order*, for police department officials, and *Mayor and Manager*, for city government officials.

Before joining IRE, Copp sold advertising for the American Institute of Physics. His explanation for leaving AIPh is characteristic: "They fired me. I had a contract to wipe out the deficit and I did."



Now you can pull computer hookup wire around tight corners—even stretch it over sharp edges —without danger of insulation cutting through. The secret: Kynar, Pennsalt's vinylidene fluoride resin, a new high-performance fluoroplastic that's *tough!* ▫ Wire insulation of Kynar offers unmatched mechanical strength and toughness, even in 5-mil sections you may need for miniaturization. It cuts cleanly, strips readily, won't burn or melt. Dimensionally stable, Kynar doesn't stretch when wires are pulled. Wire insulated with Kynar has ample stiffness yet stays in place when harness is bent to shape. ▫ Write for our brochure and the names of leading manufacturers who supply wire insulated with Kynar. Plastics Department, PENNSALT CHEMICALS CORPORATION, 3 Penn Center, Philadelphia 2, Pa.

Kynar... a fluoroplastic that's tough!

Pennsalt Chemicals®
ESTABLISHED 1850

Kynar is a Registered Trademark of Pennsalt Chemicals Corp.

CIRCLE 57 ON READER SERVICE CARD

Award Winners•1964

Seven Americans and two Canadians will receive awards from the IEEE at the International Convention this month. Recipients and their accomplishments:

MEDAL OF HONOR—the only nonannual award—goes to **Harold A. Wheeler**, founder and president of Wheeler Laboratories, Great Neck, N.Y., for "his analyses of the fundamental limitations on the resolution in television systems and on wideband amplifiers, and for his basic contributions to the theory and development of antennas, microwave elements, circuits, and receivers." Wheeler, 61, began specializing in antennas and transmission lines in 1934.

EDISON MEDAL—the annual award for long-term technical achievement—goes to **John R. Pierce** "for his pioneer work and leadership in satellite communications and for his stimulus and contributions to electron optics, traveling-wave-tube theory and the control of noise in electron streams." Pierce, 53, is executive director, research and communications principles, Bell Telephone Laboratories. He invented both the "Pierce gun" and periodic focusing.

FOUNDERS AWARD, annual recognition of outstanding service to IEEE and the profession, goes to Canadian **Andrew George Latta McNaughton**, "for his inspiring leadership and his personal contributions to the field of electrical engineering and radio communications." Joint inventor of the cathode-ray direction finder, McNaughton served in both World War I and World War II before retiring from the Canadian Army, as a General, in 1944.

LAMME MEDAL—annual award for meritorious achievement in the development of electrical or electronic apparatus or systems—was won by **Loyal V. Bewley**, consultant, engineering education, General Electric Co., Schenectady, N.Y. Bewley, 65, was head of Lehigh's Department of Electrical Engineering until 1956 and dean of Engineering until 1962.

EDUCATION MEDAL was awarded to **B. Richard Teare, Jr.**, dean of the College of Engineering and Science at Pittsburgh's Carnegie Institute of Technology. Teare's award recognizes his leadership in planning courses to give students competence in humanistic and social as well as technical fields. He has been with Carnegie Tech since 1939, before that with GE.

MORRIS N. LIEBMANN MEMORIAL PRIZE, for a recent major contribution to radio art, was won by **Arthur L. Schawlow**, Physics Professor at Stanford University, "for his pioneering and continuing contributions in the field of optical masers." Schawlow was co-author of the 1958 scientific paper that suggested the possibility of devising a laser.

HARRY DIAMOND MEMORIAL PRIZE—for outstanding technical contributions in government service—goes to **James R. Wait**, National Bureau of Standards, Boulder, Colo., for outstanding contributions in the field of electromagnetic wave theory. Wait, a 40-year-old Canadian, is a professor (adjoint) of electrical engineering at the University of Colorado.

W.R.G. BAKER PRIZE—annual award for the best paper originating in the IEEE Transactions—goes to **Donald L. White** for his paper entitled "The Depletion Layer Transducer." With Bell Telephone Laboratories since 1956, White is currently working on the physical theory and application possibilities of ultrasonics in solid-state physics.

BROWDER J. THOMPSON MEMORIAL PRIZE—for best IEEE paper by an author or authors under thirty—goes to 28-year-old **Harry B. Lee**, MIT assistant professor, for his paper on "A New Canonic Realization Procedure." Lee received S.B. and S.M. and PhD degrees from MIT, then spent a year at the Royal Technical University of Denmark as a Fullbright Scholar.

AEC Sees Wide Use of Remote Data Stations

RICHLAND, WASH.—By providing power and comfortable temperatures for electronic equipment, radioisotopes will make feasible the operation of an increasing number of automatic weather stations and marine navigational aids.

So declared Al Berman, of the AEC's Division of Isotope Development, at a meeting Feb. 25 and 26 for representatives of firms interested in commercial isotope development. Berman listed the following military applications as likely in the next five years:

- Marine navigational aids—12 to 20 underwater acoustic beacons are envisaged in the next three years, with as many as 200 additional systems possible by 1970. The generators are now being developed.
- Oceanographic and weather buoys—A network of 100 buoys similar to the NOMAD and MAMOS Buoys (ELECTRONICS, p 14, Feb. 21) is desired. Data from various depths would be correlated during underwater acoustic experiments.
- Communications satellites—A 30-watt generator is being developed for the Medium Altitude Communications Satellite program. A need is seen for 25 to 40 satellites.

Civilian Applications—Other applications include:

- Land-based weather stations—The World Meteorological Organization wants up to 100 automatic weather stations installed in remote areas. One station has operated for two years within 600 miles of the North Pole.
- Coast Guard beacons—Nuclear power supplies are economically sound for use in some 90 existing light buoys in the Alaskan area and 70 fixed lights in hazardous locations. Over 12,000 fixed lights and buoys are now powered by battery or acetylene.
- Unattended seismic stations—Lamont Geological Observatory of Columbia University is interested in building an undersea seismic station at a depth of some 20,000 ft.
- Weather services—During the next five years, at least 35 more weather buoys similar to NOMAD and MAMOS will be deployed.

Here's the First Planar Stud-Mounted Silicon Controlled Rectifier

. . . and 5 things you should know about it:

1. Low leakage, as low as $10\mu a$ @ 25°C

2. Reliability and lot uniformity for greater design margin

3. New process provides self-bias, assures greater stability at high temperature

4. Priced competitive with non-planar versions

5. Immediate availability including the following new types:

LOW LEAKAGE TCR 50 SERIES
Features: Maximum DC forward and reverse current @ rated voltage (Is, Ir) of $10\mu a$ @ 25°C and $250\mu a$ @ 125°C. Maximum forward voltage @ 25°C (VF) of 1.3 volts @ 3A.

Type	Minimum forward and reverse breakover voltage
TCR 50	50
TCR 51	100
TCR 53	200
TCR 56	400

COMMERCIAL TCR 70 SERIES
Features: Maximum DC forward and reverse leakage current @ rated voltage (Is, Ir) of $50\mu a$ @ 25°C and 1.0ma @ 125°C. Maximum forward voltage @ 25°C (VF) of 1.75A @ 3A.

Type	Minimum forward and reverse breakover voltage
TCR 70	50
TCR 71	100
TCR 73	200
TCR 76	400

TURN-OFF TRANSWITCH TCR 80 SERIES Features: Maximum forward and reverse leakage current @ rated voltage of $10\mu a$ @ 25°C and $250\mu a$ @ 125°C. Minimum turn-off beta of 10 @ 2.0 amps Ic.

Type	Minimum forward and reverse breakover voltage
TCR 80	50
TCR 81	100
TCR 83	200
TCR 86	400

STANDARD SERIES
All of Transitron's standard $^7/_{16}''$ stud mounted SCR devices are manufactured by planar process. Typical series are:

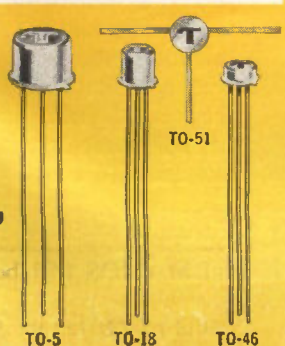
- 2N1600-1604
- 2N1770-1777
- 2N1770A-1777A
- TCR 505
- TCR 3
- TCR 13
- TCR 23
- TCR 43

All available in volume immediately

Available through your authorized Transitron Distributor

Planar SCRs in other packages, too!

Immediately available in volume.



FREE: SCR bulletin file

Gives you complete specifications and details on the broadest line of planar silicon controlled rectifiers available today. A must for your files. Write today: SCR FILE Transitron, Wakefield, Mass.

Meet us at IEEE • Booths 1811-1815

Transitron
electronic corporation
wakefield, melrose, boston, mass.
SALES SERVICES IN PRINCIPAL CITIES THROUGHOUT THE U.S.A. AND EUROPE • CABLE ADDRESS: TRELCO

Competition Keynotes the Show

Prestige products give ground to equipment that visitors will buy now

NEW YORK — While the electronics industry is getting bigger, it is also getter leaner. The IEEE Show this year will mirror that image of the industry. Few companies are going into the show to be one of the boys.

The military market is fairly tight right now. Military business is generally down, and companies going after this business are sharpening their estimating pencils as well as improving products. This competitive pressure is taking hold throughout the industry.

One of the reasons for the heightened competition, according to Robert Janning, marketing manager for Leach Corp., is due to the end of the sole-source or limited-competition concept in military buying.

Now, any company can bid on a contract, even in the middle of a program, and get in if it can supply an item at a competing or lower cost. In the past, Janning points out, the Department of Defense was reluctant to allow this and permitted some contractors to monopolize a contract.

The market should loosen up later this year. Spokesmen for several exhibitors predict a pickup in military business before election time and some expect to do better in 1964 than 1963 as a result. But right now, it's a buyers' market.

Military and Space—Almost all of the big military and space companies will be at the show, but they'll be primarily selling components, subsystems and instruments—not systems—to military and commercial companies.

Raytheon, for example, has been working on integrated circuits for the Apollo guidance computer. So, for a crowd-stopper, it will show a commercial version of an Apollo circuit, but the heart of the display will be Raytheon's other component lines (booth 2606).

RCA's Defense Electronics and Astroelectronics divisions don't plan to participate actively in the Show, but RCA will be there with the unpressurized traveling-wave tubes used in the Relay II satellite, the half-inch and one-inch vidicons used in space tv cameras, and semiconductor devices developed for space applications. Some of these, RCA believes, will attract industrial electronics interest (booth 1602).

Rohr Corporation's most famous project is the 210-foot dish being set up at the Goldstone, Calif., space-tracking facility. Rohr will feature a model of it at the Show. It demonstrates the company's capabilities in commercial antennas. Rohr does a good business selling microwave horn antennas to telephone companies (booth 1906).

Aiming its exhibit right at the space market, though, will be Antenna Systems, Inc. Smaller nations will want to tie into the global telephone networks that will come with communications satellites. But they can't afford huge installations, so the company is selling mobile antennas (booth 2434).

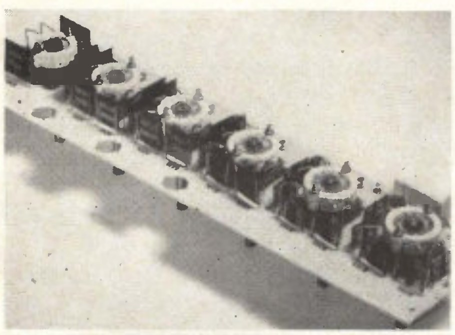
Computers—Most of the computers at the show will be working tools

MINIATURE tape recorder being introduced by Leach is designed for use in rockets and other high environment applications is typical of aerospace products being sold

Missile With Strings Attached

ANTITANK MISSILE being developed by Hughes Aircraft has hit a target within a foot of dead center in demonstration tests, Army reports. The missile is called TOW (Tube-launched, Optically-tracked, Wire-command). Missile's course is slaved to optical tracker by signals sent down wire by electronic system. Hughes has received $23 million in contracts

Panelyte Copper-Clad 1635 FR4 for printed circuit boards meets critical design requirements in efficient solid-state Voltage Calibrator by John Fluke Mfg. Co., Seattle, Wash.



Voltage Calibrator by John Fluke Mfg. Co.

For operational accuracy, capacity and application flexibility, the Fluke Voltage Calibrator is ever growing in acceptance and use by industry. One of its major features is the plug-in printed circuit board which results in both ease of calibration and simplified maintenance.

Thiokol Panelyte Copper-Clad Grade 1635 FR4 was selected for this component. 1635 is a glass-epoxy laminate manufactured to MIL SPEC MIL P-13949 whose characteristics include fire retardancy, extreme mechanical strength and excellent electrical properties. Its high machinability and fabricating qualities allow for the most complex circuit configuration. Its resistance to heat and flame make it ideal for electronic equipment subject to high temperatures.

Complete information available from Panelyte or see the design section of Sweet's Catalog.

Thiokol

PANELYTE

INDUSTRIAL

Makers of laminated sheets, rods, tubes, copperclads; high pressure plastic moldings, and fabricated parts for the missile and aerospace industry.

Thiokol Chemical Corporation, Panelyte Industrial Division,
N. Enterprise Avenue, Trenton 4, New Jersey

WHAT MAKES THE SHOW GO?

More than 1,000 exhibitors will be showing $20 million worth of products at the IEEE Show. Why?

Some companies think the Show is just great, a chance for the industry to gather once a year to trade products and ideas. Others call it a "boondoggle."

There's no inconsistency in this. It depends on what company is trying to sell what product to whom.

Several East Coast companies, for example, told us they find WESCON far more productive than the IEEE Show, because they reach customers they don't often see. And West Coast firms say just the reverse.

Smaller companies, with limited product lines and limited sales staffs and budgets find the Show a bargain. They'll hold off introducing a product until the Show opens, or they sweat to have one ready in time. To them, the Show is the biggest engineering audience they'll have all year—75,000 is the attendance the IEEE hopes for this year.

The most ardent fans of the Show are the companies which sell most of their output within the industry—companies selling components, subsystems, instruments, hardware, production equipment, and the like.

End-equipment manufacturers selling to other industries often consider the Show a waste of time and money. They may go just to show the flag for prestige. Computer companies generally prefer the joint computer conferences or business shows, industrial electronics firms would rather spend the money on shows aimed at processing industries, military companies prefer to exhibit their systems at the military shows like AFCEA and MIL-E-CON.

The conflicting viewpoints average out in the diversified companies, those that sell equipment and components. Almost all of them go to the Show, and most of those that go stress their component lines.

---

for engineers, types that can be used to design products, try out processes and quickly reduce volumes of analog test data to results in digital form.

Improvements in operating flexibility are generally featured in the newer analog computers. For instance, Electronic Associates' desktop Pace TR-20 is an improved model of the TR-10. The TR-20 has a new variable function generator that allows nonlinear functions to be set up more quickly (booth 1927). Systron-Donner's new SD-40/80 transistorized computers come with 42 or 84 operational amplifiers and can be expanded by inserting additional computing modules into prewired slots behind the problem board (booth 3916).

Engineers have found that hybrid systems, combining digital and analog computers, come in handy for solving complex engineering or scientific problems. The digital end helps the analog end out, for example, by storing data, and providing logic, switching and programming functions.

Hybrid computers can now be bought. But companies that want to link up their existing, but separate, digital and analog computers need interface equipment. These used to be custom installations, but hybrid linkage subsystems can now be bought, too.

Computer Systems is showing a hybrid linkage, the Dystac HL-20, that will hook up general-purpose analog computers (including the current Dystac line) to digital computers such as the Control Data 160A and 3200, and the Digital Equipment PDP-1 to PDP-6 computers. The HL-20 provides high-speed solid-state switching, and digital inputs to control analog coefficients. The analog sample-and-hold circuit is separately available for such data-acquiring applications as industrial process control (booth 3926).

Another digital-analog interface is General Applied Science Labs' AD-1. Four channels convert from analog to digital, and two from digital to analog. The sampling rate for a-d and d-a conversion can be selected through a rate generator variable from 10 microsec to 1 second in 10-microsec intervals (booth 3839).

Logic Modules—Integrated circuits will be giving discrete-component logic modules their first serious

ANOTHER EXAMPLE OF "TOTAL VALUE" ASSURANCE...

Cannon's new KV/PV Series enables a degree of connector standardization and economy never before accomplished in the industry

The KV and PV Series are designed to meet the new industry specification (NAS 1599) which incorporates features of layout and configuration of two existing specifications (MIL-C-26500 and MIL-C-26482) into one standardized specification with improved design and performance characteristics. Utilizing the same contacts, backshells and accessories, military crimping tool and expendable plastic insertion/extraction tool, both the KV and PV reduce costly connector inventories. This new series also lessens user assembly training time and simplifies control and specification drawings and user qualification testing programs.

Featuring the "Little Caesar" Rear Release System, Cannon's KV/PV Series are miniature circular high environmental plugs developed to provide reliability where it counts most... CONTACT STABILITY — POSITIVE CONTACT MATEABILITY — STRONGER, SIMPLIFIED CONTACTS. To support existing major aerospace programs, the KV (threaded coupling) and PV (bayonet coupling) intermate respectively with 26500 and 26482 type connectors. For design and performance data write for Cannon's KV/PV Catalog.

SEE KV/PV AT IEEE BOOTH 2516-20

Our 50th Year

ITT

CANNON ELECTRIC INC.

3208 Humboldt Street, Los Angeles 31, California

A SUBSIDIARY OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION.

CANNON PLUGS

competition at the Show this year (see p 10), but there'll be plenty of new printed-circuit and welded-circuit modules. To name a few:

- Digital Equipment Corp. has a new series of 10-Mc silicon cards (booth 3833)
- Atlantic Instruments is rounding out their line with several 250-kc cards, a 500-kc flip-flop and may show a 1-Mc line (booth 2002)
- Control Logic will have over 20 silicon welded-circuit modules that will count at 50 Mc and do arithmetic at 25 Mc (booth 3043)

Walkirt Company (booth 2708) is bringing in the first off-the-shelf item in a line of packaged integrated circuits: a decade made up of six TI Series 53 circuits. Walkirt will be packaging integrated circuits because, as one Walkirt man put it, "We couldn't beat the integrated-circuit manufacturers, so we've joined them."

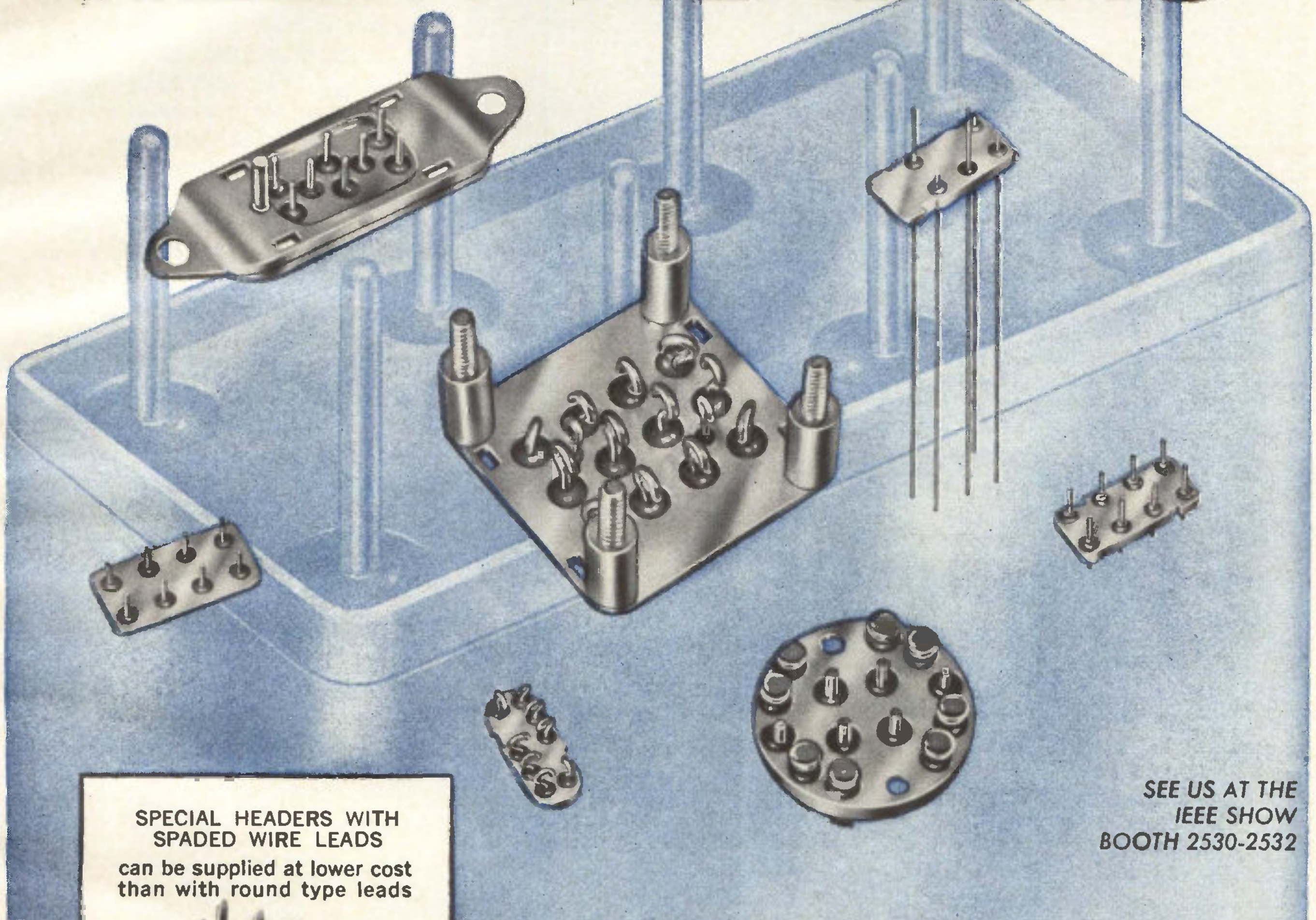
C&K Components, however, is bucking integrated circuits with counting devices based on magnetic cores. "Unlike integrated circuits, which are on all the time," C&K says, its circuits use no power when idle and can provide duty cycles of a million to one. For the show, the modules are put together as a clock that will turn off a satellite beacon after one year (booth 1629).

Honeywell hopes to have a new line of milliwatt digital logic ready in time for the show. Similar to direct-coupled transistor logic, the line is made by a planar triple-diffused process that is said to simplify fabrication and reduce cost.

Power Supplies—The trend toward solid-state is helping, and being helped by, power-supply manufacturers.

Increased use of silicon power devices are shrinking power-supply case sizes. Meanwhile, the 1964 lines contain more precision variable-voltage sources with excellent long and short-term voltage stability. Such power supplies are being brought on the market to satisfy the needs of equipment designers working with advanced semiconductor devices and integrated circuits.

Another feature catching on is one that tells an operator when his power supply has switched from current-regulated to voltage-regulated operation. Called voltage-


SEE US AT THE
IEEE SHOW
BOOTH 2530-2532

current crossover mode indication, it was shown by Kepco (booth 2636) last year and will be included in the lines of several more manufacturers this year.

Instrumentation — A substantial market is opening up for phase-measuring equipment. Many large companies are reportedly buying instrumentation to measure such things as relative phase of cable lengths and of networks. The push is attributed to the placing of large defense contracts for work on anti-missile technology. Both the Nike-X program and the Air Force's missile and space-detection program have complex phased-array radar systems in development.

Alford Manufacturing is one company that will be showing complete phase-measuring systems, equipment that can readily be converted into impedance plotters by adding an r-f bridge (booth 1716).

The trend toward digital readout continues this year, but there will be no mass swing to digital instruments. Instrument design is tuned to the needs of design engineers, and design engineers still generally prefer to use analog instruments when they are working on equipment that involves analog operation and measurement. Unnecessary conversion from analog to digital may mean loss of accuracy, and more work. The rising demand for digital instruments reflects mainly the increasing amount of work being done on digital equipment, and the use of tools like digital computers to process test data.

Lasers—A number of companies that are active in lasers don't plan to show. Among these are Perkin-Elmer, which rented a special room last year for their laser demonstration, and Maser Optics and Korad division of Union Carbide.

Spokesmen for these companies indicate that the IEEE Show is too much of a trade show for items as specialized as the laser is today. They feel that their lasers are better advertised now at the smaller, more specialized meetings.

Malcom Stitch, of Hughes, says the reasons for the scarcity of lasers at the show are that they are not yet a product to sell generally, it is hard to prepare a meaningful laser exhibit, and most of the practical

laser information is classified.

Hughes, however, will be exhibiting a laser. It is one developed for micromachining and welding, the company's first non-laboratory laser product (booth 2501). Another exhibitor is TRG, which has an improved model of their Biolaser. Used for research at the gene and chromosome level, and for microsurgery, it can be focused down to a 1-micron spot size (booth 1918).

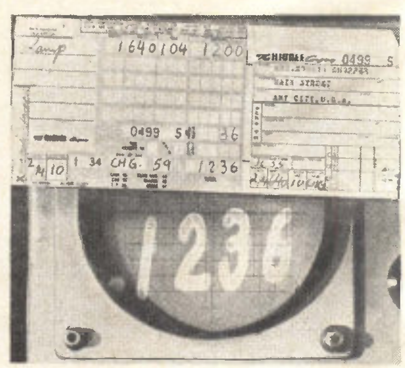
Consumer Electronics—A number of goodies have been prepared by transistor manufacturers in an effort to speed up the slow pace of tv transistorization.

Some of the devices with consumer electronics applications are reported in the review of solid-state developments on p 10.

