Electronics®

January 8, 1968
$1.00
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Below: Defense procurement gives biggest thrust to 1968 sales, page 105

1968

A year of doubt

UTC®

PIONEERS IN MINIATURIZATION

MINIDUCTOR™

SUBMINITURE HIGH Q INDUCTORS

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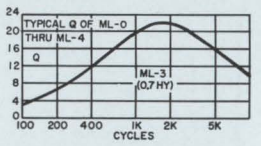

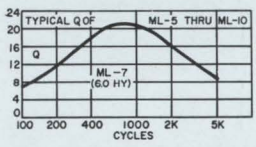

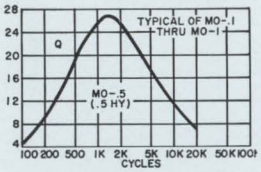

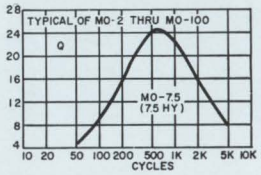

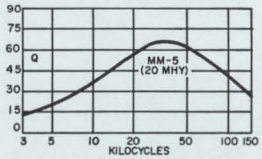

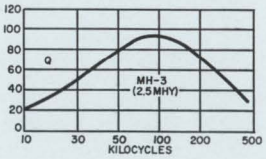

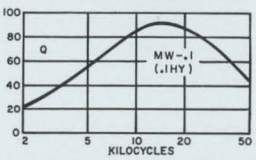

ML CASE

MO CASE

MM, MH CASE

MW CASE

Specifications depicted are nominal

ML—Hipermally cased inductors with epoxy board. Inductance range .15 to 60 hy. Adjusted to a tolerance of ± 3%. 7/16 x 31/64 x 9/16" h; wt. .2 oz.

MO—Molded inductors. Inductance range .1 to 100 hy. Adjusted to a tolerance of ± 2%. 3/4 x 1-1/16 x 13/16" h; wt. 1 oz.

MM—Molded toroidal inductors. Inductance range 3 to 120 mhy. Adjusted to a tolerance of ± 2%. 7/16 dia x 1/4" h; wt. .07 oz.

MH—Molded toroidal inductors similar to MM. Inductance range .6 to 40 mhy.

MW—Molded toroidal inductors. Inductance range .05 to 5 hy. Adjusted to a tolerance of ± 1%. 23/32 dia x 13/32" h; wt. .25 oz.

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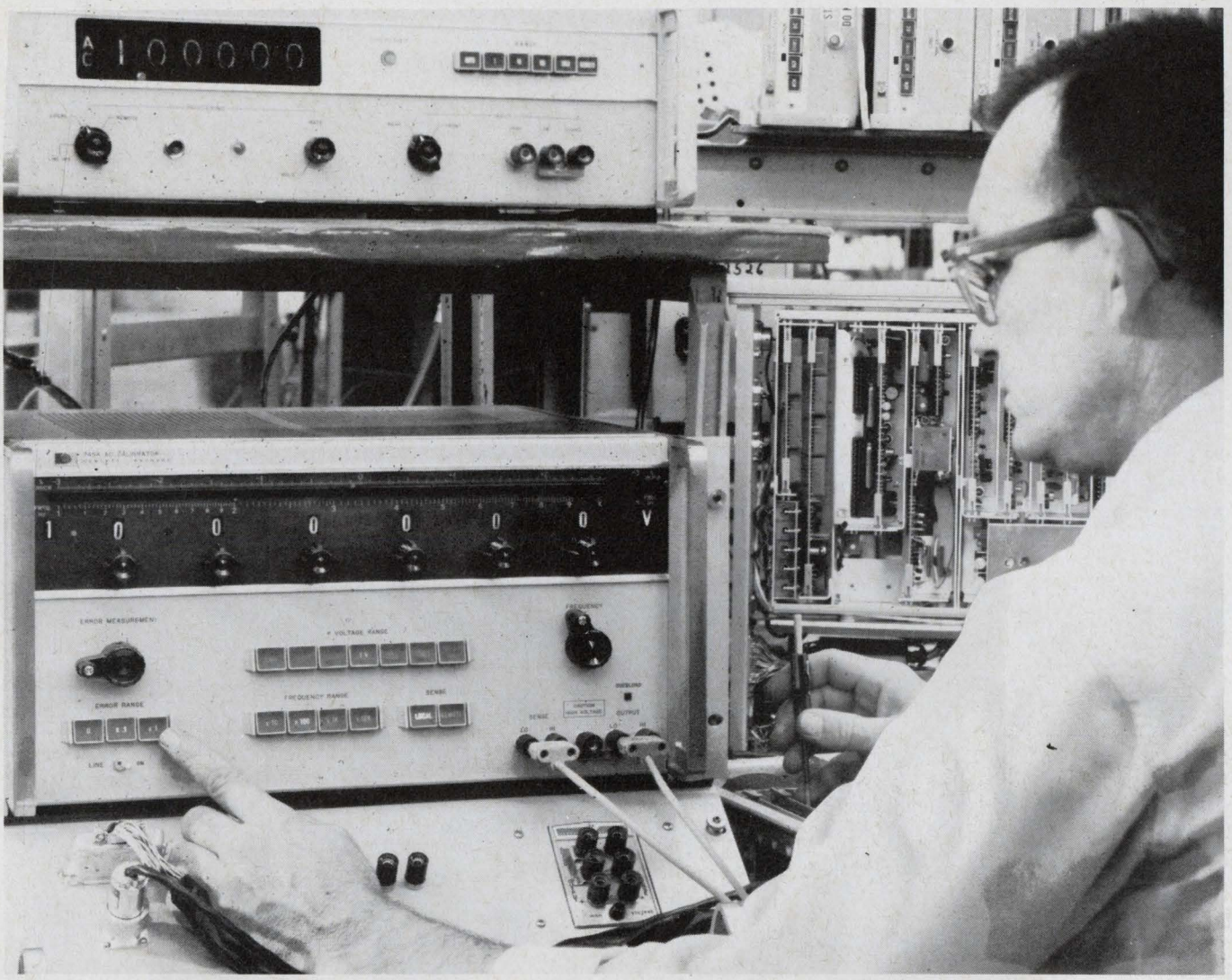
CUT AC CALIBRATION TIME IN HALF



NEW hp 745A AC Calibrator is a self-contained AC calibration system that you can depend on for accuracy and stability in checking out digital, differential and analog ac voltmeters. Use it in production test areas and in calibration and standards labs to reduce calibration time by at least 50%—with push-button range selection . . . dial your voltage, dial your frequency. There is no external thermocouple, no nulling, no transients, no extra instruments to compound your set-up and increase your costs.

Direct error measurement in terms of percent-of-setting makes instrument calibration a simple set-read operation. To use it, press error range button and dial your plus or minus error until voltmeter under test reads the preselected voltage. Any error up to ±3% is read directly on the top dial.

Operator oriented for easy, fool-proof measurements. Current limiting protects 745A from direct load short. Voltage range automatically resets to 1 mV range when 745A is turned off, to protect any instrument being calibrated from an accidental overload on turn-on. No need to disconnect instrument being tested, or turn off calibration when switching ranges, because there are no transients when ranges are being switched. Frequency, frequency range, and voltage range are programmable—an extra feature at no extra cost. Calibration of the 745A is simple using a high accuracy dc voltmeter, such as an hp 3420A, and an uncalibrated thermocouple to check flatness.

0.02% accuracy is possible because the output voltage is continually compared to an internal dc reference by a unique technique that makes an internal ac-to-dc transfer measurement twice each second. This also eliminates thermocouple drift and dc reversal error. Voltage accuracy and stability are further assured by precision inductive dividers. Calibrated ac voltages are available from 100 μV to 110 V over the frequency range from 10 Hz to 110 kHz—with an absolute voltage accuracy in the midband of 0.02% of setting and 0.05% up to 110 kHz! Price: $4500.00

To get full information on the lightweight (65 pounds) hp 745A AC Calibrator, call your nearest hp field engineer. Or, write to Hewlett-Packard, Palo Alto, California 94304. Europe: 54 Route des Acacias, Geneva.

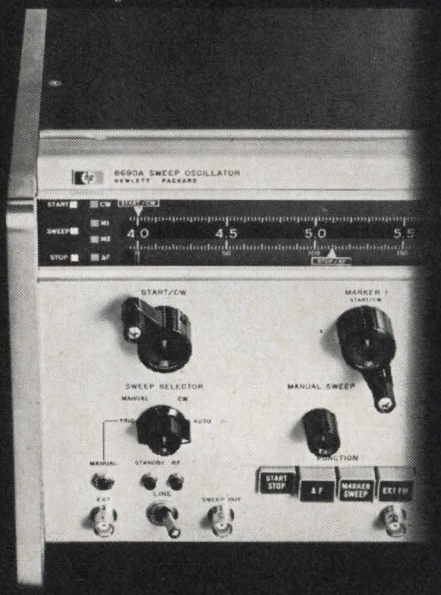
097/19

HEWLETT hp PACKARD

WORKING STANDARDS

FROM HP—THE SWEEPER THE USER DESIGNED

For the sweep mode you need, just press a button

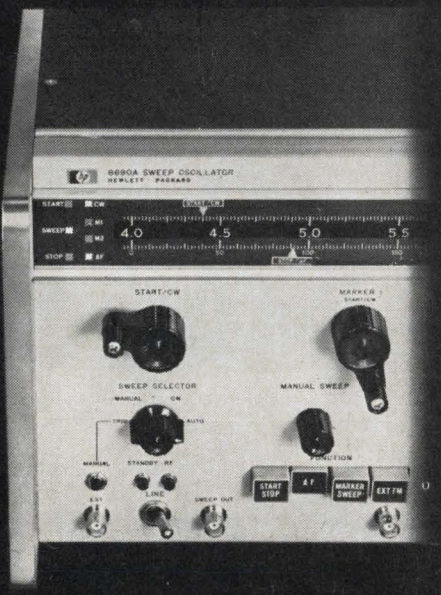


PRESS THE START/STOP BUTTON

The dial lights immediately identify the sweep mode, and the corresponding START and STOP frequency pointers indicate the frequency limits of the sweep. Frequency settings are independently adjustable over the full 13-inch scale for sweeping up or down, wide or narrow. Accuracy and sweep linearity are better than 1%.

PRESS THE MARKER SWEEP BUTTON

Now the M1 and M2 lights signify that you've selected a completely independent sweep mode whose frequency dial pointers provide a full range of adjustment. Use it to bracket a frequency segment of interest. Frequency accuracy and linearity, again, are better than 1%. In all sweep modes, the SWEEP light is "on" while the sweep is in progress, extremely convenient for slow sweep speeds.



PRESS THE △F BUTTON

The CW and △F lights now indicate you have a fully calibrated narrow-band sweep symmetrical about the setting of the CW frequency pointer. Sweep width, indicated by the △F pointer, is adjustable from 0 to 10% of the band. The full-width frequency scale affords high resolution.

The Hewlett-Packard 8690A Sweep Oscillator is the sweeper the user designed—engineered for greatest operating convenience and to eliminate errors encountered with complex dial arrangements and hard-to-read panels. Plug-in design results in a front panel free from congestion, yet the instrument is only 8¾" high. There's an RF plug-in for 0.1 to 110 MHz and microwave plug-ins from 1 to 40 GHz. PIN diode modulation/leveling is available from 1 to 12.4 GHz. Model 8690A main frame is $1600, the RF plug-in is $950 and microwave plug-ins start at $1575.

For more information call your local HP field engineer or write Hewlett-Packard, Palo Alto, California 94304; Europe: 54 Route des Acacias, Geneva.

HEWLETT hp PACKARD

SWEEP OSCILLATORS

04723

Electronics

Volume 41, Number 1 January 8, 1968

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Electronics Review

Electronics Abroad

New Products

Technical articles

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Readers Comment

Brushing up

To the Editor:

The article titled "Brush off" [Dec. 11, p. 45] described the brushless d-c motors in development at NASA's Goddard Space Flight Center, and their potential for space applications.

The General Electric Co.'s avionic controls department in Binghamton, N.Y., has had brushless d-c motors in development since 1959. Instead of brushes, our motor employs Hall-effect probes that sense the field of a permanent magnet rotor. The motor itself has a permanent magnet rotor and a proportional current drive to the motor windings. We have fabricated both torque and spin motors with impressive characteristics.

We recently delivered to NASA's Marshall Space Flight Center a 2,000-foot-pound-second momentum wheel with a brushless d-c spin motor drive. The motor is more than 95% efficient and delivers peak power of 135 watts and a running power of 40 watts. The drive electronics are more than 80% efficient. Compared to a conventional, a-c induction, motorstatic inverter combination, there is a 3-to-1 decrease in power consumption and a greater than 10-to-1 decrease in size and weight. We have also designed reaction wheels for satellites with the same high-efficiency brushless motor drives.

I confidently predict that brushless d-c motors will soon be used in the "variety of space tasks" mentioned in your article.

Gary F. Auclair
Space Stabilization & Control Engineering
General Electric Co.
Binghamton, N.Y.

Roll out the barrels

To the Editor:

We wish to clarify the portion of the article "Unmasked" [Dec. 11, p. 45] that implies that our Photorepeaters are limited to single-lens systems.

The first Mann multibarrel (lens) system, the Type 1080A, was delivered in June 1964, and a large number have since been delivered

60 MHz flip-flops, 5 nsec gates
Sprague SSL* is the fastest TTL

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and they're pin compatible with series 8000

for maximum systems speed, check out Sprague SSL Super-Speed Logic

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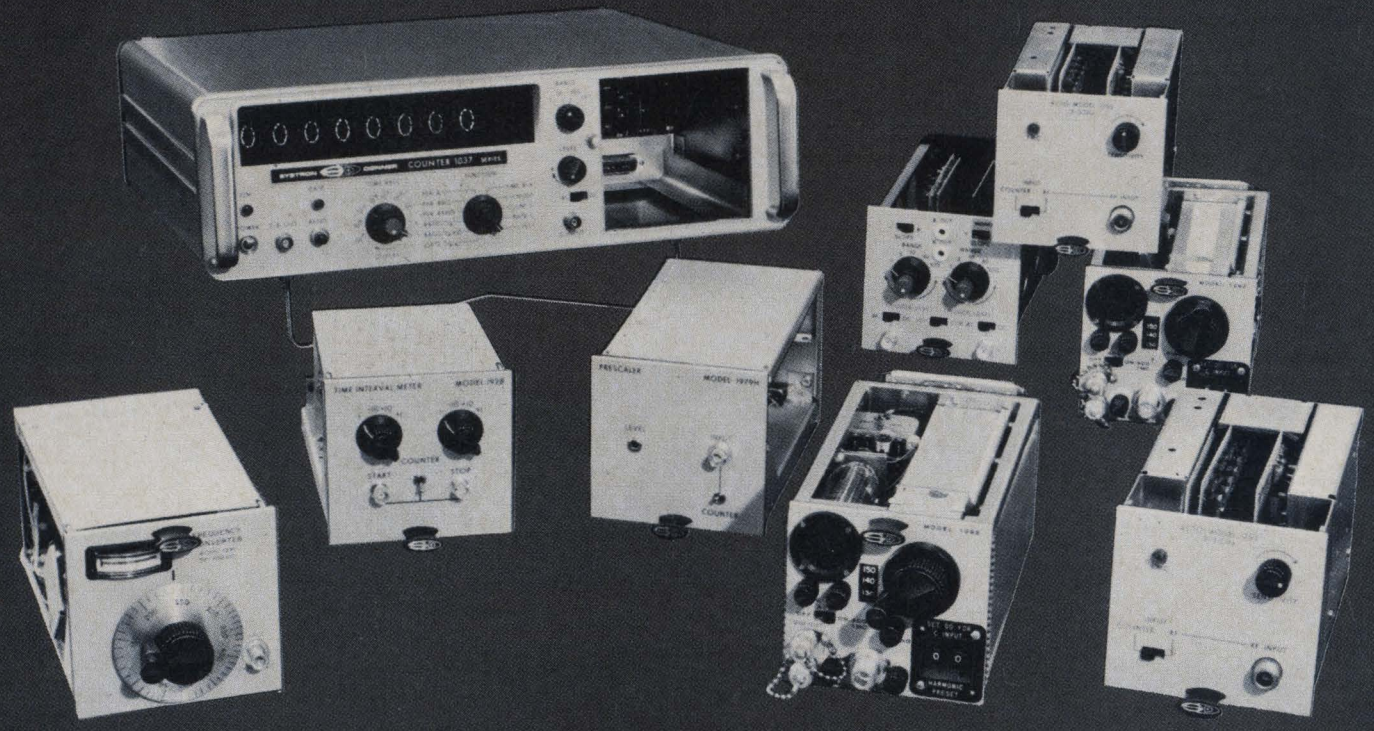
Little plug-ins make the big difference in 50 MHz counters



When you look only at the main frame, it's hard to find important differences between 50 MHz counters. But when you compare plug-ins, you'll find great differences and decisive advantages. Only Systron-Donner plug-ins can give you:

1. Final-answer frequency readings to 40 GHz.

A single plug-in, our Model 1292 semi-automatic transfer oscillator, boosts the counter's frequency-measuring range to 15 GHz. Measures FM and pulsed RF above 50 MHz. And the complete dc to 15 GHz system (counter with plug-in) costs only $3250. Our new Model 1298 semi-automatic T.O. now gives you final-answer readings up to 40 GHz—a new record.

Contact Systron-Donner Corporation, 888 Galindo Street, Concord, California.
Phone (415) 682-6161.

2. Automatic frequency readings to 18 GHz.

Three Acto® plug-ins now produce fully-automatic microwave frequency readings: 50 MHz to 3 GHz (P, L & S band), 3 to 12.4 GHz (S & X band), and 12.4 to 18 GHz (K_u band).

Find more unique measuring capability in this catalog

3. Time readings with 10-nano-second resolution.

Our latest time interval plug-in gives you time readings with 10-nanosecond resolution—greater precision than ever before possible with a standard counter.

All this unique measuring capability can be yours today—or tomorrow—when you buy your basic counter from Systron-Donner. Sixteen different plug-ins have been especially designed to give your Systron-Donner counter more measuring power at less cost than any other system.

SYSTRON DONNER

Circle 6 on reader service card

to various customers throughout the world. These include the four-barrel and six-barrel versions of both the 1080 and the 1480 series.

The original purpose of manufacturing multibarrel instruments was to achieve greater positional precision between masks. This was accomplished by manufacturing a number of masks simultaneously on the same instrument. With the 1480 series instrument and its excellent positional precision, multibarrel instruments are no longer needed to retain registration between masks. Positional precision is now maintained by the Microset Scale to within 10 microinches. Today the purpose of multibarrel instruments is to increase production capacity.

The system to which the article alludes is the Mann Type 1595 Photorepeater designed for the direct exposure of photoresist automatically. Thus far, only the single-barrel instrument has been offered. However, if a demand for multibarrel types arises, we intend to be responsive.

Aubrey C. Tobey
Director of Marketing
David W. Mann Company
Burlington, Mass.

Mother hens?

To the Editor:

As one of the oldest and most successful exporters in this country —we have promoted world trade for more than 130 years—we must take exception to some of the points brought out in "Hands across the sea" [Dec. 11, p. 52].

Texscan's Robert J. Shevlot generalizes when he says of export houses, "Thay take on your line and forget about you." There are export houses—as there are domestic representatives—that are line collectors, and Shevlot's comments are true regarding them. However, he overlooks those firms that have successfully built the export sales of their clients to the point where the clients could sell directly or even manufacture overseas.

While we cannot speak of other export organizations, we can cite our experience with Hewlett-Packard, Eitel-McCullough, Burr-Brown Research and Wavetek. In each case, the line was taken on by us when the client company was very small and export sales were built to $500,000 or more before the manufacturer "went on his own."

Contrary to what the article implies, Texscan's approach is not new; it has long been known as the "mother hen" operation and is being practiced by several U.S. manufacturers. Although this approach offers the advantage of a ready-made distributor system, there are disadvantages—notably, loss of identity.

In depreciating the difficulties of exporting, Shevlot seems to undermine his own business. If things are so easy, why should the manufacturer use any outside marketing organization? No, exporting is not as simple as he would have us believe; if it were, there would be no export houses—nor mother hens either.

J.C. Koltzau
Frazar & Hansen Ltd.
San Francisco

Recommended reading

The least-read section of any magazine is its masthead. Ours is in its customary place, at the left of page 4, and it lists the large and constantly growing editorial staff of Electronics.

But only the most eagle-eyed of our more than 70,000 subscribers will notice an important change; the first issue of this new year starts with a new name at the top of the masthead.

Donald Christiansen is succeeding Lewis H. Young, who has returned to another McGraw-Hill publication, Business Week.

It is with regret that we see Lew Young depart after four years of editing Electronics with a brilliance and skill that have made it the indisputable leader in the field.

It is with pleasure and confidence that we welcome Don Christiansen, the new Editor-in-Chief of Electronics.

Gordon Jones

Publisher

People

After three attempts to convince large corporations to add microelectronics subsidiaries, **James J. McMullen** and three associates from the old General Microelectronics Inc. have obtained private backing and created their own company, Electronic Arrays Inc. Like General Micro and the company that acquired it, the Philco-Ford Corp., Electronic Arrays will specialize in the production of metal oxide semiconductor integrated circuits.


James J. McMullen


Earl Gregory

"We really didn't want to be a subsidiary," McMullen, 39, confesses, "but we tried that approach because money was tight. So, when money loosened up in 1967, we went after our own financing and got all of it—from less than 20 private backers."

Product line. Electronic Arrays, situated in a Mountain View, Calif., building recently abandoned by the Semiconductor division of the Fairchild Camera & Instrument Corp., will concentrate on large-scale IC's.

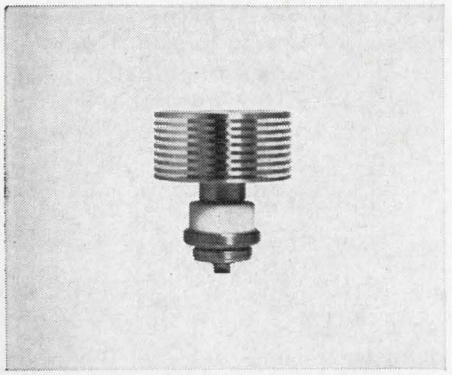
"We'll have a standard line that we'll mate to customer requirements," says **Earl Gregory,** vice president and marketing director. "We also expect to generalize our custom circuits. In either case, our objective is to build production as fast as possible."

"The big battle is cost," McMullen notes. "You have to get into reasonable volume quickly." Electronic Arrays expects to have 100 employees after a year of production. McMullen feels that the "heavy commitment by the military is the best indication that MOS technology has arrived."

Expectations. Initially, Electronic Arrays expects to do about 75% of its business with the government or subcontractors to government primes. Eventually, however, the

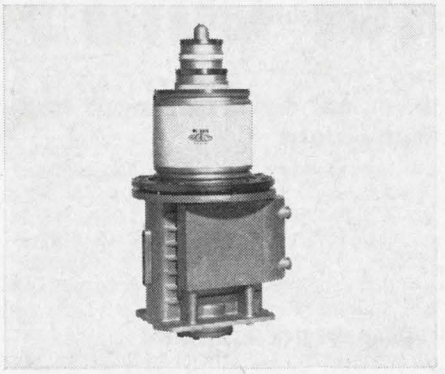
MACHLETT

Guide to Machlett Electron Tubes



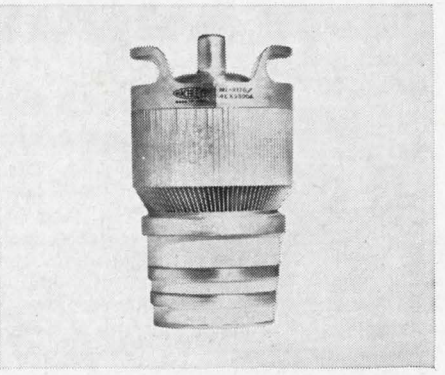
Planar Triodes.

Grid pulsed to 1 kw at 6 Gc. To 35 kw in pulse modulator service. For communications, radar beacons and navigation.



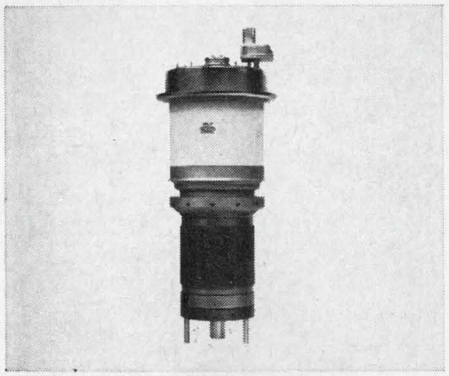
Magnetic Beam Triodes.

Pulsed ratings to 6 Mw with only 2.5 kw drive. CW ratings to 200 kW with only 0.7 kW drive.



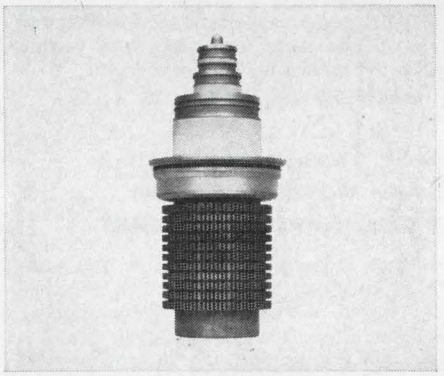
Heavy Duty Tetrodes.

Forced air cooled, water cooled and vapor cooled for broadcasting and communications.



Pulse Modulators.

Shield grid triodes (oxide cathode) to 4.5 Mw, 80 kv peak. High voltage triodes (thoriated tungsten cathode) to 20 Mw with plate voltages to 200 kv peak.

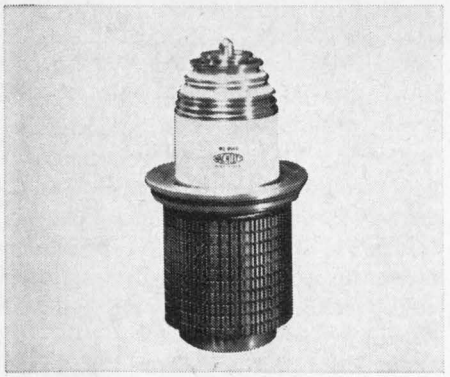


Heavy Duty Triodes.

Includes vapor cooled triodes, to 440 kW CW.

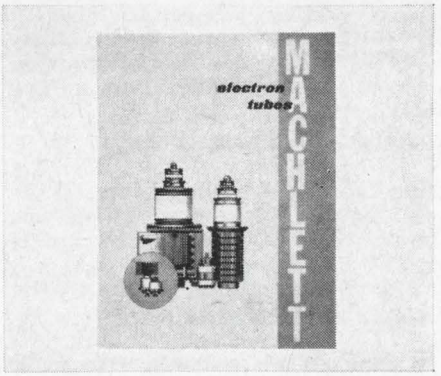
Vacuum Capacitors, Variable.

RMS amperes to 75A; voltage to 15 kv peak. Capacities from 5-750 pF to 50-2,300 pF.



High Power Tetrodes.

Vapor cooled tetrodes to 350 kw CW for communications.



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People

company hopes to reverse the ratio.

Electronic Arrays is the second MOS company to be formed by former General Micro-electronics personnel. American Microsystems Inc., under Howard Bobb and a coterie of General Micro-electronics talent, began operations in Santa Clara, Calif., in the summer of 1966.

"We're not going to be able to do as much as we'd like." **Leland Johnson,** recently appointed director of research for the President's telecommunications task force, is candid about prospects for the panel, which has been directed to make a comprehensive study of U.S. communications policies and to submit a series of recommendations by next August [Electronics, Dec. 11, 1967, p. 67].

Leland Johnson

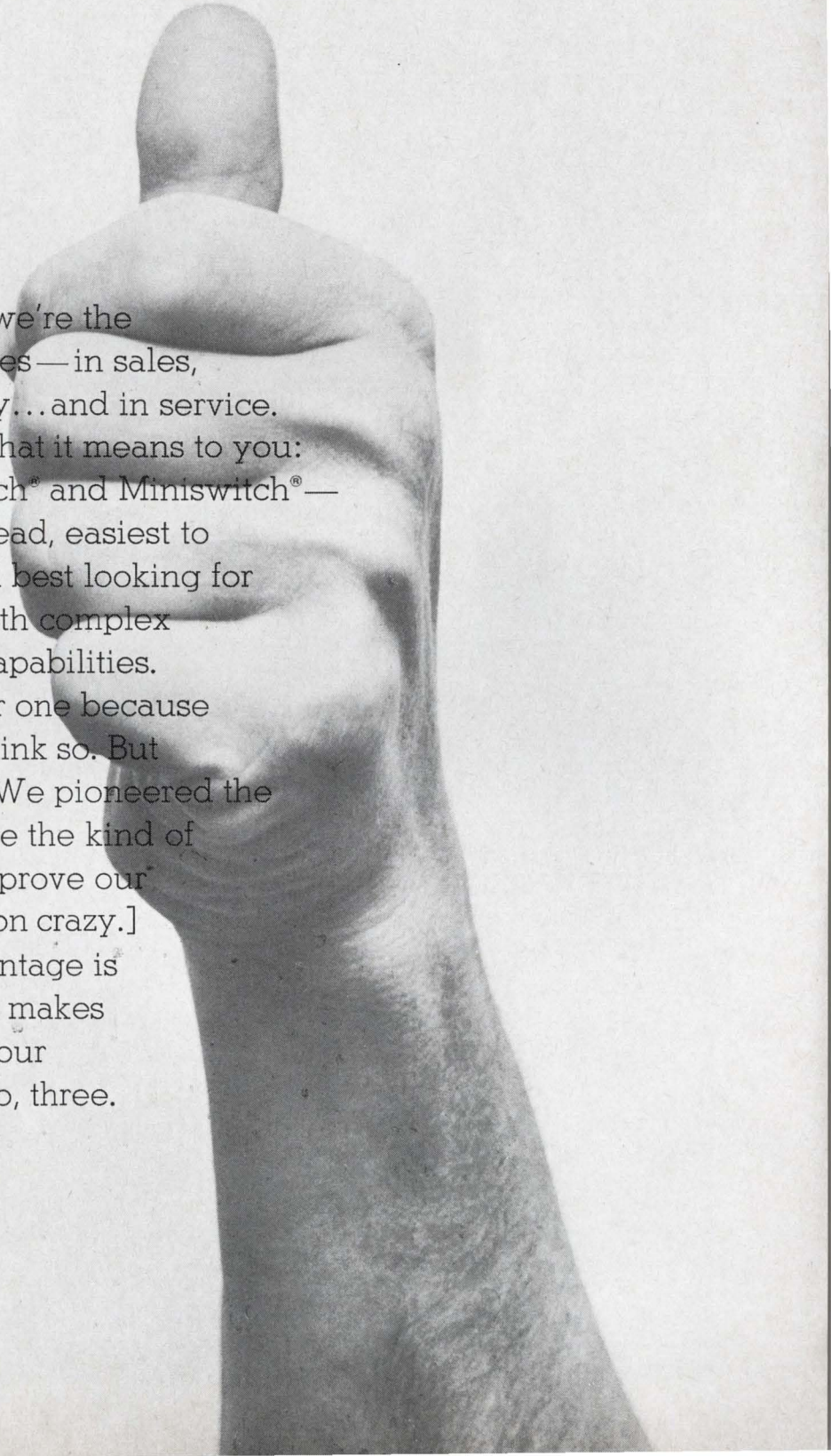
"What we'll be able to do is set the tone for future inquiries," says Johnson. "We can offer the bare bones of what we feel a well-conceived public telecommunications policy can be."

Johnson, an economist, received his Ph.D. from Yale in 1956 and joined the Rand Corp. a year later. There he conducted some pre-Comsat cost-benefit analyses of communications satellites. "We were quite pessimistic," he recalls. "Synchronous systems were considered way out in the blue and didn't figure to compete with land-line microwave systems." Johnson cites this as an example of the rapid and often unpredictable technological changes that can vitally effect the economy.

He feels the task force should tackle such major issues as frequency allocations, the role of satellites, and the possibility of merging the international operations of U.S. common carriers as first steps toward drawing up a national policy for the 1969 meeting of the International Telecommunications Satellite Consortium.

Circle 11 on reader service card→

We're number one 2, 3, 4, 5, 6, 7, 8, 9...



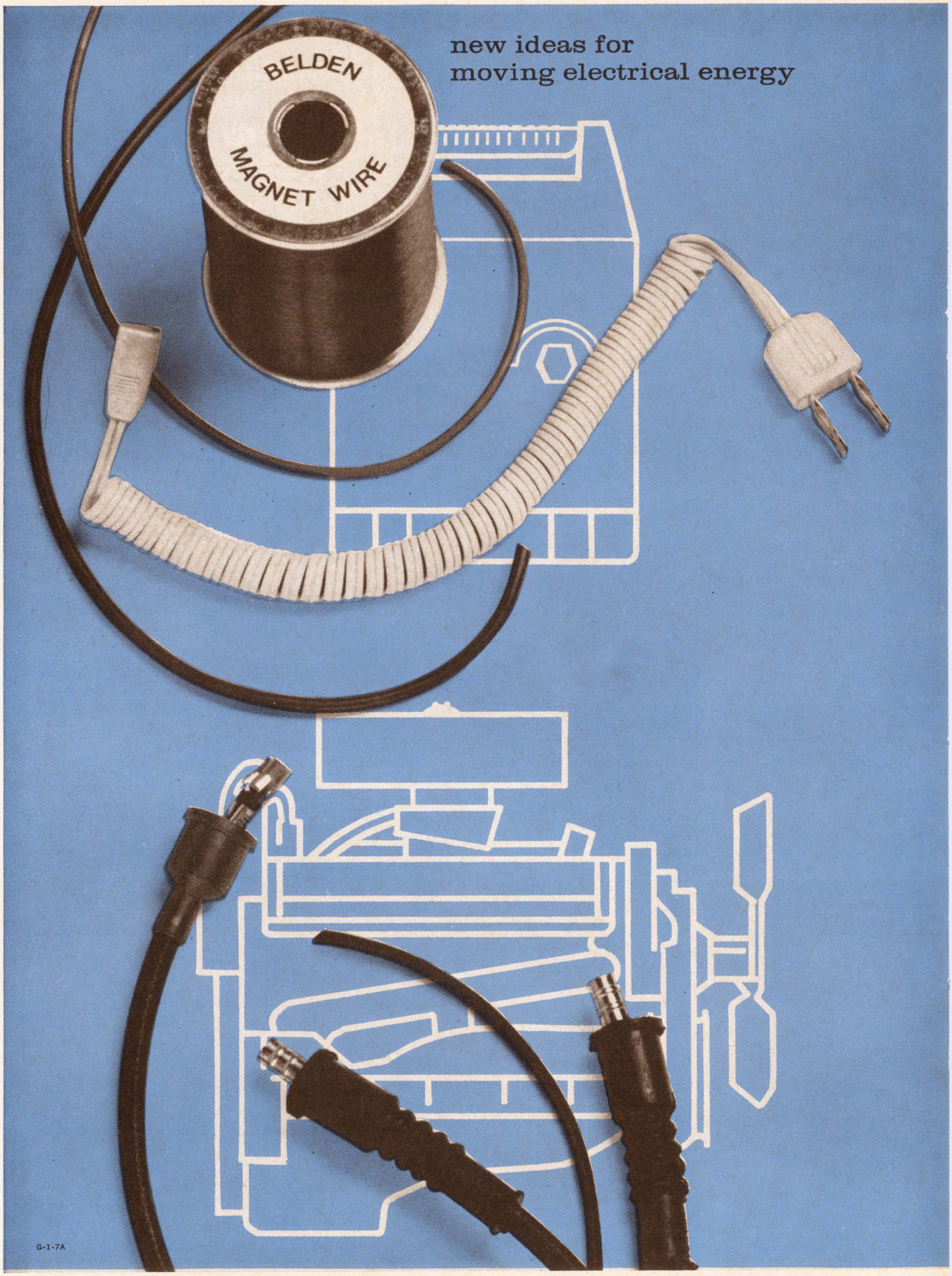
No matter how it all adds up, we're the leaders in thumbwheel switches—in sales, in product features and quality...and in service. We like leading, and here's what it means to you:

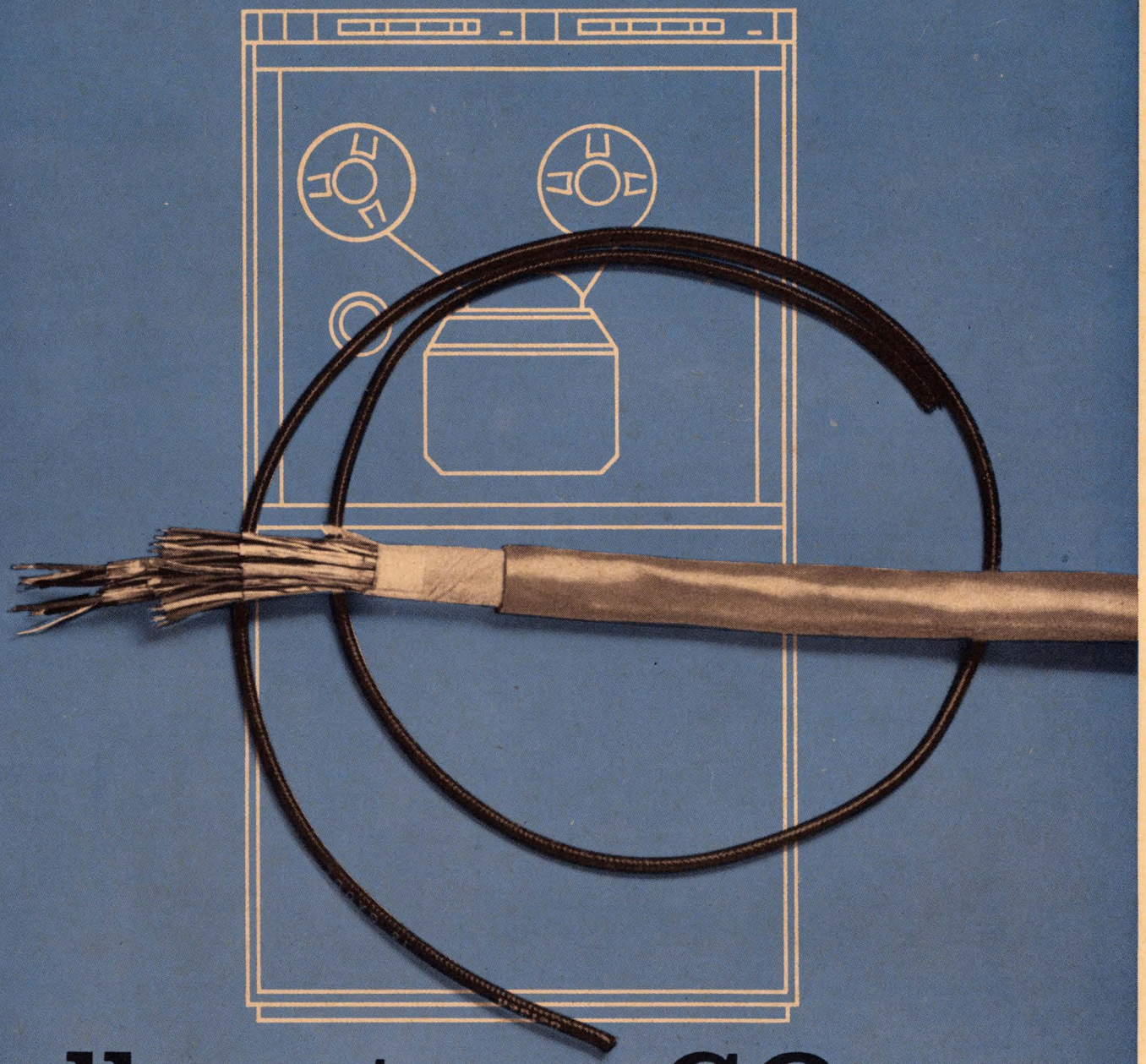
Our switches—Digiswitch® and Miniswitch®—are the simplest, most easily read, easiest to operate, smallest, biggest, and best looking for your panel. And they have both complex and simple electrical output capabilities.

Did we get to be number one because we are so smart? We like to think so. But being there first sure helped. We pioneered the thumbwheel switch. And we're the kind of engineers who continually improve our product. [Drives the competition crazy.]

But maybe our real advantage is that we like to sell things. This makes us easy to buy from. Send for our catalog. It's as easy as one, two, three.

THE DIGITRAN COMPANY
Subsidiary of Becton, Dickinson and Company B-D
855 S. Arroyo Pkwy./Pasadena, Calif. 91105
Tel: (213) 449-3110/TWX 910-588-3794


new ideas for
moving electrical energy
BELDEN
MAGNET WIRE
G-1-7A



all systems GO

...when a Belden team of wire specialists shows you their dozen or so ways to wring out hidden values and costs. For example you can delve into design..maneuver with materials..analyze assembly..pry into processing..pick different packaging..or a host of others. But success takes a supplier who is really perceptive—one who makes all kinds of wire for all kinds of systems. Want to join us in wringing out values and costs? Just call us in...Belden Corporation BELDEN
P.O. Box 5070-A, Chicago, Illinois 60680.

Meetings

Meeting of the National Society of Professional Engineers; Shoreham Hotel, Washington, **Jan. 9-13.**

Symposium on Reliability, IEEE; Sheraton-Boston Hotel, Boston, **Jan. 16-18.**

Aerospace Sciences Meeting, American Institute of Aeronautics and Astronautics; Statler Hilton Hotel, New York, **Jan. 22-24.**

Power Meeting, IEEE; Statler-Hilton Hotel, New York, **Jan. 28-Feb. 2.**

Defense Contract Administration Service Forum, American Society for Quality Control, Jack Tar Hotel, Clearwater, Fla., **Feb. 10.**

Aircraft Design for 1980 Operations Meeting, American Institute of Aeronautics and Astronautics; Mayflower Hotel, Washington, **Feb. 12-14.**

Aerospace and Electronic Systems Convention, IEEE; International Hotel, Los Angeles, **Feb. 13-15.**

International Solid-State Circuits Conference, IEEE; Sheraton Hotel, Philadelphia, **Feb. 14-16.**

National Space Meeting, the Institute of Navigation; Ramada Inn, Cocoa Beach, Fla., **Feb. 19-21.***

Scintillation and Semiconductor Counter Symposium, IEEE; Shoreham Hotel, Washington, **Feb. 28-March 1.**

Technology for Manned Planetary Missions Meeting, American Institute of Aeronautics and Astronautics; New Orleans, **March 4-6.**

Conference of the American Society for Nondestructive Testing; Biltmore Hotel, Los Angeles, **March 11-13.**

International Convention and Exhibition, IEEE; New York Coliseum and New York Hilton Hotel, New York, **March 18-21.**

Symposium on Microwave Power, International Microwave Power Institute; Statler Hilton Hotel, Boston, **March 21-23.**

Flight Test Simulation and Support Conference, American Institute of Aeronautics and Astronautics; Los Angeles, **March 25-27.**

International Aerospace Instrumentation Symposium, College of Aeronautics; Cranfield, Bedford, England, **March 25-28.**

Quality Control Conference, American Society for Quality Control; University of Rochester, N.Y., **March 26.**

Railroad Conference, IEEE and American Society of Mechanical Engineers; Conrad Hilton Hotel, Chicago, **March 27-28.**

International Magnetics Conference, IEEE; Sheraton Park Hotel, Washington, **April 3-5.**

Short Courses

Dynamic measurements in ocean sciences, Instrument Society of America, Ramada Inn, Cocoa Beach, Fla.; **Jan. 16-19,** $240 fee.

Frontiers of glass science and technology, Rensselaer Polytechnic Institute, Troy, N.Y., **March 25-26;** no fee, but preregistration will be required.

Stimulated Raman effect, Stevens Institute of Technology's Department of Electrical Engineering, Hoboken, N.J., **Feb. 14;** no fee.

Call for papers

Convention of the Audio Engineering Society; Hollywood Roosevelt Hotel, Hollywood, Calif., April 29-May 2. **Jan. 30** is deadline for submission of abstracts to Don Davis, convention chairman, 34th National Convention, Audio Engineering Society, c/o Altec Lansing, 1515 S. Manchester, Anaheim, Calif. 92803.

Design Automation Workshop, IEEE; Washington, July 15-18. **Jan. 30** is deadline for submission of summaries to Dr. H. Freitag, IBM Watson Research Center, P.O. Box 218, Yorktown Heights, N.Y. 10598

Aerospace Instrumentation Symposium, Instrument Society of America; Statler-Hilton, Boston, June 3-5. **Feb. 15** is deadline for submission of abstracts to John Westwick, Allison Division, General Motors Corp., Plant 8, Indianapolis, Ind.

* **Meeting preview on page 16.**

The connector THING

A periodical periodical designed, quite frankly, to further the sales of Microdot connectors and cables. Published entirely in the interest of profit.

The 2 MINUTE (OR LESS) BRIBE

The two minute (or 120 second, whichever is shorter) "bribe" is about how long it should take a rank amateur (or even a good-smelling amateur) to prove to his satisfaction that Microdot does not speak with forked connector. (Affidavit: "This ain't a bribe in the true sense." Signed the management.)

The "bribe" centers around our high density, circular, multipin connectors. Microdot started this particular concept over four years ago with the MARC 53, the hit of the subminiature world. It's been right up there on the Gemini space walks and, as the world's smallest, high-performance connector has also been drafted for other military (meets MIL-C-38300A) and NASA projects. It heralded a new generation in submins. The Microdot high density design is coupled with two other exclusive features: (1) Posilock, the only advanced push-pull, lock coupling mechanism that guarantees proper engagement even under "blind mating" conditions and (2) Posiseal, a sandwich insert design using silicon interwafer seals.

PRESS ON

Now that you are conversant with the MARC 53, let's try the MARC 53 RMD. Now this differs from the other much more than those three little letters on the end.

HOW SO?

Because the RMD version has rear-insertable and removable pins and sockets!!!!

BENEFITS PLEASE

No tools needed for assembly or disassembly. And tools, as every inspector knows, are oft cause of damage of a connector's rubber parts which in turn leads to insufficient sealing which in turn leads to all sorts of trouble. And the need for tools further makes field repair and/or maintenance a veritable "you're kidding" situation.

AND EVEN MORE

All this means here's a submin connector that lends itself to real mass production assembly techniques because assemblers can use factory produced, pre-crimped wire.

WHAT DOES THIS MEAN TO YOU?

Fame, fortune and undying gratitude when you tot up all the savings in time and money you'll be responsible for.

NOT ENOUGH WHAT ELSE?

BÜZ *(a case in point is a Beefeater)* If you're the fastest under the two minute barrier.

WINNERS

The three best winners, those with the neatest times, will receive a choice case of their own choice of hard stuff; Smirnoff, J&B, Beefeater, Jack Daniels, COMPLETE with THEIR OWN PRIVATE LABELS WITH THEIR OWN CUSTOM DESIGNED NAMES, very effective for impressing folk at parties and/or other get togethers.

TWO MINUTE BRIBE CONTEST RULES

You must use a Microdot RMD MARC 53 Connector. And you must use a Microdot Rep. (There are several used ones in your vicinity.)

SMALL PRINT

1. You will be handed a MARC 53 RMD.
2. You will be told to unscrew the neatly machined rear nut and
3. Dismantle the back of the device and loosen all those metal things.
4. Then pull out 4 pins.
5. Put back those 4 pins. And
6. Put all that metal stuff back in the proper order. And tighten the rear nut.

LOSERS AND OTHERS

Because, there are NO TOOLS NECESSARY WITH THE MARC 53 RMD, and to compensate you for that fact, you will receive a very tool tool. (Better than a connector tool, really.) You will receive ONE STERLING BAR SPOON. (This spoon is sterling in concept only, but it shouldn't rust.)

HURRY! For this remarkable contest closes sometime this spring o/a midnight February 28, 1968. Fill out the neat coupon below. All of this madness is, unfortunately, void where the legislature is a bit stuffy.

NEAT COUPON

MICRODOT INC.
220 Pasadena Ave., South Pasadena, Calif. 91030.

- ☐ Yes, I would like to take the two minutes "bribe," but I couldn't read your crumby contest rules.
- ☐ Yes, yes. I want to take the "bribe," rules or no rules.
- ☐ Enough of that. Just send me all the info on the MARC 53 RMD. I make my own stuff.

Name_____

Company_____

Position_____

Address_____

City_____

State_____ Zip_____

MARC 53, RMD, Posilock and Posiseal are trademarks of Microdot Inc.

What's happening in New York on March 18? Write in and tell us, and we'll send you a little surprise!

Meeting preview

Zeroing in on 'copters

With helicopters playing an increasingly larger role in both military and civilian aviation, greater attention is being paid to reducing the number of controls that are handled manually by the pilot. When the Institute of Navigation's National Space Meeting opens in Cocoa Beach, Fla., Feb. 19, one of the major topics will be automated guidance and control systems for helicopters.

Flying and landing. A paper by Marvin Taylor and Irwin Feldman, engineers at the American Bosch Arma Corp., will describe a self-contained navigation system for both helicopters and vertical-take-off-and-landing craft. Another by engineers J.G. Fellinger, R.W. Elsner, and M.W. Story, all of Lear Siegler Inc., will discuss the integration of automatic and manual flight controls for approaches and landings.

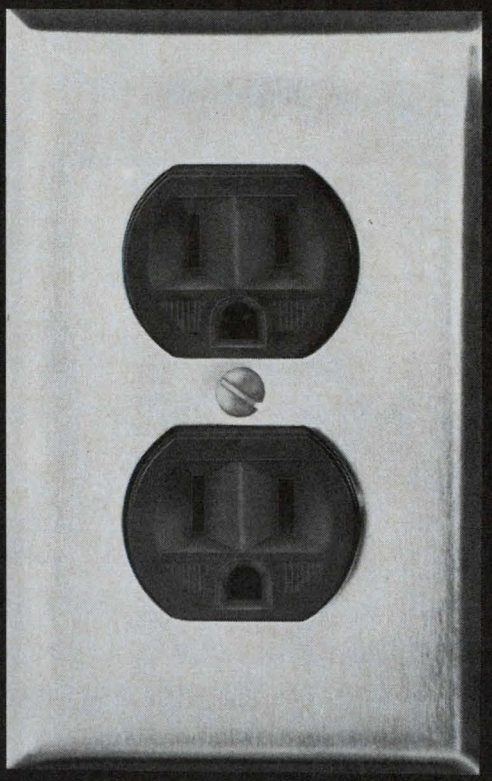
New types of computer-driven displays for station-keeping under instrument flight rules will be discussed by Robert M. Nicholson and Charles A. Baker, engineers at Honeywell Inc., Brad Gurman of the Army Electronics Command, and Lt. Cmdr. Frank Cundari of the Office of Naval Research.

Where are you? To be sure, topics other than helicopters will be covered in the three-day session. Andrew E. Scoville, an engineer at the United Aircraft Corp., will compare the advantages and limitations of strapdown and inertial-guidance systems. James E. Miller and James Sitomer, researchers at Massachusetts Institute of Technology's Instrumentation Laboratory, will describe a simplified strapdown system for extended manned space missions.

Strapdown-testing techniques will be covered in a paper by Capt. Nicholas C. Belmonte of the Air Force's Central Inertial Guidance Test Facility, Holloman Air Force Base, N.M.

One of the sessions will be devoted to a discussion of simplified electro-optical sensors.

For details, write R.E. Freeman, executive director, the Institute of Navigation, Suite 912, 711 14th St., N.W., Washington, D.C.



Do your problems start here?

Line-voltage variations are seldom blamed for the insidious little problems that plague us daily. Usually we blame the equipment. So, as a public service to protect electrical equipment from kicks, fists, cuss words, and other abuses, we would like to list a number of troubles that are directly attributable to off-normal line voltage.

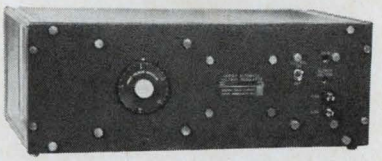
Motors . . . Low voltage increases starting time, reduces starting torque (at 10% undervoltage, a squirrel-cage motor has 19% less starting torque); efficiency of portable tools such as hand grinders will drop as much as 10%. Overvoltage may stress shafts, gears and belts; with a 10% increase in line voltage, starting current is up 12%, power factor is down 5%, and motor noise increases.

Lighting . . . Low voltage reduces lamp efficiency; a 10% line drop reduces light in incandescent lamps by 30%. Tungsten-halogen lamps blacken; color temperature of photographic lamps drops by 100°K. Overvoltage reduces lamp life; a 4% increase halves the life of incandescent lamps. A 10% increase produces a 20% increase in heat of infrared lamps — enough to scorch sensitive surfaces.

Electrical Equipment . . . At 10% undervoltage unprotected thyratrons and other gas-filled tubes can fail in minutes. Output of unregulated oscillators and generators will vary, stability will be impaired, and calibration will be questionable. Varying voltage will seriously distort the accuracy of data obtained during life testing. A 10% increase in voltage will cut tube life by 75%.

Industrial Equipment . . . At 10% undervoltage ultrasonic cleaner and induction-heater output is off 20%; plating deposition rate drops 10 to 20%; precipitator cleaning power drops 20%; solenoid holding power is reduced; electrical heating time is increased by 20 to 25%. Varying line voltage impairs weld consistency produced by energy-storage spot welders used for fabricating aluminum and exotic metals. Heat sealing processes are seriously hampered by voltage fluctuation. At 10% overvoltage, metallic rectifiers become overstressed and their ability to withstand transient surges is reduced by 50%. Idling losses in electrical distribution equipment is increased; transformer core losses increase approximately as the square of the applied voltage.

The SOLUTION . . . These and many other voltage ills can be handled simply and effectively with Variac® automatic voltage regulators. They are designed for fast (up to 80-volts-per-second correction on 115-V lines), accurate (¼% or ½%), and distortionless control of line voltage. Overloads as much as 10 times rated current can be accommodated.



These all-solid-state regulators are available in 31 electrically-different models, rated at 2- to 20-kVA for industrial use and 2- to 9.2-kVA for military applications. Models are available for line frequencies of 50 to 60 Hz or 350 to 450 Hz, single- or three-phase operation, and nominal line voltages of 115, 230, and 460 volts. Prices start at $530 in U.S.A.

For complete information, write General Radio Company, 22 Baker Avenue, W.Concord, Massachusetts 01781; telephone (617) 369-4400; TWX 710 347-1051.

GENERAL RADIO

Circle 17 on reader service card

When you're headed for trouble, there's no time to worry about microwave device performance.

That's why MEC created "super components." In most cases, systems troubles are caused not by components, but by the interfaces between them. With the introduction of "super components," MEC has made a major contribution toward minimizing microwave device interface problems.

Basically, "super components" are modular combinations of TWTs, solid-state delay devices, power supplies, limiters, switches and isolation networks. Together, they form complete sub-assemblies for systems application. Now a single specification can be generated for the combination unit . . . with MEC assuming unit responsibility.

Working closely with systems manufacturers, MEC has developed packaged amplifiers, zero loss microwave acoustic signal storage units, and chains of low-to-high power TWTs — many with shaped gain and limiting characteristics—for use in signal repeating, augmentation, microwave memory, direction finding, communications and target simulation systems.

Frequency, power and environment? MEC provides "super components" covering VHF through 40 GHz. Power levels range from milli-watts to hundreds of watts, cw, and kilo-watts pulsed. All "super components" satisfy the most demanding military or commercial requirements.

True, most of the time there is no system problem to worry about; but, when you're headed for trouble, is most of the time good enough?

For complete information, contact us at 3165 Porter Drive, Palo Alto, Calif. 94304. Phone (415) 321-1770.

MICROWAVE ELECTRONICS
A TELEDYNE COMPANY
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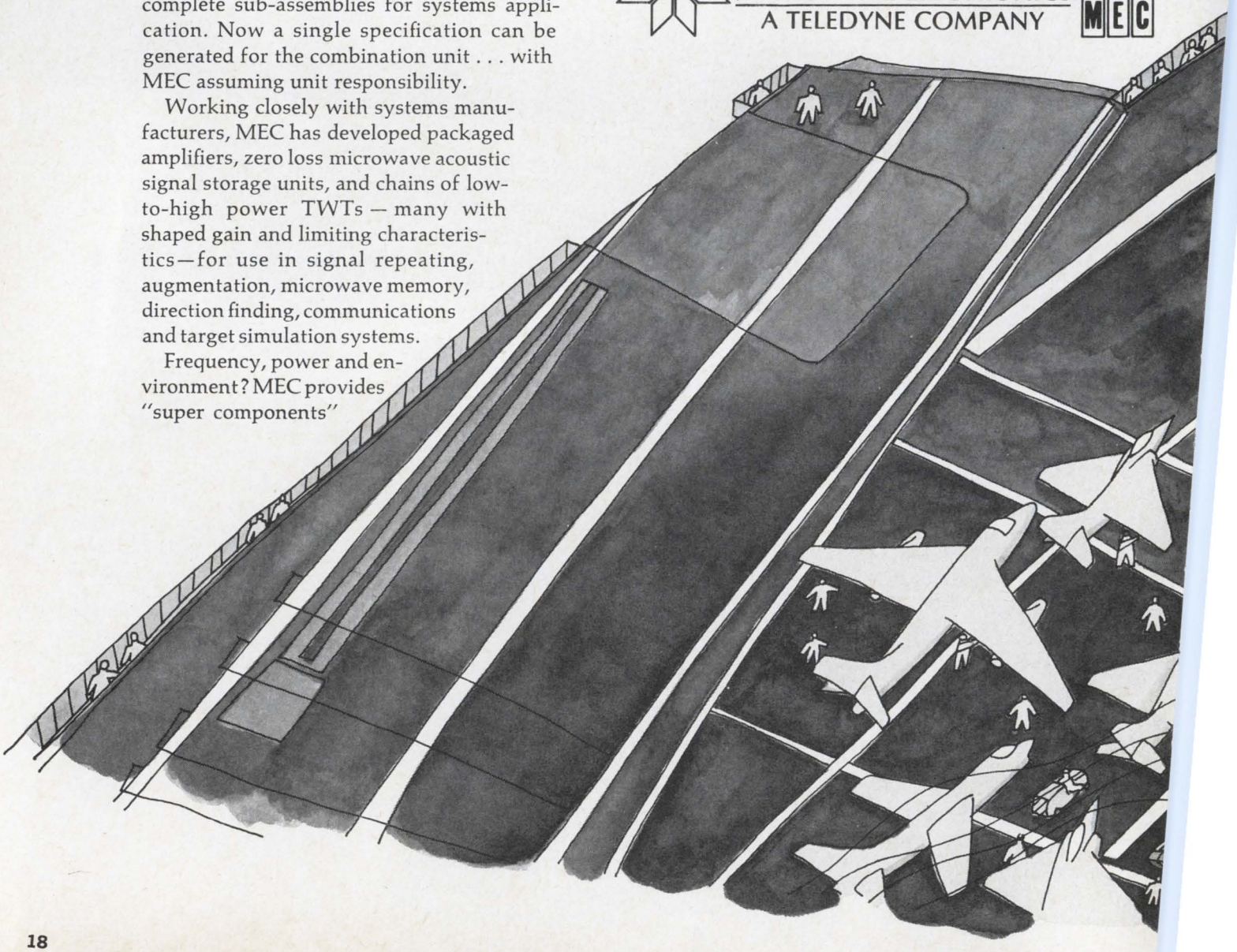

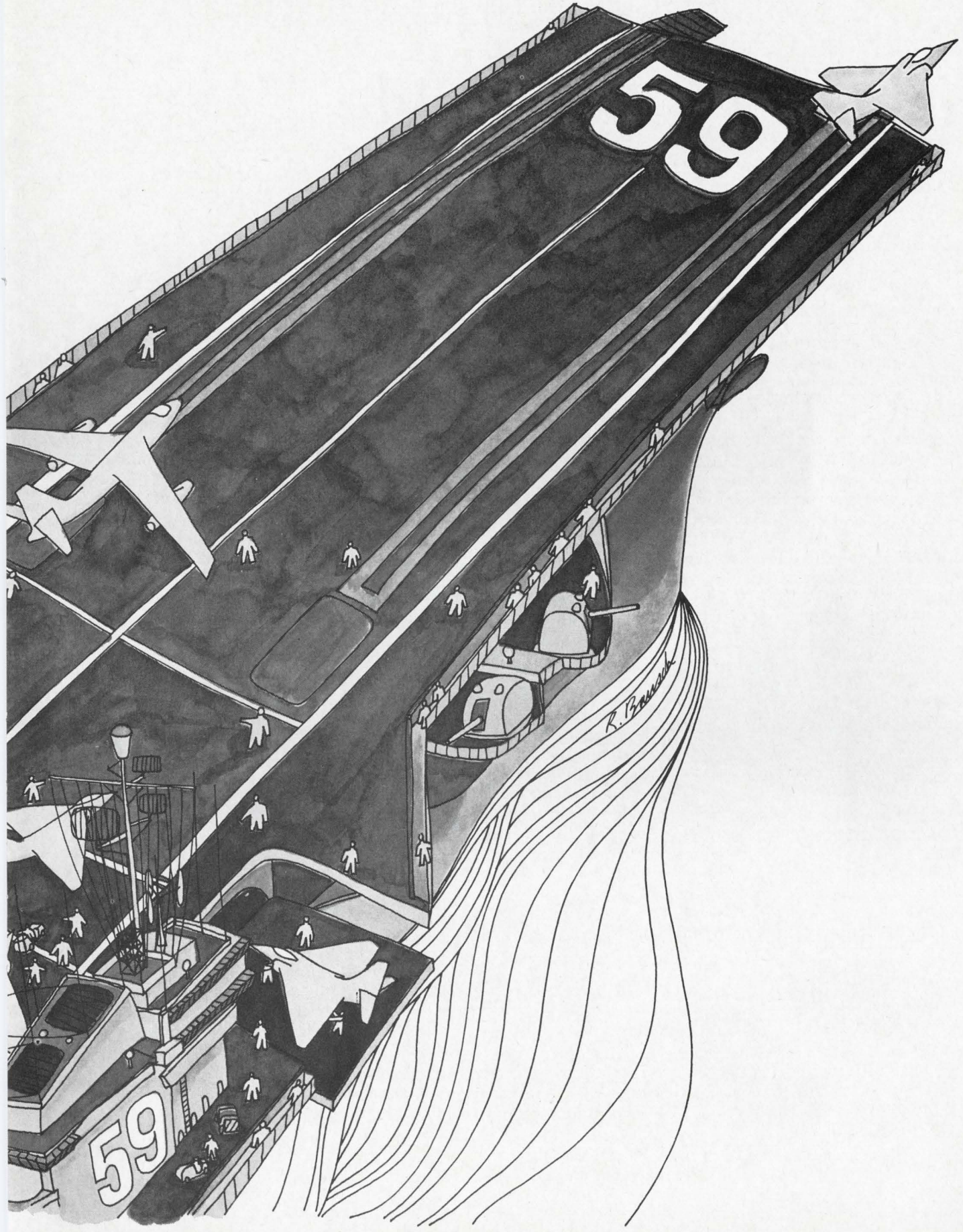
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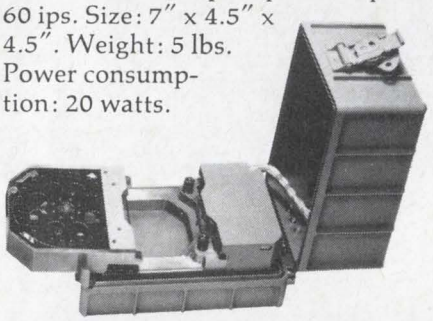
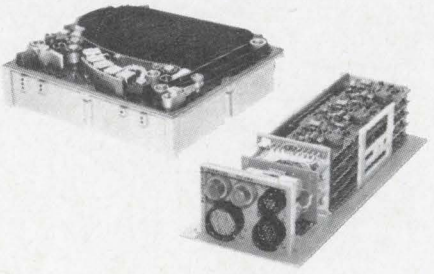
59

We build uncommon recorders

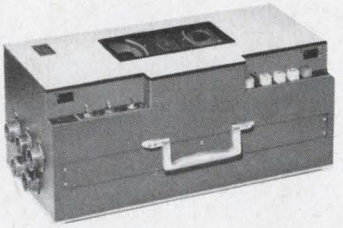
SMALL, CARTRIDGE-LOADED UNIT FOR COMPUTER PROGRAMMING, TEST INSTRUMENTATION, ECM—SERIES MTR 8000. Records and reproduces voice, analog, FM, and digital data with a variety of combinations for a wide range of applications. Eliminates tape threading and assures fast tape change. Performs with high reliability in 0 to 130°F temperature, 100% humidity, 150,000 feet altitude. Tape storage: 1/4" x 260'. Tape speed: up to 60 ips. Size: 7" x 4.5" x 4.5". Weight: 5 lbs. Power consumption: 20 watts.

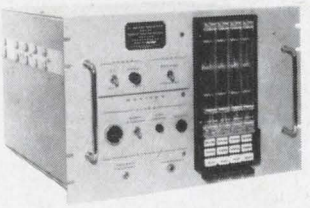


RANDOM BIN LOOP RECORDER FOR AIRCRAFT, SATELLITES, MISSILES—SERIES MTR 6000. Provides record of last 30 minutes of digital and voice information, three tracks digital and four tracks voice. Contains dual speed transport drive of 15/16 ips and 6 times speed. Tape storage: 150' x 1/2". Dimensions: 8" x 9" x 2.75". Weight: 5.5 lbs. Power dissipation: 10 watts max.



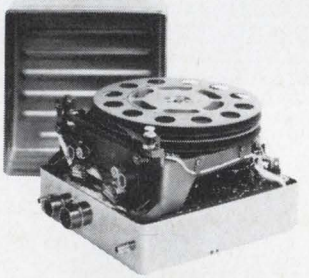
PORTABLE RECORDER/REPRODUCER FOR GENERAL PURPOSE INSTRUMENTATION TEST—SERIES MTR 3000. Provides up to 14 channels analog and FM or 16 digital channels which can be used in any combination. Plug-in modular electronic construction makes possible numerous record/reproduce options. Seven IRIG standard tape speeds available. Shock: 25 g—8 ms 1/2 sine —5% p/p flutter. Vibration: 10 g rms random operating—6% p/p flutter. Weight: 50 lbs. maximum. Size: 8.625" x 9.5" x 20".





LOW COST, LONG TIME SYSTEM FOR AUDIO MONITORING—SERIES MTR 5000. Four cartridge unit each recording 5 separate channels for 24-hour surveillance. Automatically replaces and rewinds each reel, prepares it for playback in portable reproducer. Permits recording of 20 channels (all reels) at one time. Contains alarm system for malfunction warning. Twelve cartridge military unit available. Tape: 1/4" x 1800' at 15/16 ips. Size: 19" rack mount.

LIGHT WEIGHT, LOW POWERED, LONG LIVED SYSTEM FOR SATELLITE APPLICATIONS—SERIES 2000. Backed by over 150,000 hours of successful operation in space. Offers custom flexibility in data programming. Accommodates PAM/FM, Multiplex FM, direct, single carrier FM, PDM and digital data. Releases in burst the data collected in orbit. Tape: 1/4" x 1200', 1900' and 3000'. Speeds: 0.1 to 100 ips. Size: 290 cubic inches. Weight: 10-15 lbs. Power consumption: 5-25 watts.



Write Dept. K for details on our uncommon recorders for your unusual requirements. Leach Corporation, Controls Division; 717 North Coney Avenue, Azusa, California 91702; Telephone: (213) 334-8211.

LEACH

Giant Killers

Second in the series.

International road racing had long been dominated by foreign automotive dynasties . . . until 1965, when the old regimes were toppled from the world racing throne by a bold Texan, Carroll Shelby, with his Cobra sports cars. In '66 and '67 Shelby Fords swept Le Mans —another American first—and a clear indication the giant was no longer king of the hill!

In the fast recovery power diode field, we knock heads with some industry giants, too. Take an example.

Our 251UL silicon diode boasts a 250-ampere forward current with recovery time of 1.5μs, 600 to 1000 PRV, 2.0 μs to 1300 PRV. These recovery times are tested at 785 amps peak I_F (π times the FCA rating) as recommended by JEDEC. You get microsecond recovery at operational currents.

The giants can't come near it. Brands G, W and M publish recovery times tested at I_F levels well below specified capacities—usually 1 to 5 amps or so. Try their diodes in a circuit and see how fast they recover.

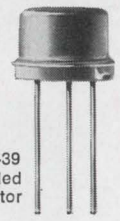
If you have inverters with critical high frequency requirements, talk to the giant killer—IR—developers of the 200 ampere power logic triac. Send for 251UL bulletin plus test procedures. Or just send your order. We've been delivering them for over a year.

IOR

INTERNATIONAL RECTIFIER

Semiconductor Division, 233 Kansas St., El Segundo, Calif. 90245, Phone (213) 678-6281. Field offices and distributors in major cities around the world

RCA "Overlay" Transistors
at home anywhere in the RF power range

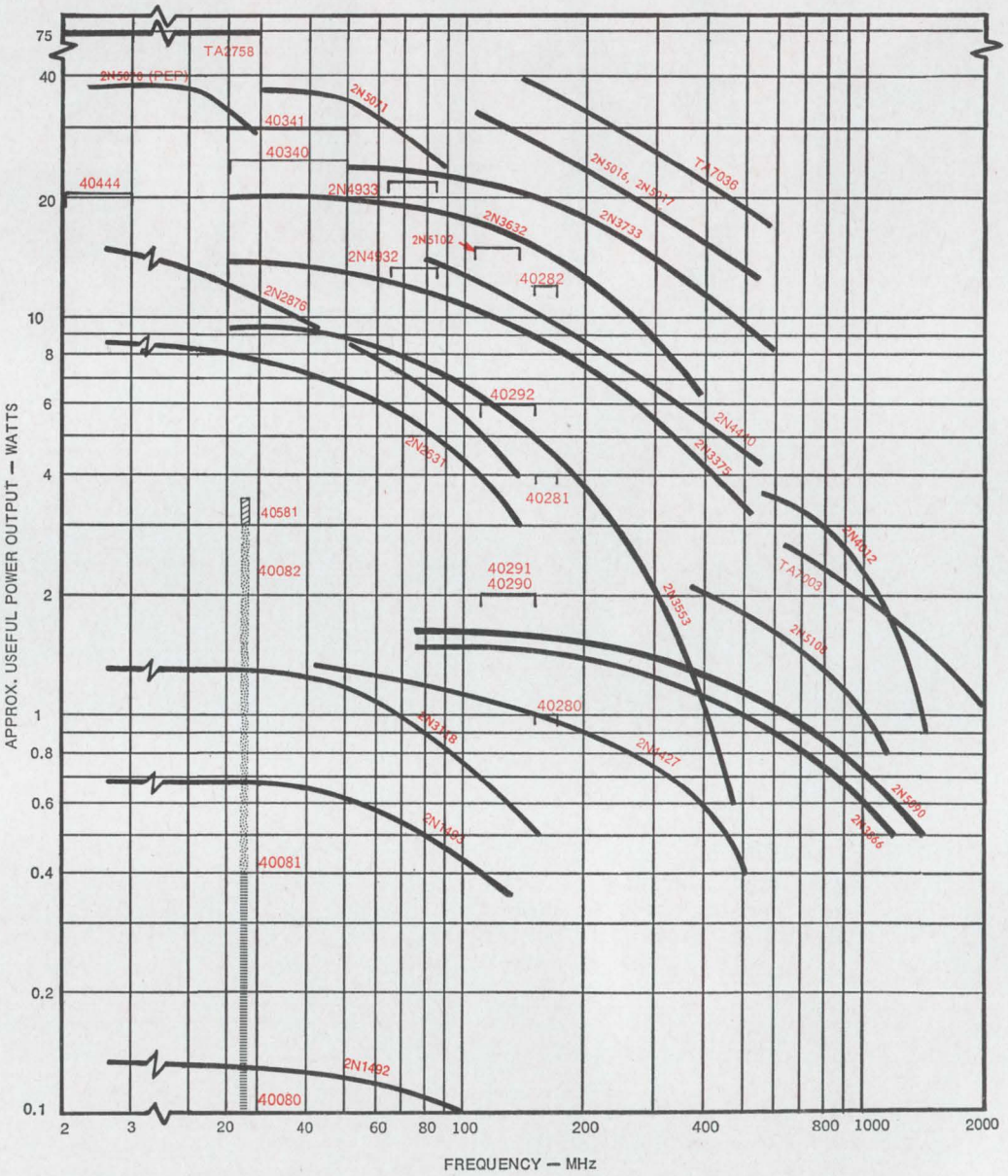


TO-39
Grounded
collector

TO-60
Isolated or
grounded emitter

Molded silicone
plastic case

Microwave
coaxial package



RCA offers you the broadest line of rf-power transistors in the industry. For more information on RCA "overlay" transistors see your RCA Representative or your RCA Distributor. For technical data on specific types, write: RCA Commercial Engineering, SectionPN1-2,Harrison, N.J. 07029.

RCA Electronic Components and Devices

The Most Trusted Name in Electronics

Commentary

All-purpose scapegoat

The world may be divided about the purpose of the war in Vietnam but the electronics industry isn't. Almost unanimously throughout the forecast for domestic markets in 1968, starting on page 105, market planners see the war as an all-purpose scapegoat. And the industry's disappointment with what will be a good—though not great—year is echoed by the military.

For example, Pentagon officials complain about the money being sluiced into procurement of hardware to fight the war day by day. Those sums, they say, reduce the amount available to develop sophisticated weapons for Vietnam-type wars of the future.

- Instrument makers say that they'll have to sell more of their less lucrative wares to satisfy war requirements. Many are claiming that this must result in fewer Government dollars for high-profit-margin research and development instrumentation.
- Microwave manufacturers decry the fact that they are inextricably tied to the military; they want Government funding with no military strings attached. Despite a general reluctance to make predictions, most makers look to a good year, if only because of a few projects like the Sentinel antiballistic missile system.
- Color-television set makers attribute the slowdown in sales to the threat of higher taxes and tighter credit that economists call for as the war escalates.

But these pat explanations for a slowdown of gains in the industry don't stand up under scrutiny. What some of the holders of Federal contracts really seem to be saying is that from an economic standpoint they can live more comfortably in a cold war, than a hot one.

They are right; it's easier. But they're forgetting that World War II provided the pressures and impetus for the development of electronics hardware as well as systems and systems concepts. Perhaps Government money flows more freely and with fewer demands on its spenders to "come across" in a cold war economy, but technology moves at a more leisurely pace.

It is doubtful that the microwave business is being hurt by the war. At least one microwave marketer says the industry pays only lip service to diversification into nonmilitary areas. Until consumer and industrial applications for microwave heating and broadcasting gear are developed, the microwave business will lack the firm footing its technology deserves.

As for the consumer electronics market, it seems a bit presumptuous of the marketers to attribute their shortcomings to the war. Wages and savings accounts are at an all-time high. The reluctance of consumers to buy color sets may be overcome when set makers demonstrate that buyers won't have to worry about the complicated adjustment and servicing that present sets still need.

Unquestionably the war is hurting some sectors of the electronics industry. Despite journeys to the Pentagon in 1967 by key NASA engineers and scientists to "save" projects they considered invaluable, large chunks were pared from the space agency's budget. For example, Congress slashed $200 million from the Apollo applications program. But some $454.7 million remains for one of the agency's potentially most valuable projects.

But even if the tremendous expenditures for the struggle in Vietnam have altered the outlook for U.S. electronics, the war cannot be used as an excuse for poor planning and management dating back months and even years—or for inadequate performance in the months ahead.

Heading toward a record

Despite the war, the consensus of the experts is that things will be pretty good during 1968—sales will be up 6.7% to put the industry at a record $23.6 billion. Among the areas of particular interest are these:

- Computers. They continue to be the darling of the electronics industry. Average annual growth has been 20% over the past five years and no slackening is predicted during this year. The integrated circuit will continue to be the handmaiden of computers as they grow in sophistication and complexity. The fly in the computer ointment remains the development and debugging of software on schedule.
- Avionics. The Federal Aviation Administration is rebounding from twin insults—budget cuts and Congressional criticism—to undertake several important air-safety programs in 1968. The agency's programs could be the forerunners of systems that could handle 140 million domestic takeoffs and landings per year in the late '70's. In 1968, commercial and military sales of flight control and instrumentation systems are expected to be up 10%.
- Communications. Three sectors account for an estimated 13% rise in the communications market: telemetry (reflecting large NASA contracts), mobile radio, and microwave relay gear.
- Educational electronics. Although overnight gains are not to be expected, experimental projects that will get under way or continue this year will add to the weight of experience gained in this fertile new field. The Office of Education, for one, will budget $400 million for equipment for local school systems, most of it electronic.
- Medical electronics. Medicare and Medicaid programs mean greater patient loads requiring analytical instruments to replace many hard-to-find technicians. The field is expected to experience a gain of 13%.

While 1968, by comparison with the spectacular growth years that preceded it, may not be a vintage year, it holds great promise.

What's the biggest problem plaguing RFI filter designers? Well, poor attenuation from available filter components has to be one of the most troublesome. Optimum attenuation leaves a lot to be desired. Our engineers tackled the problem and found we already had a solution.

It's a ferrite material we call Ferramic® O-5. This material has established an outstanding reputation for use in chokes, inductors, and transformers operating over the frequency range from audio to the broadcast band. But it does an about face and its attenuation climbs like a rocket from 10 KHz up through the megacycle range. And it exhibits extremely high permeability and dielectric constant throughout this range.

In short, our O-5 ferrite is about the finest RFI filter material made anywhere and is available as a standard production item. In addition, we have other materials, like H and Q-1 ferrites that do an excellent job for similar applications. This is just one more example of the new uses of ferrites in a widening range of industries.

Because of our demonstrated ability to handle RFI filtering problems we now have various new materials and applications under development for both the military and commercial markets. You'll be hearing about them soon. So if you have an RFI filtering problem, you ought to find out what we've got. Just write Mr. K. S. Talbot, Manager of Sales, Indiana General Corporation, Electronics Division/Ferrites, Keasbey, N.J.

INDIANA GENERAL

When it comes to filtering radio frequency interference Indiana General has what it takes.

Electronics Newsletter

January 8, 1968

Hughes to backstop TRW's Intelsat 3

Comsat has decided to go along with TRW and the Intelsat 3 satellite, but has told Hughes Aircraft to start building—as a backup development—an upgraded version of the Intelsat 2 satellite for launching in July. Development problems delaying the TRW satellite forced Comsat to hurriedly set up two teams to study the situation [Electronics, Dec. 11, 1967, p. 25] and to consider Hughes' offer to build a 1,000-circuit Intelsat 2 craft, dubbed 2.5, by July. But the teams reported that neither company had a better than 50-50 chance of delivering a satellite in time for its use to relay television signals from this fall's Mexico City Olympic Games.

These reports, plus strong assurances from ITT that it would deliver the communications subsystem for the Intelsat 3 without further delays, prompted the Comsat decision. The upgraded Intelsat 2, to be assembled from parts already built, will have a capacity of 600 to 800 circuits, somewhat fewer than planned for the 2.5 craft. Negotiations are now in progress to determine how much uprating Hughes will do with the satellite.

Bell Labs weighs a giant Illiac 4

A gigantic parallel-processor computer designed along the same lines as the University of Illinois' Illiac 4, but more than 100 times larger, may be built at Bell Telephone Laboratories. The basic processor would be designed around a monolithic arithmetic unit built as a large-scale integrated circuit. **The entire computer would be conceptually capable of working with as many as 32,000 such units at once.** Illiac 4 will have only 256 small processors running in parallel.

High-Z IC op amp without FET booster

Ultrahigh input impedances—several hundred megohms and higher—in integrated circuit operational amplifiers, are usually achieved by placing field effect transistor elements in the input stage [Electronics, Dec. 25, p. 25]. **But National Semiconductor has turned the trick by applying metal oxide semiconductor (MOS) IC fabrication techniques to standard bipolar IC's; the company has developed an all-bipolar IC operational implifier with an** input impedance of 10,000 megohms, the highest input impedance in a monolithic device.

Designated the LM102, the device was designed primarily for voltage-follower applications. **It will be offered this month as a direct plug-in replacement for the μA709.** National's new IC was designed by Robert Widlar, former Fairchild engineer and inventor of the 709. It has a 10 nanoamp input current, 3 picofarads of input capacitance, and a bandwidth of 10 megahertz.

Fourier transform may ring the phones

Bell Telephone Laboratories is studying the use of a digital technique to distinguish between the various dial tones that a push-button telephone generates. **And the technique, which would replace an analog method, is based on the fast Fourier transform** [Electronics, Oct. 3, 1966, p. 52].

Still in the proposal stage, the digital scheme may not be applied to phone equipment for a long time, if ever. But its advantages are those that make digital treatment of analog signals attractive in any application—**size savings, increased signal resolution, and greater system flexibility.**

Present push-button phone systems use seven audio-frequency tones—

three for the three columns of buttons and four for the rows. A different pair of tones corresponds to each of the 10 digits. At the central exchange, a group of bulky analog filters isolates the tones and drives logic circuits that select the line being called.

Flexibility would be by far the biggest benefit of adopting a digital technique here. **With a digital setup, changes could be made in the tone-signaling system with only minor alterations, or none, in the circuitry.** With analog filters, such changes require the replacement or adjustment of every circuit in the system.

Navy orders bipolar-MOS IFF subsystem

Cardion Electronics has developed an identification-friend-or-foe (IFF) decoder subsystem for the Navy that is unusual in three respects: **it relies almost exclusively on integrated circuits, it uses both metal oxide semiconductor and bipolar circuits, and some of the IC's are plastic encapsulated dual-in-line packages.**

The Pentagon waived its usual prohibition against the lower-priced plastic, apparently confident that the plastic units will meet the military's hermeticity specifications [Electronics, April 17, 1967, p. 106].

The main elements in the IC system are series 54/74 transistor-transistor logic and advanced MOS devices, all from Texas Instruments. The total order for the circuits alone is $1 million.

New transistor move planned by TRW

Look for TRW Semiconductors to make its next move in the upward spiral in transistor power and frequency levels about March or April. **Indications are that the firm will come out with a 6-gigahertz, 10-watt device, if management opts to push frequency higher, or a 300-watt, 30-megahertz unit, if the decision is to push the power.** TRW introduced a 50-watt, 500-Mhz transistor last summer [Electronics, Aug. 21, 1967, p. 150]. Officials said then they'd be producing a 100-watt, 500-Mhz transistor within a year. The transistor will probably be built with an interdigitated cell structure.

All-digital display for NASA likely

NASA officials are expected to approve a plan to convert the Manned Spacecraft Center's flight-controller displays to an all-digital system. Present displays use an analog/digital system. By going all-digital, up to the cathode-ray tube, NASA engineers say the size of the system can be cut, reliability improved, and black-white contrast sharpened. The all-digital system will also make it possible to use as many as seven colors in the display.

NASA's information systems division at Houston has been studying the system for several years and recently started testing a Philco-built prototype. **Evaluation will be completed before summer.**

NASA engineers aren't sulking over budget cuts

Houston Manned Spacecraft Center's engineers aren't complaining about severe budget cuts because now they get a chance to perform some in-house work that in more prosperous days was farmed out to contractors. Engineers prefer to do original work instead of monitoring the work of others, says Ralph S. Sawyer, chief of the instrumentation and electronic systems division. **However, Sawyer and other NASA managers are increasingly frustrated; the cutback prevents them from planning future manned programs.**

Component and Circuit Design IDEAS FROM SYLVANIA

IDEAS/*CRTs*

Instantaneous display of computer-generated data, plus hard-copy prints in seconds.

How a Sylvania CRT lets you select and view computer data . . . and print out only the parts you want within seconds.

Here's another imaginative use for a Sylvania CRT: one-step viewing of computer-generated data and simultaneous hard-copy recording of it on Dry-Silver paper. The 3M "129" Display/Print Module also provides ready access, at many remote locations, to a single computer-memory storage bank.

In addition to electronic data processing applications, these CRT Display/Print Modules record medical data such as ECGs VCGs, and EEGs . . . duplicates sustained TV facsimile displays . . . and reproduces repeating waveforms displayed on CRT instrumentation recorders.

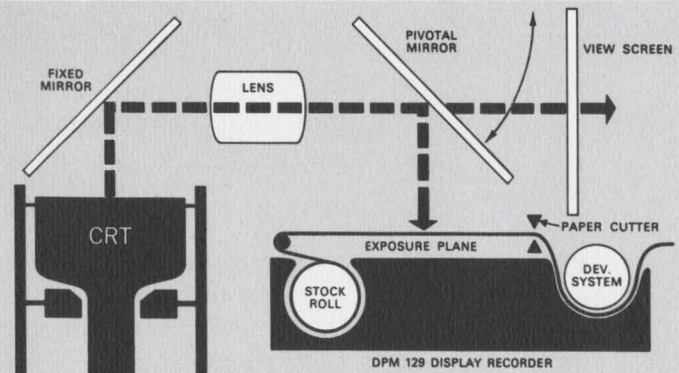
This is just one IDEA for use of a Sylvania CRT. (And we have dozens of different types—each for a specific application.)

Below are specifications for the CRT used in this 3M "129" Display/Print Module. How many ways can you use it?

SYLVANIA SC4639 CRT

Focusing Method	Electrostatic
Deflection Method	Electromagnetic
Deflection Angle	50 degrees
Phosphor	P1
Fluorescence	Green
Persistence	Short to medium
Faceplate	7-inch diameter, flat (6-inch useful screen diameter)
Length	14 inches
Trace Width	Better than 0.008 inch with light output in excess of 1,000 foot-lamberts
Anode Voltage	20,000 VDC

CIRCLE NUMBER 300



DPM 129 DISPLAY RECORDER

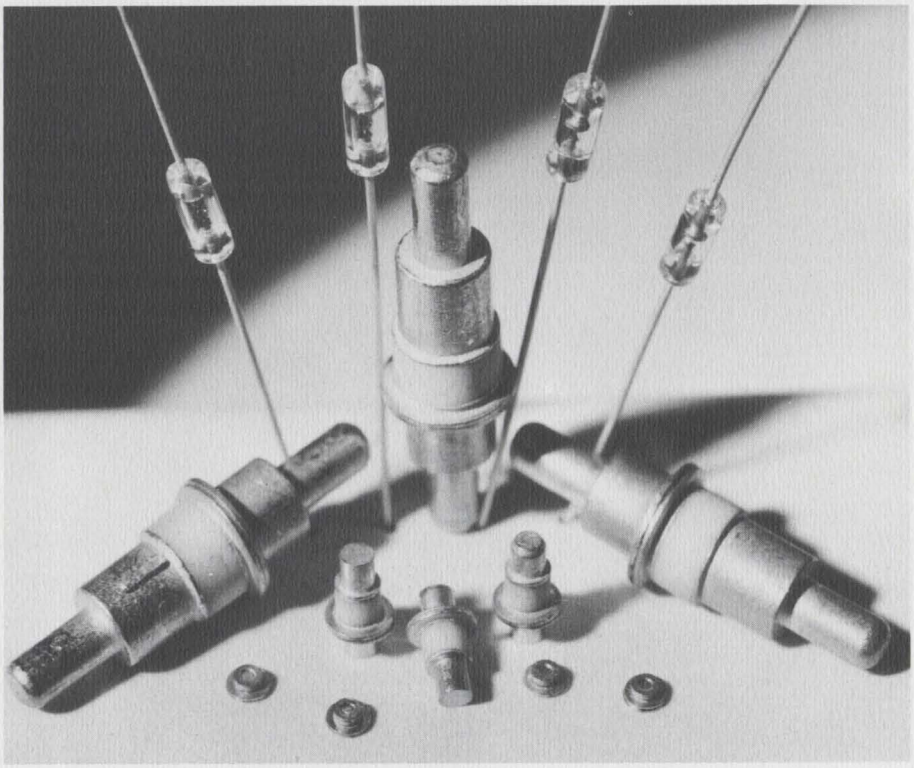
CRT provides display of computer-retrieved information. The data can then be shown, through 90° mirror deflection, on faceplate at front of module. Then, by press of a button, the readout on the CRT screen can be imprinted on Dry-Silver paper and reproduced in hard copy within ten seconds. Additional copies require still less time.

3M "129" Display CRT Print Module. Information retrieved from computer memory bank is displayed on screen at top. Press "print" button and information on screen will be reproduced on dry paper, below, within 10 seconds.

This issue in capsule

New PIN microwave switching diodes with assured R·C product (Quality or "Q" Factor).

Now, PIN configuration assures customer-specified Resistance/Capacitance product —or Quality ("Q") Factor—in microwave switching diodes.



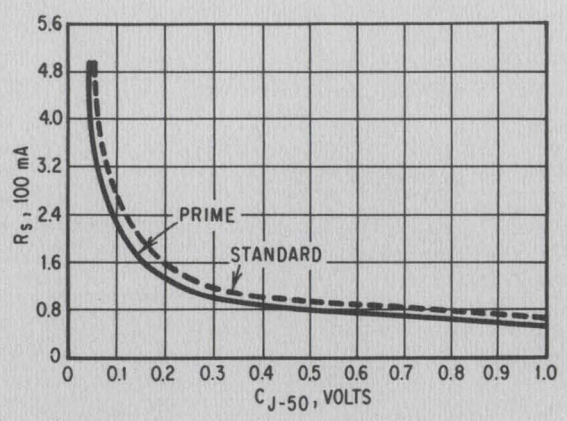
Available in a variety of package styles, both glass and ceramic-and-metal.

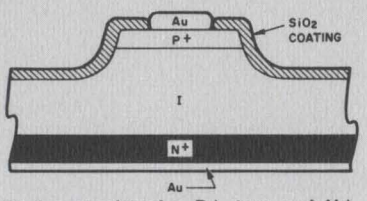
Sylvania now offers a line of PIN microwave switching diodes with an assured R·C (Quality Factor) product. In other words, you specify the maximum junction capacitance (C_J) and the series resistance (R_S) you want, and we'll provide that combination of characteristics on a unit-to-unit, lot-to-lot basis. Diodes are specified in two categories: low-cost standard and slightly higher-cost premium units so that you can obtain high performance when you need it, but don't have to pay extra for it when you don't.

Sylvania PIN microwave switching diodes are essentially voltage-dependent variable resistors, so that even at microwave frequencies they are capable of switching, limiting and controlling power from microwatts to kilowatts in cw or pulsed operation. To assure the most efficient device for operation at various power levels, these units are offered in voltage range of from 200-1000 volts.

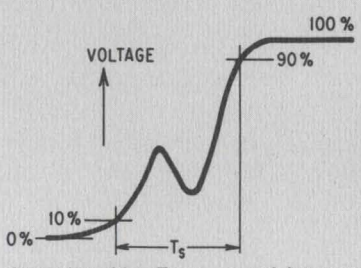
A typical forward current bias of 50 to 100 ma is required for turn-on in switching applications. Zero bias is all that is necessary to "turn off" the diode in many applications. Under a reversed bias condition, the PIN diode exhibits a gradual decrease of series resistance because of the widening of depletion layer. This process continues until the reverse breakdown voltage of the device is reached and heavy conduction starts again.

R·C curve for Sylvania PIN diodes. Broken line shows Q factor for standard units, solid line for premium units having slightly lower Q factor at slightly higher cost.





Diodes consist of a P+ type and N+ type region separated by an intrinsic layer, gold leads and a passivating layer of silicon dioxide which completely covers the junction area. Mesa construction provides high-voltage capability without sacrificing high-frequency switching performance.



Switching time, T_S, measured between the 10% and 90% points of the wave form, is about 20 nanoseconds.

We recommend them for:

- ☐ Low power switching
- ☐ Higher power switching and multiplexing
- ☐ Limiting
- ☐ Voltage-controlled attenuators
- ☐ AGC systems
- ☐ High-frequency switching
- ☐ Phase shifters

And we assure the R·C performance capability you specify.

CIRCLE NUMBER 301

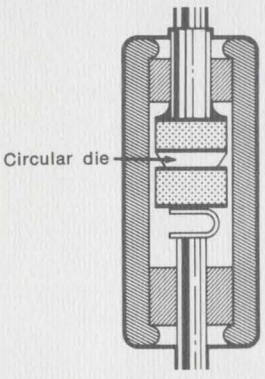
One-amp glass rectifiers that absorb 1000-watt reverse transients.

Sylvania double-diffused silicon glass-encapsulated rectifiers meet all applicable commercial, industrial and military specifications within their performance range.

Our 1-amp glass-encapsulated silicon rectifiers easily take 50-amp forward surges and 1000-volt reverse transients in stride. They have extremely low reverse leakage current: 10 nA at 25°C. Sylvania's advanced glass-to-metal sealing techniques assure virtually complete hermetic seals: Radiflo leakage rates of less than 1×10^{-10} cc/sec typical. They operate over a temperature range of from −65°C to +175°C and exceed all standard life and design requirements of MIL-S-19500.

Heat dissipation in the units is increased by welding a solid, high-conduction power lead to an oversized heat conduction stud. This increases power handling capability, makes the device last longer and keeps it cooler. The glass package is electrically neutral and smaller than most metal rectifier cases, thus permitting greater stacking and card densities. The glass body also helps improve in-process quality control by allowing visual inspection during production.

CIRCLE NUMBER 302

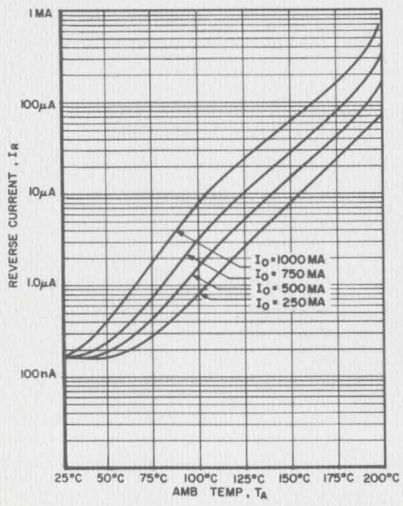


Sylvania's circular die with its truncated cross section provides better, more reliable breakdown characteristics than a straight-sided square die. This results from a uniform spreading of the field around the circular die as opposed to concentration at the corners of square ones. The truncated junction eliminates surface breakdown phenomena by controlling depletion-layer exposure at the die sides and its angle to the exposed edge. These units handle reverse power transients well over normal ratings with high immunity to catastrophic failure.

Typical Characteristics

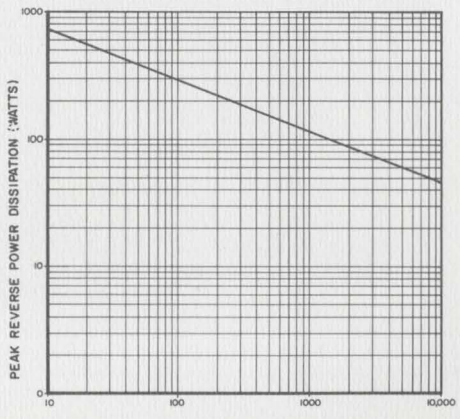
ABSOLUTE MAXIMUM RATINGS AT 25°C:	IN4383	IN4384	IN4385	IN4585	IN4586	
Breakdown Voltage, BV	200	400	600	800	1000	volts
Average Forward Current, I_o (+50°C)	1.0	1.0	1.0	1.0	1.0	amp
Average Forward Current, I_o (+100°C)	1.0	1.0	1.0	0.6	0.6	amp
Average Forward Current, I_o (+150°C)	0.3	0.3	0.3	0.2	0.2	amp
Forward Surge Current, I_F (surge) 1 cycle, F=60 cps	50	50	50	50	50	amps
Forward Surge Current, I_F (surge) recurrent, F=60 cps	6	6	6	6	6	amps
Operating Temperature, T_j	(−65°C to +175°C, all types)					

ELECTRICAL CHARACTERISTICS:			TYPES	MAX.	UNIT
Forward Voltage Drop, V_F (25°C)					
I_F=1.0 amp			All	1.0	volt
Reverse Current, I_R (25°C)					
V_R= 200v,			1N4383	10	ua
V_R= 400v,			1N4384	10	ua
V_R= 600v,			1N4385	10	ua
V_R= 800v,			1N4585	10	ua
V_R=1000v,			1N4586	10	ua
Reverse Current, I_R (+175°C)					
V_R= 200v,			1N4383	500	ua
V_R= 400v,			1N4384	500	ua
V_R= 600v,			1N4385	500	ua
V_R= 800v,			1N4585	500	ua
V_R=1000v,			1N4586	500	ua
Dynamic Reverse Current, I_R (full cycle average):					
I_O=1000ma,	V_R= 200v,	T=100°C	1N4383	275	ua
I_O=1000ma,	V_R= 400v,	T=100°C	1N4384	250	ua
I_O=1000ma,	V_R= 600v,	T=100°C	1N4385	225	ua
I_O=1000ma,	V_R= 800v,	T= 50°C	1N4585	200	ua
I_O=1000ma,	V_R=1000v,	T= 50°C	1N4586	200	ua
Dynamic Forward Voltage Drop, V_F (full cycle average):					
I_O=1000ma,	V_R= 200v,	T=100°C	1N4383	1.3	v(pk)
I_O=1000ma,	V_R= 400v,	T=100°C	1N4384	1.3	v(pk)
I_O=1000ma,	V_R= 600v,	T=100°C	1N4385	1.3	v(pk)
I_O=1000ma,	V_R= 800v,	T= 50°C	1N4585	1.3	v(pk)
I_O=1000ma,	V_R=1000v,	T= 50°C	1N4586	1.3	v(pk)



Reverse current vs ambient temperature.

MAXIMUM PEAK REVERSE POWER DISSIPATION FOR A SINGLE PULSE. (25°C AMBIENT)



SYL-PAC: The circuit boards that are finally catching up to high-speed IC capabilities.

How SYL-PAC circuit boards minimize $L\frac{\Delta i}{\Delta t}$ noise at high-switching speeds.

Until now, high-speed integrated circuits mounted on conventional circuit boards have tended to be "noisy"... or to generate spurious signals... in direct proportion to the speed of operation and the length of the current paths connecting the terminals.

In fact, it had become almost pointless to design faster ICs since, up until now, circuit-board design had not kept pace with IC speeds. Heretofore, our 50 MHz SUHL™ II TTL ICs have been limited to about 20 MHz switching speed; anything faster on available boards would result in extremely high noise levels.

But our new SYL-PAC circuit boards allow the same components to operate at about 33 MHz... and with $L\frac{\Delta i}{\Delta t}$ noise levels as much as 8 times lower than other circuit boards... a 60% improvement.

SYL-PAC board construction

SYL-PAC multi-plane laminated circuit boards are made up of two double-sided signal layers on either side of a "backbone." Signal layers are connected by plated reach-through holes, which allow the mounted ICs to contact a common power-ground plane, which carries the B+ voltage to all parts of the board (Fig. 1). With this construction, every IC lead is always within 1/64" of the power-ground source.

Such extremely short current

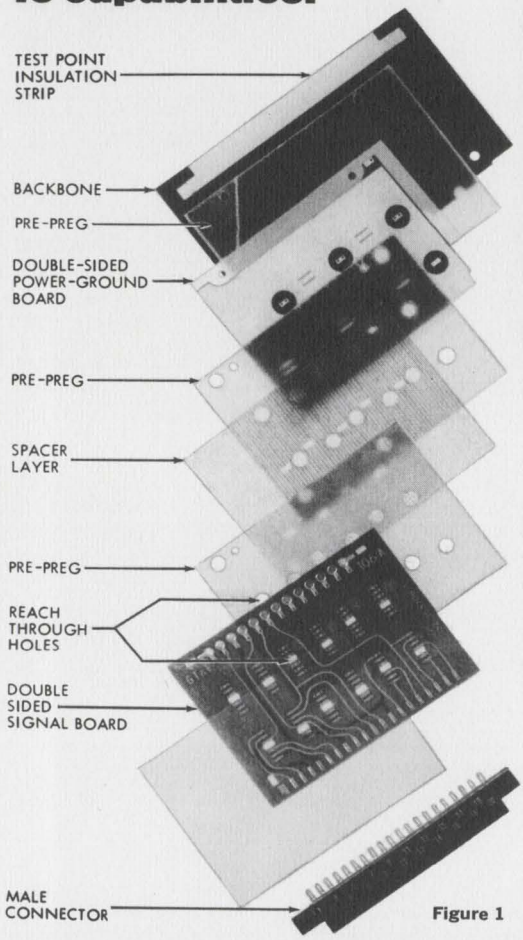
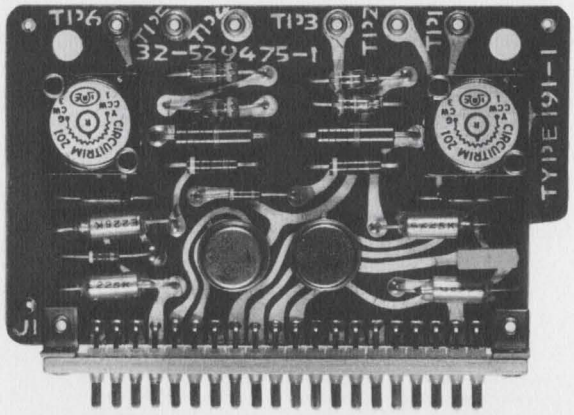


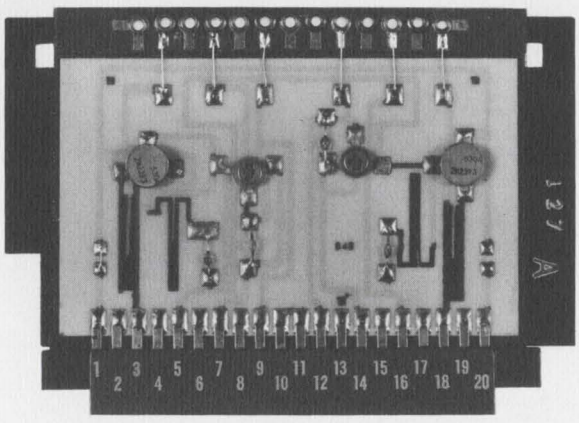
Figure 1

Exploded view, SYL-PAC laminated circuit board. Consists of a double-sided signal board, with two signal layers connected by plated reach-through holes, and a double-sided power-ground board. Any connection on either side of the board is always within 1/64" of the power-ground source.

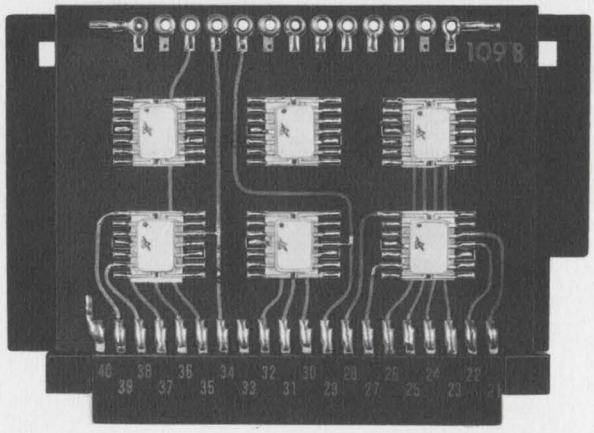
Adaptable to all forms of component mounting



Discrete-component circuit logic card. This package uses the same male connector and configuration as the IC package; both types may be freely intermixed at chassis level.



Thick-film/ceramic logic card. Here discrete components are mounted with thick-film/micro-electronic substrate components. Connectors are again the same as for the standard IC package.



Integrated-circuit logic card. Double-sided board contains up to 12 IC flatpacks or dual in-line plug-in packs. Standard board has a 40-pin double-row male connector mounted at lower edge.

connections reduce noise sufficiently to let you approach the theoretical switching-speed limits of even the fastest ICs available today, such as SUHL II units.

Reduce circuit noise

Noise, or spurious signals in a high-speed switching circuit, can originate from four primary sources:

Inherent IC noise. For this problem, start out by using Sylvania SUHL TTL logic elements and monolithic arrays, the lowest-noise units available.

Power-supply decoupling. Problem is minimized by use of controlled distributed capacitance from the power-ground planes within the SYL-PAC board. This is achieved by precise control of the quality and thickness of the dielectric elements and the parallelism of the conductive layers. In our SYL-PAC boards, the capacitance between the power and ground layers, 1500 pF per package, provides adequate decoupling for any circuit configuration.

Crosstalk, or intermodulation. Directly proportional to switching circuit speed and number of interconnecting crossovers. The SYL-PAC common power-ground plane distributes power and ground voltages evenly, eliminates excess wiring and crossovers on the signal plane, and at the same time acts as an overall capacitor between connections.

Self-induced noise. Also known as $L\frac{\Delta i}{\Delta t}$ noise, where L = inductance; Δi = pulse height, or change in current from "0" to "1" condition; and Δt = the rise time of the pulse.

This type of noise is *directly and linearly proportional* to the length of the circuit connection into which the signal is introduced. The extremely short connections characteristic of our SYL-PAC boards—particularly to the power-ground plane—can reduce $L\frac{\Delta i}{\Delta t}$ noise by as much as 8 times in comparison with other board designs.

Faster operating speed

Because SYL-PAC boards with SUHL low-noise IC components reduce circuits noise so significantly, they let you operate your high-speed switching circuits at much higher speeds without fear of spurious signal interference.

CIRCLE NUMBER 303

How about a 12-inch B&W picture tube for less than 12¢* a square inch.

Modifications in basic design are one of the factors which can increase the cost of picture tubes. This new 12" B&W standard tube is designed to sell for an extremely low price, in large quantities and without modifications.

Black-and-white TV set manufacturers—particularly of small-sized sets—have run into increasing price competition in recent years from low-cost imported sets.

To meet the challenge, Sylvania has designed a new low-cost 12" picture tube which allows U.S. set manufacturers to be competitive again in the small-size B&W set market. Our new 12DEP4 incorporates all the quality components and engineering advances found in every Sylvania CRT. No performance characteristic is sacrificed... yet the tube costs less.

Sylvania has developed the tube to sell in OEM quantities for about $9.00*. We can deliver any changes you wish, of course, but each one will increase the cost per unit.

Why was the 12" size selected?

From the glassmaking standpoint, a major picture-tube bulb manufacturer recently conducted a survey to determine the most acceptable tube size for the small-screen, low-cost B&W set market. The survey solidly established the 12" size as the most popular.

From the electronics standpoint, Sylvania has determined just which focus and deflection voltages, gun-mount configurations, anode-button location and other design considerations are most desirable.

The result is a picture tube which incorporates all the most popular features manufacturers have requested in the past... in a single 12" size which we can now deliver in volume. Custom variations on the basic model... and other sizes such as 6", 9", 11" and 13"... will cost more, naturally.

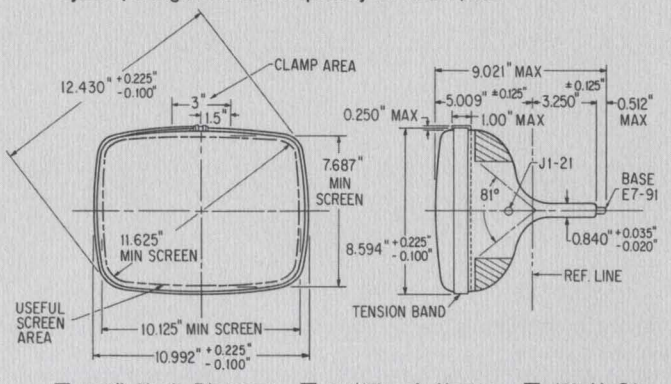
But design this tube into your next portable model and you can market a "MADE IN U.S.A." TV set that's competitive in price with foreign imports of the same size. And you get all the service and delivery benefits that only a domestic manufacturer can offer.

We feel that you'll make up in unit volume what you miss in "uniqueness of screen size".

*Determined in accordance with standard terms and conditions of sale.

CIRCLE NUMBER 304

Dimensional drawing, Sylvania Type 12DEP4 B&W picture tube with 12" diagonal screen, T-band integral implosion protection system, designed to sell in quantity for about $9.00.*



☐ .840" Neck Diameter ☐ 6.3/450 mA Heater ☐ 100 V G2 ☐ Non-ion Trap Gun ☐ 110° Deflection Angle ☐ Anode Button—Short side

How to make a low-cost TTL serial adder-subtracter.

Serial adder-subtracter subsystems are simpler than parallel subsystems to design and construct, and require fewer components. They cost less, and are ideal for medium-speed computers.

These diagrams (Figs. 1 and 2) indicate the packaging and interconnection economies permitted by serial adder subsystems.

In a *parallel* adder subsystem, the number of SM-10 adders must equal the number of bits being processed simultaneously, i.e., a 64-bit storage register would require 64 full adders.

But in a *serial* adder subsystem, only one SM-10 adder is required regardless of the capacity of the storage register. A 64-bit serial system would require 64 storage registers but only one single SM-10 adder, greatly simplifying wiring and reducing component costs.

Such subsystems are recommended for what, today, we call "medium-speed computers." But today's SUHL and monolithic-array TTL ICs are so fast that these low-cost *serial* subsystems actually operate at speeds comparable to many *parallel* adder subsystems presently in operation: about 200 ns/bit. That means our serial adders can process a 24-bit number in 3 to 4 ms. If that's fast enough for you, systems like these can save you money.

The first subsystem (Fig. 1) will add or subtract two 4-digit binary numbers, depending on the logic levels applied to the mode control. A logic "0" level applied to the subtract control will produce a difference; to the add control it will produce a sum. For a sum or difference, the contents of the A and B registers are clocked into the SM-10 full adder, one bit at a time, and the result is stored in the B register.

If adding, the result in the B register is the sum. If subtracting, the Most Significant Digit (MSD) must be checked for "1" or "0". If the MSD is "1", the B register is complemented to obtain the difference, which will be a positive number. If the MSD is "0", the B register is shifted right four times to facilitate end-around carry and provide the difference, which in this case would be a negative number.

The second subsystem (Fig. 2) performs addition only, in the same manner as the first, with the final sum appearing in the B register. Both subsystems are open-ended, and can be expanded to handle numbers of any size merely by increasing the number of flip-flops in the A and B registers. No additional SM-10 fast adders would be required in either case.

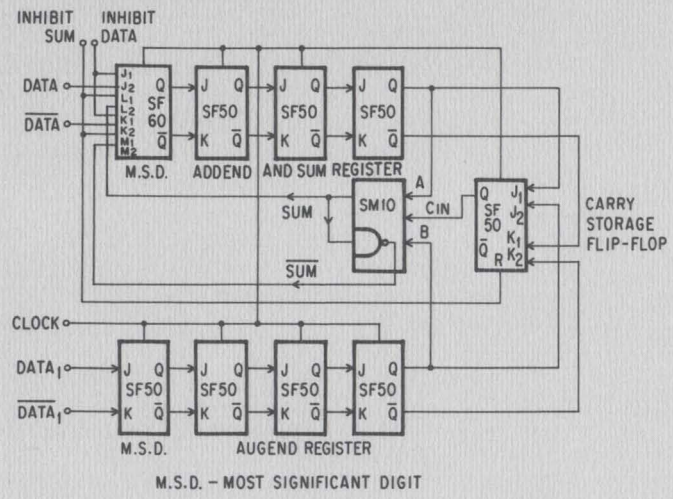


Fig. 1. Serial adder-subtracter subsystem uses SM-10 full adders, SF-60 OR J-K flip-flops, SK-50 AND J-K flip-flops, an SG-110 AND-NOR gate and SG-140 NAND-NOR gates. The full adders are monolithic arrays; the gates and flip-flops are standard SUHL integrated circuits.

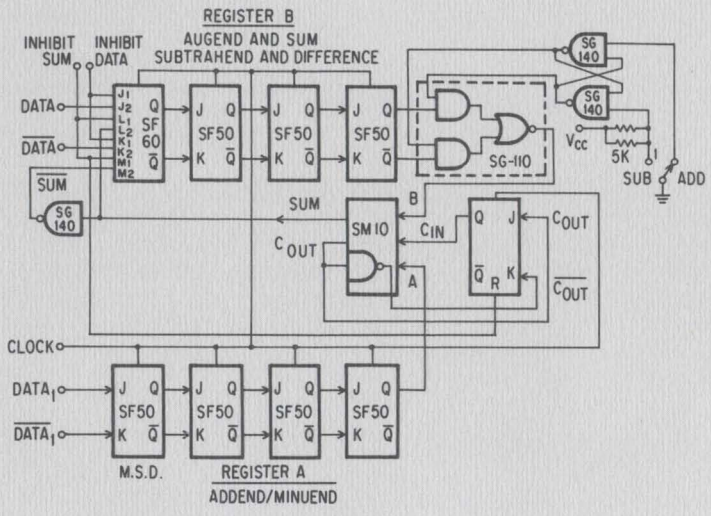


Fig. 2. Simpler subsystem performs addition only. Both subsystems can easily be expanded to handle larger numbers simply by increasing the number of flip-flops in the A and B registers.

CIRCLE NUMBER 305

SUHL™ TTL ICs help create a 131,072-bit airborne memory weighing less than 7 pounds.

The new SEMS 5™—Severe Environment Memory System—to be demonstrated at April JCC. Miniature militarized unit was designed by Electronic Memories, Inc., of Hawthorne, California.

SEMS 5 is designed for aerospace applications where small size, low weight, high reliability, high speed and minimum power requirements are demanded. It can withstand 10G vibration, 30G shock over a temperature range from −55° to +85° C. It weighs 6.9 pounds and has a volume of only 132 cubic inches. It has a cycle time of 2 microseconds and an access time of 700 nanoseconds.

It can be built to custom specifications, with memory storage capacities of from 256 to 16,384 words from 8 to 32 bits each. Voltage requirements are +15 v, +5 v and −5 v.

The system uses SUHL TTL integrated circuits for logic, sense amplifiers, address decoders, data and address registers. Logic interface is TTL positive true. Both clear/write and read/restore are standard modes. Optional modes include split cycle (read/modify/write) and buffer cycle. Memory access is by initiate and read/write mode lines or by read/write pulse lines.

Use of SUHL ICs simplifies wiring to increase reliability. Each coincident-current memory plane contains eight bits instead of the usual one. Only three wires instead of the normal four are used, with a common line performing both sense and inhibit functions.

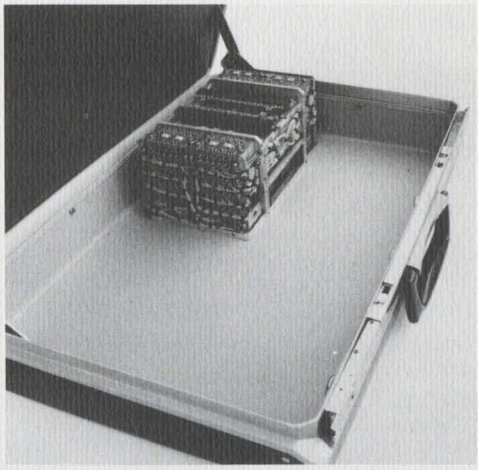
This eliminates a large number of electrical interconnections where many memory-stack failures can occur.

The unit uses approximately 50 Sylvania ICs: SG-40 and SG-140 dual 4-input NAND-NOR gates. Both are monolithic epitaxial saturated high-speed logic elements.

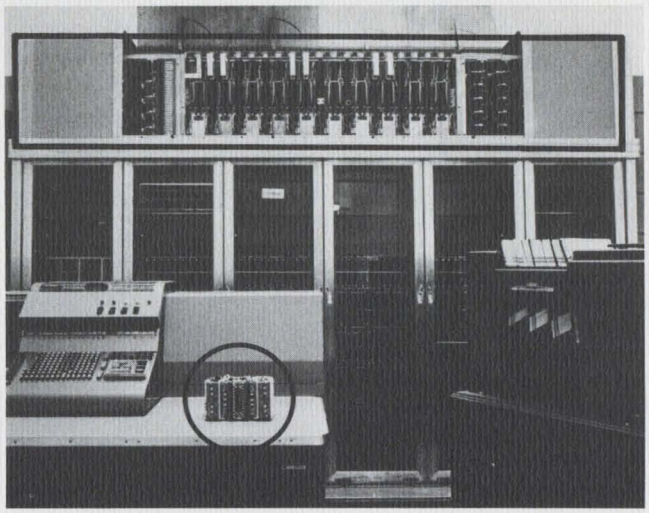
Electronic Memories naturally turned to SUHL TTL ICs to get the performance they wanted into the space available. They also inform us that: "Unfortunately, no failure data is available on the performance of your circuits, nor do (we) know when this would be available."

Because, obviously, none have failed yet . . . and none are likely to.

CIRCLE NUMBER 306



Tiny, rugged SEMS 5 militarized airborne memory system has memory storage capacity of 4096 words of 32 bits each. This extremely high packaging density is made possible by use of Sylvania SUHL TTL ICs.



SEMS 5 (circled), on table in foreground, compared with an older, discrete-component memory system of comparable memory capacity (in rectangle). SEMS 5 was designed and produced by Electronic Memories, Inc., of Hawthorne, California.

"Black and white TV receivers are dead."

How often have you heard this said?

Sylvania has a more positive approach. To paraphrase Mark Twain, we think that reports of the B&W set demise have been grossly exaggerated.

At present there are about 66 million B&W TV receivers in use in the United States, and about 7½ million were sold here in 1966. Hardly a dead market. People are still buying them for many reasons: low cost, small size and weight, portability, brightness, contrast, resolution and ease of servicing, just to name a few.

So the question is not whether to revive a dead market. It's to recapture a bigger share of a very "live" market which has been increasingly lost to foreign competition.

People buy foreign B&W sets—as opposed to domestic—on price. So to start with, you have to get the price down to compete.

One way is standardization. A decision to go with, and stick with, a standardized line of picture tubes, receiving tubes, circuitry and related components in a set that's standard except for external styling. Once this decision has been made, components can be designed into a marketable set at a very low cost.

As a start, we've developed a standard 12" B&W picture tube—the most expensive single component in a TV set—and designed it to sell, without variation, in OEM quantities for around $9.00*. (See article elsewhere in this issue.) Together with other standardization economies, this makes it possible to assemble, distribute and market a 12" set at a very low retail price.

*Determined in accordance with standard terms and conditions of sale.

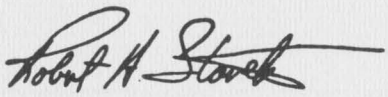
We didn't settle on the 12" size arbitrarily. As the companion article indicates, a recent survey conducted by a major picture-tube bulb manufacturer on consumer preferences in portable TV sets shows the 12" size to be the overwhelming favorite.

In deciding upon a standardized picture tube at such a low cost, you can offer the most popular features ever built into one picture tube without sacrificing any of the engineering leadership and quality assurance measures that have made Sylvania B&W picture tubes number one in the industry.

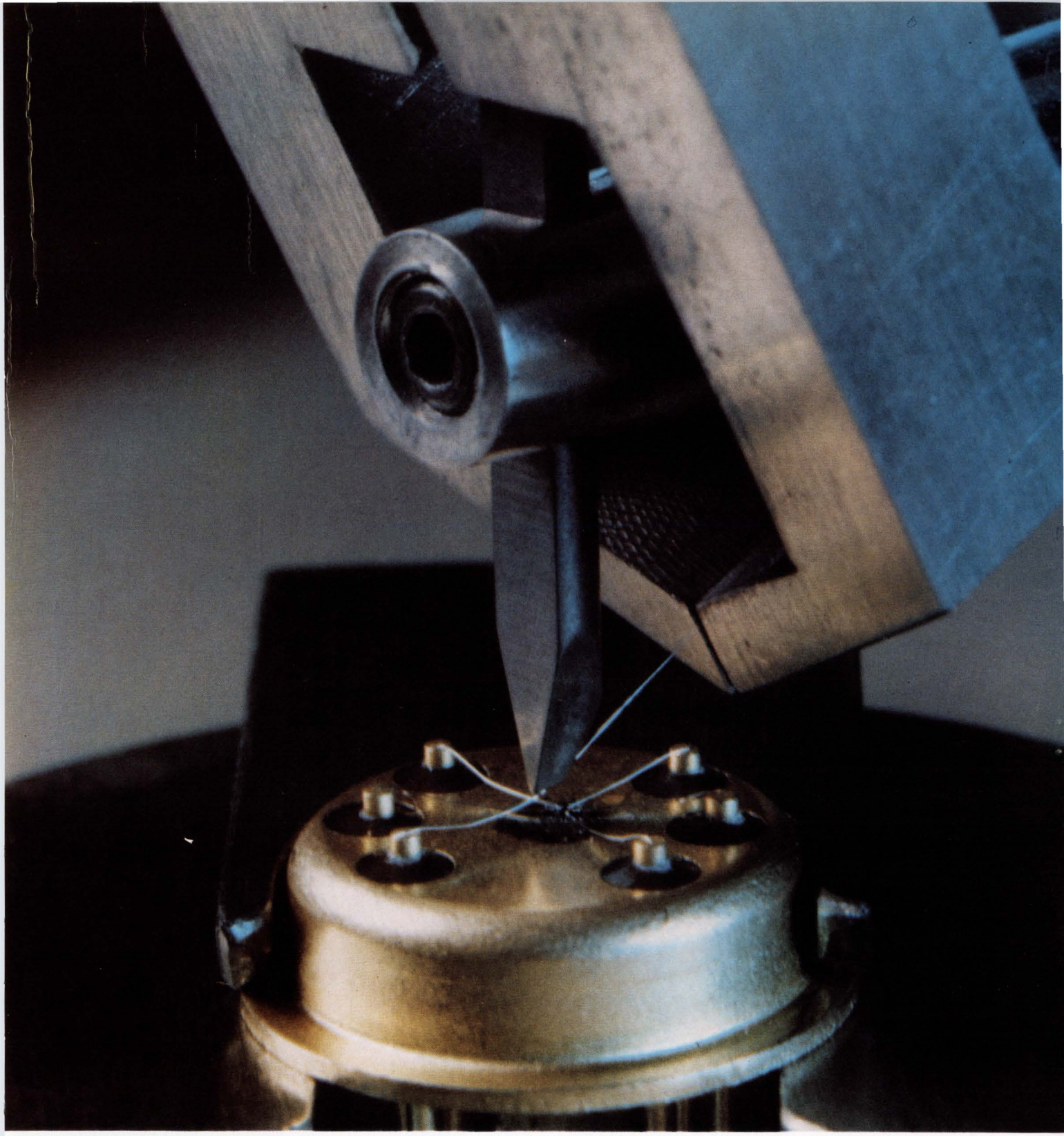
Our design and field-engineering staff still provide the full range of services and technical assistance you expect from Sylvania—and which you've probably learned *not* to expect from overseas manufacturers. With exception of the glass bulb, we still manufacture and process every component that goes into these tubes—and to our own unmatched quality standards.

The reason we can bring you a picture tube at such an extremely low price is volume production. That can be achieved only through wide acceptance of a standardized product.

Work with us and we'll help to show you that a market you may have considered "dead" is still very much "alive."



Robert A. Starek
Product Marketing Manager
Picture Tubes



Craftsmanship in hard materials...an industry standard

HIGH PRECISION TUNGSTEN CARBIDE BONDING TOOLS, SUCH AS THE ONE SHOWN IN THIS 13× MAGNIFICATION OF AN ULTRASONIC LEAD BONDING OPERATION, WERE PIONEERED AND INTRODUCED AS PRODUCTION DEVICES BY TEMPRESS . . . IN 1963, THE TEMPRESS CAPILLARY TUBE, AN INDUSTRY STANDARD . . . IN 1967, THE ULTRASONIC BONDING TOOL, AN INDUSTRY STANDARD.

The techniques and the specialized machinery developed to produce such precision products from ultra-hard materials have not been duplicated; quite probably will not be, for they are a result of the unique combination of Tempress people and the Tempress philosophy. To meet its responsibilities, Tempress maintains a continuing expansion program, limited only by strict adherence to the Tempress Standard of Excellence. (It requires as long as 11 months to train an operator for certain operations.) The same uncompromising standard is applied to Tempress Automatic Scribing Machines and to the entire growing family of Tempress miniature assembly tools and production equipment.

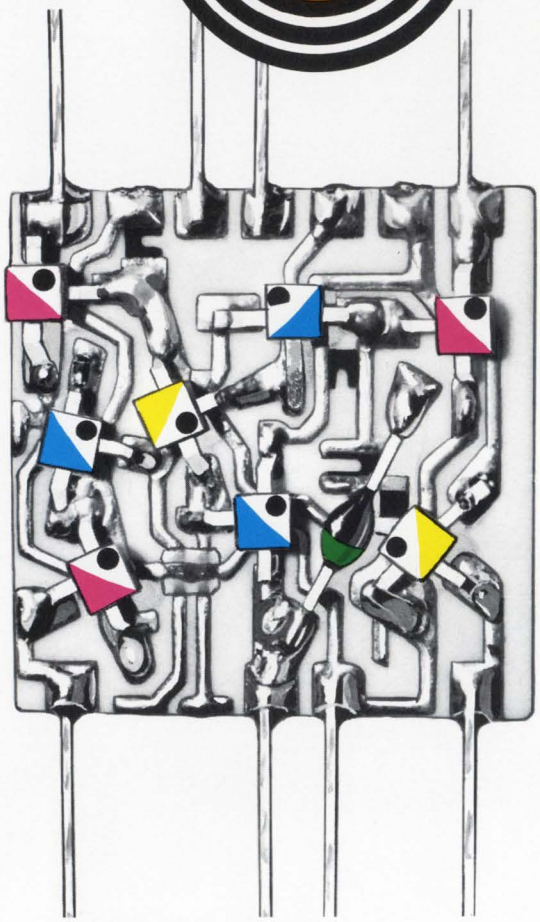
LEAD BONDING, DUAL FET, COURTESY OF UNION CARBIDE ELECTRONICS

TEMPRESS

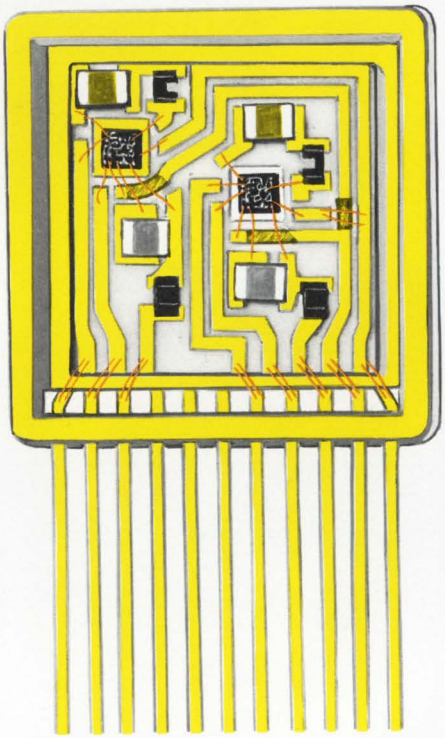
Tempress Research Co., 566 San Xavier Ave., Sunnyvale, Calif. 94086

Circle 35 on reader service card

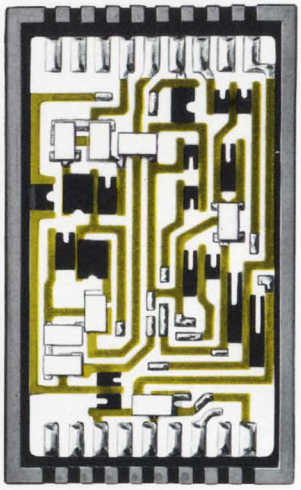
PASSIVE & ACTIVE TOTAL



Miniature Discrete Devices – Planar Soldered Construction – Conformal Coat



Uncased Monolithic Chips – Thermal Bond Construction – Hermetic Flat Pack



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1 **CTS CERMET PROVIDES GREATER STABILITY** under all operating conditions, particularly high temperatures. CTS cermet is a patented resistive material available only from CTS.

2 **EXCELLENT TC.** Exclusive CTS cermet provides excellent temperature coefficient at high sheet resistance (ohms per square).

3 **ATTACHMENT TECHNIQUES.** Six methods of attaching active devices are available: chip and wire; flip chip; LID attachment; beam lead; welded or soldered planar construction and hole through. These techniques allow unrestricted use of all semiconductor device types.

4 **PACKAGING.** Packaging includes hermetic seal using T05; T08; and flat packs up to 1½" square. Conformal coat, plastic shell and transfer molding are also available.

5 **PASSIVE CIRCUITS.** CTS can also provide you with passive modules for applications where active devices are mounted externally or where you may prefer to attach the active devices to the passive module.

6 Manufactured by
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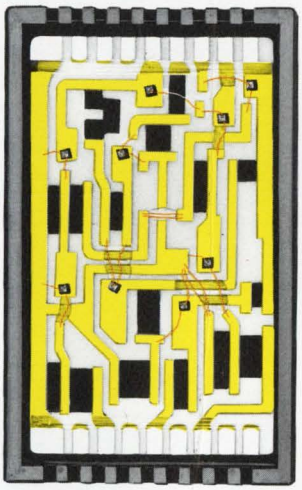
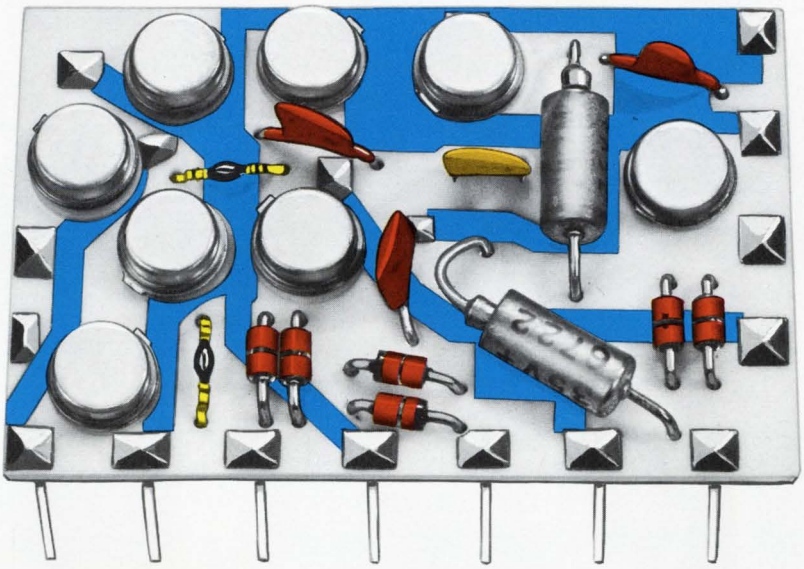
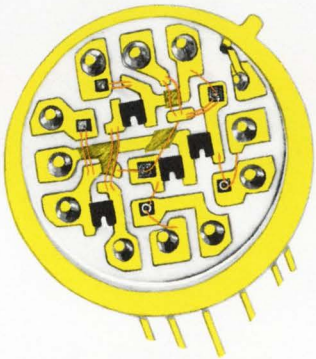
CIRCUITS
CAPABILITY



Uncased Chips – Thermal Bond Construction – Plastic Pack



Standard Discrete Devices – Hole Through Soldered Construction – Conformal Coat



Uncased Chips – Thermal Bond Construction – Hermetic T08 Pack

Note exceptionally high stability and excellent TC

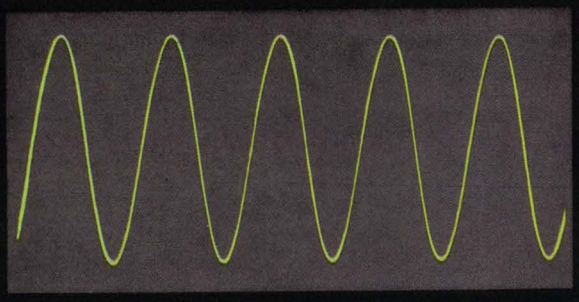
Chip (die) attach 380°C for 15 min.	0.5% △ R
Short term temp stability 500°C for 60 min.	1.0% △ R
Max hot spot temp (without solder)	200°C
Load life 10,000 hrs. @125°C	1% △ R
TC —55°C to 125°C (10Ω to 1 meg)	±100ppm/°C
TC —55°C to 125°C (1 meg to 10 meg)	±250ppm/°C
Moisture resistance	0.5% △ R
Full load temp	125°C
Solder dip @250°C for 15 sec.	0.5% △ R

Founded 1896

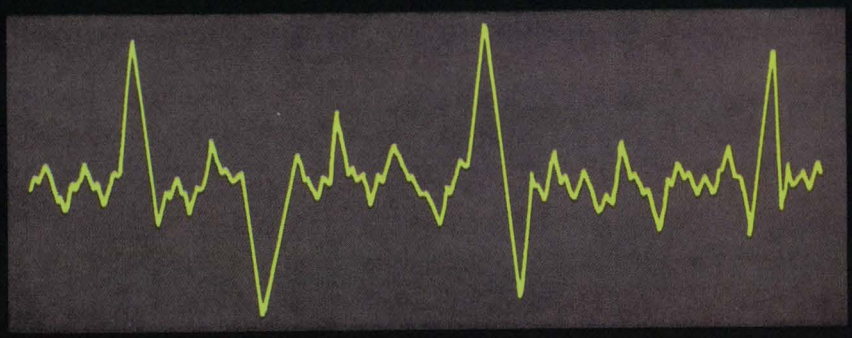
CTS CORPORATION

CIRCUITS TO SPECIFICATIONS

Is there an AC digital voltmeter anywhere that can measure this waveform accurately?



And this one too?



There is now! The new Fluke 9500A true rms automatic digital voltmeter reads these complex waveforms to an absolute accuracy of ±0.05%. And, if you know your AC's, that's progress.

Another DVM on the market? Usually that's good for a ho-hum. But as we've said above, if you know your ac's, that's not the case with the new Fluke 9500A. It's the first automatic ac voltmeter capable of reading and digitally presenting the true rms value of any input—regardless of waveform—to 0.05% absolute accuracy (50 Hz to 10 KHz). □ Frequency response is broad, 20 Hz to 700 KHz. Accepts voltage from 0.001 to 1100 volts rms in five ranges, each with 20% overranging. Range selection is automatic or manual. Crest factor of 10 virtually eliminates effects from voltage spikes or pulse trains. Low capacitance, high resistance input minimizes loading effects. □ Self-calibration is automatic whenever instrument is turned on. On-line self-calibration is either automatic or manual, selectable by front panel switching. All controls and indicators, conveniently located on the front panel, are easy to use and understand. Complete control of the 9500A is possible from a remote facility if desired. □ Price of the Model 9500A, including rack adapter, is $2,485. Extra cost options include a probe input ($75), rear panel BNC input ($50), and 1-2-4-8 or 1-2-2-4 BCD digital outputs ($195). For complete information, please call your full service Fluke sales engineer (see EEM), or write directly to us here at the factory.

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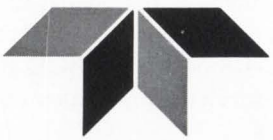
The shocking truth about Alessandro Volta who prompted Amelco to develop 18 different FET families!

Alessandro Volta invented the battery. And at the request of Napoleon in 1801, he demonstrated the power of his batteries by the flash he saw as he touched the wires to his eyelids. A slightly shocking demonstration.

The first batteries were obviously very low powered and not of much use. But today low powered batteries are in widespread use, especially in space instrumentation. And field effect transistors have helped make it possible.

To provide you with the widest possible choice of applications, Amelco has developed the largest family of FETS. Eighteen in all. So whether you're thinking of field effect transistors or bipolar transistors, chances are there is an Amelco FET to meet your needs. N or P channels, low frequency, high frequency, analog or chopper, we've got them.

And a final shock, you can order most right from stock.



For quality in quantity

AMELCO SEMICONDUCTOR

A TELEDYNE COMPANY

This painting by Kenneth Riley is one in the collection "Innovators and Leaders in the Science of Electricity," commissioned by Amelco Semiconductor. The paintings in this collection illustrate the dramatic achievements and discoveries of some of the forefathers of electronics . . . Magnes, Volta, Franklin, Henry, Edison, Shockley. The entire collection will soon be made available in handsome prints suitable for framing. They will serve as a reminder of the tradition handed down by these famous men, and as a reminder that among the leaders and innovators in the world of electronics today one name is of particular current significance. That name—Amelco.

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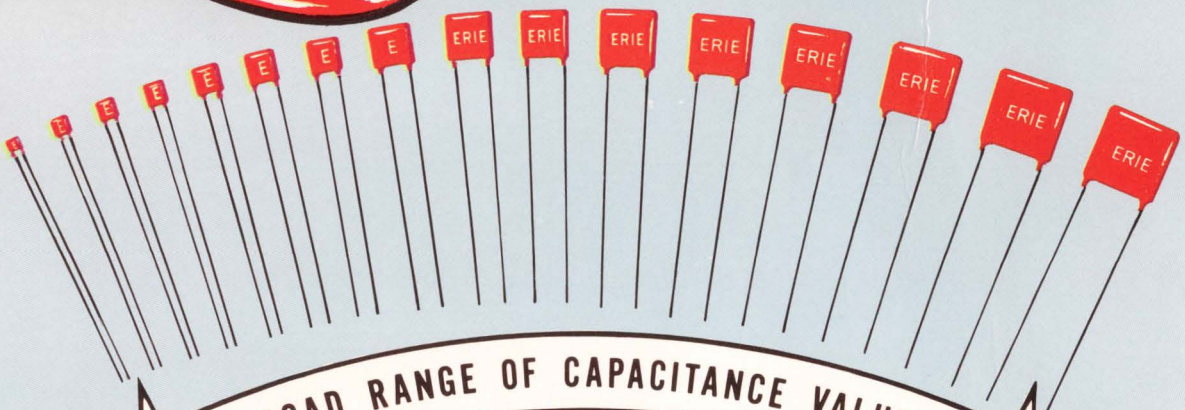
New RED CAPS



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- *Red Caps meet or exceed all applicable requirements of MIL-C-20 and MIL-C-11015 per MIL-STD-202*

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State College, Pennsylvania
Attention: Applications Engineering

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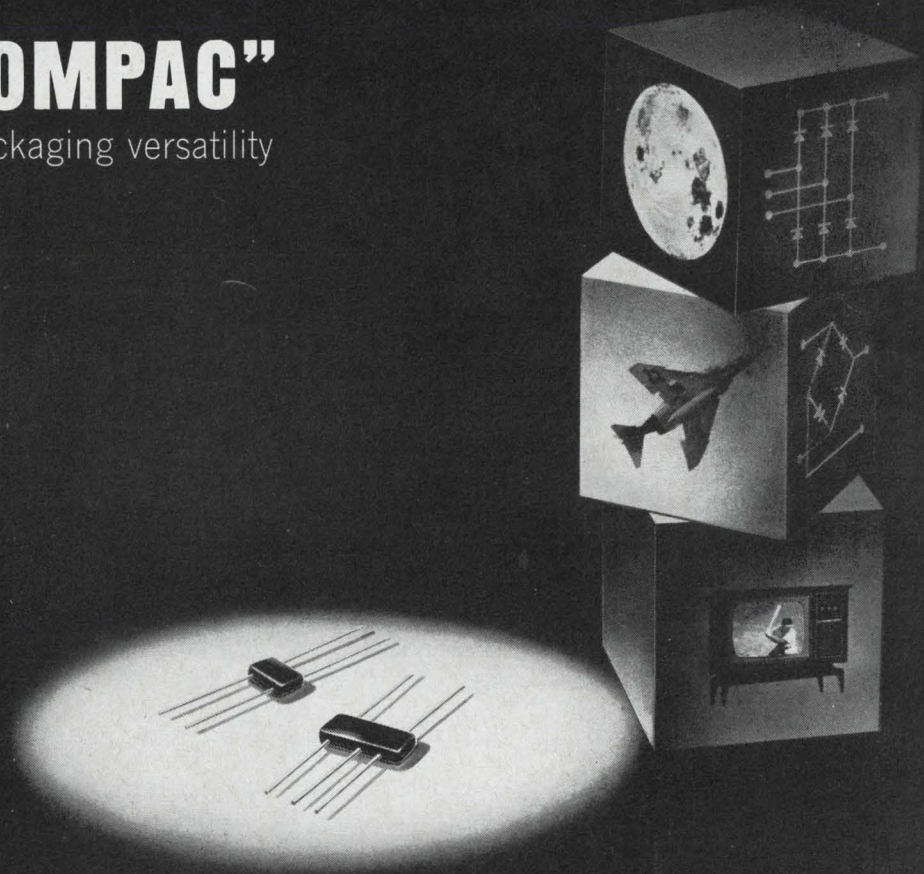
"Compac", a New Silicon Bridge Rectifier...

Semtech Corporation offers "Compac," a new silicon rectifier bridge offering packaging versatility. The units are available in a complete range of single phase and three-phase full-wave bridge rectifiers. □ Semtech's Suprataxial silicon junctions are used for maximum reliability. □ Single phase Bridges: 1.5 A, 50 to 1000 V — 360 mA, 1500 to 3000 V. Case size is .187 x .425 x .625 inches. Also available in Fast Recovery Bridges with reverse recovery of 150 ns or 1 μsec. Three-phase Full-wave Bridges: 2.0 A, 50 to 1000 V — 500 mA, 1500 to 3000 V. Case size is .187 x .425 x 1.00 inches.

"COMPAC"

for packaging versatility



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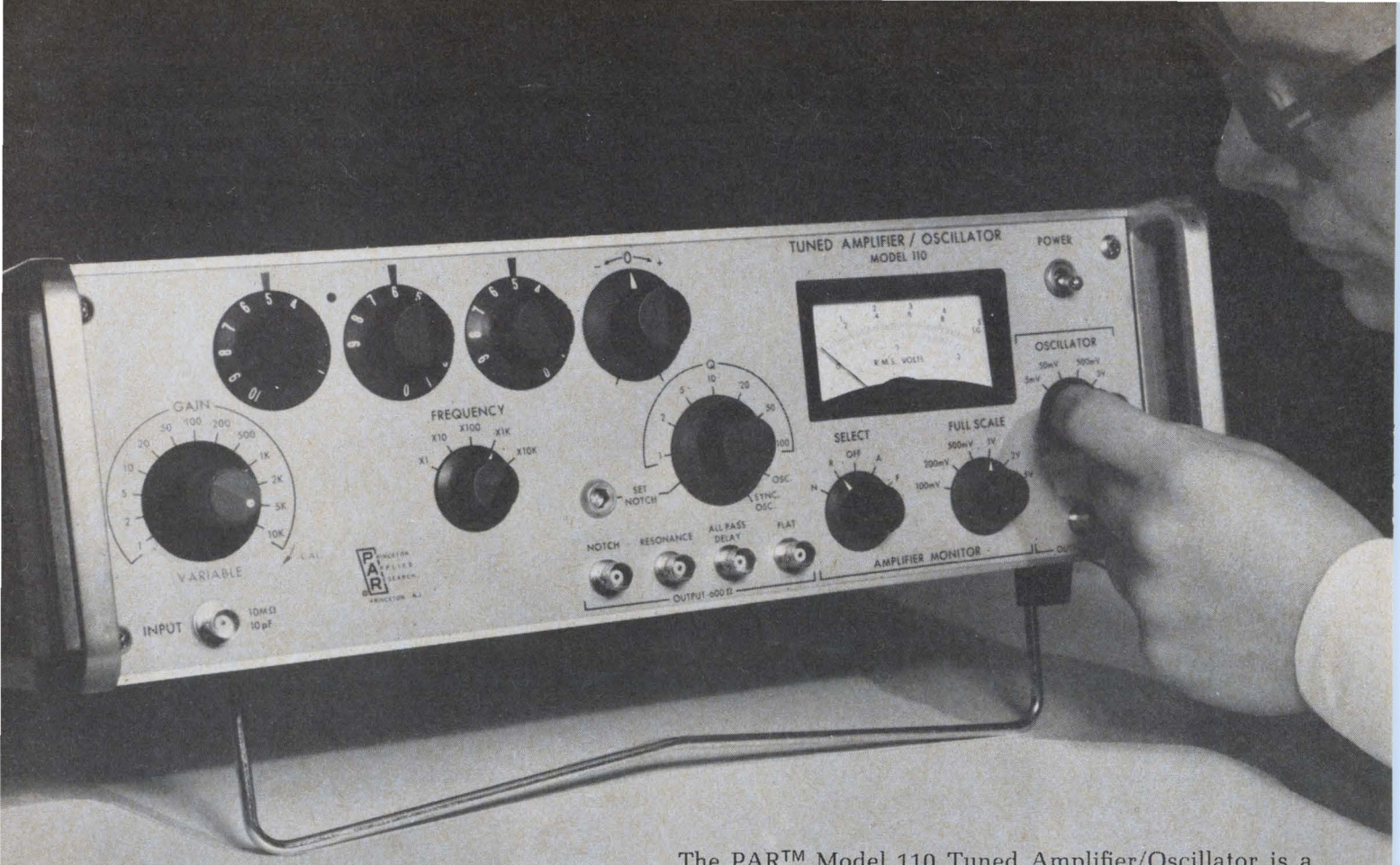

Tuned Amplifier/Oscillator is Six Instruments in One

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- LOW-DISTORTION OSCILLATOR
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- SENSITIVE AC VOLTMETER
- ALLPASS DELAY PHASE SHIFTER

The PAR™ Model 110 Tuned Amplifier/Oscillator is a frequency selective amplifier operating over the range of 1 Hz to 110 KHz with Q variable from 1 to 100 (with no gain change). This versatile unit can function as several general-purpose instruments including:

Wave analyzer with bandwidth adjustable from 1% to 100%.

Flat or selective AC voltmeter with sensitivity ranging from 10 microvolts to 5 volts rms full scale.

Distortion analyzer to measure distortion levels as low as 0.1% (as low as 0.001% when used with a second Model 110).

Low-noise amplifier (typical noise figure of 1 dB) with voltage gain ranging from 1 to 10^4.

Stable general-purpose low-distortion oscillator providing up to 5 volts rms into 600 ohms, capable of being synchronized by an external signal.

AC-DC converter with ground-based output.

Four 600 ohm outputs, each capable of delivering 5 volts rms into a 5K ohm load, are provided simultaneously: a second order (resonance) bandpass; a second order band-reject (notch) with set frequency rejection in excess of 100 dB: a second order allpass characterized by an amplitude response which is flat with frequency and a phase lag which increases monotonically with frequency; and a flat output. A front panel AC voltmeter permits measurement of any of the four outputs.

Price of the Model 110 is $1195. Export price is approximately 5% higher, except Canada. For more information, write for PAR Bulletin T-140 to Princeton Applied Research Corporation, Box 565, Princeton, New Jersey 08540 or call (609) 924-6835.

PRINCETON APPLIED RESEARCH CORPORATION

January 8, 1968

Electronics Review

Volume 41
Number 1

Solid state

See-through IC

When plastic is mentioned in the context of integrated circuitry, the topic of discussion is usually the protective coating around a dual in-line package. But engineers at the General Electric Co.'s Applications and Devices division in Syracuse, N. Y., have expanded this frame of reference by developing a Teflon-like plastic that can be used both as a bonding medium for IC's and substrates, and as a dielectric for microelectronic capacitors.

The GE team, led by J.J. Suran, C.S. Kim, and G.G. Palmer, believes the plastic will permit batch fabrication of circuits containing components previously incompatible with IC manufacture, and will also serve as a means of interconnecting large-scale integrated arrays. Further, it's transparent; the entire circuit can be inspected visually.

The process followed with the new material starts with a film substrate—thin or thick, at the maker's discretion. After a first layer of conductors and resistors has been deposited, the plastic is bonded to the substrate.

Hot and cold. Active devices, such as monolithic chips, bipolar transistors, metal oxide semiconductor field effect transistors, and even gallium-arsenide semiconductors, are then placed atop the plastic and bonded into it by a high-temperature and pressure process that liquefies the plastic. After the material is cooled, connecting links are run through the plastic by multilayer techniques. The laying of an interconnecting layer is the final step.

The result is a dual-layer, planar-like structure that uses only twice the interconnection areas required by conventional monolithics. In addition, the structure contains enough material to permit portions of the plastic to function as capacitor dielectrics. Since the material is impervious to etchants, even beam-lead elements can be isolated after the bonding steps. The plastic isn't frequency-dependent, and it accommodates all types of electronic circuits, from d-c into the microwave region.

The company has yet to decide where the first circuits will be used, Suran explains.

The team plans to report details of its work at the International Solid-State Circuits Conference, Feb. 14 to 16.

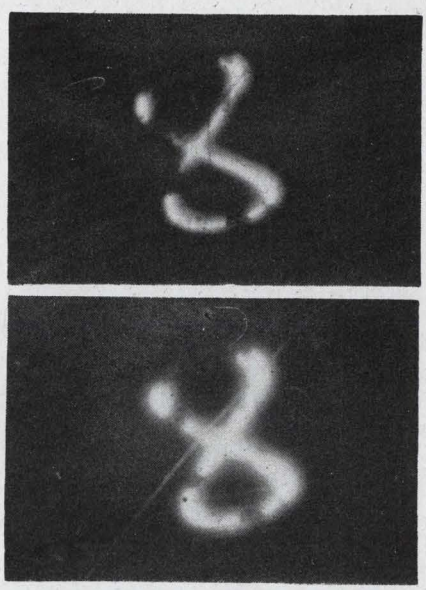
Consumer electronics

Lights out

If you can see the picture on your portable television set outdoors, you must be watching it in the shade. Usually, the sun's rays wash out tv pictures by overloading the phosphor on the inner face of the picture tube. This could become a thing of the past, though, now that Hartman Systems Co. of Huntington Station, N.Y., has developed what it calls a black-face cathode-ray tube.

Under contract to the Electronics Research Center of NASA, Hartman Systems, an affiliate of the Mid-Continent Manufacturing Co., based its new tube on the idea of letting the picture out while preventing outside light from getting in.

One way. The tube uses a four-layer faceplate that lets light pass only in one direction—out. Innermost is a layer of modified P-16 silicate phosphor. When the electron beam strikes this layer, it radiates ultraviolet light at about 300 to 500 millimicrons. This light passes through an optical bandpass filter and then strikes a layer of doped uranium oxide glass. The glass fluoresces, but at longer wavelengths than the original P-16 phosphor; its emission is about 500 to 700 millimicrons.



Bright. Sunlight doesn't wash out the image on a crt. Top photo shows crt face plate taken in shade; lower photo shows same image in sunlight.

It's the second emission that forms the picture as it passes through the tube envelope and a green or red plastic optical filter. Neither the light from the uranium oxide layer nor ambient light can reach the inner phosphor layer. It's stopped by the ultraviolet bandpass filter. Sunlight cannot affect the fluorescent glass layer since its ultraviolet components are stopped by the outer plastic filter.

Obstacles. Hartman developed the tube for the research center's control devices section as part of a program to provide displays for brightly lit cockpits or control centers. But Kenneth P. Lally, who heads Hartman's display group,

feels the tube has a good potential for home applications, too. Before either aerospace or consumer markets can be tackled, however, there are a couple of obstacles to overcome.

The most important is development of a new filter to replace the uranium-doped glass used in present tubes. The glass is so brittle and hard to handle that Hartman engineers have been forced to use layers about 20 mils thick; this makes the tube stronger but lowers resolution by a factor of three. Also, only small diameters are available with the glass, so far the largest tube has been only about three inches.

But Lally is confident of producing tubes of any reasonable size. Hartman is about six months away from a process that would substitute a thin film only five mils or thinner for the fragile glass filter. "This should let us resolve display spot sizes only about five mils in diameter," says Lally. By contrast, "commercial tubes reach spot sizes of about 10 to 15 mils."

Lally's group also plans to try to reduce accelerating voltages from the present 10 to 15 kilovolts—required for the P-16 phosphor—to something approaching the 2 to 3 kv used on most monochrome tv sets, which use zinc sulphate. But this may not be a disadvantage, says Lally, since color sets already use beam voltages of about 25 kv.

Computers

Numbers game

"The problem is that we are attempting to tie a complex set of variables to a simple number representing the mean-time-between-failure," says Malcolm A. Young, director of reliability for the International Business Machines Corp.'s Federal Systems division.

Young is one of a number of reliability men who are becoming increasingly critical of the way failure rates are determined in describing components and systems for NASA and the Defense Department. The MTBF, as it is commonly called, is all-important from the government's position in describing the reliability of a product, and all-important to industry, since monetary incentives and penalties often ride on the validity of the predicted figure.

Failure rate. Young believes there are several critical variables that are not being considered by many in industry. More important, they are not defined in military handbook 217A—the publication that serves as the bible for reliability. He points out that 217A, for example, does not even mention duty cycle, which he compares to rating the horsepower of an engine without noting the rpm. Involved in the criticism of the duty cycle is that no data is provided for determining "the time towards failure" if a device is not operating. "Is 10 hours of off-time equivalent to one hour of operating time on a device, or is it more?" Young asks.

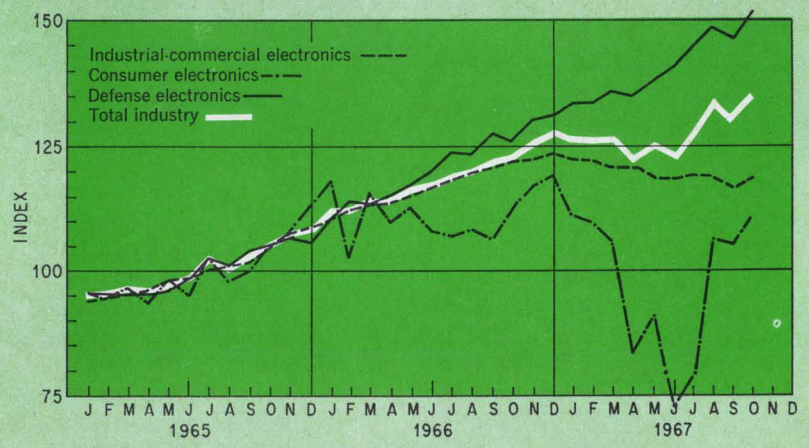
Another variable listed as crucial by Young is the temperature at which equipment is tested. He says that the common use of ambient temperature in rating equipment is not meaningful since "it does not give the temperature at the source of a failure or at the point where a failure is liable to occur."

Screening is another point that leads to trouble. Contractors are not including in their figures the degree, amount, or method of screening to weed out parts that have a high failure rate.

Finally Young says: "Above and beyond screening, the manufacturing process is one of exposure, which can result in making or breaking a system's reliability. I maintain that, if you took an identical design and gave it to company

Electronics Index of Activity

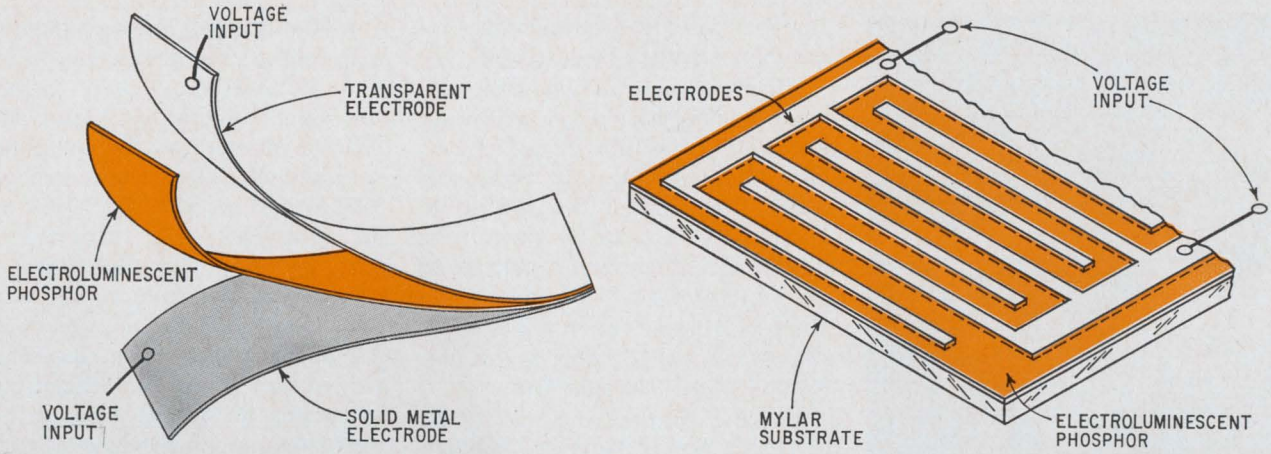
January 8, 1968



Segment of Industry	Nov. 1967	Oct. 1967*	Nov. 1966
Consumer electronics	113.2	107.3	119.5
Defense electronics	147.2	149.9	129.9
Industrial-commercial electronics	120.2	116.9	122.3
Total Industry	133.5	133.1	125.5

Electronics production improved slightly in November, edging up 0.4 index point from October to 133.5. At this level, the over-all index was up 8 points from November 1966. Consumer volume climbed 5.9 points from the prior month, and industrial-commercial output rose 3.3 points to halt an 11-month slide. But these gains were partly offset by a 2.7-point drop in defense electronics production, the third straight monthly decline in this sector.

Indexes chart pace of production volume for total industry and each segment. The base period, equal to 100, is the average of 1965 monthly output for each of the three parts of the industry. Index numbers are expressed as a percentage of the base period. Data is seasonally adjusted.
* Revised



The old and the new. Conventional electroluminescent panel, on the right, is made like a sandwich with phosphor in the middle and sheets of electrodes on the outside. Cornell Aeronautical Lab's single-layer panel is made by depositing a conducting film, etching out electrodes, and then spraying on phosphor.

A and to company B, they would come out with different reliability although the design-stage MTBF derived by conventional means would be the same. The MTBF might be as different as 1,500 versus 2,000 hours."