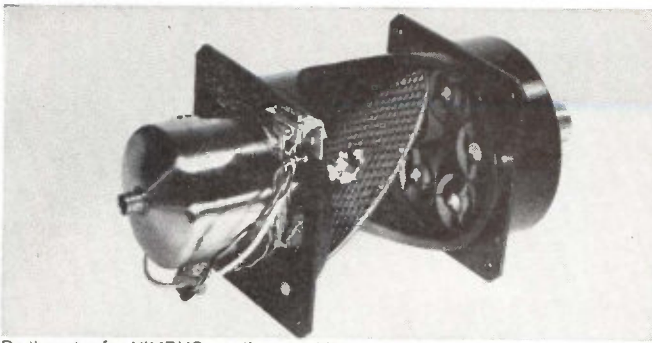
Delco Radio makes no bones about why it is introducing its DTS 3704 1-amp and DTS 3705 2.5-amp silicon transistors (booth 1522). Complete transistorization of home radio and tv, says Delco, "has been waiting for the development and introduction of just such high-voltage devices as the new 400-volt, 2.5-amp transistor for tv horizontal output circuits." It also promises to make 500 and 50-milliamp devices for operation directly from line voltages in audio output stages.

Delco says it will announce prices when sample quantities become available next May. Cost will be competitive with special-purpose tubes and germanium transistors.

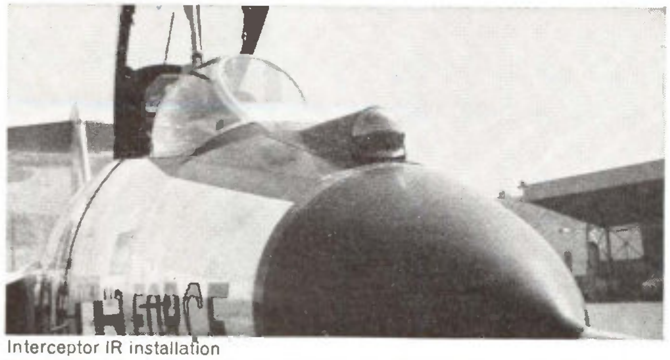
Reading Writing



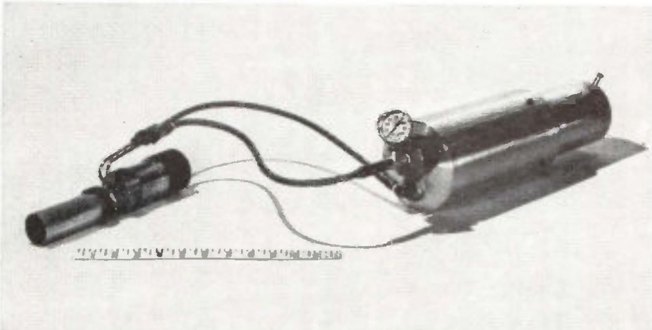
OPTICAL READER is being used experimentally in Cleveland store to find out if handwritten sales slips can be used as input to data-processors. Above, a sales total of $12.36 is displayed on oscilloscope after IBM reader has scanned character with light beam to detect shape



Radiometer for NIMBUS weather satellite

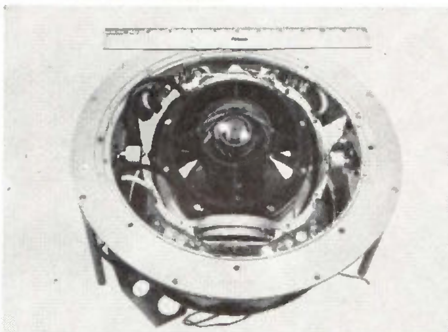


Interceptor IR installation

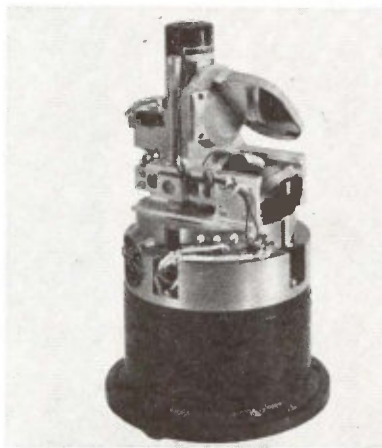


12°K closed-cycle cryostat

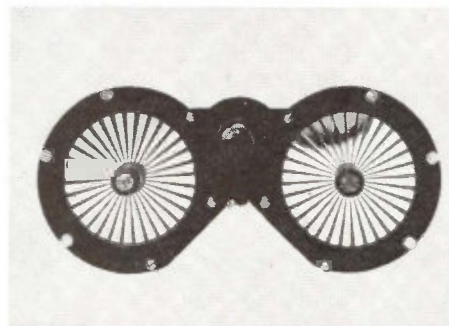
90C IR search/track set



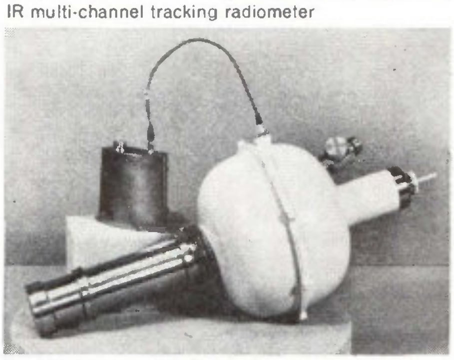
IR multi-channel tracking radiometer



Star tracker for SURVEYOR spacecraft



Modulated IR source



Liquid-helium-cooled IR detector

IR anti-tank missile controller

Expanding Infrared Programs

create new career assignments

Rapid growth of HUGHES Infrared activities in the Aerospace Divisions and the Santa Barbara Research Center has created many responsible positions for qualified engineers and scientists in all phases of IR systems development from conception through production engineering.

Immediately available assignments include openings in such diverse technologies as semiconductor physics, optical design, cryogenics, mechanical engineering, precision electro-mechanisms, electronic circuit design, servo systems... and many other areas.

Current HUGHES IR contracts include advanced systems for space exploration, weather reconnaissance, anti-ballistic missile defense, anti-submarine warfare, interceptor weapon guidance & fire control, bomber defense and tactical weapon control.

Professional experience, an accredited degree and U.S. Citizenship required.

For immediate consideration, please airmail your resume to:

MR. ROBERT A. MARTIN
Hughes Aerospace Divisions
11940 W. Jefferson Blvd.
Culver City 41, Calif.

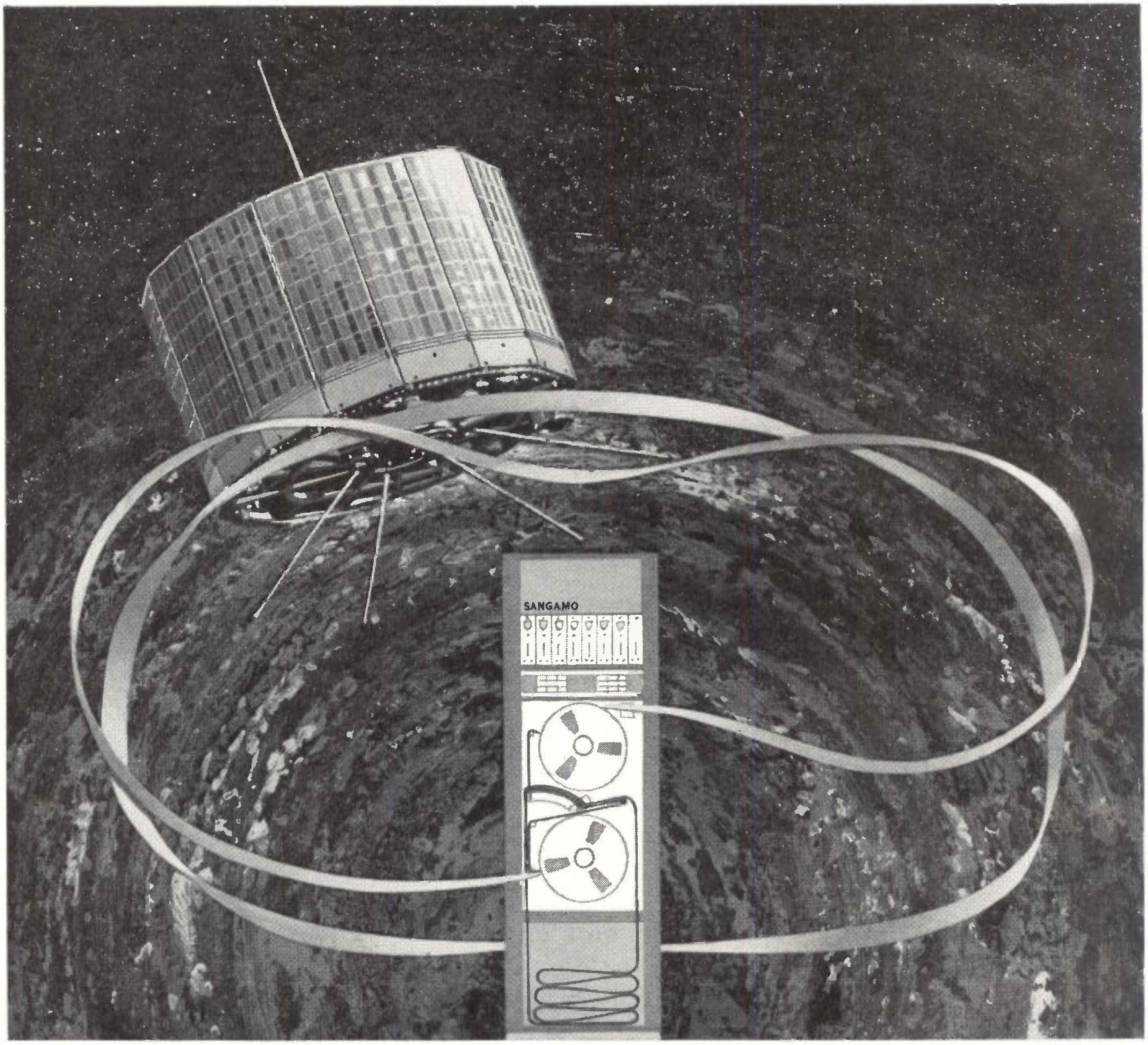
HUGHES

HUGHES AIRCRAFT COMPANY
AEROSPACE DIVISIONS
An equal opportunity employer

CIRCLE 72 ON READER SERVICE CARD→


components
you can trust
TAP SWITCHES
NEW
MINIATURE
RHEOSTAT
RHEOSTATS
RELAYS
R.F. CHOKES
NEW
MOLDED
VITREOUS
NAMELED
RESISTORS
TANTALUM
CAPACITORS
AXIAL
LEAD
RESISTORS
OHMITE


VARIABLE TRANSFORMERS
After you've established the parameters you need in a component, don't forget the one on which all others depend—the parameter of trustworthiness. We feel it is the most important characteristic of our eight component lines. Write for Catalog.
OHMITE
OHMITE MANUFACTURING COMPANY
3637 HOWARD ST., SKOKIE, ILL. 60076 • PHONE: (312) ORchard 5-2600
OHMITE 5,000 OHMS
RESISTORS
2000 OHMS NO. 0207
DIODES
OHMITE
OHMITE NON IND



Another Sangamo first in Magnetic Tape Flexibility

NOW THE SANGAMO 4700 HANDLES BOTH 1" AND ½" TAPE SIMULTANEOUSLY

Record or Reproduce either width without mechanical or electrical changes.

Make continuous loop dubs from original tapes on one recorder. Operating at your choice of 8 electrically-selected tape speeds, Sangamo 4700 now has an optional feature which allows you to handle two different tape widths at the same time. One width operates in reel-to-reel mode . . . the other width operates as a continuous loop.

Flexibility is unparalleled. Without time-consuming mechanical or electrical changes—without even changing heads or guides—the 4700 will handle ½" or 1" tape, either on reels or in a loop.

The Sangamo 4700 is unique in analog tape instrumentation. Its light mass capstan drive and unmatched servo speed control provide unsurpassed data accuracy in FM (DC to 20 KC) and Direct (300 to 300,000 cps) ranges.

Be sure to investigate the 4700 for general recording applications and the 480 time delay magnetic tape recorder/reproducer for auto- and cross-correlation applications. *See the 4700 and 480 at the IEEE Show, Booth 3107.*

SANGAMO ELECTRONIC SYSTEMS

ES64-1

SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS

SUPERCOOLED COILS

PROMISE INDUCTIVE ENERGY STORAGE

May replace capacitor banks and batteries in high-energy applications

By P. R. WIEDERHOLD
D. L. AMEEN
Ion Physics Corp.,
Burlington, Mass.

ENERGY STORAGE, a frequent requirement in aerospace and terrestrial applications such as lasers, high-energy physics, nuclear and fusion experiments, conventionally has been accomplished by one of two means: capacitors and batteries. Recent advances in superconductivity will soon be adding a third method: inductive storage in superconducting coils.

Capacitor banks are particularly suited for supplying high power for short periods of time. Although the storage capacity of batteries is about three orders of magnitude greater than that of capacitor banks, they are not suited for high-rate discharges of the order of milliseconds or microseconds.

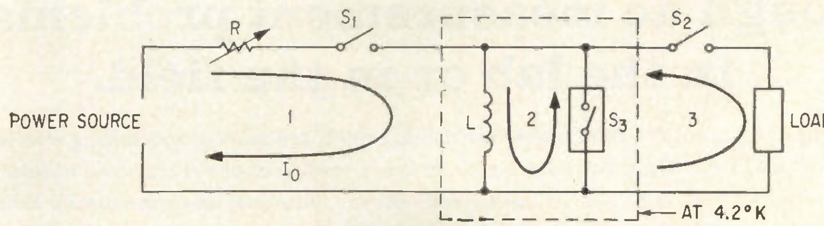
Energy densities obtainable in capacitor banks are low, of the order of 3×10^5 joules/m^3. Storage of 1 kw-hr, or 3.6 megajoules, would require over 10 m^3 of dielectric material, or a very large capacitor bank.

Another method of energy storage that allows release of the stored energy in the form of pulses, is in the magnetic field of an air-core inductor. The field energy of an inductor is

$$W = \frac{B^2}{8} \times 10^7 \text{ joules/m}^3$$

where B is flux density in webers/m^2. For a field of 10 webers/m^2 this yields a density of 4×10^7 joules/m^3, considerably higher than for capacitor banks.

However, there are several problems associated with conventional inductive energy storage. Due to I^2R losses in windings, energy is lost at twice the rate of storage during an interval equal to the coil's time constant. Therefore only short charging periods are allowed and a large power supply is needed. Further problems lie in the removal of energy from an inductive store. Consequently, few inductive storage



INDUCTIVE energy storage using a superconducting coil and discharge switch

FIRING LASER flash tube with superconducting inductive power supply. Cryogenic energy storage dewar is at right, in right center is a gaussmeter atop the thermal switch control instrument; the power supply and associated circuitry is at left

COMPACT 375-joule energy source developed by Ion Physics. A 50-liter coil, including dewar, can store 100 joules, while capacitor banks require 750-liter volume for the same job

applications existed until recent advances in superconductivity.

Superconductive storage—The elementary form of inductive energy storage in a superconductive coil is shown in the figure. The superconducting storage coil L is charged with S_1 closed and S_2 and S_3 open. Series resistance R controls the time constant and thus the charging time. After the desired current is achieved in L, S_2 is closed and S_1 opened, disconnecting the energy store from the supply. S_2 is a superconducting switch, causing the current in circuit 2 to be a persistent current. Energy discharge is obtained by closing S_3 and then opening S_2.

Such a system has several advantages:

(1) Once stored, the energy can be kept in storage for indefinite periods, as long as the 4.2 deg K temperature is maintained, because the persistent current in circuit 2 encounters no resistance.

(2) The coil can be charged over a long period of time with a small, low-voltage power supply.

(3) Unlike capacitor banks, energy is stored at low voltage; high voltages appear only during discharge.

Short discharges in the millisecond range are possible, provided that a suitable superconducting switch is available.

Several modifications of the circuit are possible; for instance, the stored energy may be discharged by a secondary winding and discharge

Prestidigitator!

Scientific-Atlanta's new Wide Range Receiver

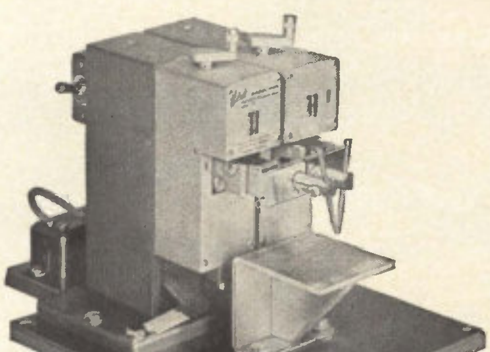
Pres'ti-dig'i-ta'tor . . . nimble, fast, a worker of magic. Well, almost! The Series 1600 antenna measurements receiver with its higher receiving sensitivity, new functional styling, compactness, and extensive application of solid state techniques is the most advanced receiver available today. Developed from Scientific-Atlanta's popular, time-tested 402 Series, this modern new design offers such features as . . . frequency coverage from 20 Mc to 100 Gc . . . sensitivity from −105 dbm to −60 dbm at the highest frequency ranges . . . selectable 40 or 60 db dynamic range . . . compact 14⅝" x 19⅝" x 21⅝" size, weighing 90 lbs . . . electronic AFC and servo driven tracking AFC . . . direct-reading linear frequency dial accurate to ±1% . . . plus many other improvements over competitive models. Priced from $7,500.00. Write today for additional data. ▪ Scientific-Atlanta, Inc., P.O. Box 13654, Atlanta, Georgia 30324
Phone: 404-938-2930. TWX: 404-938-1322

Scientific-Atlanta, Inc.

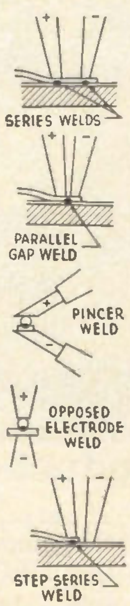
CIRCLE 203 ON READER SERVICE CARD

NEW! VERSATILE!

Model 410-DVP Weld Head Makes All Kinds of Welds!



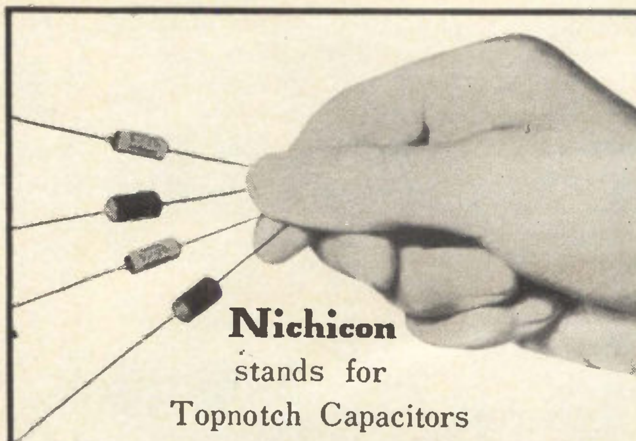
MODEL 410-DVP set up to do parallel gap welding



This all-purpose laboratory weld head will do 3 kinds of one-sided welding plus vertical opposed-electrode welding and vertical pincer welding! Bonds ribbon or wire from .0003" up to .050" diameter. Force range 3 oz. to 20 lbs. Compact, sturdy, easy to set up. Use with either DC or AC power supplies. Send for details.

FREE WELD SAMPLE SERVICE!
Send sample materials to Weltek Sales Mgr.
Or see us at Booth 4514, I.E.E.E. Show.

Weltek **Precision Welders**
by WELLS ELECTRONICS, INC.
1701 S. Main Street, South Bend, Indiana, U.S.A.



Nichicon stands for Topnotch Capacitors

Most dependable and durable quality guaranteed by our:
- Research laboratories staffed with high class engineers.
- Long experienced technicians.
- Performances over 40 years.

No capacitors are too big or too small to us.

Your inquiries with full specification are cordially solited.
Will gladly offer best prices and deliveries.

nichicon

MAIN PRODUCTS: Oil Paper Capacitor, Electrolytic Capacitor, Tantalum Capacitor, Metallized Paper Capacitor, Ceramic Capacitor, Mica Capacitor and Mylar Capacitor, etc.

Nichicon Capacitor Ltd.

Head Office Uehara Bldg., Oikedori, Karasumahigashi-iru, Nakagyo-ku, Kyoto, Japan
CABLE ADDRESS CAPACITOR KYOTO

CIRCLE 204 ON READER SERVICE CARD

initiated by causing the coil to go to normal conductivity.

Materials—The most widely used material at this time is Nb—25 percent Zr (niobium-Zirconium alloy) with a critical field of about 70 kilogauss, and a critical current density approaching 10^9 amps/m^2 at 50 kilogauss. Another material, Nb_3-Sn, has a critical field of about 200 kilogauss. This material is brittle and more difficult to use than the Nb—Zr alloys. The estimated critical field of V_3Ga (vanadium-gallium) is even higher, up to 500 kilogauss, but this material is not available in suitable forms.

Storage coils — Although energy storage coils are similar to superconducting coils used for magnet systems, their design differs considerably, and is aimed at optimizing the stored energy rather than the magnetic field properties. The coils must withstand field transients and high voltages occurring during discharge. It will generally be necessary to operate storage coils at high currents, which may involve the use of rectangular conductors or parallel windings. Although high energy densities can be obtained in properly designed superconducting solenoids, the large external fields may present problems; for fast discharges it becomes undesirable for the magnetic field to link any closed metal loop other than those necessary for the operation. A more desirable configuration in this respect is the toroidal coil, which completely contains its magnetic field.

Energy densities of more than 10^7 joules/m^3 can be obtained with presently available Nb-Zr wires, and densities of at least 10^8 joule/m^3 should be possible when the newer materials have reached a more advanced state of development allowing their use in larger coils.

Applications—Energy stores of this type, using superconductive coils and switches, have been used for experiments with flash tubes for optical pumping of lasers. One such experiment conducted at Ion Physics has delivered about 350 joules to the flash tubes with efficiencies of up to 90 percent. A 1.5-kilojoule energy store is now under test.

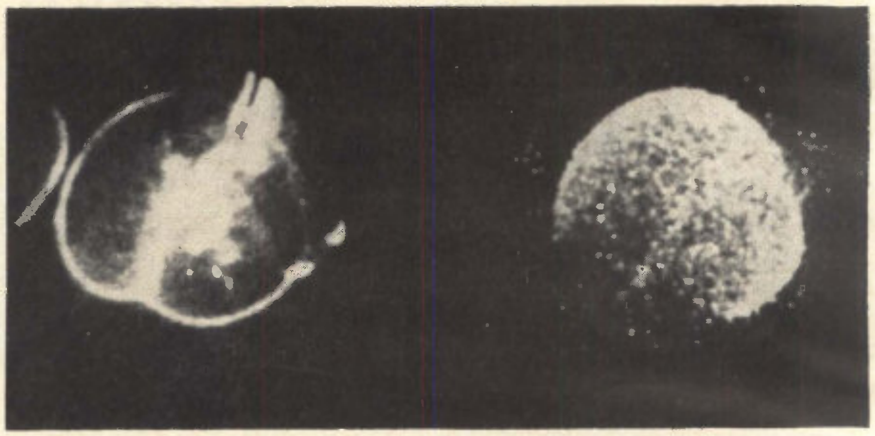
COMPONENTS AND MATERIALS

Tube Amplifies Light 500,000 Times

Increased photon gain opens up new vistas for biology and astronomy

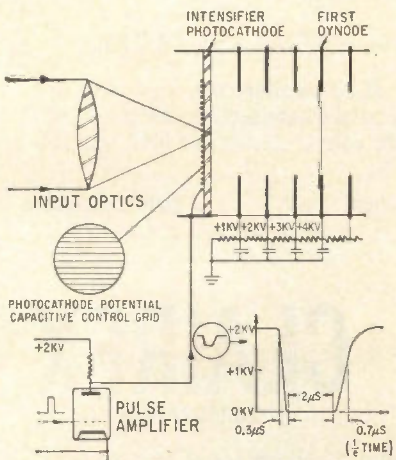
WASHINGTON, D. C.—The first known photographs of a single living cell taken by the cell's own bioluminescence were shown here at the Scintillation and Semiconductor Counter Symposium. The photographs were made possible by an image intensifier which can amplify light over 500,000 times. The tube, developed in England by English Electric Valve Co., Ltd. is available in this country through Calvert Electronics of New York. The tube will be shown at the IEEE show in New York next week.

The original P829 amplifier (ELECTRONICS, June 15, 1962, p 66) has been greatly improved and is now capable of providing very high photon gains exceeding 10^6, and low dark currents down to 3 scintillations/sq cm/sec. Under continuous operating conditions, a resolution exceeding 60 line pairs/mm has been reported, and excellent pulsing characteristics have been achieved at 20 nanoseconds exposure time.



FIRST photographs of single living marine cell, taken with its own light, were made possible by image intensifier. Photos were taken by George T. Reynolds of Princeton

Further improvements in the basic design have greatly extended the usefulness of the tube and its present performance. At Marine Biological Laboratory, Woods Hole, Mass., this has made it possible to undertake single cell investigation without the disturbing and damaging effects of external lighting. The tube has also made it possible for astronomers to take photographs of distant stars with a clarity hitherto unobtainable. At Kitt Peak National Observatory, Tucson, Arizona, exposure time for a stellar photograph has been reduced from as much as an hour and a half to two minutes. In addition to greater clarity, the image intensifier allows a far more economic use of the Observatory's expensive equipment.



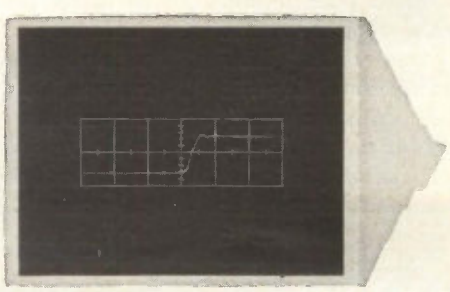
BASIC structure of pulsed-operation version of image intensifier tube

Continuous pulse—The basic structure of the input stage of the pulsed operation version of the tube (P-829A) is shown in the diagram. The preferred method of pulsing is shown. Due to the very low dark emission of these tubes, for pulses of a microsecond or less, the chance of recording one noise scintillation during the short switched off period is very small. When this tube is switched off, the background noise is somewhat less than one scintillation/sq cm/sec.