Handy book. The IBM official is not altogether pessimistic. He says the Defense Department is now at work on a new version of the handbook that will attempt to get at some of these variables. And he points out that companies such as IBM, which derive figures from their own data, have been contributing.

At the Rome Air Development Center at Griffiss Air Force Base in Rome, N.Y., a spokesman for a group now engaged in reliability says it is collecting and publishing as much data as possible on failures and failure rates in an effort to spotlight these variables.

Components

New light on the subject

Electroluminescent displays have, until now, been made like sandwiches. A layer of phosphor material is placed between two electrode layers. One electrode is transparent, the other a sheet of metal. A voltage across the electrodes causes the phosphor to glow, illuminating the display.

But now, Cornell Aeronautical Laboratory, Buffalo, N.Y., has built experimental electroluminescent displays using a new kind of structure that permits the phosphor to be deposited in the same layer as the electrodes. There is no sandwich.

The result, according to A. Scott Gilmour Jr., head of the wave electronics section of Cornell's electronics research department, is a display that is potentially brighter, with a larger illuminated area, and thinner than the old structure.

Fingers. Cornell's display consists of a sheet of clear Mylar on which is deposited a conducting film, such as copper, says Gilmour. The electrode structure is made by printed-circuit techniques, etching out of the copper two sets of interdigitated electrodes. Width and spacing of the fingers are a few thousandths of an inch, according to Gilmour, and Cornell has formed electrodes as long as a foot.

Once the electrode patterns have been etched out, the phosphor material—conventional zinc sulfide—is sprayed on or silk-screened over, continues Gilmour. Which method is used depends on the consistency of the binder and the fineness of the electrodes. Different colors in the same display panel are obtained by adding dyes to the phosphor.

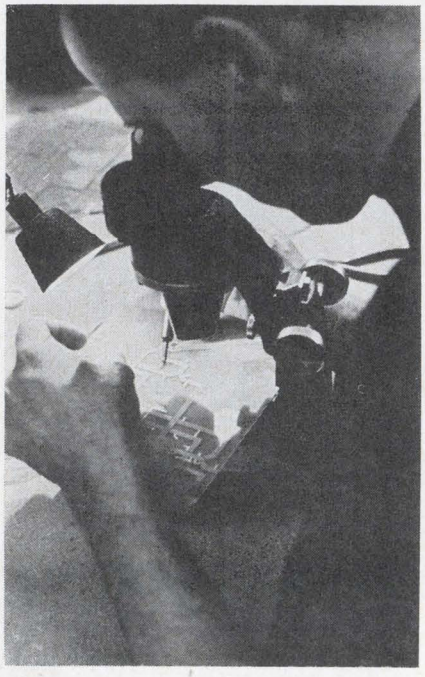
When an alternating voltage is applied across the sets of adjacent electrodes, the phosphor is excited and glows. Voltage levels depend on the spacing between the electrodes. Typically it is several hundred volts. Frequency has ranged to several kilohertz, compared with the several hundred hertz used with the conventional sandwich-type displays.

Brighter, too. Because it is able to work at higher frequencies, the new display has the potential for developing much brighter displays than the sandwich construction. Brightness is roughly proportional to frequency but in the older structure dielectric losses go up as the frequency goes up. Higher electric fields possible with the new display will also result in more brightness.

One advantage of the new display is that the phosphor, whose light output deteriorates with time, can be easily removed with a solvent and replaced, Gilmour says. This is difficult to do with the sandwich structure because an electrode layer must be removed before the phosphor can be reached.

Cornell is working to extend both the life and brightness of the displays. Light output is about the same as with the sandwich structure. A life of several hundred hours is, however, still shorter than can be obtained with the older technique.

Status report. Cornell's work was done as part of an over-all program to develop systems configuration displays for NASA spacecraft. The first complete unit is a multicolor panel, measuring 18 by 24 inches, that shows the operational status of each of 45 com-



Close look. Technician examines experimental single-layer electroluminescent panel.

ponents in an electronic system.

Besides spacecraft applications, Cornell considers the planar panel technique feasible for military, industrial, commercial, and domestic uses. For example, many square feet of wall or ceiling can be illuminated with the panels. They can also be used for low-power cabin lighting in aircraft, multicolor illumination of cockpit panels, warning lights, and alphanumeric readouts. Strips of the material as thin as 0.002 inch could be applied like adhesive tape to any surface.

Companies

Age of protest

For more than 10 years, the Pentagon has been the world's largest customer. And, like the corner grocer afraid of losing a good customer, defense suppliers have maintained that the customer is always right.

Occasionally, a disappointed supplier has quietly complained to his Congressman or to a trusted newsman about a procurement decision. But publicly, the omnipotence of the customer has been upheld.

All that may be changing. In what is being hailed as a significant test case, computer manufacturers have challenged the Air Force and won. They forced the service to reverse its decision to award the largest single computer contract to the International Business Machines Corp. After reconsideration, the award went to one of the protesters—the Burroughs Corp.

But the Air Force is not giving in easily. Some Air Force officials are leaking the word that machines built by Honeywell Inc.—the most vigorous protester—scored lowest in "benchmark tests" (operational demonstrations). And it may be significant that Burroughs' complaint was milder than those of Honeywell and the other unsuccessful bidder, the Radio Corp. of America.

Principal principle. Honeywell, however, is not worried that the Air Force might discriminate against it for the company's part in the complaint. Company officials are privately elated that the "principle of protest" has been established even though another firm got the contract.

A similar view is voiced by Sen. Walter Mondale (D., Minn.), who entered the fray at the request of Honeywell, which is headquartered in his home state. He says this case proves that the government can often get better prices than it does.

The Air Force argues that the savings are not as dramatic as they seem. The cost of the IBM contract would have been $114 million if it had been carried out. The winning Burroughs bid is about $60 million —some $54 million lower. But the Air Force says that the savings actually will amount to only $36 million. The service says the reevaluation of the contracts and the delay it caused accounts for the difference, some $18 million.

In another face-saving effort, the Air Force says that Burroughs, RCA, and Honeywell all changed their proposals for the second time around, and that IBM's was about the same. This would justify the about-face.

Little change. The specifications sent to the contractors for the second bidding round were virtually the same as the first. One small change was to have the companies' estimate that the computers' work load would increase by 100% over an eight-year period. Originally, it was specified that the 100% increase would come in six years. This change was made because the Air Force says it has a clearer picture of how its computational tasks are going to grow. Also, it now estimates the machines will last another two years.

The contractors themselves changed the hardware mainly by adding more powerful equipment. This may have been a significant factor in the benchmark competition.

Burroughs' winning bid was based on its B3500 model. They will be used to improve the Air Force's routine data process capability at air bases. Some 100 to 160 machines will be used in the evolving program.

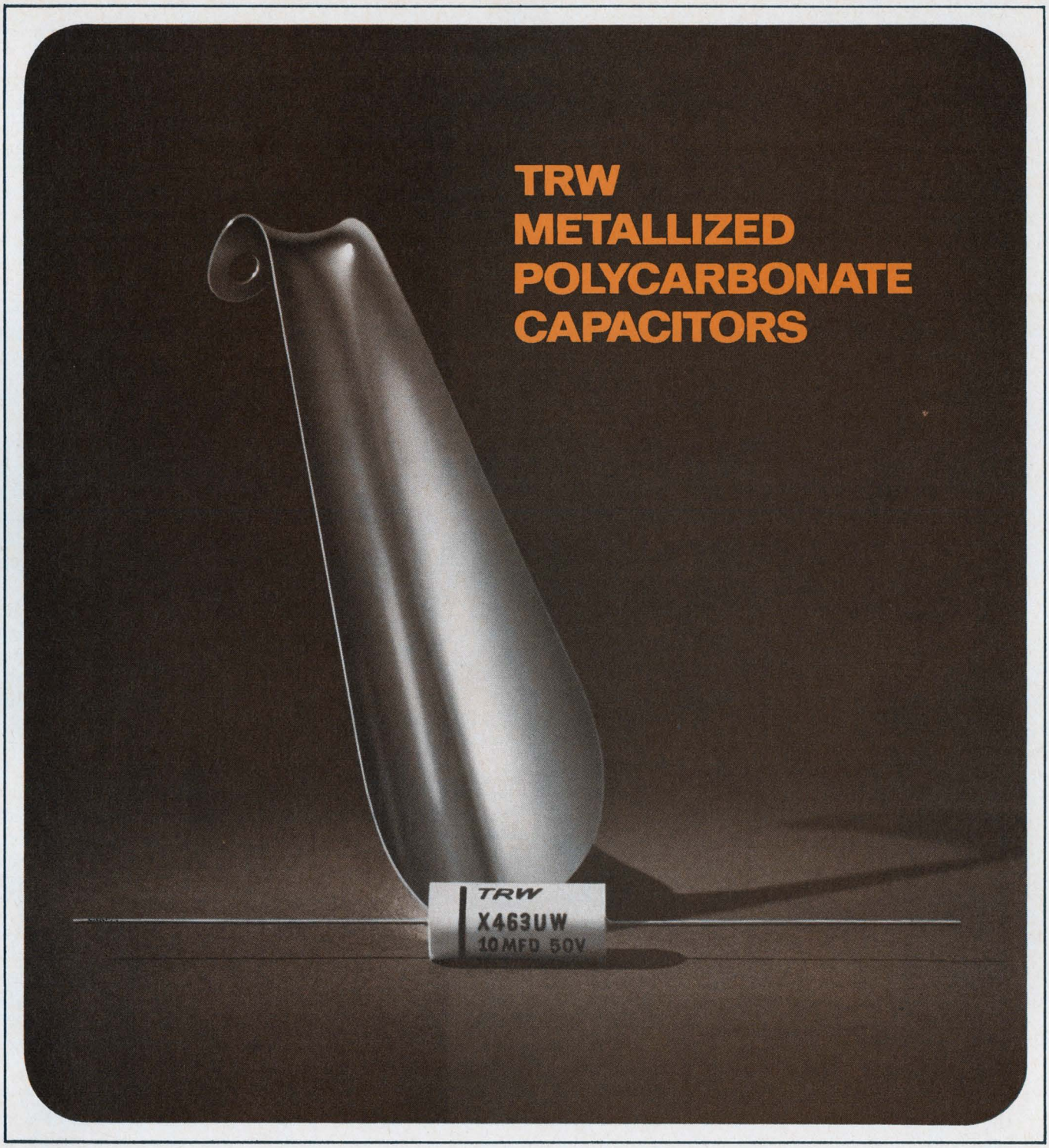
Name dropping

It's just what contractors feared: a Senator is going to blow the whistle and name names he's getting from the General Accounting Office.

A few weeks ago, when the case involving the right of the GAO to look into the Hewlett-Packard Co.'s cost records was thrust back into the news, the debate was renewed over how safe company secrets are with the investigatory arm of Congress [Electronics, Dec. 25, 1967, p. 107]. The GAO, claiming it keeps trade secrets out of its reports if possible, does concede that it must turn its material over to Congressmen on demand. They, in turn, can make confidential material public, claims industry.

Although no trade secrets are involved, Sen. William Proxmire (D., Wis.) plans to disclose which companies have substantial government-owned equipment and which have been misusing the equipment. For many firms, it's going to be embarrassing—to say the least.

Finger pointing. The GAO tried



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not to name names. Adhering to a policy it adopted five years ago after being sharply criticized for its heavy-handed methods of releasing reports on firms, the GAO issued a "blue-book" report to Congress last November entitled, "Need for Improvements in Controls over Government-Owned Property in Contractors' Plants." Using such identification as company X, Y, and Z, it gave a number of examples, where government-owned equipment — much of it electronic test equipment or machines used in the electronic industry—was being used in "private" nongovernmental work, was lost, unrecorded, or standing idle.

In a spot check of 17 manufacturing plants, two of them electronics firms, the GAO auditors came up with almost $1 billion of government-owned equipment. The two electronics firms, one under contract to the Army and the other to the Navy, had about $76 million of government property, including almost $40 million in special tooling and test equipment.

Sen. Proxmire, chairman of the Economy in Government subcommittee of the House-Senate Economic Committee, was upset with the findings. He asked the GAO to get him the names of the contractors involved.

Blowing the whistle. The GAO could do nothing but comply. But sticking to another policy—also adopted after the sharp criticism—the GAO sent out copies of the report to the companies that would be named, and asked for their comments. The companies were supposed to get their comments back to the GAO by year-end—but several asked for a delay and the GAO granted it. The GAO was scheduled to hand over the complete report —including companies' comments —to Proxmire last week. Proxmire was expected to make public the names after Congress reconvened Jan. 15.

Meanwhile, the Defense Department, a partner in the whole affair because of its loose controls, has promised to tighten up. It will mean a lot of tightening: there's about $12 billion in Government property in hands of private contractors. This is broken down into five classifications: facilities (such as buildings, machinery, R&D labs, etc.), $6.2 billion; material, $4.7 billion; special tooling (taps, dies, jigs, etc.) and special test equipment (much of it electronic), both totaling about $1 billion; and military property, (aircraft, etc.). The government supplies contractors with special equipment and facilities, when necessary, for them to fill a defense contract.

Strong words. Proxmire feels that the matter is of such importance that names of companies involved should be made public. "A number of companies were using government equipment for their own commercial gain instead of on defense work," he said, adding that there is no reason why they shouldn't be made public. "Public machines have been diverted to private use."

He said he did not know precisely when he would release the names, but it would be "sometime in January."

The Senator said there might be hearings on the problem—but no decision has been made. "But you can be sure we'll do all we can to make certain that the Department of Defense tightens its controls, that we are paid rent for the equipment, and that contractors keep proper records."

Military electronics

About-face

When Rep. Otis Pike (D., N.Y.) disclosed that the Pentagon was being grossly overcharged on numerous small purchases, the military boldly brushed aside the charge. The total amount is insignificant, the military claimed, and steps to counter overcharging would probably cost more than any eventual savings. That was several months ago.

The Pentagon has since done an about-face. It first ordered that small purchases—up to $2,500 each—be reviewed regularly by senior officers and that greater efforts be made to buy spare parts from an original contractor to avoid price markups by middlemen; junior procurement officers, who handle much of the small purchases, were to get more training in how to spur competitive bidding.

Now, the Pentagon wants to go a step further. It has proposed a regulation that would require sellers in the small-purchase category to guarantee that the government is not paying more than "any other customer purchasing the same item in like or smaller quantities under similar conditions."

Penalty. If an overcharge is discovered, the contractor would have to reimburse the government for the excess and pay liquidated damages—starting at $50, and increasing from day to day until damages are paid.

The warranty wouldn't be required when the Pentagon believes there is adequate price competition or when there are clearly established catalog or market prices. But if the item has a catalog or established market price, and the solicitation is made by telephone—as is usually the case with small purchases—the seller must swear that his quotation is not in excess of it. The procurement officer would then include this statement in the written purchase order.

The regulation would also require that purchasing officers obtain price quotation where practicable. In addition, they would solicit prices from other than previous suppliers before repeating orders.

Less than enthusiastic. The proposed regulation has been sent to industry for comment, which is hardy expected to be enthusiastic. Industry not only doesn't like to admit that overcharging exists, but is cool to adding more red tape to a contract—particularly when it could involve penalties.

Small purchases by the military add up. They account for 4% of the Pentagon's $45-billion-a-year buying operation, much of it for electronics. In fact, Pike pointed an accusing finger at several electronics firms, with the largest alledged overcharge being $30,000

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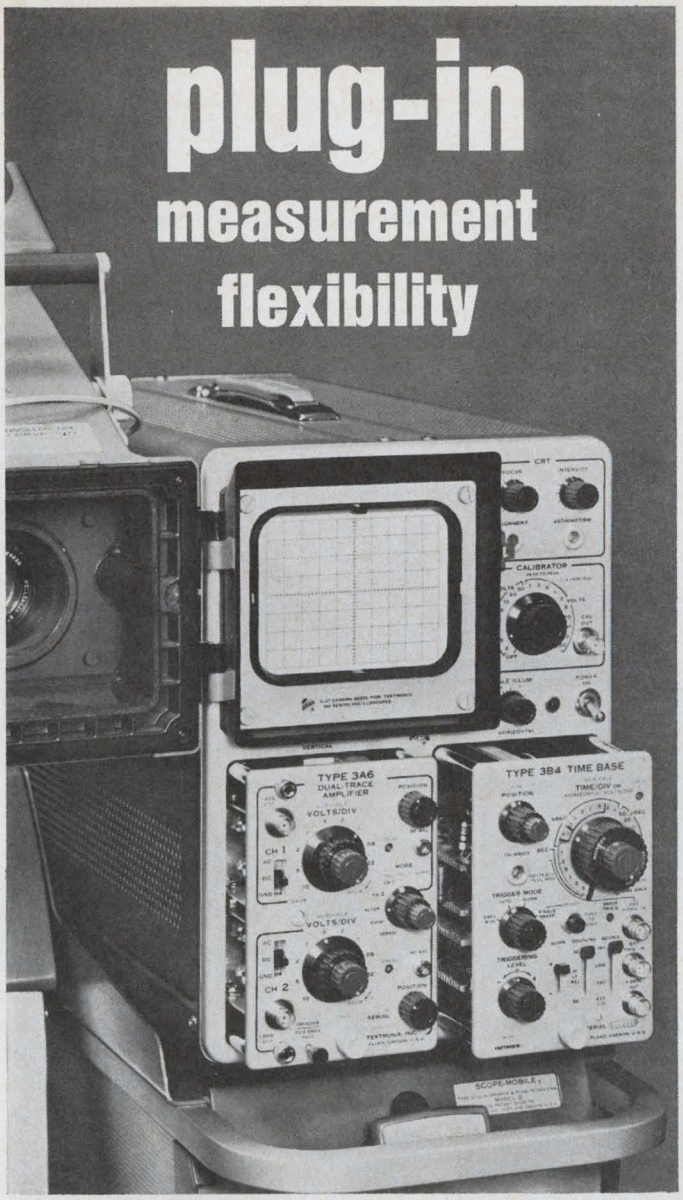

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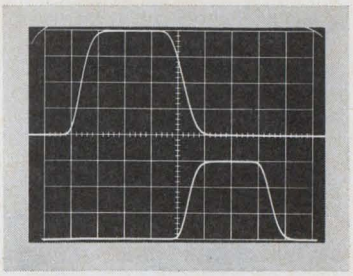

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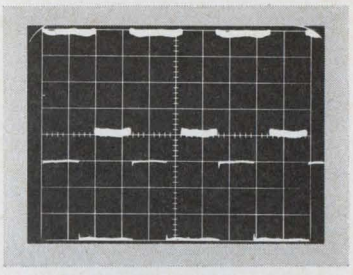

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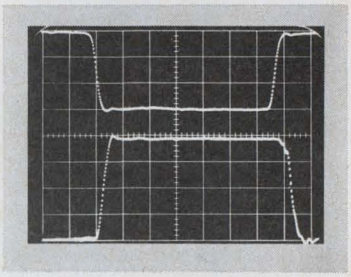

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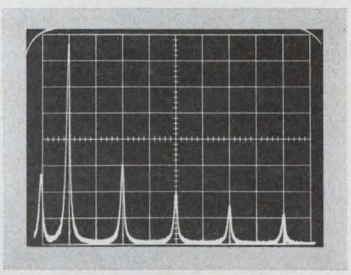

The Tektronix Type 561A oscilloscope has a complete selection of plug-ins, permitting you to change your measurement capabilities to meet your changing measurement needs. Amplifier plug-ins offer a wide range of measurement capabilities with 10 MHz dual-trace plug-ins, 10 μV/div differential plug-ins, 350-ps sampling plug-ins and spectrum analyzer plug-ins covering the spectrum from 50 Hz to 36 MHz. Time-base plug-ins include delayed sweep, X50 magnifier, single time-bases or sampling time-bases. Amplifier plug-ins may be placed in the horizontal position for X-Y or multiple X-Y displays, and automatic seeking plug-ins are available.

The Type 564 Storage Oscilloscope uses the same plug-in units and offers the added advantage of split-screen storage. Split-screen storage lets you use either half of the display for storage and/or conventional displays. The contrast ratio and brightness of the stored display are constant and independent of viewing time, writing and sweep rates, or signal repetition rates.

For a demonstration of the Type 561A Oscilloscope or Type 564 Split-Screen Storage Oscilloscope, contact your nearby Tektronix Field Engineer or write: Tektronix, Inc., P. O. Box 500, Beaverton, Oregon 97005.

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Type RM561A Rack-Mount Oscilloscope (7" high).....$580

Type 564 Split-Screen Storage Oscilloscope.....$925

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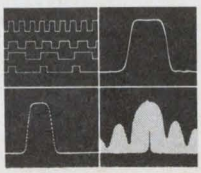


...with multi-trace, differential, sampling and spectrum analyzer plug-ins

worth of items sold by Sterling Instruments of Mineola, N.Y., a division of Designatronics Inc.

These included the Pentagon's paying $67.50 each for 30 high-voltage couplings, which were being sold to other buyers at a catalog price of $2.75. The Justice Department is considering possible legal action.

Displays

Fruit of the loom

When the Massachusetts Institute of Technology decided it wanted to develop a family of low-cost data display units for Project MAC (machine-aided cognition), it turned to some very exotic—and expensive—technology: Autonetics' silicon-on-sapphire diode matrixes [Electronics, May 30, 1967, p. 152A].

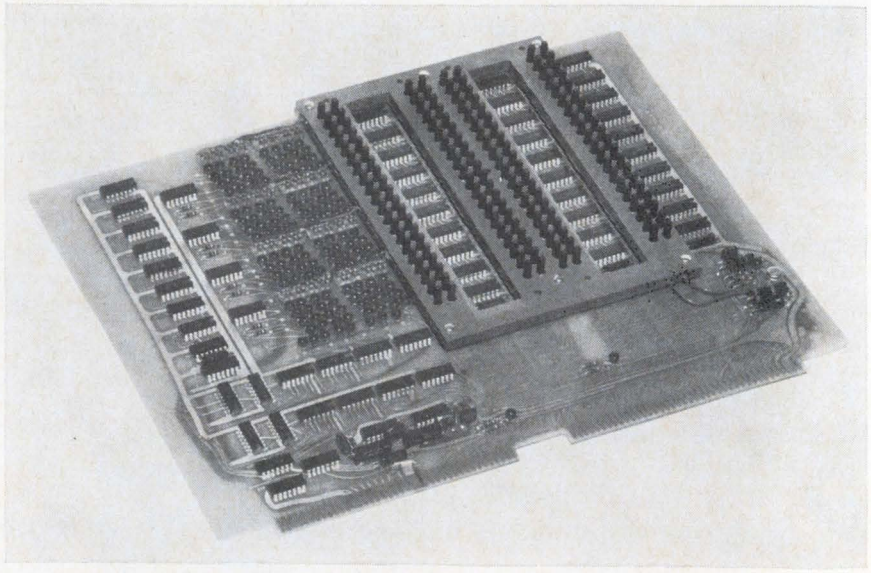
The hope was that the diode matrixes, once they went into mass production, would eventually be cheaper than anything else around. But after building a successful breadboard of the display unit, MIT went back to Autonetics for more matrixes and found that production had still not gotten into full swing and the price was still too high. So the developers went across town to a firm that was started by some former MIT people, Memory Technology Inc. [Electronics, Sept. 18, 1967, p. 121].

There they found just what they were looking for, an inexpensive memory. Memory Technology had developed a braided-wire memory which, including all the selection and read-out electronics, costs $900. The much more exotic Autonetics unit had a price tag of $1,400, which didn't include the $200 for the external circuits that were needed with it.

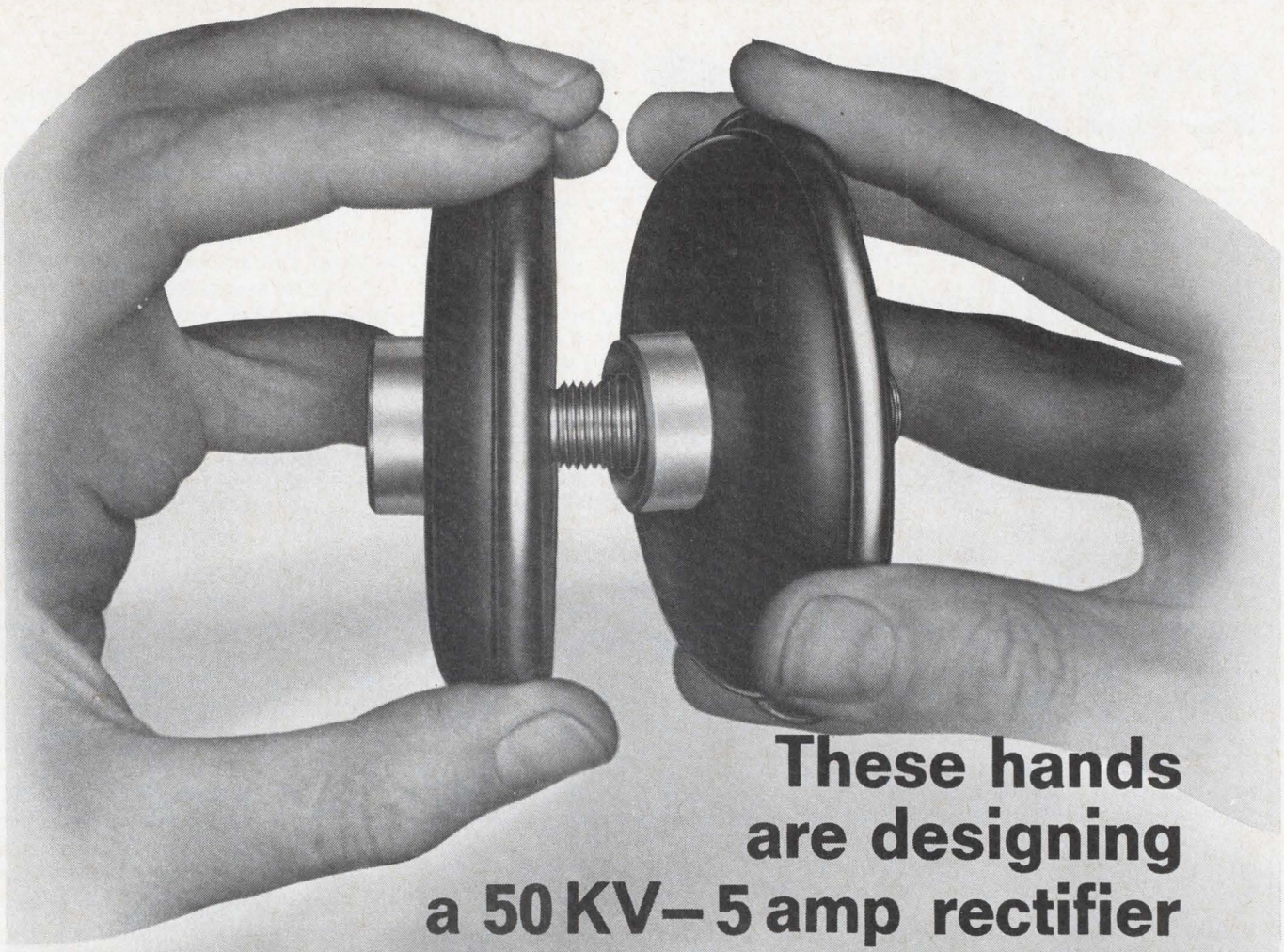
Cost-conscious. Production of the diode matrix character generator has not yet reached the point where it's commercially competitive with braided wire, although there are indications that the price may go down as production increases. Last month it was learned that Autonetics plans to market a commercial version of the diode matrix originally used for Project MAC.

Core winding. The braided memory contains a wire for each word it stores and ferrite core for each bit of the word. The routing of each wire, either through or around successive cores, determines the stored data. Each core acts like a transformer, linking the word-wires passing through it to a sense winding on the core.

The wires are preformed into a braid that is then laid over the U-shaped cores. Ferrite caps over



Keep it in mind. Project MAC engineers rejected exotic diode matrixes for computer terminal memories in favor of this lower-cost braided-wire memory.



These hands are designing a 50 KV–5 amp rectifier that is virtually fail-proof.

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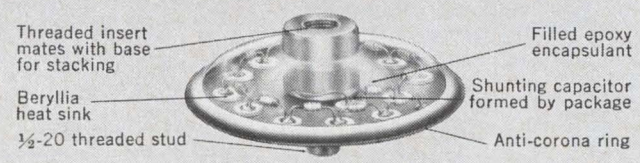

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the U's complete the flux path in each core.

Each wire in the braid corresponds to a particular character. The core through which the wires pass generate signals that create dots on the screen. Different patterns of dots within a 9-by-7 array determine different characters on the screen.

Besides its attractive price, the braided program in the memory can be changed if needed. "Even after encapsulation, a few new wires can be threaded through the cores and connected to the external terminals in place of encapsulated wires, which are left hanging," says Michael Gutman, the company's marketing manager. "To change the program in the diode matrix, you'd have to completely refabricate the entire unit, and at a great cost, including the design of a new mask."

A new unencapsulated version of the memory is now being developed, according to Gutman, in which the braid is laid into a hollow fixture made by injection molding. New wires can be added to the braid, until the fixtures contain perhaps two or three times as many wires as were in the original braid. Also, the original braid can be completely removed at any time, and replaced with a new braid for about $100.

For the record

New year in space. NASA is beginning the year with two important launches. This week, Surveyor 7, the last in the series, will be launched toward a target on the moon's Tycho crater, and on Jan. 17 the Apollo 5 shot will provide the first flight tests for the program's lunar module.

The Surveyor mission aims to land the spacecraft about 40 miles south of the lunar equator in an area where the moon's terrain is the most rugged. The craft will have in its experiment package television for the transmission of photographs, a digger to probe the lunar soil, and an alpha scattering experiment unit to analyze the ma-

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Type	I_p (mA) Min.	I_p (mA) Max.	I_p/I_v Min.	C (pF) Max.	tr (ps) Typ.
40561	4.5	5.5	6/1	25	1800
40562	9	11	6/1	25	900
40563	18	22	6/1	30	600
40564	45	55	6/1	40	350
40565	90	110	6/1	40	150
40566	4.75	5.25	8/1	15	1200
40567	9.5	10.5	8/1	15	600
40568	19	21	8/1	20	400
40569	47.5	52.5	8/1	25	200
40570	95	105	8/1	25	100
40571	4.75	5.25	8/1	8	600
40572	9.5	10.5	8/1	8	300
40573	19	21	8/1	10	200
40574	47.5	52.5	8/1	12	100

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terial exposed by the digger.

The unmanned Apollo flight will place the lunar module in earth orbit for tests of its engines. Grumman, which built the module, had been having difficulties in trimming the craft's weight, but this test module weighs an acceptable 31,325 pounds. The next major step in the program, a manned test of the command module, could come early this summer.

Logical step. Autonetics has followed up its announcement of plans for a microelectronics venture [Electronics, Dec. 25, 1967, p. 25] with an not unexpected decision to build a production facility. Slated for completion by Aug. 1, the $1.6 million, 40,000-square-foot plant will produce metal oxide semiconductors and silicon-on-sapphire devices. Some will be put on the market, but most will go into Autonetics' own systems. Weekly output is expected to eventually reach about 10,000 integrated circuits and large-scale integrated arrays.

Tantalum hike. Citing the rising cost of producing high-voltage and standard high-capacitance tantalum powder, the National Research Corp., a major producer, has announced a price increase of $1.50 a pound. Last year's prices on high-capacitance powder ranged from $39.50 to $42.50 a pound for high-voltage types and from $30.50 to $33.50 for the standard.

Lobby. Business leaders have been asked to help defend the space program's budget. Rep. Olin E. Teague (D., Texas), chairman of a subcommittee of the House Science and Astronautics Committee, tired of defending the NASA program largely in terms of racing the Russians to the moon, has asked presidents of the 750 largest companies to rate the space program in eight basic areas. Teague hopes to show Congress that the program has solid backing.

Unite? Although the Laser Industry Association was scheduled to organize as an independent group Jan. 8 in Los Angeles, leaders have not yet closed the door to a merger with the Electronic Industries Association's new laser subdivision.

VSMF is a product supermarket

John Manning, Missiles Systems Division, Raytheon Company, Bedford, Mass., has installed 4 VSMF Files: Defense Design, Documentation, Mil Specs and Mil Standards.

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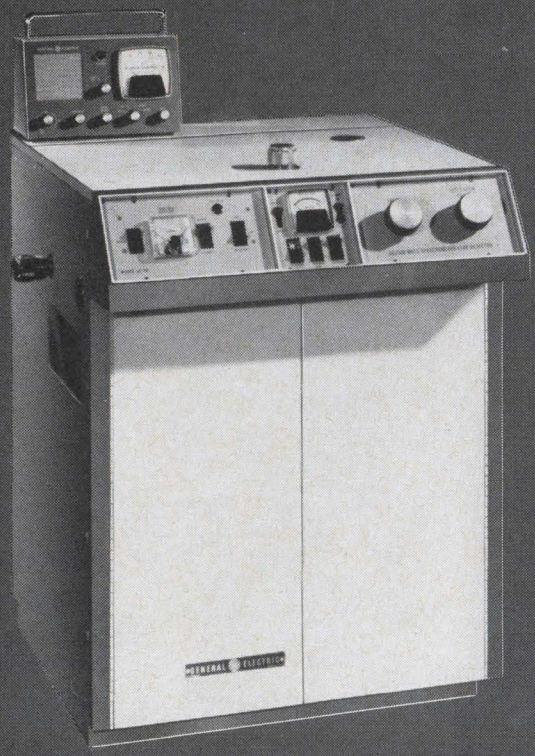
Circle 57 on reader service card



Why General Electric waited three years before introducing this all-new Helium Leak Detector:

Can we impose on you with a bit of history?

Twenty-five years ago, GE built the first Helium Mass Spectrometer Leak Detectors ever—for the Manhattan Project.

Subsequently, we made some mistakes. The main one was resting on our oars while competitors got in, caught up—and then passed us.

So, in the late fifties and early sixties our reputation in this field was—deservedly—less than good.

We got busy. We re-designed our units from scratch. We questioned everything we'd ever done, everything anybody else had done. We re-assessed every component, circuit, and operation in terms of developing leak detectors with optimum sensitivity, maximum reliability, and minimum maintenance.

Early in 1965 we were satisfied. But to make sure, we concentrated on placing them in General Electric plants. (We think you'll agree there's nobody quite as critical as a member of the family.)

Now, three years later, we can look you in the eye and tell you that GE Helium Mass Spectrometer Leak Detectors are again the finest on the market.

We don't ask you to take our word for it. But we *do* ask you to check out for yourself the new-yet-proven features that characterize our product today. Things like all the sensitivity you'll likely ever need; a spectrometer tube filament that's guaranteed for two years; reliable, long-life, solid-state circuitry; constant sensitivity; real ease of operation and servicing; an all-welded, stainless steel high-vacuum system.

And then some. Check the reader service card, or write us direct for full particulars on manual model LC-10 and automatic model LC-20. We have a product we're proud of.

VACUUM PRODUCTS BUSINESS SECTION

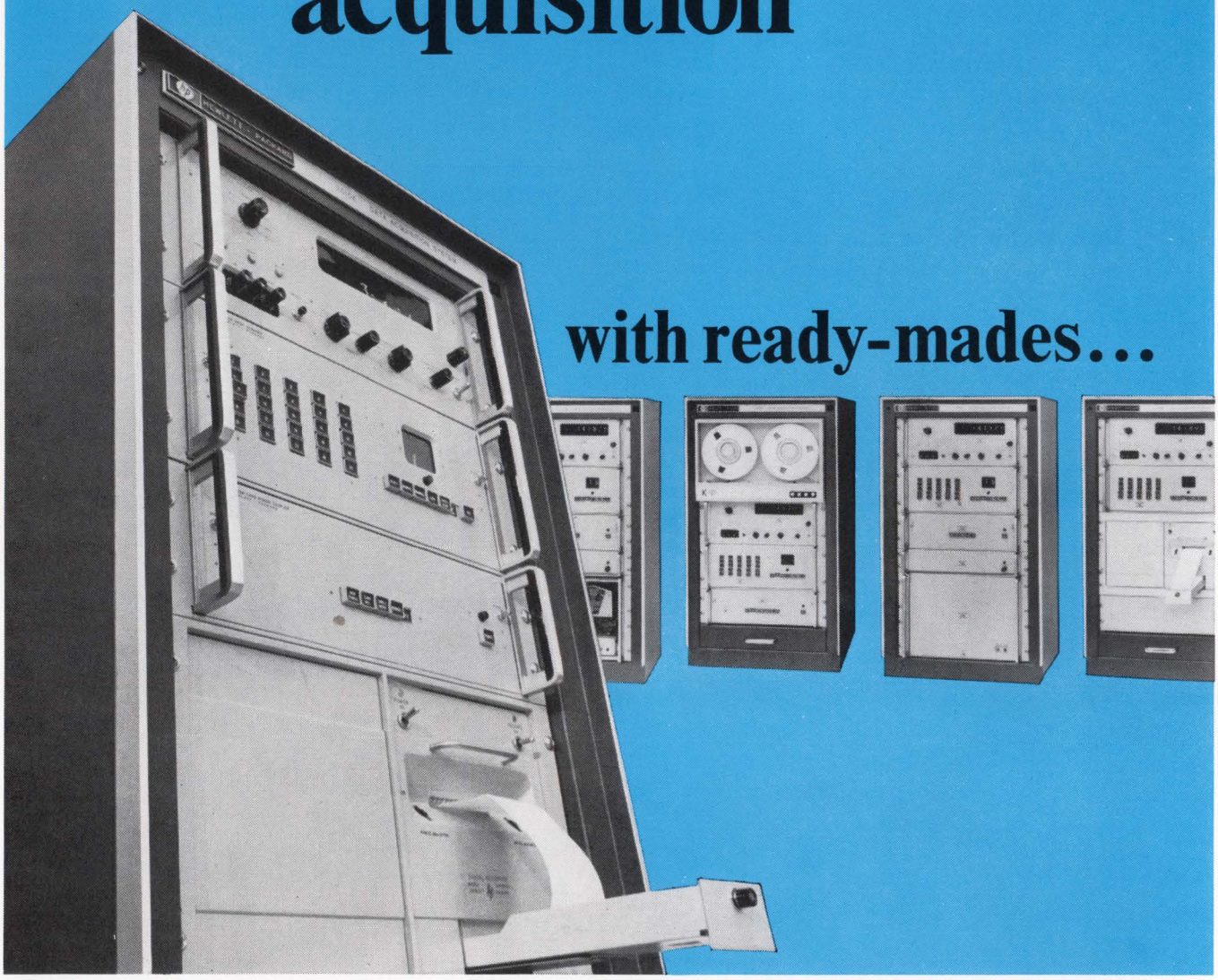
GENERAL ELECTRIC

SCHENECTADY, N.Y. 12305

LC-1

'Tailor-made' data acquisition

with ready-mades...



Versatile, high-performance data acquisition systems—virtually designed and built to the specifications you have to meet—are yours with "off-the-shelf" delivery in the eight different configurations of Hewlett-Packard 2010 Series.

The HP systems concept represented by the 2010 Series assures complete system specifications (on a data sheet), immediate delivery, proven reliability and low cost.

Basic measuring device in the 2010 Systems is the 2401C Integrating Digital Voltmeter, a floating and guarded DVM which permits measurement of low-level signals in the presence of severe common mode and superimposed noise. Standard systems offer a wide variety of input capabilities and a broad range of output... printed strip, punched tape or card, or magnetic tape. Versatile systems programming, too.

Whatever your needs, you'll find your answer with Hewlett-Packard, which, in addition to the 2010 Series, offers other complete lines of standard data acquisition systems. Detailed information on these systems is available with a call to your Hewlett-Packard field engineer or a letter to Hewlett-Packard, Dymec Division, 395 Page Mill Road, Palo Alto, California 94306; Europe: 54 Route des Acacias, Geneva.

HEWLETT hp PACKARD

DATA SYSTEMS

06701

Circle 61 on reader service card →

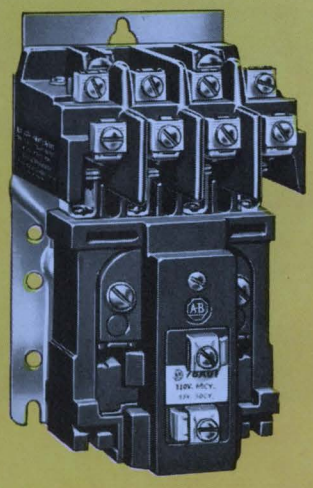
when a single downtime can cost you much more than the original price of the control...

BULLETIN 709 Size 2 motor starter rated 15 hp, 240 v; 25 hp, 480-600 v.

it's false economy not to buy Allen-Bradley

■ Have you ever stopped to consider the "cost per minute" when a control failure shuts down a production line? You can bet it's plenty—it will wipe out "flocks" of those hoped-for savings from buying motor control at "cut prices."

Allen-Bradley—the quality control—features the time-proven A-B solenoid construction—with only one moving part—which simplicity of design is *your* guarantee of millions of trouble free operations. The weld-resistant silver alloy contacts of a special double break design assure long life and the utmost in contact performance—with never a moment to be spent for maintenance. Coils are pressure molded—replaced free of cost to you if they should fail in service—regardless of atmospheric condition. The built-in air-gap in the magnets remains permanent—no matter what the frequency of service may be—"magnetic sticking" is out of question.



BULLETIN 700 Type BR 4-pole control relay with convertible contacts

The Type BR relay is of the same general trouble free design as just described and is unusually versatile. All contacts are easily convertible—all it takes is a screwdriver and 30 seconds to change a pole from N.O. to N.C. or vice versa. Also, either one or two extra poles can be quickly added in the field and they are full rated and also convertible. Type BR relays can be furnished with overlapping contacts.

Your local Allen-Bradley appointed distributor carries in his stock a very wide selection of the Allen-Bradley control commonly used in your territory. He has been trained as a control specialist. Please contact him today. Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee, Wisconsin 53204. In Canada: Allen-Bradley Canada Limited. Export Office: 630 Third Ave., New York, N.Y., U.S.A. 10017.

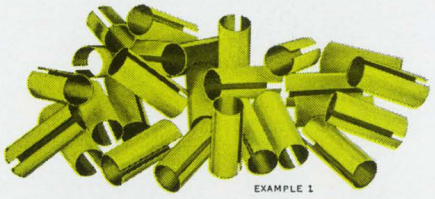
1065M-5

A-B QUALITY

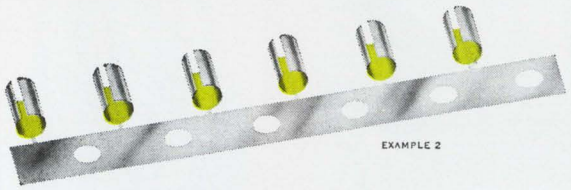
ALLEN-BRADLEY

Member of NEMA

QUALITY MOTOR CONTROL



The gold plating on these
"hard-to-handle"
female connector terminals
cost $3.78 per thousand . . .



The gold plating on these
female connector terminals . . .
adaptable to automated assembly . . .
cost only 83¢ per thousand
and they are far better parts!

ZCD* Pre-plating of strip makes the difference...

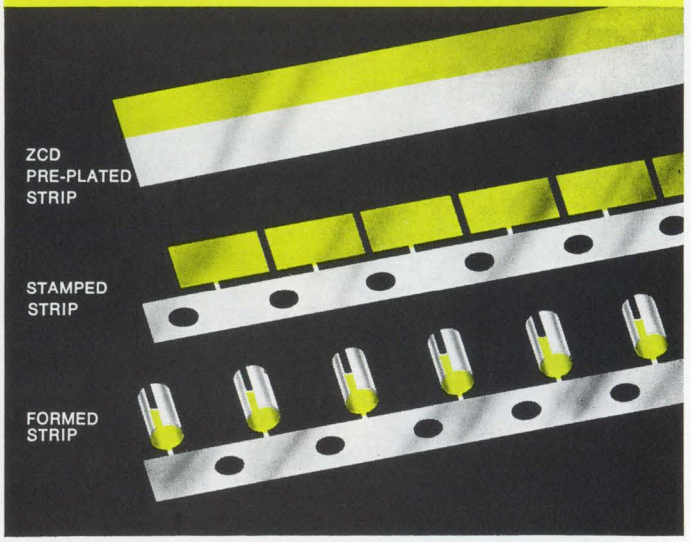
And only Burton does it!

*** Zone Controlled Deposition...** Burton's exclusive continuous plating technology reduces gold material and plating costs, produces better parts, speeds production in two important ways!
Both terminals shown were fabricated from the same strip base material. Both were gold plated with the same type of gold. The part with less gold costs approximately 80% less to produce, *yet it is a far better part!* The difference is Burton ZCD pre-plated strip!

Example 1 was fabricated from strip and then barrel plated. The surface that required gold (the inside) is the most difficult area to plate by barrel plating. To arrive at the specified thickness inside where contact is to be made, it was necessary to *overplate* the whole strip, depositing a *thicker layer where gold was not even needed.*

Example 2 was fabricated after plating, using Burton ZCD Pre-Plated Strip. Zone Controlled Deposition (ZCD), coupled with Burton's high-speed, continuous reel-to-reel plating technology, controls both the location and thickness of gold deposits on one or both sides of strip material of any width. Deposits can be held to zero where gold is not required, and the process assures a uniformity of thickness to within 10 micro inches within a reel and from reel-to-reel...for a thousand or a million feet of strip. By using Pre-Plate Strip with gold only on the side and area to be formed into the inside of the terminal, and deposited to the required thickness, 90% of the gold required by Example 1 was saved, and the part uniformity was greatly improved!

Check these added advantages of Burton Pre-Plated Strip. By using pre-plated strip, production and assembly sequences can be speeded. Drawing from an in-plant stock of pre-plated strip, the fabricator/plater/plant sequence can be reduced one step. More important, 500 to 1000 foot reels of formed parts are more readily adapted to automated assembly than short lengths of strip required to plate by barrel or rack techniques.
If you produce connector terminals or other parts fabricated from strip material, contact Burton for details on how you can achieve better parts in less time and at less cost with ZCD Pre-Plated Strip made to your specifications.



Send for a sample strip. Write on your letterhead for a sample of strip demonstrating Burton's Zone Controlled Deposition. Gold at the center, no gold on the edges or opposite side of the strip.

FREE TECHNICAL DATA. Circle the Reader Service Card to receive "Burton Plating News" containing useful data pertaining to metal plating.

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A DIVISION OF BURTON SILVER PLATING COMPANY

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We have a complete line of photodevices—from a 50-cent epoxy transistor to a $4,000 custom photo array. Light-emitting and light-sensing devices for everything from computers to electric organs. They can translate keyboard signals, read punched cards and tape, measure height and volume, perform character recognition, read motion picture sound track. You name it. Write for complete information and we'll throw in a glossary of the latest photometric and radiometric terms. FAIRCHILD SEMICONDUCTOR

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What this country needs is a good 50¢ phototransistor.

1 μV Full Scale
10 kHz to 30 MHz
Wave Analyzer

TYPE USVH

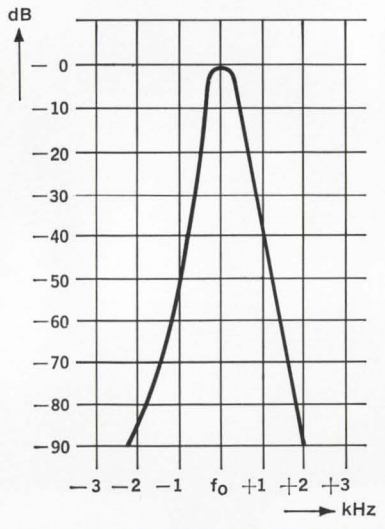
SELECTIVE MICROVOLT/AMMETER

FEATURES:

- **Wide frequency range covers 10 kHz-30 MHz**
- **Measure Voltage: 1μV to 1V, f.s.d. (—118 dB to +2 dB)**
- **Measure Current: Clip-on current probe (optional, 0.1 — 30 MHz) 1μA to 1 A, f.s.d.**
- **Dynamic Range: 60 dB**
- **Fine Frequency Adjustment: ±2.5 kHz**
- **Selectable Bandwidth: 500 & 5000 Hz**
- **Noise Level: 0.5μV**
- **Input Impedances: 50, 60, 75, 150, 600Ω and 500kΩ || 20 pF High impedance probe available.**
- **Internal reference makes unit self-calibrating.**
- **Demodulated phone output.**
- **Economically priced.**

TYPICAL SELECTIVITY TYPE USVH

BANDWIDTH 500 Hz



Type USVH Selective Microvolt/ammeter is continuously tunable over the wide frequency range of **10 kHz to 30 MHz.** High sensitivity and selectivity are outstanding features of this superheterodyne receiver with direct readings in volts and decibels. Voltage measuring range covers from 1μV to 1 V f.s.d. with an accuracy of ±3% referred to 1 MHz & 1 V. Measurements can be made to 0.25μV. Frequency response is ±0.5 dB from 20 kHz — 10 MHz, and ±1.0 dB from 10-20 kHz and 10-30 MHz. Type USVH also can be used for selective current measurements using Clip-On Current Probe, BN 150013. Instrument features selectable bandwidth of 500 & 5000 Hz, and provides six switchable input frequencies.

Applications Include:

- 30 MHz Wave Analyzer
- Attenuation and frequency response measurements on networks up to 140 dB
- Null indicator for high frequency bridges
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Circle 65 on reader service card →

Is the pivot-and-jewel meter going out of the picture?

Maybe it seems so.

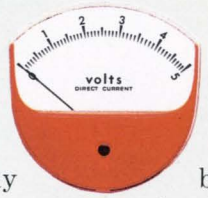
In our thrifty, Scottish way, we've brought out a Honeywell taut-band meter that costs even less than a pivot-and-jewel meter. (About 10% less, on the average.)

Does that make you think we might be short-changing you? We are: We left all the unnecessary parts out of our taut-band meter. (Fewer parts: fewer things to go wrong.)

It's simple. Which is the whole idea.

It's self-shielded.

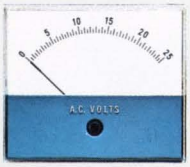
There's no friction in its moving parts. Which gives you better readout accuracy, better repeatability.



And it comes in just about any style you'd like.

Obviously, the low-cost taut-band meter from Honeywell has a brilliant future ahead of it.

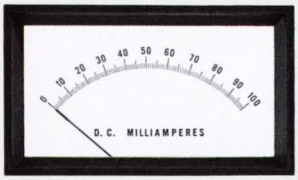
But the question is: Will it ever replace the pivot-and-jewel meter?



We doubt it. We believe there are some sensitivities and applications that will always be handled best by our good, old pivot-and-jewel meter.

But if you like the idea of our low-cost taut-band meter, by all means write us for our brochure. It'll tell you all the sizes, styles and prices.

Honeywell Precision Meter Division, Manchester, N.H. 03105.



Honeywell

Philco-Ford puts logic in a box

Now, you'll be pinning down your control system designs faster, easier, and with far greater economy

Over 200 micromodules from Philco-Ford's WDL Division stand ready to accept your system challenge. In compatible 5 to 40 MHz logic, standard DTL and T^2L circuits, they contain some of the most sophisticated designs in today's state-of-the-art, including multiplexers, operational amplifiers, D-to-A and A-to-D circuits, and an extensive array of computer interfaces.

The micromodules employ monolithic IC's, using thin-film and discrete components only where necessary. A hard nylon cover keeps out dust, protects circuits against damage. Clearance holes at the top of the micromodule provide fast front-panel access to all input/output terminals. No need to troubleshoot from the back! A color-coded label identifies module type at a glance.

The micromodule's modest dimensions, coupled with the complexity of the logic it contains, permits highly effective packaging density. A 180-module system can be mounted in a drawer only 3½" high by 19" wide. Modular systems fit readily into rack mounts, bench mounts, or portable instruments. In service for over three years at NASA's Manned Space Flight Center in Houston, WDL micromodules have compiled an excellent record of performance reliability. Write Product Sales Manager, WDL Division, Philco-Ford Corp., Mail Station C-41, 3939 Fabian Way, Palo Alto, California 94303. Or telephone (415) 326-4350, extension 6017.

ADD (Automated Design and Documentation) This Philco-Ford computer-programming service generates system documentation at a cost significantly below that of hand-prepared equivalents. The computer program error checks design input data, optimizes the arrangement and sequence of wiring instructions, calculates wire lengths, provides wire lists sorted by length and by name, and maintenance lists. The program is available to all users of Philco-Ford micromodules.

PHILCO Ford

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WDL Division • 3939 Fabian Way
Palo Alto, California • 94303

Washington Newsletter

January 8, 1968

FCC fiddles as cable, satellite interests burn

While satellite and cable backers continue to battle over the cable interests' insistence on a 50% share in the planned expansion of transatlantic communications by 1970, both sides now agree on one point: **unless the FCC reaches a decision soon, they will have serious deadline problems.** It takes at least 18 to 24 months to get either system into operation. Comsat wants to have the 10,000-circuit Intelsat-4 satellite handling transatlantic traffic, while AT&T leads the group urging the 720-circuit TAT-5 cable [Electronics, Dec. 11, 1967, p. 155].

Both sides say their overseas partners are also upset over the Yankee indecision; Spain, Portugal, and Italy have already signed the TAT-5 agreement, while members of the 60-nation Intelsat consortium are supporting Comsat's plan. One observer says he has heard that a decision could come soon, but adds, "I heard the same thing in September."

Bright spot in job program

The Commerce Department, which is having slow going with its program to get industry to set up plants in areas of hardcore unemployment, is finding one bright spot: the "fairly good" response of the aerospace and electronics industry. One example: ITT will unveil a proposal for a manufacturing center in Washington, D.C., later this month. However, Administration officials are beginning to feel that increased incentives such as tax breaks and special grants will have to be provided quickly if the program is to get moving.

Cable tv hearings: poles apart on rules

The FCC would like to hold hearings on telephone-company involvement in cable television—but laying down the ground rules appears as difficult as arriving at final rulings. **The agency is concerned over telephone pole rental practices and tariffs, and the companies' contention that their right to string phone lines into homes includes the right to string cable-tv lines.**

FCC hearing examiner Charles J. Frederick has held pre-hearing conferences with attorneys from telephone companies, the National Cable Television Association, and the commission's CATV task force, trying to establish a hearing date, order of evidence and witnesses, and other basic procedural rules. But no agreement has been reached. **The next conference is scheduled for Jan. 17, but participants aren't optimistic about making much headway.**

Bidding for Awads to be hot and heavy

At long last, it's go for the Air Force's Adverse Weather Aerial Delivery Avionics System (Awads). And the companies planning to bid for the program make up a "who's who" of avionics producers. Probable reasons: a paucity of major avionics awards in recent months and a desire by producers to get more business in the limited-war equipment market.

Bids on the contract, which eventually may amount to $300 million, are due early this year. The Air Force was all set to request industry proposals last summer, two years behind schedule [Electronics, June 26, p. 60], but was forced to postpone action by the squeeze on funds due to the Vietnam war. Air Force officials now feel that the Pentagon will release funds for the work over a period of several years. The contractor,

who will probably be selected by this spring, will supply an integrated package of Ka-band radar sets, digital computers and stationkeeping equipment for installation in C-130 transports. Awads will allow precision air drops of men and material in zero visibility.

Pentagon and AEC may sell software

Possibly goaded by NASA's success in selling computer software to industry and educational institutions, the Pentagon and Atomic Energy Commission are considering opening stands in the same store.

Representatives of the two agencies and NASA's Office of Technology Utilization are discussing details. The computer packages—tapes, card decks, run instructions, and program listings—would be sold by the space agency's Computer Software Management Information Center at the University of Georgia. The center has been selling some 200 NASA programs covering inventories, mathematical routines for problem solving, design evaluations, and tests and checkouts. **According to a NASA official, it will be paying its own way within a year or two.**

Plug for brain drain from north Europe may spring a leak

Companies worried that the new immigration laws will halt their recruiting of engineers and scientists in Britain and other northern European countries can expect some relief from Congress this year. Their problem is that immigrants will be accepted on a first-come, first-served basis regardless of nationality after next July 1. And because immigrants from northern Europe had never been on waiting lists since their quotas were always undersubscribed, they would have to get at the end of the line—after professionals from such countries as Italy, Greece, Spain, India, Pakistan, and the Philippines.

However, under pressure from organizations representing such ethnic groups as the Irish- and German-Americans, Congress will most likely modify the laws to give northern Europeans a better place in line.

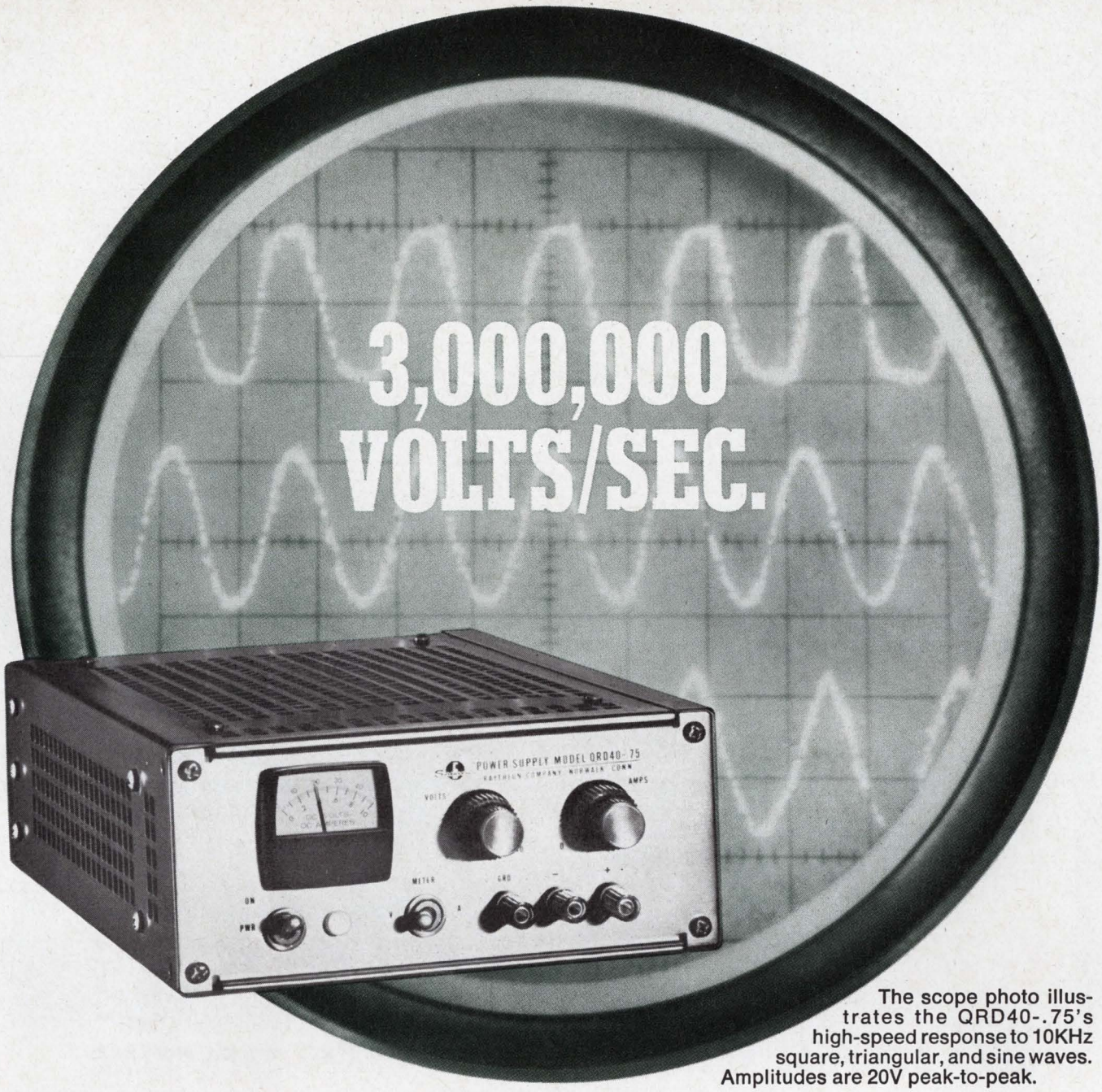
Comsat may buy Alaska phone lines

Comsat may offer to buy the long-lines telephone system in Alaska from the Defense Department late next year. The Pentagon was recently authorized by Congress to sell the commercial portion of the Alaskan system—now operated by the Air Force—to the bidder offering the best price, rates, and plans for expansion.

Sen. E.L. Bartlett (D., Alaska) suggested that Comsat be invited to bid "because of the unique attractions of satellites." In addition to a "domestic" satellite for intra- and interstate communications another might be used for a statewide television system, Bartlett believes. **Comsat has begun studies to see if the purchase might be profitable.**

Radar weathering Coast Guard test

The Coast Guard this month will complete sea trials of a prototype automatic vertical-tracking-radar system that is expected to become the service's seaborne weather observation sensor. The equipment, a modification of the Navy's Mark 56 antiaircraft radar, will permit a slow-moving or stationary ship to track ascending weather balloons. Presently, the cutters are equipped with horizontal-tracking radars that scan upward for just a few degrees. The prototype was built by Fairchild-Hiller under a two-year-old, $5 million contract that calls for two prototypes and 37 production models.



The scope photo illustrates the QRD40-.75's high-speed response to 10KHz square, triangular, and sine waves. Amplitudes are 20V peak-to-peak.

New Sorensen QRD:

☐ A High-Speed Programmable Power Supply with a "Slewing Rate" Greater than 3,000,000 volts/second.

☐ A Versatile Laboratory Supply Featuring ±0.005% Regulation.

This new precision power supply leads two lives! In the high-speed programming mode, its performance is unmatched—only 10 microseconds programming time from E_{max} to 0 Volts. Capable of being programmed by resistance, voltage, or current to 100KHz. The oscilloscope photo vividly illustrates the QRD's high-speed capability which makes the QRD unequaled in digital, microcircuit testing, and servo system applications.

The QRD also serves as a precision general-purpose instrument featuring ±0.005% voltage regulation, 200μV r.m.s. (3mV p-p) ripple, automatic crossover between constant voltage and constant current operation, and overload/short circuit protection.

Sorensen QRD's are available in seven off-the-shelf models ranging from 0-15v @ 2.0 Amps. (QRD15-2) to 0-60v @ 1.5 Amps. (QRD60-1.5). Prices start at $178.00.

Contact your local Sorensen representative or: Raytheon Company, Sorensen Operation, Richards Avenue, Norwalk, Connecticut 06856 TWX 710-468-2940.

RAYTHEON

for more data on this versatile instrument . . . **Call Sorensen: 203-838-6571**

GET YOUR FREE RELAY!...YOU'RE A WINNER EVERYTIME!

Run your own relay race (evaluation test) in your own plant, under your own conditions, using your choice of our general purpose and medium power relays.

YOU BE THE OFFICIAL JUDGE! Verify the results shown in the chart on the right. You will find that Eagle Relays run longer and better; that there is no premium in cost and that they are always readily available.

GET YOUR FREE RELAY TODAY by writing for your OFFICIAL JUDGE'S ENTRY BLANK to: Relay Race, Eagle Signal Division, 736 Federal Street, Davenport, Iowa, 52808, or by circling reader service number below.

	COMPETITIVE BRANDS						EAGLE RELAYS
CONTACTS	"A"	"B"	"C"	"D"	"E"	"F"	
Arrangement Rating	3 PDT 5 Amp.	3 PDT 5 Amp.	3 PDT 5 Amp.	3 PDT 5 Amp.	3 PDT 5 Amp.	3 PDT 5 Amp.	3 PDT 5 Amp.
LIFE Mechanical	15,061,261 Operations	14,077,866 Operations	28,808,000 Operations	21,625,333 Operations	16,923,133 Operations	29,433,600 Operations	34,492,950 Operations
ELECTRICAL 5 Amp. Resistive	295,466 Operations	490,433 Operations	129,600 Operations	235,700 Operations	778,200 Operations	921,400 Operations	948,675 Operations
1.6 Amp Inductive	488,666 Operations	1,071,666 Operations	496,000 Operations	284,333 Operations	3,529,466 Operations	1,842,000 Operations	3,102,200 Operations

This comparison chart shows that Eagle Relays have a 100% greater life than the average of our six competitors at 5 amps, resistive and an almost 140% greater electrical life than the average of the six competitors at 1.6 amps inductive.

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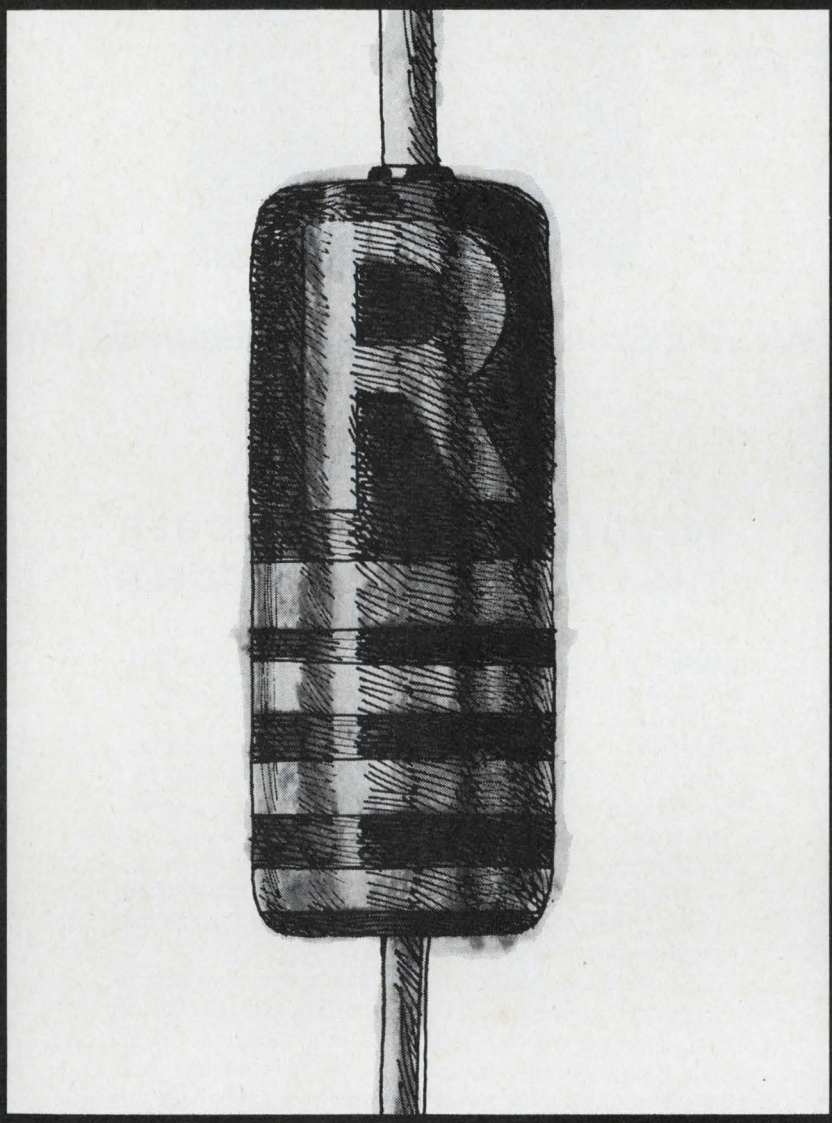
R-TX



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RAYTHEON

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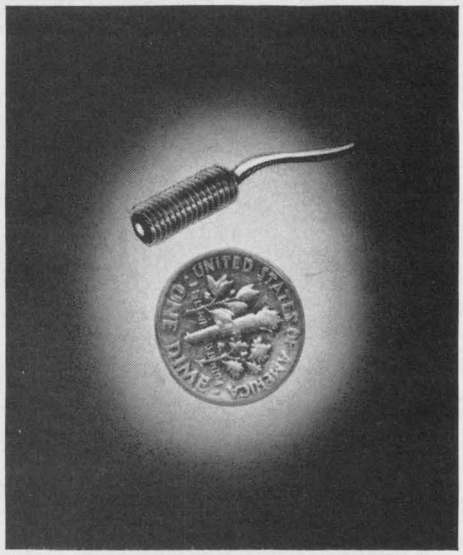

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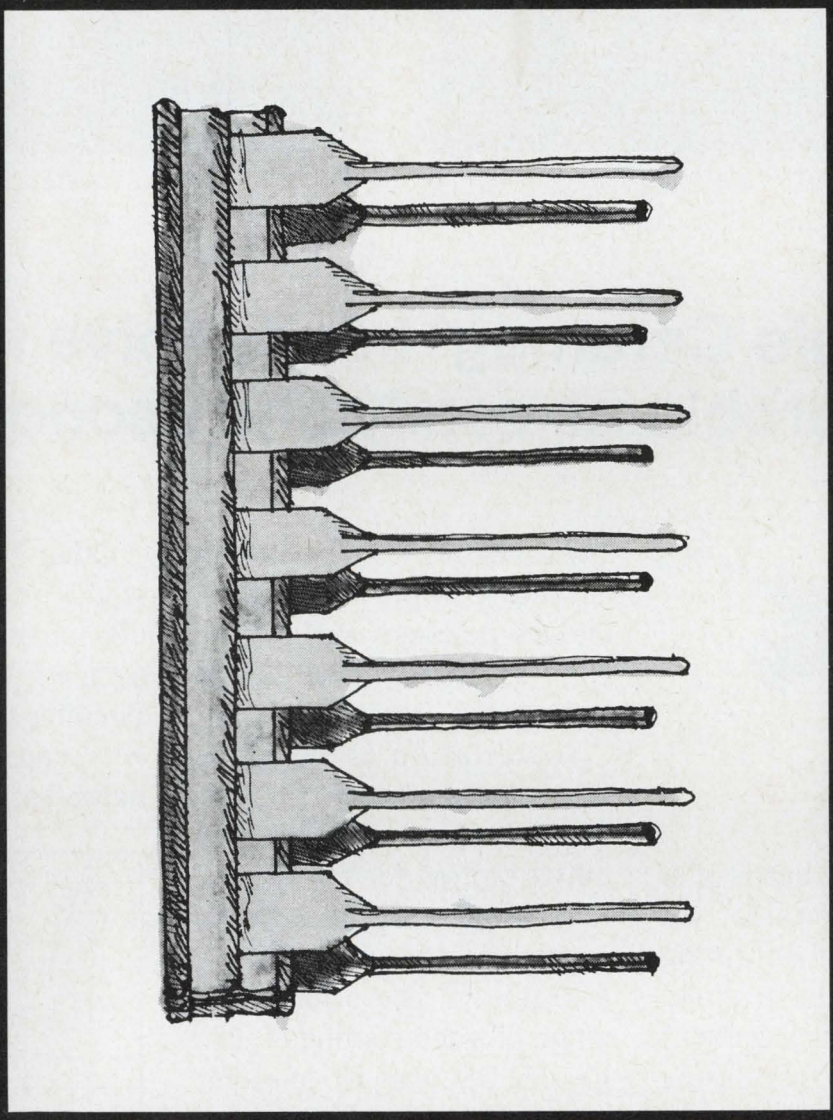
R-TX



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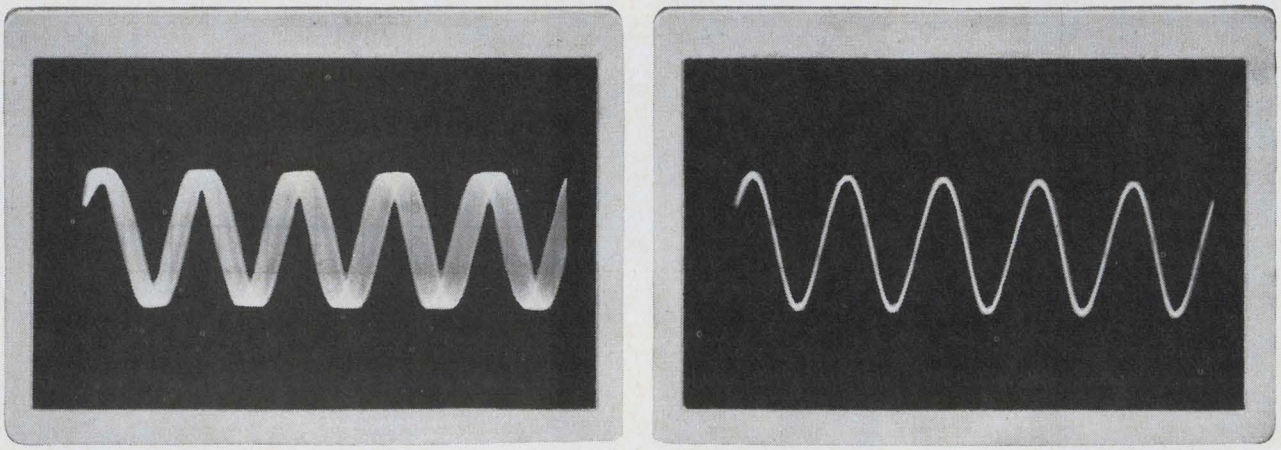
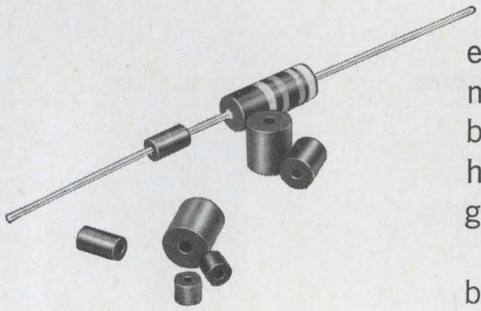
RAYTHEON

Actual photographs show the filtering effect of Stackpole ferrite beads on critical electronic circuits. Left — without beads, right — with beads.



Stackpole Ceramag® beads solve noise and filter problems easily and economically



Ceramag® ferrite beads offer a simple, inexpensive, yet effective means of obtaining RF decoupling, shielding, and parasitic suppression without sacrificing low frequency power or signal level.

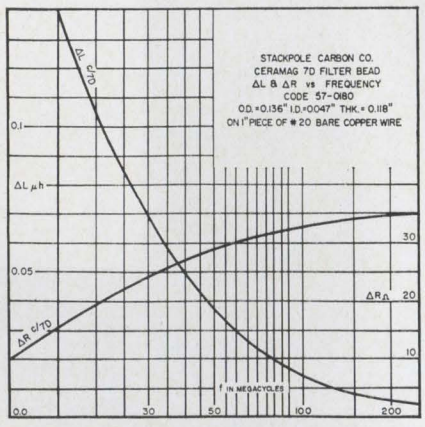
Unlike conventional RF chokes, beads are compact, have no DC losses, and will not couple to stray capacity and introduce detuning or spurious oscillations. Ceramag® beads offer an impedance which varies from quite low at low frequencies to quite high at noise frequencies. Beads need not be grounded; however, chassis contact is permissible when desired, as beads possess sufficiently high resistivity to preclude grounding.

Installation of Stackpole beads is easy. Simply slip one (or several) over appropriate conductor(s) for the desired noise suppression or high frequency isolation. Beads are available in sleeve form in a range of sizes starting at .025 ID, .060 OD, and .400 long. For special compact filtering applications such as cable connectors, beads can be supplied to tight mechanical tolerances.

Several ferrite grades provide a variety of attenuation characteristics. Inductance tolerance is normally ± 30% as measured on an LC meter. The performance of a Ceramag® 7D bead as a parasitic suppressor is shown in Figure 1.

Other typical applications might include: decoupling in "B" circuitry; noise suppression; RF isolation in filament circuits; use in combination with capacitors to form "L" networks.

FIGURE 1

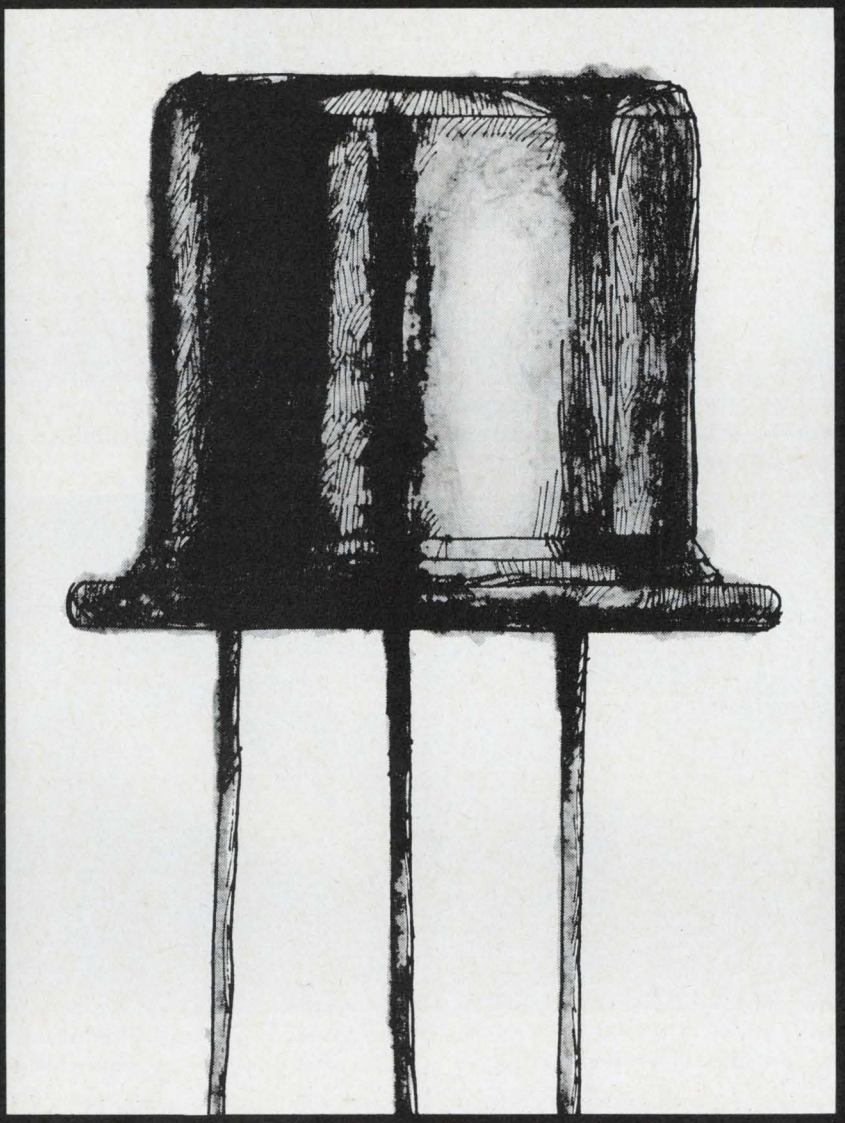


Sample quantities of Ceramag® beads are available without charge upon request. Send your requirements to Stackpole Carbon Company, Electronic Components Division, St. Marys, Pennsylvania 15857. Phone: 814-781-8521. TWX: 510-693-4511.