Some very interesting photographs relating to biological studies, such as the photo shown, were taken using a continuous-operation version of the tube (P829D). These photographs were take at Marine Biological Labs by George T. Reynolds of Princeton University, and are reproduced with his permission.

Although the specified minimum ratings of commercially-available tubes is 20 line pairs per mm., resolutions up to nearly 40 line pairs per mm have been obtained at English Electric Valve with the P829D tube. A resolution of 64 line pairs mm has been reported by W. L. Livingston of Kitt Peak National Laboratory. Great care had to be taken to achieve this re-

How do you take a picture of something you can't see?



Transient oscilloscope traces in the sub-nanosecond range move too fast for the human eye. How can you study them?

Use Polaroid 10,000-speed Land film. It's fast enough to make clear, high-contrast pictures of the most fleeting traces. And the results are fast, too.

Your pictures are fully developed in 10 seconds. If you are studying sequential traces, you can click off a full roll (8 exposures) in 20 seconds. Simply let the film stay in the camera back for 2 seconds, then pull the tab, repeating the process for each exposure. Strip away the negative and you've got eight finished pictures.

The catalog name for this film is Polaroid PolaScope Type 410. It's panchromatic, responds best to blue phosphors such as P-11. The film's extreme sensitivity lets you use small camera apertures and low beam intensities too, so your trace pictures are really sharp.

Try Type 410 Land film the next time you need oscilloscope pictures. And see.

POLAROID ®

Polaroid 10,000-speed Land film. CIRCLE 81 ON READER SERVICE CARD

ENGELHARD recovers more precious metals from discarded electronic components

How many barrels of printed-circuit scrap do you collect? Enough to justify a "scrap recovery program" for segregating and squeezing the precious metal content out of discarded electronic components such as printed circuits, tube grids, relays and wave guides? How much *hidden* value in your pile of scrap? It all depends on the efficiency of the refiner. Engelhard has a worldwide reputation for "striking it rich" for its customers, by recovering greater quantities of silver, platinum, palladium and other precious metals, than any other refiner. And its reputation for purity of product is unmatched. Advanced refining techniques, complete laboratory control, modern facilities, and the experience of a large staff of metallurgical engineers, all contribute to squeezing value out of throw-aways. Fair refining charges and a policy of basing values on mutually acceptable assays are only a few of the advantages of Engelhard's refining service. Recovered precious metals can be purchased by Engelhard or returned to you in whatever form you need. As another convenience, Engelhard maintains "Pool Accounts", whereby the recovered precious metal content of your waste material is credited to the drawing account of your company for fabrication or other purposes. Write or call Engelhard today. We'll be glad to send an Engelhard Technical Service Representative to help you initiate a scrap-recovery program, or to solve any current recovery, separation, or transportation problem.

markable resolution which was measured with monochromatic light at 5,500 A. It corresponds to 3,200 television lines per picture height.

Storage Tube Holds Television Image

LONDON — Researchers at London's Imperial College of Science and Technology have developed a highly sensitive tv camera tube, capable of integrating a weak light input over several hours, storing the integrated picture without deterioration and capable of reading off the picture within a single frame period.

In operation, the light input to the tube is focused on a transparent photocathode. The resulting photoelectron image is then accelerated to 5-7 kev and focused on a target by a combination of electric and magnetic fields.

The target consists of a single plate of aluminum oxide, 500 angstroms thick, on which is deposited a spongy layer of potassium chloride. This layer is produced by evaporating the insulator in an inert gas so that the atoms aggregate before reaching the target and form a spongy layer of lower density and dielectric constant than the solid material. The layer thickness is between five and ten microns.

With such low target densities, electrons with energies of 5 Kv penetrate and build up a positive charge by secondary emmission. The secondary electrons are collected on a positive mesh. The image is retained for several hours and can be read by scanning the layer orthogonally with a low energy electron beam from a separate gun.

Transistors Combine Speed-Voltage-Power

SOMERVILLE, N. J. — Commercial availability of three high-power, high-speed switching devices now used in military applications will be announced by RCA this month. The devices are two *npn* epitaxial silicon transistors capable of switching 20 amperes in less than 1 microsecond, and a darlington integrated circuit that can handle 5 amperes (TA-2513-14).

RCA claims the switching transistors have the best combination of speed, voltage and current ratings presently available. They come in flat types (TA2492-93) and stud packages types (TA2494-95) and are considered particularly useful for high-speed power inverters and switching regulators.

Equivalent circuit of the integrated circuit is a four-leaded darlington amplifier with a commutating diode in the output circuit. Current gain is 1,000 at 5 amperes, VCEO's can be 60 volts (TA2513) and 80 volts (TA2514), turn-on time is 350 nanoseconds.

Profit Squeeze Continues For Printed Circuits

PROFITS have declined in the printed-circuit manufacturing industry, reports The Institute of Printed Circuits, a national trade association representing manufacturers and users of printed-circuit boards. A recent survey of sales and profits in the industry indicates that average profits in 1963 were about 1.5 percent of sales, after taxes.

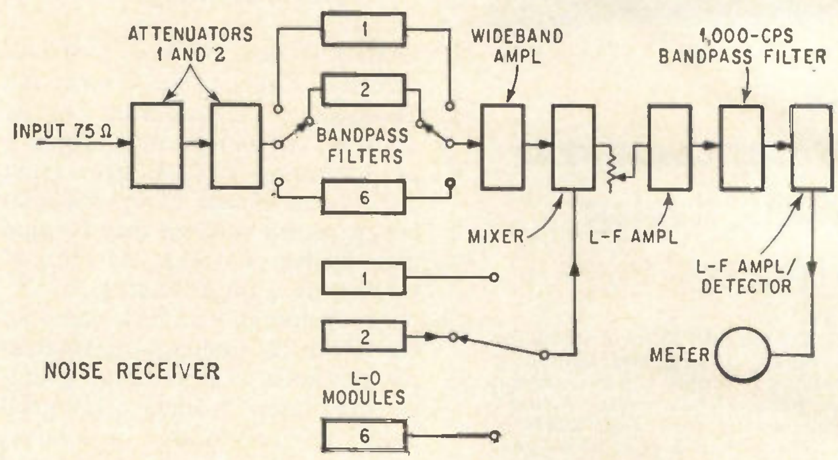
Sales of printed circuits have grown only slightly in recent years. In 1960, profits were 3.2 percent after taxes; in 1961, 1 percent after taxes. In 1962 profits were 2.9 percent after taxes.

The Institute estimates that the total value of production of printed-circuit boards reached 85 million dollars in 1963. Of this amount, 60 percent or 51 million dollars of sales were produced by independent printed circuit-board manufacturers. The balance of the market is made up of manufacturers producing printed-circuit boards for internal applications, and is estimated at 34 million dollars.

The outlook for 1964 is for increased usage of printed-circuit boards of 5 percent to 10 percent. Competition in the industry, however, will continue its squeeze on profits. The increased units of production in 1964 is expected to be produced at about the 1963 dollar volume.

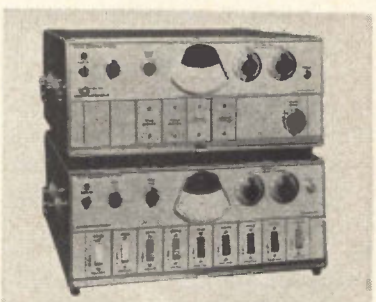
Test Set Checks Noise Power Ratio

Tests communications systems with up to 2,700 channels



ALL-TRANSISTOR noise-loading test set, model 2090, allows noise power ratio checks to be made on communications systems designed for up to 2,700 telephone channels or complex modulation systems having an equivalent bandwidth, such as television or telemetry.

In practice, the baseband of the equipment under test is loaded with noise having a Gaussian distribution over the baseband bandwidth. A bandstop filter is then inserted to provide a quiet channel. The receiver section (shown in block diagram and upper half of photo) contains band pass filters at frequencies corresponding to the quiet channels. Ratio of noise in quiet channel to channel noise without bandstop filter inserted, is noise power ratio.



Model 2090 will accommodate six band-stop, two low-pass and one high-pass filters. Filter selection is from a wide range of CCIR recommended frequencies as well as many others for use in in-band or out-of-band testing. Changing filters to suit different bandwidth systems is a simple operation.

For users requiring out-of-band monitoring to provide a continuous indication of noise or power ratio, or who wish to read out noise power in picowatts at a site where the noise generator is not available, an accessory noise source may be fitted into the receiver to permit calibration of each test channel.

The small, lightweight and reliable test sets are used to measure the noise or power ratio on systems, either at a single station or over a number of hops. Other uses include checking intrinsic channel noise, checking satellite communications, measuring crosstalk in wideband independent side-band systems or intermodulation in multichannel cable transmissions. Marconi Instruments, 111 Cedar Lane, Englewood, N.J. *Booth* 3701-3705.

CIRCLE **301**, READER SERVICE CARD

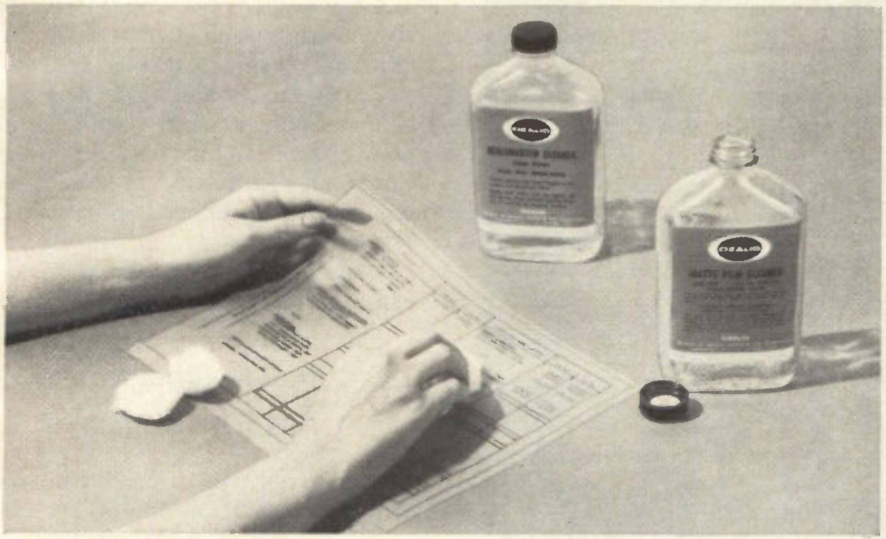
Radial-Resolution CRT Has Variety of Uses

TYPE CK1378 radial-resolution cathode-ray tube can be used as a multiplexer for coded transmission, a frequency multiplexer from 60 cps to 30 kc, an analog-to-digital converter, for time sharing of any type and numerous other applications where it is desirable to segregate signals into narrowly defined angular sectors. In its present configuration the tube can separate signals into 10-degree sectors.

From a single cathode-ray gun at the input end of the CK1378 an electron beam is projected to the target end where the 3-in. diameter target face is precision-etched into 36 equal and electrically-isolated sectors. The tube can also be supplied with any number of divisions

gaf OZALID *NEWSLETTER*

NEW IDEAS TO HELP YOU WITH ENGINEERING REPRODUCTION AND DRAWING



SCALEMASTER Intermediate Films
take erasure after erasure after erasure after erasure ...and pen or pencil corrections!

Here are the films that can save you time and effort in your drafting work...films that give you sharp reproducible duplicates of originals that you can work from with all these advantages:

Punishment Proof. Scalemaster films keep their quality and dimensions despite use, age, changes in temperature or humidity. Made with a polyester film base of DuPont Mylar®, specially stabilized by an exclusive GAF Ozalid process, Scalemaster films won't fray!—won't crack!—won't become brittle!—and remain flexible forever!

Superior Reproductions. Scalemaster films produce a dense, actinically opaque sepia or black image for superior white print reproduction. Designed for top operation in high-speed ammonia machines, Scalemaster is completely developed in a single pass through the developer regardless of machine speed.

Quick Corrections. Scalemaster film has a fine toothed matte surface which assures easy drawing and uniform line density and permits easy erasing so you can make line changes quickly in pencil or ink.

Worry-free Filing. There is no need for interleaving Scalemaster films in file. Images will not offset to other diazo materials under normal front to back filing... nor will they offset if filed in rolled form.

Instant Cleaning Companion. Scalemaster Cleaner solution instantly, effectively removes pencil lines from the matte surfaces of sensitized Scalemaster films... without disturbing the diazo image! It works faster than erasing and won't harm the drawing surface. It's the perfect cleaning companion to all Scalemaster sensitized films.

Yes, these are the films you've been looking for to give you speed and economy in your drafting operation. They're available in thicknesses of .003" and .005" in standard cut sheet and roll sizes. See for yourself all the advantages Scalemaster Films can offer you. Mail the coupon below for descriptive folder about our complete line of sensitized and unsensitized drafting films.

GAF OZALID DEPT. HH-6
GENERAL ANILINE & FILM CORPORATION
BINGHAMTON, NEW YORK

Please send me information about Scalemaster Intermediate drafting films and accessories.

NAME ____________________

COMPANY ____________________

ADDRESS ____________________

CITY ____________ STATE ____________

gaf OZALID REPRO PRODUCTS OF GENERAL ANILINE & FILM CORPORATION
BINGHAMTON, NEW YORK

of the target screen. Outputs of the discrete sectors are terminated through the fritted glass faceplate with four E9 nine-pin bases. Each sector is connected to a separate output lead terminating in one of the external bases.

The tube's output end also has an externally-visible screen to facilitate focusing and alignment of the quadrants within particular systems.

Combining state-of-the-art achievements in both display tube and optical engineering, the new tubes can be modified to accommodate special customer requirements. Raytheon Company, 55 Chapel St., Newton 58, Mass. *Booth* 2614.
CIRCLE **302**, READER SERVICE CARD

Nanovoltmeter Has 18 Ranges

DEVELOPMENT of a nanovoltmeter that measures 10 nv to 100 mv full scale without elaborate laboratory setups previously required is announced. Model 148 was designed to measure extremely low d-c voltages or voltage changes from low impedance sources; as a laboratory standard, for fundamental or applied research, cryogenics or space instrument developments. The instrument measures thermocouple outputs, thermoelectric potentials from metals and thermopiles, Hall effects, contact potentials, conductances and superconductivities in the 10 to —6-ohm range.

Resolution is better than 1 nv on the most sensitive range. Noise is said to be lowest of any commercially available nanovoltmeter. Sixty-cycle rejection is more than 1,000 to 1 on the three most sensitive ranges. Stability is 10 nv per 24 hr.

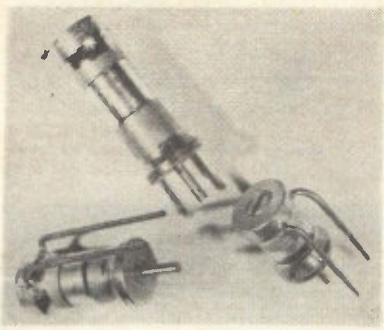
High stability of zero suppression circuits permits up to 100 times full scale suppression, so variations of less than 1 μv are measurable in a steady 100-μv signal.

Model 148 may be used in nulling bridges with potentiometers, ratio sets or resistance bridges, and as

d-c amplifier, feeding signals to recorders or scopes.

Impedances in the input circuitry have been held low to minimize Johnson noise or thermal agitation—often a limiting factor in measuring small potentials. Pressure mating of crimped copper to copper internal connections eliminates thermal noise between unlike metals. Keithley Instruments, Inc., 12415 Euclid Ave., Cleveland 6, O. *Booth 3704-3706.* **(303)**

Components and Hardware



Trimmer Capacitor Has High Q Factor

ALL MODELS of the Mini Trimmer are 5/16 in. in diameter. The 1-to 5-pf model stands 0.480 in. above the board; the 1-to 10-pf model, 0.680 in.; and the 1-to 14-pf model, 0.870 in. The metallized glass trimmer has a center pin terminal as one electrode on its base and parallel side leads near its top. The leads fit 0.1-in. grid hole spacing of circuit boards. The dcvw is 750 v, and dielectric strength is 1500 v. Q factor at 50 Mc is 500 minimum. Corning Electronic Components, Bradford, Pa. *Booth 2326.* **(304)**

Square Design Reduces Cooler Space

AN EFFICIENT new square design for milliwatt transistor and diode coolers is being introduced. According to the company, extensive testing has proven that, in a number of instances, these units can be used to do the same cooling job in less space than is required by a radial-fin model; or in the same space, they can provide greater cooling capacity. Present milliwatt line consists of 5

where laboratory use
requires ultimate
pressures as low as
5×10^{-7} torr

**KINNEY
HIGH VACUUM
EVAPORATORS**

*KINNEY
HIGH VACUUM
EVAPORATOR
MODEL . . . KSE-2*

KINNEY'S MODEL KSE-2 HIGH VACUUM EVAPORATOR is a new, compact unit designed for laboratory and production use. Applications include deposition of thin films, optical coating, metallizing, electron microscopy, and many other uses.

The KSE-2 consists of a nominal 2-inch diffusion pump, a liquid nitrogen cold trap combined with a water-cooled baffle, and a 3 cfm mechanical vane type pump.

KINNEY EVAPORATORS are also available in both single and double 4 and 6 inch models. All Evaporators are encased in a hammertone grey finished cabinet with a formica top work surface. Electrical controls are conveniently grouped on a sloping front panel.

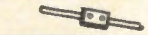
**KINNEY
VACUUM**

Division The New York
Air Brake Company
3529 Washington Street
Boston 30, Massachusetts

MINITAN

CHIP

SOLID TANTALUM CAPACITORS

ACTUAL SIZE	
DIMENSIONS	.125 x .075 x .045
CAPACITANCE RANGE	.001 MFD AT 20 VDC to 2.2 MFD AT 2 VDC

Designed to meet a demand. Chip Capacitors provide large capacitance values in an ultra small package for use in integrated or thin film circuits. Substantially smaller than any other capacitor currently available in this range of values.

See our broad line of solid tantalum capacitors at the IEEE Show—Booth M7

COMPONENTS, INC.

SMITH STREET, BIDDEFORD, MAINE
AREA CODE 207-284-5956

CIRCLE 205 ON READER SERVICE CARD

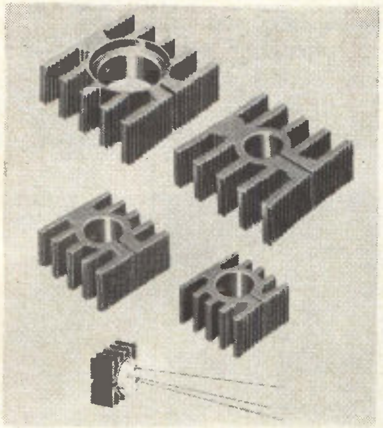
Around the world ...

KYORITSU Measuring Instruments

Kyoritsu

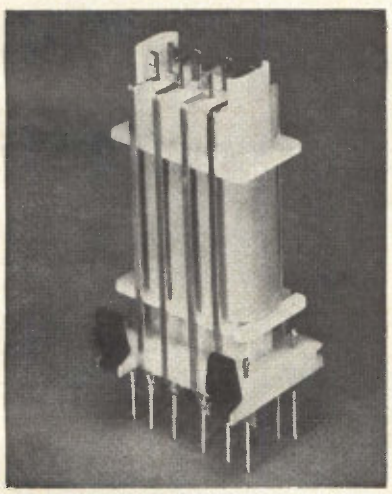
ELECTRICAL INSTRUMENTS WORKS, LTD.
120, Nakane-cho, Meguro-ku, Tokyo, Japan
Cable address: KYORITSUKEIKI TOKYO
Telex: TK 2849

CIRCLE 206 ON READER SERVICE CARD



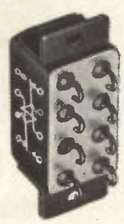
models ranging from $\frac{1}{2}$ in. to 1 in. square and with thicknesses of $\frac{1}{4}$ in., $\frac{5}{16}$ in. and $\frac{3}{8}$ in. All have standard Mil Spec black anodized finish and are slotted for fast, precise production mounting. George Risk Industries, Inc., Columbus, Neb. *Booth 4044.*

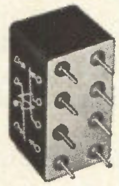
CIRCLE **305**, READER SERVICE CARD



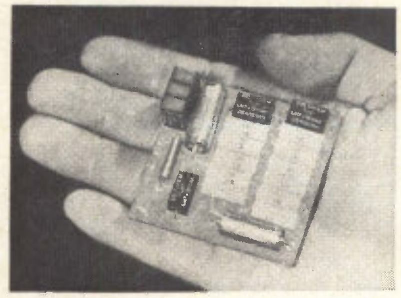
Dry-Reed Switch Has Long Life

THE CORREED is a reliable, high-speed, dry-reed switch. The line is available in a variety of contact combinations. The Correed is composed of 1 to 10 reed capsules having flat ferromagnetic reeds with diffused gold contacts. Reeds are sealed in glass with a dry nitrogen atmosphere. The capsules are mounted in a molded nylon bobbin carrying the coil windings. Coil windings are concentrated at the reed gap for high sensitivity. Gold contacts permit switching from dry circuit up to 50 v-a, resistive. Operate time is as low as 1.5 millisec; release



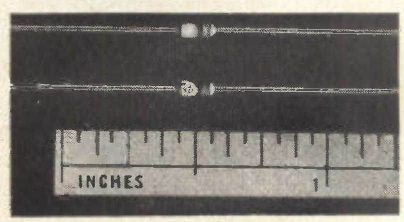


time, less than 100 μsec. Sensitivity is 100 mw. Life expectancy is over a billion operations for low-level switching. Price is $2 to $17 each. Automatic Electric, Northlake, Ill. 60164. *Booth 1908-1910.*
CIRCLE **306,** READER SERVICE CARD



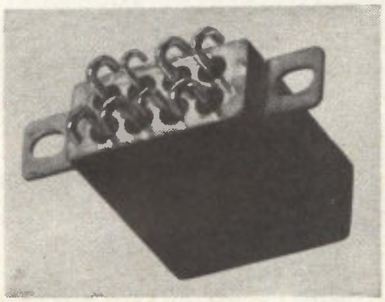
Capacitors Provide High Packaging Density

LINE of microminiature capacitors utilizing the Deltafilm LM dielectric (metallized polyethylene terephthalate) is being introduced. The LM7 line is lightweight, displaces minimum volume, and provides extremely high packaging density. For example, a 0.018-μf, 200-v d-c unit measures only 0.17 in. wide by 0.29 in. high by 0.42 in. long. They operate over the temperature range of -55 C to $+125$ C. Units are available in values from 0.01 μf to 5.0 μf in 100-v d-c ratings, 0.01 μf to 3.0 μf in 200-v d-c ratings, 0.01 μf to 1.5 μf in 400-v d-c ratings and 0.01 μf to 0.68 μf in 600-v d-c ratings. Dearborn Electronic Laboratories, Box 3431, Orlando, Fla. *Booth 2933.* **(307)**



Half-Watt Resistor Is Sapphire-Based

A SUBMINIATURE 1/20-w size sapphire-based resistor is capable of dissipating a full half-watt at 25 C. Units derate to 1/20 w at 125 C, and to zero dissipation at 175 C. Resistor utilizes a mono-crystalline material as the substrate, rather than alumina or steatitie, inasmuch as the thermal conductivity of sapphire is 3 times that of alumina and 10 times that of steatite. Units, tested in accordance with MIL-R-10509E requirements, are available in resistances from 30 ohms to 100,000 ohms, with tolerances of from 0.1 to 1 percent. Voltage coefficient is 5 ppm per v, and temperature coefficient is 50 ppm per deg C for values from 30 ohms to 50,000 ohms, and 100 ppm per deg C for values from 50,000 to 100,000 ohms. Electra Mfg. Co., Independence, Kansas 67301. *Booth 2741-2743.* **(308)**



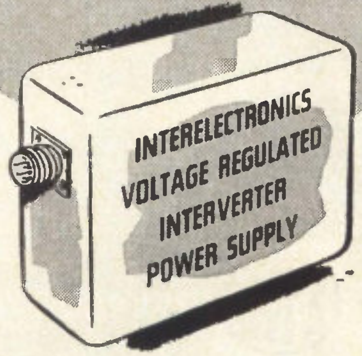
Relay Features High Reliability

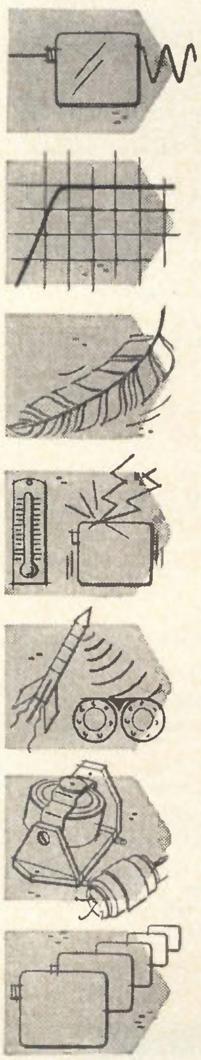
CONTACT RATING of 10 amp and reduced size are featured in the series T relay. Life at rated contact load is 100,000 operations. Coils are available to 9,000 ohms and sensitivity is 500 mw. Designed to provide high reliability under adverse environmental conditions, the relay has an operating temperature range from −65 C to +125 C and is hermetically sealed. It will withstand shock of 50 g for 11 ms and vibration of 20 g to 2,000 cps. Hi-G, Inc., Rt. 75 & Spring St., Windsor Locks, Conn. *Booth 2603.* **(309)**

Metal Film Resistor Exceeds MIL-R-10509E

DEVELOPMENT of a 1/20-w metal film precision resistor is announced. Engineered for space age, military and industrial applications involving subminiature circuitry, it features: rugged end cap construction consisting of gold-plated end caps and butt-welded nickel leads for maximum strength and low contact resistance; extremely small size (0.180 in. long by 0.65 in. in diameter); a hard, high-temperature silicone base coating for excellent

PROVEN RELIABILITY—
SOLID-STATE POWER INVERTERS,
**over 260,000 logged operational hours—
voltage-regulated, frequency-controlled,
for missile, telemeter, ground support,
135°C all-silicon units available now—**





Interelectronics all-silicon thyratron-like gating elements and cubic-grain toroidal magnetic components convert DC to any desired number of AC or DC outputs from 1 to 10,000 watts.

Ultra-reliable in operation (over 260,000 logged hours), no moving parts, unharmed by shorting output or reversing input polarity. High conversion efficiency (to 92%, including voltage regulation by Interelectronics patented reflex high-efficiency magnetic amplifier circuitry.)

Light weight (to 6 watts/oz.), compact (to 8 watts/cu. in.), low ripple (to 0.01 mv. p-p), excellent voltage regulation (to 0.1%), precise frequency control (to 0.2% with Interelectronics extreme environment magnetostrictive standards or to 0.0001% with fork or piezoelectric standards.)

Complies with MIL specs. for shock (100G 11 mlsc.), acceleration (100G 15 min.), vibration (100G 5 to 5,000 cps.), temperature (to 150 degrees C), RF noise (I-26600).

AC single and polyphase units supply sine waveform output (to 2% harmonics), will deliver up to ten times rated line current into a short circuit or actuate MIL type magnetic circuit breakers or fuses, will start gyros and motors with starting current surges up to ten times normal operating line current.

Now in use in major missiles, powering telemeter transmitters, radar beacons, electronic equipment. Single and polyphase units now power airborne and marine missile gyros, synchros, servos, magnetic amplifiers.

Interelectronics—first and most experienced in the solid-state power supply field produces its own all-silicon solid-state gating elements, all high flux density magnetic components, high temperature ultra-reliable film capacitors and components, has complete facilities and know how—has designed and delivered more working KVA than any other firm!

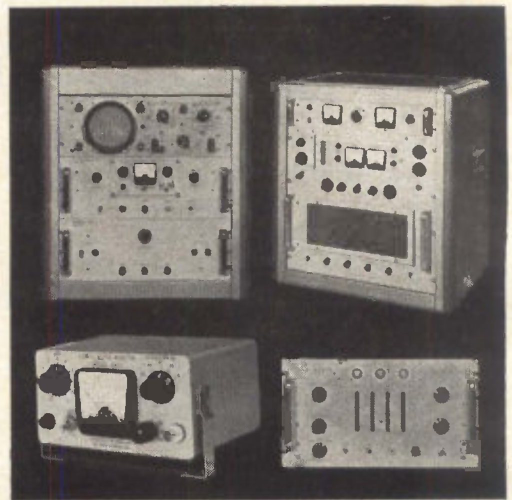
For complete engineering data, write Interelectronics today, or call 914 ELmwood 8-8000

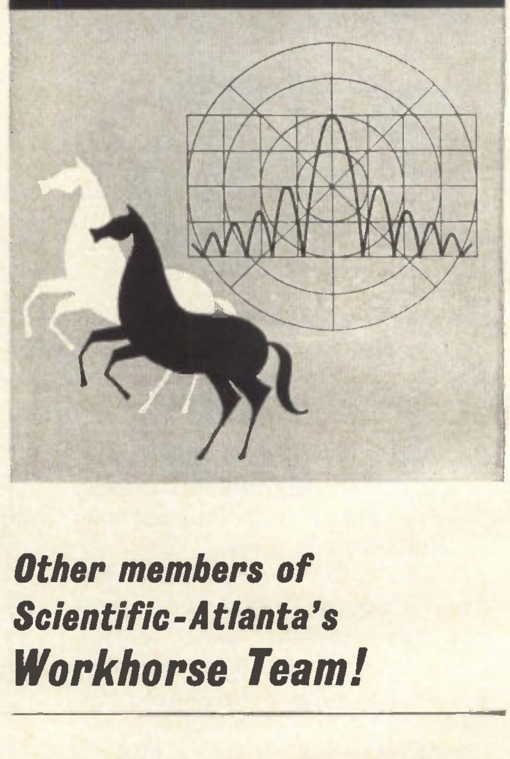
INTERELECTRONICS CORP.

700 U. S. Route 303 Congers, New York 10920

CIRCLE 92 ON READER SERVICE CARD

Scientific-Atlanta, Inc.

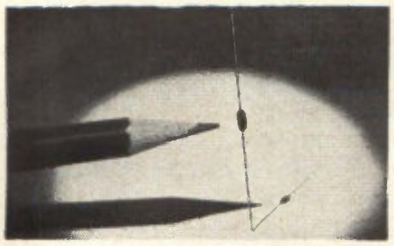




Other members of Scientific-Atlanta's Workhorse Team!

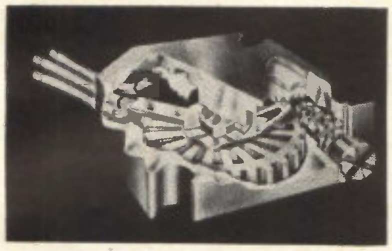
ANTENNA PATTERN DISPLAY UNIT . . . Scientific-Atlanta's Model APD 1 is primarily designed for production testing of antennas. It features polar or rectangular oscilloscope display, linear, logarithmic, and square-root deflection responses, 3 rectangular-sweep expansions, and angular reference shift for both polar and rectangular coordinates. ■ ANTENNA PATTERN INTEGRATOR . . . Model API 1B will accept a.c. or d.c. signal input; it has digital readout to four places, crystal-controlled clock frequency, automatic shut-off at the end of 360° antenna rotation, and speed up to 3 rpm. Model API-1-3D adapts this to weighted spherical-coordinate operation with full storage of samples over complete sphere. ■ SIGNAL LEVEL MONITOR . . . Model SM 1 is small and portable, used for monitoring cw or modulated rf signals, has high sensitivity, no d.c. drift, and adjustable center frequency on selective amplifier. ■ REMOTE TUNED SIGNAL SOURCE . . . Model SS 21 and Series RFO oscillator units feature remote tuning and control, high signal purity, low residual fm, interchangeable oscillators, and will operate cm- and mm- wave klystrons. Write today to: ■ Scientific-Atlanta, Inc., P. O. Box 13654, Atlanta, Georgia 30324 Phone: 404-938-2930 TWX: 404-938-1322

CIRCLE 207 ON READER SERVICE CARD



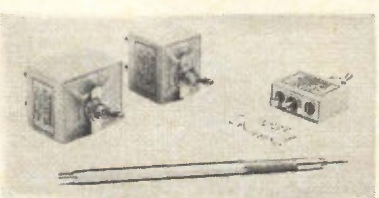
moisture protection and dielectric strength. Resistance range is 30.1 ohms to 100,000 ohms; available temperature coefficients, ±25, 50 and 150 ppm/deg C; and standard tolerance ±1 percent. Ward Leonard Electric Co., Mount Vernon, N.Y. *Booth 2231.*

CIRCLE **310**, READER SERVICE CARD



Metal-Film Trimmer Meets MIL-R-22097B

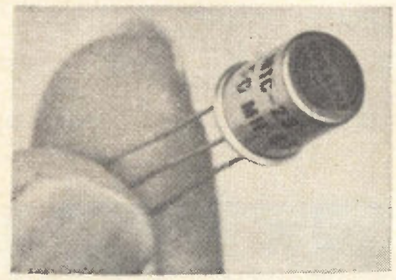
INFINITE-RESOLUTION trimmer, the 2950 Micropot, offers ultra-low temperature coefficient and ultra-low noise. Temperature coefficient is only 50 ppm/deg. C. With no inherent noise, the ½-in. square trimmer offers zero noise level at trimmed position . . . only 100 ohms maximum during adjustment. It meets all requirements of MIL-R-22097B. Borg Electronics, a division of Amphenol-Borg, 120 South Main St., Janesville, Wisc. *Booth 1907-1908.* **(311)**



Circuit Breakers Come in 3 Models

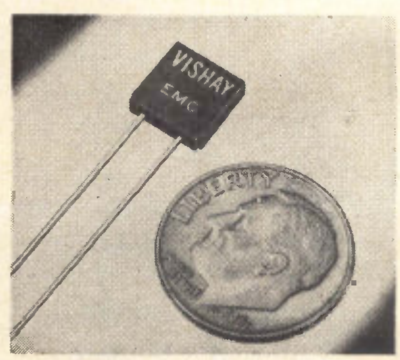
AVAILABLE in one-, two-, or three-pole models, the series SM subminiature circuit breakers have built-in switches for operating signal lights, alarms, or other auxiliary devices. They are ruggedly built to military specifications and will function properly under exposure to shock, vibration, high humidity, salt-sea atmosphere, or sand and dust. The hermetic seal provides for compliance with requirements for explosion-proofing, fungus resistance, and high-altitude operation. The Heinemann Electric Co., Trenton, N. J. *Booth 2841-43.*

CIRCLE **312,** READER SERVICE CARD



Micro Inductors Offer High Q

LINE of microminiature inductors which meet MIL-T-27A, Grade 4, Class R, is introduced. They are packaged in transistor-size cases and offer minimum Q's ranging from 30 at 20 kc to 120 at 200 kc. Units may be inserted by machine and may be used in almost any application requiring a high-Q microminiature inductor. They are hermetically sealed for long term stability in resonant circuit applications. Ambient temperature range is —55 C to +85 C. Units are available from stock. Collins Radio Co., 19700 San Joaquin Road, Newport Beach, Calif. *Booth 2317-2319.* **(313)**



Bulk Film Resistors Fill H-F Needs

FIRST of a new line of bulk film resistors carries a power rating of 0.3 w at 125 C and standard tolerances from 1 percent to as tight as 0.01 percent. Temperature coefficient of resistance runs ±5 ppm or less from −55 C to +125 C. Resistor gives the precision, stability, zero noise and zero voltage coefficient associated with the wirewound, coupled with the high frequency characteristics of the thin-film type. Max voltage (d-c) is 200 v. Noise is below the level of commercially available equipment. Inductance is non-measurable for most applications, while rise time is approximately 1 nsec up to 100 Mc for a 5,000-ohm unit. S-102 resistors are available from 10 to 30,000 ohms. In production quantities they will sell for below $2 each, depending on tolerance and range. Vishay Instruments, Inc., 63 Lincoln Highway, Malvern, Pa. *Booth M-8.* **(314)**

Precision Pots for Industrial Use

FOUR new single-turn linear and non-linear precision Faircon potentiometers are designed for industrial use. They will fill the gap between the ultra sophisticated MIL spec pots and the "volume control" variable resistors—both types of which have had to be utilized by industry in the past . . . the former for inherent accuracy and reliability and the latter for cost. For example, Faircon type F200B, a 2-in. diameter, bushing mount, ±0.5-percent linearity pot is priced at approximately $12 each in quantities of 100. Fairchild Controls, 225 Park Ave., Hicksville, L.I., N.Y. *Booth 2701-2715.* **(315)**

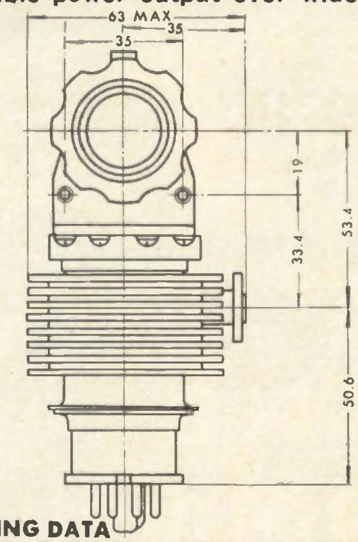
Dry Reed Switch Sealed in Inert Gas

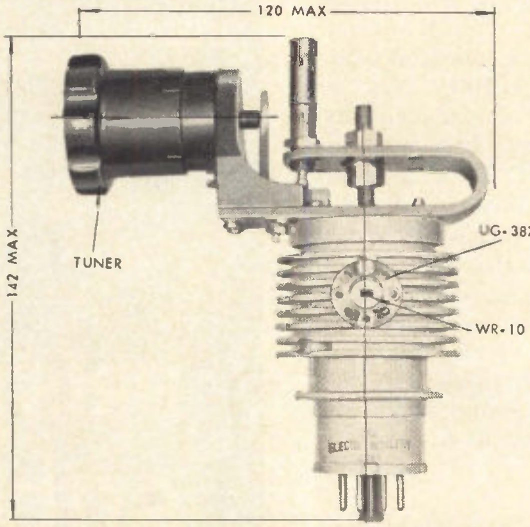
MINIATURE dry reed switch consists of a pair of low reluctance, magnetically actuated flat metal reeds, hermetically sealed in an atmosphere of dry inert gas. The switch can be used in applications that require long life and low power actuation such as reed relays, pulse circuit, ring

NEW 3mm BAND KLYSTRONS FROM OKI

incorporating all the features of Oki millimeterwave tubes

- Excellent frequency stability
- Stable power output over wide range
- Wide and smooth mechanical tuning
- Long operating life





TYPICAL OPERATING DATA

TUBE MODEL	FREQUENCY RANGE	OUTPUT POWER	RESONATOR VOLTAGE	RESONATOR CURRENT
80V10	75 - 85 Gc	20 mW at 80 Gc	2.5 kV	25 mA
90V10	85 - 95 Gc	20 mW at 90 Gc	2.5 kV	25 mA
100V10	95 - 105 Gc	5 mW at 100 Gc	2.5 kV	25 mA

A complete line of OKI mm wave tubes now covers 15 Gc to 105 Gc. All tubes in the range promptly available from commercial production.

OKI electric industry co., ltd. TOKYO JAPAN

Write For Detailed Information to:
SOLE DISTRIBUTOR IN U.S.A.
BUTLER ROBERTS ASSOCIATES, INC.
A Subsidiary of
Oki Electronics of America, Inc.
500 S.E. 24 St. Ft. Lauderdale Fla. Phone. 523-7202
202 E. 44 St., New York 17, N.Y. Phone. MU 2-2989

CIRCLE 209 ON READER SERVICE CARD

NEW MAGNETIC LATCHING RELAY plugs into your Printed Board!

NO Springs, **NO** Wiring,
NO Sockets, **NO** Soldering,
NO Mechanical Linkage

Printact® Series LS/LD, Latching Series G, Standard

PLATED CONDUCTORS ON YOUR PC BOARD ARE THE FIXED CONTACTS OF THIS NEW RELAY

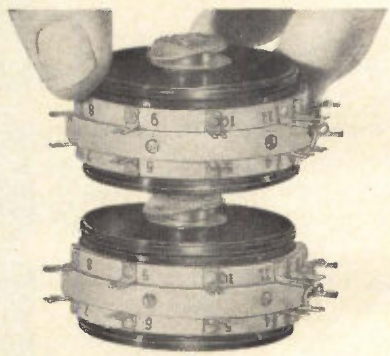
Save SPACE, MONEY and MANHOURS with these new small, lightweight, highly reliable Standard and Latching PRINTACT Relays.

Available with Bifurcated Palladium or Gold Alloy contacts for more than 10 million cycle 2 or 3 pole switching. Handles up to 3 amp. res. loads. Coils for 6, 12, 24 and 48 vdc at 500 mw. Operating temperature —30°C to +95°C. Operate time 7 ms. The little gem is an 0.8 oz. ⅞" cube.

Quality features include: double-break contacts; balanced armature, enclosed housing, plug-in application; encapsulated coil; self-wiping contacts and inherent snap-action—and the cost is lower than you **think**!

Write today, on your letterhead, for data and prices.

Executone inc. PRINTACT RELAY DIVISION
47-37 Austell Place, Long Island City, N. Y. 11101



STACK UP MORE FUNCTION

with Gamewell precision pots

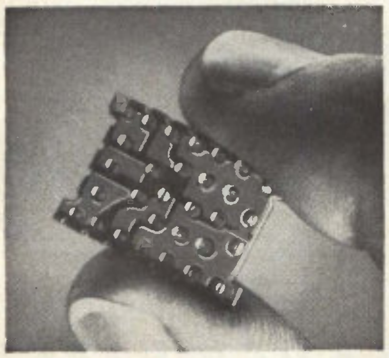
Model MP 2" Modular Potentiometer — already widely popular in the simulator field — packs versatile performance in minimum space. Supplied as individual pots or modular units suitable for stacking . . . *up to 15 modules* can be ganged with no loss in accuracy. Each can be supplied with as many as 13 pre-set taps — or untapped, for adaptation by the user. Available in a wide range of resistance values. Write for details — or complete catalog — to The Gamewell Company, 1602 Chestnut Street, Newton, Massachusetts 02164. A Subsidiary of E. W. Bliss Company.

GAMEWELL
ELECTRONICS DIVISION

CIRCLE 210 ON READER SERVICE CARD

counters, read-out equipment and component accessory equipment. Micro Switch, a division of Honeywell, Freeport, Ill. *Booth 2511-2513.*

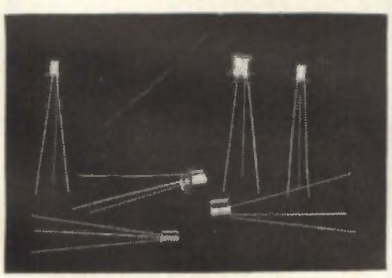
CIRCLE **316**, READER SERVICE CARD



Weldable Module Wafers Use Malleable Nickel

A LINE of low-cost, chemically clean, weldable nickel circuitry wafers for constructing miniature "cordwood" modules is announced. Mounted on a glass epoxy substrate, the malleable nickel weldable circuitry is produced with extremely close tolerances that insure speed with standard weld schedules. Chemically clean tabs eliminate the problem of contaminants that "blow" welds and cause rejects. Manufactured on standard tooling to reduce costs and speed delivery, the wafers come in formats that can be contained in 1 in. by 1 in.; 1 in. by 2¼ in.; and 2¼ in. by 2¼ in. Sanders Associates, Inc., 95 Canal St., Nashua, N. H. *Booth 2535.* **(317)**

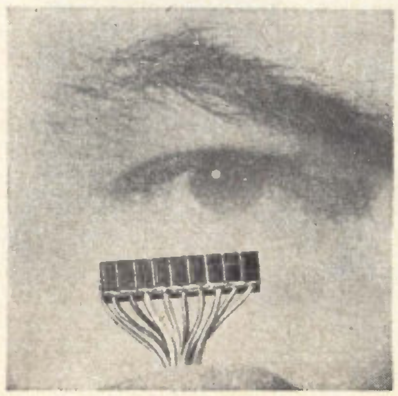
Semiconductors



Transistors Feature Low Leakage

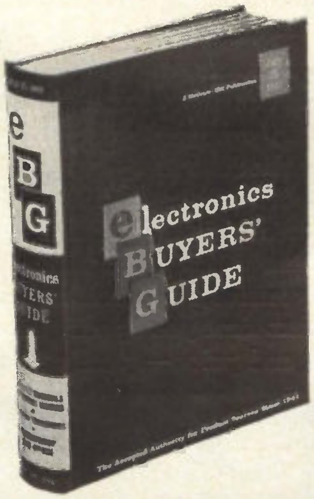
DESIGNERS of high-impedance amplifiers will benefit from the 2N3084 (TO-5) and 2N3085 (TO-18) N-channel field-effect transistors. Both types feature absolute maximum gate leakage current of 0.1 nanoamp, which makes them useful in many applications previously dependent on electrometer tubes. The devices are manufactured by the epitaxial junction process which combines the advantages of alloy, epitaxial and planar techniques. Both devices are bed-mounted and oxide-passivated. They feature a gold-nailhead bonding process which eliminates "purple plague" and results in extreme ruggedness and parameter stability. Drain current is 0.8 ma minimum, 3.0 ma max; transconductance, 400 μmho minimum, 1200 μmho max; pinch-off voltage, 10 v max. Unit price is \$45 in quantities from 1 to 99; \$36 (100 to 999). Crystalonics, Inc., 147 Sherman St., Cambridge 40, Mass. *Booth 2112.*

CIRCLE **318**, READER SERVICE CARD



N-on-P Photocells Use Silicon Transistors

NEW SERIES of N-on-P silicon readout photocells permit the use of silicon *pnp* transistors in place of the germanium *npn* transistors previously used, thus enabling data processing design engineers to increase the temperature range and speed of response of perforated tape and punched card data reading circuitry. The new cells are available with 1, 5, 6, 7, 8, 9 or 10 readout positions, with an active cell area (per segment) of 0.080 in. by 0.160 in., and center-to-center spacing of 0.100 in. Typical ratings at 500 foot candles are: short circuit current of 250 μa min; open circuit voltage of 300 mv min; and a dark current at 0.5 v of 10 μa max. Price range: (5 to 10 readout positions)



$13.65 to $26.40—1 to 99 quantities. International Rectifier Corp., 233 Kansas St., El Segundo, Calif. *Booth 2633-2637.* **(319)**

Integral Heat Sink SCR Rated at 400 Amperes

INTEGRAL heat sink scr type 222 is rated at 400 amperes with voltages up to 800 v, for use in industrial systems control and other high power applications. Designed to a new type of scr construction which eliminates a thermal interface, the device is said to provide more power at a given ambient than a corresponding, non-integral combination of scr and heat sink. Reliability is also increased. The integral package provides the application engineer with a straightforward method of determining electrical characteristics from ambient temperature. Westinghouse Semiconductor Division, Youngwood, Pa. *Booth 1402-1408.* **(320)**

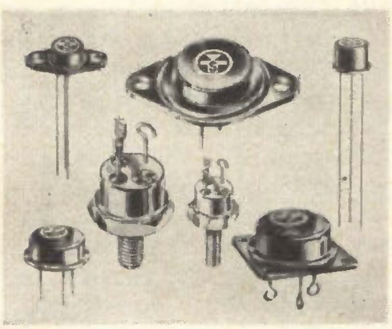
Silicon Transistors Offer High Voltage

NEW silicon transistors, the DTS-3704 and 3705, will exhibit 1- and 2.5-amp current ratings with sustaining voltages ranging in the 400-v area. They are presently being packaged in the low-cost, universal TO-3 package. Smaller 50-ma and 500-ma devices may be fabricated into TO-5 or other intermediate package configurations depending on customer needs. Units will find wide application in power supplies, voltage regulators and ignition circuits. Company says the most exciting and promising uses, however, are ex-

pected to be in the consumer product area. Delco Radio Div., General Motors Corp., 700 E. Firmin St., Kokomo, Ind. *Booth 1522-1524.*
CIRCLE **321,** READER SERVICE CARD

Integrated Circuits Feature High Gain

TWO NEW integrated power circuits capable of producing minimum d-c current gains of 1,000 at 5 amperes are announced. Each, using epitaxial silicon planar construction techniques, employs two transistors connected as an emitter-follower high-gain amplifier with commutating diode protection. Both devices offer outstanding performance when used as high-speed switching regulators and inverters, switching control amplifiers, series regulators and linear amplifiers. The 2N3230 and 2N3231, when used in high-frequency pulse power applications, enable the designer to use fewer components and realize significant size, weight and power savings. The devices are suited for aerospace, military and industrial applications where very high gain is desired. RCA Electronic Components and Devices, Harrison, N. J. *Booth 1602-8, 1701-7.* **(322)**

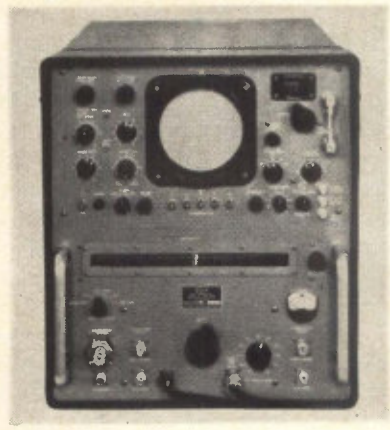


Silicon Transistors Deliver up to 85W

DEVELOPMENT of a broad new line of *pnp* silicon power transistors is announced. They are available from 8.75 w to 95 w of power capability in a wide variety of package types. BV_{CED} ratings range from 40 v to 110 v, with saturation resistances as low as 0.3 ohm at $I_C = 1$ amp. To accommodate other power circuit designs, these characteristics are available in the following packages: TO-5, $\frac{7}{16}$ in. double-ended stud, TO-8, TO-37, TO-3, TO-53, $\frac{11}{16}$ in. double-ended stud, and the isolated collector versions of the TO-53 and $\frac{11}{16}$ in. double-ended stud. Silicon Transistor Corp., Carle Place, N.Y. *Booth 1328.*

CIRCLE **323,** READER SERVICE CARD

Instruments



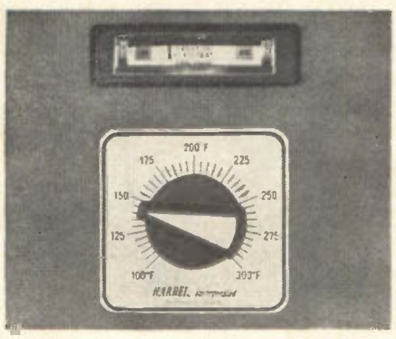
Spectrum Analyzers Use Phase-Lock Control