STACKPOLE
ELECTRONIC COMPONENTS DIVISION

Circle 75 on reader service card →

R-TX



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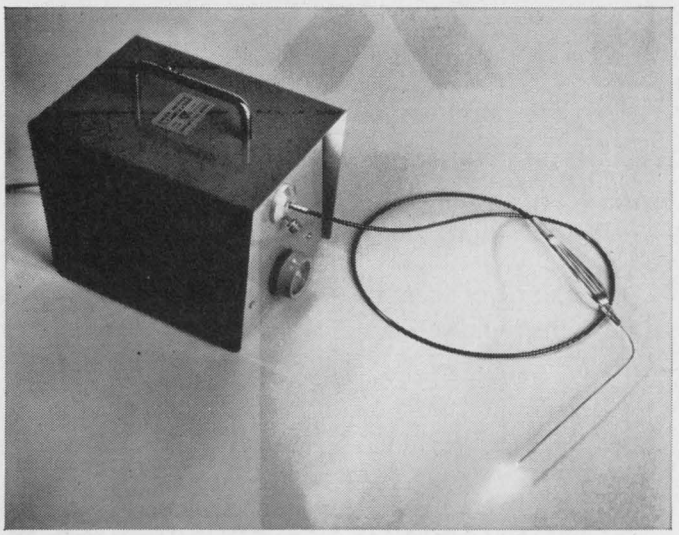
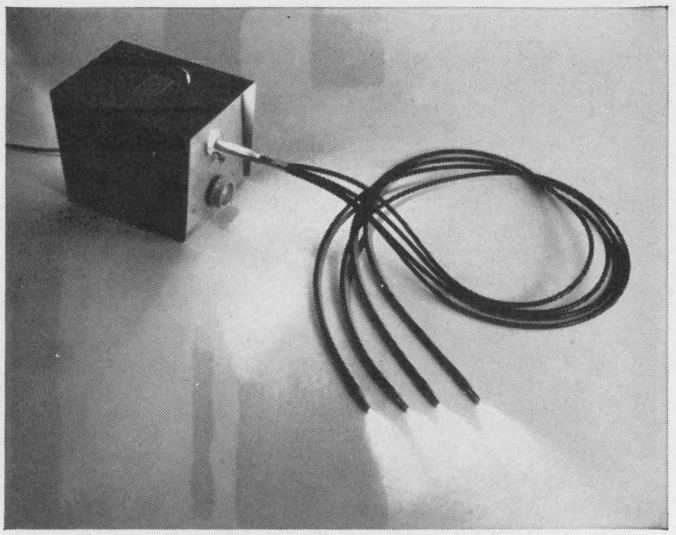
RAYTHEON

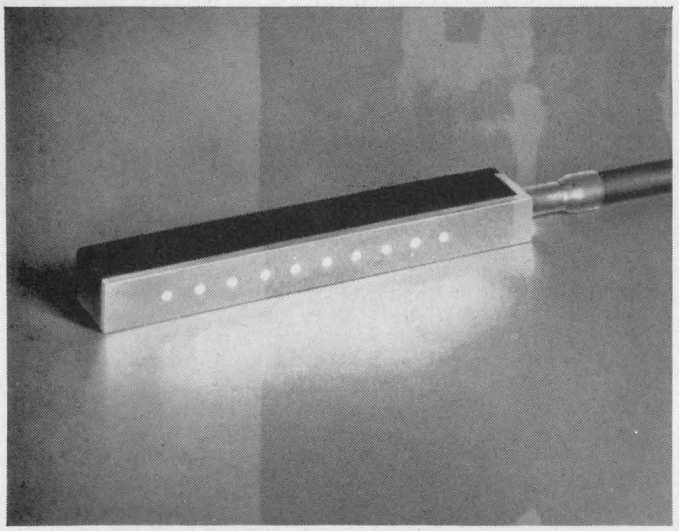
How AO fiber optic light guides solve illumination problems.



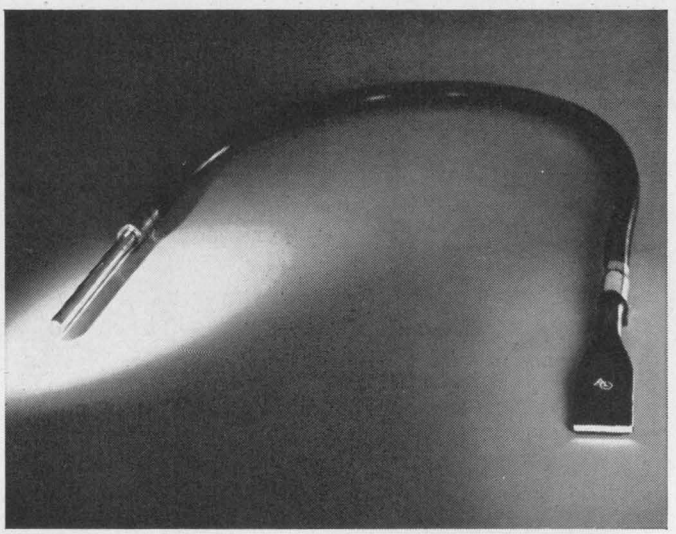
Transmit "cold" light like other forms of energy—by flexible routing to remote or inaccessible locations, hazardous areas, or any abnormal environment.



Supply multiple illumination from a single light source, with multi-branched light guides.



Simplify lighting problems by eliminating lens systems, multiple lamps, complex electrical circuitry.



Provide input-output geometry conversions such as round-to-square, round-to-slit, etc.

These are only a few of the ways in which American Optical fiber optic light guides are used to help solve illumination problems. Specific applications range from mark sense readout to electro-optical sensing in data processing, circuit verification, fire control, null detection, light pens, spot illumination, and many others.

Simple, reliable, economical. AO fiber optic light guides are simple, passive elements which remain extremely reliable under normal vibration, temperature or humidity changes, or other environmental fluctuations. This results in long service life with minimum maintenance.

Standard and custom light guides from American Optical have light transmission ranges from 400 to 1500 millimicrons. Standard light guides are available in bundle sizes from .020" to ¼", with 30 to 6000 fibers, lengths up to 72", plastic or stainless steel tips, and PVC sheaths. Custom light guides can be supplied in any length desired, with special end tips, sheaths, diameters, input-output face configurations, and branchings.

A leader in optics since 1833, American Optical Company brings a great breadth of related experience to the technology of fiber optics. Our versatility in fiber optics is unmatched by any other manufacturer. In fact, AO scientists already hold more than 200 important patents or patents pending in this relatively new field.

For Fiber Optics Data Kit, send reader service card, or write to Fiber Optics Department:

AMERICAN OPTICAL COMPANY
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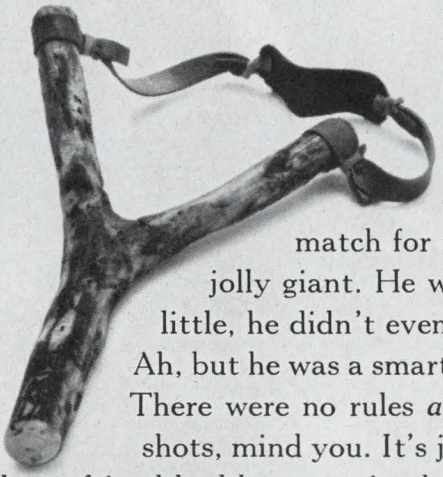
When you're little you have to think fast or play dirty.



Take David, for instance. He was no match for that not-so-jolly giant. He was not only little, he didn't even play dirty! Ah, but he was a smart little devil! There were no rules *against* slingshots, mind you. It's just that our large friend had been getting by on his size so long that he turned into sort of a clumsy thinker.

David took an existing device, applied it to a new situation and bingo! One dead giant.

At MIDTEX/AEMCO we call that creative thinking. And we do a lot of it for our customers, because believe us, we don't get by on our size. Compared to some of the giants in the relay and time delay business . . . we're a David.

But we think quick. And creatively. We've solved an unusually difficult time delay problem for Xerox, dozens of relay problems for Collins Radio and given solid assistance to RCA, Bruning, E. F. Johnson Co., and many more.

But we're not going to sit here and crow about what we did for somebody else yesterday, it's what we can do for you tomorrow that's important. So, if you have a giant relay problem, or giant timing problem, remember little MIDTEX/AEMCO. We're smart little devils . . . specializing in dead giants.

How can anybody forget a ridiculous story like that?

MIDTEX INCORPORATED

AEMCO DIVISION
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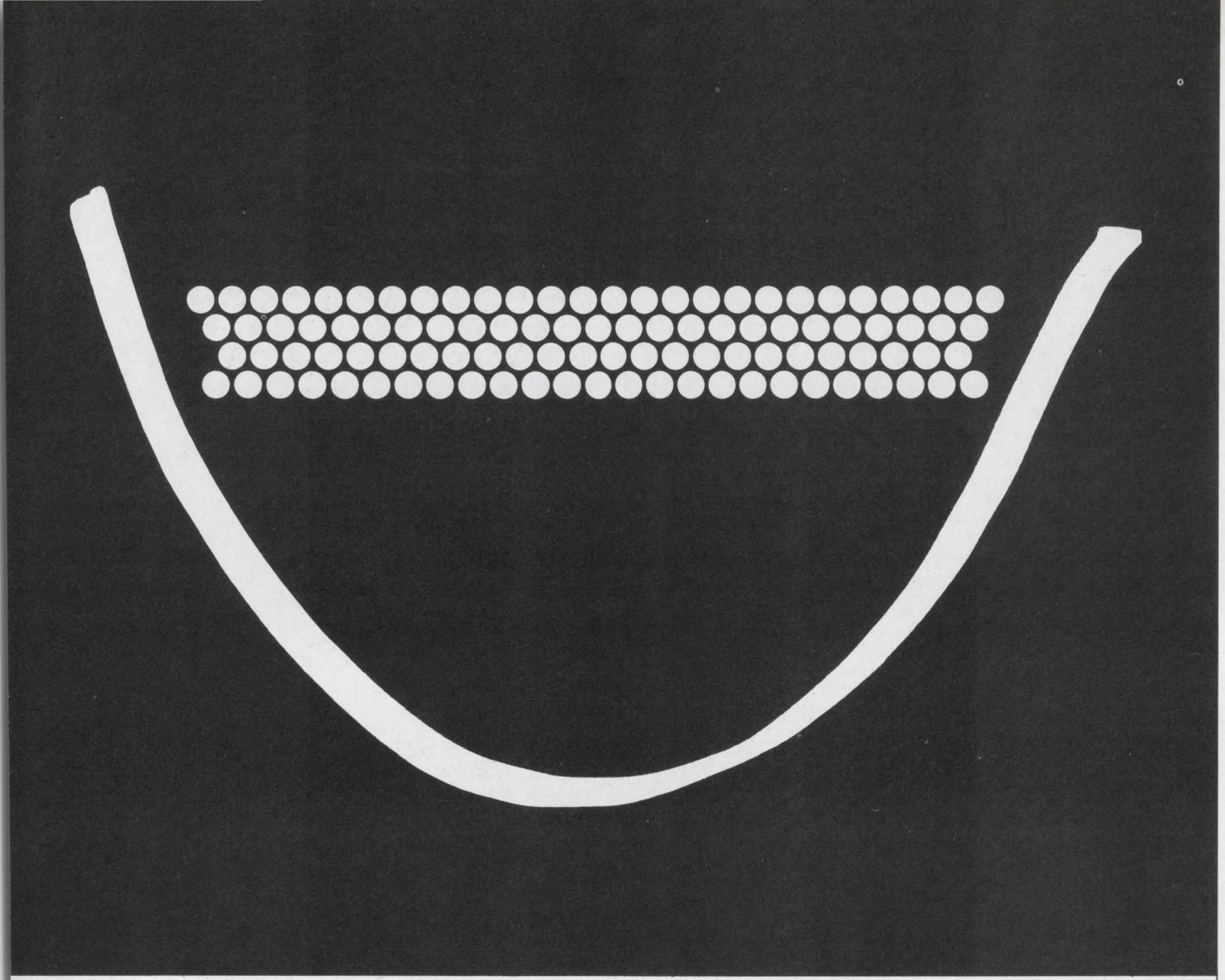
PROGRAMMERS/TIME DELAY RELAYS/MINIATURE COAXIAL RELAYS/INDUSTRIAL RELAYS/MERCURY-WETTED CONTACT RELAYS



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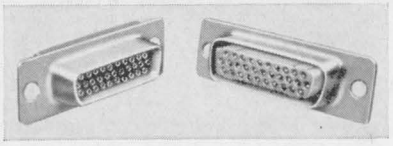

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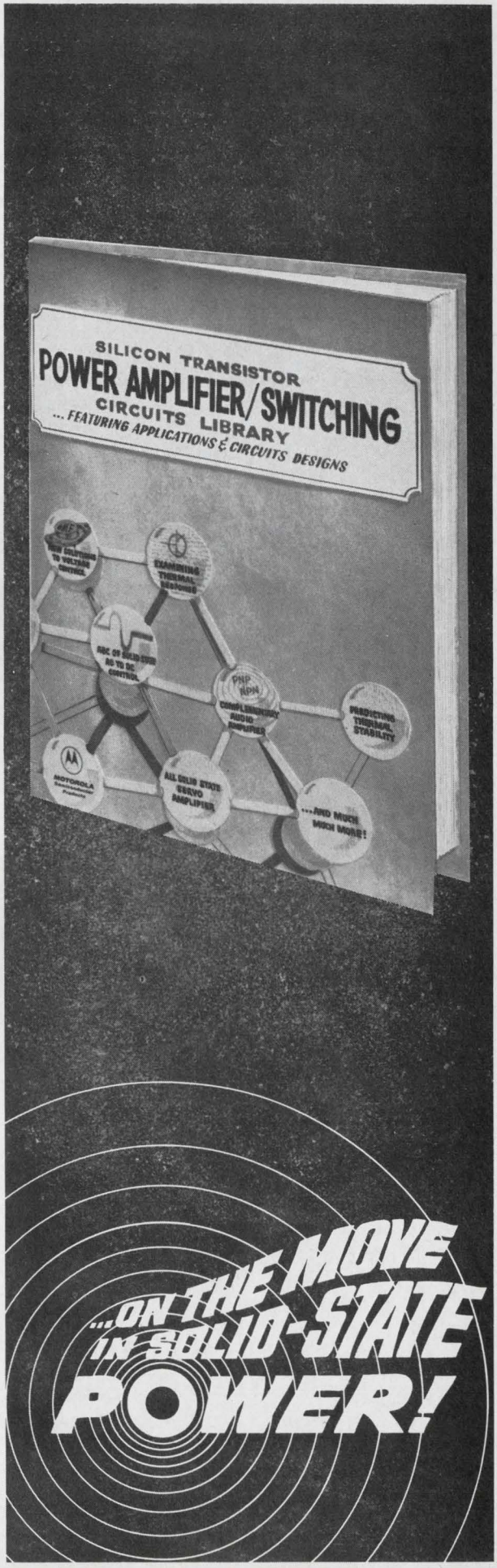


MOTOROLA Semiconductors
– where the priceless ingredient is care!

←Circle 78 on reader service card

How do you gruntle the buyer of memory stacks?

(Take a powder and control it all the way).

The man who buys memory stacks (or planes or just cores) knows that a myriad of tiny variables which affect performance can pass right through the tightest spec. It's nobody's fault, but still it leaves the buyer disgruntled.

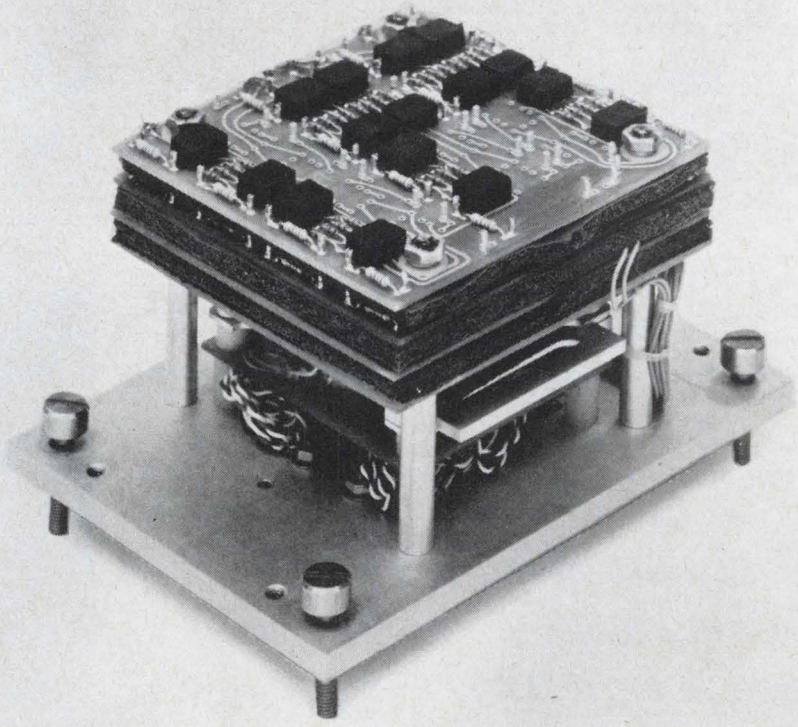
How to gruntle him? Well, this is what we do at Ferroxcube. We control the entire process from formulation of the powder for the cores to the planes or stacks that go out the door. To the naked eye much of this looks like textbook QC procedure. But some of it goes deeper. It's the kind of control you associate with a veteran airline pilot whose experience amounts almost to intuition. As pioneers in ferrites and core memory components, we have people like that in control at every vital stage of manufacture.

This is one reason why Ferroxcube can design and build to exacting requirements (example: military stacks that exceed the environmental requirements of MIL-E-16400 and MIL-E-5400). And it's the main reason why every production unit performs like the prototype you approved.

If you specify cores, planes or stacks, talk with the people who pioneered ferrite technology. As a conversation piece, a sheaf of technical literature awaits you. Write for it today.

Ferroxcube

Saugerties, New York



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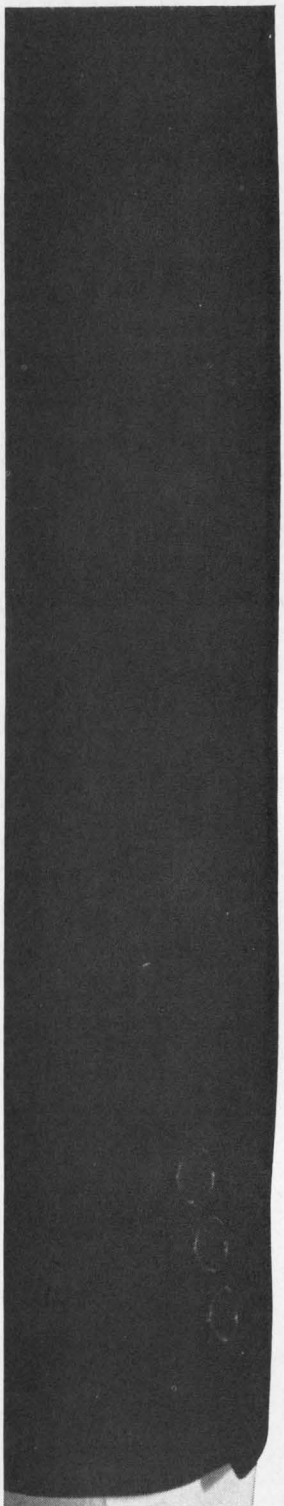

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All this with a low, low silhouette (just 0.350 inch above mounting surface).

MPC Correeds measure as small as 17/32 by 1.350 inch. We located the terminals on 0.050 inch centers to match your board grids. You can stack them tightly in your racks—without magnetic interaction.

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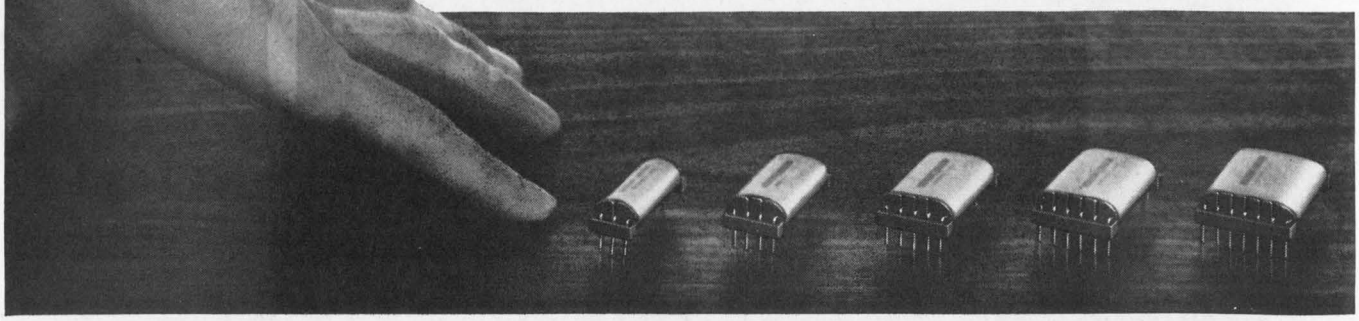
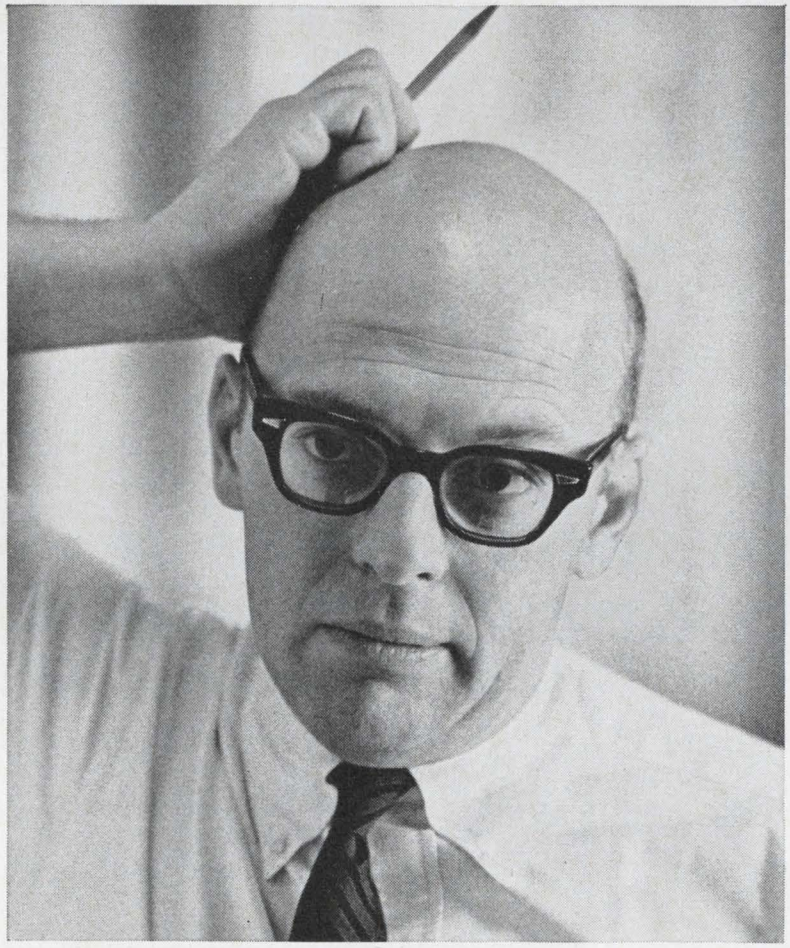


Circle 82 on reader service card

Circle 83 on reader service card→

How do most companies move a doodling, advanced-thinking, problem-solving computer systems engineer?



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Tube photograph is actual size.

Circle 84 on reader service card

Burroughs Corporation

Only Burroughs manufactures NIXIE Tubes.

Technical Articles

Guarding industry's electrical loads
page 86

When electrical machinery is connected to in-plant generators or to small electrical utilities that can't afford sophisticated frequency-regulating equipment, short-term variations in power-line frequency can throw it out of whack. These installations can protect themselves with a new guard circuit that sounds an alarm or disconnects the load when the deviation is potentially dangerous.

Integrated circuits in action, part 9
Digital techniques shrink recorder
page 93

A switch from analog to digital circuitry and the use of off-the-shelf IC's can cut the cost and size of an instrumentation recorder and improve its performance. The substitution of a digital one-shot multivibrator for an analog f-m discriminator in the playback circuit gives the recorder a bandwidth twice that of earlier versions.

U.S. electronics markets: 1968
page 101

A compilation of market statistics by McGraw-Hill's economics department and Electronics' market research manager, Milton Drake.

State of the mart: gains are slowed by war priorities
page 105

The unforeseen slowdown last year has made market analysts a bit cautious about 1968. Electronics' annual survey forecasts a modest 6.7% rise in electronics sales to $22.6 billion. Although the war in Vietnam is squeezing many sectors of the industry and curtailing long-range research projects, 1968 shapes up as a year of technical advances. Integrated circuits are beginning to produce profits, and semiconductor houses are readying medium- and large-scale arrays for the marketplace. For the cover, art director Saul Sussman chose photographs of the Spartan, a key part of the Sentinel antiballistic missile system, to illustrate the market's strong military orientation.

Coming January 22

- **Correcting errors in data transmission**
- **Time compression**
- **IC's cut counter costs**

Guarding industry's electrical loads

High-resolution circuit protects equipment sensitive to variations in power-line frequency by detecting deviations from preset limits and setting off an alarm or disconnecting the load

By Joseph Bodow

Bulova Watch Co., Woodside, N.Y.

Many industrial operations can't tolerate short-term deviations in power-line frequency. The daily corrections usually made by power companies suffice for most electricity consumers, but not for facilities where a sudden frequency shift will throw machinery speeds completely out of whack. These plants must have their own round-the-clock watchdogs guarding equipment.

The problem is especially critical when equipment is connected to in-plant generating systems or to small utilities that can't afford the cost of automatic, high-quality gear to regulate frequency. The larger the frequency deviation and the longer it lasts, the more serious is its effect on sensitive equipment.

Electrical installations can arm themselves against excessive frequency variations with a newly developed guard circuit. Using an integrated-circuit flip-flop and a tuning-fork oscillator, it senses the phase difference between a line-frequency signal and a tuning-fork, limit-frequency signal. When an excessive difference is detected, the circuit fires a silicon controlled rectifier whose pulse output can set off an alarm or disconnect the load from the line.

Reaction to a violation of a preset limit frequency can be made fast or slow, depending on application needs. Monitoring a 60-hertz power line, for example, the circuit will respond in no more than 10 seconds to a 0.1-hz deviation, and in no more than 5 seconds to a 0.2-hz deviation.

The author

Joseph Bodow came to Bulova in 1946 as a technician, and four years later earned a BSEE from New York University. He is now laboratory director at American Time Products, Bulova's electronics division, where he specializes in tuning-fork oscillators, frequency generators, and timing devices.

Change of phase

As long as the power-line frequency is within the limit frequencies, the guard doesn't interfere with normal operation. The reference oscillators essentially provide go, no-go control.

The high and low circuits are independent, so the guard can be designed to detect frequency excursion beyond only high or only low limits.

The circuit continually compares the instantaneous difference in phase between a cycle of the line frequency and the corresponding cycle of the reference frequency. If the two frequencies are constant but different from each other, the phase difference between the two will increase as time passes. When the accumulated phase difference reaches 360 electrical degrees, the circuit will deliver a pulse to indicate that the line frequency has slipped a full cycle, see page 88. This pulse can be used as a control signal to actuate an alarm, turn off the motors, or take other corrective measures.

The basic purpose of the guard circuit is to convert a phase difference into a corresponding d-c voltage that will trigger the generation of a control pulse by an SCR. Consider a typical cycle. The circuit first shapes the line and reference signals to square waves, which then set and reset a bistable flip-flop. The flip-flop output is therefore alternately on and off, and the time duration of the on pulse, T_{on}, relates to the instantaneous phase difference. Disregarding the small voltage drop in the flip-flop, the on-state voltage equals the supply voltage, V_{sup}.

The integration of the flip-flop output involves:

$$V_{out} = \frac{1}{T}\int_0^t V dt$$

$$= \frac{1}{T}\left[(V_{sup} \times T_{on}) + (0 \times T_{off})\right]$$

$$= V_{sup}\frac{T_{on}}{T}$$

Further, because T is the time for one cycle and is equivalent to a phase difference of 2π radians, or 360°, then

$$V_{out} = V_{sup}\frac{\phi}{2\pi}$$

where ϕ is the instantaneous phase difference between reference and line frequencies. Thus, the output voltage is $V_{sup}/2$ for 180° phase difference. In general, the output voltage ranges between 0 and V_{sup} for each 360° of accumulated phase.

As the phase relationship changes, the d-c output voltage changes according to

$$\frac{dV_{out}}{dt} = \frac{V_{sup}}{2\pi} \times \frac{d\phi}{dt}$$

That is, the rate of change of integrated output voltage is directly proportional to the rate of change in the phase relationship. The larger the difference in the two frequencies, the faster the output voltages rises from zero to full supply voltage.

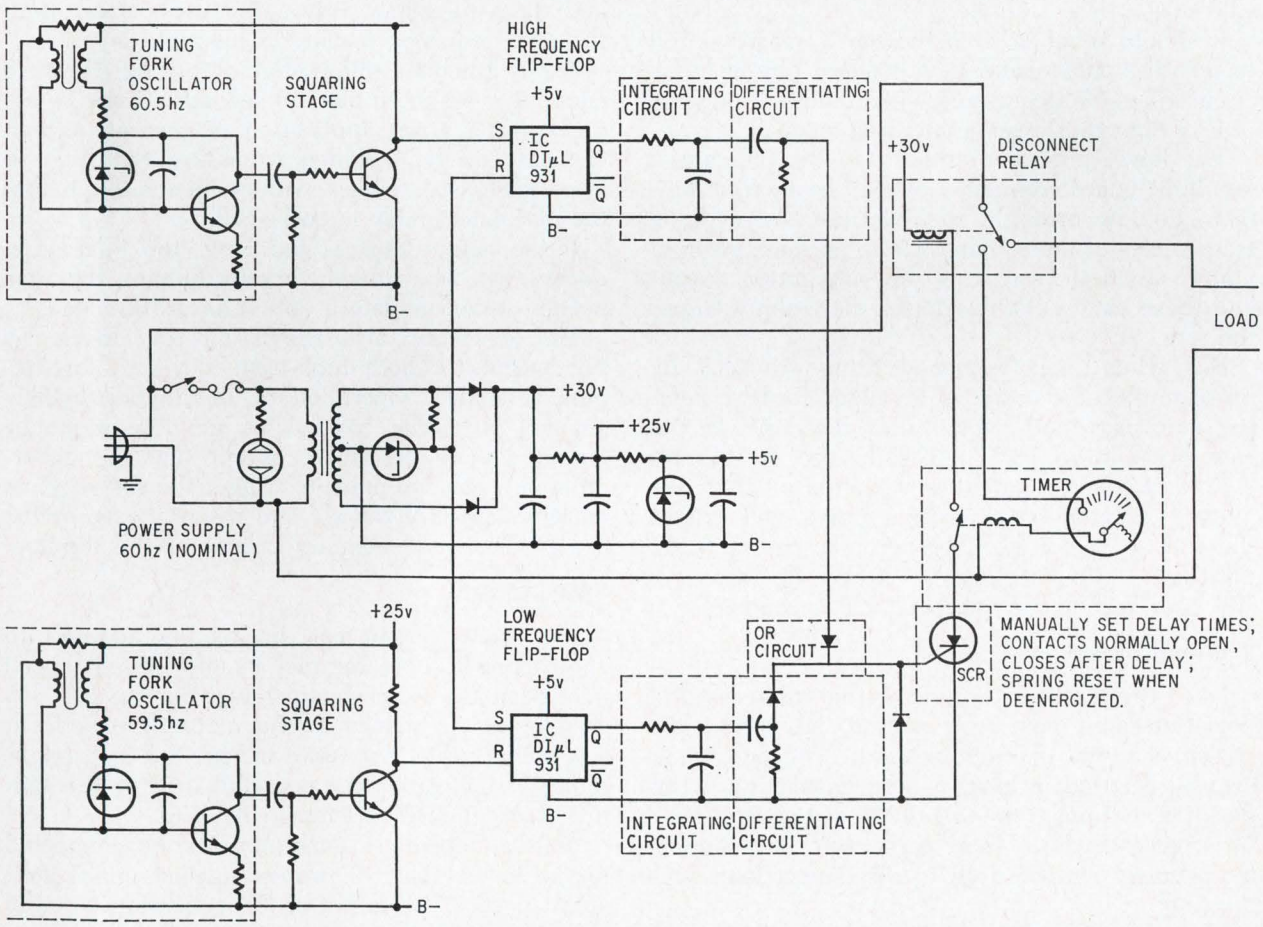
The set of waveforms at specific points in the guard circuit shows what happens when the line

Under pressure

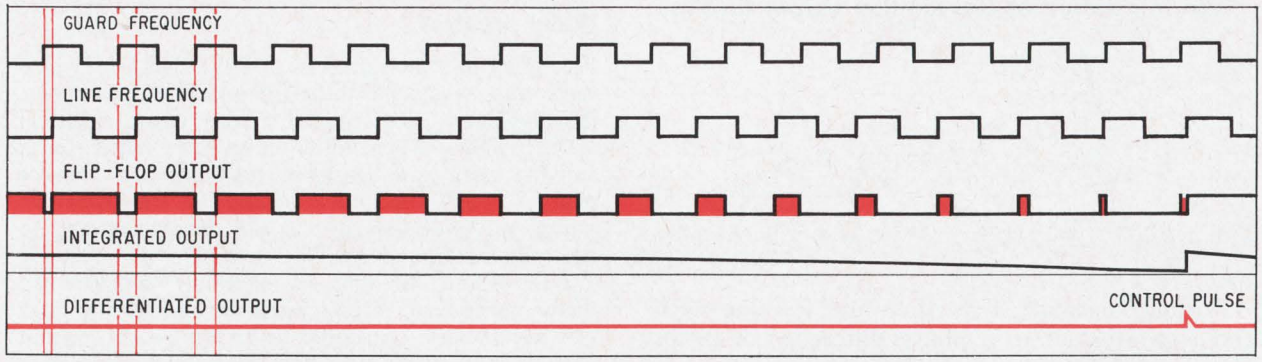
Electricity in some refineries is generated from waste fuels and waste heat, and frequency regulations may be poor. Line frequency dips when electrical load rises, and when a 100-horsepower motor starts and the extra load causes a frequency dip, another motor, already on line and driving an hydraulic pump, say, will slow to a speed directly related to the reduced frequency.

Pump flow, though, is extremely sensitive to motor speed, and a prolonged change in flow rate can have severe consequences. A boiler not getting enough feed-water from the pump will undergo a fast rise in steam pressure and perhaps explode.

The guard circuit could be used in such installations to trigger an alarm or start up an auxiliary water pump when the situation begins to develop.



Phase into pulse. In each monitoring channel, a tuning-fork oscillator generates a reference frequency for comparison with the line frequency. An excessive difference between the two is converted—in flip-flop, integrating, and differentiating circuits—into a pulse that triggers the SCR.



Voltage spike. When line frequency drops below guard frequency, the phase difference between them decreases until the integrator voltage reaches zero and suddenly rises to full value. The differentiator senses the rise and produces a positive pulse.

frequency drops below the low-limit guard frequency. The duration of the flip-flop's pulse output shrinks as time progresses, and the d-c voltage integrated by the resistor-capacitor decreases until the circuit slips a full cycle.

The differentiator circuit senses the rate of change of the integrated voltage. With a small frequency difference, the integrated voltage changes slowly. The differentiated voltage is practically zero in this case except when the phase shift reaches 360°, at which point the differentiator produces a sharp positive pulse that triggers the silicon controlled rectifier.

It should be noted that the SCR is sensitive only to positive pulses, and that positive pulses in the circuit, page 87, occur only when the line frequency is less than the lower guard frequency.

The lower portion of the schematic indicates a low-limit guard frequency of 59.5 hz monitoring a 60-hz line. According to the polarities assigned, line frequencies of more than 59.5 hz produce positive-going sawtooth waves at the integrator output, and these yield negative pulses that cannot trigger the SCR.

But when line frequency drops—to 59.4 hz, for example—the output d-c voltage forms a negative-going sawtooth with a uniform slope. In this case it would be (59.5 — 59.4) hz/sec, or 10% per second. Looked at another way, for a 0.1-hz frequency difference, a positive pulse will trigger the SCR every 1/0.1 = 10 seconds. For a 0.2-hz difference, the integrated voltage decreases at 20% per second, or once every 5 seconds.

Working pulses

Once the SCR fires to indicate that an acceptable deviation limit has been passed, its output can initiate a visual or audible alarm. The pulses can also be counted in cases where knowledge of the duration and magnitude of the deviation is needed for open- or closed-loop correction. And one or more pulses can be used to disconnect load from the line.

The schematic shows how a load can be disengaged from the line when frequency deviation exceeds an allowable level, and restored when the deviation is corrected. When triggered by the first positive pulse, the SCR energizes a disconnect relay that removes the load to be protected from the line and starts a motor-driven timer. After the set delay time elapses, the timer's contacts close, and this operates a relay whose contacts open the SCR anode circuit.

The disconnect relay then reapplies line voltage to the load for continued operation, provided the line frequency is no longer lower than the guard frequency. If it is still below the reference level, the disconnect relay again opens the load circuit and starts the timer, continuing this pattern until the line frequency reaches a tolerable level.

For a low-limit differential of 0.1 hz, the unit cuts out in no more than 10 seconds. If this is too quick for a given application, a separate circuit element can be included to assure that two or more successive pulses will be generated before the disconnect relay is energized.

If the cutout time is too long, the guard frequency can be doubled, thereby halving the time needed to accumulate a 360° phase difference.

The schematic also shows an SCR driven by the outputs of both high-frequency and low-frequency guards. Operation of the high-frequency channel is similar to that of the low-frequency circuit already described, except that the generation of a positive pulse to trigger the SCR requires an interchange of the set and reset signals, or the use of the complementary output of the flip-flop.

Speed control

The guard circuit can be readily adapted to speed control. For example, a motor's shaft speed may decrease as mechanical load increases, even though line frequency to the motor is exactly at a specified value. Excessive mechanical load might indicate such problems as a dull drill or the failure of a clutch to disengage its load.

An a-c tachometer generator can be connected to the motor shaft to protect against out-of-limit shaft speeds. The output of the generator, suitably shaped to produce square waves, would serve as the guard frequency, and a tuning-fork oscillator would again act as the reference.

Designer's casebook

Designer's casebook is a regular feature in Electronics. Readers are invited to submit novel circuit ideas, packaging schemes, or other unusual solutions to design problems. Descriptions should be short. We'll pay $50 for each item published.

Unijunction transistor controls stable one-shot

By David A. Brooks

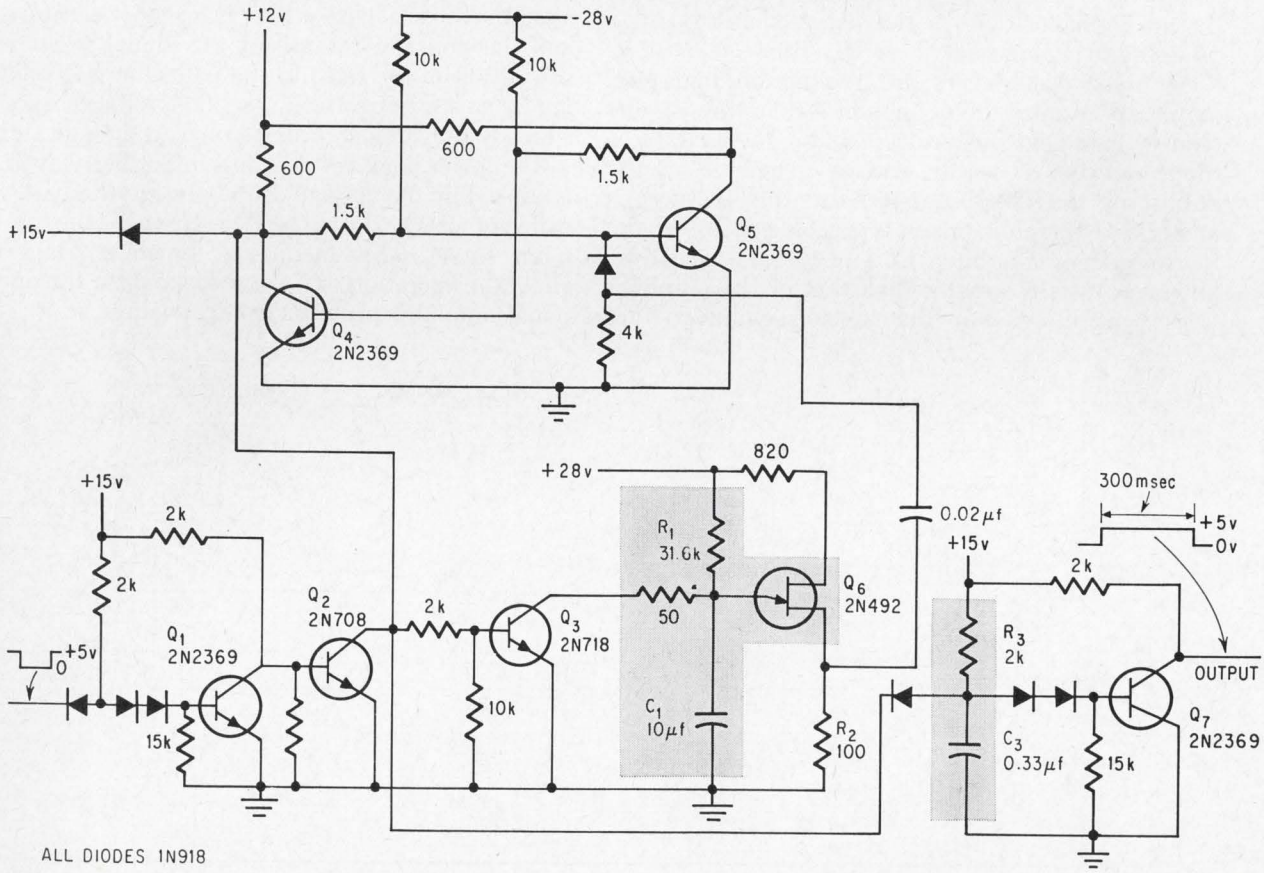
Honeywell, Inc., St. Petersburg, Fla.

Expanded pulse widths from a one-shot multivibrator are always obtained at the expense of stability and recovery time. The capacitor and resistor changes that increase the pulse width lower the d-c bias points on the transistor and make the circuit susceptible to false triggering. These changes also increase the time constant of the turn-off voltage, prolonging the recovery time and giving the trailing edge of the pulse an exponential characteristic.

An external trigger designed around a unijunction transistor allows a stable multivibrator to expand a 5-microsecond pulse up to 100,000 times and maintain a recovery time of less than 10 microseconds.

In the circuit, the turn-on time of the output pulse is determined by the unijunction transistor. This assures a sharp output pulse. A computer's 5-microsecond pulse is thus able to generate a sharp and accurate 300-millisecond pulse to control readout equipment.

The computer's 1-microsecond pulse momentarily turns off Q_1 removing the short on Q_2's base and allowing Q_2 to conduct. Transistor Q_2 is driven into saturation by the supply voltage and enables the forward bias to be removed from Q_3, Q_5, and Q_7, causing these transistors to turn off. The turning off of Q_7 removes the collector of that transistor



Unijunction control. The multivibrator when triggered by the unijunction transistor turns off Q_7 and places the 5-volt collector supply on the output. When C_1 discharges through R_1 the unijunction transistor removes the trigger and the multivibrator turns off. After C_3 charges through R_3, Q_7 turns off and the output is placed at ground.

from ground and establishes the leading edge of the output pulse.

When transistor Q_5 turns off, Q_4 turns on. Because Q_4 is conducting the base of Q_7 is kept at ground when Q_4 turns on. The 5-volt supply is thus kept at the collector of Q_7 until transistor Q_4 is turned off.

As Q_3 turns off, capacitor C_1 charges through R_1 to the firing potential of Q_6. Conduction through Q_6 causes a voltage to appear across R_2 that triggers Q_5 into conduction. Transistor Q_4 is now turned off and the 5 volts on the supply turns Q_5 on and backbiases D_1. The output remains at 5 volts until C_3 charges to a voltage that turns on Q_7. The collector of Q_7 is now returned to ground and C_1 discharges through Q_3.

Single transistor rectifies agc signal

By Robert W. Knighton

University of Michigan, Ann Arbor, Mich.

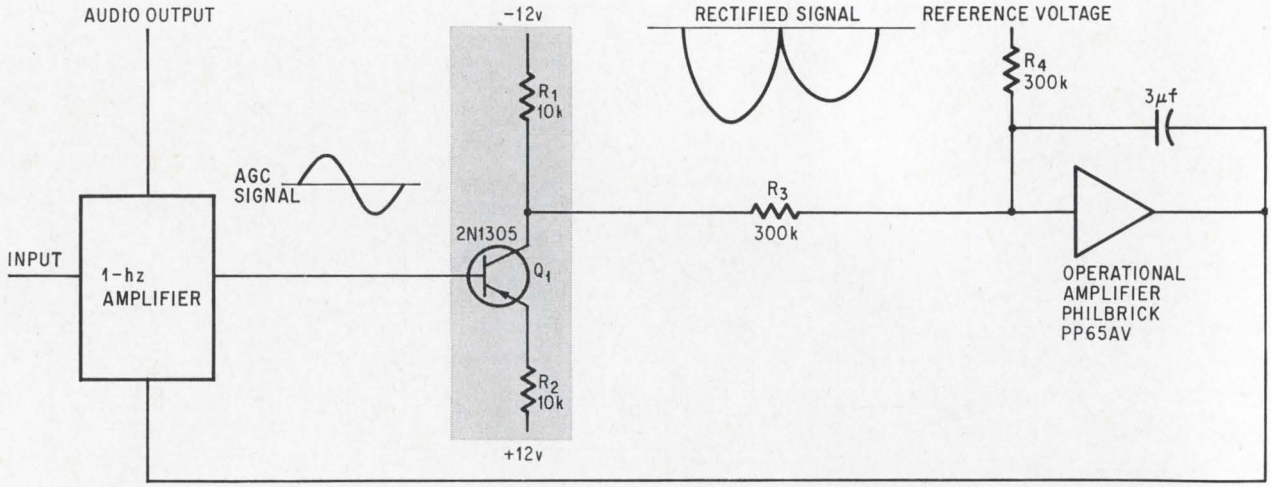
Full-wave rectification of a low-frequency, automatic-gain-control signal is necessary for stable and precise control of an amplifier output. It can be accomplished with a transistor connected in a phase-splitting network.

At present engineers are relying on high-gain amplifiers to raise the voltage of low frequency agc signals to a level where it can be rectified by a diode network. The d-c voltage generated at the output of the diode network by this method is stable and therefore gives a precise control of the low frequency amplifier. Cost of the agc circuit is, however, usually greater than that of the amplifier it is controlling. For that reason engineers are considering other low-frequency agc methods.

A transistor biased between its active and saturated region rectifies the low-power agc signal without attenuating that signal. The stability and precision of the d-c voltage produced by this method is close to that of the amplifier-diode method, and is much less expensive.

The positive portion of the agc signal backbiases transistor Q_1 and causes the voltage drop across R_1 to change. This places a negative voltage on the collector of Q_1 identical in wave shape to the positive portion of the input signal. When the input signal swings negative, the transistor is saturated and the negative portion of the signal is coupled directly from the base to the collector. After filtering by an RC network the rectified voltage becomes a steady d-c voltage, proportional to the agc signal.

The lower peak voltage in the rectifier waveform is caused by the voltage drop between the base and collector of Q_1 during the negative swing of the input signal. This inequality, however, does not affect the operation of the agc loop, since the operational amplifier provides compensation.



Rectifying transistor. A d-c voltage, proportional to the agc signal level, is supplied to the input of the operational amplifier by Q_1. The transistor, inverts the positive portion of the agc signal. Because it saturates the transistor, the negative portion of the signal can be transferred directly to the collector and results in full-wave rectification.

Feedback protects spacecraft's power supply

By Russell Burkett

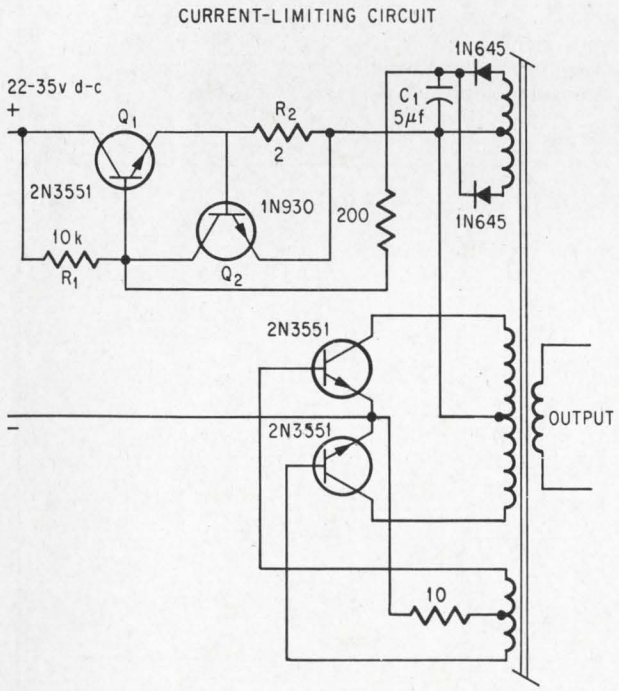
Aerojet-General Corp., Azusa, Calif.

A current-limiting feedback loop prevents persistent shorts in an inverter or its output circuit from draining the battery pack of a satellite.

When a short occurs, the low-resistance path between the supply and inverter is opened. Simultaneously a high-resistance path is switched between the supply and the inverter. This high resistance remains in the line as long as the short circuit persists.

Resistor R_1, between the collector and base of transistor Q_1, provides a current path necessary for starting of the inverter. Initial current flow through R_1, the emitter-base junction of Q_1 and R_2, allows oscillations to begin and biases Q_1 into its active region. As the a-c voltages in the inverter increase, a rectified voltage capable of driving Q_1 into saturation appears on C_1. Thus, Q_1 and R_2 offer the only resistance in the line.

A high-surge current raises the voltage drop across R_2 and biases Q_2 into conduction. This prevents the voltage on C_1 from reaching the base of Q_1, forcing that transistor into cutoff and placing Q_2 and the current limiting resistor R_1 in the line.



Current limiting. Resistor R_1 is switched into the line to limit high currents caused by load or inverter failures.

Detecting data errors boosts transmission accuracy

By A.E. Fein

Surface division, Westinghouse Electric Corp., Baltimore

Checking the accuracy of received signals in data-transmission systems requires complex and expensive equipment. This is particularly true for systems where errors can't be tolerated or where a high transmission rate must be maintained. However, applying time-spread coding provides a high degree of accuracy with less complicated hardware.

Time-spread coding is a technique that converts a burst of errors in a single block of data to a random distribution over several blocks, thus enabling the simple block codes to correct them.

A block of bits, or a word, is usually supplied with additional code bits that follow a Hamming code, for example. Assume that each block—including check bits—is 7 bits long and that the coding is to be time-spread over 9 blocks. The original bit stream would be $a_{11}\ a_{12}\ a_{13}\ \ldots\ a_{17}\ a_{21}\ a_{22}\ \ldots\ a_{27}\ a_{31}\ \ldots\ a_{37}\ \ldots\ a_{97}$. Under the time-spread concept, data is stored temporarily in a buffer memory, rearranged, and transmitted in the sequence: $a_{11}\ a_{21}\ a_{31}\ \ldots\ a_{91}\ a_{12}\ a_{22}\ a_{32}\ \ldots\ a_{92}\ a_{13}\ \ldots\ a_{93}\ \ldots\ a_{97}$. Thus:

Bit matrix in buffer

$a_{11}\ a_{12}\ a_{13}\ \ldots\ a_{17}$
$a_{21}\ a_{22}\ a_{23}\ \ldots\ a_{27}$
$a_{31}\ a_{32}\ a_{33}\ \ldots\ a_{37}$
$a_{91}\ a_{92}\ a_{93}\ \ldots\ a_{97}$

Data and code bits form a matrix in the buffer, and the buffer is loaded row by row and emptied column by column. At the receiver, this bit stream, which includes both data and code bits, is regrouped into its original word-by-word pattern for error checking.

In the Hamming code, first developed in 1950 by R. W. Hamming of the Bell Telephone Laboratories, several code bits are added to each data bit block. Each code bit establishes parity for groups of selected data bits. Thus if a word is received that contains an error, several parity checks identify the inverted bit. Hamming codes correct a single error in blocks of any size; however, larger blocks usually require proportionately fewer code bits. Also, codes can detect and correct multiple errors.

Hamming codes are most effective in channels where errors occur randomly and infrequently. Unfortunately, errors in most digital channels do not occur randomly; they tend to appear in clusters or bursts caused by lightning, solar flares, atmospheric noise, or fading.

The less complex error-correcting codes for ran-

domly distributed errors are relatively useless in channels where errors occur in bursts. Other more powerful and complex coding schemes that can combat burst patterns do exist, but their implementation is extremely complicated and expensive.

Time-spread coding adapts these simple codes to the error-burst situation. The technique spreads an error burst in the transmitted stream among the reconstructed words to prevent the appearance of more than one error in any code word. Longer bursts require either a multiple-error-correcting code or a larger spreading interval.

Despite its advantages, time-spreading techniques cause two delays in data flow. Consequently, memories at both the transmitter and the receiver must be loaded before the bits can be time-spread at the transmitter and regrouped at the receiver. In continuous-transmission systems, time shift of twice the time-spread period is required.

Transistor replaces resistor and improves amplifier

By Maurice J. Wright

Joseph Lucas Ltd., Solihull, England

Signal transfer from a resistor-capacitor amplifier to its load is efficient and relatively undistorted when a transistor is used in place of the conventional collector resistor. The transistor develops the output voltage across its emitter and collector, using only a minute portion of the amplifier's collector signal. Most of the amplifier's alternating signal is used in the load, thus reducing the peak-to-peak current requirement in the collector.

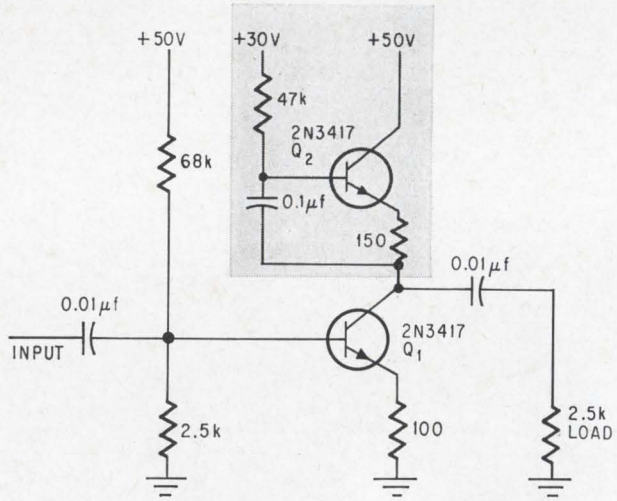
The reduction in the collector current proportionately reduces the base current swing. Operation of the amplifier's transistor is therefore always on the linear portion of the base voltage-base current curve, assuring undistorted amplification.

The high impedance of the transistor makes the amplifier an ideal driver for magnetic tape heads, demodulators and galvanometers. The low frequency response of the amplifier is also improved by the high resistance in the collector.

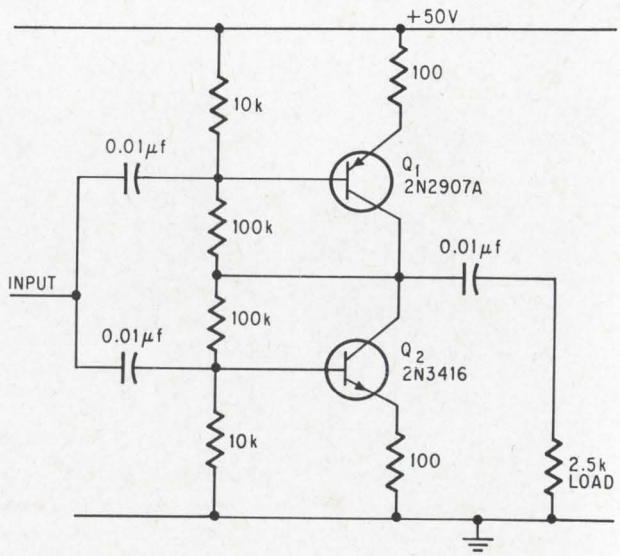
In the amplifier at the upper right a peak-to-peak swing of 2.01 milliamperes in the collector current produces a 1 ma peak-to-peak swing in the load. If a 2.5-kilohm resistor replaces transistor Q_2, a 4-ma peak-to-peak swing in the collector current would be necessary to deliver the 1-ma current to a 2.5-kilohm load. A 2.5-kilohm load was used to avoid distortion while keeping signal levels the same.

Maximum power output, achieved when the input signal sweeps the entire linear region of Q_1's current-voltage curve, is 242 milliwatts at 22 volts. The high output voltages available from this amplifier, are attained because Q_1 saturates Q_2 thus placing the supply potential on the load.

In the complementary circuit at the bottom each of the transistors operate class A. Transistors Q_1 and Q_2 are in parallel; Q_1 is the collector impedance for Q_2 and vice versa. This amplifier can deliver 506 milliwatts at 22 volts to the load.



Constant-current source. Transistor Q_2 offers a high impedance to the amplifier, requiring only bias current to develop the output voltage. Nearly all the collector current modulation of Q_1 is delivered to the load.



High efficiency, low distortion. Each transistor is both an amplifier and a collector load.

Integrated circuits in action: part 9 Digital techniques shrink recorder

Swing away from analog design also cuts costs and improves performance of magnetic tape machine

By Ivars P. Breikss

Honeywell Inc., Denver, Colo.

When engineers at Honeywell Inc. considered designing integrated circuits into the 7600 instrumentation recorder, they were trying to lower costs, reduce the product's over-all size and improve performance. That IC's filled the bill can be seen clearly from a summary of results: space savings amounted to 20%, material costs were cut by 10%, and assembly costs were dramatically reduced by a factor of 30.

The use of off-the-shelf IC's—mostly resistor-transistor logic (RTL), then the least expensive on the market—helped magnify the cost savings.

Substitution of a digital one-shot multivibrator for an analog f-m discriminator in the playback circuit was an important change in design. Together with other digital techniques employed, it doubled the recorder's bandwidth—yet the recorder was still capable of operating over a wide range of temperatures and duty cycles, just as it did in the medium-band version. And in the new circuitry, 11 integrated-circuit flatpacks took the place of about 30 components such as relays, a buffer amplifier, and timing capacitors.

The digital one-shot is one of the few functions that does not use RTL—it has both transistor-transistor logic (TTL) and diode-transistor logic (DTL).

The author

A senior engineer at Honeywell's Test Instrument division, Ivars P. Breikss heads the group responsible for improving designs for the 7600 tape system. Before joining Honeywell two years ago, he was with Martin-Marietta's Denver division and the Ford Motor Co.'s Research Center.

The 7600 magnetic tape system consists of five functional circuits—control, tape handling, data handling (record/playback), power supply, and monitoring. The recorder is suitable for direct recording, narrow, medium, and wideband f-m recording, and digital recording. The basic machines can be made to operate in any of the three basic modes simply by inserting the corresponding printed circuit card in the data housing.

The system uses low-cost digital IC's like Fairchild's resistor-transistor logic (RTL) line and some monolithic operational amplifiers. Hybrid devices for the same functions were not economically competitive with discrete component circuitry.

Diode-transistor logic (DTL) would have made for a simpler design and lower can count, but RTL IC's were selected instead since this series was about 10 times cheaper than anything else on the market when the 7600 was on the drawing board.

Only one circuit, a one-shot multivibrator that operated as an f-m discriminator in the reproduce channel, was initially designed with a DTL, a type 951 IC. The reason: there was no RTL available that would meet the circuit requirements. However, the original f-m discriminator designed for the 7600 recorder is capable of operating only in a narrow- or medium-band recording system.

The digital one-shot multivibrator was designed to overcome this restriction. But DTL's proved inadequate in meeting the design requirements of the digital one shot and transistor-transistor logic was utilized instead. Specifying a center frequency after doubling of about 900 kilohertz and a maximum deviation of $\pm 33\frac{1}{3}\%$ required a one shot period of approximately 200 nanoseconds.

The data-handling assembly and circuits process the input signals for recording on magnetic tape;

during playback, these circuits retrieve and amplify the recorded data to give a usable output.

First try

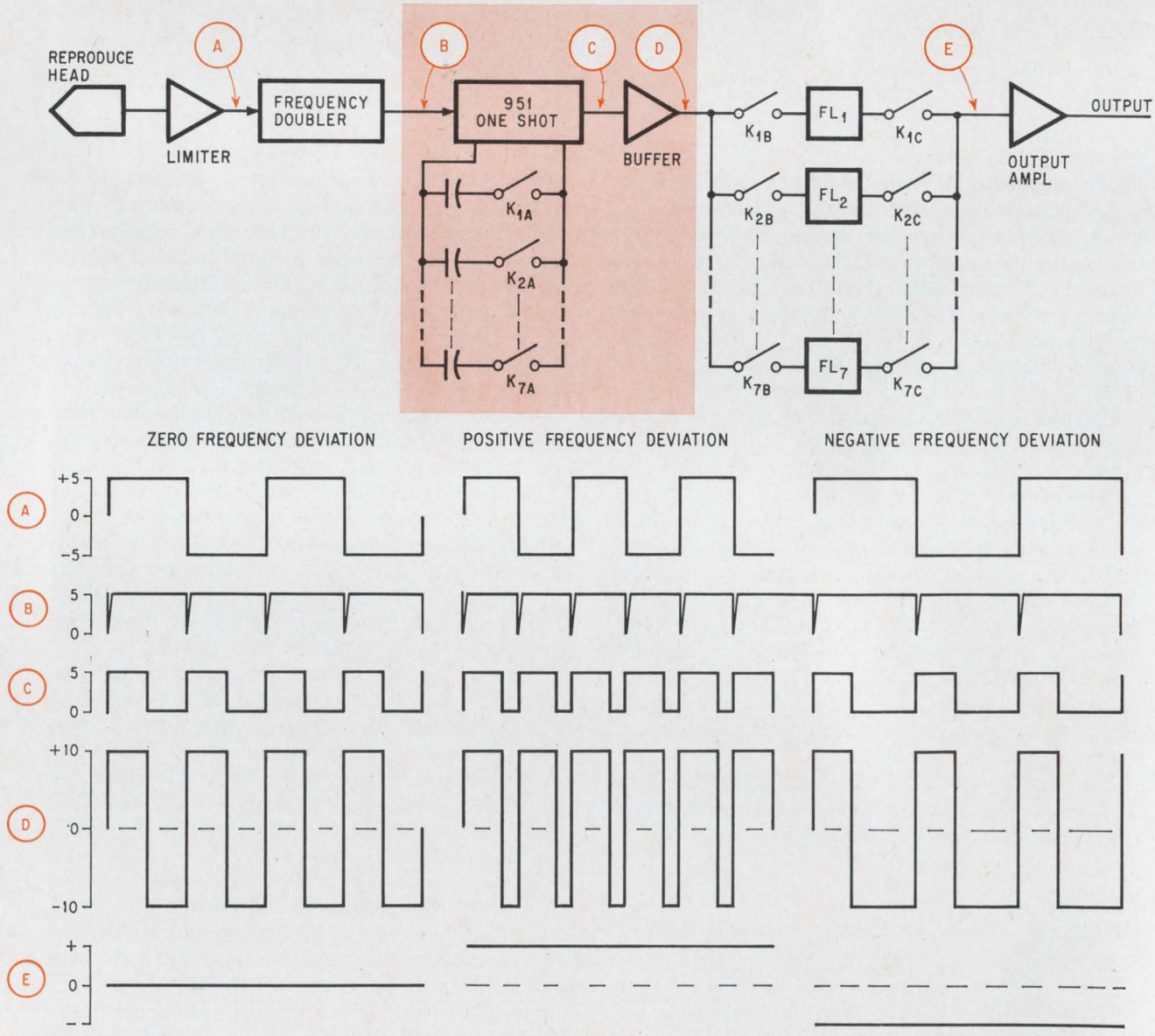
In the original medium-band f-m reproduce channel shown below, the retrieved signal first is restored to an acceptable square wave by a limiter circuit. Frequency of the square wave is then doubled; the output of the doubler triggers the one-shot multivibrator, a type 951 IC, functioning as an f-m discriminator. The signal passes through a buffer amplifier to a low-pass filter for integration and thence to an output amplifier.

If the buffer's output signal has equal positive and negative excursions and a duty cycle of exactly 50%, the integral of the output signal will be zero. A zero integral corresponds to a center frequency output from the record electronics voltage-controlled oscillator.

If the period of the one-shot is kept constant, the integral of the buffer output waveform increases in a positive direction as the frequency of the VCO is increased. Similarly, the integral becomes negative as the frequency of the VCO is decreased below the carrier frequency, as shown below.

Integration is performed by the low-pass filter. The same techniques utilized in the capstan control section are used here to reduce the center frequency as tape speed is decreased. The period of the one-shot is doubled each time the center frequency is decreased by a factor of 2. In addition, filters with progressively lower cutoff frequencies are switched into the circuit with relays as the center frequency is decreased.

The f-m recording system described works satisfactorily only if a relatively long and constant one-shot period can be employed. Two problems are immediately apparent. First, the period of the one-



Medium band. IC one-shot functions as an f-m discriminator in f-m reproduction channel electronics. One-shot's period isn't constant enough over temperature range and duty cycle variations for this reproduction technique to operate properly over a wide frequency band. Switching to accommodate different tape speeds is done with relays. Waveforms show circuit's operation.

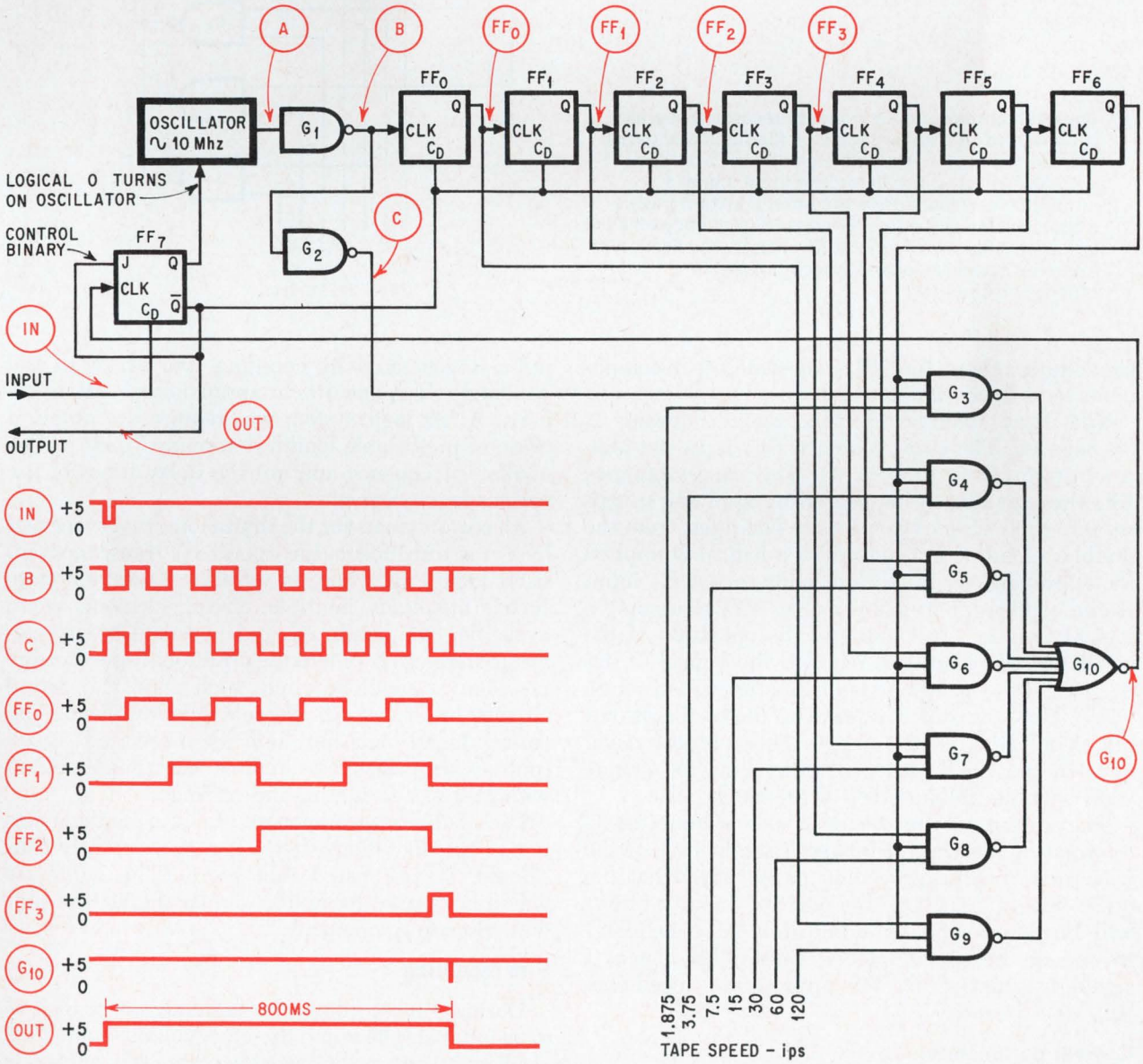
shot changes considerably as the duty cycle is varied, causing the reproduced signal amplitude to deviate from the original signal and yielding unacceptable signal linearity. Secondly, the one-shot's period is temperature-dependent to the extent that the transistor's base-emitter voltage is affected by temperature. This problem is more severe as the period of the one-shot is decreased to accommodate higher frequencies.

A better way

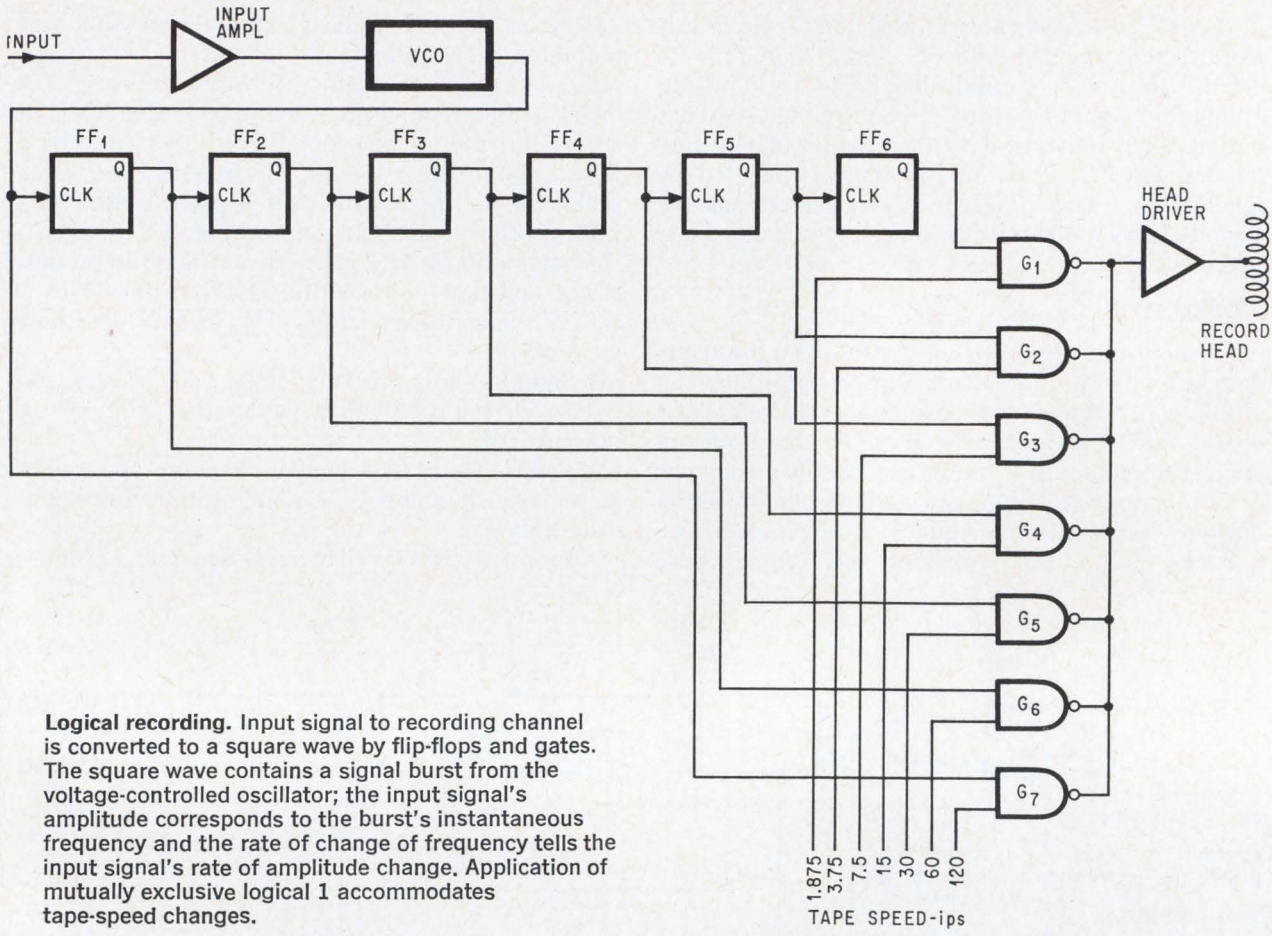
An integrated circuit usually exhibits a lower degree of temperature-dependence because of its monolithic construction and close temperature tracking of the various components. Even so, the performance of the integrated circuit used in the analog f-m discriminator in the initial or medium-band recorder design was found inadequate at the higher frequencies found in a wideband recording system.

To meet the stiff requirements for a one-shot multivibrator in a wideband f-m system—a constant pulse duration with duty-cycle variations from 30% to 60% and temperature excursions from 0°C to 50°C—the digital one-shot design was conceived. Besides eliminating the temperature and duty-cycle problems, the digital one-shot approach also led to several other significant improvements:

- System linearity increased considerably because of the constant pulse width. Over-all linearities of ±¼% for a full deviation of ±33⅓% have been measured.
- Signal-to-noise ratio is improved because the duty cycle for ±33⅓% deviation can be increased beyond 70%.
- Reliability was enhanced because the period of the one-shot now is varied digitally instead of using relays.
- Product cost was decreased because the timing



Digital one-shot. Digital technique for one-shot enables reproduce electronics to operate over wide frequency band. The digital one-shot replaces 951 analog one-shot, buffer amplifier, capacitors, and relays used in the conventional f-m reproduce technique. Switching is now done digitally by application of a mutually exclusive logical 1 from the tape-speed selector.



Logical recording. Input signal to recording channel is converted to a square wave by flip-flops and gates. The square wave contains a signal burst from the voltage-controlled oscillator; the input signal's amplitude corresponds to the burst's instantaneous frequency and the rate of change of frequency tells the input signal's rate of amplitude change. Application of mutually exclusive logical 1 accommodates tape-speed changes.

capacitors, relays, the 951, and some other components have been eliminated.

The logic diagram of the digital one-shot is on page 95. The control binary FF_7 is in the logical 1 state ($Q = 1$, $\overline{Q} = 0$). This causes binaries FF_0 through FF_6 to be cleared by applying a logical 0 to their direct (C_D) input. The input from the doubler circuit is in the form of a logical O applied for approximately 20 nanoseconds to the C_D input of the control binary. This causes FF_7 to assume a logical O state which initiates the operation of the oscillator, which in turn removes the logical O signal from the C_D terminals of binaries FF_0 through FF_6. Gate G_1 is used to square up the oscillator output signal. Binary FF_0 changes state with the rising edge of the clock pulse; all other binaries change state with the falling edge of the clock pulse.

The output of the circuit is taken from the Q terminal of the control binary. Examination of the waveforms on the preceding page shows that the pulse length at Q of the control binary (FF_7) will be determined by application of a logical 1 to one of the speed selector lines. This logical 1 signal is supplied by the appropriate speed-control logic circuitry.

Critical parameters

Several IC parameters critical for this design precluded the use of DTL's. For example, speed. The narrowest pulse required was 200 nanoseconds. This pulse is generated by counting two cycles of the oscillator which operates at approximately 10 megahertz. A fast logic system was required to obtain a pulse of predictable length determined only by the oscillator frequency and not the delay times of the various logic elements.

All requirements for the digital one-shot were met by Texas Instruments Incorporated's transistor-transistor logic (TTL) line. In addition to its adequate speed, numerous multiple circuit elements were available. One quadruple and two dual binary elements were used. Where the additional speed of the TTL logic was not required, such as in the gating circuits, lower cost DTL elements were utilized. The entire digital one-shot and its associated speed (pulse-width) selector circuitry was implemented with 11 14-lead, dual in-line packages.

Use of discrete components for the implementation of the digital one-shot was never seriously considered. It's estimated that more than 250 parts would be needed to build a similar digital one-shot with discrete components.

F-m recording

During f-m recording, the input signal is applied to an input amplifier and then to a voltage-controlled oscillator. With no input signal, the VCO output is equal to the f-m channel center frequency. As input voltage increases in the positive direction, the frequency of the VCO increases. As input voltage in-

creases in the negative direction, the frequency of the vco decreases. If the vco's output is recorded, the recording will contain a square-wave signal where the instantaneous frequency represents the input signal's amplitude and the rate of change of frequency represents the rate of the input signal's amplitude change.

A dividing system similar to that used in the capstan servosystem reduces the vco frequency as tape speed is reduced. Each additional binary added to the countdown chain reduces the center frequency by a factor of 2. Percent deviation is not affected by frequency divisions.

Ic's in the f-m record/reproduce assembly made possible a 13% space-saving over welded modules and 15% per track over discrete components.