MICROWAVE spectrum analyzers, models SA-84WAB and SA-84-WBC, incorporate as an integral part of the circuitry a control point of suitable impedance, level and sensitivity, so that almost any of the conventional phase-lock control devices or circuits may be employed to "close the loop" and effectively eliminate incidental f-m from all sources. Features include: excellent sensitivity; wide-range variable dispersion; wide-range variable resolution; crystal-controlled markers over the entire frequency range; log-linear display; and accurate i-f attenuator. Frequency range for the model SA-84WAB is 10 to 63,680 Mc; for model SA-84WBC, 10 to 91,040 Mc. Dispersion is 10 kc to 80 Mc; resolution, 1 kc to 80 kc. Polarad Electronic Instruments, 34-02 Queens Blvd., Long Island City, N. Y. *Booth 3205-3211.* **(324)**

Meter Tests Transistor Heat Sinks

HEAT TRANSFER METER has probes to simulate various transistors, and will quickly determine the amount of power dissipation possible from

a heat sink at a given semiconductor case temperature. With the instrument it is possible to confirm in minutes thermal measurements that normally take hours and require complex and costly laboratory equipment. Model 5900 is a solid-state, precision lab instrument. It is also useful in making thermal resistance, thermal mass and other heat transfer measurements. Temperature range is 30 to 80 C; power dissipation range is 0 to 30 w in three scale ranges. Price of meter with one probe is $545. Extra probes are $95 each. IERC Division, International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, Calif. *Booth 1204-1206.* **(325)**



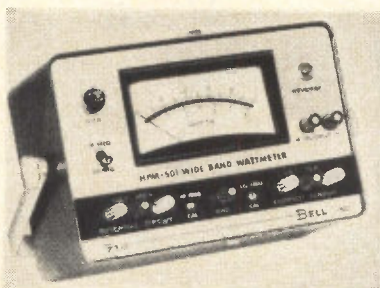
Temperature Controller Is Truly Proportional

INDICATING temperature controller, the TC400 series, is entirely solid state and is of true proportional design—that is, there is a steady and continuous flow of power to the heater just sufficient to maintain the temperature at the desired value with no oscillations. A new type of indicating system is used. Both temperature setting and indication are done on one large, easy-to-read dial. A separate meter shows by means of two red danger zones whenever the actual temperature is not at the value indicated on the dial. When the operator changes his temperature setting, all he has to do is wait until the meter pointer moves out of the red zone. He can then be assured that the actual temperature is at the set value to a tolerance of 1 deg or less. Standard ranges as low as —200 C and as high as 1100 C are available. Harrel, Inc., 16 Fitch St., East Norwalk, Conn. *Booth 2109.*

CIRCLE **326,** READER SERVICE CARD

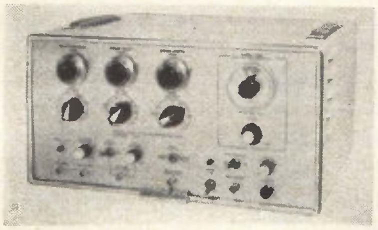
Test Chamber Has — 100 to + 350 F Range

ADVANCED VERSION of the Space Jr. test chamber, with an altitude of 1,100,000 ft (7.5 $\times$ 10^{-8} torr), is announced. Designed for satellite component development and production testing, the compact, bench-model unit also has a temperature range of —100 to +350 F. Vacuum equivalent to 500,000 ft (3 $\times$ 10^{-6}) is reached in two hours with a mechanically refrigerated cold trap. A built-in liquid nitrogen cold trap is then utilized to reach ultimate altitude. Space Jr.'s clear work area, 14 in. in diameter by 12 in. deep, is now lined with black-surfaced stainless steel. Externally, it measures 56 in. wide by 26 in. high by 24 in. deep. Price is under $5,000. Tenney Engineering, Inc., Union, N. J. *Booth 3118.* **(327)**



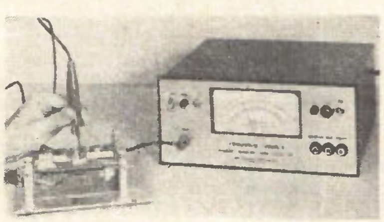
Wide-Band Wattmeter Uses Hall Effect

MODEL HPM-501, a self-contained instrument utilizing a Hall effect wattmeter transducer, is designed to measure electrical power over a frequency range of 40 to 50,000 cps. Its outstanding feature is versatility. The panel meter provides the user with a direct measurement of real power in four ranges from 100 to 3,000 w, full scale, and over the frequency ranges of 40 to 4,000 cps and 500 to 50,000 cps. The influence on the measurement with a leading or lagging power factor of 1 to 0.1 is less than 1-percent full scale. Applications include audio power measurements, sonar research and development, ultrasonic transducer research and tuning of ultrasonic systems, and determination of power factors and phase angles. F. W. Bell, Inc., 1356 Norton Ave., Columbus, O. *Booth 3938.* **(328)**



Pulse Generator Offers Flexibility

PULSE DELAY, width and rep rate accuracies better than 1 percent over 0 to 50 C ambient, direct-reading amplitude control, solid state circuitry and wide range general purpose capabilities are features of the model 107 precision pulse generator. Decade switching and 10-turn vernier dials allow resolution better than 1 part in 10^3. Unit offers both single or double pulse operation, rep rates from 0.5 cps to 1 Mc, 50-v output into 50 ohms, rise times of less than 10 nanosec (with degradation control), pulse delays to 1 sec and pulse widths from 50 nanosec to 10 millisec. Price is $1,880. Datapulse Inc., 509 Hindry Ave., Inglewood, Calif. 9031 *Booth 3108-3111.* **(329)**

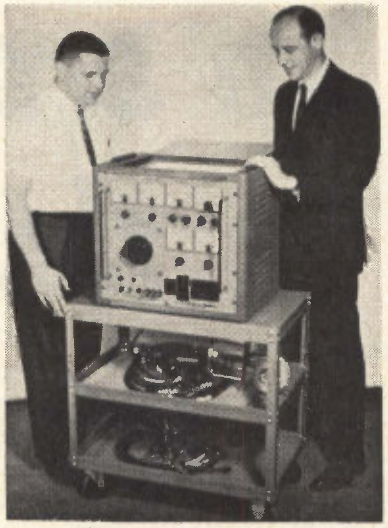


Instrument Tests In-Circuit Transistors

NEW TESTER measures the true pulsed beta of transistors installed in circuits. Simplicity of operation has been achieved through automatic control circuits which adjust the test conditions to provide a direct reading of beta from 5 to 500 on a single meter scale. The pulsed current is 5 ma with a duty cycle of 25 percent. Protective circuits prevent damage to the transistor under test. The instrument has been designed for production line, laboratory and maintenance operations. Adjustable accessory fixture holds p-c cards under a template to permit rapid and accurate testing by nontechnical operators. Price is $850. Test Equipment Corp., 3009 S. Post Oak Rd., Houston 27, Texas. *Booth 3947.*

CIRCLE **330,** READER SERVICE CARD

Klystron Gas Tester Can Be Custom-Made



MODEL 710 klystron gas tester comes complete with a variety of cable harnesses and a fan attachment. These accessories adapt the instrument for testing and gettering the majority of klystrons now on the market. Also supplied is a shelved cart which holds the instrument and all accessories required. All meters, controls, and cable connections (except power cord) are conveniently mounted on the front panel. Instruments of this general type can also be furnished according to customer specifications in rack mounted, mobile and laboratory configurations. Price of the model shown is approximately $2,200. Solitron Devices, Inc., 500 Livingston St., Norwood, N.Y. *Booth 2208.* **(331)**

Voltmeter-Bridge Has Wide Applications

MODEL 300 Portametric PVB provides a complete five-dial d-c measurement facility in one convenient battery-operated portable package. It combines the functions of a potentiometric voltmeter, a pico-ammeter, a wide-range guarded Wheatstone bridge, a four-terminal Kelvin bridge, a resistance comparison bridge, a ratiometer and a high-sensitivity electronic null detector in a single instrument. A new modulator-type null detector with an integral high-gain solid-state amplifier provides better than 5-μv d-c sensitivity with an input impedance of approximately 1 megohm. Price

Audio Signal Generator Has Sine Wave, Square Wave Output

Model H-1 audio signal generator has sine wave or square wave output, either selectable with front panel switch. Features 15 cps to 50 KC frequency range. 20 μv to 20 v RMS sine wave output, less than 1.0% distortion at 1 K cps at a level of 20 volts ±2 db, with less than 3 μ sec. rise time. Sine wave generators, models J-1 and J-2, offer additional features at slightly higher price. Price FOB Houston: H-1 $155, J-1 $165 and J-2 $195. Availability: 1 week ARO. Houston Instrument Corp., 4950 Terminal Ave., Bellaire, Texas 77401.

CIRCLE 201 ON READER SERVICE CARD

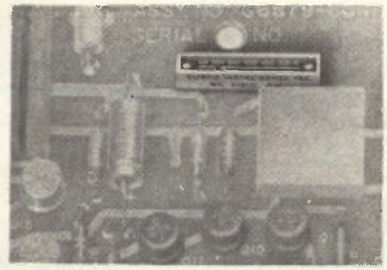
is $750. ESI/Electro Scientific Industries, Inc., 13900 NW Science Park Drive, Portland, Ore. *Booth 3015-3019.* **(332)**

Transient Indicator Works Automatically

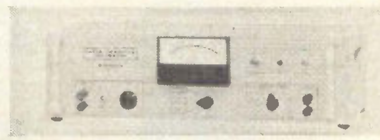
HIGH-VOLTAGE transient indicator model V-610 automatically monitors voltage transients in a circuit. Appearance of any voltage transient beyond the preset level lights the indicator lamp. This indication is stored until the instrument is reset manually, so the unit may be used for unattended monitoring of transients over extended periods of time. Transient level is continuously adjustable from 100 v to 60 kv in six self-checking, self-calibrating voltage ranges. Accuracy is ± 2 percent full scale on transients of 1-μsec duration or more. Price with probes is $449.50. Solitron Devices, Inc., 500 Livingston St., Norwood, N. J. *Booth 2208.* **(333)**

Elapsed Time Meter Records Data Visually

A LOW-COST miniature elapsed time meter for installation on p-c cards is announced. Designed to provide in-depth elapsed time instrumentation, it visually records unit operating hours. It provides means for determining component operating life from the "birth" of unit subassemblies, eliminating costly and inaccurate data logging and unit serialization. Model 120-PC measures 1.1 in. long by 0.18 in. wide and can be calibrated to any re-



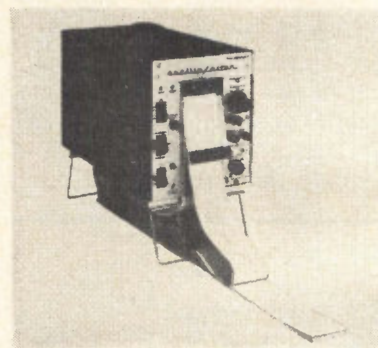
quired time scale to 25,000 hr by provision of an appropriate series resistor. Full-scale deflection is 4.2 ma hours against a 5-division scale. Curtis Instruments, Inc., 351 Lexington Ave., Mt. Kisco, N.Y. *Booth 2241.* **(334)**



Versatile Voltmeter Is Phase Sensitive

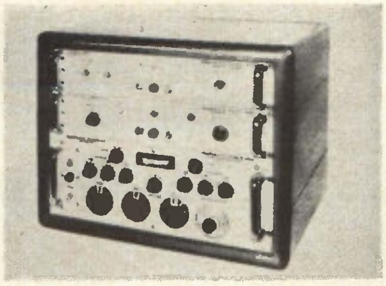
MODEL 242 will operate either as a standard vtvm, measuring the total magnitude of a signal, or as a phase

sensitive voltmeter, measuring the in-phase vector component of a signal. When measuring the total magnitude, the operating frequency extends from 20 cps to 60 kc. As an in-phase voltmeter, operating frequency extends from 20 cps to 20 kc. Full-scale sensitivity is varied in steps from 1 mv to 300 v by a 12-position calibrated range selector. Input impedance is 10 megohms shunted by 40 pf. Typical applications include measurement of transformation ratio, null indicator for precision ratiometer and synchro bridge, measurement of power factor and complex impedance, zeroing of synchros, resolvers, and transducers. Dytronics Co., Inc., 5485 N. High St., Columbus 14, O. *Booth 3837.*
CIRCLE **335,** READER SERVICE CARD



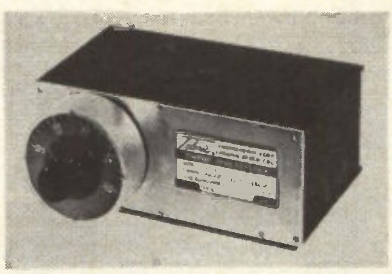
Oscillographs Offer User Convenience

SINGLE-CHANNEL oscillographs with interchangeable amplifiers are announced. Either standard roll or optional Z-fold charts may be used interchangeably to record signals from d-c to essentially 100 cps. Units feature the user convenience found in two-channel Oscillo/Riter recorders. All controls are front-panel mounted and chart loading is simple. Appropriate plug-in preamps provide signal conditioning for the desired applications. Standard chart speeds are 5 and 50 mm/sec selectable by a push-button switch. Specifications without preamp include: recording grid, 50 mm; input sensitivity to driver amplifier, ± 2.5 v ± 5 percent into 6,000 ohms for 25-mm deflection; linearity, 1 percent; stability, $\frac{1}{2}$ percent; rise time, 8 ms max for 90 percent of full span. Texas Instruments Inc., 3609 Buffalo Speedway, Houston, Texas. *Booth 1409.* **(336)**



Resistance Bridge Performs Rapid Tests

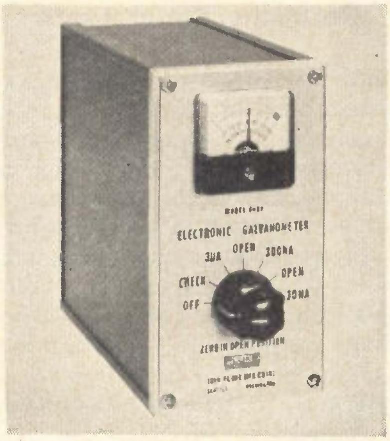
FULLY AUTOMATIC precision resistance limit bridge performs high-speed dual-limit go/no-go resistance tests over a range from 1 ohm to 100 megohms with resolutions as low as 0.1 ohm. Model 100 provides test conditions in conformance with MIL Spec requirements for carbon composition, film and wire-wound resistors. Tolerance range is continuously adjustable from 0 to ±30 percent and excitation voltage is continuously variable from 0 to 100 v, d-c. Unit will make up to 36,000 decisions per hour. It may be used with a simple test jig for manual loading or with an optional control unit which provides actuation signals to materials-handling equipment for fully automated production testing. Model 100 with control unit, cabinet and associated cabling costs $3,640; without control unit, $3,090. Boonton Electronics Corp., Parsippany, N. J. *Booth 3114-6.* **(337)**



Tunable Multipliers Are Self-Biased

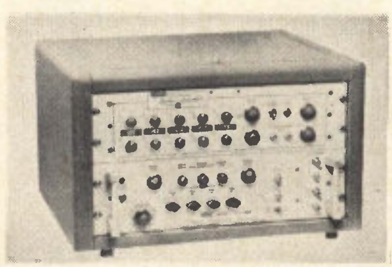
TWO new tunable frequency multipliers are available with input ranges of 0.5 to 0.85 Gc and 0.6 to 1.0 Gc. Respective outputs are 1.0 to 1.7 Gc and 1.2 to 2.0 Gc. Models TTM-2 and TTM-3 are identical in all respects except frequency coverage. They incorporate two gang-tuned filter networks in combination with a varactor circuit to achieve highly efficient frequency doubling over a wide tuning range. Operating at a 10-percent minimum bandwidth the conversion loss is 3 db max, with 1-w output. Price of both models is \$850. Telonic Engineering Co., 480 Mermaid St., Laguna Beach, Calif. *Booth 3924*.

CIRCLE **338**, READER SERVICE CARD



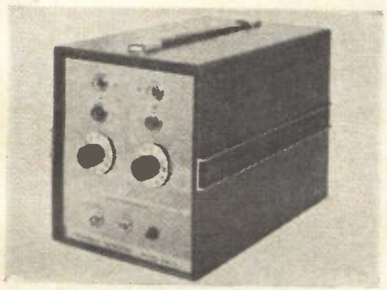
Galvanometer Has High Sensitivity

MODEL 840A electronic galvanometer is solid state, with 2 na per scale division sensitivity. Recorder output provides 100 mw d-c full scale on all three ranges. Manufacturer claims 50 times the power sensitivity of light-beam galvanometers for OEM applications; no damage from current overloads of 110 db; and rugged construction. Size is 5½ in. high by 3 in. wide by 4¾ in. behind panel. Price is \$175. John Fluke Mfg. Co., Inc., Box 7428, Seattle, Wash. 98133. *Booth 3233-35*. **(339)**



Test Sets Align R-F Circuits

MODELS 601-CM and 602-CM for the test and alignment of r-f circuits in the total frequency range of 4 to 225 Mc are available. The sets are a combination of a new sweep frequency generator and a CM-10 marker generator mounted together in one compact housing. The sweep generators, models 601-5BR and 602-5BR, feature a built-in r-f detector, a 70-db built-in attenuator in 10-db steps, and a built-in marker inserter and amplifier. They also have an output vswr of less than 1.1 and a horizontal output featuring approximately 360-deg phasing. The 601-5BR has a total frequency range of 12 to 225 Mc, and the 602-5BR a range of 4 to 112 Mc. Total sweeping range of each generator is divided into 11 overlapping ranges. The 601-CM and 602-CM are priced at $745 each. Jerrold Electronics Corp., 15th and Lehigh Ave., Philadelphia 32, Pa. *Booth 3904-3914.* **(340)**

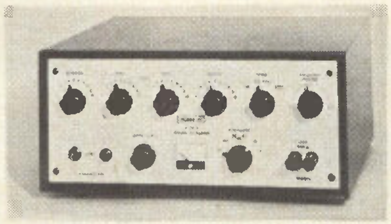


Transient Detector Aids Systems Reliability

OCCURRENCE of short-duration transient voltages can reduce the reliability of electronic systems in two ways: (1) exceeding the rated breakdown voltage of solid-state components, and (2) generating interfering electromagnetic radiation. The 2601A enables the engineer to eliminate these transients by providing a method for detecting them, quantizing their amplitudes, and determining their polarity. Brief specifications include: response—transients as short as 100 nsec separated by as little as 300 μsec; threshold level, 0.1 to 250 v; minimum input impedance, 1 megohm/40 pf; indicators—four front-panel lights indicate polarity of transients exceeding either of two preset levels; outputs—2 v, 100-μsec pulse for counters or event recorders; 117 v, 100-msec pulse for flashing remote indicator lamp or actuating electromagnetic counters or relays; 1 v, 100-μsec scope trigger. Huggins Laboratories, Inc., 999 E.

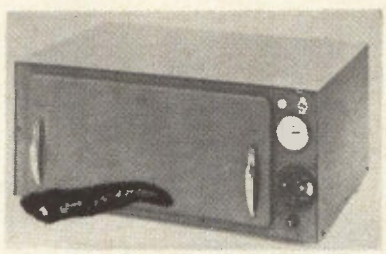

MAKE IT TRACK SIGNALS OVER AN 8 TO 1 FREQUENCY BAND
Briefs on the Kind of Assignments You Can Expect at SES-West
What's unique about this broadband tracking antenna? Almost everything. The lightweight reflector and feed support boom—polyurethane foam over an eggcrate-like frame, metalized by flame spraying. Lens-corrected feed horn with an 11 to 1 bandwidth—reflector-feed combination uses constant bandwidth techniques to minimize change in crossover level with frequency. Performance thought impossible a few months ago—tracks signals over an 8 to 1 frequency band!
We're proud of this advancement—and of the men at SES-West who achieved it.
SES-West is a "Quick Reaction" facility developing systems and hardware that are on the forefront of our nation's defense technology. Job assignments are as vital and varied as the unique projects we handle. You put your ideas to work on projects in advanced antenna development, arms control, space vehicle guidance, RF systems, reconnaissance, microwaves.
Expansions in size and scope continue at SES-West—creating exceptional opportunities for you. See listing on next page.
SYLVANIA ELECTRONIC SYSTEMS
Government Systems Management
for GENERAL TELEPHONE & ELECTRONICS
SYLVANIA ELECTRONIC SYSTEMS-WEST
DEPT. 61, P.O. Box 188, Mountain View, California
An Equal Opportunity Employer

Arques Ave., Sunnyvale, Calif. *Booth 2210-2212.*
CIRCLE **341,** READER SERVICE CARD



Decade Oscillator Covers Wide Range

NEW OSCILLATOR model K-126-A, utilizes the advantages of transistors and decade control, to provide a versatile, lightweight, and compact instrument. Principal features are a high frequency accuracy with low harmonic content combined with a high order of stability. The wide frequency range of 1 cps to 222.2 kc is covered by four decade dials. A fifth continuously variable trimming control provides interpolation between the steps of the fourth decade so that frequency increments of at least 0.1 percent can be made with ease. Muirhead Instruments, Inc., 1101 Bristol Road, Mountainside, N. J. *Booth 3230.* **(342)**



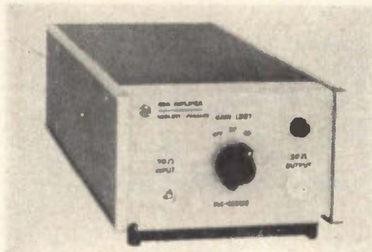
Temperature Chamber Has Portable Design

PRECISION temperature chamber model 5701 is 30-percent lower priced than the lowest priced of the company's chambers of the past. It features a stainless steel liner and accurate temperature control of ±3 F at temperatures up to +400 F. It has a 1.8-cu-ft oven capacity with external dimensions of 14 in. high, 29 in. wide and 22½ in. deep. Designed with portability for bench use, it weighs 40 lb. A wide range of drawers is available for testing of components of various sizes. Price is $385. Delta Design, Inc.,

 CIRCLE 113 ON READER SERVICE CARD

P. O. Box 728, Del Mar, Calif. *Booth 3046.*

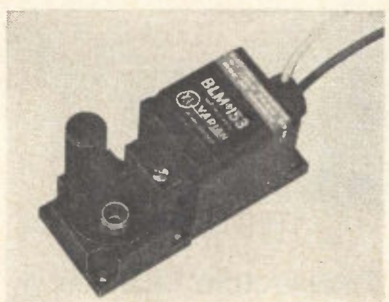
CIRCLE **343**, READER SERVICE CARD



Laboratory Amplifier Is Solid-State Unit

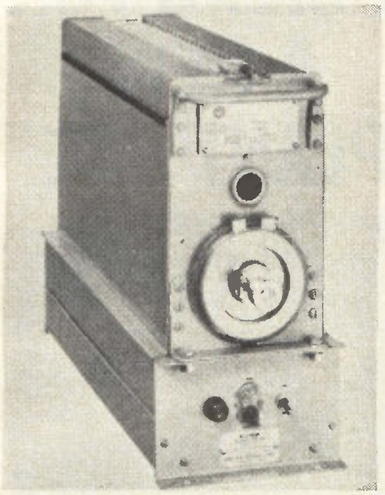
RESPONSE of ± 1 db from 1 kc to 150 Mc is featured in model 461A general purpose solid-state laboratory amplifier. Gain of 20 or 40 db may be selected on the front panel. Output is up to 0.5 v rms into 50 ohms, and equivalent wideband input noise level is under 40 μv with 40-db gain. Input impedance is 50 ohms. The a-c powered unit is $3\frac{15}{32}$ in. high, 5⅛ in. wide, and 11 in. deep. Weight is 4 lb. Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif. *Booth 3401-3418.* **(344)**

Microwave



Beacon Magnetron Has Integral Isolator

NEW BLM-153 beacon magnetron features an integral load isolator that allows 5 kw of output power from a 20-oz package. The tunable C-band unit is designed for use in radar beacon transponders. Operating at a frequency of 5.7 to 5.8 Gc, the tube offers 25-percent efficiency and unusually high reliability. Pulse duration is 0.75 μsec; duty cycle is 0.0015; peak anode voltage is 4.8 to 5.2 kv and peak anode current is 4.5 amperes. The tube has a coaxial TNC output connector. Laboratory experiments have demonstrated power output capabilities up to 10-kw peak and/or 10-w average. Bomac Division, Varian Associates, Salem Road, Beverly, Mass. *Booth—Varian Center, 2nd Fl.* **(345)**



R-F Attenuators for High-Power Use

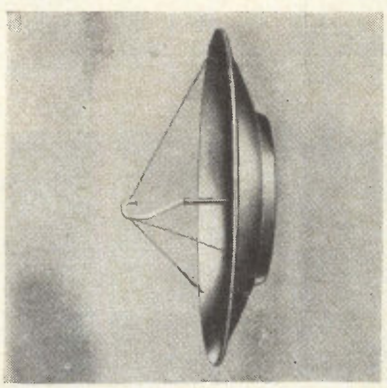
NEW SERIES of coaxial r-f attenuators for high-power applications in the d-c to 2,000-Mc range includes 3 models rated at 500 w (No. 8325), 2,000 w (No. 8329) and 4,000 w (No. 8329 with BA-88 blower). These 50-ohm units have a maximum input vswr of 1.1 to 1,000 Mc and 1.2 to 2,000 Mc and are available with uniform attenuation of 30 db or 40 db. Bird Electronic Corp., 30303 Aurora Road, Solon, O. *Booth 3215-3217.* **(346)**

Device Synchronizes BWO's and Klystrons

MODEL 243 synchronizer phase-locks backward-wave oscillators as well as reflex klystrons to crystal stability. Its increased current capability enables it to be used with certain types of triode oscillators that fall within the current range of 25 ma max. A phase-lock indicator has been incorporated into the model 243 which permits easier locking indication. The phase-lock disable switch, also incorporated into the design, permits disabling of the phase-lock so as to be able to lock to the next adjacent frequency. The bwo and klystron synchronizer features a short term stability of 1 part in 10^8 per sec and a long-term stability of 1 part in 10^6 per week. It operates over a frequency range of 1 to 15.0 Gc. The compact unit is priced at $1,950. LFE Instruments, 1079 Commonwealth Ave., Boston 15, Mass. *Booth 3716-3718.* **(347)**

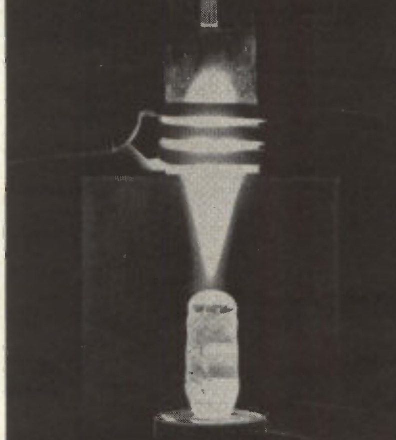
Microwave Phase Meter Gives Fast Response

TO SATISFY the need for a very precise but fast responding device that would provide a flicker-free scope trace, an all-electronic microwave phase meter with auxiliary functions of level in db and impedance plotting is being introduced. Phase resolution is 0.1 deg and absolute accuracy for typical usage is ±1 deg. The instrument has novel readout options; in addition to phase versus frequency and gain or loss in db versus frequency it also has a readout of phase and gain (in db) plotted simultaneously on the X and Y scope axes. Company is demonstrating the 310-L1 covering 1.2 to 1.4 Gc. Wiltron Co., 717 Loma Verde Ave., Palo Alto, Calif. *Booth 3934.* **(348)**



Antenna Systems Have High Gain Pattern

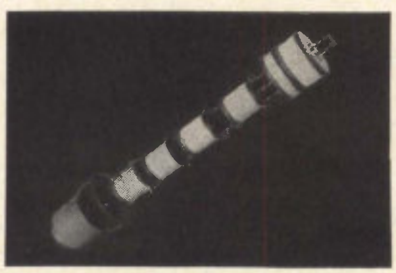
NEW LINE of communication microwave antenna systems in the 6-Gc band are available in 2 ft through 14-ft sizes and consist of a sectional horn feed mounted in a precision spun parabolic reflector. They are for use in common carrier, studio-transmitter links, operational fixed, government, and industrial service. Features include high gain pattern



characteristics, symmetrical beamwidths, and low side lobes. The feeds are tuned in three broad ranges (over the 5,925 to 7,425-Mc bandwidth) so that the vswr remains below 1.1:1 for any specific range. Ainslie Corp., 531 Pond St., Braintree, Mass. *Booth 1817.*
CIRCLE **349**, READER SERVICE CARD

Directional Couplers Have Rugged Design

TWO NEW octave bandwidth directional couplers have been added to a line of strip-type microwave components. Available in coupling values of 10 or 20 db, these units offer 15 db minimum of directivity over frequency bands of 250 to 1,000 Mc, 750 to 3,000 Mc or 1,000 to 4,000 Mc. Advantages are light weight, small size, rugged encapsulated design with reliable performance over a broad frequency band. Price is $120. LEL, Inc., 75 Akron St., Copiague, N. Y. *Booth 2106-2108.* **(350)**



Klystron Uses Vapor-Phase Cooling

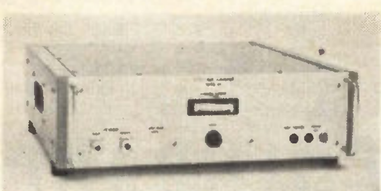
NOW BEING INTRODUCED is the 4KM-V100LA vapor-phase cooled klystron for uhf-tv. It is a four-cavity, power amplifier klystron for use at frequencies from 470 to 610 Mc. Although designed primarily for television visual service, the klystron can also be used for audio tv and troposcatter communications service. In tv video service, the unit provides 25-kw power output, power gain of 30 db, and a 1-db bandwidth of 8 Mc. Beam voltage is 16 kv and beam current is 3.8 amperes.

Use of vapor-phase cooling requires only half as much cooling apparatus, reduces operating noise, and cuts maintenance cost.

The tube's electron gun uses a semi-confined flow field which minimizes focusing adjustments and produces a very stable beam. Cathode loading of only 100 ma per sq cm at beam voltage of 18 kv helps lengthen tube life. Price is $6,500. Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, Calif. *Booth 2415-2419.* **(351)**

Band-Pass Filters Tune Five Ranges

TUNABLE cylindrical TE_{111} mode waveguide band-pass filters are available in two- and four-cavity configurations and will tune the frequency ranges 4.4 to 5.0 Gc, 5.4 to 5.9 Gc, 7.5 to 8.5 Gc, 8.5 to 9.6 Gc, and 9.6 to 10.7 Gc. Constructed of aluminum, the higher frequency units weigh only 2.5 lb. Filters of this type are used in beacon, radar, troposcatter and other communications systems, as well as laboratory test equipment. Gombos Microwave Inc., Webro Road, Clifton, N. J. *Booth 2818-2820.* **(352)**

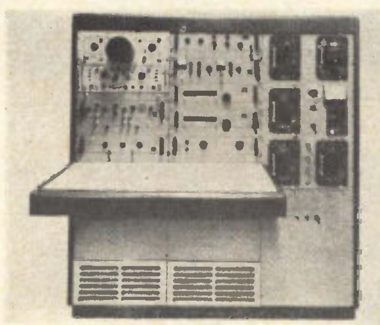


TWT Amplifier Uses PPM-Focused Tube

FOUR new twt amplifiers of solid state design feature a ppm-focused tube. Designed for both laboratory and field use from 1 to 12.4 Gc, series 560 power amplifiers provide 1 w output with less than 1 mw input at one setting of front panel controls. Features include outstanding phase stability and modulation response. Long and short term phase stability is obtained through low ripple, well regulated power supplies. For flexible amplitude modulation the tube grid is d-c coupled and rise and fall time response is better than 1 μsec. A 20-v signal reduces output by 40 db. Other specifications are: spurious modulation, 45 db below signal level; input power 115/230 v $\pm$10 percent, 50/60 cps; prices, from $2,150 to $2,800 according to frequency range. Alfred Electronics, 3176 Porter Drive, Stanford Industrial Park, Palo Alto, Cali. *Booth 3038-3039.*

CIRCLE 365, READER SERVICE CARD

Systems and Subassemblies



RFI Analysis System Displays on Two Beams

NEW SYSTEM CONSOLE for specialized measurement and analysis of conducted and radiated radio-frequency interference is said to be the most comprehensive group of rfi equipments offered to cover all applicable military specifications. Primary function of the system is to provide a means of displaying and measuring repetitive r-f interference in the presence of non-coincident, synchronous and/or random rfi signals. The detected signals may be displayed on a dual-beam oscilloscope with a long persistence crt. One beam is intensity modulated to display the raster presentation, the second beam displays a monitor signal from the suspected source. The interfering source is then identified when a correlation is noted between these displays. Included preamps cover from 0.150 to 1,000 Mc. Electro International, Inc., Box 391, Annapolis, Md. *Booth 3844.* **(366)**

Encoding System Has Modular Design

MODEL RDC4162-1000 Redicon (resolver to digital converter) is a precise shaft angle encoding system that is completely self-contained. Digital data is continuously available in 16-bit, parallel-binary form, and a visual display of angle data in 16-bit form is presented. Logic zero is -12 v, and logic one is zero volts. The all-solid state system is accurate to within one bit. It will receive analog inputs from a dual speed ($1\times$ and $16\times$) pancake resolver. Data outputs are available in both analog and digital form, with the analog data accurate to 10 sec of arc. System employs modular design techniques throughout, and is readily adaptable to either one speed or dual speed inputs other than 16 speed, for higher or lower bit levels, and to a variety of mechanical configurations. Reeves Instrument Corp., Garden City, N.Y *Booth 1307-1309.* **(367)**

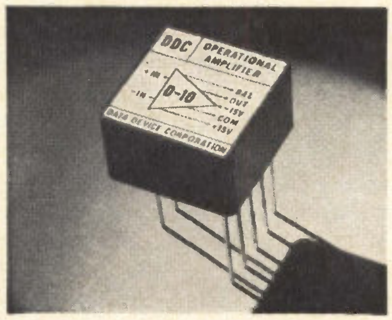
Tape Angle Counter Saves Space

PRODUCTION of a space saving tape angle counter with front reading area of approximately ½ sq in. is announced. Type X-1532 provides readings in 1-deg increments from 000 deg to 359 deg and return to 000 deg, fully reversible, with operating speed rated at 600 rpm continuous. Special advantage is the small amount of panel space required for display of the three 0.187-in.-high white digits. Overall dimensions of the counter, including frame components, are

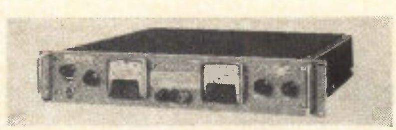
0.818 in. width, 0.774 in. height and 4 in. length, not including the drive shaft. Bowmar Instrument Corp., 8000 Bluffton Road, Fort Wayne, Ind. *Booth 1508-1514.*
CIRCLE **353**, READER SERVICE CARD

Operational Amplifier Avoids Short Circuits

ALL-SILICON, encapsulated operational amplifier is designed for use in automatic test equipment, analog computers, automatic controls and



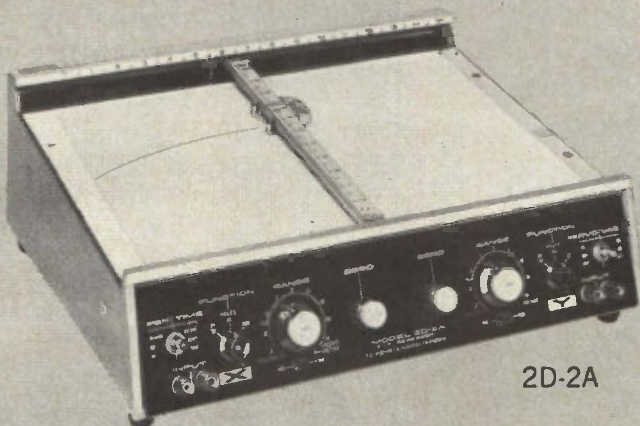
as a highly stable amplifier in measurement circuits. The D-10 has a differential input with an open loop gain of 20,000; drift is less than 100 μv per day. Output is ± 10 v at 2 ma. Protection against damage from accidental overloads or short circuits is provided by a current limiting circuit. The D-10 operates over a temperature range from -25 C to $+85$ C from a ± 15-v supply. Dimensions are $1\frac{1}{8}$ in. by $1\frac{1}{8}$ in. by $\frac{5}{8}$ in. high. Price: 1 to 9, \$55; 10 to 24, \$54. Data Device Corp., 240 Old Country Road, Hicksville, N. Y. *Booth 2008.* **(354)**



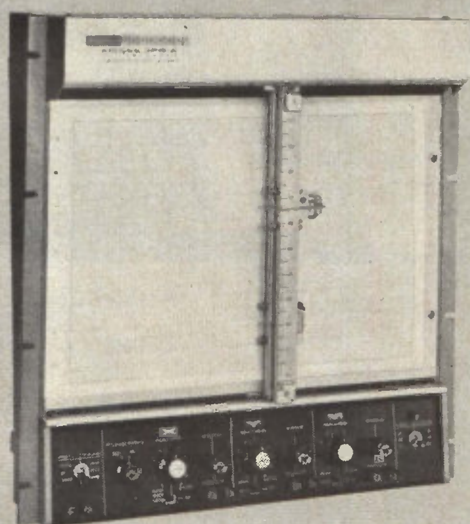
Regulated Supplies Indicate E/I Modes

VOLTAGE/CURRENT regulated power supplies, the KS group, which embrace the ranges from 0 to 8 v at 0 to 15 amp to 0 to 8 v at 0 to 100 amp, have been provided with timesaving VIX mode indicators and signal circuit. The VIX system is

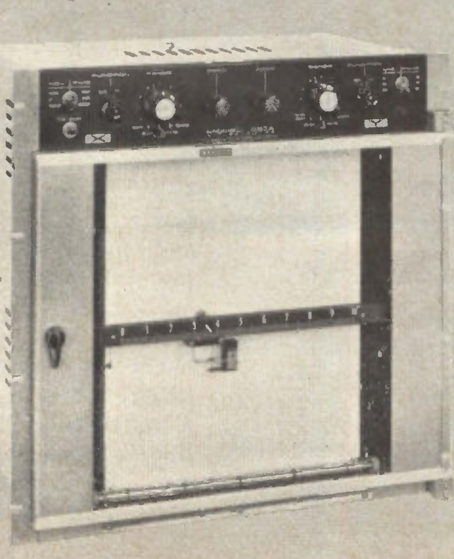
These and other new Moseley
1 MEG X-Y RECORDERS
give maximum recording accuracy



2D-2A



2FRA



6S-A

New high-impedance models of standard Moseley Autograf® X-Y Recorders automatically increase your recording accuracy, especially in recording low-level measurements. The high input impedance (one megohm on all ranges) prevents loading of the circuit being measured, ends inaccuracies caused by such loading. This high-impedance feature, designated by the letter "A" on the model number, is available in the Moseley 135A 8½"x11" recorder ($1650), the 136A two-pen 8½"x 11" recorder ($2650), the 2D-2A series 11"x 16" recorders ($1950), the 2FRA two-pen 11"x 17" recorder ($3575), and the 6S-A 10" x 10" automatic chart advance recorder ($3150). The 135A and 2D-2A are also available with metric scale, as well as standard, while the 2D-2A models are available in separate bench and rack mount models, all at no increase in cost. Call your Moseley/Hewlett-Packard field engineer for information.

F. L. MOSELEY CO.

409 N. Fair Oaks Ave., Pasadena, California

an affiliate of Hewlett-Packard

To Order Reprints

Fill in,

Cut out coupon below, insert in envelope and mail to:

electronics Reprint Dept.
330 West 42nd Street,
New York, N. Y.—10036

REPRINT ORDER FORM

For Listing of Reprints Available See Reader Service Card

(To help expedite mailing of your reprints please send cash, check or money order with your order.)

For Reprints of the latest Special Report:

Modern Electronic Packaging

Send me...... Reprints of Key No. R-48 at 50¢ each.

For Reprints of previous **Special Reports** or **Feature Articles** fill in below:

Send me.......... Reprints of Key No.(s)........... @ ....¢ each.
(For prices, see Reader Service Card.)

*For orders of **Bulk Reprints** of other editorial articles in this issue or past issues:

Send me........ Reprints of page no.(s)........ of issue date...............

of article entitled..

*Minimum bulk order 100 copies. You will be advised of costs by return mail.

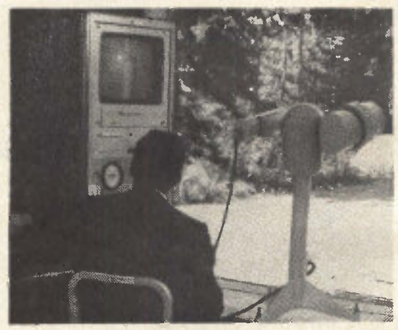
Name ....

Number and Street..

City, Zone No., State..

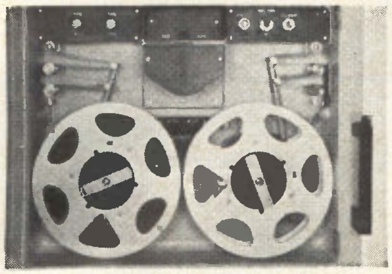
particularly useful in the KS group since they possess circuits exhibiting practically instantaneous automatic voltage/current crossover and 100-percent voltage compliance in the constant-current mode. The 10-turn voltage and current controls provide resolution compatible with the basic 0.01-percent regulation and stability of these supplies. The VIX voltage/current mode indicators include a first light which shows when the power supply is in its voltage-regulating mode, and a second when it is in its current-regulating mode. Prices range from $495 for the KS36-5M (0-36 v at 5 amp with two meters) to $1,395 for the KS8-100 M (0-8 v at 0-100 amp with two meters). Kepco Inc., 131-38 Sanford Ave., Flushing 52, N. Y. *Booth 2636-2638.*

CIRCLE **355,** READER SERVICE CARD



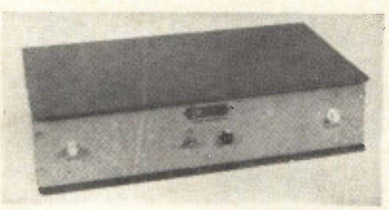
Automatic Tracker Uses Two TV Cameras

AUTOMATIC television tracking system comprises a pair of television cameras (wide-field and narrow-field) mounted on a compact servo-driven pedestal, plus a remote control console equipped with multiple displays and an operator's joystick. Tracking is initiated by an operator who uses the joystick to bring the target within the acquisition field (wide-field camera). By releasing the trigger on the joystick, he surrenders manual control of the pedestal, and automatic acquisition and precision fine tracking take place. The system has a static pointing accuracy of 0.1 milliradian. It is useful in tracking high-speed space, re-entry and airborne targets, a field where automatic equipment helps eliminate possibility of human error. Barnes Engineering Co., 30 Commerce Road, Stamford, Conn. *Booth 3505-3507.* **(356)**



Tape Readers for Military & Industry

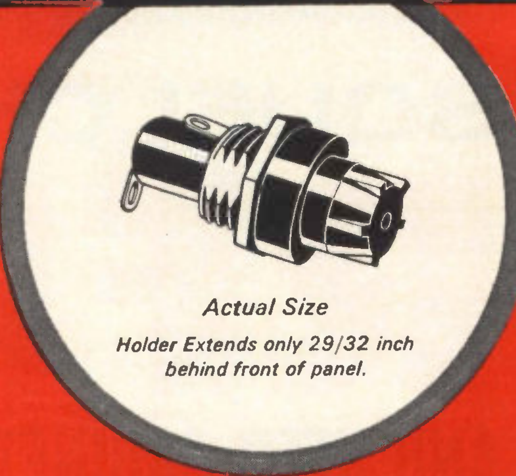
TWO NEW photoelectric tape readers utilize the printed motor direct capstan drive which eliminates pinch rollers, brakes and clutches in the transport of tape. Model 500 RM was designed to meet all applicable military specifications for tape readers and conforms to Class II of MIL-E-16400E, MIL-T-21200D and MIL-T-945A. It is bidirectional with 8-in. reels and optional polarities on both inputs and outputs. Free-running reading speed is up to 500 characters per sec. A proportional reel servo system allows bidirectional wind-search at 1000 characters per sec with the tape in contact with the capstan. Model 500R is the commercial version of the 500 RM with similar characteristics at lower cost. It is available as a separate reader or spooler or as an integral reader/spooler combination. Photocircuits Corp., Glen Cove, N. Y. *Booth 2202.* **(357)**



Amplifiers Provide High Output

WIDE RESPONSE and high output characterize a new series of solid-state amplifiers. Band pass is 100 kc to 150 Mc. Output is 5.5 v p-p into 50 ohms at 10 Mc. Impedance is 50 ohms in and out with noise and hum 35 μv rms equivalent input. Units are available with a gain of 20 db, 40 db, and 60 db nominal. Amplifiers are packaged as single chassis only (3000 series). Models are 3062/4062, 20-db gain; 3064/4064, 40-db gain; and 3066/4066,

New! BUSS SPACE SAVER PANEL MOUNTED FUSEHOLDER



- Fuseholder takes ¼ inch x 1¼ inch fuse. Converts to 9/32 x 1¼ inch fuse simply by changing screw type knob. Holder is rated at 30 ampere for any voltage up to 250.
- It is completely water-proof.
- Holder meets the need for a highly reliable military fuseholder made to minimum dimensions for commercial and military applications.

BUSS Write for BUSS Bulletin SFH-10

BUSSMANN MFG. DIVISION, McGraw-Edison Co., St. Louis 7, Mo.

Save Assembly Time with Quick-Connect Terminals on BUSS Fuseholders

BUSS Write for BUSS Bulletin SFB.

BUSSMANN MFG. DIVISION, McGraw-Edison Co., St. Louis 7, Mo.

BUSS: 1914-1964, Fifty years of Pioneering...

CIRCLE 125 ON READER SERVICE CARD

CIRCLE 125 ON READER SERVICE CARD

HOW TO USE CATALOG 700

FOR ALL IT'S WORTH!

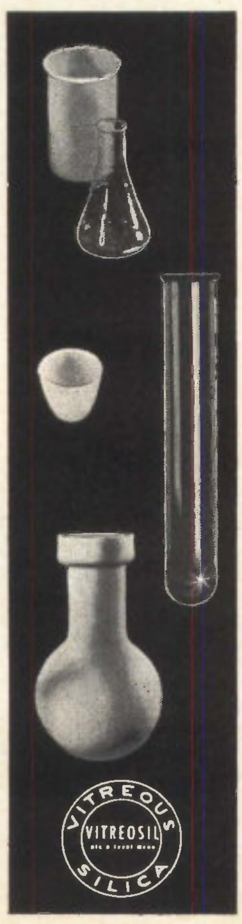
STUDY THE HANDY DIGEST OF CIRCUIT FORMULAE (PAGE 128)

Invaluable aid in coil and capacitor selection — concise compilation of common circuit symbols and formulae found in no other single reference. Also capacitance curves, coil winding data and a related coil form section allow greatest design flexibility. Many other engineering features to help you select from more than 15,000 *guaranteed* CAMBION® electronic components. Contact your Authorized CAMBION Distributors for local availability. Write for particular samples, sales engineering or additional free copies of full-line Catalog 700. Cambridge Thermionic Corporation, 203 Concord Ave., Cambridge, Massachusetts 02138.

CAMBION®

Standardize on CAMBION...The Guaranteed Electronic Components

CIRCLE 124 ON READER SERVICE CARD



"VITREOSIL"®

is the word for VITREOUS-SILICA (PURE FUSED QUARTZ)

Pure fused quartz is no longer a laboratory curiosity. More and more industrial production in chemical, semiconductor, electronic, optics, etc. find quartz the only answer to many demands of higher production. Virtually chemically pure quartz does not contaminate any process, operates up to temperatures of 1100°C continuously, takes unlimited thermal shock, is unaffected by most acids, has excellent electrical and heat insulating qualities and is exceptional for light transmission. Write for more details on **VITREOSIL** pure fused quartz.

22

THERMAL AMERICAN FUSED QUARTZ CO.

RT. 202 & CHANGE BRIDGE RD.
MONTVILLE, NEW JERSEY

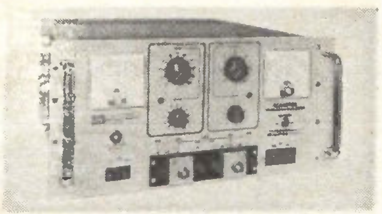
CIRCLE 224 ON READER SERVICE CARD

60-db gain. C-Cor Electronics, Inc., P. O. Box 824, State College, Pa. *Booth 1819.*

CIRCLE **358,** READER SERVICE CARD

Constant E/I Supply Has Sharp Crossover

POWER SUPPLY model PVC36-100M employs two regulator channels: one for constant-voltage; one for constant-current. Output is 0 to 36 v at 0 to 100 amp. Features include sharp crossover from constant E to constant I or vice versa; full range programmability and M[illegible]ogrammability in either mode; long-line remote sensing, providing rated regulation up to 300 ft away;

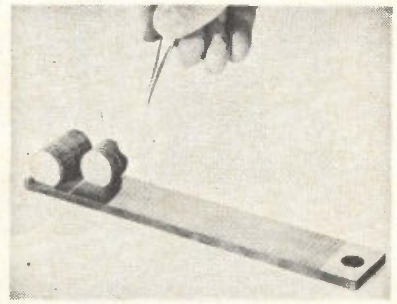


master-slave series or parallel operation for higher-than-single unit output; 0.01 percent or 2 mv line or load regulation in constant E operation, 0.05 percent or 8 ma line or load regulation in I operation. Electronic Measurements Co., Eatontown, N. J. *Booth 2423.* **(359)**

Materials

Combination Materials For Printed Circuits

LINE of combination materials for welded printed circuits is introduced. They combine a glass epoxy base laminate with a cladding of nickel alloy, such as Kovar or Nichrome. The combination is said to allow parallel gap welding techniques to fasten components to the circuits, since leads on the micro-modules are made from the same alloy. The combination materials are offered in 6-in. by 12-in. sheets. A variety of thicknesses of base laminates and cladding is available, and the sheets can be clad on one or both sides. Synthane Corp., Oaks, Pa. *Booth 4421-4423.* **(360)**

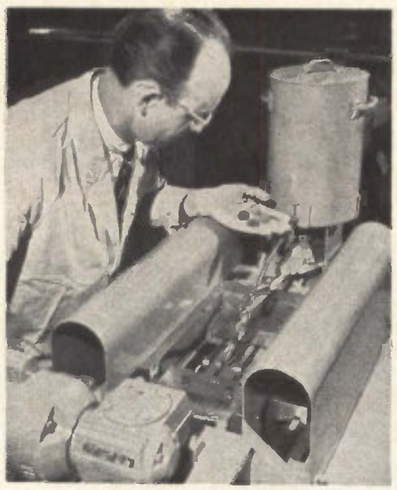


Diffusion Boats Use Silicon and Quartz

CUSTOM-CRAFTED silicon and quartz diffusion boats are now being fabricated. The line is available in two ways: The buyer may use a standard drawing, selecting seven different dimensions (length, width, thickness, slot depth, slot spacing, slot width, and anti-roll fence location), type of material to be used, and finish; or, the buyer may supply his own drawings and dimensions. Available materials are single-crystal doped silicon, for which the customer may specify resistivity; polycrystalline undoped silicon of greater than 100 ohm/cm resistivity; or type 101 clear fused quartz. The silicon boats do not devitrify, even at temperatures as high as 1,300 C; therefore, with normal handling and wear, they have useful life in excess of 10 times that of equivalent quartz boats, the manufacturer reports. Semiconductor Specialties Corp., 252 Garibaldi Ave., Lodi, N. J. Booth 4036.