Digital speed control

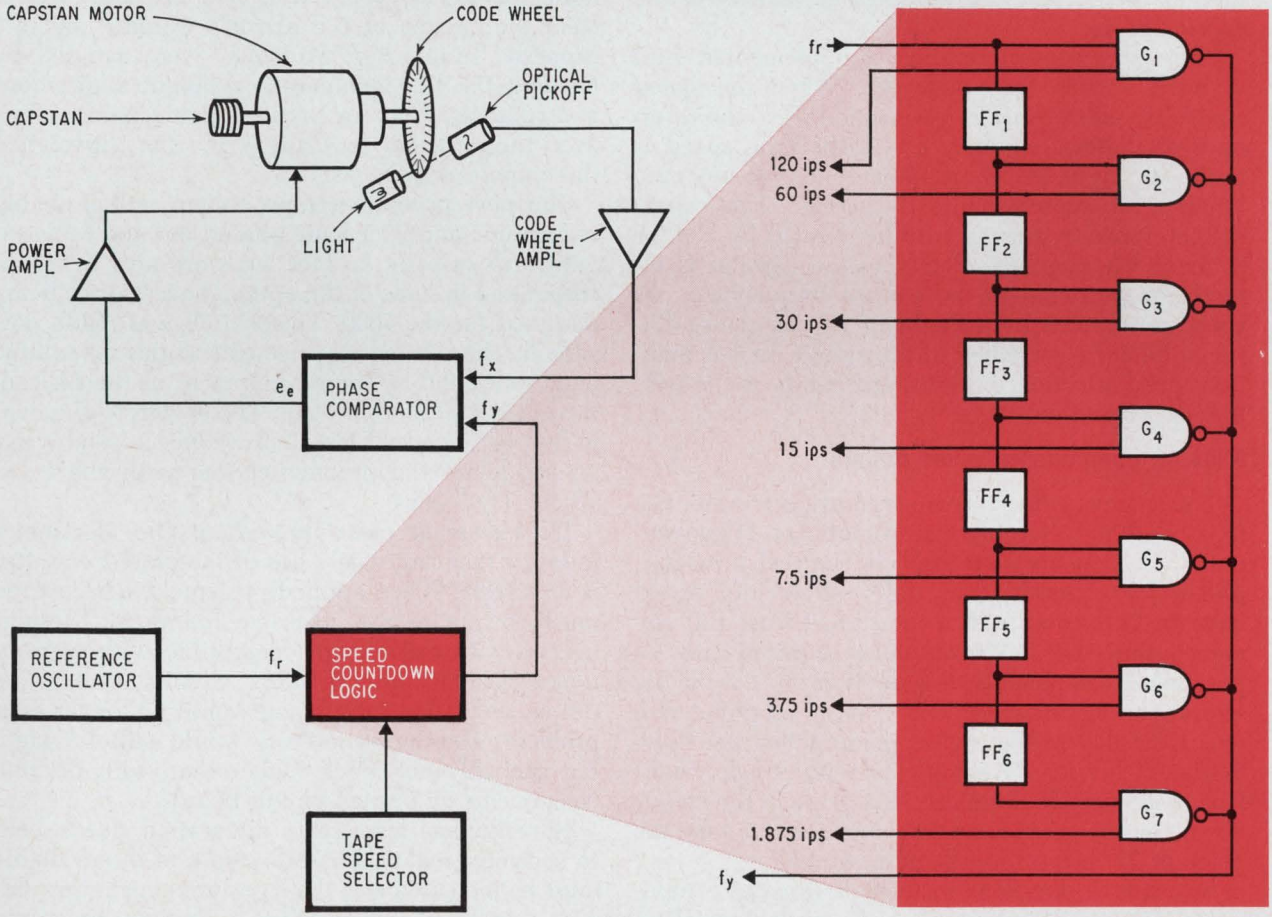
As a standard recorder, the machine can operate at tape speeds of 120, 60, 30, 15, 7.5, 3.75, and 1.875 inches per second. Control circuits set the system's operating mode and speed. A phase-lock servosystem maintains the capstan speed constant to within approximately 0.1%. The phase-lock approach was chosen since it is the easiest to implement with digital integrated circuits. In addition the phase-lock method is independent of the power-line frequency for speed stability.

Major components (see figure below) of the phase-lock servosystem are a reference frequency source, d-c capstan motor, and a code wheel mounted on the shaft of the motor.

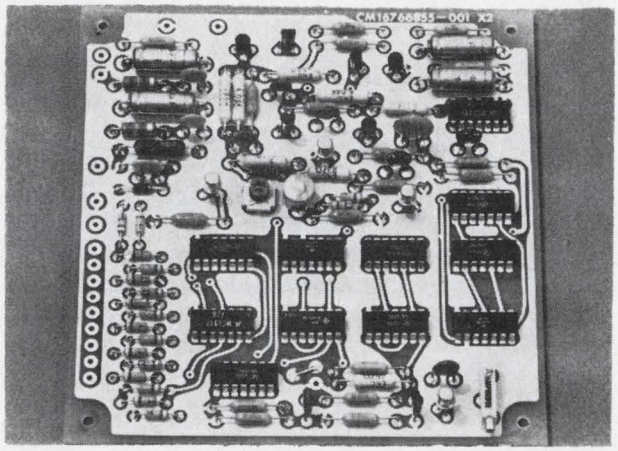
The capstan drive motor is driven by the power amplifier. The power amplifier's input is from the phase comparator. Angular velocity of the capstan shaft is directly proportional to the output frequency of the code wheel amplifier. This frequency, in turn, is derived optically from alternate opaque and transparent areas on the code wheel using a simple light and photocell arrangement.

If the frequency of the code wheel amplifier's output (f_x) is less than the control frequency (f_y), output of the phase comparator is at a maximum and the power amplifier applies maximum voltage to the capstan motor. Then the angular velocity of the capstan increases causing f_x to increase. On the other hand, if f_x is greater than f_y, output of the phase comparator is zero and there is no output from the power amplifier. Under these conditions, the angular velocity of the capstan and, consequently, f_x decreases.

When f_x is within one cycle of f_y, both signals are in phase and the output of the phase comparator, and consequently the power amplifier, is be-



Digital speed control. Capstan speed is controlled by phase-locked servo loop. Optical pickoff signal's frequency and phase is compared to signal from reference oscillator. Output of comparator either increases or decreases signal to power amplifier to bring capstan to desired speed. Logic diagram of speed countdown circuit shows how reference frequency is controlled digitally.



All on one. The digital one-shot, buffer, frequency doubler, and speed selector circuitry, all part of the 7600's f-m reproduce electronics, are mounted on one card. The 11 14-lead in-line integrated circuit packages constitute the digital one-shot circuitry. The oscillator is located directly above these IC's.

Getting down to cases

This is the ninth in a series of articles approaching IC's chiefly from the point of view of users.

Part 1, which appeared in the Oct. 17, 1966 issue, examined design problems and solutions. This was followed by discussions of trends and tradeoffs [Nov. 14], reliability and misuse [Dec. 26], failure analysis [Jan. 23, 1967], and digital logic schemes [March 6].

The focus shifted to case histories last May 29 with "Shrinking a military calculator," by R. W. Ward of Motorola Inc. in which he described how both bipolar and MOS integrated circuits led to a small radar calculator that had low power consumption and high performance. In the Sept. 18 issue, "Cutting costs on the factory floor," by Michael French of the Potter Instrument Co., described the marriage of DTL and TTL in a redesigned coordinate-measuring machine. And in the Dec. 25 issue, two GE engineers told how IC's led to the use of range gates and filters in an airborne radar.

tween zero and maximum and the motor's speed is constant. This system tends to adjust the voltage applied to the capstan motor so f_x is always within one cycle of f_y. The greater the number of bits in the code wheel—several thousand in this case—the greater the accuracy of the angular velocity of the capstan motor.

The speed control circuitry is implemented with IC logic circuits (see page 97). When the speed control is set to the 120 ips position, f_y is the reference oscillator frequency f_r. As the tape speed is reduced, say to 60, 30, or 15 ips, one, two, or three binaries are switched into the circuit. This causes the reference frequency f_r to be divided by 2, 4, or 8. Since the angular velocity of the capstan is directly proportional to the control frequency f_y, its speed is reduced by a factor of two as each additional binary is switched in the circuit. In this manner, speed selections in ratios of 2 can be made with IC binaries and gates.

Shaving components saves dollars

The savings gained by incorporating IC's into the tape-handling assembly were significant. If conventional components were used in the reel servo-amplifier, for example, four different circuits would have been needed with a total of at least 150 elements. But, the μA709 amplifier required only 75 peripheral components, a reduction of 50% in the size of the circuit card. The same IC amplifier also saved the day in the digital preamplifier assembly. Without this IC, 29 components per track would have been needed. Similarly, using IC's in the countdown circuits enables seven components to take the place of 77 in the servo logic assembly.

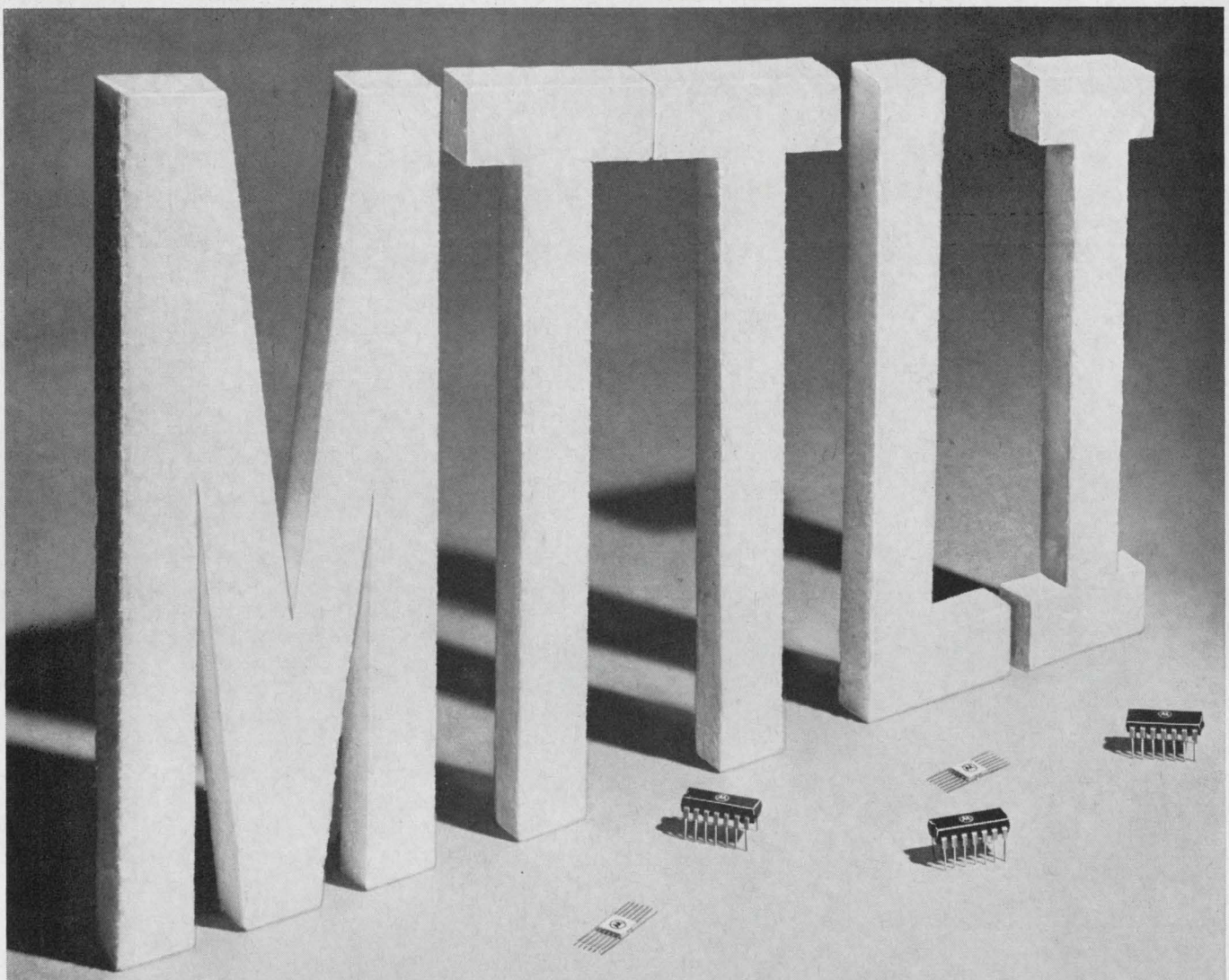
By using IC flip-flops instead of discrete components, Honeywell saved what the transistors alone would have cost. Moreover, it is possible to get by with a smaller inventory—about 10% of equivalent discrete components. With the μA709 in the digital and servo preamps, for instance, inventory cost was cut 15%.

Even so, the move to IC's in the 7600 was not without its problems. Integrated circuitry required a special, low-voltage d-c power supply. Moreover, noise sources like the motors had to be decoupled from the circuits or the RTL IC's wouldn't operate properly. Interfacing headaches were avoided by heeding the IC manufacturer's fanout suggestions and resorting to a worst-case design scheme. However, the pluses of the shift to IC's far outweighed these minor drawbacks.

The next generation tape system will probably see resistor-transistor logic phased out and replaced with TTL's or DTL's. In fact, TTL's are now being incorporated in some of the optional accessories being designed for the 7600. This switch was made possible by the substantial price cuts in this monolithic logic series and by the development of the 14-lead, dual in-line plastic package. The switch to the dual in-line package will also help reduce assembly erors made on the production line with the 8- or 10-pin TO-5 cans.

It's becoming clear throughout the electronics industry that large-scale use of integrated circuitry is inevitable. When applied piecemeal, IC's cost too much, owing to the extensive interfacing designs necessary to make them compatible with conventional elements. But if entire circuits were to be put on tiny chips, interfacing would no longer be a problem. Development costs would still be high, but probably not much higher than with discrete components on printed-circuit boards.

Nevertheless, large-scale integration needs help to become a reality. First, the types of IC's available must be increased and their performance improved. Also, integrated circuit design techniques must mature, so that engineers can make the most effective use of the IC's on the market. That both requirements will be met is inevitable.



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Motorola has production quantities immediately available of all circuit functions in the MTTL I (some call it SUHL* I) T²L circuit series! Even the "hard-to-get" J-K Flip-Flops (SF50 & SF60) are readily available from Motorola. Just ask for MC515 or MC516 . . . or, any of the others shown at the right.

So, for systems now in production — or for new designs — you'll want to choose from our MC400/500 series (flat-packs or plastic) to fit all of your application needs. Don't wait on that important order that you're holding. Call Motorola, today! For complete technical details on these two popular series, write: P.O. Box 955, Phoenix, Arizona 85001.

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MOTOROLA'S MTTL I SERIES PROVIDES OPTIMUM SELECTION & DESIGN FLEXIBILITY!

DESCRIPTION	−55 to +125°C F.O. = 15	−55 to +125°C F.O. = 7	0 to +75°C F.O. = 12	0 to +75°C F.O. = 6
Dual 4-Input NAND/NOR Gate	MC500 (SG40)	MC550 (SG41)	MC400 (SG42)	MC450 (SG43)
Expandable Quad 2-Input AND-OR-INVERT Gate	MC501 (SG50)	MC551 (SG51)	MC401 (SG52)	MC451 (SG53)
Single 8-Input NAND/NOR Gate	MC502 (SG60)	MG552 (SG61)	MC402 (SG62)	MC452 (SG63)
Dual 3-Input AND-OR-INVERT Gate (with complement)	MC503 (SG90)	MC553 (SG91)	MC403 (SG92)	MC453 (SG93)
Expandable Triple 3-Input AND-OR-INVERT Gate	MC504 (SG100)	MC554 (SG101)	MC404 (SG102)	MC454 (SG103)
Expandable Dual 4-Input AND-OR-INVERT Gate	MC505 (SG110)	MC555 (SG111)	MC405 (SG112)	MC455 (SG113)
Expandable Single 8-Input NAND/NOR Gate	MC506 (SG120)	MC556 (SG121)	MC406 SG122)	MC456 (SG123)
Quad 2-Input NAND/NOR Gate	MC508 (SG140)	MC558 (SG141)	MC408 (SG142)	MC458 (SG143)
Quad 2-Input AND/OR Expander	MC509 (SG150)	MC559 (SG151)	MC409 (SG152)	MC459 (SG153)
Dual 4-Input AND/OR Expander	MC510 (SG170)	MC560 (SG171)	MC410 (SG172)	MC460 (SG173)
Dual 4-Input AND Expander	MC511 (SG180)	MC561 (SG181)	MC411 (SG182)	MC461 (SG183)
Triple 3-Input NAND/NOR Gate	MC512 (SG190)	MC562 (SG191)	MC412 (SG192)	MC462 (SG193)
Set-Reset Flip-Flop	MC513 (SF10)	MC563 (SF11)	MC413 (SF12)	MC463 (SF13)
J-K Flip-Flop (AND Inputs)	MC515 (SF50)	MC565 (SF51)	MC415 (SF52)	MC465 (SF53)
J-K Flip-Flops (OR Inputs)	MC516 (SF60)	MC566 (SF61)	MC416 (SF62)	MC466 (SF63)

All MTTL I circuits are available in the TO-86, 14-lead flat package ("F" suffix). Types MC400 thru MC466 are also available in the 14-lead, dual in-line plastic package ("P" suffix).

-where the priceless ingredient is care!

MOTOROLA Semiconductors

Reader's Choice

IEE introduces 10-gun CRT Display Tube

New readout offers 12 advantages over tubes now in use.

The state of the readout art took on a new dimension recently when IEE, world leader in rear-projection readouts, introduced the 10-gun CRT — an unparalleled method for electronic projection of numbers, letters, messages, etc. Observers report character brightness and clarity, viewed on a fluorescent screen, are optimum under any ambient light condition. Powerless control grid switching . . . extremely low power consumption . . . small grid control swing . . . exceptionally wide view angle . . . all are features which make the new device ideal for instrument applications. Now available in quantity, all it lacks is a name!

Name IEE's new display tube and win a portable TV set!

On your company letterhead, describe a particular application for the new tube. Then fill in the coupon, attach it to the letter and send them to:

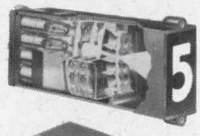
IEE ADVERTISING DEPARTMENT
7720 Lemona Ave.,
Van Nuys, Calif. 91405

Sirs:
My name for the new IEE 10-gun CRT display tube is_____
Name:_____
Firm:_____ Dept.:_____
Address:_____
City:_____ State:_____ Zone:_____
Entries must be in by Feb. 28, 1968. The judges' decision will be final.

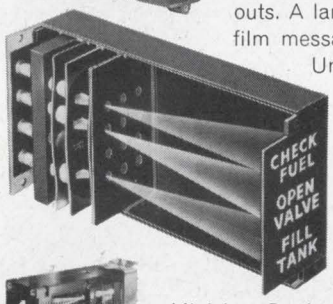
IEE bright, legible, wide-angle readouts:

Any characters desired
Any colors or combinations
Any input, BCD or decimal
Any input signal level
Any mounting, vertical or horizontal

Many sizes
Many configurations
Many lamp lives (to 100,000 hours)
Many brightness choices
Many options and accessories



Standard Readouts: Rear projection principle, like all IEE readouts. A lamp in the rear of the unit illuminates one of the 12 film messages, and projects it to the front viewing screen. Unbeatable readability and versatility.

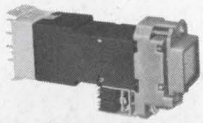


Large Screen Readouts: For reading distances up to 100 feet. Maximum character size 3⅜".

Miniature Readouts: Only 1" wide x 1-5/16" high, yet can be read at 30 feet because of clarity of one-plane projection. Character size: ⅝".

Micro-Miniature Readouts: Only ½" wide x ¾" high, but 20 foot viewing distance and maximum 175° viewing angle because of front-plane display. Character size: ⅜".

Hi-Brite Readouts: Special lens system increases character brightness 50%. Particularly good when high ambient light conditions exist.

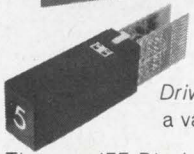


Cue-Switch Readouts: Rear projection readout with push-button viewing screen. Combination switch and display device.

Bina-View Readout: Accepts binary or teletype code, decodes, and displays the proper character.

Status Indicator Readout: Displays up to 12 different messages, individually or in combination. Viewing screen only 3 sq. in.

Indicator Assemblies: Available with up to 11 rear projection readouts, for indicating seconds, minutes, hours, days, etc.



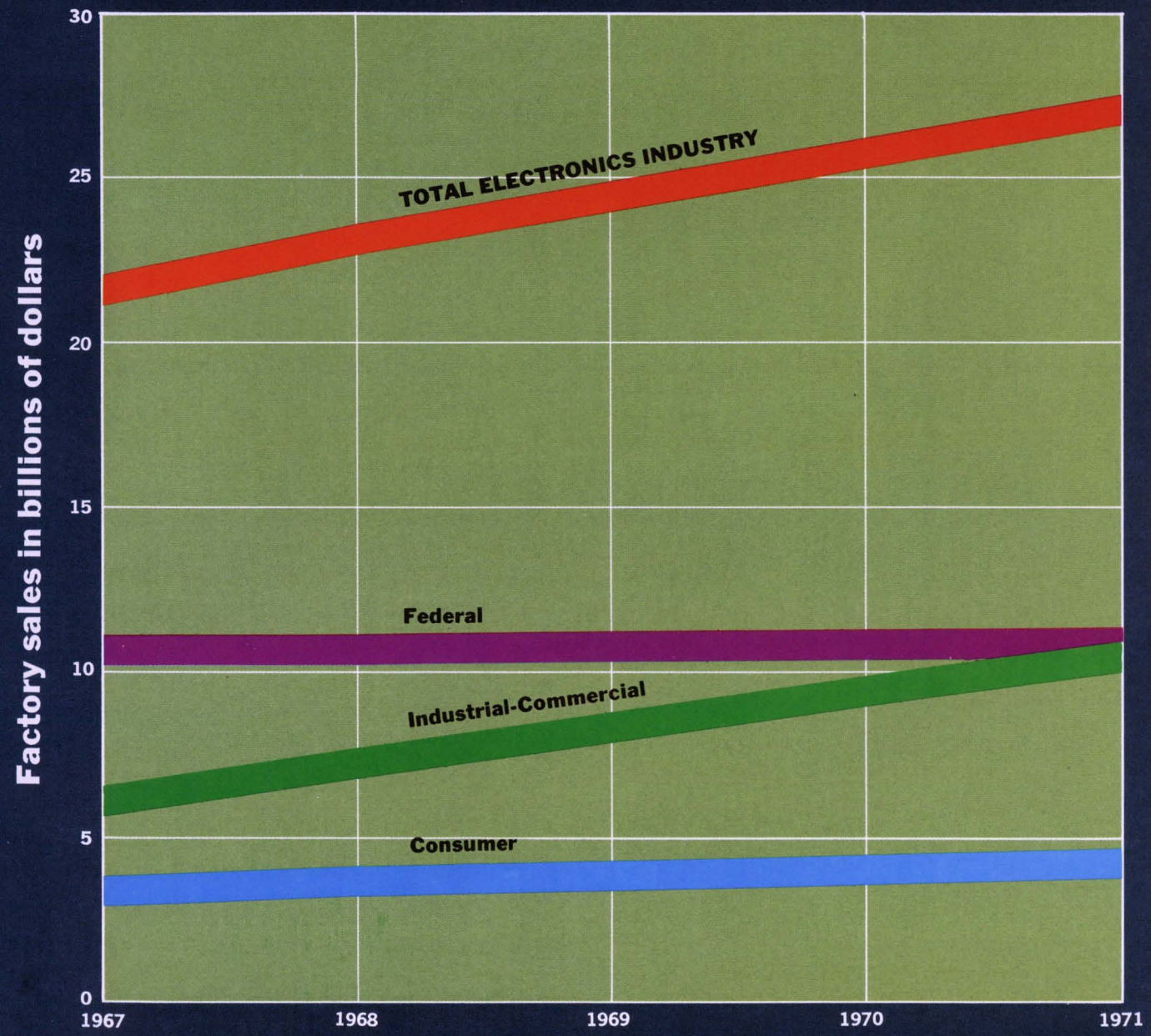
Driver/Decoder Module: Designed to work with IEE Readouts. Accepts a variety of binary codes for decimal conversion.

The new IEE Display Devices catalog gives complete information and specifications on these products, and their accessories. Ask for it.

IEE "I-double-E", the world's largest manufacturer of rear projection readouts.
Industrial Electronic Engineers, Inc. 7720 Lemona Avenue, Van Nuys, California

Electronics Markets

1968



The market estimates in this tabulation are based on a survey conducted by Electronics magazine. Estimates are of U.S. factory sales in millions of dollars. This survey is not directly comparable to those made in previous years; some categories have been added, others deleted to reflect dominant trends in the field.

Industrial and Commercial Markets

	1967	1968	1971
	(millions of dollars)		
X-ray equipment, therapeutic	25.2	28.4	33.3
Ultrasonic	3.4	4.5	7.5
Diathermy, shortwave and microwave	2.5	2.7	3.7
Computers and related equipment	**3,118.9**	**3,740.6**	**5,540.0**
Digital computers, except process control	2,420.0	2,855.0	3,980.0
Analog computers, except process control	46.5	60.3	100.5
Hybrid computers, except process control	42.0	47.0	65.0
Peripheral equipment, total	450.3	556.8	844.5
Converters, A to D	23.2	25.9	39.0
Converters, D to A	15.8	17.7	26.5
Converters, card to tape	7.1	7.3	3.1
Readers, paper tape	32.0	33.5	57.0
Readout devices (printers, plotters, crt's, digital displays)	164.4	221.5	318.6
Mass storage memories, total	207.8	250.9	400.3
Core memories	31.3	41.2	39.5
Magnetic tape machinery	62.3	67.5	83.7
Magnetic drum memories	17.5	24.0	48.0
Magnetic disc memories	96.7	118.2	229.1
Data transmission and acquisition equipment	160.1	221.5	550.0
Nuclear instruments and equipment, total	**113.4**	**135.9**	**179.0**
Pulse analysis instrumentation	16.4	17.4	19.5
Power supplies for nuclear equipment	7.5	8.2	15.5
Personal dosimeters	1.3	1.4	2.3
Radiation monitoring, portable survey instruments	3.2	3.7	5.3
Radiation monitoring, fixed position	4.0	5.0	7.4
Detectors (all, separate unit or part of system), total	7.4	9.0	12.4
Solid state (semiconductors, scintillation, crystals, and organic phosphors)	3.9	4.9	6.3
Tubes (geiger, gas flow, BF_3)	2.8	3.3	5.0
Ionization chambers	0.7	0.8	1.1
Reactor controls	24.6	25.0	26.0
Nuclear instruments and equipment, other	49.0	66.2	90.6
Communications equipment	**1,288.8**	**1,438.5**	**1,828.3**
Radio, total	477.1	545.0	703.8
Airborne, including ground links	140.0	150.5	186.2
Land mobile	166.0	177.0	207.8
Marine radio	20.4	23.1	31.2
Microwave relay	84.7	121.6	189.9
Amateur equipment	28.5	30.8	38.7
Citizens band equipment	37.5	42.0	50.0
Navigation, total	112.4	147.6	255.8
Radar	75.5	90.6	156.5
Other navigational aids (Sonar, Loran, VOR)	36.9	57.0	99.3
Carrier current	16.2	18.4	30.0

	1967	1968	1971
	(millions of dollars)		
Intercom	96.5	99.2	108.0
Commercial sound and public address	216.3	228.5	258.8
A-m station equipment	14.0	14.5	16.0
F-m station equipment	11.2	12.0	18.4
Tv station equipment	135.7	134.0	134.0
Facsimile	24.3	27.4	30.5
Telemetry	185.1	211.9	273.0
Lasers and equipment, total	**51.9**	**66.3**	**114.5**
Gas lasers	37.5	45.0	68.4
Ruby lasers	1.0	1.2	1.8
Semiconductor lasers	4.0	7.5	22.0
Liquid lasers	1.0	2.5	6.9
Laser power supplies	3.5	4.2	6.4
Auxiliary laser equipment	4.9	5.9	9.0
Closed circuit television equipment, total	**69.1**	**82.3**	**131.3**
Industrial	22.8	26.8	42.6
Education	16.6	19.7	32.0
Theater	1.0	1.5	3.0
Medical	4.7	5.8	9.0
CATV equipment	24.0	28.5	44.7
Dictating devices (for business)	**103.5**	**113.0**	**145.0**
Power supplies, OEM type	**72.0**	**80.0**	**99.5**
Industrial operations electronic equipment, total	**905.1**	**1,052.8**	**1,496.2**
Manufacturing control equipment, total	192.5	231.3	386.3
Analog computer systems	61.0	75.0	117.0
Digital computer systems	64.0	89.0	134.0
Positioning controls (electronics only)	30.1	37.3	67.0
Contouring controls (electronics only)	37.4	30.0	68.3
Process control equipment, total	229.0	290.1	406.8
Analog computer systems	22.0	25.0	41.0
Digital computer systems	130.0	171.6	234.9
Controllers	33.0	41.5	69.2
Actuators & valves	39.7	46.2	55.0
Indicators	4.3	5.8	6.7
Other industrial operations equipment, total	483.6	531.4	703.1
Motor speed controls	55.5	59.4	75.0
Welding equipment	20.2	22.5	29.0
Power supplies	105.0	114.6	145.0
Cryogenic equipment	66.0	72.0	92.0
Ultrasonic cleaning equipment	15.7	18.0	24.3
Ultrasonic testing equipment	20.0	22.3	31.7
Infrared equipment	41.0	45.3	63.2
X-ray, industrial	26.0	28.5	39.2
Nuclear gauging & processing	72.5	80.5	121.0
Recorders	61.7	68.3	82.7

Federal Electronics

	1967	1968	1971
	(millions of dollars)		
FEDERAL ELECTRONICS, TOTAL	**10,932**	**11,101**	**11,348**
Department of Defense, electronics portion, total	**8,976**	**9,266**	**9,518**
Procurement, total	4,916	5,320	5,025
Communications	995	1,064	1,105
Aircraft	1,383	1,589	1,357
Missiles	1,671	1,763	1,709
Mobile and ordnance	276	266	251
Ships	591	638	603
Research, development, test, and evaluation	2,245	1,957	2,383
Operations and maintenance	1,815	1,989	2,110
NASA, electronics portion	**1,793**	**1,661**	**1,590**
Federal Aviation Administration, electronics portion	**98**	**102**	**165**
Atomic Energy Commission, electronics portion	**65**	**72**	**75**

Consumer Electronics

	1967	1968	1971
	(millions of dollars)		
CONSUMER ELECTRONICS, TOTAL	**3,847.7**	**4,087.8**	**4,694.1**
Television receivers, total	**2,382.2**	**2,463.5**	**2,779.6**
Monochrome tv receivers	477.0	393.0	281.0
Color tv receivers	1,905.2	2,070.5	2,498.6
Radios, total	**492.5**	**523.1**	**580.0**
A-m and f-m radios	242.9	254.7	276.8
Auto radios	249.6	268.4	303.2
Phonographs	**511.3**	**550.3**	**599.4**
Tape recorders	**144.0**	**184.6**	**225.0**
Tape cartridges	**51.0**	**80.0**	**135.0**
Hi-fi components (including tuners, speakers, amplifiers, etc.)	**85.3**	**89.0**	**108.0**
Kits, except toys	**48.1**	**52.1**	**62.0**
Light dimmers	**8.7**	**9.5**	**10.5**
Garagedoor openers	**13.7**	**17.0**	**29.3**
Guitar amplifiers	**32.5**	**35.3**	**42.3**
Organs, electronic portion	**64.2**	**63.5**	**71.4**
Automotive electronics, total	**14.2**	**19.9**	**51.6**
Discharge systems, transistorized and capacitative	0.4	0.5	0.8
Voltage regulators, integrated	0.3	2.4	27.0
Sequential flashers	1.5	2.0	2.8
Alarm systems	12.0	15.0	21.0

Industrial Electronics

	1967	1968	1971
	(millions of dollars)		
INDUSTRIAL AND COMMERCIAL, TOTAL	**6,631.7**	**7,732.9**	**10,901.4**
Test and measuring instruments	**648.5**	**727.5**	**944.7**
Medical equipment	**260.5**	**296.0**	**422.9**
Nuclear instruments and equipment	**113.4**	**135.9**	**179.0**
Computers and related equipment	**3,118.9**	**3,740.6**	**5,540.0**
Communications equipment	**1,288.8**	**1,438.5**	**1,828.3**
Lasers and equipment	**51.9**	**66.3**	**114.5**
Closed circuit television	**69.1**	**82.3**	**131.3**
Dictating devices	**103.5**	**113.0**	**145.0**
Power supplies, OEM	**72.0**	**80.0**	**99.5**
Industrial operations electronic equipment	**905.1**	**1,052.8**	**1,496.2**

	1967	1968	1971
	(millions of dollars)		
Test and measuring instruments, total	**648.5**	**727.5**	**944**
Spectrum analyzers, subaudio to 1 Ghz	12.5	14.4	20
Signal generators, up to 1 Ghz	18.1	21.0	26
Sweep generators, up to 1 Ghz	5.8	7.2	10
Pulse generators, up to 1 Ghz	6.3	7.0	9
Oscillators, subaudio through video	17.2	19.2	25
Waveform generators, all shapes	11.4	12.9	16
Waveform analyzers and distortion meters	4.8	5.2	6
Counters, time and frequency	37.8	40.6	49
Timers, electronic	75.0	80.2	104
Panel meters	38.2	41.8	51
Noise measuring equipment, up to 1 Ghz	10.5	12.7	17
Frequency measuring instruments, except counters	10.5	12.3	17
Voltmeters and ammeters, electronic, d-c to 1 Ghz, meter indicating	18.1	21.4	28
Digital voltmeters	24.6	28.1	38
Power meters, d-c to 1 Ghz	5.0	6.1	8
Impedance measuring equipment, up to 1 Ghz	14.9	16.0	18
Calibrators and standards, active and passive	15.4	17.6	22
Oscilloscopes, d-c to 1 Ghz, main frame only	87.5	95.5	114
Oscilloscope accessories and plug-ins, up to 1 Ghz	21.0	25.0	36
Recording instruments, digital and analog	48.0	53.3	65
Components testers (capacitor, transistor, tube, integrated electronics, etc.)	23.0	27.5	47
Power supplies, lab type	53.9	57.8	67
Amplifiers, lab type	7.1	7.9	9
Microwave measuring equipment (above 1 Ghz), total	**81.9**	**96.8**	**134**
Oscilloscopes, above 1 Ghz	9.8	11.1	15
Microwave phase measuring equipment	4.6	6.4	11
Microwave impedance measuring equipment	11.1	14.6	21
Microwave power measuring equipment	4.9	5.4	8
Spectrum analyzers, above 1 Ghz	10.4	12.7	19
Frequency measuring and analysis, above 1 Ghz other	8.5	9.8	11
Microwave noise measuring equipment	5.6	6.8	9
Signal generators, above 1 Ghz	11.4	11.6	11
Sweep generators, above 1 Ghz	8.7	10.1	15
Pulse generators, above 1 Ghz	4.7	5.3	7
Field intensity meters and test receivers	2.2	3.0	4
Medical equipment, total	**260.5**	**296.0**	**422**
Diagnostic equipment, total	214.1	241.1	347
Radioactive tracer equipment	14.5	17.5	24
X-ray, & fluoroscopic equipment	171.5	192.0	283
Electroencephalographs	4.3	5.3	6
Electrocardiographs	12.0	13.2	16
Electron microscopes	8.5	9.4	11
Ultrasonic	3.3	3.7	6
Patient-monitoring systems	15.3	19.3	30
Therapeutic equipment, total	31.1	35.6	44

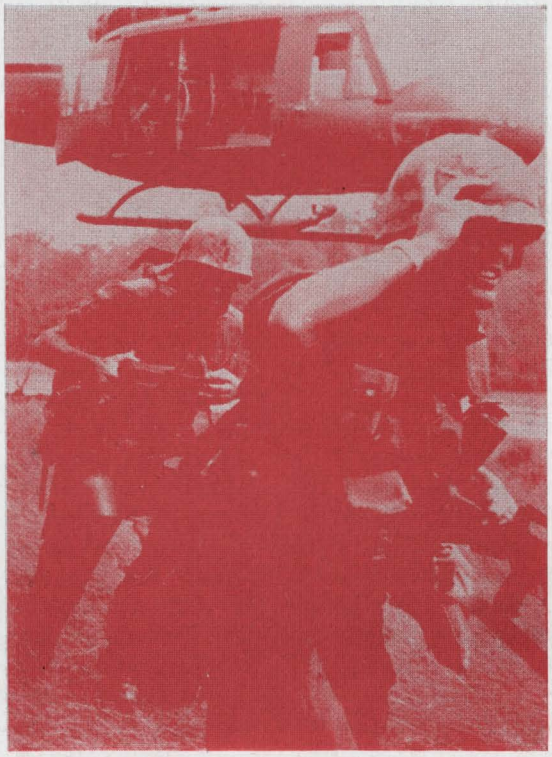
Components Markets

	1967	1968	1971
	(millions of dollars)		
ALL COMPONENTS, TOTAL	**6,661.8**	**7.194.9**	**8,358.6**
Antennas and antenna hardware	**375.5**	**410.8**	**496.0**
Batteries	**87.2**	**96.5**	**127.4**
Capacitors, total	**436.8**	**473.3**	**522.8**
Paper capacitors	58.5	58.2	60.0
Film capacitors	62.0	66.3	85.2
Electrolytic capacitors	197.2	220.8	252.6
Mica capacitors	30.6	32.2	28.5
Glass and vitreous enamel capacitors	9.0	9.0	5.0
Ceramic capacitors	53.7	58.8	62.3
Variable capacitors	25.8	28.0	29.2
Connectors, total	**327.0**	**353.5**	**422.8**
Coaxial connectors, standard size	28.4	29.8	32.5
Coaxial connectors, miniature	20.0	22.9	33.0
Cylindrical connectors	121.9	129.2	150.3
Rack and panel connectors	56.8	59.8	66.0
Printed circuit connectors	46.3	52.0	64.5
Special purpose & fused connectors	53.6	59.8	76.5
Delay lines	**17.5**	**18.8**	**21.0**
Electroluminescence	**1.3**	**1.5**	**3.0**
Electromechanical devices, total	**134.4**	**152.9**	**178.5**
Resolvers	10.9	11.4	12.2
Servo motors	21.7	24.5	30.0
Synchros	36.7	36.0	35.4
Rate generators	5.0	5.2	5.3
Motor generators	15.0	16.5	18.0
Solenoids	24.3	25.5	31.8
Encoders & Decoders	20.8	33.8	45.8
Electron tubes, total	**1,361.2**	**1,383.6**	**1,322.3**
Receiving tubes	266.3	241.3	173.8
Power and special purpose tubes, total	289.6	295.2	303.4
High-vacuum tubes	66.0	65.0	62.0
Gas and vapor tubes	18.5	18.0	15.5
Klystrons	46.4	46.6	44.8
Magnetrons	40.4	39.1	36.7
Twt's, including backward wave types	45.8	47.6	50.2
Light-sensing tubes	36.5	38.5	46.5
Storage tubes	14.2	16.2	19.8
Display tubes, except cathode ray	5.6	6.8	8.9
Cathode ray tubes, except tv	16.2	17.4	19.0
Tv picture tubes, black-and-white	107.0	84.5	64.5
Tv picture tubes, color	676.5	739.0	751.0
Cold cathode display tubes	14.5	15.1	18.3
Rear projection readout devices	6.3	7.1	9.2
Bar segment devices (incandescent and electroluminescent)	1.0	1.4	2.1
Ferrite devices, total	**304.4**	**328.7**	**367.5**
Computer cores	9.0	18.0	28.8
Transformers and chokes, except tv	249.1	258.7	290.0
Tv ferrite components, including yokes, flybacks	46.3	52.0	48.7
Filters, electronic	**38.2**	**42.8**	**51.0**
Loudspeakers	**110.6**	**119.4**	**136.0**
Magnetic tape	**169.3**	**193.9**	**279.5**
Audio tape	51.0	58.6	85.0
Computer tape	66.0	75.5	107.7
Instrument tape	33.0	36.5	45.8
Video tape	19.3	23.3	41.0
Microwave components and hardware, total (tubes & antennas excluded)	**100.7**	**111.5**	**163.0**
Microwave ferrite devices	20.2	22.3	31.4
Multicomponent packages, total (two or more separate active or passive components in a single package)	**200.0**	**226.5**	**389.5**
Printed circuits	**167.4**	**200.4**	**279.0**
Quartz crystals (including mounts and ovens)	**57.5**	**62.0**	**74.5**
Resistors, total	**373.3**	**395.3**	**396.6**
Fixed resistors, total	214.2	220.8	217.5
Composition resistors, fixed	90.3	91.1	83.7
Deposited carbon resistors, fixed	17.8	16.0	11.0
Metal film resistors, fixed	47.8	51.9	61.0
Wirewound resistors, fixed	58.3	61.8	61.8
Potentiometers, total	159.1	174.5	179.1
Wirewound potentiometers	79.1	84.5	88.0
Non-wirewound potentiometers	80.0	90.0	91.1
Relays, total	**262.8**	**300.0**	**343.9**
Solid-state relays	15.8	22.0	46.2
Electromagnetic relays, total	115.9	126.5	134.9
Contact meter relays	6.3	6.3	5.3
Crystal can relays	28.2	29.8	31.0
Dry reed relays	21.6	24.8	32.5
Mercury wetted relays	14.5	15.0	18.0
Resonant reed relays	1.3	1.3	2.0
Stepping switches	15.4	20.0	18.5
Telephone type relays	24.5	24.8	23.9
Thermal relays	4.1	4.5	3.7
Other relays	131.1	151.5	162.8
Semiconductors, total	**999.0**	**1,110.5**	**1,414.8**
Discrete, conventional devices, total	561.9	570.7	586.8
Transistors, total	391.7	400.0	432.1
Transistors, silicon, bipolar	244.7	261.2	311.1
Transistors, germanium bipolar	126.3	108.9	67.3
Transistors, field effect	15.9	22.7	39.0
Transistors, unijunction	4.8	7.2	14.7
Diodes, total	170.2	170.7	154.7
Discrete, special devices, total	140.1	154.3	201.2
Thyristors (SCR's, 4 layer diodes, etc.)	56.1	66.8	98.2
Tunnel diodes	4.4	4.7	6.2
Microwave diodes, excluding varactors	13.5	15.5	21.5
Microwave transistors	4.0	4.4	10.0
Varactor diodes	8.8	9.7	13.9
Multiple devices (duals, diode arrays)	27.0	25.0	20.6
Other special devices (temperature sensing, strain gauge, etc.)	26.3	28.2	30.8
Integrated electronics, total	268.6	346.5	544.3
Monolithic IC's total	237.6	304.0	476.1
Linear	51.0	80.5	159.0
Digital	186.6	223.5	317.1
Hybrid IC's total (Semiconductor devices and thin or thick film components combined on a common substrate)	31.0	42.5	68.2
Passive thin or thick film devices	28.4	39.0	82.5
Motors, fractional HP, all	**408.2**	**413.9**	**489.5**
Optoelectronic devices, total	**19.0**	**24.1**	**32.5**
Photovoltaic (solar) cells	5.2	6.2	7.0
Photoconductive cells	6.1	7.4	9.6
Light-emitting diodes	0.3	0.6	2.4
Photodiodes	6.7	8.7	11.4
Special optoelectronic devices (isolators, switches)	0.7	1.2	2.1
Rectifiers, solid state, total	**130.1**	**145.6**	**173.2**
Rectifiers, silicon	100.4	113.0	132.6
Rectifiers, selenium and copper oxide	18.0	17.7	12.1
Rectifier assemblies	11.7	14.9	28.5
Switches, mechanically actuated, total	**143.6**	**159.2**	**178.1**
Coaxial switches	4.7	6.0	8.0
Pressure switches	19.0	26.2	26.0
Rotary switches	43.6	48.1	58.6
Snap-action switches	49.6	53.1	60.5
Toggle, mercury, knife, misc.	26.7	25.8	25.0
Transducers, total	**115.1**	**135.1**	**164.8**
Pressure transducers	41.0	43.6	51.4
Position transducers	38.7	40.0	44.6
Strain transducers	20.0	33.5	50.0
Acceleration transducers	15.4	18.0	18.8
Wire and cable, total	**321.7**	**335.1**	**331.4**
Coaxial cable	69.2	76.2	80.0
Flat and flexible printed circuit cable	16.9	19.0	25.0
Hook-up wire	152.0	154.0	132.0
Magnet wire	83.6	85.9	94.4

State of the mart:

gains slowed by war priorities

"I'd rather project what's going to happen five years from now than five months," says a marketing executive at Microwave Associates Inc. His caution and candor are typical of electronics executives assessing the industry's 1968 prospects.



Last year at this time, officials, euphoric over 1966 results, were shooting from the hip and painting bull's-eyes around the holes. But a slowed rate of economic growth, uncertainties arising from the country's Southeast Asian commitment, and the reluctance of consumers to plunge on big-ticket items like color-television sets put most forecasts wide of the mark.

The electronics industry is looking for a comparatively modest—by past standards—over-all gain of 6.7% next year to $23.6 billion. But the pace of sales increases varies widely throughout the industry.

Computer makers, despite spiraling labor costs and continuing software woes, are still riding a gravy train as commercial and industrial firms, universities, and Government agencies snap up their output.

In one way or another, Pentagon spending trends will have a profound effect on electronics concerns. The military budget for Vietnam-oriented hardware, including communications and avionics gear as well as components, will continue to expand. But the Pentagon's vast outlays for Vietnam equipment are causing stretchouts and, in some cases, cancellations of long-term research and development projects. Companies in the instrumentation and related fields are being especially hurt. Space expenditures also appear vulnerable, as do outlays for medical electronics.

But educational electronics, now attracting state and local as well as Federal funds, is set for a big year. Pacesetting installations of computer-assisted instruction systems will be completed this year in New York City and Philadelphia.

Despite uncertainties in capital markets and the economy's general sluggishness, industrial concerns can plan on a good year. But consumer firms, their bright dreams for 1967 faded, are facing problems. Market prospects for next year are dimmed by doubts about the international monetary situation, a Federal income tax surcharge, and a tightening of credit. Color-tv sales will post a good, if unspectacular, gain, but the effects of last year's debacle in this area will continue to make waves throughout the industry, particularly in the components sector.

Dollar sales of solid state devices will rise only slightly from 1967 levels, largely because of tumbling prices in the discrete-semiconductor field. However, IC's will take up much of the slack.

Integrated circuits are now a fact of technological life, and next year they will expand their position in commercial, military, consumer, and space applications. Semiconductor houses will devote increasing attention to medium-scale integration, the step before introduction of commercial quantities of large-scale integration devices sometime during the early 1970's.

Last year's big story was the emergence of linear and microwave IC's as a market force. This year, such devices will win a larger place in commercial and consumer equipment.

Military electronics

Stretching the sinews of war

Defense Department officials perennially consider next year's problems the worst they've ever faced. They're probably right about 1968.

"Under the gun of Vietnam, the budget is already down to the bone," says a Pentagon source. "Now it's a question of what part of the bone must go." Research and development activities will be hit hard: openly, by canceling programs that don't contribute immediately to the war effort; covertly, by stretching out projects that would trigger an adverse public reaction if dropped. "Some projects are being tested to death and this will get worse," another Pentagon official says.

Programs for equipment and systems for Vietnam-type wars will suffer. So will strategic offensive weapons. Instead of new starts, operational systems will be modified to perform extra jobs.

Some studies will be kept alive to keep Congress pacified, as well as to have something under way, should the cold war cool further. But the brass wonders what good a drawing-board design will do in five years, should the U.S. be attacked.

Secretary McNamara's departure may bring about changes in detail on some scheduled programs. Every cabinet member has pet projects. But, on balance, the Pentagon's shopping list is longer than ever and there's plenty of hardware business for production-minded electronics firms.

Strategic weapons

The biggest single outlay in the strategic category will be for the so-called "thin" antiballistic missile system, Sentinel (orginally Nike X). Depending on how fast the Pentagon launches the program—now estimated to be a $1-billion-dollar-a-year pace—Sentinel could push much of the industry beyond present capacities. An estimated 75% of the total price tag, officially set at $5 billion, will go for electronic equipment such as radar and computers. Manufacturers of discrete semiconductors, who had their troubles last year, also stand to gain because of the system's frozen design.

Last fall Congress appropriated $47 million to keep the Advanced Manned Strategic Bomber alive. The Defense Department also allocated $26 million for work on the avionics, the airframe, and engines.

The Poseidon submarine-launched ballistic missile will be in full production this year. More Minuteman 3 missiles will be bought. Penetration aids and reentry warheads will be built, and an advanced intercontinental ballistic missile will be studied. Approximately $2.5 billion will be spent to buy operational missiles of all kinds for all services during calendar year 1968; about $10 billion is earmarked for aircraft.

Air power

The giant C-5A passenger/cargo plane will be ready for instrumentation late next month, test-flown in June, and delivered by the end of the year. The initial contract calls for 57 planes with an option for 58 more. Avionics orders, the province of the prime contractor, the Lockheed Aircraft Corp., will be sizable during 1968.

The F-111A in its several configurations—reconnaissance, fighter-bomber, and fighter—will also be a big buy this year. In addition, the Air Force will buy the A-7D attack plane, more F-4E Phan-

toms and RF-4 reconnaissance planes, the C-141 cargo plane, and an air-to-surface missile.

The Air Force will continue to work on an ultrareliable ARC-34-type radio, molecular electronics for radars, large-scale arrays, microwave power sources, and cryogenic coolers to facilitate the use of infrared sensors.

The Air Force is also looking for three kinds of new tactical ground-based radars: to detect low-flying aircraft; to provide three-dimensional fixes; and to ground-control approaches under poor flying conditions. In addition, overland radar for the Airborne Warning and Control System is needed so a high-flying plane can detect low-flying aircraft against a background of rugged terrain.

All the big command and control "L" systems in development, such as Spacetrack, will be continued. So will the system for detecting and reporting nuclear detonation, and the post-attack command-control system.

Tactical equipment sought by the air arm includes navigation aids for remote fields, control towers, uhf and vhf radios, lightweight Tacans, point-to-point single sideband radios, and operations and communications centers.

The Army game

An urgent Army requirement is for a 360° mortar-locating radar. Development work on the AN/TPQ-28 at ITT-Gilfillan, a subsidiary of International Telephone & Telegraph Corp., should be finished by April. The system will be used for permanent base defense in Vietnam. A sizable production contract may be let this year.

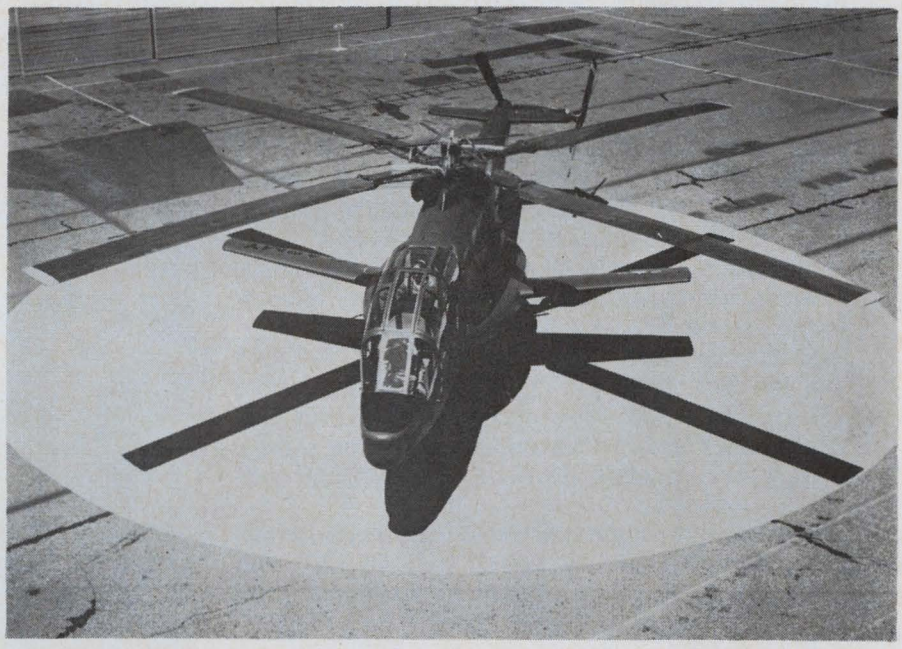
Army communications efforts will proceed along a number of fronts. For example, feasibility contracts will run through 1968 for Mallard, the four-nation, integrated tactical trunking and distribution system. A limited number of breadboard models of Rada (random access discrete address) subscriber units will be bought and the whole system simulated. Also, a new generation of field radios, beyond the VRC-12 family, will be checked.

"There's nothing wrong with the radios we've got in Vietnam now. The PRC-25 is winning the war," says an enthusiastic communications officer. "But by 1975 even better equipment will be possible. We're going to marry f-m and ssb a-m radios and expand the frequencies from the present 30 to 76 megahertz to 2 to 76 Mhz."

Tacfire, a complex computerized system for automating combat artillery batteries, will be a $100-million business next year. But two of the biggest problems will involve finding suitable computer memories and good display, says Milton A. Lipton, chief of the Data Processing Branch, Communications and Automatic Data Processing Laboratory, Army Electronics Command, Ft. Monmouth, N.J.

To coordinate all of the Army's aviation activities, work will continue on the integrated ground-airborne avionics system. The system will include a semiautomatic flight observation center, landing aids, beacons, and communications. If all goes well, the concept could be sent to industry for definition-phase contracts by the end of the year.

Night vision is still a preoccupation, and the Army is seeking to turn night into day with low-light-level television, infrared, lasers, and passive image intensifiers. Work is far enough along in this highly classified area for a number of devices to be going into helicopters and fixed-wing planes as well as on guns and tanks.



On the warpath. The AH-56 Cheyenne helicopter will be bought this year, possibly in volume for Vietnam. The Army will buy most of the avionics for Lockheed, the prime contractor.

Research and development work will continue on manpack and airborne versions of the Loran C/D navigation systems. A Decca navigation manpack will also be tested.

Avionics packages for the OH-6A Cayuse and AH-56A Cheyenne helicopters will be bought this year. The Army will buy and furnish much of the Cheyenne's avionics to Lockheed, the prime contractor. Lockheed's contract calls for 10 prototype Cheyennes. But a volume award is probable.

Naval engagements

The trend to buy new capability by modifying existing equipment will produce the Grumman Aircraft Engineering Corp.'s biggest 1968 program. The Navy's A-6A attack plane will be equipped with low-light-level television and infrared sensors to

give it a night-fighting capability. The A-6A will also get a new computer, the 4 Pi system built by the International Business Machines Corp. In addition, the plane's tracking radar will be removed and the search-terrain avoidance equipment will be modified to take on the tracking job.

The Naval Electronic Systems Command will spend $100 million this year for uhf and ssb, high-frequency, ship-to-ship and ship-to-shore communications equipment. Over the next three years, another $100 million will be spent to convert the Navy missile range telemetry systems to S band. A follow-on program will center on system security.

The command, which set up shop only last July, is moving to become the technical authority for development and procurement of electronics throughout the Navy without interfering in specific systems. Rear Adm. J. E. Rice, who heads the command, says: "We're going to push standardization of microelectronics. We also want to encourage automatic control in production to get more reliability and to reduce costs."

Ships at sea

Requests for proposals for the Navy's advanced surface-to-air missile system will be sent out before July and a contract awarded later in the year. A contract for the automated, integrated air defense system to replace the Terrier-Tartar-Talos missile systems, also to be let this year, specify a high-performance missile and a 3-D phased-array radar.

Electronic warfare to combat any threat to a warship from land, sea, or air will also be a major effort during 1968. Procurement of the Naval Tactical Data System will continue, sustaining a large market for computers, displays, data links, and communications gear.

The trend in Naval radar is toward phased array, even for small surface vessels and aircraft, says a Navy source. Emphasis will be on signal processing improvements, digital moving target indication, and digital pulse compression. The command wants more self-test features in equipment and automatic checkout gear like Teams, built by Nortronics, a division of the Northrop Corp., for radar and sonar gear. If Teams lives up to its press notices, there will be many more similar systems. "We just don't have enough trained technicians to handle the $25 million worth of electronics we have on every large ship in the Navy," says an official.

According to a spokesman at the Navy's Ship Systems Command, a systems engineering approach will be taken to design work for more equipment. However, the Navy will not match the Air Force in this regard since many vessels' subsystems are already in the works; in addition, integration is not as critical a factor as in aircraft.

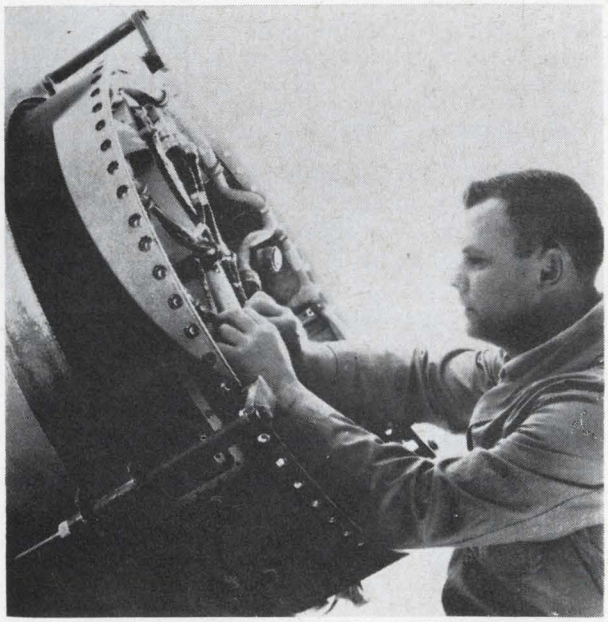
In avionics, the Navy is considering a systems approach to aircraft antennas. At the moment, the sea service has some 50 different kinds, many of which are add-on devices that project from the aircraft, causing interferences, and aerodynamic problems. "A new approach to all electromagnetic radiation and reception in aircraft is needed," says Capt. Frank W. Ewald, who heads the avionics division of the Naval Air Systems Command. "Antenna time-sharing might be the answer."

A long-range objective, Ewald says, is for avionics subsystems to last the life of the aircraft. "They could then be built into the plane. Short of this, throwaway repair modules might be the answer."

The Subroc and Asroc antisubmarine warfare missiles will be big buys during 1968. But most of these new weapons are going into the inventory.

Production of the Mark 44 torpedo is being phased out in favor of the Mark 46. This weapon is now in preproduction development. Evaluation will be completed later this year and a production award made in 1969.

The Office of the Director of Defense Research and Engineering will oversee a program to forestall electromagnetic compatibility problems before the design of new equipment is frozen. The Army will develop the instrumentation for measuring the new gear; the Air Force will analyze the results to determine the extent or lack of compatibility; and the Navy will write up the standards to be used by all services when buying equipment.



Getting through. Penetration aids hardware like this Mark I unit from Avco for intercontinental ballistic missiles will continue to receive development money.

Cost of ownership rather than initial cost is expected to receive more weight in equipment-buying decisions than in the past. In addition, Defense Research and Engineering is pushing throwaway modules and integrated circuits.

Nonetheless, support equipment will still be big business this year. Grumman alone expects to sell close to $200 million worth. To aid inexperienced maintenance men, the systems will be diagnostic and automatic wherever possible.

The prospects are solid

Semiconductor houses will be leaning more heavily than ever on their integrated-circuit operations during 1968. Last year's revenues of $268.6 million in this area on volume of nearly 100 million units brought many firms into the black on IC's for the first time. The market outlook this year is for $346.5 million on sales of more than 200 million units.

The emergence of IC's as a market force may have come just in time. Discrete semiconductor components, which have carried their more glamorous cousins through several unprofitable years, have endured severe price attrition since the end of 1966. And while sales of conventional discrete units are rising, dollar volume will make scant headway, going from last year's $561.9 million to $570.7 million. Discretes account for such a significant portion of all semiconductor sales that the price cuts will hold the industry's total 1968 revenue gain to 11%—$1.1 billion against $999 million last year.

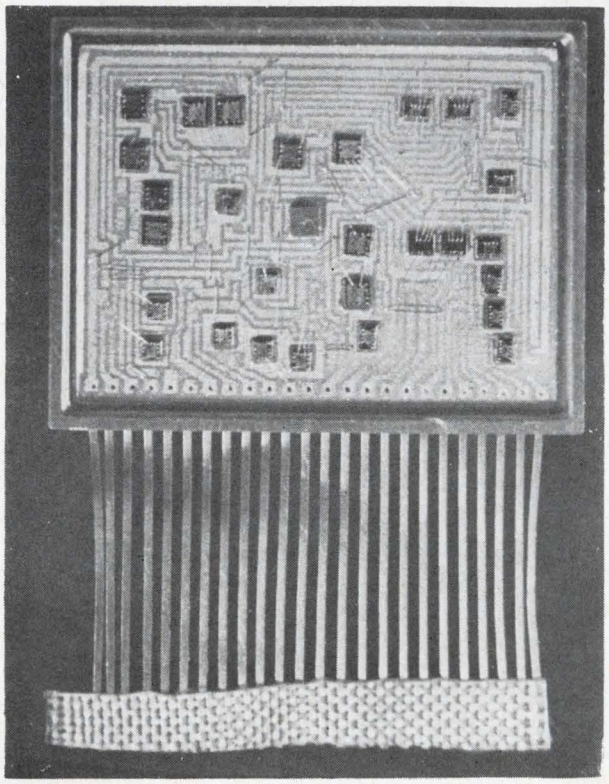
There's been a less martial atmosphere in semiconductor sales in recent years; military business is expected to account for less than 40% of dollar volume in 1968, against more than 60% in recent years. Computer and aerospace applications will each contribute about 20% of revenues. Industrial sales should be about three times as great as consumer.

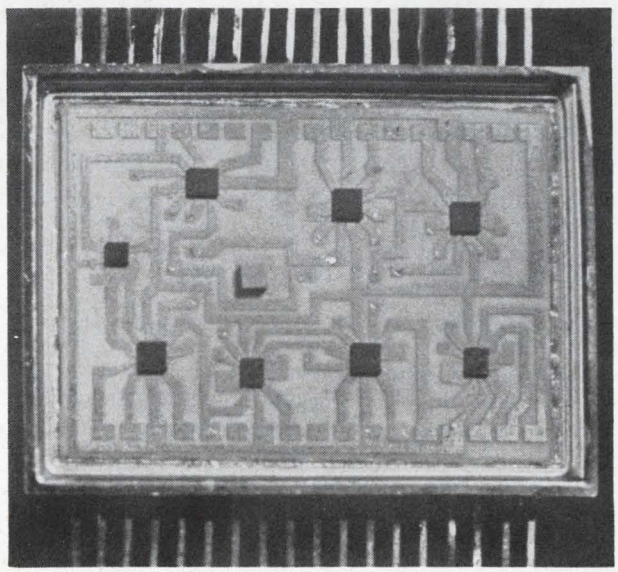
Monolithic digital assemblies will continue to lead the IC pack during the year. "The computer industry will absorb huge production quantities," says Richard J. Hanschen, assistant vice president and marketing director for Texas Instruments Incorporated's components group. Bill Berg, product marketing manager at the Signetics Corp., a subsidiary of the Corning Glass Works, agrees: "Integrated circuits are making further inroads in discrete preserves, particularly computer peripheral gear."

Newest darling on the digital scene is transistor-transistor logic. Many applications engineers estimate that 80% of new computer designs now call for TTL. The semiconductor division of Sylvania Electric Products Inc., a subsidiary of the General Telephone & Electronics Corp., is a leader in TTL. The firm is offering two versions of its SUHL—for Sylvania Universal High-Level Logic—lines.

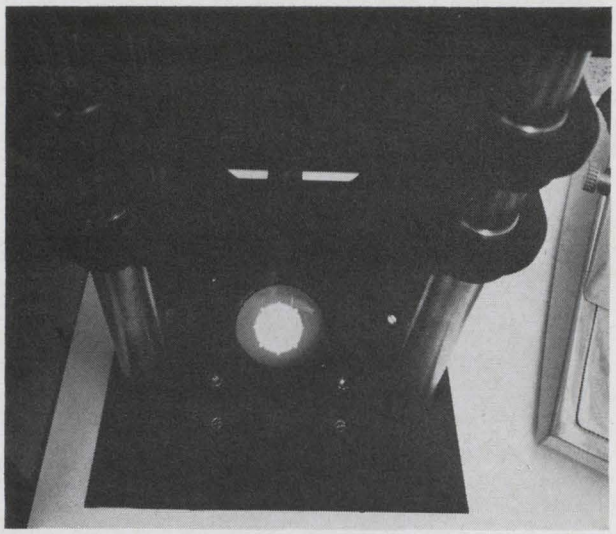
Speed is perhaps TTL's most attractive advantage over competitive families; the SUHL-2 line, for example, has a 6-nanosecond propagation time. But Harry Luhrs, Sylvania's marketing manager for IC's also cites noise-protection features, versatility, and a broad line as big reasons for TTL's runaway popularity. "In addition, TTL circuits have a smaller-element geometry," he says. "They can be arranged more compactly on a chip, making development of functional arrays a lot easier."

Sylvania, with about 135 circuits in both lines, including gates, expanders, flip-flops, and functional





Bridging a gap. Amelco's microelectronic modular assemblies, or MEMA, are a step beyond integrated circuits but short of LSI. During 1968, the concern will make MEMA available as an off-the-shelf item.



Bright picture. LSI interconnection mask is generated on the face of a cathode-ray tube at Texas Instruments.

arrays, has been hard-pressed to keep pace with demand. Semiconductor firms abhor a vacuum no less than nature and a host of would-be rivals have rushed into the marketplace either as second sources or as suppliers of other TTL devices.

In the TTL sweepstakes, Sylvania has worked toward higher speed by improving components; Texas Instruments opted for complexity, putting more components into each circuit. The result was TI's 54/74 series which the company believes will furnish a viable means of getting into large-scale integration later on.

Hank Schunk, assistant operations manager at the Raytheon Co.'s Semiconductor division, which second-sources SUHL, says that both of the top two have had difficulty in filling orders. "Most people agree that SUHL is technically superior to the TI line," he says. "If supply problems remain equal, SUHL will become the market-accepted line."

Motorola Inc., Raytheon, the Westinghouse Electric Corp., and even TI are all making some sort of SUHL. But Signetics, the Sprague Electric Co., ITT and the National Semiconductor Corp. are following TI's lead. Fairchild and the Transitron Electronics Corp. are vending their own versions.

Linear growth

Linear, or analog, IC's are set for a nearly 60% dollar jump to $80.5 million during 1968; unit volume should be around 15 million. In marketing terms linear devices are still in an early stage. The bulk of the volume is still in Government sales for military and aerospace applications. But manufacturers are wooing buyers in such industrial and commercial outlets as instrumentation, medical electronics, controls, power supplies, and entertainment goods. Computer makers and other original-equipment manufacturers using discrete assemblies to interface with digital IC's are also prime targets.

Among the linear wares seeking, or winning, approval in the marketplace are: low-cost operational and differential amplifiers; voltage regulators; comparators, high-frequency amplifiers active filters; and memory arrays as well as motor-control and timing assemblies.

Lou Solomon, marketing manager at the Amelco Semi-Conductor division of Teledyne Inc., says that never again will a single op amp dominate the market like the 709. (Jack Gifford, marketing manager for linear circuits at Fairchild Semiconductor, a division of the Fairchild Camera & Instrument Corp. —the 700's proprietor—agrees with this analysis.) Solomon expects good, solid growth in linear circuits: "All memory makers are going to IC sensing systems, and industrial feedback applications, requiring op amps, should grow." Linear circuit prices which averaged $14 last year are now at about half that level, says Solomon. "And it's never unwise to predict another 50% reduction."

At Fairchild, which has 30% to 40% of the linear market, Gifford says the big question during 1968 will center on whether or not giant consumer houses like the Radio Corp. of America can get entertainment circuits into volume production.

"The emphasis is going to be on volume," Gifford says. "Given equal output linear circuits can be made as cheaply as digital devices."

Chris Goodman, vice president and U.S. marketing manager of Motorola's Semiconductor Products division, looks for the growth rate of IC's for consumer goods to outstrip that of devices earmarked for military and computer applications. However, Roger A. Swanson, marketing manager of Sylvania's Semiconductor division, believes the consumer market will not be a substantial factor until next year. Linear IC's will first crack television, he says, and then small business machines, appliances, and automobiles.

Microwave potential

Still another sector of the IC field beginning to develop some strength is the microwave area; here, integrated assemblies are chipping away at the once private preserves of high-frequency tubes and components. Military and space systems, notably radar, are the main potential outlets at the moment. But consumer and commercial applications will be increasingly in evidence within five years.

Reliability and lower costs explain the gathering push behind IC's. But the multifunctional characteristics of microwave assemblies promise other operating advantages that should enhance their appeal. Hybrid techniques are still dominant, but monolithic technology is making up lost ground and will prevail as mass markets are opened.

As a result of three years' experience on the Air Force's MERA (microelectronics for radar applications) program, Texas Instruments has a headstart over other semiconductor firms in the race for microwave markets. On the systems side of the fence, Microwave Associates Inc., which has a solid IC capability, holds a commanding lead. But coming up fast to give the top two a run for the money are Sylvania and RCA. Also in the running are the Gen-

eral Dynamics Corp., TRW Inc., the Hughes Aircraft Corp., Bell Laboratories, and Motorola.

Marvin Groll, marketing manager for microwave semiconductor products at Sylvania, says his operation will base its approach to microwave IC's on beam-lead semiconductors. "Using this technique, we should be able to reach higher frequencies," he says. Sylvania is virtually the only contender for business in the Ku band—a frequency range that has as yet attracted few projects. "Dollar estimates for microwave IC's are an unrealistic proposition at the moment," Groll says. "But by the end of the year, specific programs will have emerged, permitting some assessment."

Small, medium, and large

Large-scale integration—upwards of 100 gates on a single chip— is still waiting in the wings this year. However, major producers are developing techniques and an increasing number of prototypes will be available.

"We'll see a lot of multipackaging in the discrete field," says Amelco's Solomon. "This is the step before LSI; whether or not you're selling it, you'll need a lot of leads." Later this year, Amelco will announce an off-the-shelf line of circuits in its MEMA (for microelectronic modular assembly) packages, which it has been supplying its parent company for the integrated helicopter avionics system.

Signetics is working on a 64-bit memory element for a computer. During the latter part of 1968, Berg says, assemblies of equivalent complexity will be offered commercially. However, he does not feel that MSI devices will capture much more than 5% of the total IC market.

At Fairchild Semiconductor, a circuit-a-week promotion, lasting for the next year or so, is well under way. Most of the new assemblies will be digital, about half of which will fall into the MSI category. Several, however, will be genuine dual-metal-layer LSI devices for which computer-aided design was used to lay out interconnections. The company, now supplying a bipolar LSI circuit to the National Aeronautics and Space Administration, plans to offer at least two more as standard commercial items during the first quarter.

Fairchild takes a somewhat philosophical approach to LSI, according to Ben Anixter, IC marketing manager. Criteria are not limited to the number of gates on a chip: rather, any circuit requiring two-layer metal for interconnections, as well as computer-aided design, to lay them out, falls into the LSI category. And as a rule, Anixter says, the circuit must be of sufficient complexity to somehow affect the vendor-customer relationship.

"It will be two years before anyone develops the production technology and discretionary wiring techniques needed for true LSI," says Tom Longo, vice president of Transitron. "However, within the next two years, we'll see 15 to 50 gate chips as well as chips with 5 to 20 flip-flops. Longo also believes that LSI will produce more teaming: "As a matter of fact, component and systems people are already living very close together to solve common problems."

As the market for functional arrays expands, Sylvania plans to jump to a 28-lead package with center-to-center lead spacings of 50 mils. (The company's 14-lead IC's have 100-mil spacings.) These devices represent the leading edge of Sylvania's LSI marketing program, and they will not be available until late this year or early in 1969.

Sylvania also believes that with the trend to even larger scale integration, the semiconductor supplier will become an increasingly important part of the customer's design staff. Continuously exposed to proprietary information, vendors might eventually sell specialized arrays to particular companies, rather than offer a broad line of multipurpose devices. Over the longer run, arrays or LSI devices might be pooled in the same way that computer programs are. "In any event, the higher the degree of integration, the more nearly impossible it will be for purchasers to find second sources," says Swanson. "Suppliers may even attempt to second-source themselves through production over-runs."

Swanson also believes that the cut-rate tactics used to establish market dominance in discrete semiconductors are unlikely in the LSI field. It is to the interest of the single-source supplier to build and sell circuits at the lowest possible price to keep his "teammate's" systems competitive.

Until recently, the metal oxide semiconductor sector of the IC field was virtually the exclusive preserve of two second-tier semiconductor suppliers, the General Instrument Corp. and the Philco-Ford Corp. Top houses were just not prepared to devote financial and technical resources to MOS, so potential customers eschewed it in droves. In addition, criticism about low yields, erratic delivery, and instability were rampant in the industry.

Now, however, the big boys are ready to get into the off-the-shelf game. "Until bipolar techniques were established, MOS had to wait its turn," says a Texas Instruments official. "There would have been little sense in having both technologies compete for the same space in printed-circuit boards.

A latecomer in the semiconductor field, the General Electric Co., is expected to try to make MOS IC's the mainstay of its digital line. So, too, is RCA, best known for its linear wares. Motorola, which introduced a number of standard MOS devices last year, is preparing to expand its business during 1968. Finally, Fairchild and TI, both of which have concentrated on custom work for the past few years, are preparing to launch complete lines of custom MOS products this year.

Aside from gaining a share of a market that may account for up to 15% of the action in the IC field within a few years, semiconductor houses are looking ahead to LSI. Metal oxide semiconductor wares dovetail nicely with LSI products like memories, shift registers, and multiplexers. In such applications, the high-density characteristics of MOS give it an edge over bipolar technology.

Not everyone is bullish, however. "The emphasis on bipolar problems will slow the answers for MOS,"

says Sylvania's Luhrs. "It could be great, but it will take years to find out." He feels that computer designers are inclined to take a conservative approach. For example, Luhrs says, if a machine is to last 20 years, bipolar devices will be specified.

Pick a pack

"Trends in packaging can be traced directly to IC's higher power and speed as well as greater complexity," says Motorola's Burns. "We're trying to come up with packages that have a high degree of volumetric efficiency." Burns says Motorola is working on packages that can dissipate more than 10 watts, the current norm. He notes that "the trend is to higher power, especially in linear circuits."

"Plastic is in, no question about it," says Transitron's Longo. "This year, 70% of our dual in-line output will be in plastic. In 1967, only 50% of production was plastic-packaged."

Texas Instruments' Hanschen agrees that plastic is the dominant packaging trend. "The greatest area of change during 1968 will be in power products where conversion to plastic may cut costs by more than 50%," he says.

Despite higher yields and expansion programs throughout the IC field, semiconductor makers do not, apparently, face an overcapacity situation. According to Raytheon's Schunk, there may be an artificial reason for this: "While the industry has tremendous chip-making and packaging capabilities, there's a real bottleneck in testing flexibility."

As a rule, every customer wants his specifications just a bit different, Schunk explains. Even on semi-standard lines, he wants some control. Although all manufacturers have elaborate test set-ups, they still experience delays in testing. "We might be shipping a particular IC to 15 customers—with two standard data sheets and 13 other specs," says Schunk. "It makes for very difficult logistics. Even where we try to simplify, perhaps by checking several orders to the more difficult specs, shipments are still slowed."

Separate and unequal

Discrete semiconductor components took quite a beating last year. And, with certain exceptions, little relief is in sight. "There's no question that prices are eroding," says Amelco's Solomon. "Companies without proprietary designs are in trouble."

Donald Dickson, president of the Dickson Electronics Corp., attributes last year's slump largely to overinventorying by original equipment manufacturers and overcapacity among producers.

"Sluggishness in the color television market was no help either," Dickson says. The company experienced a leveling-off in demand for zener diodes, a situation its president says he does not understand. However, as a result of falling prices and stretched-out military demand, there won't be any real recovery in this area during 1968.

Goodman of Motorola believes germanium transistors suffered because of computer makers' overstocks. The situation promises to get worse since machines using such assemblies are being phased out of production. Goodman foresees further inroads by integrated circuits in discrete components' territory, especially in TV and stereo sets. In the industrial-commercial area, Goodman discerns a trend to digital tuning of aircraft radios, an eventuality that will cost discrete devices more sockets.

Robert Irvin, market planning manager at Teledyne's Crystalonics division, says the 1967 slump may have been exaggerated. "Probably as many, if not more, dice were made last year than during 1966," he says. "But semiconductor makers cut into their own sales by selling them for use in hybrid IC's."

Irvin feels the jump from discrete components to monolithic integrated circuits accounts for much of the drop. "Discrete houses turning to dice sales to keep their furnaces running simply accelerate a downward spiral," he says. "The only people unhurt in this sort of runaround are the header builders."

Power play

Special switching characteristics of thyristors should push sales from last year's $56.1 million to $66.8 million. These discrete power devices are in the enviable position of being superior to components such as tubes and relays and are not threatened by integrated circuitry. But within the power family, a struggle is shaping up between silicon controlled rectifiers and triacs. Triacs are functionally equivalent to two SCR's and sell for about 50% less. Glenn Geissinger, marketing manager at International Rectifier, anticipates a good year in both fields largely because his company concentrates on applications in the 35-amp area. Sylvania will join RCA, GE, TI, Motorola, and others in the power club later this month, after 18 months of development work, introducing an SCR line designed to drive electroluminescent displays. The devices will operate at about 350 volts and 400 hertz at around 100 microamps. About midyear, the company will test-market a short line of triacs for control applications in home appliances.

Triacs are shaping up as a battleground. General Electric has led this discrete business, but RCA has been coming on strong and TI is about to make a move. The first triacs were developed for industrial customers but the devices have since proved their mettle in military applications.

Field effect transistor sales are up, and will continue to grow across the board. They replace tubes more handily than IC's in industrial and consumer applications. The leading firms are TI, Siliconix, Dickson, and Teledyne. Field effects are also being sold in chip form for use in modules. The year should see voltage levels climbing higher, greater power-handling capabilities, faster speed, more duals amplifiers, and more plastic packaging.

Unijunction transistors, which among other things trigger thyristors, will take off. The market, $4.8 million in 1967, should hit $7.2 million this year. Unijunctions compete with trigger diodes and other solid state devices but should outstrip them because of greater reliability and user acceptance.

Growing—but still in the incubator

The prognosis for medical electronics remains uncertain. Although 1968 is expected to see sales hit $296 million, up 14% from last year's $260.5 million, it is doubtful that it will be a year in which the field's much-ballyhooed promise will be fulfilled.

For one thing, better than half of the field's volume is still in such commonplace apparatus as X-ray machines and hearing aids. For another, engineers and physicians have yet to develop a meaningful dialogue. As a result, electronics concerns aren't in a position to satisfy the medical profession's requirements. Finally, because research is to a great extent dependent upon Government grants, a shift in Federal expenditures can adversely affect funding in this area. And this is exactly what happened when the Administration clamped down on non-Vietnam spending.