CIRCLE **361,** READER SERVICE CARD

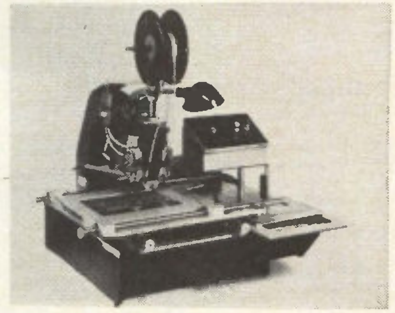
Production Equipment



Wafering Machine Uses Multiblade Method

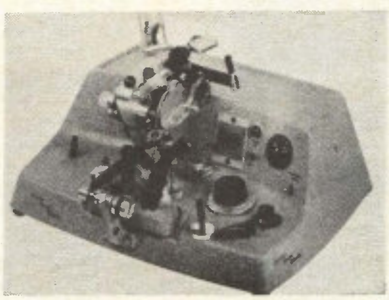
SLICING of semiconductor materials with the multiblade wafering machine produces only 25 microns depth of damage compared to 125-150 microns for other methods, according to company reports. As a result, the percentage of acceptable semiconductor units from production lines is considerably higher where the multiblade method is used. Also featured on the machine are a vertical feed mechanism and improved workpiece mounting techniques. These produce improved wafer tolerances and surface finish so that many lapping operations can be eliminated, especially on germanium wafers. Norton Co., 1 New

Bond St., Worcester 6, Mass. *Booth 4053.* **(362)**



Component Inserter Has Numerical Control

NEWLY DEVELOPED equipment to prepare and insert components of different physical configurations and values into p-c boards is announced. The machine illustrated is capable of 45 insertions per minute or better—depending on specific application. Numerical control positions table and adjusts chuck permitting insertion of different components of various diameters in a preprogrammed sequence. Universal Instruments Corp., 139 E. Frederick St., Binghamton, N. Y. *Booth 4049.* **(363)**



Toroid Winder With Built-In Counter

FEATURES of model 600A toroid winder include: jockey stick core position control, winding down to 0.055 in. i-d and up to over 2 in. o-d; wire range from No. 26 to No. 46 Awg; built-in predetermined counter with dynamic braking; automatic sector and bank winding; automatic 360-deg rotation either clockwise or counter-clockwise; winding speeds to 1600 turns per minute. It takes only minutes to change from one size shuttle to another without need to change winding head. Gorman Machine Corp., Randolph, Mass. *Booth 4233.* **(364)**

IEEE Booth 3701-5

new SOLID STATE NOISE LOADING TEST SET TO 2700 CHANNELS

MODEL 2090

- Weighs 25 lbs. per unit excluding filters.
- Checks Noise Power Ratio of multi-channel systems, satellite communications, cables, etc.
- High Pass, Low Pass, Band Pass and Band Stop filters to CCIR recommendations
- Out-of-band accessories available

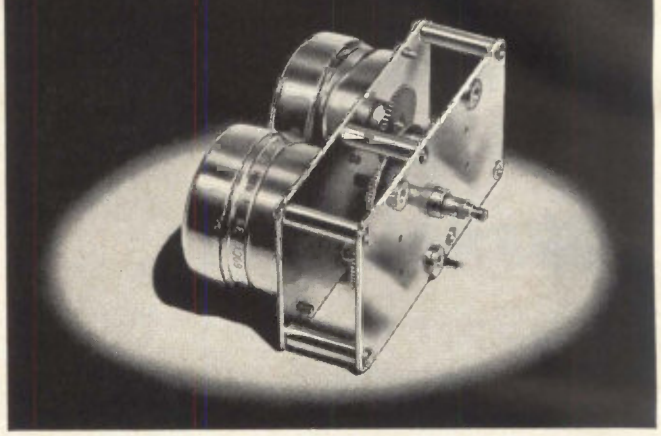
Write for detailed catalog sheet.

MARCONI INSTRUMENTS

DIVISION OF ENGLISH ELECTRIC CORPORATION
111 CEDAR LANE • ENGLEWOOD, NEW JERSEY
Main Plant: St. Albans, England

DUAL MOTOR MOUNT

shows versatility...



TWO SYNCHRON® MOTORS BY HANSEN

provide flexible output speed from one shaft

Two SYNCHRON motors on a dual mount provide a good mix of accurate speeds from the same shaft in right or left rotation, or both; this or a similar mounting might solve a timing problem you have. There can be three precise speeds: the speed of one motor by itself, the speed of the second motor by itself, and the combined speeds of both. Perhaps you need only two speeds — fast and slow — but both must be accurate. This particular unit meets that specification; as an example, it can be applied for fast, accurate readout to a chart drive.

ALL SYNCHRON MOTORS will perform reliably for years. Two burnished Babbitt bearings on the polished rotor shaft of SYNCHRON motors are permanently lubricated with Hansen's own silicon formula. Gear train plates are of bearing bronze and gears are subject to 100 per cent inspection.

Hansen's hardened steel rotor ring has patented separations to delineate residual magnetic fields — providing additional torque — and the rotor moves between paired shaded inner and outer fields.

SYNCHRON motors and gear trains are available in 179 speeds at 8, 20, or 30 inch ounce torques rated at 1 RPM; a full range of voltages at 25, 50, or 60 cycles. Inquire today for full information.

MAXIMUM SPACE REQUIREMENTS
Round Mount — 2" diameter, 1 3/8" deep
Pear Shape — 2" wide, 2 1/2" high, 1 21/32" deep

OUTPUT DRIVES
Pinion drives, flatted, threaded, cross-drilled, knurled, or slotted shafts; adapters, or crank assemblies. OR HANSEN WILL INTEGRATE PINIONS, GEARS, OR SPECIAL DRIVE ASSEMBLIES OF YOUR OWN MANUFACTURE.

Sweet's Product Design File

Information on D.C. motors available on request.

HANSEN MANUFACTURING COMPANY, INC.
PRINCETON, INDIANA

HANSEN REPRESENTATIVES:
R. S. HOPKINS COMPANY
Sherman Oaks, Calif.
EICHORN & MELCHIOR, INC.
San Carlos, Calif.
THE FROMM COMPANY, Chicago, Ill.
H. C. JOHNSON AGENCY, INC.
Fayetteville, N.Y., Rochester, N.Y., Schenectady, N.Y., Williamsville, N.Y.
WINSLOW ELECTRIC COMPANY
Essex, Connenticut, New York City, Philadelphia, Pa.
EXPORT DEPARTMENT
64-14 Woodside Ave., Woodside, N.Y. 11377

Handled exclusively in Canada by Sperry Gyroscope Ottawa Ltd., Ottawa, Canada

CIRCLE 226 ON READER SERVICE CARD

LITERATURE OF THE WEEK

TRIMMER POTENTIOMETER TEST REPORT Mechatrol, a division of Servomechanisms/Inc., 1200 Prospect Ave., Westbury, L. I., N. Y., has available a 4-page test report for its ¼ in. Mechatrim type HT 250-2 miniature trimmer potentiometer.
CIRCLE **370,** READER SERVICE CARD

TUNNEL DIODES Micro State Electronics Corp., 152 Floral Ave., Murray Hill, N.J., offers a data sheet on its new series of gallium arsenide and germanium tunnel diodes. **(371)**

ROTARY PRECISION COMMUTATORS Computer Instruments Corp., 92 Madison Ave., Hempstead, L.I., N.Y. A 12-page catalog is devoted to rotary commutators that feature precious metal flush contacts and multiple fingered wipers in precision assemblies. **(372)**

DIGITAL MAGNETICS Di/An Controls, Inc., 944 Dorchester Ave., Boston 25, Mass. Brochure entitled "Digital Magnetics" highlights the past, present and future of magnetic techniques as they relate to commercial, military and aerospace equipment requirements. **(373)**

LOW PRESSURE TRANSDUCERS Taber Instrument Corp., 107 Goundry St., North Tonawanda, N.Y. Bulletin P-63254 lists low pressure transducers with overload protection. **(374)**

DIGITAL TEMPERATURE SYSTEM Riverbank Laboratories, P. O. Box 65, Geneva, Ill., 60134. Bulletin TSU-1 describes 100-percent digital probe and counter for precise temperature measurement between −50 C and +125 C. **(375)**

MEGOHMMETER Herman H. Sticht Co., Inc., 27 Park Place, New York 7, N.Y. Bulletin introduces model 29U Twenty Million Megohmmeter, an instrument designed to measure very high resistances, with direct reading scales, without any calculations. **(376)**

TRANSDUCER INSTRUMENTATION SYSTEMS Gilmore Industries, Inc., 3355 Richmond Road, Cleveland, O. Bulletin describes transducer instrumentation systems for measuring thrust, weight, force, pressure and flow. **(377)**

PISTON TRIMMER CAPACITORS Voltronics Corp., 296 Route 10, Hanover, N.J. Catalog No. 123 covering standard glass dielectric styles and a MIL-C-14409B specification summary are available. **(378)**

FIELD-EFFECT TRANSISTORS Siliconix Inc., 1140 West Evelyn Ave., Sunnyvale, Calif., has published a 2,000,000 unit-hour reliability report on four representative field-effect transistors. **(379)**

SILICON RECTIFIERS Edal Industries, Inc., 4 Short Beach Road, East Haven 12, Conn. Bulletin 104 gives full operating characteristics applicable to a line of miniature, flangeless silicon rectifiers. **(380)**

SAMPLE AND HOLD AMPLIFIER Adage Inc., 292 Main St., Cambridge 42, Mass. Technical data bulletin describes the new sample and hold amplifier, model SA3. **(381)**

DECADE POTENTIOMETERS ESI/Electro Scientific Industries, 13900 NW Science Park Drive, Portland, Ore. 97229. Catalog sheet C-50 describes a line of Dekapot precision resistive decade voltage dividers. **(382)**

DVM CALIBRATION Cohu Electronics, Inc., KinTel Division, 5725 Kearny Villa Road, San Diego 12, Calif. Calibration of production line digital voltmeters through company standards laboratories by a d-c voltage standard is the subject of technical application bulletin 5-15. **(383)**

COMMERCIAL COOLING FAN Rotron Mfg. Co., Inc., Woodstock, N. Y. Designed for commercial electronic cooling applications, the Sentinel fan described in bulletin E-2810 is rugged, low in cost, and delivers up to 100 cfm of air at free delivery. **(384)**

SOLDERS AND COATINGS Epoxy Products Inc., division of Joseph Waldman & Sons, 133 Coit St., Irvington, N. J. 07111. Six-page information bulletin on epoxy silver solders and conductive coatings is available. **(385)**

ANALOG MULTIPLIER American Aerospace Controls, Inc., 123 Milbar Blvd., Farmingdale, N. Y. Product data bulletin 0164 describes performance characteristics and application notes on a new solid-state analog multiplier, MistoR model MMA-3001. **(386)**

ADVANCED NUCLEAR SYSTEMS Hamner Electronics Co., Inc., P. O. Box 531, Princeton, N. J. Nuclear systems incorporating the Moduflex line of all-solid-state instrument modules are described in a new brochure. **(387)**

C-W GAS LASER Watkins-Johnson Co., 3333 Hillview Ave., Stanford Industrial Park, Palo Alto, Calif. Technical bulletin covers the WJ-291 helium-neon d-c pumped gas laser with integral regulated power supply. **(388)**

SYSTEMS BUILDING BLOCKS Scientific Data Systems, 1649 Seventeenth St., Santa Monica, Calif. Catalog describes a complete line of compatible systems building blocks, which includes general purpose digital computers, all-silicon logic circuit modules, amplifiers, multiplexers, A/D and D/A converters, and computer-controlled systems. **(389)**

MEMORY DRUM Litton Industries, Guidance and Control Systems Division, 5500 Canoga Ave., Woodland Hills, Calif., has published a descriptive brochure on the SD-1000 memory drum with large storage capacity. **(390)**

TIMING DEVICES E. W. Bliss Co., Eagle Signal division, 736 Federal St., Davenport, Iowa, offers a bulletin entitled "Electronic Timing Devices for Military and Aerospace Programs." **(391)**

INTEGRATED SYSTEMS COMPONENTS Data Tech, Inc., 238 Main St., Cambridge, Mass., offers a brochure detailing its complete line of shaft encoders, bidirectional counters and rotary transformers. **(392)**

M. H. Kebby

E. F. Tuck

A. R. Meier

Californians Form New Company

A NEW communications equipment manufacturing company has been formed in San Carlos, Calif., by three former employees of Lenkurt Electric Co. The new firm, known as the Kebby Microwave Corp., will engage in the design and manufacture of microwave and other communications equipment for telephone companies, railroads, electric utilities, pipelines and other industrial users of communications.

Maurice H. Kebby, president of the new organization, was chief engineer for commercial products at Lenkurt, and more recently was manager of a special microwave project under which were produced the type 76 microwave systems.

Edward F. Tuck, vice president, was an engineer with Lenkurt for seven years, working on many carrier and microwave projects. He served with Kebby on the 76 Microwave Project as production manager and later supervised the engineering development of new, high-capacity microwave equipment, as microwave development manager.

Albin R. Meier, marketing manager for the new company, served with Lenkurt for five years as technical promotion manager.

According to Kebby, special emphasis will be placed on developing equipment for commercial systems in preference to military. First efforts of the new company will be directed toward developing high-performance radio equipment that will substantially reduce the cost of microwave repeaters.

Connors Accepts Motorola Post

THOMAS J. CONNORS has accepted the position of vice president and general manager, Motorola Semiconductor Products, Inc., subsidary of Motorola, Inc. He has also been named manager, marketing, Semiconductor Products division.

Connors, formerly with Texas Instruments, replaces R. H. Rudolph, who resigned to take the position of president and director of Glass-Tite Industries, Inc., Providence, R. I., producer of semiconductor packages and other electronic components.

Roanwell Announces Plant Expansion

Roanwell Corporation, New York City, has expanded its floor space by 20,000 square feet, This represents the company's third expansion since it was founded in 1948, and brings total operating space to 76,000 square feet. The latest addition will be used by the firm's Elcom department.

Roanwell designs, develops and manufactures high-quality communications equipment for use in the voice communication field. Its products are widely used throughout the naval, military and aerospace fields. The firm's Elcom department manufactures a line of precision piston trimmer capacitors used in sophisticated equipment.

The company also owns and operates Teltronics, Inc., Nashua, N. H., manufacturer of laboratory test equipment.

Vaughan Moves Up to Chief Engineer

APPOINTMENT of A. J. Vaughan as chief engineer of the Radio Corp. of America's Astro-Electronics division, Princeton, N.J., has been announced. This division built the Tiros series of weather satellites, the Relay communications satellites, and other space systems.

Vaughan was formerly a member of the division's engineering technical advisory staff.

L. W. Howard Joins Dressen-Barnes

LEWIS W. HOWARD, former vice president of Litton Industries, and former president of Triad Transformer Corp., has been retained as a consultant to Dressen-Barnes Electronics Corp., Pasadena, Calif.

Howard will act as a special assistant to Louis M. Purcell, president, in developing a program of growth for the company. Present planning is for external expansion by acquisition and for internal growth by development of new products and expansion of sales.

Dressen-Barnes designs and manufactures d-c power supplies.

PEOPLE IN BRIEF

R. J. McGeehan elevated to president and chief exec officer of Entron, Inc. **William M. Lynch** promoted by GE to g-m of the Radio Receiver dept. **Charles Hill,** formerly with Ampex Computer Products, appointed mgr. of computer systems at Computer Control Co.'s Western div. **Jules Lehman,** previously with RCA, joins Electro-Optical Systems as mgr. of the Payloads and Imaging Systems Group. **Ronald E. Frohman** advances to g-m of Telemetal Products Inc., subsidiary of Polarad Electronics Corp. **James Nicol,** research director, elected v-p, research, for Cryonetics Corp. **Derrill M. Unruh** raised to supervisor of inspection services for quality control at Electra Mfg. Co. **William R. Hoover** leaves Cal Tech's Jet Propulsion Laboratory to become mgr. of the L.A. div. of Computer Sciences Corp. **H. H. Koppel** promoted to mgr. of electrical product engineering at Bailey Meter Co. **Maurice Nelles,** formerly with Borg-Warner Corp., named mgr. of mfg. R&D for the Aerospace div. of the Westinghouse Defense and Space Center. **Wayne E. Phillips,** from Beckman Instruments to Varian Associates as mgr. of engineering for the Vacuum Products div. **G. F. Fryling** moves up to chief exec officer of Erie Technological Products, replacing **Marion E. Pettegrew** who resigned as president and continues as a director. **Philip G. Cobb** advances to mgr. of Vamistor engineering of Weston Instruments and Electronics div., Daystrom, Inc. **William B. Allen,** ex-Hughes Aircraft Co., appointed mgr. of engineering at Ampex Corp.'s video and instrumentation div.

EMPLOYMENT **electronics** OPPORTUNITIES

WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

ATTENTION: ENGINEERS, SCIENTISTS, PHYSICISTS

This Qualification Form is designed to help you advance in the electronics industry. It is unique and compact. Designed with the assistance of professional personnel management, it isolates specific experience in electronics and deals only in essential background information.

The advertisers listed here are seeking professional experience. Fill in the Qualification Form below.

STRICTLY CONFIDENTIAL

Your Qualification form will be handled as "Strictly Confidential" by ELECTRONICS. Our processing system is such that your form will be forwarded within 24 hours to the proper executives in the companies you select. You will be contacted at your home by the interested companies.

WHAT TO DO

1. Review the positions in the advertisements.
2. Select those for which you qualify.
3. Notice the key numbers.
4. Circle the corresponding key number below the Qualification Form.
5. Fill out the form completely. *Please print clearly.*
6. Mail to: Classified Advertising Div., ELECTRONICS, Box 12, New York, N. Y. 10036.

COMPANY	SEE PAGE	KEY #
ASSEMBLY PRODUCTS Chesterland, Ohio	133	1
ATOMIC PERSONNEL, INC. Phila., Pa.	133	2
DELCO RADIO Div. of General Motors Corp. Kokomo, Ind.	25*	3
LINK GROUP Div. of General Precision Inc. Binghamton, New York	71*	4
NATIONAL CASH REGISTER CO. Hawthorne, Calif.	134	5
GUIDED MISSILES RANGE Div. of Pan American Worlds Airways Inc. Patrick AFB, Fla.	134	6
SYLVANIA ELECTRONIC SYSTEMS WEST Mountain View, Calif.	112-113	7
P-3865	133	8

* These advertisements appeared in the March 6th Issue.

(cut here) (cut here)

electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

(Please type or print clearly. Necessary for reproduction.)

Personal Background

NAME ....

HOME ADDRESS ....

CITY ........................ZONE.......STATE..............

HOME TELEPHONE ....

Education

PROFESSIONAL DEGREE(S) ....

MAJOR(S) ....

UNIVERSITY ....

DATE(S) ....

FIELDS OF EXPERIENCE (Please Check)

31364

- ☐ Aerospace
- ☐ Antennas
- ☐ ASW
- ☐ Circuits
- ☐ Communications
- ☐ Components
- ☐ Computers
- ☐ ECM
- ☐ Electron Tubes
- ☐ Engineering Writing
- ☐ Fire Control
- ☐ Human Factors
- ☐ Infrared
- ☐ Instrumentation
- ☐ Medicine
- ☐ Microwave
- ☐ Navigation
- ☐ Operations Research
- ☐ Optics
- ☐ Packaging
- ☐ Radar
- ☐ Radio—TV
- ☐ Simulators
- ☐ Solid State
- ☐ Telemetry
- ☐ Transformers
- ☐ Other ....
- ☐ ....
- ☐ ....
- ☐ ....

CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

	Technical Experience (Months)	Supervisory Experience (Months)
RESEARCH (pure, fundamental, basic)	....	....
RESEARCH (Applied)	....	....
SYSTEMS (New Concepts)	....	....
DEVELOPMENT (Model)	....	....
DESIGN (Product)	....	....
MANUFACTURING (Product)	....	....
FIELD (Service)	....	....
SALES (Proposals & Products)	....	....

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

*ADDRESS BOX NO. REPLIES TO: Box No.
Classified Adv. Div. of this publication.
Send to office nearest you.
NEW YORK, N. Y. 10036: P. O. Box 12
CHICAGO, Ill. 60611: 645 N. Michigan Ave.
SAN FRANCISCO, Cal. 94111: 255 California St.*

POSITION VACANT

Electronic and Electro/Mechanical Technicians, designers, checkers, draftsmen and detailers—Work for leading firm of licensed professional Engineers. Write to United Engineers, 150 Causeway Street, Boston 14, Mass.

ELECTRONIC ENGINEER

Diversified experience—Manufacturer of ultra-high precision electronic equipment offers hi-salaried growth job to expert producer of electronic circuits, instrument designs, and hardware. Must be extraordinarily capable of initiating and completing new projects. We're looking for someone at the top of his class, who is fast-moving, well-motivated and ambitious. Mid-Manhattan location.

P-3865, Electronics
Class. Adv. Div. P. O. Box 12, NY, NY 10036

E. E.'s
for FEE-PAID Positions
WRITE US FIRST!
Use our confidential application for professional, individualized service . . . a complete national technical employment agency.
ATOMIC PERSONNEL, INC.
Suite 1207L, 1518 Walnut St., Phila. 2, Pa.

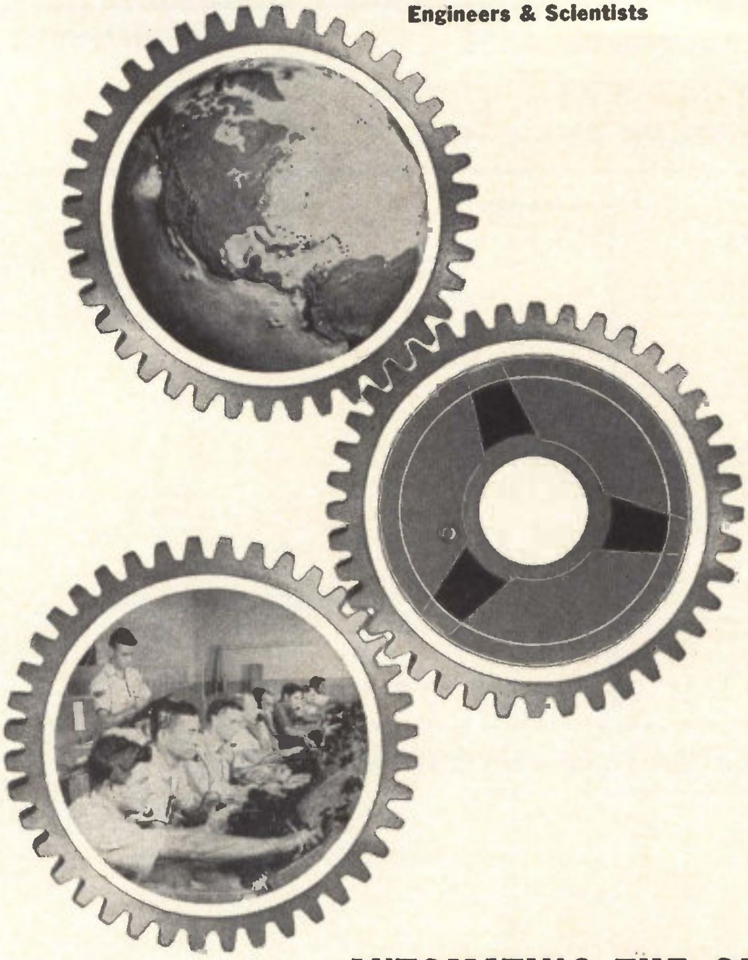
LIVEWIRE ENGINEER

Needed for small, transducer system development and application group in rapidly growing activity within a moderate size growth company. Unusual flexibility required in a position with excellent technical and financial future. Desired man probably is an E. E., experienced with both industrial electronic instrumentation AND cold finishing operations of steel sheet mills. Personality must be suitable for both customer relations and development lab. Travel up to 50% of the time, but usually home (Cleveland area) weekends.

Air mail resume, including home phone number, references, availability and salary requirements, in first communication to R. Petruschke,

ASSEMBLY PRODUCTS, INC.
Chesterland, Ohio

Engineers & Scientists



AUTOMATING THE GLOBAL RANGE CONTROL NETWORK

A new dimension in fast-response control and global reporting of space vehicle and missile performance is now being engineered by Pan Am's Guided Missiles Range Division.

A centralized range instrumentation control system (RICS) will automate range support on the Atlantic Missile Range and link with other national ranges on a world-wide basis. Basic to this new system will be the Central Control Processor at Cape Kennedy. This master computer will accept data from all land, air and shipborne stations down-range—and eventually from communications satellites (now in the planning stage). It will provide real-time separation and recording of data, and process necessary information and commands.

In its full scope, RICS offers the master "space traffic" management capability needed to maximize the success of range support for complex space missions in the near future: orbital rendezvous and docking, lunar orbits, manned lunar flights, and interplanetary probes. The system will give push-button control of instrumentation, communications, assignment, status, data selection for real-time biomedical evaluation and range safety and post-flight analysis, security code changing, function transfer, and vehicle control to alter in-flight missions.

On this and other sophisticated space programs, assignments are immediately available to electronic engineers and physicists with broad systems and planning backgrounds in: pulse & CW radar/telemetry/optics/infrared/data handling/communications/closed circuit TV/frequency analysis/command control/underwater sound/timing/shipboard instrumentation/meteorology.

Write in confidence to Manager—Professional Employment, Dept. 28C-2

PAN AM

GUIDED MISSILES RANGE DIVISION

PAN AMERICAN WORLD AIRWAYS, INC.
P. O. BOX 4465, PATRICK AIR FORCE BASE, FLORIDA

An Equal Opportunity Employer

DIGITAL SYSTEMS ENGINEERS

Step into worldwide business automation with NCR, Los Angeles

At NCR, you can make original contributions in the most advanced areas of digital technology, creating business systems for use in 120 countries. You can step into a life where independent, searching minds find greater nourishment and reward—where there is no compromise between career values and living values.

Why not take that step now?

SYSTEMS ANALYSIS ENGINEERING

Programming and analysis of business and industrial electronic data processing systems with real-time applications involving communications network.

ADVANCED MECHANISMS DESIGN

Position will entail analysis and advanced design of complex mechanisms and applied mechanics problems. Ph.D. preferred with applicable experience. Should be equally skilled in mathematical analysis and laboratory measurements.

ADVANCED ELECTRONIC MEMORY DESIGN

Job entails design of word-select memories and memory circuits. Requires BSEE, MSEE desired, and at least three years' experience in the above-mentioned field.

RANDOM-ACCESS MEMORY DESIGN

Senior position open in development of high-speed random-access mechanisms and general random-access equipment. Requires BSEE with at least four years' applicable experience.

SYSTEMS/COMMUNICATIONS DESIGN

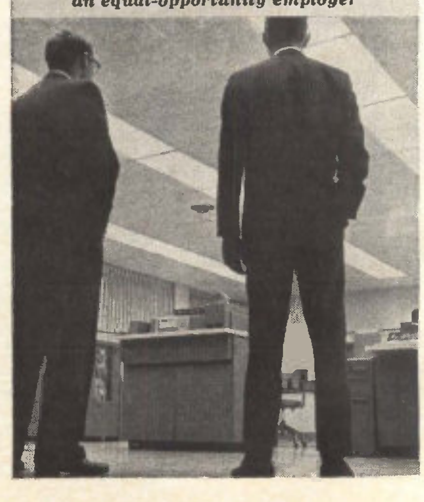
This senior position will involve analysis and advanced design of on-line, real-time systems. Requires BSEE, MSEE desired, with some applications experience necessary.

INTERVIEWS AT IEEE CONVENTION, NEW YORK CITY, MARCH 23-26

For an appointment, please send a resume, including training, experience and salary history, to Bill Holloway, Personnel Department, or phone collect.

NCR

The National Cash Register Company
ELECTRONICS DIVISION
2815 W. El Segundo Blvd., Hawthorne, Calif.
Telephone: Area Code 213-757-5111
an equal-opportunity employer



AUTOTRACK ANTENNA MOUNT

TYPE SCR 584, MP 61B
360 degree azimuth, 210 degree elevation sweep with better than 1 mil. accuracy. Missile velocity acceleration and slewing rates. Amplidyne and servo control. Will handle up to 20 ft. dish. Supplied complete with control chassis. In stock—immediate delivery. Used world over by NASA, ABMA, USAF.

SCR 584 RADARS AUTOMATIC TRACKING 3 CM & 10 CM
Our 584s in like new condition, ready to go, and in stock for immediate delivery. Ideal for telemetry research and development, missile tracking, satellite tracking, balloon tracking, weather forecasting, antiaircraft defense defense tactical air support. Used on Atlantic Missile Range, Pacific Missile Range, N.A.S.A. Wallops Island, A.B.M.A. Desc. MIT Rad. Lab. Compl. inst. bk. available $25.00 ea. Series, Vol. 1, pps. 207-210, 228, 284-286.

PULSE MODULATORS

MIT MODEL 9 PULSER
1 MEGAWATT—HARD TUBE
Output 25 kv 40 amp. Duty cycle, .002. Pulse lengths .25 to 2 mcirosec. Also .5 to 5 microsec. and .1 to .5 msec. Uses 6C21. Input 115v 60 cycle AC. Mfr. GE. Complete with driver and high voltage power supply. Ref: MIT Rad. Lab. Series Vol. 5 pps. 152-160.

500KW THYRATRON PULSER
Output 22kv at 28 amp. Rep. rates: 2.25 microsec. 300 pps, 1.75 msec 550 pps, .4 msec 2500 pps. Uses 5C22 hydrogen thyratron. Complete with driver and high voltage power supply. Input 115v 60 cy AC.

2 MEGAWATT PULSER
Output 30 kv at 70 amp. Duty cycle .001. Rep rates: 1 microsec 600 pps, 1 or 2 msec 300 pps. Uses 5948 hydrogen thyratron. Input 120/208 VAC 60 cycle. Mfr. GE. Complete with high voltage power supply.

15KW PULSER—DRIVER
Biased multivibrator type pulse generator using 3E29. Output 3kv at 5 amp. Pulse lgths .5 to 5 microsec, easily adj. to .1 to .5 msec. Input 115v 60 cy AC. $475. Ref: MIT Rad. Lab. Series Vol. 5 pps. 157.

MIT MODEL 3 PULSER
Output: 144 kw (12 kv at 12 amp.) Duty ratio: 001 max. Pulse duration: 5.1 and 2 microsec. Input: 115 v 400 to 2000 cps and 24 vdc. $325 ea. Full desc. Vol. 5 MIT Rad. Lab. series pg. 140.

MICROWAVE SYSTEMS

NIKE MISSILE GUIDANCE SYSTEM
Complete electronic guidance section of Nike missile including: control amplifier, steering amplifier, roll amplifier, R.F. transmitter, Pitch & Yaw accelerometers, beacon, modulator, video amplifier, steering order demodulator, magnetron #RK6229, gyro unit, pressure transmitter, roll amount gyro, roll rate gyro, yaw rate gyro, pitch rate gyro.

300 TO 2400MC RF PKG.
300 to 2400MC CW. Tuneable. Transmitter 10 to 30 Watts. Output. As new $475.

X BAND DOPPLER SYSTEM
AN/APN-102 G.P.L. ANT/RCYR/XMTR PKG. 4 Beam Pulsed Janus Planar Array—New $1600.

AN/TPS-ID RADAR
500 kw 1220-1359 mcs. 160 nautical mile search range P.P.I. and A Scopes. MTI. thyratron mod. 5J26 magnetron. Complete system.

10 CM. WEATHER RADAR SYSTEM
Raytheon, 275 KW output S Band. Rotating yoke P.P.I. Weather Band. 4, 20 and 80 mile range. 360 degree azimuth scan. Supplied brand new complete with instruction books and installation drawings. Price $975 complete.

AN/APS-15B 3 CM RADAR
Airborne radar. 40 kw output using 725A magnetron. Model 3 pulser. 30-in. parabola stabilized antenna. PPI scope. Complete system. $1200 each. New.

10KW 3 CM. X BAND RADAR
Complete RF head including transmitter, receiver, modulator. Uses 2J42 magnetron. Fully described in MIT Rad. Lab. Series Vol. I, pps 616-625 and Vol. II, pps. 171-185 $375. Complete System. $750.

AN/APS-27 X BAND RADAR
Complete 100 kw output airborne system with AMTI. 5C22 thyr. mod, 4J52 magnetron. PPI, 360 deg az sweep, 60 deg. elev. sweep, gyro stabilizer, hi-gain rcvr. Complete with all plugs and cables $2800.

M-33 AUTO-TRACK RADAR SYSTEM
X band with plotting board, automatic range tracking, etc. Complete in 2 van complex incl. 1 megawatt acquisition radar.

AN/APS-45 HEIGHT FINDER
Airborne system, 40,000 ft. altitude display on PPI & RHI. 9375 mcs. 400kw output using QK-172 megatron, 5622 thyratron.

L BAND RF PKG.
20 KW peak 990 to 1040 MC. Pulse width .7 to 1.2 microsec. Rep rate 180 to 420 pps. Input 115 vac. Incl. Receiver $1200.

200MC RF PKG
175 to 225 mc. Output: 200 to 225 kw. 5 microsec 60 pps. Input: 115v 60 cycle AC. $750.

Radio-Research Instrument Co.
550 5th Ave. New York 36, N Y
Tel. JUdson 6-4691

CIRCLE 962 ON READER SERVICE CARD

STEPPING SWITCHES · SIGMA · HERMETICALLY SEALED · KURMAN · SENSITROLS · WARD LEONARD · STRUTHERS DUNN · AUTOMATIC ELECTRIC · ROTARY RACHET · LEACH · CLARE · ALLIED · LEDEX · CLARE · LEACH · MINIA · SIGMA · NORTH ELECTRIC · DORMEYER · TELEPHONE TYPE · KURMAN · STEVENS ARNOLD · CONTACT MERCURY · SOLENOIDS · ADVANCE · ALLEN BRADLEY · POTTER BRUMFIELD · EVENS · NOLD · ANCE · LLIED · CRAFT · LEDEX · KEYING · PHILLIPS CONTROLS · AMPERITE · WESTERN ELECTRIC · CUTLER HAMMER · GENERAL ELECTRIC · GUARDIAN · CONTACTORS · PRICE ELECTRIC · SQUARE D · WESTON · MINIATURE AIRCRAFT

LARGEST STOCK OF RELAYS IN THE WORLD

PRODUCTION QUANTITIES
MOST MAKES IN STOCK
Send for Latest Catalog E

Universal RELAY CORP.
42 WHITE ST. NEW YORK 13, N. Y. WAlker 5-6900

CIRCLE 963 ON READER SERVICE CARD

The Battery That's Used in Guided Missiles Now Released as Government Surplus

For Photography, Aircraft, Models, Searchlights, Radios, etc. .95 ea. Sintered-plate Nickel-Cadmium alkaline storage batteries designed for "NIKE" Missile and now surplus due to design change. A lifetime battery with no known limit of service (over 5000 recharges on test without loss of capacity). Other features: Virtually indestructible, compact & lightweight, withstands heavy shock and vibration. Flat voltage curve during discharge retains charge year or more, high discharge rate up to 50 amps. for this cell, no corrosive fumes to harm clothing or equipment, spill-proof construction, discharge in any position, indefinite storage without deterioration, operates in temperatures 60° F to +200° F. Each cell is approx. 6 ampere hour capacity. Nominal voltage per cell is 1.2 volts. (A 6 V. battery requires 5 cells.) Cell size 6" H. x 2" W. x ½" T. Wt. 6 oz. ea. Uses potassium-Hydroxide (30%) electrolyte. Negligible loss during lifetime service. Add only distilled water once a year. A fraction of Government cost.

Used Cells (As Rec. From Gvnmt.) .... .95 ea.
Brand New Cells .... $2.49 ea.
6AH Cells Size 4" x 2 3/16" x 15/16" New..$4.95 ea.

All cells guaranteed to your satisfaction or money refunded (less postage).

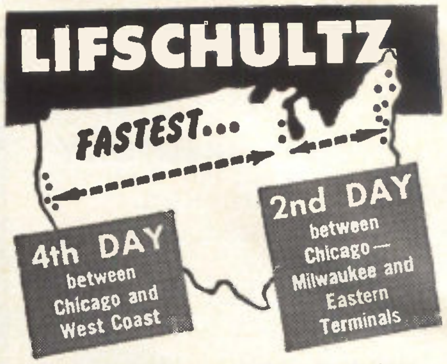
ESSE RADIO COMPANY, Dept. 3-B
42 W. South St. Indianapolis 25, Indiana

CIRCLE 964 ON READER SERVICE CARD

LM-18 Frequency Meter, 125 KC to 20 MC with Modulation, rectifier power unit 117 V 60 cy, shock mounts, cables, operating manual crystal & calibration book. Brand new $135.00
BC-221 Frequency Meter 125 KC to 20 MC in TS 164/AR compact metal case (no battery compartment) with shock mount crystal & original calibration book. Excellent Condition $69.50
Standard Lab Receiver APR-4Y
AM & FM W/3 tuning units 38-1000 MC..$199.50
W/4 tuning units 38-2200 MC xclnt cond. $314.50
TS-726/UPM-8 Radar Transponder Test Set 10007.5 to 112.6MC 115V 50-1000 cy Used Good..$39.50
TS-726/UP "x" Band Radar Test Set 9,285 to 9465 MC FM Field unit 115V 50-1200 cy Good $24.95
TS-226 A/AP Power Meter. Peak power to 1KW 405-425 MC 117V 40-2400 Cy Like New...$9.95
Write for Bulletin #39—Loads of Bargains

R W ELECTRONICS, INC.
2430 So. Michigan Avenue
Chicago, Ill. 60616
Calumet 5-1281

CIRCLE 965 ON READER SERVICE CARD



Specialists in Shipment of Electronics Products

LIFSCHULTZ FAST FREIGHT
NEW YORK — CHICAGO — PHILADELPHIA — BOSTON
HOLYOKE — BALTIMORE — BLOOMFIELD, N. J.
NEW HAVEN — PROVIDENCE — MILWAUKEE
LOS ANGELES — SAN FRANCISCO

CIRCLE 966 ON READER SERVICE CARD

SMALL AD but BIG STOCK
of choice test equipment and surplus electronics
Higher Quality—Lower Costs
Get our advice on your problem
ENGINEERING ASSOCIATES
434 Patterson Road — Dayton 19, Ohio

CIRCLE 967 ON READER SERVICE CARD

FREE Catalog
OF THE WORLD'S FINEST ELECTRONIC GOV'T SURPLUS BARGAINS

HUNDREDS OF TOP QUALITY ITEMS — Receivers, Transmitters, Microphones, Inverters, Power Supplies, Meters, Phones, Antennas, Indicators, Filters, Transformers, Amplifiers, Headsets, Converters, Control Boxes, Dynamotors, Test Equipment, Motors, Blowers, Cable, Keyers, Chokes, Handsets, Switches, etc., etc. Send for Free Catalog—Dept. E-4.

FAIR RADIO SALES
2133 ELIDA RD. • Box 1105 • LIMA, OHIO

CIRCLE 968 ON READER SERVICE CARD

VISIT THE
★ HEADQUARTERS ★
FOR IBM COMPUTER SURPLUS
AND OTHER ELECTRONIC EQUIPMENT
• OPEN EVENINGS DURING SHOW •
ASCO ALLOYS & METALS CORP.
345 CANAL ST., NEW YORK 13, N. Y.
(212) CO 7-8728

CIRCLE 969 ON READER SERVICE CARD

ONE OF THE WORLD'S LARGEST SUPPLIERS OF ELECTRONIC TUBES, SEMICONDUCTORS & TEST EQUIPMENT
• PLEASE WRITE FOR CATALOG •
LIBERTY ELECTRONICS, INC.
582 BROADWAY NEW YORK, N. Y. 10012
PHONE 212-925-6000
CABLE TELERSUP NEW YORK

CIRCLE 970 ON READER SERVICE CARD

EIMAC
UNUSED JAN
304-TH

1- 9 Pcs.	$22.00
10-24 Pcs.	21.00
25-49 Pcs.	20.00
50 or more	18.00

CAP ELECTRONICS, INC.
83 Warren St. New York 7, N. Y.
Rector 2-8078

CIRCLE 150 ON READER SERVICE CARD

INDEX TO ADVERTISERS

■

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr. (2557)

CLASSIFIED ADVERTISERS INDEX

■

• See advertisement in the July 25, 1963 issue of electronics Buyers' Guide for complete line of products or services.

electronics

Audit Bureau of Circulation
Associated Business Publications
AUDITED PAID CIRCULATION

JAMES T. HAUPTLI (2210)
Advertising Sales Manager

HENRY M. SHAW (3485)
Market Research Manager

DAVID M. TEMPEST (3139)
Promotion Manager

electronics Buyers' Guide
R. S. QUINT (2335)
General Manager

RICHARD J. TOMLINSON (3191)
Business Manager

THEODORE R. GEIPEL (2044)
Production Manager

NEW YORK TELEPHONE: Dial Direct: 971 plus number in parenthesis, Area Code 212

ADVERTISING REPRESENTATIVES

ATLANTA, GA. 30309
G. Krimsier, Michael H. Miller
1375 Peachtree St. N.E.,
Trinity 5-0523 (area code 404)

BOSTON, MASS. 02116
William S. Hodgkinson
McGraw-Hill Building, Copley Square,
Congress 2-1160 (area code 617)

CHICAGO, ILL. 60611
Robert M. Denmead
Daniel E. Shea, Jr.
645 North Michigan Avenue,
Mohawk 4-5800 (area code 312)

CLEVELAND, OHIO 44113
Paul T. Fegley
55 Public Square,
Superior 1-7000 (area code 216)

DALLAS, TEXAS 75201
Frank Le Beau
The Vaughn Bldg.,
1712 Commerce St.
Riverside 7-9721 (area code 214)

DENVER, COLO. 80202
David M. Watson
Tower Bldg., 1700 Broadway,
Alpine 5-2981 (area code 303)

HOUSTON, TEXAS 77025
Kenneth George
Prudential Bldg., Halcombe Blvd.,
Riverside 8-1280 (area code 713)

LOS ANGELES, CALIF. 90017
Ashley P. Hartman, John G. Zisch,
1125 W. 6th St., Huntley 2-5450
(area code 213)

NEW YORK, N. Y. 10036
Donald R. Furth (212) 971 3616
Donald H. Miller (212) 971 3615
George F. Werner (212) 971 3617
500 Fifth Avenue

PHILADELPHIA, PA. 19103
William J. Boyle, Warren H. Gardner
6 Penn Center Plaza,
LOcust 8-6161 (area code 215)

SAN FRANCISCO, CALIF. 94111
Richard C. Alcorn
255 California Street,
Douglas 2-4600 (area code 415)

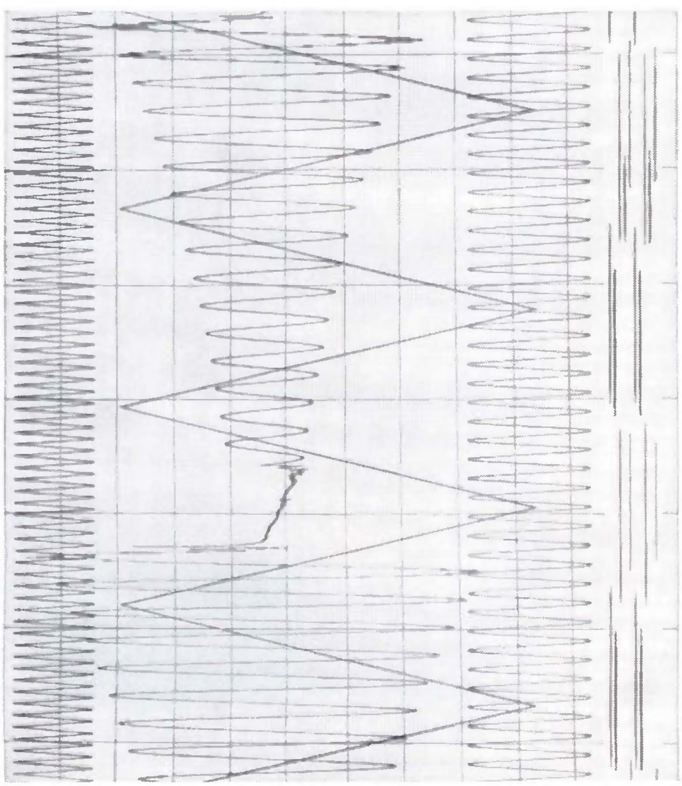
LONDON W1:
Edwin S. Murphy Jr.
34 Dover St.

FRANKFURT/Main:
Matthee Herfurth
85 Westendstrasse

GENEVA:
Michael R. Zeynel
2 Place du Port

TOKYO:
Shigeo Chiba,
1, Kotohiracho, Shiba, Minato-ku

In graphic recording nothing is as versatile as the Brush 2300



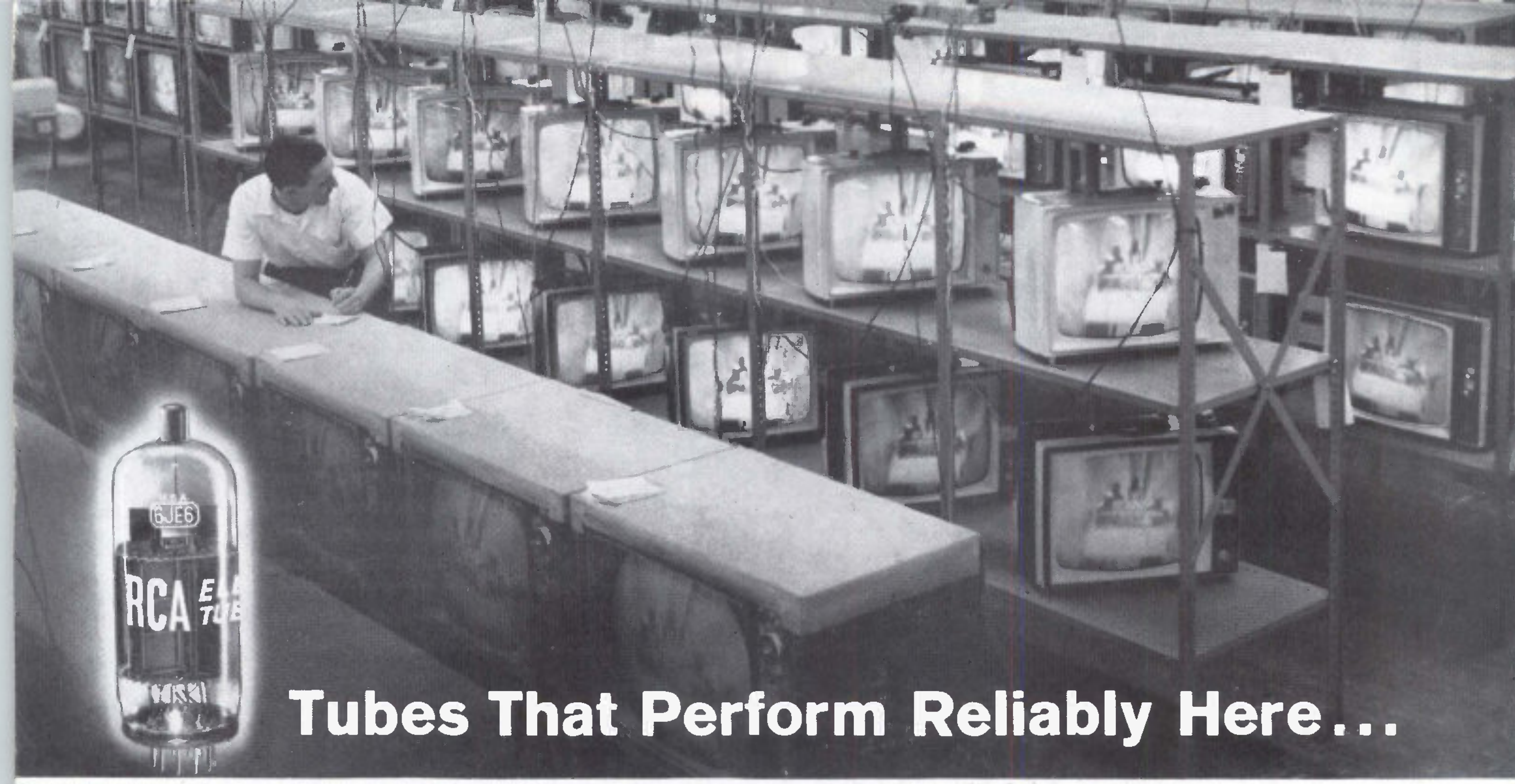
There's hardly a recording requirement that cannot be met by this new addition to the complete Brush line. Your application possibilities are almost unlimited . . . whether they're industrial or aero-space. Check out these facts.

1 to 16 Analog channels . . . or 120 event channels . . . or any combination of both
Meets MIL RFI Specs and Safety Codes
Writing Speeds . . . 0 to 30,000 in./sec.
Start and Restart time . . . 50 milliseconds
Inputs from microvolts to kilovolts
Choice of Galvanometers and Amplifiers
Internal chart take-up
Full remote control

Add to this a low cost-per-channel and you'll understand why we believe the Brush 2300 satisfies the widest range of requirements in graphic recording today.

brush INSTRUMENTS
DIVISION OF CLEVITE 37TH AND PERKINS, CLEVELAND 14, OHIO

CIRCLE 901 ON READER SERVICE CARD



At top, you're looking into the RCA Receiving Tube Reliability Laboratory—a most important factor behind the exceptional reliability of RCA receiving tubes. This Lab is one more reason why you can confidently fill all your sockets with RCA receiving tubes; one more plus-value that you have in RCA tubes.

Here in two-hundred TV sets of all sizes—black-and-white and color—samples of each week's production of RCA receiving tubes are subjected to extensive tests under actual field conditions. The operating conditions for the TV sets vary from low-line to high-line voltages. And the sets are regularly cycled on and off to check the effects of heating and cooling on the tubes.

The Tube Reliability Laboratory reveals—and allows us to eliminate—problems that do not show up under normal production life testing. It also permits us to conduct pre-production tests of new tube designs to make certain that the RCA standards of quality will be fulfilled before the new tubes are marketed.

Testing in the Tube Reliability Laboratory enables us to verify the consistent high quality of RCA receiving tubes—to maintain uniformity of characteristics from tube to tube and throughout life. It is another example of the care we take to assure that RCA receiving tubes give RELIABLE PERFORMANCE where it really counts—in your customers' sets.

RCA ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

RCA DISTRICT OFFICES—EAST: 32 Green St., Newark 2, N. J., (201) 485-3900 • MID-ATLANTIC: 605 Marlton Pike, Haddonfield, N.J., (609) 428-4802 • MID-CENTRAL: 2132 E. 52nd St., Indianapolis 5, Ind., (317) 251-1405 • CENTRAL: 1154 Merchandise Mart Plaza, Chicago 54, Ill., (312) 527-2900 • WEST: 6801 E. Washington Blvd., Los Angeles 22, Calif., (213) RA 3-8361

The Most Trusted Name in Electronics