Rx for growth

Samuel Merion, marketing vice president at American Electronics Laboratories Inc., believes many medical-measurement problems could be solved speedily if more Government R&D money went to industry. Of the funds doled out by the National Institutes of Health for bioengineering and medical research, only a small portion is earmarked for development of medical instrumentation. And only a fraction of this finds its way to electronics firms even though, as Merion points out, "industry has both the personnel and technological resources to adequately cope with such programs."

The most promising area of medical electronics is patient monitoring; 30 or so companies are trying to gain a foothold in this market.

Says David Kelch, medical electronics product manager at the Hewlett-Packard Co.'s Sanborn division: "It's really caught on in the past three or four years. Now almost every hospital wants patient-monitoring equipment of some type." Sanborn's monitor line ranges from small, mobile machines to large, custom-designed installations like the multibed cardiac unit at New York City's Lennox Hill Hospital.

Although development still has a long way to go, monitoring equipment is already credited with halving the 40% mortality rate of coronary-occlusion cases admitted to hospitals. Despite this, most physicians feel far better equipment is needed.

The cry is for equipment that can monitor parameters considered better early warning indicators than electrocardiographic signals, pulse and respiratory rates, blood pressure, and temperature. What the medical profession wants is electronic gear that might measure the amount of blood pumped with each heartbeat, the flow of blood to certain organs, oxygen levels in the blood, and a patient's metabolic state.

Another segment of the medical market that holds out great promise is analytical instrumentation. Clinical analysis systems have proved superior to conventional laboratory techniques in speed, accuracy, and cost. Also, many different kinds of systems can be tied to a general-purpose computer that controls measurements and analyzes results.

Since such systems are costly, running as high as $50,000, they must provide immediate and substantial savings. Most achieve this, say clinicians, pointing to the machines' capacity to do the work of 20 technicians at about 2% of the cost. Because of such savings, analytic instrumentation systems such as

Reliable source. Electronic instruments like this coagulation analyzer from Hewlett-Packard provide better test results at less cost than conventional lab procedures; they are gaining wide acceptance.

the Technicon Corp.'s Autoanalyzer; Becton, Dickinson & Co.'s amino acid analyzer, and Sanborn's coagulation analyzer, are expected to become standard equipment in an increasing number of hospitals.

Still another reason leading to the greater use of these systems in hospitals is the larger patient loads resulting from such large-scale programs as the Federal Government's Medicare.

With sales of intensive-care monitoring gear showing healthy signs of growth, several electronics firms are now examining the potential of surgical monitoring—including such specialized areas as cardiac catheterization. And a renewed interest is being shown in research systems. Previously, the medical community encountered problems with research equipment because of the inability to combine systems from different manufacturers. Interface problems caused the jettisoning of many projects. Now, however, individual electronics firms are able to supply complete systems.

A funny thing happened on the way to prosperity

Sales of color television sets continue to disconcert the experts. Only 12 months ago, scores of self-appointed seers were freely predicting that the bellwether of the consumer sector would rack up a year-to-year gain of as much as 70%, selling 8 million receivers in the process.

But even as the confident forecasts were being issued, distribution pipelines were clogged with excess inventory. And consumers simply did not turn out to buy in the anticipated numbers. The rate of annual gain turned out to be more like 15% —a traumatic experience for an industry budgeted to do at least three or more times better.

This year, the optimism of those who draw wages for merchandising color sets is tempered by considerable caution. A demonstrably softening economy in which tight money slows sales of big-ticket items, generally bought on credit, is scarcely the place for euphoric projections. Besides, there is no precise way to gauge consumer reaction to international monetary crises and the income tax surcharge proposed by President Johnson.

Off-color stories

As a result of a varied assortment of uncertainties, industry executives are inclined to take a retrospective, rather than forward, view of the situation. "The slowdown in color tv sales is due largely to a shift in the economy from the 1966 level," says B. S. Durant, president of the Radio Corp. of America's sales organization. "Color sets will certainly show a marked increase in volume from present levels. But I wouldn't want to make a guess and have to eat my predictions."

Armin E. Allen, vice president of the Philco-Ford Corp.'s Consumer Electronics division, feels that the disappointment was due to overoptimism about prospects. "The fact is color tv didn't saturate the market as expected," he says.

This year the industry is looking for about an 8% gain in color set sales to $2.07 billion from $1.91 billion. The total consumer electronics market will fare less well, rising only about 6% from $3.85 billion to $4.09 billion.

The relatively modest progress cloaks a number of interesting developments. "Unit sales of color tv sets should pass black-and-white for the first time," says Ross D. Siragusa, Jr., executive vice president of the Admiral Corp. This prospect is less a reflection of color's success than monochrome receivers' problems. Dollar volume in this category is expected to drop from $477 million to $393 million during 1968.

As a result of this deteriorating market situation

Just looking, thanks. At Zenith showroom in New York, a handful of prospective buyers inspects television sets. Manufacturers' estimates for color were undone largely by economic uncertainties stemming from Vietnam war.

and spiraling costs of manufacture, domestic set makers are following their radio colleagues to the Far East for small-screen—19-inch to 23-inch—tv sets which they merchandise under their own brand names.

"The trend will continue," says RCA's Durant. "We will be seeing a greater transfer of products between continents. First it was Japan, now it is Taiwan, Hong Kong, and Korea; soon it may be Malaysia and Indonesia." Some companies, the Emerson Radio & Phonograph Corp., a subsidiary of the National Union Electric Corp., for example, have abandoned their U.S. assembly lines for transistorized radios and are relying entirely on imports.

Sweet music

Sales gains are in store for the more expensive high-fidelity entertainment products. William F. Glasser, sales manager for H. H. Scott Inc., says, "The public is buying higher-priced goods than it did a few years ago. They want better quality and are willing to pay for it." A spokesman at Admiral says, "Fewer portable phonographs will be sold in 1968 as consumers raise their sights and go after the larger units." The public is also expressing a strong preference for compact equipment in which the receiver, amplifier, record changer, and tape deck are combined into a single package.

Radio sales will continue to increase, going from $242.9 million to $254.7 million. William Keepin, manager of the Norelco radio department of the North American Philips Co., estimates that f-m sets accounted for about 43% of 1967 radio sales. This compares with about 35% in 1966 and only 10% in 1960.

"The number of commercial f-m stations has jumped to 1,800 from only 800 in 1960," says Keepin. "F-m broadcasters now represent about 25% of the industry. In addition, the programing diversity required by the Federal Communications Commission of commonly owned stations has attracted bigger audiences to the medium."

All industry spokesmen agree that tape recorder sales will be considerably higher this year. "It is safe to say that the prerecorded tape industry has created a demand for better fidelity and more expensive tape recorders," says an executive of a consumer electronics firm. Casettes are also set to take off. While total recorder sales will be up 29% this year, from $144 million to $184 million, tape cartridge volume will register a 60% gain, going from $51 million to $80 million.

Big gains for small devices

Semiconductors will continue to strengthen their hold on consumer goods. Silicon controlled rectifiers, triacs, transistors, and even integrated circuits are being used in a wide assortment of appliances. Heating and air-conditioning equipment, clothes washers, and dryers, as well as dishwashing machines, are all starting to incorporate solid state devices. Integrated circuits are being used for switching and speed-control in such household wares as vacuum cleaners, food blenders, and power tools.

Another growing outlet for solid state assemblies is the musical instrument business. The ranks of amateur musicians—defined as those who play an instrument at least six times a year—is swelling at an annual rate of more than two million. And manufacturers are filling the demand with electric guitars, electronic organs, and electric pianos, as well as a variety of amplification equipment and accessories, such as microphones and speakers. This $100-million business will continue to grow.

Ironically, however, the television field is by and large holding out against using integrated circuitry en masse in color sets. Motorola Inc. has marketed an all solid state color receiver, but for the record, many manufacturers still consider IC's a promotional gimmick. "The full impact of solid state is another year off," says a spokesman for a semiconductor house.

The latest and largest area to feel the impact of electronics is the automotive industry. Last year more than 9 million cars rolled off the assembly lines, carrying nearly $14.4 million worth of electronic equipment, excluding radios. This year, electronics' share should increase to nearly $20 million. An increasingly significant factor in the automotive electronics picture will be the integrated voltage regulator first used in the General Motors Corp.'s Pontiac. By 1971, IC regulators should be accounting for more than $27 million dollars of the $50 million that Detroit will be spending on electronic devices.

This year car makers will also introduce some electronic tachometers and speedometers as well as engine performance analyzers and failure sensors.

Reviving the radiation issue

Manufacturers of color television sets may be facing problems far more serious than a case of arrested growth. Last year's well-publicized flap over the 90,000 or so large-screen receivers built by the General Electric Co. that were emitting excessive X rays from shunt regulator tubes alerted legislators to the possibilities of the radiation issue. Two bills were immediately thrown into the Capitol Hill hopper. After a series of hearings which generated more heat than light, the story drifted off the front pages.

Now, however, the probe is back in the limelight. The Public Health Service in a recent report to Congress suggested that the radiation problem may be industrywide. While investigating sets in Florida, the agency says it found that 38 of 131 "corrected" GE receivers still emitted radiation in excess of the 0.5 milliroentgen level deemed safe by the National Council on Radiation Protection and Measurements.

While the downward radiation problem had been licked with replacement components and high-voltage rectifier tubes, the report says, the new shunt regulator is emitting excessive radiation from the sides of the sets. The upshot is that the National Center for Radiological Health is bent on examining all elements of every set in the marketplace for radiation.

Educational electronics

Computer-assisted instruction stepping up in class

Educators, Government officials, and electronics executives are paying their annual homage to computer-assisted instruction (CAI). But while increasing amounts of seed money are available, the field is longer on promise than performance.

Bright outlook

Long-term prospects are, of course, still dazzling. For example, sales of computer-assisted instruction systems could hit an annual rate of $1.5 billion within five years, says R. Louis Bright, associate commissioner for research at the U.S. Office of Education. "Any college or high school that fails to give its students experience in data processing techniques and ignores the impact of the computer on teaching techniques is obsolete," he says.

Bright's agency will spend about $6 million of its $90 million 1968 budget on projects involving computer-assisted instruction. And more money for local school systems will be allocated from the Office of Education's over-all budget of $3.9 billion during 1968. Approximately $400 million is earmarked for equipment, much of which will be electronic.

Computer-assisted instruction, although still considered an experimental technique, is being given a fair trial. As many as 300 installations involving some form of computer access—ranging from simple electric typewriters to cathode-ray-tube terminals—are in use around the U.S., says one knowledgeable observer. Probably 25 use the more sophisticated crt input/output display consoles, estimates Robert D. Gates, director of the Philco-Ford Corp.'s Education Development Center. This figure, which compares with the six or seven systems in place a year ago, should double by the end of 1968, he says.

A study made last year by the International Business Machines Corp. for the Federal Government indicates that by the early 1970's, as many as 50 large high schools and junior colleges within a 100-mile radius could be provided services from a single centrally located computer.

"At the conferences we attend, CAI is on everyone's lips," says one educator. "But at this point it really hasn't been fully tested. We still don't know how to best use it or just how useful it can be."

Teaching materials for computer-based systems continue to get a lot of attention, as do backup data systems to individualize the instruction, says Gates. A data base contains information on a student's educational history, his strengths, weaknesses, and learning ability.

"This sort of backup to the subject programs is going to be especially important to the long-term development of CAI," says Gates. "It will permit CAI to get beyond straight subject programing and deal with the needs of the individual."

"There's been good acceptance by the educational research community of computer-assisted instruction," says Clagett Jones, manager of instructional systems marketing for IBM's Data Processing division. "We've proven technically that we can teach. The question now is how well we can teach. In the next year or so we'll be refining and developing our teaching programs."

Tale of two cities

The Radio Corp. of America will begin work this March on the largest CAI system in the world for the New York City school system. Philadelphia began installing a system with crt terminals, built by Philco-Ford, last fall.

The New York system will use 192 Teletype terminals spread through 15 separate schools. The terminals, modified for the student's use by RCA, will be tied into a central Spectra 70/45 computer.

The system will be used for drill and exercise programs in mathematics, spelling and reading for grades two through six, says Hugh McDougall, assistant director of computer-assisted instruction for New York City schools. The project is being helped by a three-year, $2.5-million Federal grant.

New York chose to go with a Teletype system, rather than with crt terminals, because more units could be linked to the computer. At present, programing problems limit the number of crt terminals that can be tied into a central processor to about 32. Eventually, this number will be increased, but New York officials wanted to expose as many students as possible to the system from the outset.

Junior and community colleges, which are springing up around the country, at a rate of 50 to 60 a year, will provide a big boost for educational electronics because they are more receptive to new technologies than old institutions.

"They're not inhibited by existing systems or by faculties, because they're building everything from the ground up," says an electronics industry spokesman.

In time, the economics of computer-assisted instruction will become more attractive. For example, IBM estimates that hardware costs can be pushed as low as $2 per hour per terminal for a system using cathode-ray-tube apparatus.

New wine from old bottles

Dial-access systems, in which a student dials the number of a program and gets either an audio or video playback or both, will figure strongly in educational electronics systems during 1968, says Robert H. Barnaby, manager of instructional systems merchandising at RCA.

Such equipment is an offshoot of the language laboratories used for a number of years at many colleges. Now they're being used for a variety of other subjects, and educators are interested in adding the video capability to systems already installed.

"Dial systems with both audio and video terminals have been around for just a year or so," says Barnaby. "Only now are they getting the attention and understanding of educators."

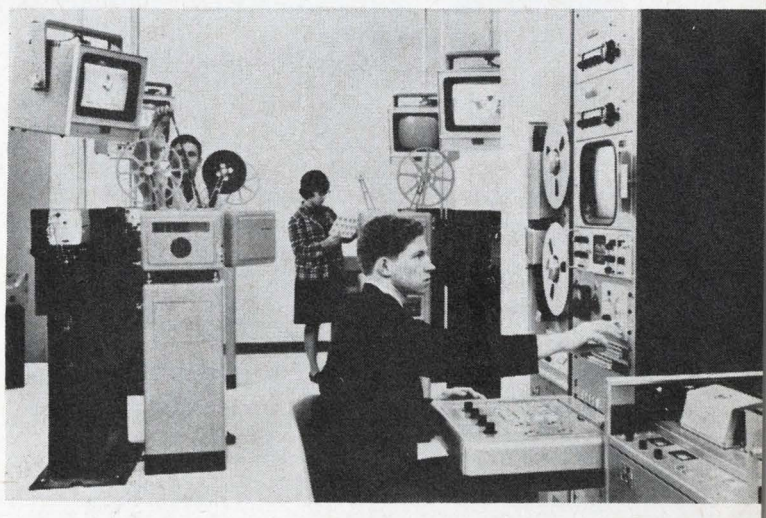
The systems aren't particularly fast sellers since they're generally ticketed for new campus buildings or learning-resources centers, Barnaby says. And these take years to get off the ground.

The video portion of dial-access systems, which cost from $30,000 to $100,000, can be tied into closed-circuit television systems. Closed circuit tv is also being used increasingly in schools and colleges. Sales volume is expected to jump almost 19% to $19.7 million this year.

Odds and ends

Educational television got a boost last fall with passage of a public television law authorizing $37 million over the next three years for construction of educational broadcasting facilities and programing. The bill also authorizes $500,000 to the Department of Health Education and Welfare to conduct a study to determine the roles of Federal, state and local governments in promoting instructional media. The study will cover closed-circuit tv and cable antenna tv as well as data and computer links.

A smaller but fast-growing segment of the educational electronics market is video tape recording. Sales, including accessory equipment, such as cameras and monitors, are growing at a rate of about $10 million a year. John H. Trux, marketing manager of the Ampex Corp.'s Consumer and Educational Products division, anticipates a $40 million market during 1968 and at least $75 million by 1972.



Control center. Bank of audio and video equipment is part of a college dial-access system built by RCA.

Growth rate a Vietnam casualty

Instrument makers will settle for half a loaf again in 1968. Firms in the field are looking for a year-to-year sales gain of 12% from $648.5 million to $727.5 million. This rate of growth is about even with last year's pace but far below the 1966 level of 21%.

Research-and-development sales continue to fall because of U.S. commitments in Vietnam, says Allan B. Dallas, director of marketing at Honeywell Inc.'s Test Instrument division. Barring an unexpected peace, more funds will be diverted from research tools into direct military production. As a result, instrument manufacturers will sell more of their less lucrative wares: simple oscilloscopes and oscillographs as well as data-logging systems.

In addition, cutbacks in nonmilitary programs, particularly those in the aerospace field, are adversely affecting sales of specialty apparatus.

Despite the Vietnam situation, instrument makers' short-run prospects are good to excellent in many areas. Measurement-minded firms, in particular, will do well; many are developing means of checking previously unsurveyed parameters.

Oscilloscopes—the instrumentation field's bread-and-butter offering—are another likely area as producers keep pace with users' demands for units with faster rise times and such display plug-ins as dual-beam, sampling, and storage apparatus. But scope customers are now pressing for the same features in portable instruments for field use. Chances are good that buyers will get what they want.

Test case. Typical, low-cost ($4,850) IC tester from Teradyne Inc. makes 15,000 analog-logic checks on digital devices in 1/100 of a second. The outlook in this segment of the market is clouded by the need to educate potential users and standardize test goals.

"Last year's growth in oscilloscopes was largely attributable to expanding markets in the computer and color television fields," says Keith Williams, marketing vice president at Tektronix Inc. This year, however, Williams believes sales to these outlets will hit a plateau. A growing number of scope applications with machine tools, automated systems, and instrumentation apparatus will take up some of the slack. One industry source says, "If the Pentagon ever gets the money, now earmarked for Vietnam, that is needed for all the shelved military electronics development projects, laboratory-scope sales will take off."

Better wed

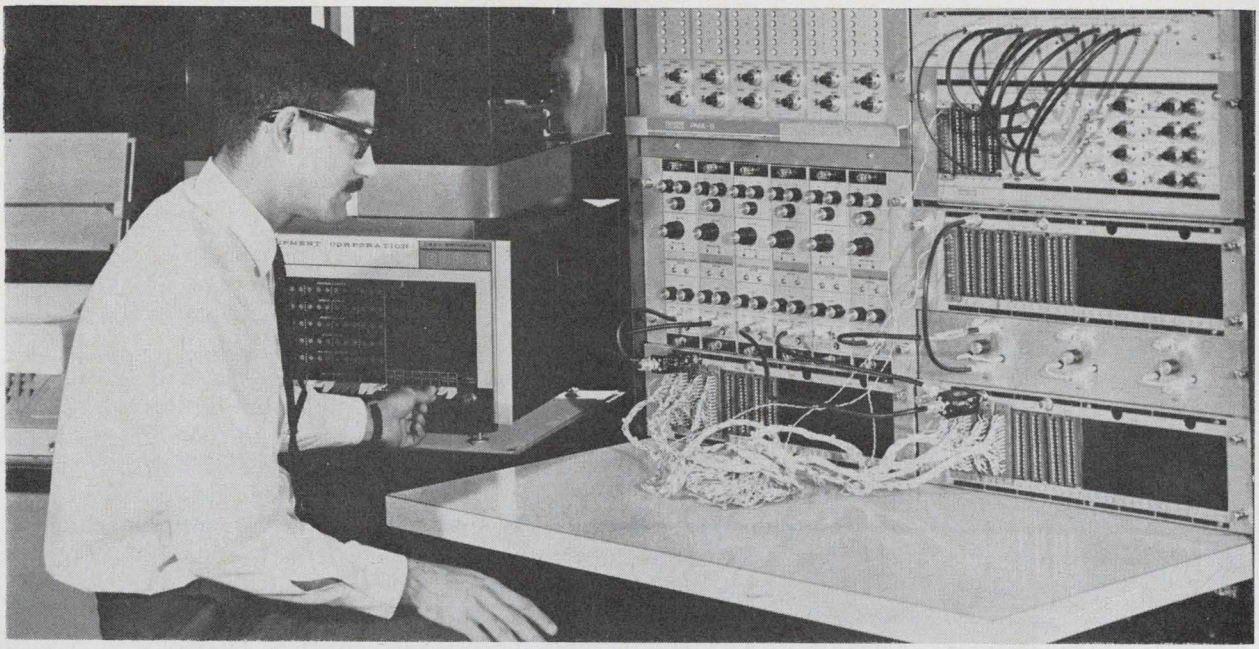
Integrated circuits are triggering a number of changes in instrumentation. For one thing, manufacturers are turning out more complex instruments which combine the capacities of two or more units. For another, the widespread use of IC's has led many firms to develop testers. In addition, IC's have made for lower price tags on some units as well as on computers, which now are being rapidly designed into instrumented measuring systems.

"Microcircuits make more complex functions possible," says Peter Richman, a consulting engineer and formerly engineering vice president at the Weston-Rotek division of Weston Instruments Inc., "This stimulates growth by opening up new applications and by further automating measurement."

Automated measuring systems were well-received during 1967 and sales should increase at a good clip this year, Leo Chamberlain, sales manager at the General Radio Co., believes. But he warns: "Sales will hinge on engineers' being educated to the fact that there are computers which are not huge and prohibitively expensive."

"Inexpensive computers provide the means for automatic data reduction and recording," says Richman. He notes that these are "possibly the two most expensive aspects" involved in making measurements. "The need to provide these functions by means of computer-operated test complexes exists, but it has hardly begun to be satisfied," he says.

Although many instrument makers sell automated systems, Hewlett-Packard Co. is the only firm producing its own computer. Other companies rely on inexpensive, general-purpose machines like the Digital Equipment Corp.'s PDP-8/S. W. Noel Eldred, H-P's marketing vice president sees great potential in this area. But while the company has a wide range of automatically controllable instruments



Marriage of convenience. Increasingly, test gear is being coupled to a digital computer to get more precise data faster and at a lower cost. Above is Digital Equipment Corp.'s programed memory analyzer.

available, Eldred says, "our problem is finding better ways to combine reliability, performance, and economy."

Bargain hunting

In many instances, using IC's in instrumentation results in a lower price tag. "The process industries and production-line users don't normally demand the accuracy of laboratory or aerospace customers," says Honeywell's Dallas. "However, they are still looking for reliable but less complex and less costly recording and display techniques for their data acquisition requirements."

Honeywell's 7600 instrumentation recorder, for example, was designed with off-the-shelf IC's and introduced last year at a price about 30% lower than comparable competitive units. The machine became a runaway best-seller in short order.

Digital voltmeters are another case in point for IC's. Long priced out of production-line and industrial applications, such instruments have profited, and will continue to profit from integrated IC's.

Last March, the Instrumentation division of the Fairchild Camera & Instrument Corp. introduced a three-digit dvm selling for $325. Subsequently, Weston brought out an all-digital panel meter to replace their precision d'Arsonval line.

Both devices won widespread acceptance in industrial applications, so comparable gear is sure to follow from rival firms.

Counters provide yet another IC success story. The Monsanto Co.'s Electronics division, for example, recently introduced a counter-timer in which IC's not only led to a smaller package with more functions but a reduced price tag as well—about $575. "The instrumentation field's growth is linked to direct digital, rather than analog, displays," says Myron C. Pogue, marketing manager at Monsanto's electronics operation, a comparative newcomer to the instrumentation field.

Virtually all instrumentation houses are enthusiastic about the outlook for IC testers, a market that could mean as much as $35 million in sales for instrumentation firms this year. The companies that have entered the field so far have tended to concentrate on low-priced—$5,000 or less—devices. Hewlett-Packard, for example, last year introduced an instrument capable of testing IC's for incoming inspection at $1,575. Soon after the Redcor Corp. unveiled a more elaborate unit, selling for $4,950, that can perform d-c, a-c, linear, or function tests. But Beckman Instruments Inc. made it a whole new ball game by bringing out a low-priced unit for $475. The outlook favors more economy testers coming to market.

Integrated circuits are a threat to certain instruments, notably those devices tied to discrete components application. Hewlett-Packard's Eldred views the rapid growth of IC's as an opportunity to expand his company's instrumentation markets, as does General Radio's Chamberlain. But Eldred's view of the immediate potential is pessimistic because "it's hard to spot any uniformity in users' needs." Chamberlain feels that "to fill such needs right now, the instrument house would almost have to take a job-shop approach, generating a new tester for each new customer."

"What's needed more than anything else to make this a potentially profitable market is standardization of test aims and procedures," Chamberlain says. "All this fussing about such items as Y or S parameters, variations in package styles, and whether to test on the wafer, after dicing, or in the package, just muddies the waters." Help is on the way, however. Sometime next month the Defense Department will issue standards on IC testing.

Aviation's growth sends 1968 prospects soaring

Up, up, up! That's what avionics makers are saying about 1968 prospects And with little wonder.

- Commercial and general aircraft sales are growing at a lusty rate.
- Avionics, which accounted for 20% of an aircraft's basic price in 1967, is expected to account for 25% this year.
- The Federal Aviation Administration, still reeling from Congressional criticism, is planning several major air-safety programs and seeking follow-ons for others.

What these add up to is a banner year for avionics. In flight-control and related instrumentation systems alone, commercial and military sales are expected to hit $400 million, up 10% from last year. And the outlook for general aviation may be even better. Operators of general aircraft are showing a mounting interest in avionics systems.

Not only are more and more corporate aircraft being fitted out with doppler and inertial navigation systems as well as better flight-control gear, but the trend in general aviation is to trade up. According to the Aviation Dealers and Manufacturers Association, there is a marked increase in pilots buying sophisticated equipment they weren't even aware of several years ago.

The growth of both commercial and general aviation will have a tremendous impact on the FAA, not only in 1968 but in the years to come. Presently, the domestic-airlines fleet numbers 2,000 craft, mostly jets. But by 1977, this number is expected to swell to 3,500, mostly in the jumbo and supersonic jet categories. And the general-aviation fleet, now numbering 104,000, is expected to grow to 180,000—about 8,000 of which will be business jets.

As the traffic in the skies increases, so will the problem of directing it.

At the moment, FAA controllers handle 42 million takeoffs and landings a year. But, based on the agency's own data, this load will grow in 10 years to 140 million. Beset with an already overburdened control system, the FAA is finally making a serious effort to automate traffic-control procedures at the nation's major airports.

Top-priority purchases this year include terminal radar control (Tracon) equipment and a low-cost

Only make-believe. Terminal radar control equipment, simulated at the FAA's Atlantic City, N.J., facility, will be a big item during 1968. The system will give air controllers automated alphanumeric identification.

FAA-developed instrument-landing system, says John Weber, the agency's manager of research and development services.

Better late

Tracon, tested at Atlanta, Ga., for more than two years as part of the FAA's Advanced Radar Traffic System, will bring to terminal control the same kind of automated alphanumeric identification used in the National Airspace System now being installed at 20 en route traffic-control centers. About $100 million in airspace system contracts were awarded last year for computers, radar displays, and video digitizers.

Initially, says Weber, Tracon will be installed at medium- and high-density terminals—there are 83 such airports in the U.S.

Designated Tracon C, the equipment is hooked up to existing terminal radars to display an aircraft's identification number, range, altitude, and speed. Typically, a package includes a video digitizer to accept data from an aircraft beacon and convert it into alphanumerics that are written on the bright radar displays at the terminal. A computer processor will store flight-plan information and calculate aircraft speed. Hardware to modify radar displays is available if necessary. Installation costs run upwards of $500,000, depending on whether the package includes new radar displays.

During 1968, all domestic commercial aircraft will be equipped with beacon transponders to communicate with the en route and terminal systems. And although these transponders aren't required for general aircraft, there are indications that a growing number of these pilots may want to work with the system. This suggests a market for both low-cost transponders and hardware that adds altitude-reporting capabilities to existing units.

In addition to Tracon, the FAA will be installing its bargain-priced Mark I instrument-landing system at as many as 80 airports, Weber says. This solid state equipment, incorporating a simple localizer antenna, was developed by the agency last year and designed to cost $50,000 installed—about one-third the price of comparable systems.

Emphasis on traffic-control gear is only one part of the bright picture for avionics; another is the newer commercial aircraft, with their greater reliance on avionics.

The first deliveries of the Boeing Co.'s twin-jet 737's will be made this year, and there will be stepped-up shipments of the McDonnell Douglas Corp.'s stretched-out DC-8's and DC-9's. Boeing will roll out its 500-passenger 747, and American and European development will continue on supersonic transports as well as on medium-range airbus craft. Falling into the latter category are the Lockheed Aircraft Corp.'s L-1011 and the McDonnell Douglas' DC-10. Boeing and a continental consortium are also readying designs.

Still another bright spot is nonmilitary inertial navigation—despite the setback last summer when Pan American World Airways cancelled a $25-million contract with the Sperry Gyroscope Co., a division of the Sperry Rand Corp., calling for installation of commercial systems in its fleet.

Pan Am turned instead to dual-doppler systems supplied by the Bendix Corp. Nonetheless, installations of inertial guidance equipment should start to mushroom in 1968. Some 200 systems will be ordered by the airlines this year, says Lewis Lawton, manager of commercial systems requirements at the General Motors Corp.'s AC Electronics division.

Looking ahead, Lawton predicts some 800 inertial systems will be ordered by 1969 and 2,500 systems by the end of 1971. And with the emergence of the supersonic transports, this number can be swelled by as much as 2,000.

American Airlines, which last year successfully tested Litton Industries Inc.'s LTN-51 systems on 707 airfreighters, will install dual production versions on at least four, and possibly six, cargo planes flying military runs in the Pacific.

Other international carriers, including British Overseas Airways, will continue looking into different inertial systems before deciding which will be used in the Boeing 747's now on order. Several carriers are also weighing the possibilities of retrofitting such systems into planes already in service. Thus far, Litton with its LTN-51 and AC Electronics with its Carousel 4 appear to have the edge, at least as far as American firms are concerned. Sperry Gyroscope, whose SGN-10 flunked at Pan Am, may decide to drop out of the field.

Ounce of prevention

Maintaining and troubleshooting increasingly complex avionics gear continues to be a major problem for the airlines. American, for example, is installing a $250,000 electronic testing unit, bought from Britain's Hawker Siddeley Dynamics Ltd., which will automatically test autopilot systems; the unit simultaneously produces data for computerized performance analyses.

American is also installing a dual-purpose recorder-computer system that will monitor both engine and flight-crew performance. The computer provides a diagnostic readout, which will enable the ground crews to spot potentially serious faults before they can ground a flight or, worse yet, lead to a fatal tragedy. A management section will study crews' flight procedures and use the findings to supplement the airline's training program.

Twenty of the systems have been ordered from the Garrett Corp.'s AiResearch division at a cost of $2 million. If these units live up to expectations, American will equip its entire fleet. The total cost: $17 million. Hopefully, the carrier can save $10 million a year by improving maintenance control and reducing flight cancellations.

As a step toward better maintenance, says John Woodward, marketing manager of aviation equipment at the Radio Corp. of America in Los Angeles, more built-in self-testing circuitry will be added to avionics gear. This self-test capacity will tell the pilot, before he takes off, whether his equipment is

in working order and inform ground-based maintenance men which portion of a piece of gear has malfunctioned.

The company has incorporated self-testing features in its new AVQ/30 weather radar. This unit displays its own monitored performance information on the cathode-ray tube. Designed for airborne applications, the radar's self-testing is conducted before the user aircraft takes off. RCA is still weighing the possibility of modifying some of its other equipment to do the same thing. Last fall, American Airlines, for example, began testing a fault-isolation retrofit for RCA's AVQ/10 weather radar. Eventually, self-testing could be extended to incorporate a central memory unit capable of diagnosing troubles in all electronic equipment aboard aircraft, says an industry source.

Also possible is transmitting monitored performance information via a digital data link to ground stations while the plane is airborne. Such a link was successfully tested last year by Pan Am. Very-high-frequency signals were relayed from the first Applications Technology Satellite.

Also giving rise to avionics' optimistic outlook is the further development of digital processing techniques. With this will come increased use of silicon integrated circuits and hybrid devices. Several companies, including RCA, the International Telephone & Telegraph Corp., and the Collins Radio Co., are developing digital distance-measuring equipment (DME) for commercial airlines. Last year, for example, the Airborne Instruments Laboratory, a division of Cutler-Hammer Inc., delivered to the FAA a vhf omnirange (VOR) receiver with an all-digital navigation section built of silicon IC's. And RCA will be counting heavily on silicon IC's in an integrated navigation-communications package it plans to introduce later this year.

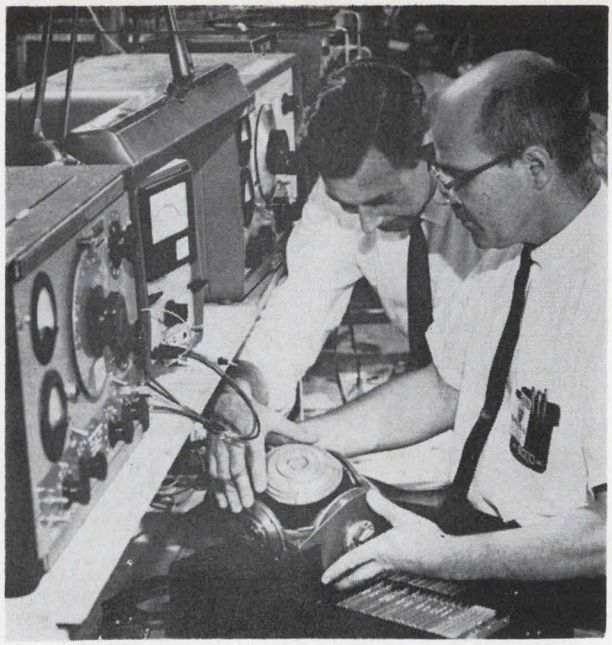
In addition to reducing the size—and possibly the price—of the equipment, such new designs would make it possible to acquire a DME station in a fraction of a second instead of the 20 seconds it now takes, says Siegbert B. Poritzky, head of the navigation wing of the Air Transport Association of America (ATA). And, he points out, the accuracy of a DME system could even be improved to ±250 feet—a far cry from the present level of ±half-mile.

Experiments will also continue with VOR/DME area-navigation techniques. Last October, the FAA designated the first routes—in the Northeast corridor—for area navigation. Both Eastern Airlines and American Airlines are using this navigation technique along these routes.

Safety in the skies

Not only will IC's find greater use in digital navigation systems, but they are also being relied heavily upon for collision-avoidance systems. This year should see giant strides in development work.

Last year, the ATA prepared a technical description of a time-frequency control system favored by the airlines. Several companies, among them Collins Radio, Bendix, and TRG Inc., a subsidiary of the Control Data Corp., will be building systems to these requirements. The ATA program calls for the first flight testing of manufacturer's collision-avoidance gear early next year.



Logical contender. AC Electronics with its Carousel 4, shown above, and Litton with its LTN-51 appear to be the only American firms able to supply commercial inertial-navigation systems to the world's airlines.

The system envisioned by the airline group will have aircraft—up to a theoretical limit of 1,000—transmit range, range rate, and altitude information to one another. Each aircraft will transmit signals in one of 2,000 reserved time slots. Timing for the over-all system will be controlled by ground stations. When a collision appears imminent, the system will send the appropriate evasion maneuver commands to the pilots.

Although the airborne equipment for commercial aircraft is likely to be expensive—possibly running as high as $75,000—the ATA hopes devices will be developed for general aviation that will be both simpler and less costly. Such equipment would allow private pilots to "listen in" and be warned when commercial craft are in their vicinity.

Still another area that will continue to get its share of attention is clear-air turbulence detection systems. The North American Rockwell Corp.'s Autonetics division, for example, is testing an infrared sensor aboard a Pan Am Boeing 707-321B on regular passenger runs. The system will have logged 140 hours of flight time by the time the project is completed next month. Prior to the Pan Am checkout, Autonetics' system was installed on an Air Force cargo plane, detecting CAT fronts at distances up to 30 miles.

Boeing has been experimenting with long-wave (220 megahertz) and L-band (1.3 gigahertz) radar systems to detect turbulence. Thus far, the apparatus has been tested on the ground. However, light planes have been sent up to confirm the existence of detected CAT. This month, one of the systems will be flight tested in a company-owned 727.

Too hot not to cool down?

Computer makers' enthusiasm for their domestic prospects is tempered only by nagging doubts about their ability to serve all possible markets. For example, the difficulties involved in hiring and training programers and system support personnel largely account for the failure of some producers to help their customers in the proper use of electronic data processing equipment. Moreover, spiraling labor costs, offset only partially by improvements in production techniques, are continually exerting upward pressure on system prices.

Against the backdrop of the big numbers involved, however, such problems seem small indeed. Current-year sales of computers and related apparatus are pegged at $3.74 billion, a whopping 20% improvement over the $3.12 billion rung up in 1967.

During the past five years, the field has enjoyed an average annual growth rate of about 20%. Over the longer run, this heady pace may slacken a bit. "We are projecting annual gains of 15% beyond 1968," says Curtis W. Fritze, director of corporate planning at the Control Data Corp.

Lebensraum

Despite reservations in some quarters, production and marketing curves are still pointing firmly upward. And plant expansion is the order of the day throughout the industry.

The Burroughs Corp., which hopes to break even on its EDP operations this year and turn a profit next year for the first time, plans 11 new installations around the world during the next five years. And the General Electric Co. has just increased the size of its Oklahoma City plant by 35%. Expansion programs are also under way or have been recently completed at Electronic Associates Inc., the National Cash Register Co., Scientific Data Systems Inc., the Univac division of the Sperry Rand Corp., and the Ampex Corp.

For more than a decade, big, fast, and costly processors have thoroughly dominated the computer scene. But the picture is changing: bargain-priced, bantamweight machines will take much of the play away from supersystems this year.

In the vanguard of this upheaval are two outfits not normally considered dominant figures in the EDP fields—the Digital Equipment Corp. with an integrated circuit takeoff on its PDP-8 series and the Hewlett-Packard Co. with its model 2115A, an economy version of the 2116A, introduced early last fall.

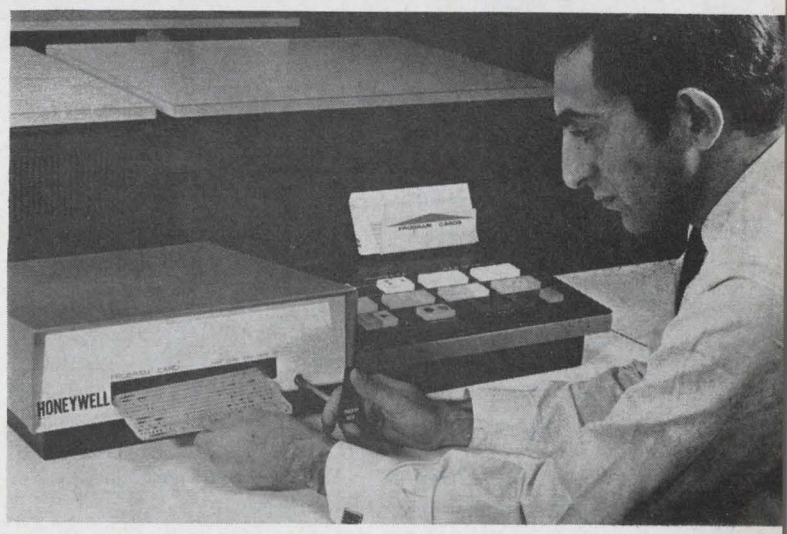
Probably the main reason for small computers' having caught the fancies of users and manufacturers alike is the extreme difficulty experienced in programing the large, third-generation machines. Moreover, both groups are waking up to the fact that there is a real place for small computers that can perform specific tasks efficiently for a reasonable cost. Finally, IC's have helped bring the price of general-purpose machines below $20,000.

"We see continued growth in the market for small computers for quite a few more years," says Kenneth H. Olson, president of DEC. "There are still many applications to be developed." Analysts put 1967 volume at more than $200 million and say the annual rate of gain outstrips that of the computer field as a whole.

Univac and GE also do well with small machines, selling the majority as terminals that are linked to larger processors in time-sharing systems. National Cash Register reports that it is always pleased to get an order for a small unit since, frequently, customers graduate to larger equipment.

The Radio Corp. of America eschews both the mighty mites and supersystems, preferring to concentrate its efforts on medium-size machines. "We should continue to do well in this area," says William R. Lonergan, divisional vice president for product planning. "Most of our sales are in communications applications where the computer is connected to, say, another computer over a telephone line."

The industry's colossus, the International Business Machines Corp., which controls upwards of two-thirds of the market, will continue to dominate outlets buying small- and medium-sized machines. Most of the company's customers are in the old-friends category, having started out on punched-card gear, graduated to the 1401 during the early 1960's, and switched to model 20's and 30's of the



Traffic cop. Integrated read-only memory in Honeywell H-4200 primarily controls internal hardware operations.

System 360 in recent years. Loyalty like this, reinforced by IBM's highly qualified corps of support personnel, is hard to beat. Ironically, however, IBM has been less than successful in cracking the high end of the line where large machines hold sway. As a matter of fact, the 360/90 series was withdrawn from the marketplace last spring with the lame excuse that such was IBM's intention all along.

Control Data, which bills itself as the manufacturer of the world's largest computer (the CDC 6600), expects to continue thriving in the big machine sector. Univac and Scientific Data Systems should continue to do well at the two extremes of the market.

Diminishing returns

Until recently, the dominant trend in computer design was to reduce the cost per calculation by increasing the size and speed of the machine. Where it cost $1 to process 35,000 program instructions in 1950, according to IBM data, 35 million can now be handled for the same price.

Big hit. Small units like the PDP-8/I built by the Digital Equipment Corp. will find a ready market during 1968.

Theoretically, this enables processors to work on several problems at the same time. But the larger the machine, the more important is precision scheduling of peripheral gear like tape transports, printers, punched-card input and output devices, and data transmission apparatus. Exactness must be automatic—a situation requiring complex operating system programs that have proved difficult, or impossible, to write. Worse yet, the programs for operating systems have grown so large, they choke computer memories, reducing a machine's capacity to perform useful tasks.

Since a computer system's performance is as dependent upon software as hardware, and manufacturers show few signs of being able to solve their programing problems any time soon, it's possible that cost per calculation could begin to rise. If this should occur, the likelihood of separate pricing for software and hardware increases.

With programing now accounting for upwards of half the purchase price of a system, there is at least some appeal in this practice for all parties. Manufacturers would be able to get a truer picture of costs; customers could shop for the best deal on their particular application; and software houses could compete head-on with hardware outfits. Already, CDC and SDS have sent up trial balloons on separate pricing; others are likely this year.

Read-only memories, used increasingly as sequence controllers in computers and other digital systems, may offer a way out of the wilderness. Their content has been dubbed "firmware," something of a cross between hardware and software; such units appear to have the potential to ease the burdens of designers on both sides of the fence. Honeywell, for one, has incorporated a read-only memory with integrated and hybrid circuits in its H-4200 computer, the second largest in its line.

Practically all large computers can now operate in the time-sharing (simultaneous access by several users from remote terminals) or multiprograming (simultaneous maintenance of several programs in a single processor's memory) modes. Both, however, are still in search of viable futures. Time-sharing, in particular, has exacerbated software problems by introducing complex coding and programing requirements to assure each user's privacy.

Nonetheless, all of the giants, including IBM, Control Data, RCA, Univac, GE, and Honeywell are committing themselves heavily. Among other installations, Honeywell has set up a system with 600 on-line terminals for the New York State Racing Association; and IBM is seeking to extend its RAX (for remote access computer system), which was checked out last year at the Lockheed Aircraft Corp.'s Marietta, Ga., plant, to university campuses as well as industrial applications.

But progress, it would seem, produces as many problems as paucity. "The advent of multiprograming, time-sharing, and remote inquiry systems has taken away the cushion of excess central process capacity that characterized the industry until a year or so ago," says a Honeywell source. "We need faster central processors again."

Quo vadis?

But computers are approaching limits imposed by such universal constants as the speed of light. And since an enormous effort is now required to achieve even an incremental improvement in performance, there is no clear consensus on just how advances are to be achieved:

- "We expect cheaper, faster, and smaller electronic circuitry as well as better direct-access devices over the next several years," says RCA's Lonergan.

- "Performance levels will be enhanced by more parallel processing. As we get complete arithmetic units on a large-scale-integration chip, we will be limited only by our ability to write software languages that can generate a large degree of parallelism," says a Burroughs spokesman.
- Processor performance levels will improve greatly as a result of significantly higher memory speeds and from parallel organization in larger systems where additional speed is essential," says Donald E. Eckdahl, vice president of NCR's Electronics division.
- "The real breakthrough in computer systems' capabilities still hinges upon vastly increased speeds in input/output peripheral equipment," says a GE spokesman.
- "Improvements in software will be the principal means of improving performance," says Control Data's Fritze.

Around the circuits

Monolithic integrated circuits are finally making a big move in computer applications. During the months ahead, Burroughs, Electronic Associates, RCA, and the Digital Equipment Corp., among others, all expect to make greater use of them.

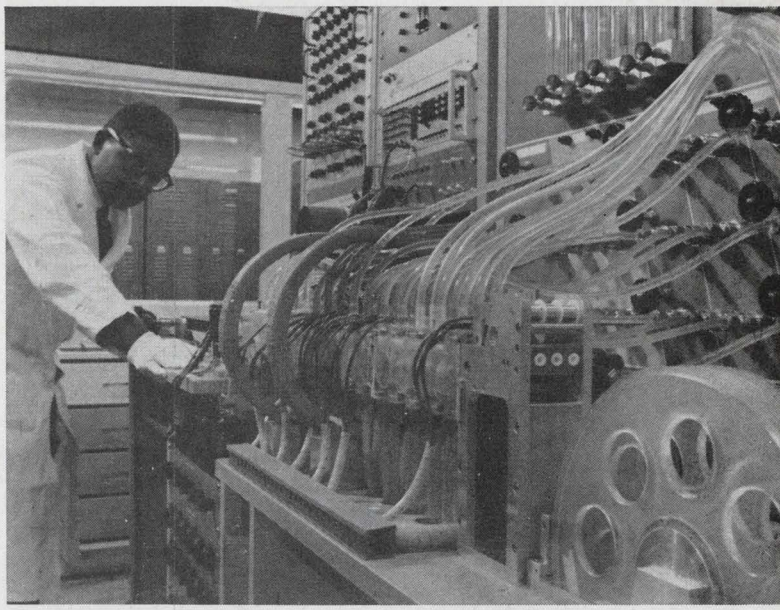
Discrete and hybrid assemblies are, however, by no means dead. In its System 360 series, IBM is heavily committed to hybrids. And Control Data is, for the moment at least, sticking to discrete components for its supercomputers on the grounds that monolithic IC's have only recently achieved the speed levels necessary for large processors.

Large-scale integration, though it continues to arouse great interest, is still a will-o'-the-wisp for most computer manufacturers. "The change from IC's to LSI will be gradual and evolutionary, as was the transition from transistors," says a Honeywell spokesman. "The basic justification for quantity application of one over the other is cost. Speed becomes secondary."

However, at Burroughs, a spokesman says, "Large-scale integration using metal oxide semiconductor techniques will really hit in 1968 as vendors swing into production and systems houses get going with new designs that incorporate this low-cost, relatively slow circuitry." Although this opinion is not shared by others in the computer and semiconductor fields, Burroughs is expected to use large-scale arrays in Illiac 4.

Ferrite cores have dominated the computer memory field for many years and are likely to continue to do so for some time to come. Engineers at Ampex, a leader in the industry, anticipate development of core assemblies with cycle times as short as 250 nanoseconds. They are also looking for a renaissance of three-dimensional, three-wire memories where high speed is not a requirement. The most recent development in core memories—and one that may catch on in higher-speed applications—is the 2.5-dimension organization.

"Cores are entrenched," says Lester Spandorfer, director of technical planning at Univac. "They won't be displaced overnight. But the plated-wire memory used in our 9000 series computers will give cores a horse race at higher speeds."



Speed merchant. Univac technician oversees making of plated wire for memory systems. Ferrite cores still dominate the computer field, but plated wire is gaining ground in applications where high speed is essential.

Spandorfer's position is somewhat at odds with that of Ampex, which feels that plated wires will be useful only for military and special-purpose applications in the foreseeable future. But RCA has tacitly recognized plated wire's gathering strength by recruiting an expert from a rival. Ferroxcube Corp., another stalwart of core memories, took the same step and will introduce a plated-wire assembly later this year.

Thin films are also getting a good look. Burroughs uses such memories in its larger machines as does NCR, which is pressing development of thin-film rod memories. Integrated circuits will be commonly employed as memory drivers this year. Eventually, such devices will be used as storage cells in large-scale arrays—as they are now in scratchpad assemblies—but most observers agree this development is five or so years away.

"By the mid-1970's, terminal units will account for half or more of the total dollar volume of EDP equipment being produced," says Ray W. Macdonald, president of Burroughs. His industry fellows say amen; Univac, in particular, feels this trend goes far toward explaining the marketing success of smaller machines.

Optical character readers, which can eliminate the document-to-punched-card and card-to-tape steps long necessary to prepare data for computer use, will get more attention this year. As pattern-recognition techniques improve, such readers will win wider acceptance. Even now, there are machines that can read typewritten copy; others can even handle a limited number of handwritten characters drawn in standard positions on special forms.

Signal gains in store for 1968

Communications firms are looking for about an 11% improvement in 1968, from $1.29 billion to $1.44 billion. Telemetry, land-mobile, and microwave relay equipment will all register healthy gains.

Telemetry sales will spurt from last year's estimated $185.1 million to $211.9 million, reflecting large contracts from the National Aeronautics and Space Administration for its Apollo and unmanned satellite programs. In addition, the armed forces are in the midst of converting their air-to-ground communications from vhf to L band and S band.

Land, sea, and air

Despite the shortage of frequencies in metropolitan areas, an increasing number of applications are being found for mobile radios, both vehicle-mounted and portable, in the civilian sector. Police departments, transit authorities, and fire departments are among the agencies buying equipment in quantity with an eye to assuring the public's safety, convenience, and comfort.

Motorola Inc., which has filled recent orders in St. Louis, Dallas, Detroit, and other areas, and the Radio Corp. of America, which has scored in California, New York City, and Chicago, are probably the leaders in urban outlets. They must, however, be constantly on their mettle. For example, Sylvania Electric Products Inc., a subsidiary of the General Telephone & Electronics Corp., is preparing to introduce this year an automatic bus identification-and-emergency beacon system that provides instant alarm protection while affording more efficient routing of vehicles in a fleet.

Where there's smoke. Mobile communications center, built by RCA for the Chicago Fire Department, has two tv cameras; one remote-controlled unit is atop cab while the second with 1,000 feet of cable can be hauled up ladders for close-up views of fires and other disasters. Rig is also equipped with 10 radios for two-way communication with other state and local agencies as well as video tape recorders.

Edward J. Hart, manager of RCA's communications department, attributes the company's success in two-way radios—it claims an annual growth rate almost double that of the industry—to the reliability of its solid state units. Besides, the prestige attendant to cracking the vast New York City market has proved helpful.

On a higher plane, W. J. McKnight, assistant vice president in the Collins Radio Co.'s New York City office, sees a great future for computer-controlled aircraft communications systems. Collins has built a mock-up that permits push-button channel tuning in the cockpit. Although there are as yet no takers, the company has high hopes for its unit.

"Functional integration of aircraft communications and navigation subsystems is going to have a revolutionary impact on design," says Paul Hansel, vice president of engineering at Electronic Communications Inc. "And once you combine systems in a single black box, your reliability requirements go way up. In the past, we put equipment on trial and either convicted or acquitted it. Now we deliberately set out to get reliability."

Hansel expects that functional integration will increase the incidence of digital transmission. "Here integrated circuitry holds great promise," he says. "Such devices afford greater reliability and allow designers to be bolder in exploring more complex systems." Pressures to conserve spectrum and packaging exigencies are adding impetus to the trend to sophisticated digital systems. As a result, ECI is exploring such exotic techniques as chirp modulation, frequency hopping, and wave compression in its research and development programs.

"Satellite communications is experiencing considerable growth as a result of simultaneous implementation of both military and commercial networks around the world," says Robert G. Lynch, vice president of military marketing at Sylvania Electronic Systems, also a GT&E subsidiary. Sylvania has the best of both possible worlds, supplying ground-station gear and mechanically despun antennas for satellites.

Frank P. Barnes, senior vice president for telecommunications at the International Telephone & Telegraph Corp., which has a more than casual interest in the matter, says: "Urgent requirements for more and better international channels are typified by the current discussions on implementing the proposed new transatlantic cable, TAT-5." Whatever the eventual resolution of this interesting contretemps between cable and satellite interests on both sides of the Atlantic, Barnes looks for increasing use of IC's in commercial communications equipment. He cites transmission networks as

well as computer-controlled and pulse-code-modulation switching among prospective applications.

Television signals

Sales of television broadcasting gear will level off this year, going from $135.7 million to $134 million. Andrew F. Inglis, a division vice president with RCA's broadcast and communications products division, says the first color buying wave—largely from big city stations—is over; the next will come from stations expanding their color facilities and new outfits in smaller communities. "The market's going to depend in part on the prosperity of the stations and they've suffered a drop in income of late," reports an industry source.

The attrition in color equipment sales is offset, at least partially, by the uhf market which, according to Inglis, looks even better than it did in 1967, a very good year. More stations set up shop last year than at any time since the 1952-54 period, and, with an assist from the Federal Communications Commission, the trend should persist in 1968. Educational outlets will provide an important plus for many firms interested in selling uhf broadcasting equipment. For example, RCA has a sizable contract with Kentucky to set up 12 ETV stations.

Another positive factor in the uhf equipment business is the switch by metropolitan broadcasters to higher-power apparatus to get greater geographical coverage. Available this year will be an omnidirectional package with a 110-kilowatt transmitter as well as an antenna with a gain of 55. This set-up will permit uhf stations to broadcast at 5 megawatts in all directions.

In the video-tape-recorder field, the trend is still to so-called high-band equipment, which records a signal modulated on a carrier about 4 megahertz from the color signal's subcarrier. The Ampex Corp., the leader in the field, is being challenged by RCA, which introduced an economy-priced recorder late last year. The unit, designated the TR 50, sells for $54,500—as against about $80,000 for comparable equipment—and is aimed at the small-station market.

Cable antenna television will enjoy comfortable gains during the year. But Walton Clark, a marketing executive with the Jerrold Corp., an operator and equipment maker, is not looking for spectacular sales growth in hardware. "Short of some crippling legislation, business will prosper regardless of what turn Government regulation takes," he says. Jerrold has introduced a 20-channel cable system that can be installed underground as well as above-ground. This will eventually supplant the 12-channel cable that is now the industry's standard.

Among the factors contributing to cable tv's brushfire growth around the U.S. are the greater market penetration of color sets, particularly in ghost-haunted urban areas, and the greater number of channels in operation. Negative influences include a much-waived freeze on operators' entering the 100 top markets, a copyright squabble, and vigorous opposition from broadcasters' trade groups. However, on the theory that "if you can't lick 'em, join 'em," all three networks and an impressive number of top independents have jumped into cable tv.

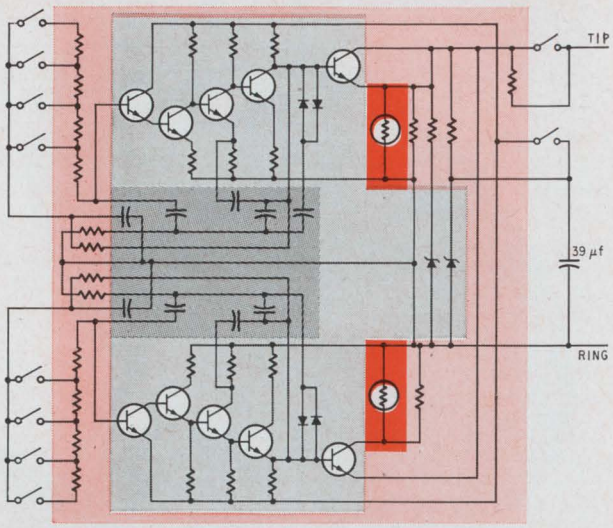
Two in one. Dual-polarized, 10-foot parabolic antenna, built by the Technical Appliance Corp., eliminates the need for second unit in 6 and 11 Ghz microwave service.

Jerrold, along with many of its industry fellows, is looking toward the day when it can offer cable services other than tv. Coax can easily be used to transmit f-m, data, and telephone signals as well as tv into the home, Clark points out. To the end of achieving ultrareliability, Jerrold is introducing solid state devices into its CATV and microwave systems as rapidly as posible.

Independent phone companies—and the Bell System too, for that matter—are waking up to the fact that cable tv's future has great potential in a consumer-oriented society. For example, Claude E. Munsell, director of engineering at General Telephone, says: "The phone companies have the know-how and set-up to handle CATV signals from the head end to their destination, amplifying and making adjustments as necessary along the way so subscribers can get the service they expect." The company, which has several manufacturing units capable of producing cable tv equipment, has filed a wide-spectrum tariff proposal with the FCC with an eye to getting into the field on a substantial basis.

Ties that bind

Earlier this year, the American Telephone & Telegraph Co. filed for rate increases on its Telpak lines, bulk communications media which provide voice-grade channels at economical charges. Favorable action by the FCC might result in consideration



Bell ringer. Tone generator in Bell System's new handset has 26 elements on a silicon chip 1/16-inch square.

of privately owned microwave systems by some large users. For such a move to make financial sense, of course, the traffic load would have to be comparatively large.

Utilities and railroads have long been proprietors of their own microwave networks. And Kerry R. Fox, assistant vice president for marketing at Collins Radio, expects that the latter will continue to be a lucrative outlet for some time to come. Fox notes that the Burlington and Northern Pacific, among others, are putting in new major systems.

"Pipeline companies were also among the first to use microwave," says Fox. "But their systems are now, in some cases, 10 or more years old. They are beginning to think about replacing and upgrading their equipment."

Q. W. Weist, general manager for engineering at the Western Electric Co., the manufacturing and supplier arm of the Bell System, also looks for a good year in microwave sales. During 1968, improved versions of the phone company's TD-2 system will be shipped.

Overall, sales of microwave relay gear are expected to climb 43% to $84.7 million this year.

A number of companies, including Jerrold, are preparing to introduce new equipment to cash in on this incipient demand. The company has developed a new cassegrain antenna for use in commercial systems. Built by Jerrold's subsidiary, the Technical Appliance Corp., the 10-foot parabolic unit provides dual polarization in both the 6 Ghz and 11 Ghz bands, eliminating the need for two separate antennas.

Busy signals

Communications networks linking remote terminals to a central processor will continue to proliferate during the year, making for lush markets in interface equipment like high-speed teletypewriters, graphic displays, and cathode-ray viewers.

The emergence of computer utilities should boost sales of digital modulator-demodulator units. The General Electric Co., for example, will push new digital modems that are compatible with Bell System equipment. Principal marketing targets, according to a spokesman, are industrial firms with private communications networks, Government agencies, independent phone companies, and original-equipment manufacturers.

The GE unit is claimed to be the first acoustically coupled data set providing a full-duplex circuit for the transmission of asynchronous binary data at speeds of up to 300 bits per second over switched or private telephone lines.

General Telephone will also introduce some wideband data modems this year, including one with a range of one to 10 megabits for microwave applications. "The state of the art's with us to go to higher bit rates," says John O. Norback, a GT&E transmission engineer. "But right now we're not so sure about the economics involved."

A new data modem will also be unveiled at AT&T. The set, which operates on vestigial sideband modulation principles, is designed for both switched telephone network and private line applications. Forward-acting, error-control circuitry which reduces the bit rate can be included at the customer's option. The apparatus can be operated at several rates: over private lines at 2,400, 4,800, or 7,000 bits per second. Over the switched network, the rates are 1,800 and 3,600. Robert L. Hess, AT&T's sales project manager, feels that the new modem's sales potential is good.

The Bell System's new teletypewriter will also make its debut this year. The unit prints 150 words a second in upper and lower case and in black and red. Ray Hochstuhl, data communications planning manager at AT&T, sees a particularly good market for this equipment in educational applications involving time-shared computers.

The new 12-button Touch-Tone handsets are being introduced; such anticipated services as Picturephone or abbreviated dialing could use either or both extra buttons.

During 1968, Western Electric expects to ship 44 electronic switching systems of various sizes and capacities to Bell System companies, according to Emil C. Deutschle, manager of customer planning. (This total excludes four-wire apparatus earmarked for the military.) "Electronic systems do not loom particularly large in switching at the moment," says Deutschle. "But use should grow rapidly."

On the device side of the business, Western Electric is working on beam-leaded, sealed-junction integrated circuits on a pilot basis, but Bell has no immediate plans to incorporate them in electronic switching systems because of the economics involved. During 1968, the only major application of IC's in Bell System apparatus will be in the tone circuit of the Trimline phone.

General Telephone is equally circumspect; it is replacing electromechanical components with solid state devices, using, for example, transistors in its newer dial-tone units. However, the company has no immediate plans to use IC's en masse.

Still tied to Pentagon purse strings

Though still looking for more commercial and industrial outlets for their varied wares, microwave companies are anticipating a good year. Aside from general agreement about integrated circuitry's bright prospects, however, there is no clear-cut consensus on how or where growth will come.

"Estimating dollars now is ridiculous," says Marvin Groll, microwave marketing manager at the semiconductor division of Sylvania Electric Products Inc., a subsidiary of the General Telephone & Electronics Corp. "There's a growth potential of 50% in discrete components over the next five years. Right now, the best market is obviously the military, but commercial and consumer business could account for 20% to 30% of the sales picture by 1972."

Frederic Byers, manager of plans and analysis at the Rantec division of the Emerson Electric Co., says that without a go-ahead on the "thin" Sentinel antiballistic missile system, microwave sales during 1968 would have made little headway over the previous year. But Rantec is now budgeting for a 20% to 30% increase. Over the longer term, Byers says, implementation of Sentinel should effectively stave off a decline in the field.

A marketing executive at Microwave Associates Inc. notes that Federal research and development funds will be in shorter supply during 1968 as a result of the Vietnam squeeze. But, he says, the Pentagon will be buying a lot of avionics for, among other aircraft, the F-111, the A7A, and C5A as well as several helicopters. Specifically, solid state components for doppler navigators, terrain-following radar, and reconnaissance gear loom large in the procurement picture. Microwave Associates also looks for a big replacement components market to shape up as the military retrofits tube equipment.

War and peace

There is little doubt that the microwave field is mortgaging some of its future by concentrating on Vietnam applications. To what extent this is true is the subject of some debate among the companies involved. "The industry is producing hardware for Vietnam at the expense of R&D," says Harold D. Tenney, a group vice president at Western Microwave Laboratories Inc. "These products are behind the state of the art and doing microwave no good." Tenney believes that if the war ended, the emphasis on tactical items would end; thus, research would take up much of the slack.

But Norm Hierstand, marketing manager for tubes and electron devices at Varian Associates, says a great deal of defense spending is unrelated to Vietnam. And R&D cuts, especially in long-range projects, tend to counteract boosts in hardware procurement by the Pentagon.

"What the microwave industry needs is commercial outlets to balance fluctuations in military sales," says Palmer Derby, vice president of the Raytheon Co.'s Microwave and Power Tube division. "Such outlets are only now materializing, and the microwave business is still unstable.

Hierstand says that, while the industry pays a lot of lip service to diversification, he sees few signs of real progress: "The real thing that would save us, if war spending were to halt, is that we're all a little smarter than we were in 1963."

Industrial microwave systems should enjoy a good year, according to Hierstand. Varian has a $500,000 order from one of the auto makers for industrial heating equipment. "It may sound like the same old song, but acceptance is growing rapidly for microwave heating and cooking in both commercial and consumer markets," says Burton Silver, manager of the electron tube division of Litton Industries Inc. "We're getting reliability on a par with that of television tubes."

The growth of ultrahigh-frequency television stations is just beginning, according to Hierstand. And these broadcasters could furnish a lucrative market for microwave equipment during 1968 as well as over the longer run.

All is not beer and skittles in the nonmilitary field, however. "The agony of commercial marketing lies in the fact that though purchasers want low prices, their specifications and performance standards are often just as high as the Pentagon's," says George Kariotis, president of Alpha Industries Inc.

Concern about end uses of microwave gear obscures some interesting technical developments in the field. Most of the money being spent on microwave now goes into subsystems and equipment. But industry sources agree that the $40 million to $60 million market for discrete semiconductor components and hybrid and monolithic integrated circuits could grow tenfold by the mid-1970's. Low cost and higher reliability are behind the push now developing. "Microwave IC's are still in the embryonic stage," says John Sie, president of Microstate Electronics, a Raytheon subsidiary. "But we're really pushing the tube people hard in power and efficiency."

As a result of the keener interest in integration, there will be a further blurring of the traditional roles played by systems manufacturers, such as Microwave Associates, and IC makers, such as Texas Instruments Incorporated. Eventually, there probably will be a direct confrontation. But for the moment, despite occasional skirmishes, an uneasy truce prevails.

The fiscal squeeze tightens

"Word has come down from the executive level—President Johnson, that is—that we're in for a two-year famine," says an official at the National Aeronautics and Space Administration. "Our internal thinking is predicated on this."

Slashes in the total space budget will be felt keenly in the electronics sector this year as well as next. The space agency has no major programs in the works beyond Apollo, which should get the U.S. to the moon by the 1970 target date. Interplanetary exploration projects have yet to be organized, much less funded.

Military spending for space will suffer along with other research and development work not directly related to the war in Southeast Asia. Only high-priority reconnaissance efforts will be spared.

The Apollo Applications Program, a $454.7-million appropriation, is probably NASA's major new effort. But Congress hacked $200 million from the original request. The ongoing Apollo project accounts for about $2.5 billion of the agency's total appropriation of just under $4.6 billion. Large outlays will also be made for about 20 launches in continuing programs like the Advanced Technology Satellite, Nimbus, Bios, the Orbiting Geophysical Observatory, Solar Observatory, and Astronomical Observatory.

Apollo Applications' objectives now center on a manned scientific workshop that will orbit the earth for month-long periods and a manned astronomical observatory that will put the astronomer and his telescopes in orbit above the earth's atmosphere. However, James Webb, NASA's administrator, warns: "Only after fiscal 1969 are funds likely to be made available for these missions."

Survival gear

The space agency's Office of Advanced Research and Technology will spend about $40 million this year in its Electronics and Control division. An official says about $7 million will go into avionics programs, including equipment for advanced versions of the supersonic transport, collision avoidance systems, proximity warning displays, and clear-air turbulence indicators.

Large-scale integration will be a major item in the research budget as will metal oxide silicon devices and field effect transistors. Much of this work will go on at a new IC facility at NASA's Electronics Research Center in Cambridge, Mass.

The space agency will check LSI and associative memory techniques in an Experimental Aerospace Multiprocessor, a test-bed computer to be developed at Cambridge.

In communications research, funded at about $7 million, projects include more work on solid state electronics as well as research on high-power transmitter tubes, ground-to-satellite laser communications, and the application of gas lasers for spacecraft stabilization. There is also $9 million available for work on guidance systems.

Webb believes Congress will revive the planetary exploration programs, now scheduled to end with two Mars-Mariner flights in 1969. NASA has allocated $143.4 million to the lunar and planetary category, which Webb hopes will permit his agency to seek more funds for exploration next year. And $12 million has been set aside, he says, so that NASA can hold onto its team of skilled scientists.

Military space

The Pentagon's $2-billion budget for space will probably decline this year. And the biggest, single project, the Air Force's Manned Orbiting Laboratory, is being pared. Officials say they have $500 million in the fiscal year beginning July 1 to keep MOL on schedule, but many concede privately that $400 million is probably a top figure unless the Vietnam war slackens. Even now, the program is starved for money: about $50 million in funds promised from reprograming efforts is being redirected into war-related R&D.

Military communications satellites will not fare much better, though the highly successful Interim Defense Communications Satellite project is serving the military in Vietnam and other areas of the war zone. No significant increase in the budgeted $83 million is anticipated.

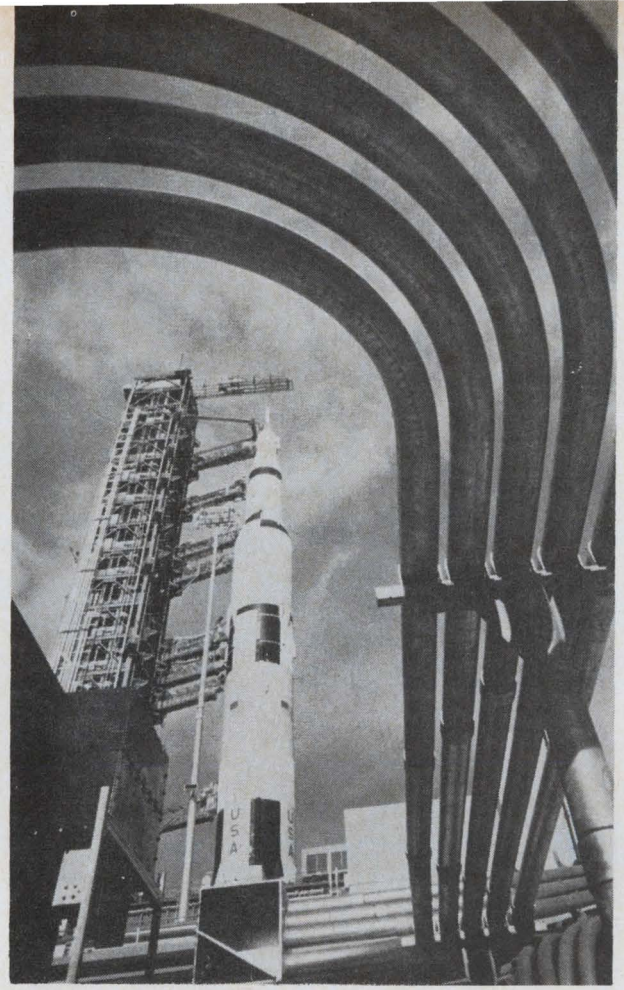
Plans for a new-generation satellite system will be slowed because the Defense Department refuses to release money for development work. A replenishment launching of the first-generation satellite is planned for the summer.

The Tactical Satellite Communications (TacSatCom) program will continue at a relatively slow pace. It will not move into operational hardware development unless the money squeeze eases.

The Vela nuclear-blast detection satellite program will continue with a move toward further coverage of the earth's surface and space.

The services' request for navigation satellite money may encounter serious opposition. Only the Transit, primarily used for precision navigation of missile-firing submarines, will sail through without difficulty. Even this program will not be moved into advanced stages. Users will have to be content with the system which requires complicated charts and manuals to arrive at doppler fixes.

But even if military and civilian spending for space slackens, many companies are thankful they have been working in both areas. "We're quite fortunate to have the military business we started get-



Outward bound. Little will be left to the U.S. space effort after completion of the Apollo Saturn 5 program. Manned earth-orbit missions are planned for this year.

ting into five or six years ago," says Hugh Bradshaw, marketing manager for the Radio Corp. of America's Aerospace Systems division. "We believe the space effort will come back but it will take awhile."

The company will deliver about 30 systems to the Grumman Aircraft Corp. in 1968 for the Apollo program's lunar module, including the rendezvous radar and attitude and descent control equipment. But the slack in the civilian space program foreseen by RCA has prompted it to look into automatic checkout equipment for the military, as well as classified avionics and electronic warfare systems.

The Electronic Systems division of TRW Inc. is also looking to the military for new business and has high hopes for the communication and navigation satellites being studied by the Air Force. The real market in this area, TRW feels, is in the many user ground installations, rather than the limited number of satellites.

And last autumn the Autonetics division of the North American Rockwell Corp. proposed a solid-state beam-scanning system for a synchronous communications satellite that could focus hundreds of independent data links anywhere over the globe.

An offshoot of military space projects with civilian applications—accurate location of land boundaries—is being examined at the Raytheon Co.'s Space and Information division. Taxing agencies could use such systems, which are based on stereo photography techniques, aboard airplanes to determine whether property improvements have been made. Raytheon is also investigating the possibility of determining pollution in bodies of water, using broad-band spectrum techniques.

Embarrassment of riches

While the space agency cannot get money for many of its projects, the Communications Satellite Corp. is in the position of having the wherewithal but not permission to get on with its work. With about $160 million in uncommitted funds, Comsat would like to spend them on a $57-million pilot domestic satellite program; a $40-million aeronautical satellite, and four Intelsat 4 communications satellites with 5,000 to 10,000 circuits.

The multipurpose domestic satellite—for commercial and educational television and communications—proposed by Comsat last August is still awaiting approval by the Federal Communications Commission. Before work starts the project must get an okay from the International Telecommunications Satellite consortium. The aeronautical spacecraft, which will provide vhf communication links between transoceanic airliners and ground stations, needs a go-ahead from the Federal Aviation Administration.

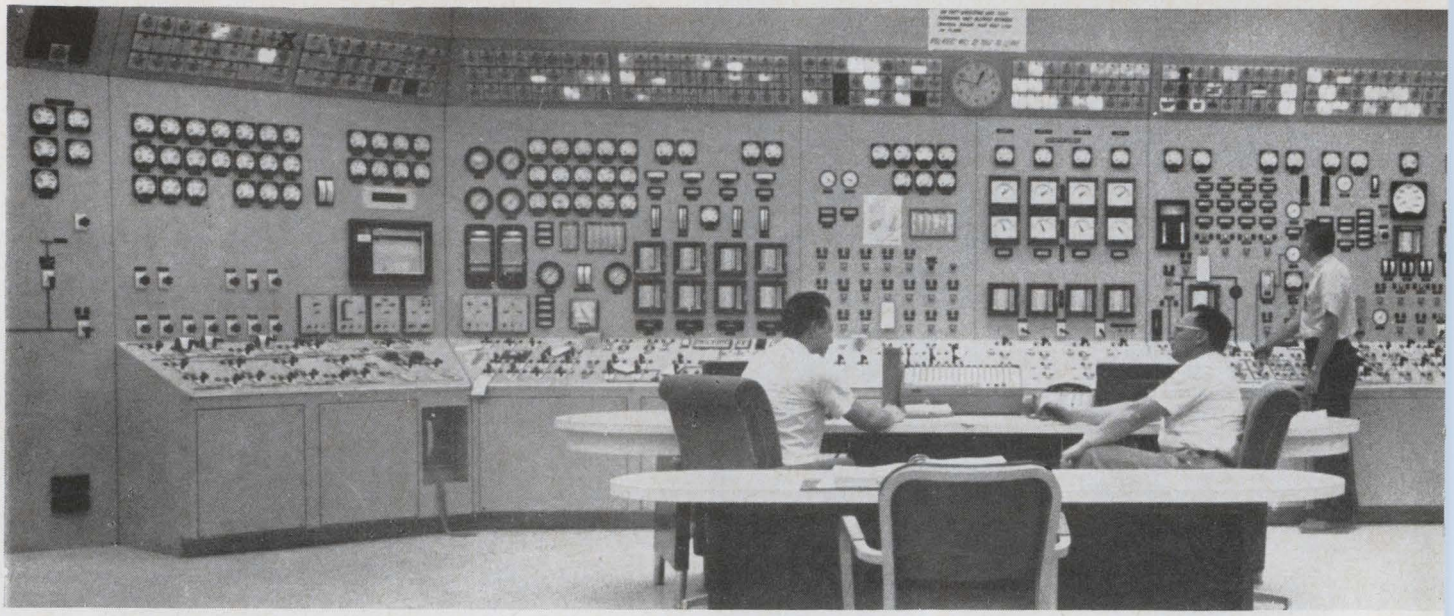
Comsat officials say permission for any or all of these projects this year would unleash funds during 1968, but the major outlays would be next year.

A big part of Comsat's spending during 1968 will be for the six Intelsat 3 satellites to be delivered by TRW at monthly intervals starting in the middle of the year. The completion of three new ground stations and the expansion of three others will account for more than $6 million in new equipment outlays. The Philco-Ford Corp. will produce the antenna subsystems for the stations at a cost of $7.6 million. Raytheon is delivering four ground communications equipment subsystems for $4.5 million, and the Nippon Electric Co. has a $2.1-million contract for channel multiplexing gear.

Comsat's new research laboratory will open this year in Germantown, Md. The major electronics expenditure for the laboratory will be for test equipment costing about $1 million. Comsat will spend $6 million on research and development during the year, most of it on outside contracts.

Among the electronics research projects on tap for 1968 are: travelling wave tubes with greater bandwith and high power; protective coatings to prevent radiation damage to solar cells; and nickel-cadmium batteries with greater power output.

Frequency techniques will also be examined, including an investigation of the use of frequencies up to 10 gigahertz rather than the 4 to 6 Ghz bands now employed. Research on low-noise receivers will center on expanding bandwidth to 300 megahertz or more. With the first Intelsat 3 probably going up in early fall, Comsat will expand the capacity of three existing ground stations for about $1 million per installation in electronics equipment.



Industrial electronics

New member of the billion-dollar club

This is the year industrial electronics sales should top the billion-dollar mark—by a comfortable margin of at least $50 million. This would represent a spurt of about 16% from the $905.1 million volume posted last year. And gains in such areas as water resources control and rapid transit systems, where growth is fueled by Federal funds, will far outpace the industry average.

No major technical innovations are in sight—not even uses for integrated circuits. Companies making process instrumentation continue to study integrated circuitry but little more than a few prototypes of IC equipment will be available by yearend.

While these firms sit on their status quo, their customers may take a more aggressive approach to IC's. Customized assemblies might help industrial concerns bypass computer control makers, thereby foregoing higher costs and long delays while retaining proprietary information.

Specifically, process-control engineers may develop conventional and advanced control laws and elect to implement them with digital IC's rather than with programs for a general-purpose control computer. As integrated-circuit prices decline, this approach, which at least one process company is seriously investigating, could become even more appealing.

Controlling factors

Because electronic analog controllers sell for about 25% more than their pneumatic counterparts, the best electronic equipment could do until recently was capture a quarter of the market. In 1968, however, electronics' share will be closer to half.

Lower installed cost than their pneumatic rivals, better control on some loops, easier maintenance, and compatibility with data loggers and digital computers are still the electronic gear's main selling points. Apparently, experience with electronic controllers has enhanced the attraction of these features.

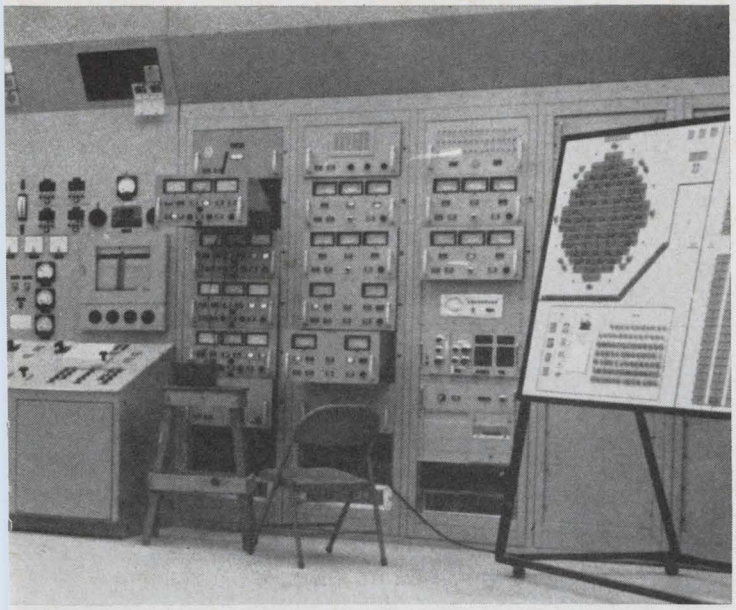
But equipment quality may have to improve if partisans of pneumatic control are to be won over. Industrial concerns that stress product quality and plant performance aren't going to put up with bad solder connections, for example.

Instrument manufacturers expect continuing pressure from users to produce more accurate sensors for digital computer control installations. But improving the accuracy of a differential-pressure sensor from 0.5% to 0.1% can boost costs by 400%.

Bruce H. Baldridge, manager of systems applications planning for the Foxboro Co., sees 1968 as the year of "make or break for direct digital control." Several systems of more than 100 loops will go into operation this year, and if results match expectations, new orders and reorders should follow.

The market for control apparatus will expand with the stepped-up activity in the process industries. Papermakers are building new facilities and investing a bigger percentage of capital outlays in instrumentation than in past years. And metalworking concerns are installing instrumentation and computers to raise production efficiency to meet foreign competition.

But from an electronics marketing viewpoint, the petroleum and chemical fields are bellwethers. The chemical industry, though it appears overbuilt, will remain a major buyer of instruments and controls over the next two years or so. On the other hand, refinery construction is undergoing a boom.



The price of process-control computers can account for up to half of the cost of industrial instrumentation systems. Baldridge estimates that the chemical industry last year had a total of 150 digital control computers in operation worldwide, and the petroleum industry about 75; he predicts that 40 more machines will be sold to chemical plants this year and 30 to refineries. The figures cover only computers "that influence operation of the process," and thus exclude data-acquisition units.

Control isn't the only reason behind prospects for a big market in small digital computers. After successful initial installations at the Monsanto Co. and Du Pont, chromatograph computer systems are expected to find a growing number of applications this year. Chromatographs, which analyze product composition, are used in many plants and research laboratories; computerized setups tying many of these units together reduce the time needed to get results and increase research yield.

Henry A. Hancock, senior applications engineer at Electronic Associates Inc., predicts that 40 such systems will be sold this year. An installation that can handle 40 analyzers sells for about $100,000 exclusive of chromatographs. Major suppliers are Electronic Associates, the International Business Machines Corp., and Realtime Systems Inc.

Checking up

Industrial supervisory control systems and related telemetry equipment are used to channel instant information from farflung plants and process operations to a central location. And public demands for improved air and water pollution control programs and for construction of rapid transit systems will boost the market for such equipment.

Sales of industrial supervisory control systems are expected to approach the $50 million mark in 1968. Leon C. Menkes, sales vice president at Quindar Electronics Inc., breaks the market down this way: electric power, $20 million; pipelines and petroleum, $14 million; waterworks, $8 million; gas distribution, $4 million; miscellaneous, including traffic control, $4 million.

Supervisory-control and telemetry sales to utilities for electric-power generation and distribution jobs have gone up 300% since 1965. And as a result of a growing interest in conservation, managers of waterworks seem to be shedding their reserve and looking to electronics technology to improve operating efficiency. The result last year was a 45% increase in sales of waterworks supervisory systems, a gain that should be duplicated in 1968.

Grow power

Over the next six or seven years, installed electric-power generation capacity will double from its present level. New rapid transit systems and increased electric heating of buildings will add to power sales.

Two major innovations in power generation methods—nuclear reactors and once-through boilers—are already causing an increase in the amount of electronic instrumentation at generating stations. Because the new equipment responds faster than conventional boilers, emphasis is being placed on safety as well as control. Digital computers play an important role here and 90% of the generating units now being installed employ such machines for data gathering, plant monitoring, and boiler-turbine control.

But the real sizzle in electricity generation is nuclear stations. According to the Atomic Energy Commission the capacity of nuclear electric stations has tripled in the past five years to 2,810 megawatts; it will rise to 10,000 Mw by 1970, the agency says, and to 150,000 by 1980. Fourteen atomic plants are on-stream and 46 are in the works. Most of the newer ones have rated capacities exceeding 1,000 Mw.

Electronic instrumentation and controls are commonplace in atomic installations, which generally don't require much auxiliary equipment such as pumps and fans, so the use of conventional instrumentation per megawatt is decreasing.

But in nuclear generating plants, the watchword is safety. "Every time a plant is built or planned," says a knowledgeable source, "someone at the AEC dreams up a new safeguard." Until operational experience has produced a body of safety data, more sensors, more monitors, and more computers will be installed, increasing electronics' controls more than 50%.

As a result of legislation, Government grants, and public concern, the U.S. has started to take positive action to assure an adequate supply of pure water. The key organization among the 35 or so agencies active in the field is the Federal Water Pollution Control Administration (FWPCA). It has the power to direct states to enact quality standards for interstate waterways within their boundaries, and is just starting to release funds.

The Minneapolis-St. Paul Sanitary District, for example, received a matching Federal grant and has awarded contracts totaling $1.75 million for a

Ounce of prevention. As a result of stepped-up research in the pollution field, more water-quality monitors like this nine-parameter Beckman unit are ready for market.

computer-based sewer control system. Using simulation techniques, an operator will determine the best settings for control gates, especially during rainstorms, to fully utilize the sewer system and minimize river pollution.

A big allotment is going for electronic equipment. For $387,105, the Badger Meter Manufacturing Co. will furnish and install a process control computer plus remote telemetering and supervisory control equipment for 38 locations. The Fairchild Camera & Instrument Corp. has a $64,702 order for five robot river quality monitoring stations.

F. L. Mascitti and A. H. Keyser, of Honeywell Inc.'s Industrial division, estimate that sales of instrumentation for water-resources applications, including waste treatment, could run as high as $50 million this year, with $1 million to $2 million of this going for water-quality monitors. They also expect the market to "double in the next several years." But Roy F. Brown, manager of Beckman Instruments Inc.'s Process Instruments division, anticipates a doubling of the market only by 1980. The Honeywell engineers explain the disparity in these forecasts by noting that the Vietnam squeeze may tighten money for such projects.

"Proven hardware is now readily available for water-resources and waste-treatment applications," says Brown. But further technical advances may await more certain prospects. According to Mascitti, "No company is going to invest large amounts of money to develop, for example, automatic sensors unless there is a profitable market."

On the right track

Where railroads go, prosperity follows. This 19th century truism has new meaning for electronics firms. State authorities, along with the Department of Transportation, now see alleviating the plight of the commuter as a major challenge in regional planning.

Already the green light has been given to rapid rail transit systems in San Francisco, Philadelphia, Atlanta, and on Long Island, and some construction is under way. Though vast sums will be spent in this field during the rest of this decade, the major push will come in the 1970's. But even now, rapid transit represents a big market for electronics.

An example here is the Delaware River Port Authority transit project, a two-track, 14-mile system running from Philadelphia southeast through Camden to Lindenwold, N. J. Scheduled for completion by late 1968, the job includes $11 million for electrification, $1.5 million for telecommunications, and $3 million for signals.

About 20% of the telecommunications funds will go for carrier current radio, 15% for telephone equipment, 20% for public address systems on trains and in stations, 25% for supervisory controls for the electrification and signaling subsystems, and 20% for cables. The $3 million expenditure for signals will cover train detection, control, and indication gear.

The Metropolitan Commuter Transportation Authority, a New York State agency that now operates the Long Island Rail Road, has undertaken a major study aimed at an upgrading that transit system. The agency is expected to spend about $10 million a year for electronic equipment over the next decade as part of the projected modernization. Of this, about 80% will go for signaling equipment, the balance for telecommunications.

Sewed-up market

Numerical controls producers are eyeing new applications, particularly those in which production machines are linked to digital computers.

In this regard, Don O. Dice, marketing manager of the General Electric Co.'s Specialty Control department, points to cloth-cutting operations in the textile industry. Synthetic fiber is expensive and it stretches. Thus, patterns have to be cut both to make maximum use of materials and to assure that each piece will be the right size and shape when stretched by the wearer. To this end, GE is now developing computer software to direct numerically controlled cloth-cutting machines.

But metalworking remains the major application for numerical control. Early installations were mostly on milling machines, but a major portion of recent sales were for lathe applications.

Despite the greater use of numerical control, suppliers' ranks are decreasing, partly because some machine-tool makers have abandoned development of their own systems and partly because some companies couldn't meet the competitive demands. More than 50 firms have tried for orders in the U. S. over the years; the roster has only 29 names today.

On balance, the outlook for numerical controls is good. "In 1968, sales of positioning and contouring systems will increase to 4,000 units worth $67 million," Dice predicts, well ahead of the pace of recent years.

Selective gains for the resourceful

Less than expected volume in production of color television sets and other entertainment goods during 1967 caught components firms at a time when they were pondering the challenges of integrated circuitry. Whole markets—logic circuitry in computers, for example—have been taken over in recent years by IC's. Other areas are similarly under attack. And around midyear, as a result of swollen parts inventories at consumer electronics plants, there was an across-the-board slackening of demand; many component producers took a bad beating.

On balance, the 1968 outlook is rosier, especially for firms able to offer small devices that are cheap and reliable. Gross sales are expected to reach $7.2 billion, a 7% improvement over the $6.7 billion level reported for last year.

Leading the list of discrete assemblies with a new lease on life are trimmer capacitors and trimmer resistors. Jack Goodman, vice president of the JFD Electronics Co., says, "We feel that the demand for ceramic and trimmer capacitors will be greater in 1968 than in 1967. In fact we experienced a 15% increase in the last half of 1967 and see every indication that this will continue during 1968."

Demand will probably be greater in military and industrial markets, but consumer and commercial outlets, too, are picking up again, he says. Steve O'Connor, vice president for marketing at IRC, Inc., says, "We've been able to reduce the price of our trimmers by as much as 40% over the last five years, making them more attractive to users."

Resisting change

Resistor manufacturers admit IC's will take over many jobs now performed by fixed resistors, but point out that the continuing rise in production of such equipment as desk-top computers will offset this decline. Although these machines incorporate many IC's, their power circuitry still requires fixed resistors.

Fixed resistor sales are expected to total $220.8 million, up slightly from the 214.2 million worth of business done in 1967. Potentiometer volume should jump from $159.1 million to $174.5 million.

"Additional growth is in store for the precision metal-film resistor," says IRC's O'Connor. "Present monolithic technology cannot produce high-precision resistors. Indeed, metal-film resistors will be used extensively in fabricating hybrid microcircuits."

Much of a computer's circuitry, aside from the logic section, requires metal-film resistors. As the computer industry continues to expand during 1968, so will the use of these devices. Eventually, metal-film resistors may replace carbon-film versions. However, this is not in the cards for 1968; they must first be manufactured with the large—up to 100 megohms—values available from carbon-film types.

As yet, wirewound power resistors have nothing to fear from integrated circuits. These assemblies still can't handle high power, so it's a good bet that wirewounds will be used increasingly with hybrid IC's.

A major outlet for both metal-film and wirewound resistors will be in the resistor networks used in digital-to-analog converters. These assemblies provide guaranteed ratio matching. When discrete resistors are used, engineers often overspecify, winding up with more components than needed. It's more economical to buy resistor networks, so there should be a sharp increase in demand during 1968.

This year there should be a marked improvement in the temperature coefficient and tolerance of metal-film resistors; power-handling capabilities will also rise. This will mean that a 20-pulse-position-modulation resistor will be feasible for volume applications in analog computers. The big thing going for the metal-film devices is that they have more resistance value in a smaller package than their wirewound counterparts.

But makers of wirewounds are reacting resolutely, and during 1968 there should be further advances in miniaturization, tolerances—0.01% down to 0.0025%—and degrees of stability—20 ppm per year to 20 ppm per three years. For example, Dale Electronics Inc., a subsidiary of the Lionel Corp., plans to introduce several industrial-grade wirewound power units with tight tolerances for tv, radio, and appliance applications.

Of late, resistor manufacturers have had to face increasing competition from foreign producers. Only five years ago imports were considered inferior to U.S. equivalents, but this is no longer true. What's more, imported resistors are selling for less than their U.S. counterparts. In 1966, about 800 million resistors—mainly carbon-composition types, were imported. During 1967, the total rose to about 1 billion, and another jump is expected this year.

Capacity for growth

Paralleling the optimism in the resistor field, capacitor manufacturers are also looking forward to a good year. Tantalum units especially are enjoying great success, largely because of their virtually exclusive franchise in the computer business. Total capacitor sales are pegged at $473.3 million this year, as against $436.8 million in 1967.

JFD Electronics' Goodman says the development of new miniature ceramic-type fixed capacitors with high r-f current and voltage capabilities is a major

advance. "It opens a new market for such units in communications transmitters and other applications," he says.

"Capacity ranges of these units are very wide, from 3.5 to 3,000 picofarads," Goodman says. "The development of these and similar capacitors is due to improvements in the ceramic formula which provide greater stability and capacitance in smaller packages. High production rates on epoxy packages for miniature sintered tantalum capacitors have been responsible for their low price. They are now almost competitive with aluminum-foil-type electrolytics. And they make possible quite a savings in size."

However, improvements in electrolytes have permitted fabrication of some aluminum units with upper temperature ranges comparable to those of tantalum capacitors. The Sprague Electric Co., for example, has brought the ratings of its devices up to 125°C.

Relay race

Many engineers were writing premature obituaries for the relay last year. With integrated circuitry's emergence, the reasoning went, the relay's already small size could not be further reduced; nor could reliability be significantly improved. As it happens, such writeoffs were too hasty: relay sales are at all-time highs and going higher. This year, volume will go up 14% from $262.8 million to $300 million. The viable state of relays is largely attributable to the greater reliability and smaller size achieved by suppliers working on devices for volume outlets like the Apollo program. Among others, Teledyne Inc. and the Hi-Spec Electronics Corp. have produced assemblies in TO-5 cans while the Branson Corp. has a relay available in a flatpack.

On another front, Filtors Inc., a subsidiary of the Deutsch Co., has developed a new mounting technique with considerable market potential since it reduces the size of a relay and guarantees good performance under almost any kind of operating conditions, including vibration and shock.

The method, dubbed integration termination system, does not require soldering, sockets, or pins. The most important advantage is that the hundreds of different tools usually needed to wire or remove a relay from a board are completely eliminated. As a result, inspection, testing, calibration, and recycling are no longer necessary steps. The job is done with one inexpensive insertion tool.

All wires of the same size are crimped and inserted, or removed, with the insertion tool. The base of the relay does not have a conventional pin arrangement, but female receptacles for the crimped wire leads. Once in place, contact is assured and the wires cannot be pulled out. However, they are easily removed by reversing the procedure. Cold-solder joints, always a problem in conventional wiring schemes, are thus eliminated. Besides, since no base is required for conventional pins, the relay can be mounted in any position, effectively reducing its height. This means that the leads do not have to be brought in from the rear, as in conventional configurations. The integration termination system can be used in terminal junctions, switches, lamp indicators, circuit breakers, bus bars, or any other device with pins. Deutsch, for example, is applying the technique to its connector lines.

Respectable connections

In common with most of the other makers of discrete components, connector firms can look forward to sales gains during 1968. Volume should rise about 8% from $327 million to $353.5 million. The biggest percentage gains are anticipated in small coaxial assemblies and printed-circuit connectors.

But connector outfits also share the industry's challenges. Customers want mounting techniques that will enhance over-all system reliability, decrease space requirements, and be available at lower cost. The task here has been quite difficult because the circuits in space and defense projects typically require many thousands of connections.

A new method that could win acceptance this year was developed at the Elco Corp. It permits multiple connections in computers, printed-circuit boards, circuit modules, terminal blocks, card cages, and integrated-circuit packages. The technique centers on contacts mounted on a metal base plate with a variety of insulated contacts. Connectors may be fabricated in almost any size and shape from 1 inch x 1 inch to 24 x 36 inches. Contacts may be arranged in either a symmetrical or asymmetrical pattern. A wiring density of 2,500 is possible.

The plate provides mechanical support for the connector contacts and serves as ground plane. By using a ground bushing, individual contacts may be connected to a ground plate instead of remaining insulated from it.

An important advantage of the technique is that connections can be made automatically and precisely with wire-wrap methods. And high-speed machinery—rates of 1,100 connections an hour are not unusual—also affords substantial cost savings on production runs.

Small gains

"The most significant development in operational amplifiers has been the improvement in monolithic assemblies by the IC manufacturers," says Dan Sheingold, manager of applications engineering at Philbrick Researches, a Teledyne subsidiary. "Combinations of monolithic and bipolar elements have made these devices considerably better during last year; progress will continue through 1968 and beyond."

Although military projects will continue to be the leading outlet for op amps during 1968, other applications are beginning to emerge. This year, for example, car makers will investigate using them as regulators. Toy firms are also expected to use limited quantities of "rejects" during 1968. Eventually, large-scale integration will bring the cost of manufacturing op amps down to more universally attractive levels.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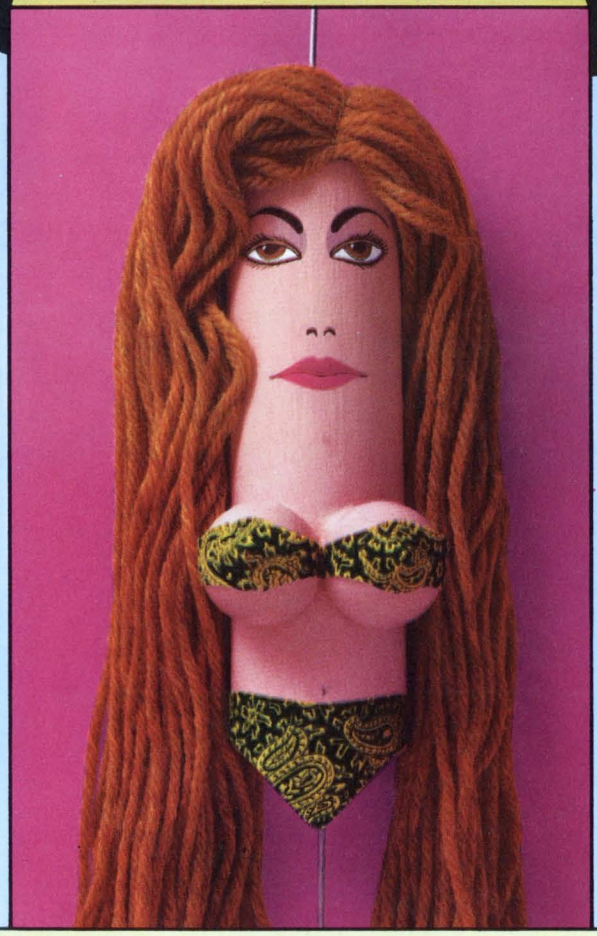

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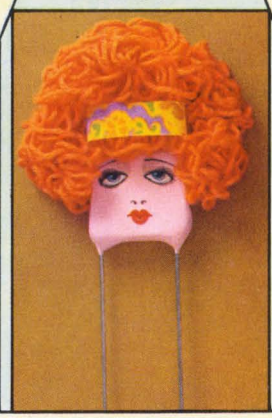

Flat Line—Mylar Film/Foil
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Type Number TO-61	DESIGN LIMITS			PERFORMANCE SPECIFICATIONS					
	$V_{(BR)CBO}$	$V_{CEO(SUS)}$	$V_{(BR)EBO}$	h_{FE}		V_{CE} (sat)	V_{BE} (sat)	I_{CBO}	f_T
	Volts	Volts	Volts			Volts	Volts	μA	MHz
	$I_C = 200\mu A$	$I_C = 100mA$	$I_E = 200\mu A$	$I_C = 10A$,	$V_{CE} = 5V$	$I_C = 10A$,	$I_B = 1.0A$	$V_{CB} = 60V$	
	Min.	Min.	Min.	Min.	Max.	Max.	Max.	Max.	Typ.
SDT 8151	150	120	8	40	120	1.0	1.5	10	30
SDT 8152	100	80	8	40	120	1.0	1.5	10	30
SDT 8153	80	60	8	40	120	1.0	1.5	10	30
SDT 8154	100	80	8	100	—	1.0	1.5	10	30
SDT 8155	80	60	8	100	—	1.0	1.5	10	30
SDT 8156	150	120	8	20	60	1.0	1.5	10	30
SDT 8157	100	80	8	20	60	1.0	1.5	10	30
SDT 8158	80	60	8	20	60	1.0	1.5	10	30
SDT 8159	40	25	5	20	—	2.0	2.0	10*	30

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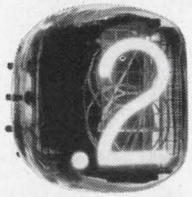
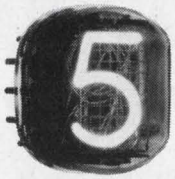
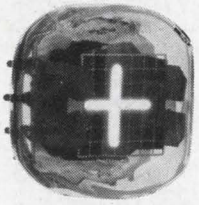


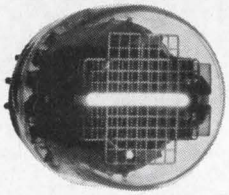
CK1904—Interchangeable with B59956 and NL809.



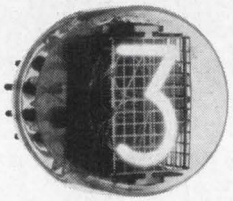
8422—Interchangeable with B5991 and NL8422.



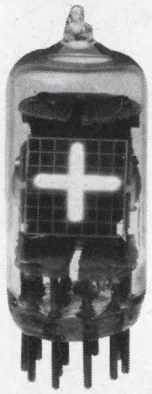
CK1903—Interchangeable with B5992 and NL5992.



CK1901—Interchangeable with B5016 and NL5016; CK1902—Interchangeable with B5032, NL5032, B50911 and NL50911.



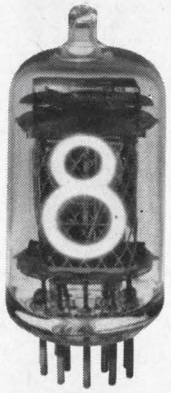
8421—Interchangeable with B5092 and NL8421; 8037—Interchangeable with B5031 and NL8037. Also available: 6844A.



CK1900 (used with CK8650, CK1905, CK1906); CK1907 (used with 8754)—Interchangeable with NL843.

8754—Also available with right- and/or left-hand decimal points; Interchangeable with NL840/8754. Decimal-point types interchangeable with NL841, 842, 848.

CK1905; CK1906 (right-hand decimal point).



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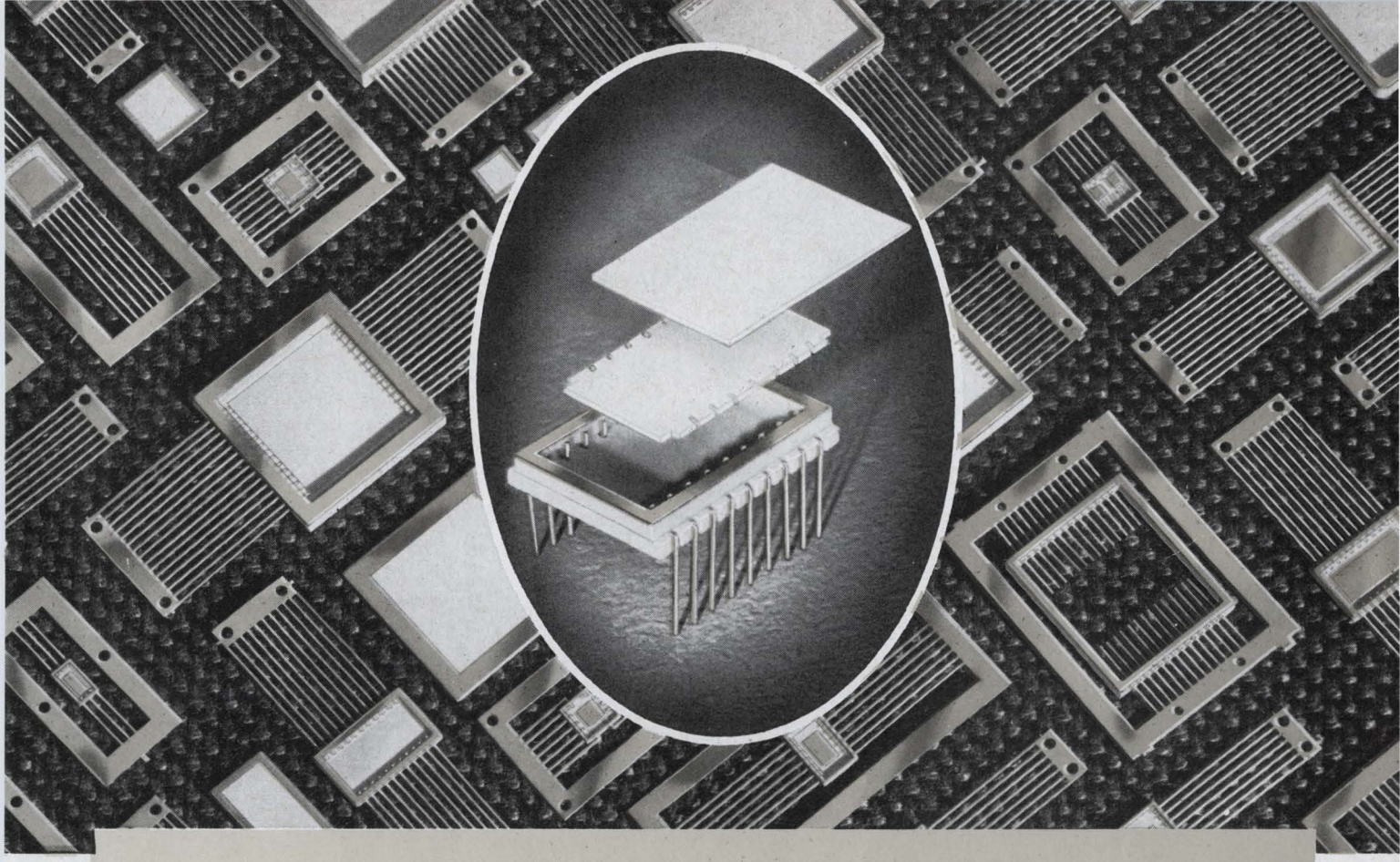

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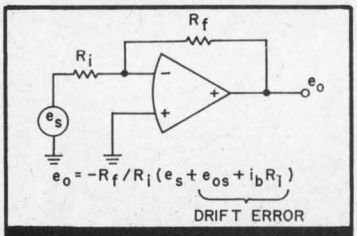
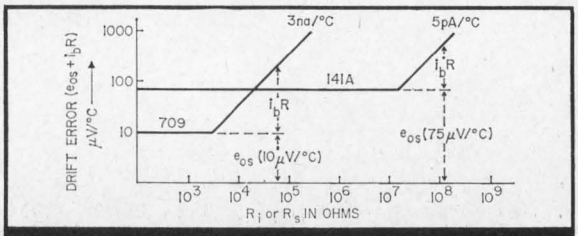


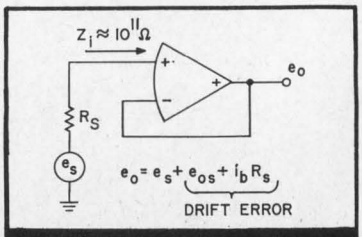
HIGH IMPEDANCE INVERTING CIRCUITS

Curve shows that the 141 gives low drift errors even for summing resistors (R_i) up to 15 M ohms. Curve at right applies using R_i. Applications include long term integration, picoamp current measurements, D-A converters and high Z summation or subtraction.



DRIFT OF 709 vs. 141A

Curve compares total drift error of 709 type ICs to the 141A. Total drift error consists of voltage drift error (e_{os}) and voltage errors caused by the current drift component ($i_b R$). For low resistances, drift error is constant since it is due primarily to voltage offset drift (e_{os}). For high resistances, drift increases rapidly due to the effect of bias current drift (i_b). For resistances above 10^4 ohms drift error of the 709 exceeds that of the 141 due to the effect of larger bias current drift.



HIGH IMPEDANCE NONINVERTING CIRCUITS

When connected as a follower the 141 gives 10^{11} ohms input impedance (Z_i) and low drift errors for sources (R_s) up to 15 M ohms. Curve at left applies to using R_s. Applications include pot unloading, sample and hold circuits, A-D converters and ph meters.

IC op amps, like the 709, are small and inexpensive and for many applications they are quite satisfactory. But when you need high input impedance or low bias current IC's are no match for FET's. That's why we have worked so hard to produce the industries lowest priced FET op amp. In large quantities the Model 141 is priced lower than your cost for a 709 with an FET input stage and our performance is better too. Moreover, the 141 offers guaranteed specs and is 100% tested from −25°C to +85°C which is not usually the case for home brewed circuits.

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Open Loop Gain, min.	—	20,000
Rated Output, min.	—	±10V @ 2mA
Unity Gain Bandwidth	—	3MHz
Full Power Response, min.	—	50kHz
Slewing Rate, min.	—	3V/μsec.
Common Mode Voltage, min.	—	±7V
Common Mode Rejection	—	1000
Input Impedance, C.M.	—	$10^{11}\Omega$
Supply Voltage Rejection	—	150μV/%

	Model A	Model B	Model C
Bias Current, 25°C, max.*	50pA	30pA	30pA
Bias Current Drift, 25°C*	5pA/°C	3pA/°C	3pA/°C
Voltage Drift, max.**	75μV/°C	40μV/°C	25μV/°C
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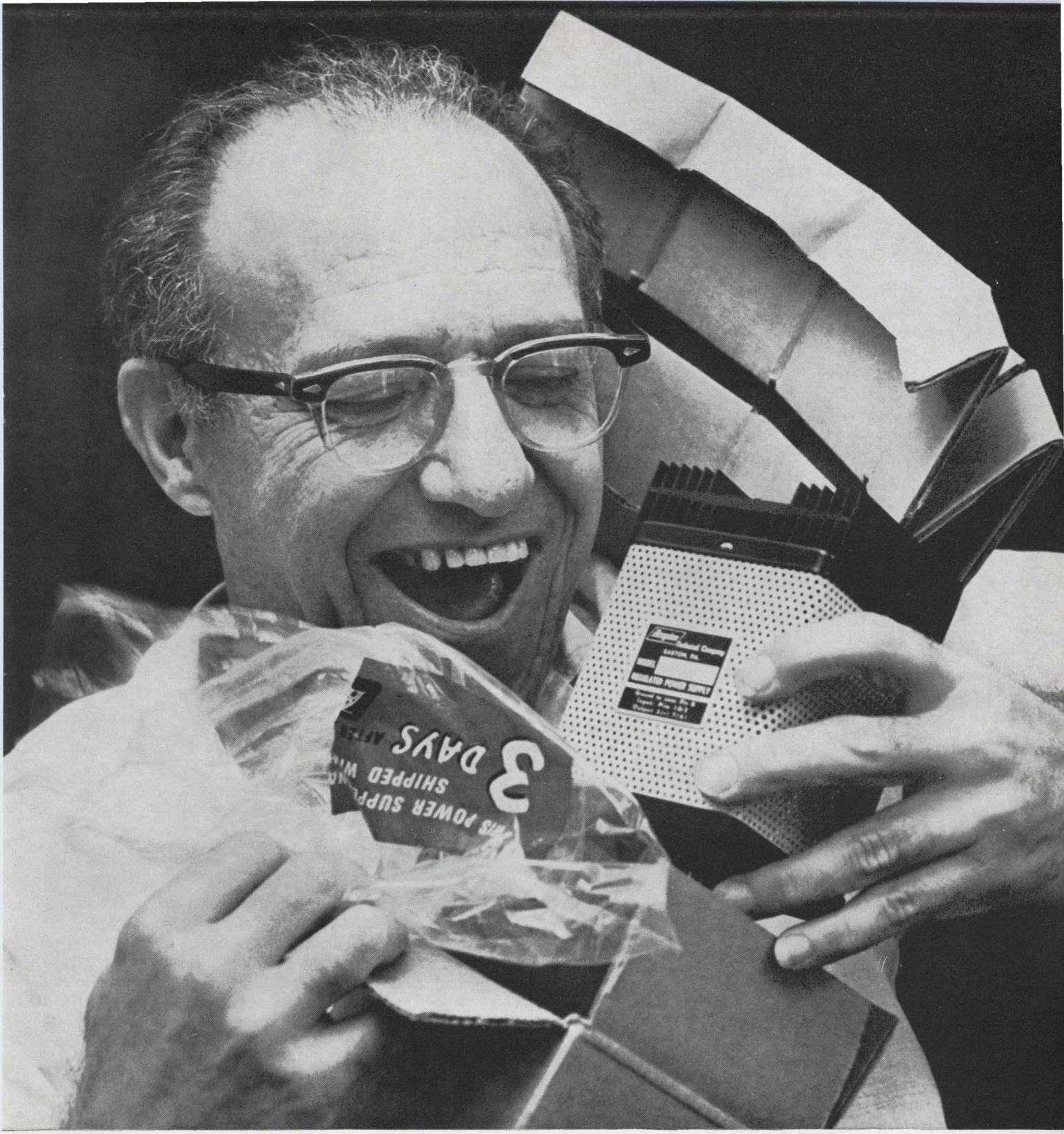

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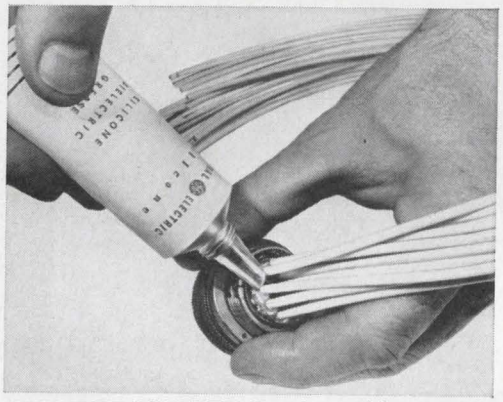

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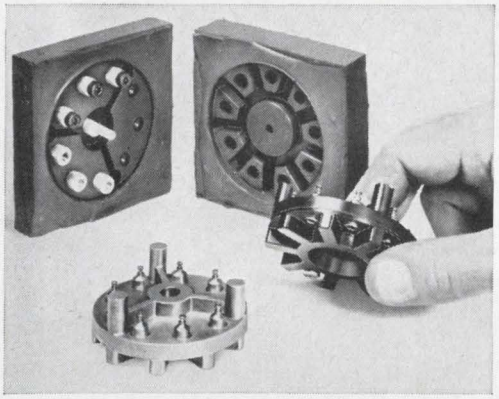

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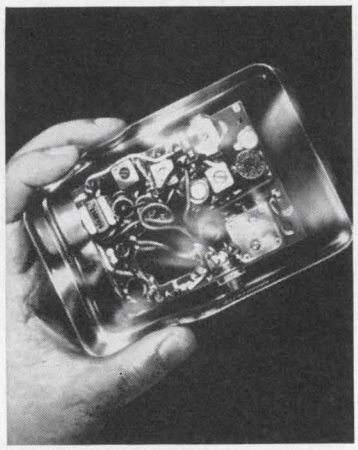

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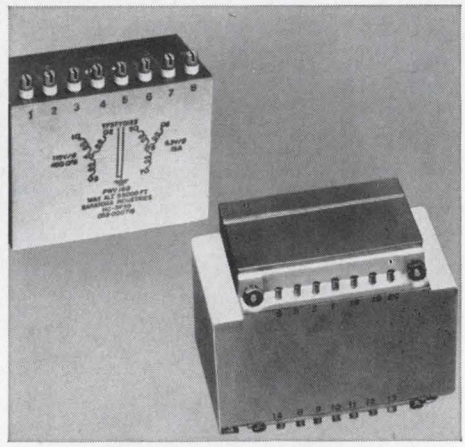

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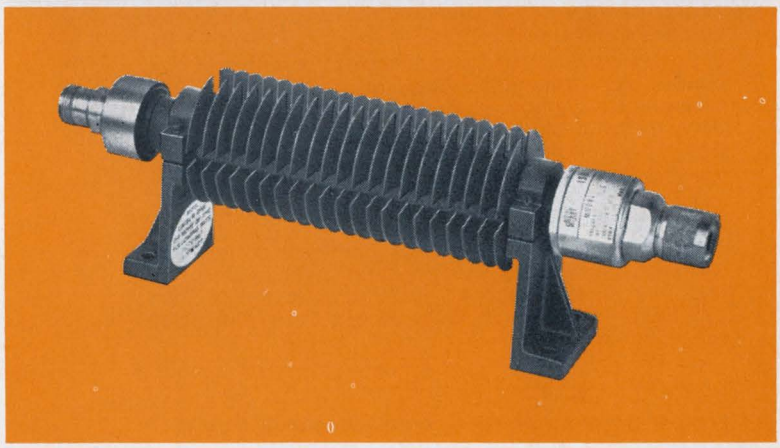

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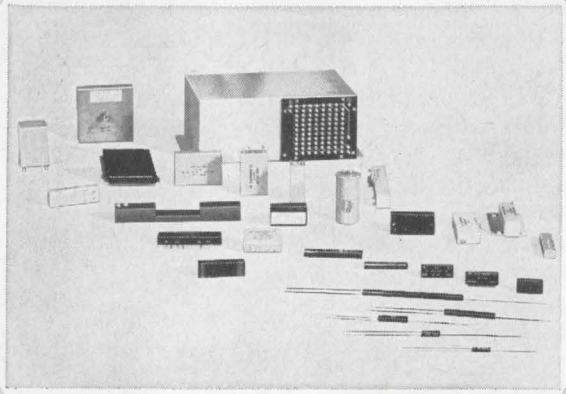

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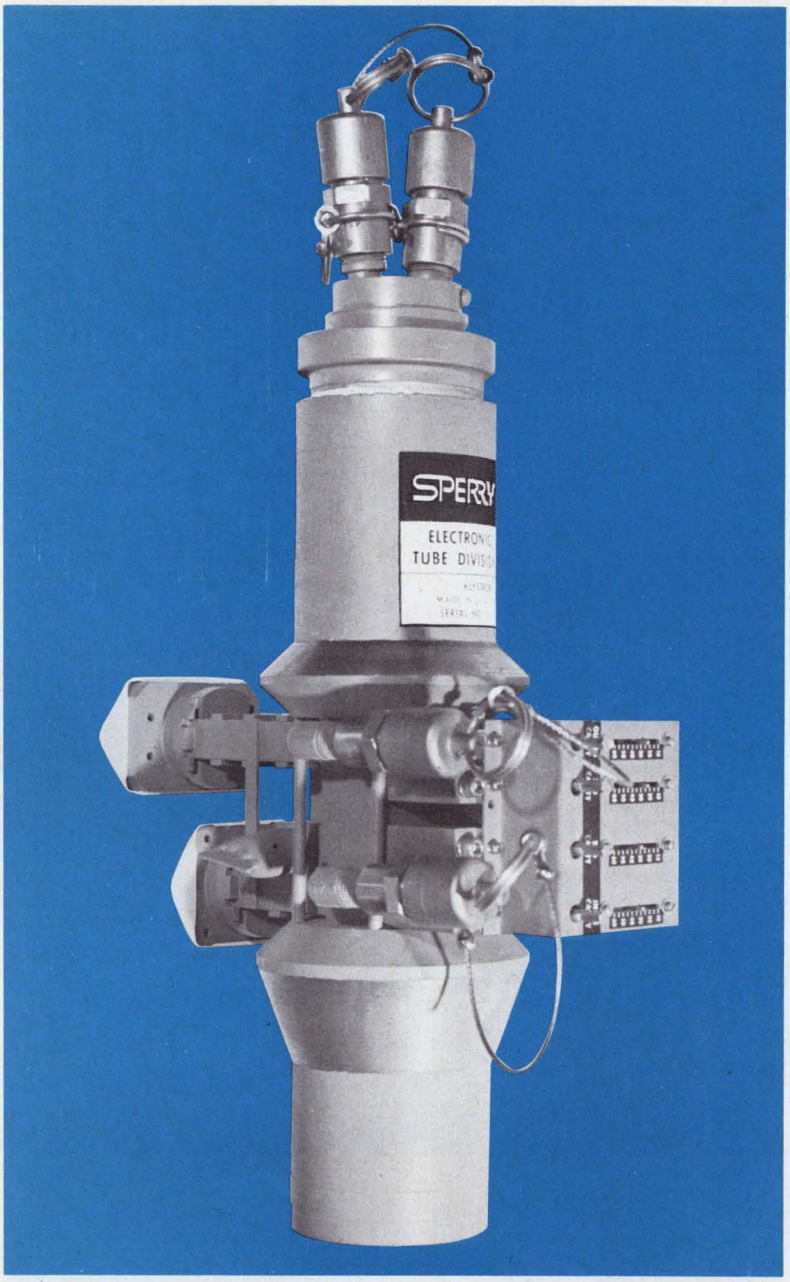
SPERRY RAND



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Gain	45-54 db
Efficiency	36-40%
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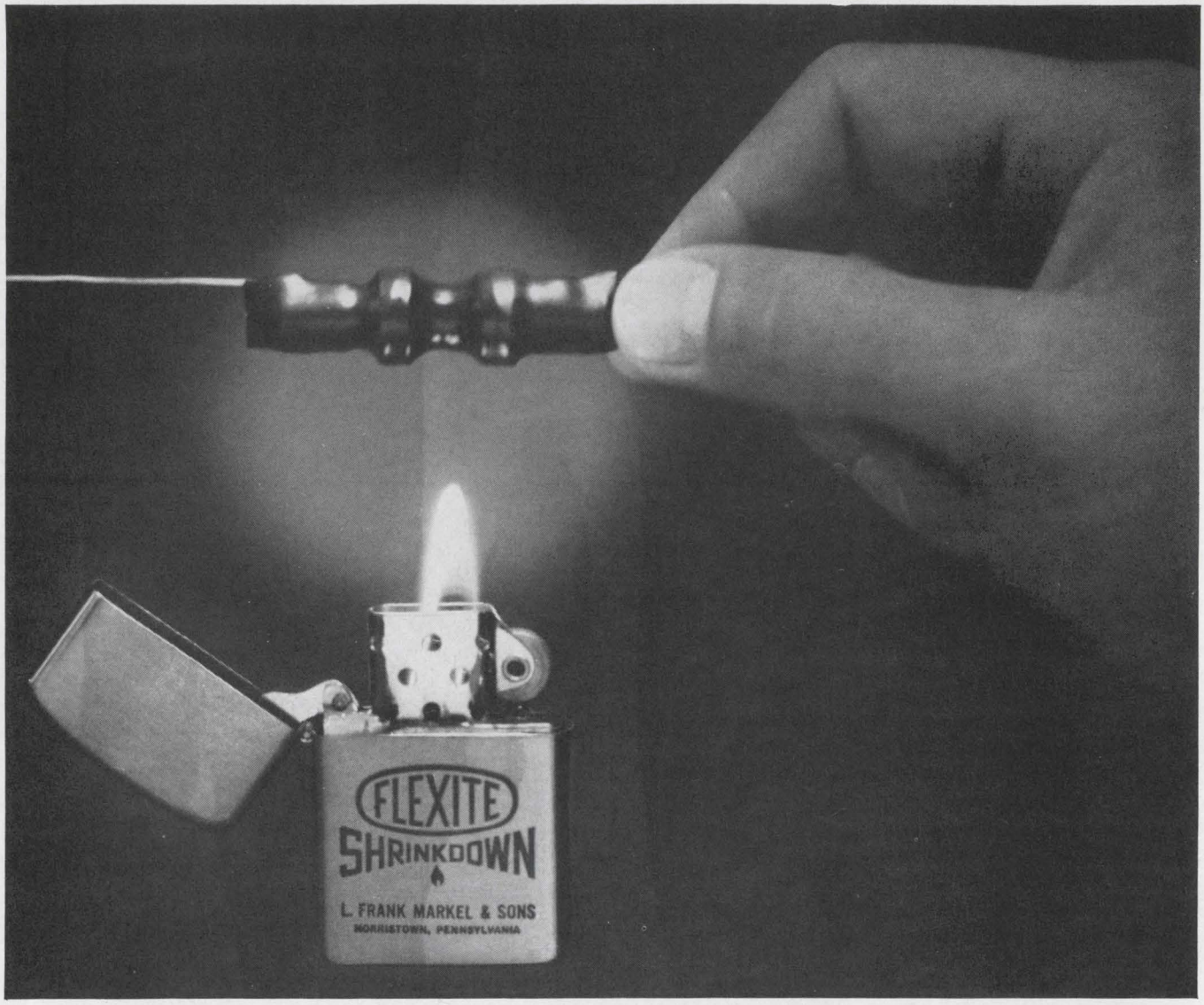
Military communication satellite terminal application proves versatility of Sperry klystron amplifiers.



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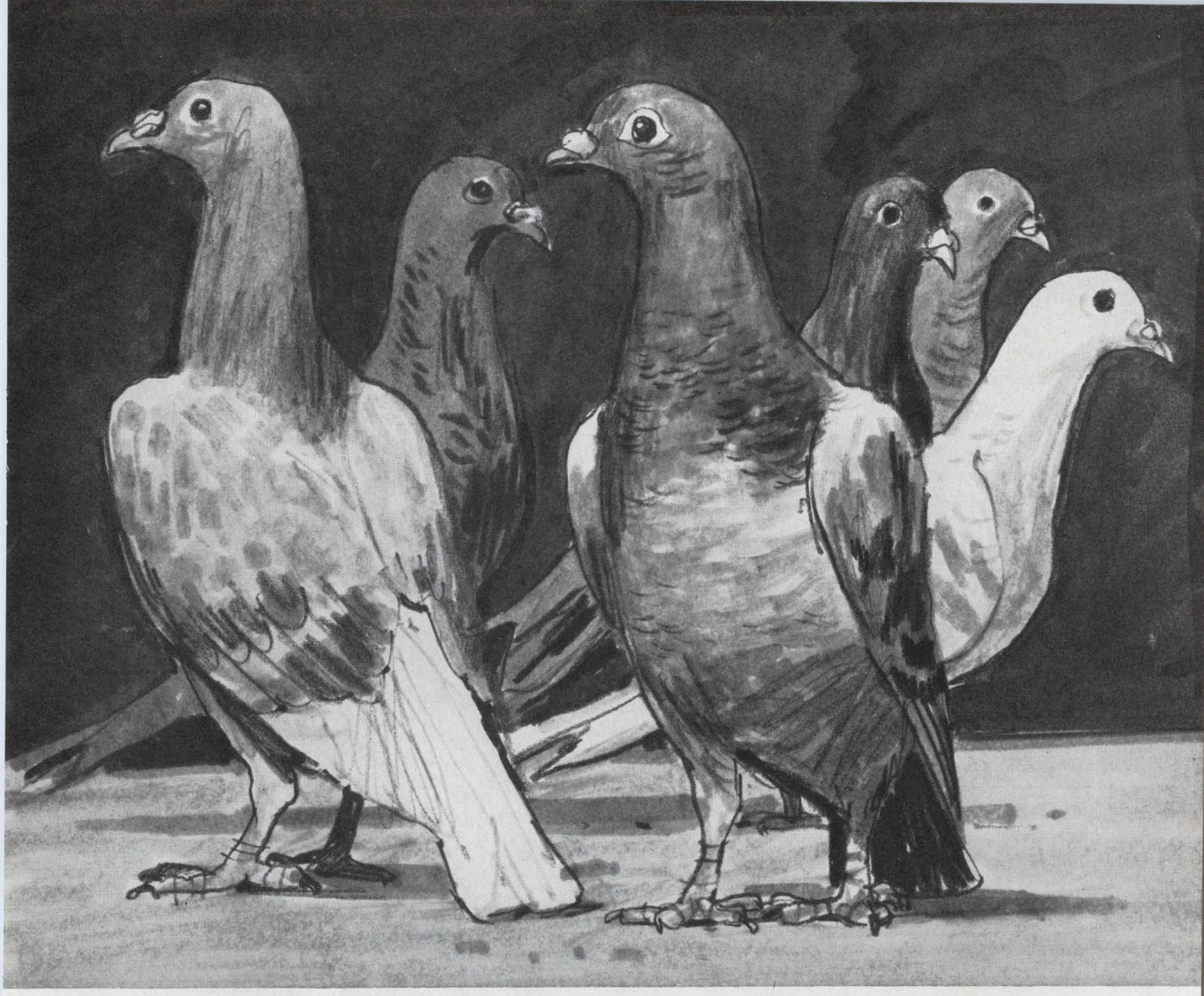

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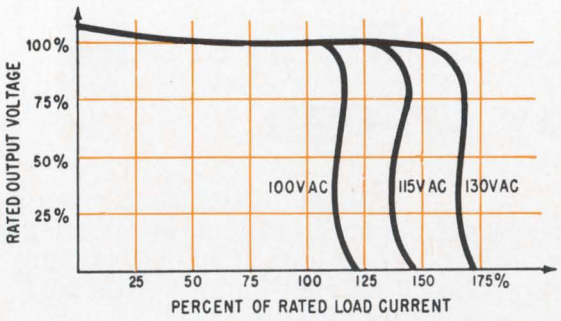

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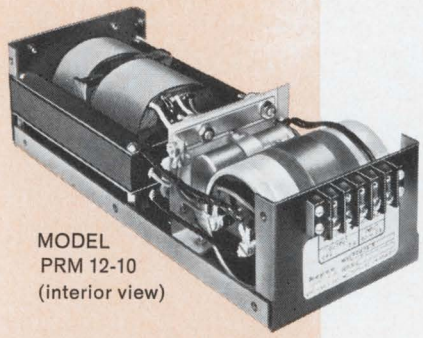
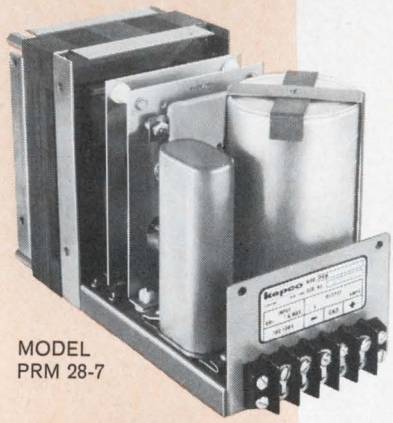


MODEL PRM 12-10 (interior view)



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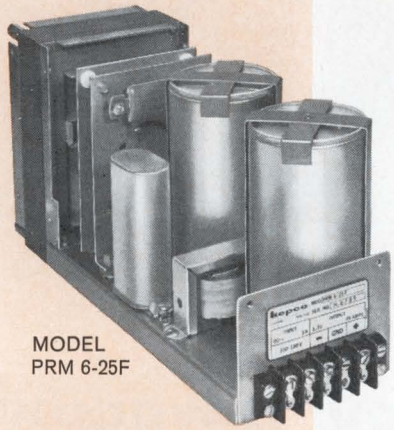

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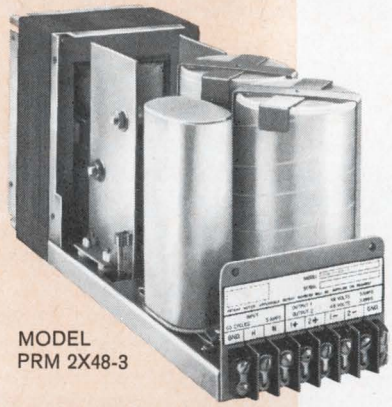

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PRM 18–10F	18	0–10
PRM 24–8F	24	0–8
PRM 28–7F	28	0–7
PRM 36–5F	36	0–5
PRM 48–4F	48	0–4
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PRM 2X 6–20	6.3 6.3	0–20 0–20
PRM 2X 12–12	12 12	0–12 0–12
PRM 2X 15–10	15 15	0–10 0–10
PRM 2X 18–8	18 18	0–8 0–8
PRM 2X 24–6	24 24	0–6 0–6
PRM 2X 28–5	28 28	0–5 0–5
PRM 2X 36–4	36 36	0–4 0–4
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Probing the News

Government

FCC begins to get the message

Commissioners and industry agree that the agency needs a new image; changes are overdue, and the President's task force may propose some

By Robert Skole

Washington bureau manager

Under the "No Smoking" sign in an elevator at the Federal Communications Commission's old quarters in the Post Office Department Building, someone once scratched the words "No Nothin'."

The FCC last month moved to a new building in another part of Washington. As yet, no one has scratched "No Nothin'" in any of the elevators, but the move away from the old offices does not portend any speedup in the commission's operating procedures.

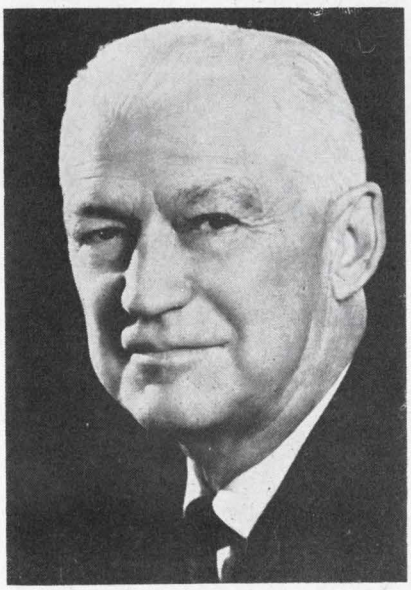
However, communications problems are piling up at an alarming rate as rapid technological advances give added dimensions to crises caused by a swelling population and a burgeoning economy. All concerned agree that something must be done. What they don't agree on is whether that something should take the shape of a new cabinet-level department or simply a reorganized FCC, and whether Congress and the Administration should start applying themselves to the problem now or wait until the President's Task Force on Telecommunications delivers its recommendations next summer.

I. Soup to nuts

The FCC has long been criticized for its composition and its wide authority. Established in 1934 to cope with the overcrowded radio spectrum (ironically, this is still a major problem), the commission has seven members, no more than four of whom are from one political party. The commissioners must make rulings in a wide range of controversial areas, from allocating chunks of the frequency spectrum and issuing extremely profitable television and radio broadcasting licenses to regulating telephone rates and even trying to deal with garage-door openers and other devices that can cause radio interference. Highly vocal and politically powerful forces therefore have a stake in the FCC's deliberations.

Faint praise. Considering the job it's charged with, and the fact that it hasn't changed its organization to any great extent since it was established, the agency isn't doing such a bad job, many observers feel. The attitude of most of the companies that deal with the agency are summed up this way by one West Coast executive:

"The FCC is technically competent and, on the whole, not too bad to deal with when you consider the straitjacket of politics, budget limitations, and staff shortages it must wear. The straitjacket certainly can stand some loosening, but in Wash-



Chief. Rosel H. Hyde, chairman of the FCC, has 40 years with agency and its predecessor.

Critic. Nicholas Johnson is quick to find fault with fellow commissioners.

ington nothing happens overnight."

Commissioners have learned over the years that the "No Nothin'" image is a hard one to dispel. But when one of them, Kenneth A. Cox, had an assistant go through the records since 1963—the year Cox joined the agency—to list some of the FCC's "more significant actions," the citations covered 39 pages of single-spaced type.

Nevertheless, many general and special publications have declared open season on the FCC during the past several years. They have charged that the agency fails to control loud television commercials, that it backs the broadcasters in their battle against cable tv, that it plays footsie with the large common carriers, and that former commissioners often wind up working for firms whose activities the FCC controls.

Obsolete? "I don't expect anyone to agree with all we've done," says Cox. "I don't approve of all of it myself. . . . In the last five years we've handled an amazing array of problems, some of them of transcendent importance. For an allegedly obsolete agency, we've managed to get quite a bit done. However, I think the next five years may be even busier."

Nobody on the commission disagrees with this. It's perhaps one of the few things that the seven commissioners do agree on. This, of course, is one of the major problems of the agency: it is run by seven politically appointed men.

II. It takes all kinds

The commission's current composition is typical in that its members have widely varied backgrounds and political colorations—factors that influence their votes.

- Chairman Rosel H. Hyde, a Republican, has been a commissioner since 1946. He's been with the FCC and its predecessor, the Federal Radio Commission, for 40 years.
- Robert E. Lee, another Republican, is a former FBI agent. He was named to the commission in 1953.
- James J. Wadsworth, the third Republican, is a former ambassador to the United Nations. He was named to the FCC in 1965.
- Robert Bartley, a Democrat, is a nephew of the late Rep. Sam Rayburn. He was named a commissioner in 1953 after working on the FCC staff in the 1930's and then for the National Association of Broadcasters.
- Lee Loevinger, also a Democrat, is a former law professor and Minnesota Supreme Court justice. He joined the agency in 1963 after heading the antitrust division of the Justice Department.
- Nicholas Johnson, another Democrat, is, at 33, the commission's enfant terrible. He's a former law professor who joined the FCC in 1965 after heading the Federal Maritime Commission—he was 28 at the time—under President Kennedy.
- Cox, the fourth Democrat, is an attorney who worked for the Senate Commerce Committee and headed the FCC's broadcast bureau before being named a commissioner in 1963.

Diplomat. James J. Wadsworth is a former ambassador to the U.N.

Splashy. Commissioner Johnson is most articulate about the agency's shortcomings. When he first started rapping the FCC for not adapting itself to modern needs and for not taking longer-range views, he was brushed off as "a brash young kid" by his fellow commissioners. This didn't slow Johnson down—although he has perhaps become more diplomatic with time. He knows the questions he raised

weren't welcomed by his colleagues, "but they are starting to listen to me now," he says. If Johnson represents one extreme of FCC opinion, Hyde represents the other. Most people characterize Hyde as the epitome of the don't-make-waves type of career bureaucrat; people who do make waves usually don't stay long at the FCC.

Muscle. "We don't need to be superseded," says Hyde. "We need to be strengthened. We need greater capacity to study and analyze the uses of communications We've been dependent over the years on information and technical details given to us by interested parties. We definitely need to strengthen our research capabilities."

Hyde notes that in the FCC's fiscal 1968 budget of $19 million, there is $600,000 earmarked for "research" —the first such money the commission has ever received. It will be applied toward three broad goals, he says: improving allocation of land mobile radio service; devising better ways of handling Citizens Band both on a short- and long-term basis; and studying the "purpose and mission" of the FCC.

"We're trying to get some sense into planning the use of the spectrum," Hyde continues, "and trying to see that the FCC doesn't just follow but takes the lead in making the best use of technology."

Limited view. Johnson likens the FCC to a traffic cop who controls vehicles only as they arrive at and leave an intersection. The cop doesn't care where the vehicles come from, what new vehicles might show up, what the effect of highway construction down the block may have on the traffic stream, or what will happen to the vehicles after they've been sent on their way.

Johnson agrees that the initial $600,000 of research money should help the FCC find out just what it should be doing. However, with the Administration now tightening up on outlays unrelated to the Vietnam war, there's a possibility that the funds won't be released for spending this year.

A year ago, Commissioner Johnson started to push for a long-range national communications policy. In a speech before the Federal Communications Bar Association, he

said: "The fact is that the Federal Government has no coordinated administration of communications and virtually no long-range research and development program."

This is one of the problems the President's Task Force on Telecommunications is tackling. The panel, established last August, has been given a year to come up with recommendations for a U.S. communications policy. Off to a late start because of difficulty in finding an executive director, it will have a tough time meeting its deadline. But regardless of how close it gets to formulating a national policy, the task force may outline definite steps toward modernizing the FCC.

So far, so fair. The FCC—with all its faults—has been doing a fair job so far as the public and Congress are concerned. People can generally get radio and television programs without interference. Telephone and telegraph rates are not intolerably high, and service is usually good. Taxi fleets and diaper services are able to get licenses covering their own radio dispatching requirements.

However, the problem of overcrowded frequencies is causing Congress to take a look at the commission. Police and fire departments in large cities have been crying for years for additional frequencies, and recent urban riots have given added weight to their pleas. Congressmen are starting to feel grassroots pressure regarding this issue.

Most commissioners, and most of the FCC's staff, consider overcrowded land mobile frequency spectrum the agency's chief problem.

An FCC study group is now considering three possible courses. One would give the seven lower ultra-high-frequency channels to land mobile users, a stopgap measure that might be effective for 10 to 15 years. Under another plan, channels would be shared on a geographical basis. The third proposal would allow operation in the 800-900 megahertz region.

Strapped. "If we had a Bell Labs we could find out more about the 30-to-300-gigahertz range as a long-range answer," says Ralph Renton, the FCC's chief engineer. "If we had the money, we could do the research that industry says it's unable or unwilling to do."

III. Away from the limelight

Although overcrowded spectrums are attracting the most attention—especially in Congress—the FCC is involved in a wide range of other problems that are of significantly greater long range importance although perhaps not as urgent.

- The commission has been inquiring into subscription television for the past 12 years; a solution eventually will have to be found by Congress.
- The growth of cable television is still blocked by the FCC's "second report and order." The Supreme Court will give a final answer to the commission's claim that it has the right to regulate cable tv.
- By Feb. 15, interested parties will have filed their initial comments on the FCC's inquiry into the relationship between computers and communications.
- The FCC's study of domestic satellites is still under way, and according to Nicholas Johnson, the issues at stake here may be "fully as important and unique as those confronted when Comsat was established."
- The FCC is pondering the question of whether to allow the attachment of foreign devices to telephone-company equipment, or at least to force the phone companies to establish technical standards for foreign attachments.

The agency is moving ahead at its own pace in these areas—and others—but there are many in Washington and in the FCC itself who feel that the only real answers will have to come from the President's task force.

No upheaval. Nobody expects the panel to recommend anything particularly revolutionary, but proposals that might find favor with the Administration and Congress include:

- Either charging fees for spectrum space or auctioning it off.
- Giving the FCC something of an appellate court role. The commissioners would sit as judges, be appointed for long terms, and be politically independent.
- Forming a separate section to handle the routine administrative problems and agency details.
- Establishing a research and development division to keep the FCC on a technical par with the firms it regulates.

New terminals in display picture

In applications where computer-driven display terminals can be clustered, tv-like monitors coupled with time-shared memories promise cost savings

By Walter Barney

San Francisco regional editor

Raster-scan techniques similar to those used in commercial television are leading to low-cost graphic displays for special-purpose computer terminals. Four firms—Data Disc Inc., the Philco-Ford Corp.'s Western Development Laboratories, the International Business Machines Corp., and the Radio Corp. of America—are already developing display systems using conventional tv monitors and a variety of memory types.

No one's claiming that such setups are useful for all applications. For one thing, the wide bandwidth required for a video signal doesn't permit these systems to operate at the end of a phone line. For another, the development of terminals capable of working off communication lines having low bit rates has become an important objective of designers of sophisticated, but costly, cathode-ray-tube displays. But this capability isn't critical where terminals are clustered—in scientific laboratories, control centers, and classrooms. As a result, monitor systems, which hold out the possibility of time-sharing remote character and graphics generators as well as refreshment memories open the way to dramatic reductions in the terminal cost total for certain applications.

I. Ways to go

Data Disc., for example, is developing disc-memory systems with full graphics capability that will be priced in the $1,500-$2,000 range. The company will soon offer a 64-terminal, alphanumerics display-only system for $500 per channel; a tv monitor is extra. Key to the low cost is the location within the system of both the character generator and the remote memory.

One or another. Basically, there are two types of graphic display organization. Either a digital memory feeds a character generator, which drives the crt, or the character generator feeds the memory, which then refreshes the crt.

Where the memory feeds the generator, the memory can be relatively small, since it needs only to store a single six-to-eight-bit code for each character to be displayed; for a 1,000-character display, this amounts to 6,000 to 8,000 bits, well within the capability of a simple acoustic delay line. Such a system, however, must have a separate character generator for each terminal. Moreover, says Herbert C. Hendrickson, manager of display-control systems engineering at Western Development Labs, the symbol and vector generators must recreate the entire display with each refreshing cycle; and complex displays may be degraded in such circumstances.

But when the memory is fed by the generator, the memory must be larger. The character generator's output is a 16-to-100-bit display code. Thus, for the same 1,000-character display. The memory must store 16,000 to 100,000 bits. However, the generator need operate only during updates, an advantage that gives the user two alternatives:

- He may use the same generator to serve other channels, in which case he will need a high bit rate from the computer and will have to use coaxial cable or microwave transmission lines;
- He may generate characters slowly via ordinary telephone lines, a method used in some slow-scan television systems [Electronics, Aug. 7, 1967, p. 218].

Viewpoints. Central to the Data Disc system and those developed by Philco, RCA, and IBM is raster scanning. "We have a lot of missionary work to do in this respect," says William W. Stevens, vice president in charge of Data Disc's Special Products division. "Most people think about an x-y type of scanning for graphics."

But Western Lab's Hendrickson believes the missionary work has been completed, pointing out that there has already been a shift in crt design from random beam positioning to raster techniques.

"At first glance, the digital system seems expensive," Hendrickson

Dissenting voices

Not everyone is enthusiastic over raster scanning.

James Clements, manager of the data and display system department at Sanders Associates Inc., says a raster system causes a horizontal line to be broken into "stair steps." He favors a technique in which each character is generated individually. The line, he says, could be painted directly with better quality than that with a raster technique.

Another in the opposition camp is Robert H. Stotz, assistant leader of the display group at the Massachusetts Institute of Technology's Electronic Systems Laboratory. Stotz points out that raster displays require conversion from the point-and-line display description used by a computer to deflection- and intensity-modulated signals for the tv-like consoles. This requires either a lot of computer time or a special conversion module, both of which are expensive proportions, according to Stotz.

. . . getting sufficient memory capacity at a remote location isn't a problem . . .

says. "But random beam steering requires electrostatic deflection and high voltages, and that costs money." He says Western Labs undercut one competitor by 75% on a Government contract by going to raster scan, and saved $500,000 on three tubes on a military project, using the same technique.

"It's like the analog versus digital computer argument," Hendrickson says. "People worried about the cost of digital memories, but the cost per function has dropped steadily."

Stevens agrees that the raster technique is much cheaper, but offers different reasons: "The x-y display requires a big chunk of core memory. A 1,000-character display might take 1,000 eight-bit words, and the cost of refreshing the tube in this case would run to 25 cents a bit."

Flexibility. Stevens also points out that because random beam steerers need 5 microseconds to settle, they are limited as to the number of points they can make in 30 milliseconds—the duration of one conventional television frame. This means flicker will be troublesome in frames of longer duration.

On technical grounds alone, Hendrickson says, the raster scan is preferable: the electronics are simpler, the tubes are cheaper and can accept conventional video signals as well as digital input. In addition, registration problems are eliminated, polarity may be inverted, and light pen operations are easier.

Allan B. Corderman, director of RCA's instructional systems unit, says that his organization is interested in raster scan because it wants its systems to be compatible with closed-circuit tv. He points out that RCA already has a broad closed-circuit-tv line in schools. Ultimately, he believes, his company will be able to market systems that work off phone lines for $1,000 a terminal.

Says Data Disc's Stevens: "We're utilizing the investment of 20 years of television. But there's still a lot of investment to recoup in x-y scanning."

Getting sufficient memory capacity at a remote location is no problem. Delay lines, drums, discs, and semiconductors can all fill the bill. The big question is cost. "Our gospel is the cost per bit," says Donald I. Frush, development manager in charge of the IBM 1500 computer-aided educational system.

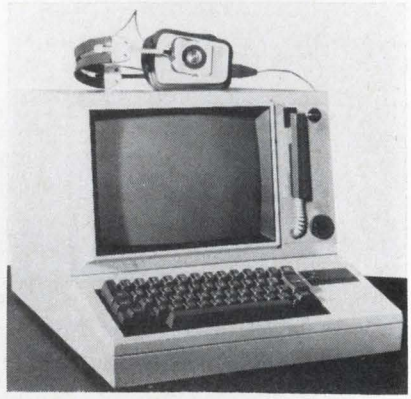
Provincialism. The 1500 uses a disc-pack memory — "perhaps," quips Frush, "because we're west of the Mississippi." Other IBM computer systems use core memory, but the 1500 is made in San Jose, Calif., in the company's largest disc-memory manufacturing center.

II. Who's in first

Frush ranks discs, cores, and delay lines in that order of descending initial cost. But delay lines, he says, have an inherent jitter that can cause a display to have waves. Cores, which have no mechanical parts, aren't subject to this problem. Discs, Frush says, have certain mechanical difficulties—with belts and pulleys—but the incremental cost of storage is virtually nil. "All you need is an extra head and an extra amplifier," he says.

"The question boils down to how big a cluster you want to drive," he says. The 1500 can handle as many as 32 terminals.

Most of Philco's systems use delay lines—in one case, 64 per channel in an eight-channel system



Teacher's pet. The cathode-ray tube of this RCA display terminal for a computer-aided instruction system uses a television-type raster scan.

that has seven colors, full graphics, and 729-line resolution. Another of the company's systems uses a drum to obtain a million bits per frame with a 945-line resolution. But Philco eventually plans to build systems with metal oxide semiconductor memories in the hope of lowering cost, and thus edge out the competition.

At present, Hendrickson says, delay lines cost about 2 cents a bit, drums under a penny a bit, cores about 6 cents a bit, and MOS about 50 cents a bit. (Actually, Philco's Microelectronics division has offered a 200-bit shift register at $50, or "two bits a bit," and the National Semiconductor Corp. has a shift register available at 14.8 cents a bit.) All of these assemblies operate at around 1 to 2 megahertz. Says Hendrickson of the potential of MOS memories: "It's my feeling that MOS will beat out drum memories in two or three years."

Time off. Hendrickson points out that raster scan is not producing any picture 25% of the time—during the 20% horizontal and 10% vertical blanking intervals. But neither a delay line nor a drum can stop to use this off-line storage opportunity, he notes.

If the memory were sufficiently versatile, he says, facsimile techniques could be used for digital video. A 1,024-point line that is half black and half white must be stored in a mechanical memory as 512 binary 1's and 512 binary 0's. "But," says Hendrickson, "if you can wait while a video synthesizer spits out 512 bits, you can simply store a binary '512 white,' thus saving on memory capacity."

III. Cost plus

Data Disc's Stevens can draw a whole series of curves to demonstrate the dramatic drop in cost per terminal as a user adds to a disc-memory system. The company's DM-64, for example, will sell for $8,000, including the memory and a character generator. Each read-write head, with amplifiers and clocking, sells for $300; a one-terminal system, then, would cost $8,300, a monitor would be extra.

Added attractions. Other channels may be added at the cost of only the extra recording heads and required interface electronics; a 64-channel system will run about

. . . the memory tracks are only 25 mils wide . . .

$32,000 installed. Monitors, required at each terminal, may each cost as much as $500 doubling the cost of the system. The cost per display comes out to $1,000. A teletypewriter can be added to each terminal for less than $2,000, making a fully flexible system possible for $3,000.

The character generator for the DM-64 is on one of the disc tracks, and is time-shared by the other tracks. Display is on 16 rows of 80 characters each, on a 512-by-640-dot matrix. The Lawrence Radiation Laboratory has already ordered a system to supplement its 100-odd teletypewriter terminals. Lawrence is reportedly set up for some 800 terminals for its computer complex, and would like to have crt displays at all of them.

IV. Waste not, want not

Although the disc may be as much as 16 inches in diameter, the memory tracks on a single disc are only about 25 mils wide and are packed into an inch or so around the edge. The reason for this waste is that the read-write heads take up too much physical space; Data Disc cannot make a "DM-128" because the heads would not fit around the disc.

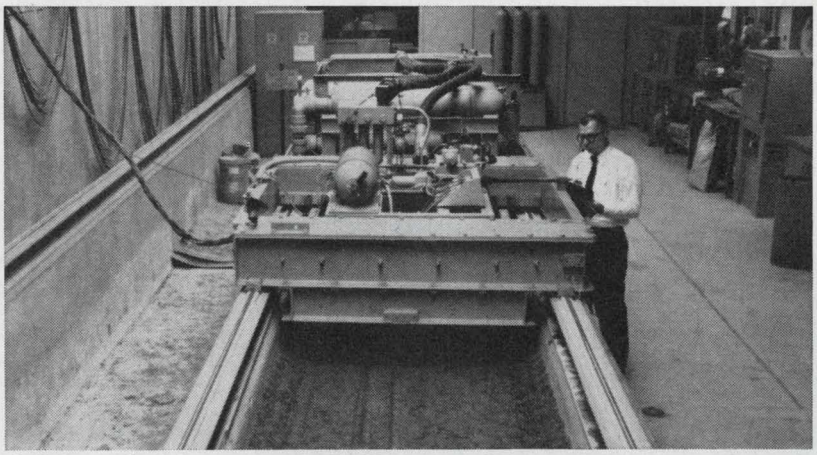
The company is, however, working on what it calls an integrated head—a mask-fabricated transducer made with integrated-circuit techniques. Using this method, 16 transducers could be put on a single head, and as many as 512 transducers could work from a single disc. Stevens talks about building an eight-disc pack with 4,096 heads (at a cost of $1 each) and a half-billion bits of storage. The Western Electric Co., the Bell Telephone System's manufacturing arm, is reportedly interested in such a system for permanent memory applications in its phone switching matrices.

Data Disc admits to being stymied by requirement for high data-rate transmission, but Stevens feels that the terminal clusters represent a sufficiently large portion of the total terminal market (estimated by Philco at $100 million a year) to make development worthwhile.

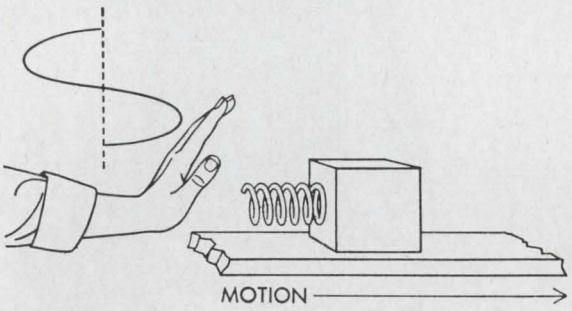
Report from

BELL LABORATORIES

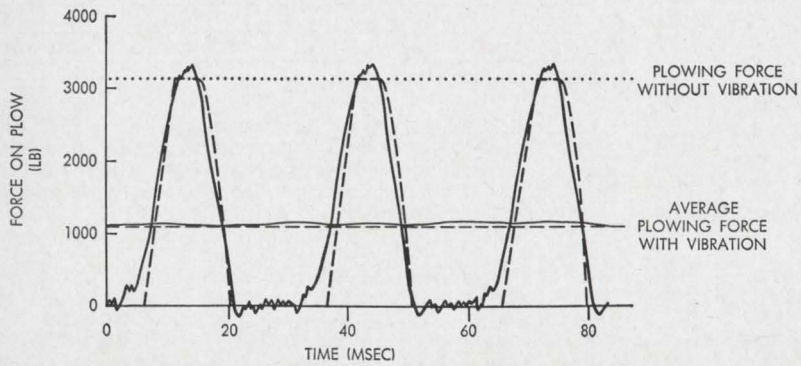
Equations for plowing



Soil dynamics laboratory at the Bell Telephone Laboratories location in Chester, N. J. Test soils of various kinds are placed in the long bin (foreground). A plow blade, not visible in this photo, rides under the carriage frame. The blade can be vibrated over a wide range of frequencies and amplitudes as the carriage is driven along the length of the bin.



According to Bell Laboratories' mathematical model, soil reacts to a vibrating plow blade much like an elastic object being pushed against friction over a surface (sketch above). The hand moves sinusoidally and, during part of each cycle, contacts the spring. The resulting theoretical force-time plot (dashed line in the graph below) shows how vibration reduces plowing force. Superimposed is a solid line showing typical test results with a vibrating blade in a test bin (photo above) filled with silty sand. The blade vibrates front to back 30 times per second. The mathematical model, based on the above analogy, has allowed computer simulation of such soil-plowing systems.



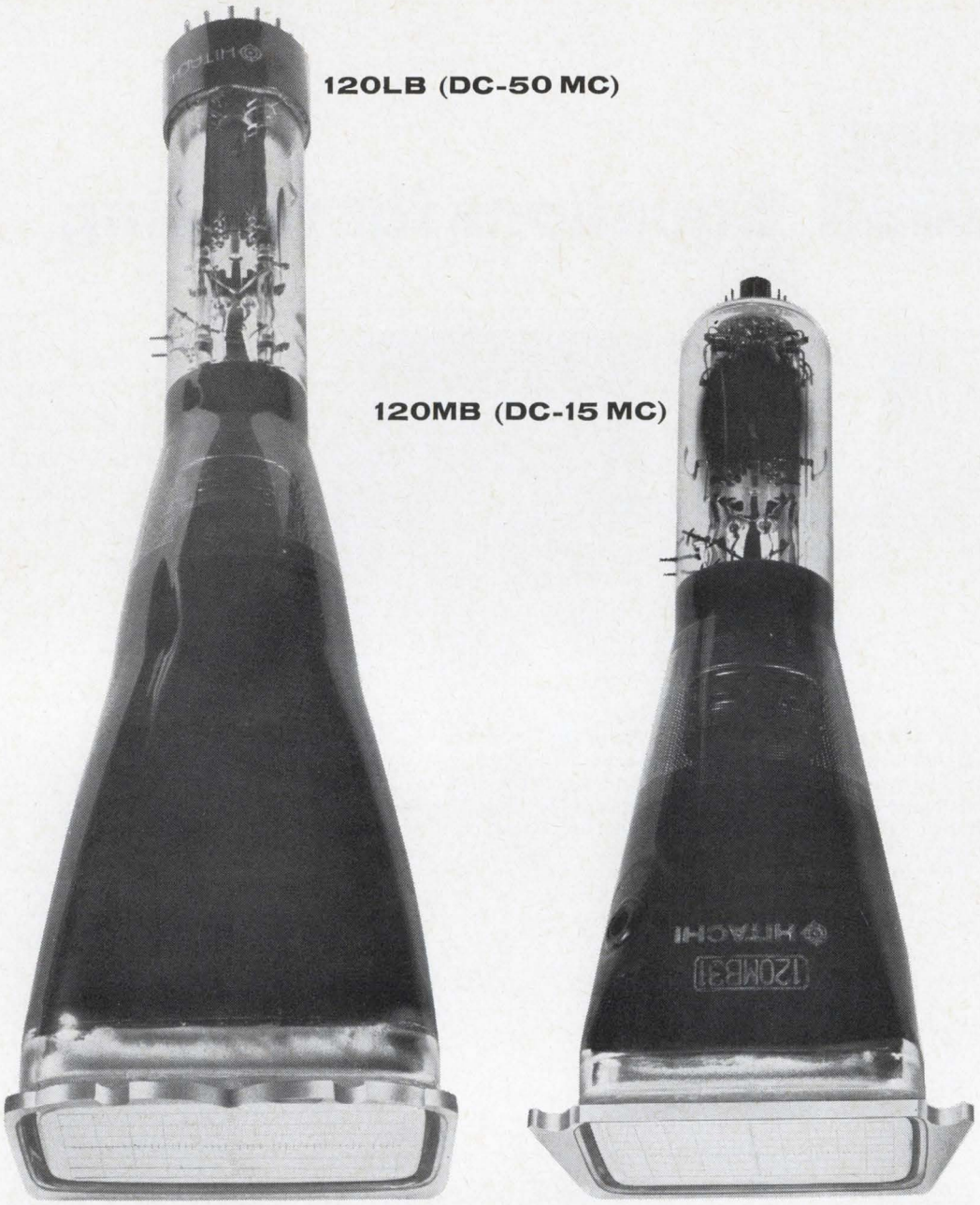
It has long been known that vibrating a plow blade makes it easier to force through soil. But what kind of vibration is most effective? That is, how much power should be applied to the blade and in what manner should the blade be vibrated?

We at Bell Telephone Laboratories are accumulating considerable information on this subject because we need a small, highly efficient plow that will bury telephone wires across lawns and up to houses with minimum drawbar pull. Unlike agricultural plows, which are built for maximum disturbance of the earth, Bell System plows must bury cable and wires with least possible marring of the property.

Recently, this work has been aided by a mathematical model of plow blade-soil interaction. Bell Laboratories engineers R. J. Boyd and C. L. Nalezny found that forcing a vibrating blade through the ground is analogous to pushing periodically on a spring, attached to a block on a frictional surface (left).

This simple model has helped us design a prototype plow that buries telephone wires two feet deep at speeds up to 75 feet per minute. With most of its power applied to the blade, it can cut through rocky soil and tree roots where conventional machines might stall.

Bell Telephone Laboratories
Research and Development Unit of the Bell System



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Surveyor VI was relaunched November 17, becoming the first spacecraft ever launched from another heavenly body. The three vernier engines burned only 2½ seconds and exerted 150 pounds of thrust to lift the 616-lb. spacecraft 10 feet and move it laterally 8 feet.

Four new shipboard radar-computer systems --three of them earmarked for warships of the Federal Republic of Germany -- were delivered recently to the U.S. Navy. Used on guided-missile ships, the advanced systems scan the sky with a high-frequency, narrow pencil beam to determine target's height, range, and bearing. Three systems built under an earlier contract are already operational on Australian destroyers, and others are being installed on U.S. destroyers.

From its synchronous station above the Amazon, NASA's Applications Technology Satellite III has successfully carried out several major experiments. Its "spin-scan" camera (developed by Santa Barbara Research Center, a Hughes subsidiary) is returning high-resolution color photos of the earth's full face. Their accurate color will make it possible to determine height of clouds, width and location of ocean currents, and moisture content of soil.

The mechanically despun antenna aboard ATS-III is receiving signals from earth 10 times more effectively than antennas presently used on communications satellites. Its new VHF transponder is providing high quality two-way radio communications between ground stations and aircraft thousands of miles apart.

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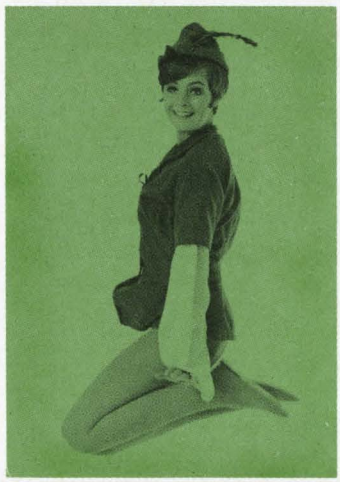

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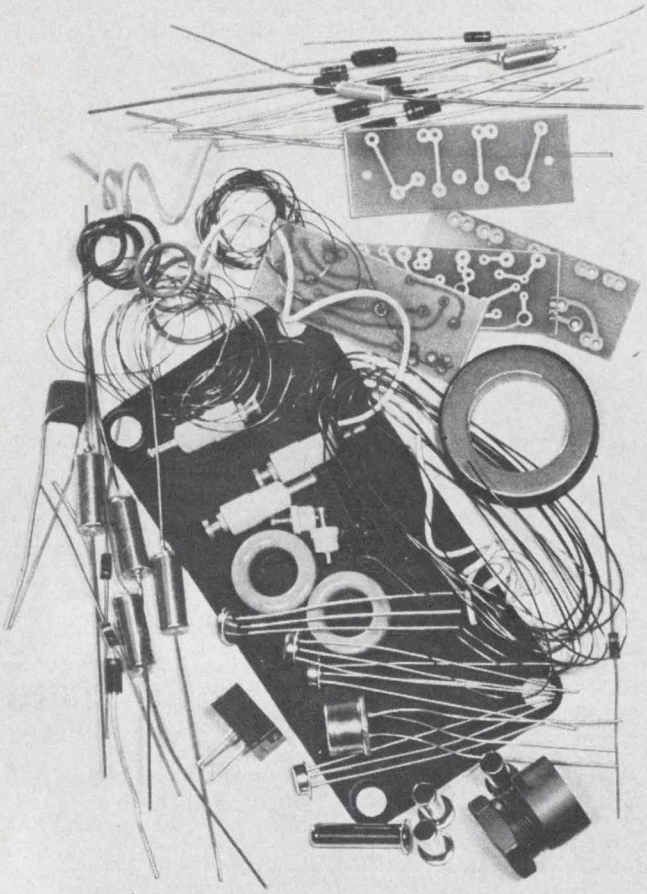

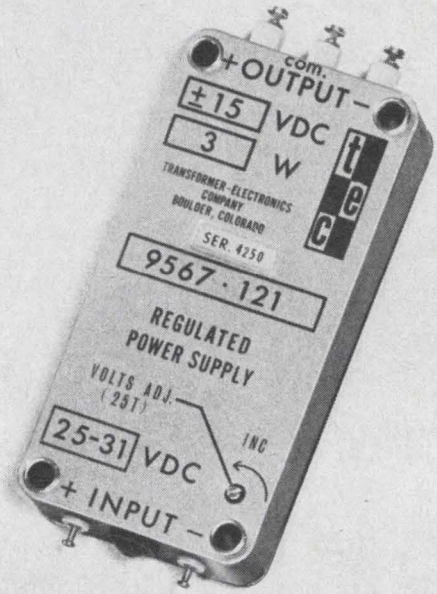

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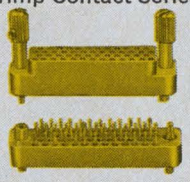

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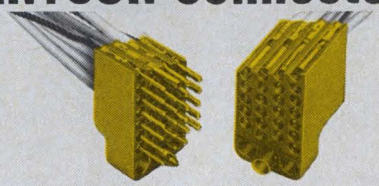

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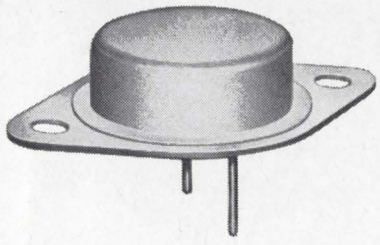
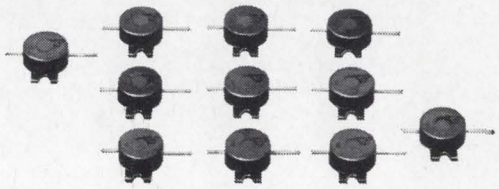


TO-3



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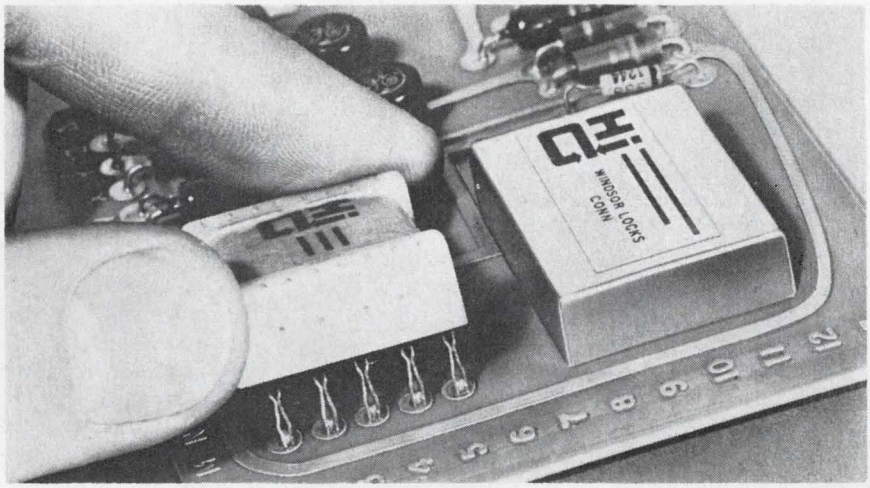
New Products



New components

Outflanking suppliers in the reed-relay field

Hi-G surveyed existing designs before entering the fray with a line of second-source devices

Companies usually enter the relay business by one of two routes. They either develop a unit for a single customer's specific needs and then extend the design to cover broader applications, or they start with a new design and then find a market for it.

A third course has been charted by Hi-G Inc., a manufacturer of crystal-can relays. The company opened its drive to get into the reed-relay business by making a careful study of the 20 major firms in the field to detect areas of product commonality. With this data, Hi-G has come up with a single line of devices that can second-source all the major suppliers of reed relays.

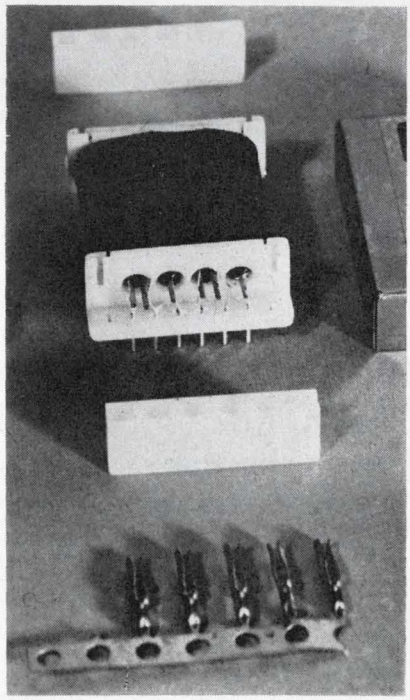
Filling a need. Why would a customer go to a second source in the first place? According to Kenneth Leff, project manager at Hi-G, the answer lies in "workmanship deficiencies" in the primary-source products. He cites the example of one company that has to use an epoxy coating to protect coil terminations because the coil wire is attached to a metal tab. This exposed tab is subject to short-circuiting, he notes. No tab is used on the Hi-G relay and the termination isn't exposed.

Also, "some companies haven't been able to deliver," Leff says. Often, he explains, their main reason for producing reed relays is to fill an in-house need, and when they can't meet their own supply requirements, the outside consumer is out of luck. "Since we don't use the relays ourselves, our customers won't have this problem," he adds.

I. Norms and tradeoffs

In compiling data on the industry, Hi-G found that out of the mass of reed-relay specifications, a few could be considered constant or obviously desirable. For example, a maximum case height of 0.35 inch and length of 1.187 inches were found to be "normal" and were applied to the Hi-G units. These dimensions represent a compromise between the size required by the reed switch and the need for maximum packing density on printed circuit boards. Since the grid size of p-c boards is getting smaller, however, a distance between pins of 0.1 inch was chosen rather than the norm of 0.15 inch. The distance between the pins along the length of the relay is 1 inch.

Make and break. As for the reed switch itself, the question was: make or buy? Leff says many companies that decided to make their own found that the glass-to-metal



Pin and socket. By adding adapter blocks to its top side, the relay can be used in a plug-in setup.

. . . new pin terminal requires only one weld, so overheating during manufacture is avoided . . .

seal used in the switch cracked after the switches had been shipped from plant to plant or even from one part of a factory to another. Further, extremely clean plant conditions are required to avoid contamination on the contacts. Therefore, in designing its 3500 series, Hi-G decided to buy. "We rely on the giants in the switch industry," says Leff. "We're buying the best we can get and pretesting them."

Another problem was switch termination. If the switch leads were bent into position near the connecting pins and welded, a stressed joint was formed. After a while, either the pins would lose their alignment or the glass-to-metal seal would crack. One way to eliminate the problem is to use an intermediary connection between switch and pin—a ribbon lead, for example—but this increases over-all cost and, with the extra weld needed, can lead to overheating of the unit.

Flattop. To get around these hazards, Hi-G engineers designed a new type of pin terminal called a Flextop. It's similar to the standard type of terminal so far as its connecting pin and mounting flange are concerned, but its top, instead of being as thick as the rest of the unit, is swaged to a ribbon thickness. Thus, it's easily positioned next to the switch and requires only one weld.

A unique feature of the Hi-G assembly line is that a printer is connected to the test station. If a customer wants to know the exact specifications for each relay he receives, the units are serialized after testing and the readout is shipped along with them.

II. Plug-in block

The 3500 series includes a wide range of switching arrangements and both dry and mercury-wetted types of contacts. Pin terminals are standard, but a terminal block that enables the units to be used with Berg pins is available if a plug-in arrangement is desired. The block attaches to the top side of the relay and the whole assembly is flipped over with the case reversed, giving the package a plug-in terminal configuration without adding to the device's height.

With the machine Hi-G uses to mold the bobbins, adjustments can be made in the final mold without changing the dies. If 0.15-inch pin centers are needed, a plate is added to the bobbin mold and a new series, called the 3600, is produced. Also, the holes in the bobbin are big enough to accept the largest of the miniature reed switches.

Though Hi-G is getting into the reed-relay field as a second source, it feels its line of standard devices can win a big slice of the $33 million market.

Hi-G Inc., Windsor Locks, Conn. **[338]**

Comparison of Major Characteristics

Characteristic	½ Size Crystal Case Relay	Series 3500 Dry	Reed Relays Mercury-Wetted	Solid State Switching Device
Overall height	0.400 in.	0.350 in.	0.350 in.	0.300 in.
Weight	10.5 gm	6 gm	7 gm	10 gm
Operate time	2.5 msec	6 msec	2.0 msec	10 nsec
Bounce time	2.5 msec	0.2 msec	None	None
Release time	1.0 msec	0.05 msec	0.05 msec	50 nsec
D-c contact mating	52 watts	10 watts	50 watts	10 watts
Life at rated load	1×10^4 cycles	10×10^6 cycles	100×10^6 cycles	Measured in hours
Life at dry circuit load	1×10^6 cycles	100×10^6 cycles	Indefinite	Measured in hours
Initial contact resistance	0.050 ohm	0.100 ohm	0.050 ohm	1.0 ohm
Open circuit resistance	1×10^8 ohms	1×10^{11} ohms	1×10^{11} ohms	1×10^5 ohms
Inductive load switching	Excellent	Poor	Fair	Poor
Inrush load switching	Excellent	Poor	Good	Good
Transient voltage immunity	Excellent	Good	Good	Poor
Shock	50G	50G	Poor	Excellent
Vibration	30G	30G	Poor	Excellent
Approximate cost	$6	$2	$4	$8

Pick and choose. Each of the four most popular types of miniature relay provides certain advantages. If speed is needed more than isolation, solid state switches should be used. When cost is the prime factor and high isolation is also required, the reed relay is the best choice.

Let's put our catalogs on the table

Your table (or desk) to be more specific. They're the most valuable set of reference manuals available on magnetic shielding materials and fabrication methods. They cover the complete line of Netic and Co-Netic Alloys from MSD. They're a veritable gold-mine of information from the company that's provided over 80% of the magnetic shield designs currently in use and whose products are the recognized world standard in its field.

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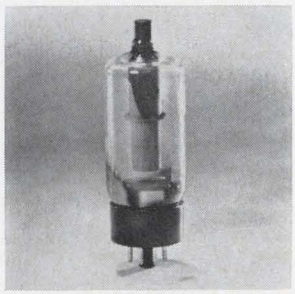
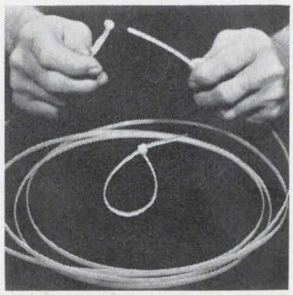
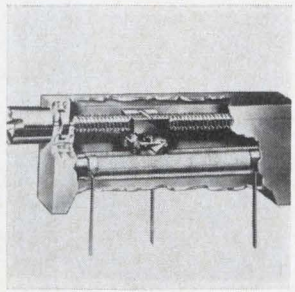
New Components Review



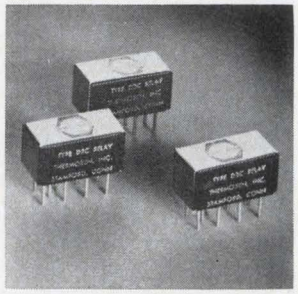
Beam triode 6LH6-A is for use as a shunt regulator in the h-v power supply of color tv receivers. It has built-in x-ray shielding. With a maximum d-c plate voltage of 27,000 v, the tube has a max. d-c plate-current rating of 1.6 ma, and a max. plate-dissipation rating of 40 w. Heater voltage is 6.3 ±0.6 v; heater current, 0.2 amp. General Electric Co., Owensboro, Ky. 42301. [341]



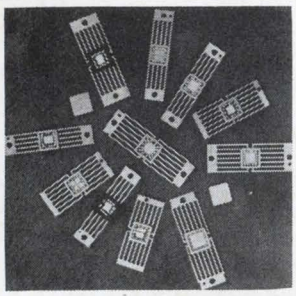
Nylon-fabricated cable ties series Ty-228 come in 19 sizes, in lengths ranging from 18 to 120 in. They are designed to tie oversize wire bundles or to secure wires running parallel to large size cable pipe and/or conduit. They have self-locking heads for easy installation without special tools in the field or plant. Thomas & Betts Co., 36 Butler St., Elizabeth, N.J. 07207. [342]



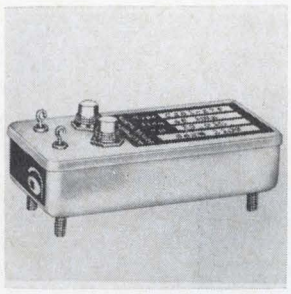
Wirewound commercial trimmer 3800, employing a solvent resistant case, is suited for all applications employing dip and flow soldering. Resistance values are from 10 to 20,000 ohms. A damage-proof clutch eliminates open circuits, contact damage and wiper slippage. Volume price is under $1. Amphenol Controls Div., Amphenol Corp., 120 S. Main St., Janesville, Wis. 53545. [343]



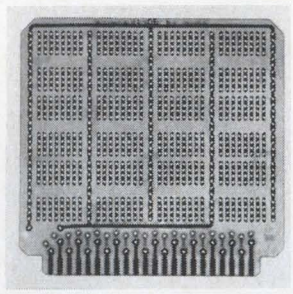
Type D multireed relay incorporates 2 Form C contact groups in a half-crystal-can size package. Operate and release times, including bounce, are in the order of 1.5 msec max. Thermal electromotive force, generated by coil warm-up, is less than 3 μv. Dynamically generated noise is less than 3 μv peak-to-peak. Thermosen Inc., 375 Fairfield Ave., Stamford, Conn. 06904. [344]



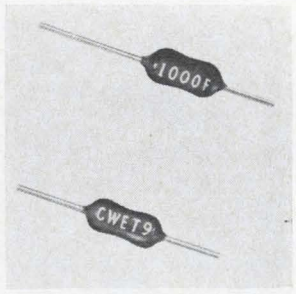
Flatpacks measuring ¼ x ¼ in. are available in both 10- and 14-lead configurations with ceramic, metal or glass bottoms. On glass bottom types, a grounded pad is provided for device mounting. On ceramic bottom types, up to 4 electrically isolated metalized pads are offered. All are gold plated to a minimum thickness of 100 μin. Philco-Ford Corp., Blue Bell, Pa. 19422. [345]



Crystal oscillator series CG features dual output of the same frequency for redundancy applications. Holding a frequency tolerance of ±0.01% over a temperature range of −55° to +75°C, the series is available with frequencies from 20 khz to 150 Mhz. Size is 1½ x 3⅛ x 1⅜ in. Price range is $85 to $225. Accutronics Inc., 628 North St., Geneva, Ill. 60134. [346]



Breadboard model 11-DE-1 accepts up to 12-, 14-, or 16-pin dual in-line packages, as well as associated discrete components. It is glass epoxy (G-10) 2 oz copper on two sides, and is finished with 0.00002 in. gold over 0.0002 in. bright nickel. It accepts standard 22- or 44-pin edge connectors. Douglas Electronics Inc., 718 Marina Blvd., San Leandro, Calif. 94577. [347]



Miniature, 1/10-w metal film resistor type X55 is designed to meet and exceed mechanical and electrical parameters of MIL style RN55 C and E as specified in MIL-R-10509. Two temperature coefficients are offered: T2 (±50 ppm) and T9 (±25 ppm). Resistance ranges to 1 megohm are available. Continental-Wirt Electronics Corp., 26 W. Queen Lane, Philadelphia, Pa. 19144. [348]

New components

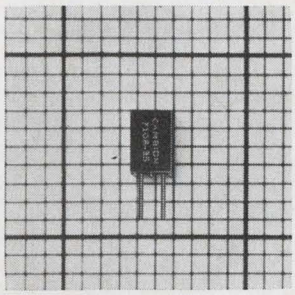
Pots straighten out and go linear

Slide-motion instrument gives visual indication without extra knob; swing to linear motion control seen

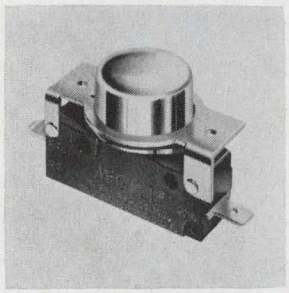
Linear motion potentiometers have made their appearance in European consumer products during the last few years and, says Clyde Robison, sales manager for the Stackpole Carbon Co., "The big swing is coming now to the U.S. We plan to get a jump on the rest of the industry." Stackpole's version of the linear motion potentiometer, called the Slide-trol, is the first low-cost unit to be made and marketed in the U.S.

To hold the price to 10-15 cents each in quantity orders, Slide-trol was designed for completely automated production. Major parts are two bakelite sections that make up the body, a carbon-composition resistance element, and a sliding contact. Unlike the wiper contact in rotary controls, the Slide-trol uses a coil spring, not a point contact. The spring provides nine contact points, reducing contact pressure and wear, and keeping contact resistance at a minimum.

In consumer products, such as small power tools and kitchen appliances, the speed of the tool is controlled by sliding a thumb switch or by depressing a trigger. This linear motion is transferred by a linkage arrangement to a rotary

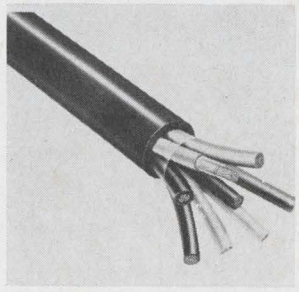


Molded subminiature r-f chokes in the 7108 line consist of 49 models that cover a range of inductances from 0.10 μh to 1,000 μh. They measure 0.365 x 0.228 x 0.125 in. Mounting pins are 0.020-in. diameter with a pin spacing of 0.125 in. Price is 65 cents to $1.11 each (in 100-499 lots). Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass. 02138. [349]

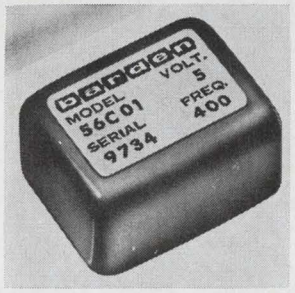


Snap-action switches in the 2600 series are now equipped with chrome-plated actuator buttons. Rating is 20 amps, 125-250 v a-c, 1 h-p 125 v a-c, 2 h-p 250 v a-c. They are single-pole double-throw devices with a choice of spade or screw terminals. Mechanical characteristics feature differential travel less than 0.005 in. McGill Manufacturing Co., Valparaiso, Ind. 46383. [350]

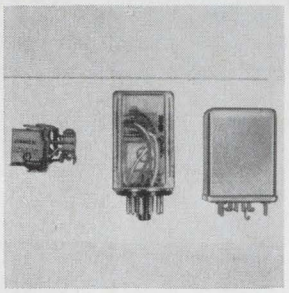
Circular ceramic chip carrier CM329 is for large volume commercial semiconductor use. It allows cross-over metallization under the carrier, and noncritical alignment on the p-c board with consequent use of mass production equipment to attach all carriers to the substrate simultaneously. Price: 2 cents/unit in 10 million lots. Frenchtown/CFI Inc., Frenchtown, N.J. 08825. [351]



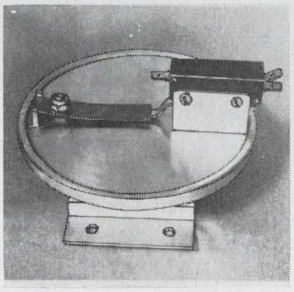
The 600-v type 20/10 control cable is rated for safe continuous operation at temperatures of —40° to 75°C. The 19-strand copper conductors insure extreme flexibility and can be specified in sizes 10, 12 and 14 AWG. Each conductor is insulated with 20 mils of polyethylene and 10 mils of polyvinyl chloride. ITT Wire and Cable Div., ITT Corp., Pawtucket, R.I. 02862. [352]



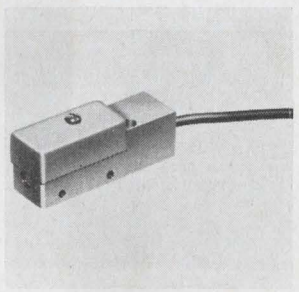
Microminiature tuning forks occupy less than 0.29 cu in. and weigh under ½ oz. Designed to meet MIL-STD 202B, specifications include accuracy to 0.001%; stabilization time, approximately 1 sec; rise and fall time, 0.2 μsec or less; operating temperature, —55° to +125°C. Price is from $47 in quantities of 25. Barden Co., 675 Valley Dr., Hermosa Beach, Calif. 90254. [353]



Sensitive relay series 5 is offered with single-to-6-pole contacts in 3 package designs (open, dust cover, and hermetically sealed). All are rated for 5 amps except the spdt which is rated at 2 amps. Standard sensitivity is 100 mw per pole but the spdt relays are available in either 5- or 10-mw sensitivity. Kurman Instrument Corp., 15 Burke Lane, Syosset, N.Y. 11791. [354]



Sensitive, static pressure switch Catalog 144 can operate on gas or liquid pressures of from 0.3-in. water column to 20-in. water column by proper selection of one of the available adjustable ranges. It will withstand overload of 150 lbs/sq in. Contacts have an electrical rating of 15 amps, 125-250 v a-c. Henry G. Dietz Co., 14-26 28th Ave., Long Island City, N.Y. 11102. [355]

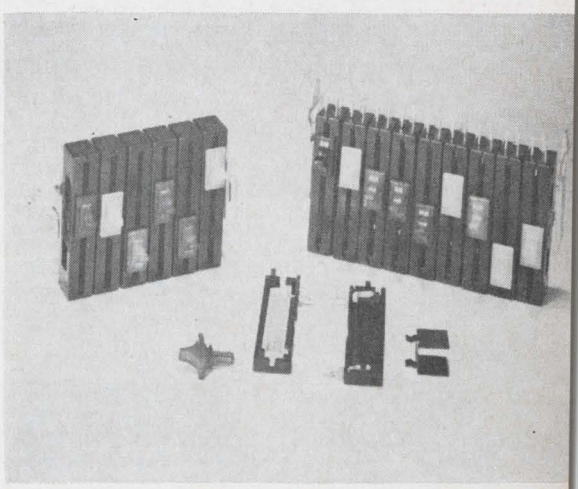


Magnetic detector switches in the Ferotec line sense ferrous metals without the use of external magnets. Operating medium is the smallest possible to give maximum air gap, and switching repeatability is generally ±0.002 in. Operating elements are hermetically sealed reed relays encapsulated in a high density plastic. Electro-Tec Corp., Box 667, Ormond Beach, Fla. 32074 [356]

potentiometer. In this application, the Slide-trol eliminates the "middleman"; the linkage isn't needed because the trigger is connected directly to the slider on the linear potentiometer.

In industrial applications, the Slide-trol offers the advantage of small size and close mounting. Because the units are rectangular, they can be packed closer together, taking up less space on the instrument panel. Another reason why instrument manufacturers like the idea of a linear potentiometer, Robison says, is that its value can be seen at a glance by observing the position of the thumb-slider that moves the contact.

Television manufacturers see an application for the Slide-trol in the convergence panel on color sets. Such panels contain about nine potentiometers, used to adjust the focus and color purity. As a set comes down the production line, an operator adjusts each control until he's satisfied the picture he sees is correct. If the controls are too far out, there may not be enough time to get a good picture, and the set is pulled off the line and adjusted again, raising the cost. If Slide-trols are used, all nine controls could be placed side-by-side and a template used to set them at an



Slider. Linear motion potentiometers are grouped for easy mounting.

approximate value. This would minimize the amount of adjustment needed on the assembly line.

The units, which are being sampled now, are made in three configurations: mounted horizontally, vertically, or sideways. With resistance values between 10 and 100 ohms they are rated at 1.75 watts safe load, 2 watts maximum. For 100 to 1,000 ohms, they're rated at 1.5 watts safe load, and for values over 1,000 ohms, 1.25 watts is the safe load.

Stackpole Components Co., Box 14466, Raleigh, N.C. **[357]**

New components

Amplifier bridges cost-specs gap

Cuts the drift to 3 microvolts at low signal levels

Drift is the largest single problem with circuits designed to handle d-c signals. To overcome the problem, Analog Devices Inc. has developed an amplifier that employs a novel circuit to limit drift. The differential operational amplifier, designated the model 183, costs $40, and provides a maximum voltage drift of 3 microvolts per degree centigrade.

The amplifier's low drift enables it to handle 5 millivolt signals with better than 1% accuracy for a 20°C temperature variation. Ordinarily, such accuracy for low-level signals would involve a chopper-stabilized amplifier costing about $100 or the recently-announced generation of ultra-low-drift differential amplifiers, priced from $80.

The 183 bridges the gap between the high-priced but excellent-performance chopper, low-drift differential types, and the existing conventional amplifiers, based on discrete-transistor input stages.

Key to 183's high voltage stability is a dual-transistor input stage, which reduces the effects of temperature gradients within the am-

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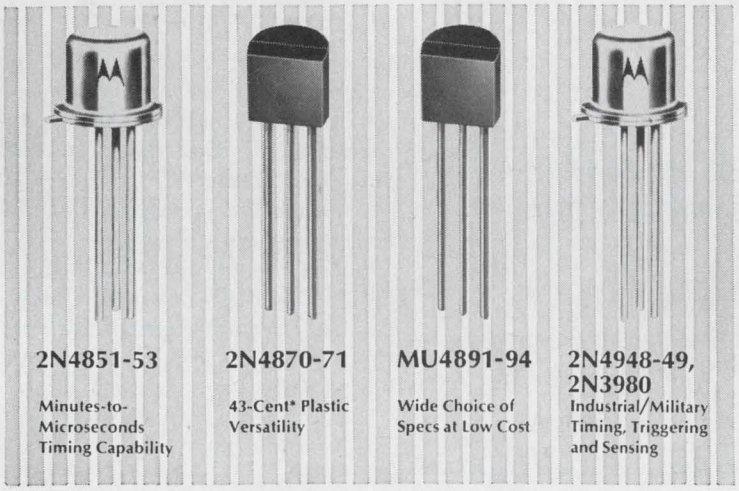

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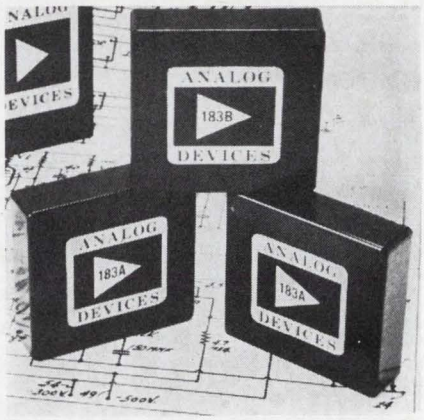
Semiconductors

Circle 177 on reader service card



Chopperless. Differential op amp uses dual-transistor input stage for high sensitivity.

plifier. This reduction is due to the low thermal mass and the close physical placement of the two input-transistor junctions. The net result is a temperature stability 10 times better than conventional discrete-component op amps.

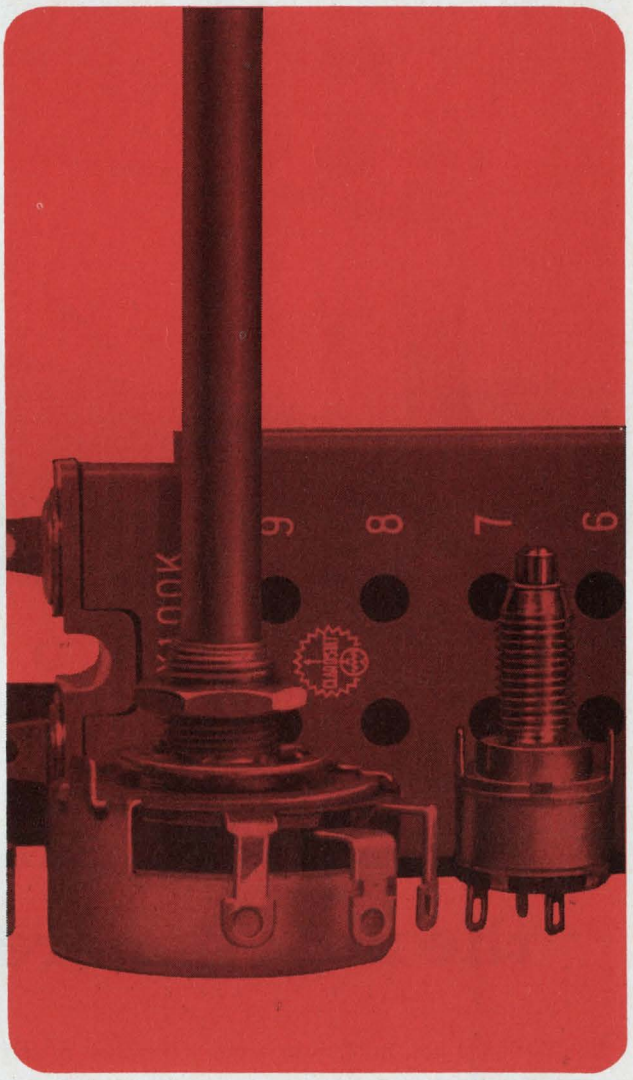
One of the subtle points of op amp specmanship lies in the definition of equivalent input drift. Amplifiers with 5 μv/°C maximum voltage drift have been available for some time. However, such units use separate transistors in the input stage, each with an intrinsic base-emitter voltage drift of 2500 μv/°C. The 5 μv/°C specification comes about because, under isothermal conditions, the two input transistors track each other within the specified 5 μv/°C error band.

In practice, the two input-stage junctions are rarely allowed to attain the same temperature, which is the condition for the 5 μv/°C spec to mean anything. Instead, thermal gradients that produce as little as 0.1°C temperature-difference between the two junctions can create a 240 μv offset. Such a temperature gradient occurs during initial warmup. It can be caused by locating the amplifier near drafts, or near high-power resistors, transformers, and other heat-dissipating elements.

Reduces error. The dual-transistor input stage in the 183 cuts the error due to temperature gradients because the two input transistors have virtually no thermal mass, so that they quickly reach temperature equilibrium.

Besides lower cost, the 183 offers a number of technical advantages in comparison with chopper stabilized amplifiers. Differential inputs

RUGGEDNESS ...a New England Tradition



A TRADITION AT CLAROSTAT TOO is ruggedness. The qualities that have contributed to the New England tradition of strength of character as well as industrial products are reflected in Clarostat potentiometers, resistors and switches. Clarostat components work harder at the job—last longer in the most critical applications. For more than 40 years, the name Clarostat has stood for the finest performance at the fairest prices. Today's applications are far more precise—much more demanding—yet Clarostat is still the leader—the recognized single source of quality and honest value thanks to a continuing program of research and engineering. For the finest in hard working potentiometers, resistors and switches—the most in honest value—fast service—off-the-shelf delivery—you can't do better than...

CLAROSTAT

CLAROSTAT MFG. CO., INC., DOVER, NEW HAMPSHIRE 03820

Circle 179 on reader service card

. . . metal film resistors improve stability . . .

allow the amplifier to be used in noninverting configurations, which in turn bootstraps the input impedance up to 1,000 megohms or higher. This is roughly 1,000 times better than the input impedance of most chopper-stabilized types. Another important advantage over chopper-stabilized amplifiers is the 183's low noise of 1 μv peak-to-peak. By contrast, a chopper amplifier's noise level is typically five or 10 times higher, typically 5 μv to 10 μv, peak-to-peak.

Another advantage of the 183, as compared with chopper types, is its low height, 0.4 inches. This means the difference between occupying one instead of two card spaces in a standard 0.5-inch centered card file. Actual dimensions of model 183 are 1.5-inch square by 0.5 inch high, whereas most encapsulated chopper amplifiers are about 1 inch high by 1 inch wide, and up to 3½ inches long.

Long-term stability. Metal film resistors are used to achieve good long-term stability. It is roughly 10 times more stable, at a long-term drift rate of 5 μv/day, than conventional op amps. Its long-term stability—absence of any need for readjusting the zero—is the prime remaining reason for using chopper-stabilized amplifiers. These amplifiers correct internal drifts regardless of whether aging or temperature variation causes them.

The dual-transistor input circuitry has the ability to minimize low-frequency offset variations caused by slight changes in temperature gradient. Ordinary discrete-transistor amplifiers are highly sensitive to slight ambient temperature changes, and develop output variations that resemble noise.

The 183 comes in two versions, designated models 183A and 183B, which are identical except for maximum voltage drift and price. Model 183B is the high-stability version discussed, and features the 3 μv/°C maximum drift and $40 unit-quantity price. Model 183A has a worst-case drift spec of 6 μv/°C and is priced at $30.

Analog Devices Inc., Cambridge, Mass. **[358]**

The one-up op amp.

Since we announced the LM-101 op amp, our improvement on the 709, we've had great response: fan letters, purchase orders, and a new idea.

So now we have two 101's. The original LM-101 and the LH-101 which goes it one better by putting all required frequency compensation inside the package.

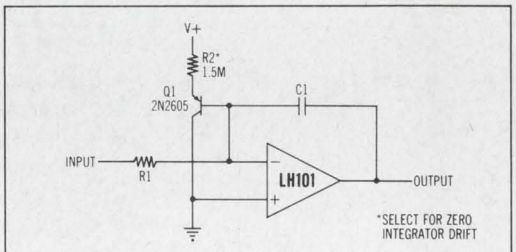
Operation guaranteed for supply voltages from ±5V to ±20V.

Low current drain—even with the output saturated. No latch-up when common-mode range is exceeded. Continuous short-circuit protection.

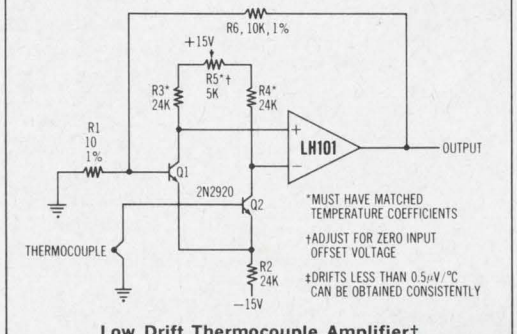
Input transistors protected from excessive input voltage.

Available now from our stocking distributors.

Prices (100 pcs.): LH-101, $48.00. LH-201 (commercial unit), $11.40. Write for details: National Semiconductor Corporation, 2975 San Ysidro Way, Santa Clara, California 95051, (408) 245-4320.



Integrator with Bias Current Compensation



Low Drift Thermocouple Amplifier‡

National Semiconductor

Two photoresistors share the light

Independent cells, controlled by same lamp, track each other closely

A two-in-one deal is offered designers in a light-controlled resistor.

Hewlett-Packard Co.'s dual-cell, photocontrolled resistor enables one input to control two isolated, independent circuits. Consisting of two identical, resistive photocells and a 12-volt incandescent lamp in one package, it was designed for control applications in low-frequency (less than 10 hertz) circuits. It can also be used in switching applications where contact noise has to be avoided.

"You can also use one resistor for modulation and the other for demodulation. And the device can help in analog modeling," says applications engineer Frank Lee.

Resistance of each cell ranges from hundreds of megohms if the lamp is off to less than 10 kilohms when 10 volts are applied to the lamp.

One of the most important features of the unit is close tracking: resistances of the cells are always within 10% of each other for lamp voltages between 3 and 10. "The biggest problem we had was getting uniform light distribution on the two cells," says Lee.

The length of the package, designated the HP 5028-4509, is four inches, including leads. The unit price is $11; for quantities between 10 and 99, the price is $9.50.

Specifications (at 25°C)

Cell dissipation	125 mw
Cell resistance (10 v)	3.9 kilohms typical 6.8 kilohms max
Cell resistance (dark)	500 megohms typical 100 megohms min
Maximum lamp voltage	12 v (45 ma)
Lamp-to-cell resistance	10^{12} ohms
Lamp-to-cell capacitance	0.03 pf typical 0.05 pf max
Breakdown voltage across cell	100 v

Hewlett-Packard Co., Palo Alto, Calif. 94304 **[359]**

Super Zener

$4.50

Who would be mad enough to come into the market with a four-dollar-and-fifty-cent Zener when you can buy some cheaper than aspirin.

We would. And did.

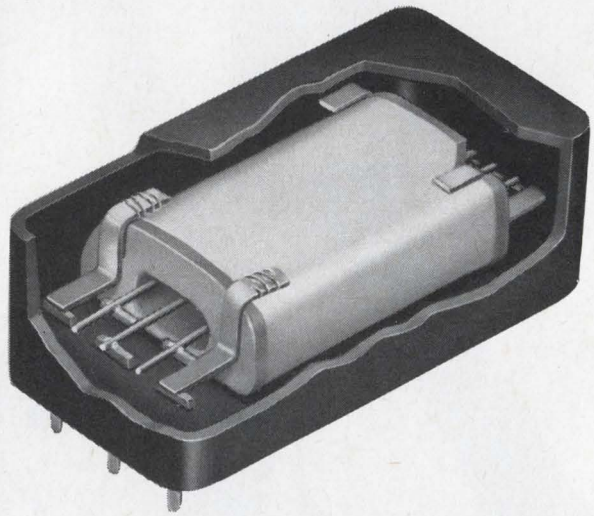
Our new LM-103, Super Zener, has the sharpest low-current knee there is. It's a monolith, packaged in a two-lead TO-46 header.

Impressively, breakdown voltage changes less than 150 mV when the current is varied between 10 μA and 10 mA or only 15 mV between 100 μA and 1 mA. This is true for any of the 10 voltages available from 5.6V down to 2.4V.

The only way to get our $4.50 Zener any cheaper is to buy them at $3.00 for 100 or more. O.K. now, let's hear from the big spenders. National Semiconductor Corporation, 2975 San Ysidro Way, Santa Clara, California 95051 (408) 245-4320.

National Semiconductor

the fate of the "open" Reed Relay IS SEALED!



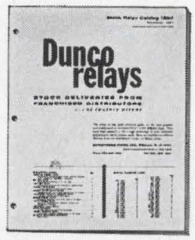
For almost the price and size of open types, this new Struthers-Dunn MRRK Series has all the advantages of conventional enclosed, magnetically-shielded reed relays.

A new fast method of plastic sealing gives complete protection that your production department will really appreciate during mounting, soldering, and cleaning. Insulation resistance remains above 10^{12} ohms.

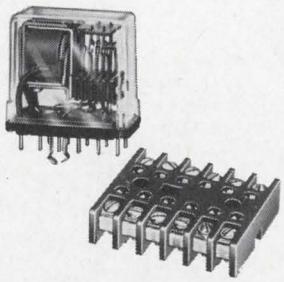
Only 0.66″ wide by 1.29″ long by 0.48″ high (including 4 standoff pads), the case accommodates single or double coils and up to 3 single-throw or up to 2 double-throw, miniature reed switches. Internal leads are welded to 0.1″ grid-space P/C terminals.

In stock now at Struthers-Dunn distributors in most popular configurations. For detailed information, request Data Bulletin B/3110 on the new MRRK Series. Check the Reader Service number shown below.

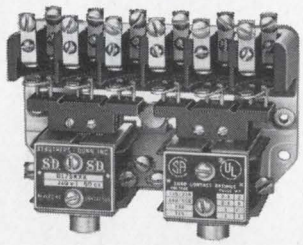
There's always more to draw on where you find the most to start with



World's Largest Relay Line
More than 5,348 different types! Sold through more than 100 franchised distributors! Get our Stock Relay Catalog 1520 for details on the most frequently-needed aerospace, reed, industrial, and special-purpose relays, contractors, and motor controls. Check the appropriate Reader Service number at right.



Largest Line Of Plug-Ins
This integrated line of general-purpose, latch, sequencing, and timing relays will save your wiring time, make control panels neater, cut costs. S-D socket terminals are all instantly accessible and on one plane. No complex multiple-level wiring! Send for full story. Check the proper Reader Service number at right.



More Ways To Reverse A Motor
No one else offers as wide a choice of motor reversing contactor designs for general and definite purpose applications up to 100 HP . . . including hoists, motor-operated doors, windows and elevators as well as machine tool auxiliaries. Details on request. Check the proper Reader Service number at right.

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Check numbers on the Reader Service Card for any or all the items of interest to you.

#512 **MRRK Relay Bulletin**
#513 Stock Relay Catalog
#514 Plug-in Relay Bulletins
#515 Motor Control Catalog

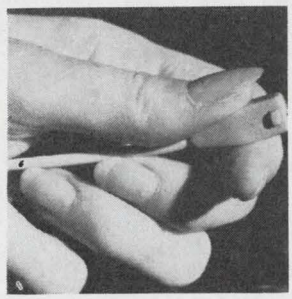
S-D

STRUTHERS-DUNN, INC.

PITMAN, NEW JERSEY 08071

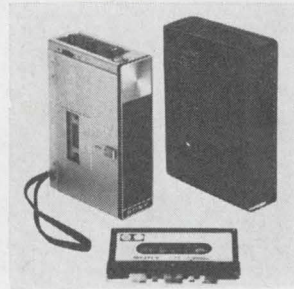
New Consumer Electronics Review

Cassette tape recorder 28L09 operates on six "C" batteries or a-c power. It has solid state 7-transistor circuitry. The unit records up to 60 minutes at 1⅞ ips, and has an easy-to-read combination record and battery indicator. It measures 10 x 7 x 2½ in. and weighs 5 lbs. Suggested retail price is $69.95. Arvin Industries Inc., 1531 E. 13th St., Columbus, Ind. 47201. [381]

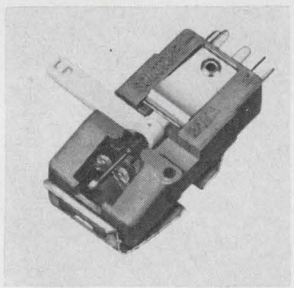


Subminiature push-to-talk microphone called MicroMike is self-shielded against external fields and has a nominal impedance of 5,000 ohms at 1 khz. Useful response is from 400 to 5,000 hz and typical sensitivity is 80 db below 1 volt per dyne/sq cm rms pressure. It is suited for pocket transmitters and tape recorders. Unex Laboratories, Hathorne, Mass. 01923. [382]

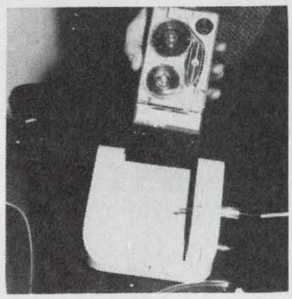
Solid state inverter/charger KG-666 is a Knight-Kit unit that converts 12 v d-c to 110-130 v a-c. It operates a-c appliances in cars, boats and trailers. Square-wave output is 55-65 hz at 200 w continuous power rating. The unit measures 4¾ x 8 x 8¼ in. The kit, designed for easy assembly, is priced at $44.95. Allied Radio Corp., 100 N. Western, Chicago 60680. [383]



Pocket-size cassette tape recorder, Sony Easy-matic TC-50, offers built-in microphone and speaker, as well as push-button rewind or back-up and push-button fast forward. It also has automatic recording control. Clearly visible is a battery level and recording modulation meter. Retail price will be under $125. Superscope Inc., 8150 Vineland Ave., Sun Valley, Calif. 91352. [384]



Phonograph cartridge 24TA is for the new sound in recordings being offered by major disk companies. Mechanical design includes a snubber pad of resilient synthetic rubber that is set between cartridge body and mounting bracket to avoid mechanical vibrations. Frequency response is 20 to 15,000 hz; separation, 25 db at 1,000 hz. Sonotone Corp., Elmsford, N.Y. 10523. [385]



Dictating-transcribing system Fi-Cord 300/303 fits in a case no larger than a woman's handbag. It is compatible for transcribing on double- as well as single-track recorders. The transistorized and automated units sell for $209.95. Price for the transcribing stand and footpedal, stethophone and earpiece is $69.95. Karl Heitz Inc., 979 3rd Ave., New York 10022. [386]

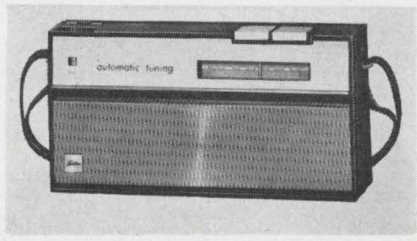
Stereophonic solid state home reproduction system HA-20 features a 20-w peak music power amplification system with integrated 8-track tape cartridge player and 2 matching speaker cabinets, with each cabinet containing 2 high fidelity 5¼-in. speakers. Suggested retail price for the ensemble is $139.95. Lear Jet Corp., 13131 Lyndon Ave., Detroit, Mich. 48227. [387]

Ultrasensitive intruder detection system, Detectalarm ML-1, utilizes a built-in microphone audio sensor to give early warning of forced entry. It will alert police, set off alarms and/or automatically dial a pre-set phone number. With supplementary sensors added, it also detects fire, flooding, etc. Alarmtronics Engineering Inc., 154 California St., Newton, Mass. 02195. [388]

New consumer electronics

Tuning bar replaces radio dial

Motor-driven system hunts strong signals; sensitivity selector squelches weak, remote stations



Music by the bar. Radio automatically searches spectrum for stations when either section of bar is depressed.

Because most transistor radio circuits are similar in design, both manufacturers and consumers tend to rely on transistor count, speaker size and battery capacity as indexes of the radio's sensitivity and over-all performance. When a producer goes beyond these parameters and manufactures a radio with some added features, marketing aspects of the new design warrant special attention.

Tokyo Shibaura Electric Co. has introduced a touch-tuning a-m portable transistor radio, model 15M-915, which may signal a new trend in radio receiver design. The set, marketed in the U.S. by Toshiba America Inc., has a motor-driven, signal-seeking tuning system that hunts for the stations when one side of a double tuning

our adaptable conformist.

. . . a-m signal from desired station shuts off tuning drive motor . . .

bar is touched, a tone switch that adds treble to improve the quality of voice reception or bass to enhance musical programs, and a sensitivity selector switch by which weak, distant stations can be selected or rejected at will.

Drives capacitor. Touch tuning does away with manual tuning by dial. Automatic tuning is achieved with the aid of a tiny d-c motor that drives a standard tuning capacitor in either desired direction by a light touch of a tuning bar, which operates a clutch that engages the transmission system.

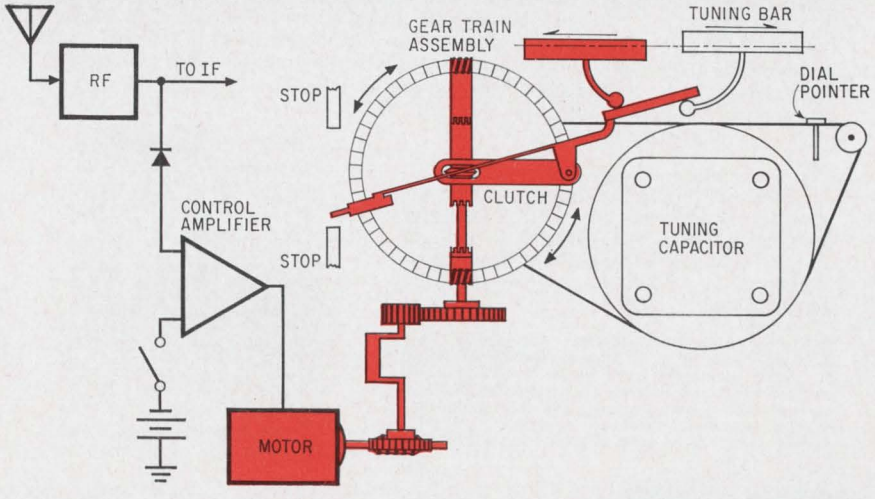
The direction of rotation is determined by selection of the upper or lower drive gear through the tuning bar, and the tuning capacitor rotor is then driven through a conventional dial cord with station pointer attached. The drive motor is turned on or off by an amplifier whose input signal is derived from the mixer output. The amplifier is biased to saturation, enabling the motor to be turned on when power is applied. However, if the set is tuned to a station, the presence of a signal reverse-biases the control amplifier to remove power from the motor.

In operation, the indicator is driven to the next station where it stops automatically, unless the tuning bar is depressed to defeat this action. When the indicator comes to the end of the dial, it will automatically stop and reverse direction. An automatic frequency control circuit ensures that the set is always tuned to the station.

The squelch. The 15M-915 can be set to pick up or reject distant stations by setting a three-position switch for the desired sensitivity. In the local position, the set rejects all weak stations with a squelching action, and only strong ones are received. In the distant position, the switch enables the set to operate at its maximum sensitivity.

The Toshiba radio covers the standard broadcast band, from 530 kilohertz to 1600 kilohertz, and delivers a maximum power output of 300 milliwatts into its 8-ohm, 3½-inch diameter permanent-magnet speaker. The set's high output level is achieved by a push-pull power amplifier which is driven by an interstage transformer with a high step-up ratio. An earphone jack mutes the speaker for private listening while a volume selection window avoids loud turn-ons. It employs a ferrite core antenna and is powered by three C-size flashlight cells. It has a complement of 14 transistors and 8 diodes, measures 8¾ inches wide, 4⅜ high, and 1¾ deep, and weighs 2 pounds. Equipped with earphone and carrying case, the model 15M-915 retails for $39.50.

Toshiba America Inc., 530 Fifth Ave., New York, N.Y. 10036 **[389]**



Autotuned. A light touch on tuning bar engages forward or reverse drive mechanism to rotate capacitor and move pointer. A station signal inhibits the amplifier to turn off drive system.

←Circle 186 on reader service card

Test-set kit for plant or shop

Sweep/marker generator simple to use, requires infrequent calibration

Kit-building is one way the radio and television set-maker or service technician can increase his test capability without going overboard on high-priced laboratory instruments.

For most test and alignment applications in the factory or on the service bench, low-cost service instruments are not only acceptable but desirable since they are simpler to use and require less frequent calibration. One instrument that falls into this category is a sweep/marker generator for servicing television sets and frequency-modulation receivers. Marketed in kit form by Allied Electronics Corp, it is called the KG-687. The instrument, priced at $120, exceeds the requirements for production testing.

Sharp on the mark. The all-solid-state generator has a minimum of drift, Allied says, and does not require warm-up. Its sweep oscillator circuit covers a range of 3 to 220 megahertz in five bands, and the marker oscillator frequencies extend from 2 to 225 Mhz.

The sweep width goes up to 18 Mhz at the highest center frequency, far exceeding television bandwidth requirements. The sweep/marker generator employs crystal-controlled markers, and a post-injected marker system to ensure sharp marker signal definition.

Close control. A radio-frequency retrace blanking and horizontal phase adjustment is provided for viewing on an oscilloscope. Several potentiometers are provided for calibration and setup. The circuit contains an automatic level control with a-c/d-c coupled feedback to provide a constant output level, even when frequencies are switched.

Allied Electronics Corp., Chicago, Ill. 60680 **[390]**

Move With Advanced Computer Technology At NCR Electronics Division

SYSTEMS FORMULATION

Analysis and development of advanced systems specifications; consultation on systems design, hardware configuration, software trade-offs; analysis of competitive systems. Applicant should have familiarity with very high speed memories, large-scale integration, disc files, drum files, communications and time sharing plus related BS degree and 3 to 5 years' experience in one or more areas mentioned.

SOFTWARE SYSTEMS

Programmers to develop executive and operating systems for third-generation computer systems. Desire experience with medium- and large-scale general-purpose systems employing high speed peripheral units, tapes, random-access files, disc files, drum files, on-line, time sharing and multiprogramming. Requires related BS degree and 3 to 5 years' directly related experience. Positions also open for hardware-oriented programmers to do systems diagnostic work.

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Analyst position entails systems analysis in financial and administrative areas. One year of EDP experience required, degree desirable. Programming positions involve accounting and manufacturing systems. Degree and recent experience on medium- to large-scale systems desired.

OPTICAL SYSTEMS

To do computer-aided design of specific elements in complex optical systems, such as field and condenser, as well as image-forming elements. Activity includes optical-electronic lab work, systems layout and design, technical liaison. Involves geometrical and physical optics. Requires BS in physics or optics plus 2-5 years' directly related experience.

MEMORIES RESEARCH

To design high-speed magnetic memory circuits. Requires knowledge of nanosecond pulse techniques and magnetic memory organization. Familiarity with plated-wire and mass-storage memory concepts desirable. Requires BSEE plus five years' experience.

SYSTEMS ENGINEER

For systems design on advanced computers. Requires extensive knowledge of memory technology, systems logic and large-scale integration as applied to medium- to large-scale general-purpose computing systems. Minimum of BSEE and five years' direct experience required.

LOGIC DESIGN

Several positions available for EE's with 2-5 years' experience in logic design on either special- or general-purpose equipment. Positions require thorough knowledge of logic as related to real-time hardware development or automatic test equipment.

CIRCUIT DESIGN

Positions for both systems- and device-oriented circuits men to work either in developmental projects or standard circuits group. BSEE required plus 3-5 years' design experience and thorough understanding of IC technology. Knowledge of large-scale integration concepts and ramifications desirable. Projects include thin-film memories, IC utilization and development, project/vendor liaison, systems applications.

FACILITIES/LAYOUT

Work entails projecting needs of expanding division, development of proposals, program implementation. Requires three years of facilities and layout experience, preferably in electronics industry; BSIE or equivalent; ability to deal effectively with all levels of personnel. Knowledge of safety codes desirable.

MACHINE DESIGN

Creative mechanical engineer capable of designing sophisticated manufacturing hardware and of developing machines to do jobs which heretofore have not been encountered. Requires BSME and minimum of two years' experience.

CHEMICAL PROCESSES

Positions in both engineering and manufacturing for man with BSChe and 2-5 years' experience in electroplating and electrodeposition in thin and thick films. Thorough knowledge of related materials, pre-plating surfaces, plating equipment required. Work entails development of advanced processes and techniques for computer development and production.

QUALITY ASSURANCE ENGINEERS

Q.C. assignments include process capability studies, failure analysis, design reviews, establishment of inspection standards. Position requires 2-3 years' experience with EDP equipment, knowledge of magnetic materials, BSME degree. Reliability positions involve planning, conducting and reporting reliability tests of electronic components, assemblies and units. BSEE required plus experience with reliability mathematics, computer circuitry. Positions also available in systems test.

NCR Electronics Division is the largest commercial computer manufacturing facility in Southern California and one of the most advanced in the world. The Los Angeles plant and laboratories have recently been doubled, and an additional manufacturing facility is now under construction in San Diego. At NCR you will enjoy stable, non-defense activity in a thoroughly professional environment. Your job and your future: the creation of advanced business automation for NCR markets in 121 countries.

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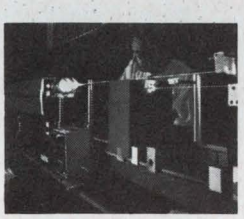

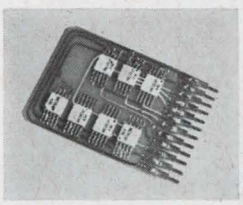

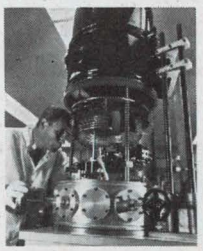

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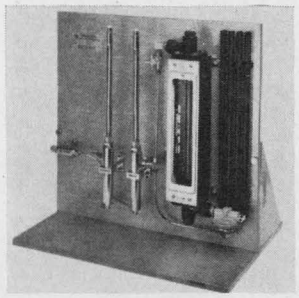
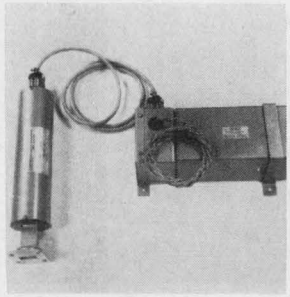
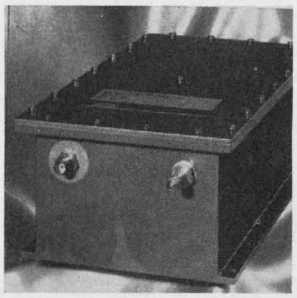
New Microwave Review



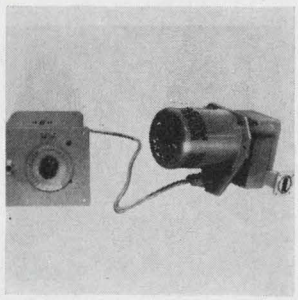
Precision r-f calorimeter model 6020 measures power in 50-ohm coaxial systems up to 1 kw with 3% typical accuracy. Units are self-checking at d-c or 60 hz a-c, which eliminates half the measurement uncertainties, resulting in 1½% accuracy. Vswr is 1.1 max. d-c to 1,000 Mhz, 1.25 max. to 3,500 Mhz. Bird Electronic Corp., 30303 Aurora Rd., Cleveland, Ohio 44139. [401]



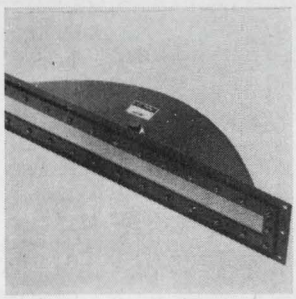
Hot reference loads series HL are for calibrating microwave receivers and radiometers. Consisting of a waveguide termination in a thermostatically controlled oven, the loads can be furnished for any temperature in the range of ambient to 60°C with ± 0.3°C stability. Waveguide sizes from RG-91 through RG-139 are offered. Advanced Technology Corp., Timonium, Md. 21093. [402]



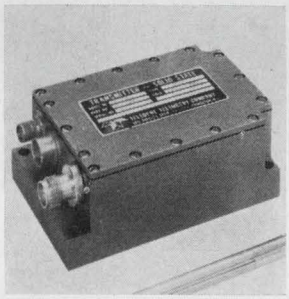
F-m transmitter model 382 can deliver 20 w minimum at L-band. It is intended for transmitting telemetry data in the 1.435-1.540 Ghz uhf range. It withstands 55 g's shock at any altitude and in a temperature range of −20° to +75° C. The unit measures 12 x 6½ x 4½ in. and weighs less than 13 lbs. Electro-Mechanical Research Inc., Box 3041, Sarasota, Fla. 3378. [403]



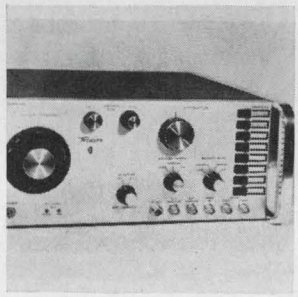
Servo driven phase shifters DB-X-195, for remote control of phase shift, may be controlled manually or by external error signals. Twelve sizes cover 2.6 to 90 Ghz. Each unit provides 0 to 360° of phase shift. Max. insertion loss is 1.25 db on the higher, 0.15 db on lower frequencies. DeMornay-Bonardi, Div. of Datapulse Inc., 1313 N. Lincoln Ave., Pasadena, Calif. 91103. [404]



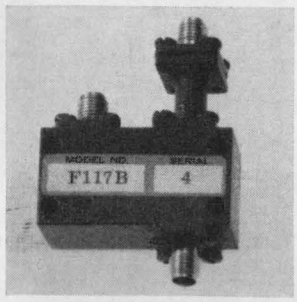
Airborne antenna type 55439 provides a linearly polarized beam. It is constructed of aluminum and has a maximum air speed rating of Mach 2 and maximum altitude of 80,000 ft. The flush-mounted unit operates in the 4.2 to 4.4-Ghz range with 13 db gain. Maximum vswr is 1.35. The antenna meets Mil-Specs. Andrew Corp., 10500 W. 153rd St., Orland Park, Ill. 60462. [405]



Solid state S-band transmitters TR-2300 offer a full spectrum of r-f output power levels from 0.2 to 2 w in less than 13 cu in. Design features include use of open loop heterodyne technique of frequency synthesis developing r-f power in the region of 750 Mhz. Price, in lots of 1 through 3, starts at $4,200. Teledyne Telemetry Co., 9320 Lincoln Blvd., Los Angeles 90045. [406]



Solid state sweep generator VS-120 covers the 1-Ghz to 2.3-Ghz range. Swept frequency range is 950 Mhz to 2.5 Ghz. Sweep width is variable from 50 khz to 25%. R-f output is 0.25 v rms into 50 ohms. R-f flatness is ±0.5 db at maximum sweep width. Distortion is 30 db down. Price is $1,695; delivery, 2 to 4 weeks. Texscan Corp., 2446 N. Shadeland Ave., Indianapolis 46219. [407]



Broadband diplexer F117B, intended for system use, is generally used with a broadband antenna to separate a signal at the common port into C- and X-bands at the output ports. Loss is 1 db max., and is typically less than 0.5 db. The unit measures less than 1½ x 1½ x ½ in. and weighs 1⅓ oz. Peninsula Microwave Laboratories, 855 Maude Ave., Mtn. View, Calif. 94040. [408]

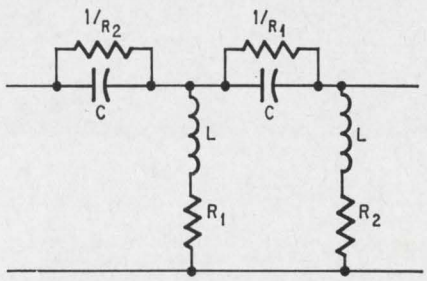
New microwave

A design-a-day channel filter

Computer-aided technique shaves days, even weeks, from design time

By Jayanti K. Sinha

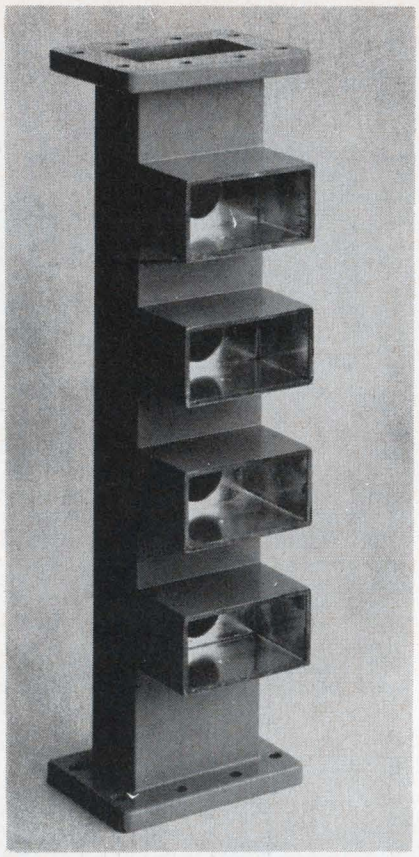
Amphenol Corp., Danbury, Conn.



Input. Values of equivalent circuit are inputs for computer program.

It's no longer true that filters can't be designed in a day. That's all the time it took for engineers to nail down the close-tolerance dimensions of the Model 1308 band-elimination filter at the Amphenol Corp.'s RF division. Previously, the company's designers needed up to two weeks to do the job. The time-saver: computer-aided design.

Used primarily for channel separation in communications systems, the filter consists of four cavity



Blocker. Channel-separation filter drops out frequency band between 6375.5 and 6424.2 Mhz.

resonators attached to a waveguide by irises. Separation between cavities is three-quarters of the wavelength of the waveguide. This is the smallest distance at which interaction between cavities has a negligible effect on filter performance.

In such a filter, iris diameter, cavity length, and cavity separation are critical to performance. A small change in any of these dimensions causes a large change in both the power output to power input ratio and the voltage standing wave ratio (vswr).

Usually, the engineer first makes a preliminary design based on filter specifications. Then he goes to the laboratory and checks the filter response. Unless the response fulfills the requirements on the designer's first try, a rarity, he adjusts the lengths of the cavities and the diameters of the irises, and checks the response again. He adjusts and checks again and again until the optimal dimensions are achieved. This process, however, can take days, even weeks to complete.

Speedup. Amphenol's computer-aided technique cuts design time

The hope of doing each other some good prompts these advertisements

Kodak

A little help with your LSI

One month a few people want to understand a concept like large-scale integration ("LSI"), and three months later the term is heard from every table in the steak house. Identifiable circuit components fade dimmer into the complexities of the chip's architecture. The number of circuit functions on the chip rises by a power or two of ten, while the tolerance on placement and width of the elements of the pattern moves on down toward the wavelength of light itself. Creation of the original "artwork" for optical reduction to masks is getting to be a little too much to ask of the human hand and mind. Interconnections in the pattern, we are further told, will have to be determined by testing each separate chip—such is the combined-reliability problem. Presumably the proper image will be generated and somehow imposed on a resist of sufficient resolution. To have a good one ready will be our part.

For the present we wish to advise that if the new KODAK Photosensitive Metal-Clad Plate is flooded with nitrogen gas during the exposure, the 0.6μ photopolymer layer over the chrome acquires what might be considered projection speed, given a strong source. With only an 0.32 N.A. microscope objective comes the 900 lines/mm of microelectronically usable resolution that required an 0.65 N.A. objective with the currently favored KODAK High Resolution Plate. An 0.32 N.A. objective is easier to keep in focus. Although the High Resolution Plate is a lot faster, perhaps it can be skipped (unless the cushioning of its gelatin against epitaxial spikes is needed) and the camera exposure made directly on the plate which becomes the chrome mask for the resist-coated silicon.

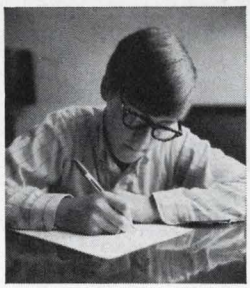
Those who want details on this can get them from Eastman Kodak Company, Industrial Photo Methods, Rochester, N.Y. 14650.

Liquid crystals: breadth of choice now, purity later if needed

From *Physical Review Letters 18:393,* it seems that the random alignments available in "swarms" of organic liquid crystals of the cholesteric type can simplify the generation of second harmonics from Q-switched lasers. Meanwhile, some who are less interested in basic optical principles use "liquid crystals" to depict slight but significant temperature anomalies in the skins of people or airframes. Those concerned with the latter tell us we are doing a good job in making them what they want.

In serving the optical investigator with liquid crystals, the chemical talent we have invested might have been devoted to higher purity for fewer compounds. Instead, we reasoned that once his investigations establish a need for higher purity in a given compound and it happens that purification overtaxes his own chemical facilities, we would be happy to see what we can do for him.

To check on current offerings and prices in cholesteric, smectic, and nematic compounds, write Eastman Organic Chemicals Department, Distillation Products Industries, Rochester, N.Y. 14603 (Division of Eastman Kodak Company).



Eastman Kodak Company
Rochester, N.Y.

Dear Sirs:

In only 7 years hence I expect to be 21 years of age and it will be legal for me to engage in investment and speculation without consent. I am now preparing for that time. It is therefore necessary for me to have certain information about scientific developments that will take place. As I have been interested in photography I would like to know what plans you have for bringing out new kinds of films to work with laser light instead of plain light. I also happen to understand how cathode-ray tubes work and would like to know why you don't make film where the electron beam works right on the film instead of making light on the tube face and then photographing that.

Yours very truly,
Herman Small
("Herman Small" is a composite.)

Dear Mr. Small:

You sound like the sort of person who is going to be taking charge of things in the comparatively near future and we had better not kid around with you.

As a matter of fact we have been working hard for years on film for direct electron recording of cathode-ray images. We have even sold a little of it, but not much. It seems to be a very good way to pack information at megacycle frequencies into far more compact form than magnetic recording permits. (We assume you are familiar with megacycles.) Sale is still small because there is as yet very little equipment around that can make use of such film. To the extent that this development is involved in the planning of the financial program that you intend to launch in 1975, we wish you luck. It may be big then or it may have died. If we knew, we'd be bolder now.

On films for use in the laser art, it is the same old question of how bold to be with funds such as you yourself might have already entrusted to us (if it had not been for the matter of consent). It seems fairly clear that by the time you settle down into the driver's seat, much more of what we have already learned in making the film that has kept you interested in personal photography will have moved from that area into the use of color film technology in dealing with modulated optical frequencies. We have the color film technology in pretty good shape, but we can't afford to bet it on every horse in the race. It costs an awful lot of money to make a few feet of new color film not made before, even if you have a pretty good idea of how to make it. Lots of ideas will doubtless be brought to us in hope of film. We too need a little luck in picking winners.

Very truly yours,
EASTMAN KODAK COMPANY

. . . circuit values in and vswr's out . . .

to one day by eliminating these steps. Instead, an equivalent circuit is used to describe the filter to the computer. The circuit elements—inductor L, capacitor C, and resistors R_1 and R_2—are expressed as functions of insertion loss and the 3-decibel bandwidth of each cavity. Measurements are taken in one inner and one outer cavity only. The filter is symmetrical about a midplane perpendicular to the long axis of the waveguide. Because of the symmetry, the inner cavities are identical, and the outer cavities are identical. Thus, insertion losses and bandwidths are the same for the inner pair, and the same for the outer pair.

Based on the measurements, values are assigned to C, L, R_1 and R_2—for the 1308, they were 1.062 farads for C, 0.5045 henry for L, 0.01017 ohm for R_1, and 0.02677 ohm for R_2. These values are the input to the computer. Equations which relate filter performance and circuit values are stored in memory. The computer prints out voltage standing wave ratios at given frequencies as a function of frequency. Running time is less than a minute.

By comparing the results with the specifications, the designer can easily determine insertion-loss and bandwidth changes necessary to bring the filter's response to the required level. These changes are then translated into changes in the filter's physical dimensions.

In the case of the 1308—which was intended to eliminate frequencies between 6,375.5 and 6,424.2 megahertz—the diameter of the hole of each inner-cavity iris was enlarged by 0.004 inch, to 0.582 inch; the outside-cavity holes were enlarged by 0.002 inch, to 0.645 inch.

The computer used in designing the filter was an IBM 1130.

The technique is particularly useful in the laboratory. A microwave design engineer often needs a filter not available commercially. Now he can quickly design a specific unit to fit his needs.

Amphenol Corp., RF Division, 33 E. Franklin St., Danbury, Conn. **[409]**

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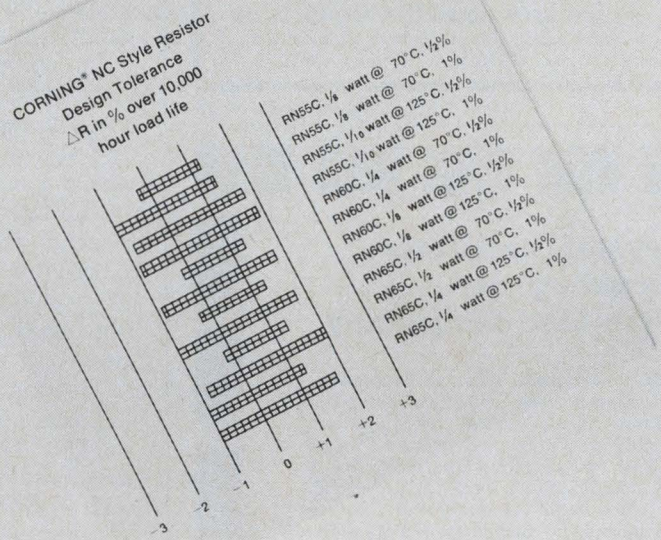

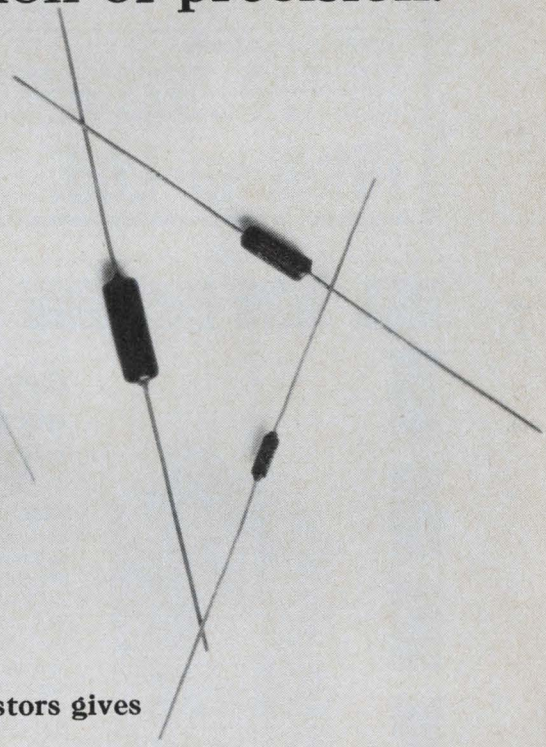

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New microwave

On-the-spot tests for relay links

U.S., Japanese companies marketing portable units to measure performance

Parabolic dishes may not be as numerous as rooftop television antennas, but their increasing number is an indication of the growing use of microwave relay links by common carriers and utilities. Even industrial firms, to some degree, are turning to such systems.

Accompanying the widespread use of microwave is the gnawing problem of maintenance, particularly of long-haul channels.

Since the major difficulties are distortion, crosstalk, and decreasing signal-to-noise ratio, test equipment is necessary to spot the culprits: nonlinearities. What has been needed is instrumentation to measure—at repeater stations—voltage-to-frequency and frequency-to-voltage conversion, frequency response of the intermediate-frequency components, the sensitivity of both the modulator and demodulator, and other characteristics. Such monitoring could pinpoint the nonlinearities.

Meeting this need are two firms —Japan's Anritsu Electric Co. and the U.S.' Hewlett-Packard Co. Both are marketing compact, portable test systems for on-site analysis.

Overseas. Except for the klystron tube, Anritsu's system is solid state. The test set includes its own power supply, readout, and separate plug-ins for automatic power control, power bridge and barretter mount, i-f sweep signal generator, and voltage standing wave adapter. Stack-mounted instead of rack-mounted, the plug-in modules can be easily installed for independent operation. Only the power-control can't be operated independently.

In designing the set, Anritsu worked closely with the Nippon Electric Co., which now buys about 90% of the production. Nippon Electric, a major builder of microwave links, includes the sets with

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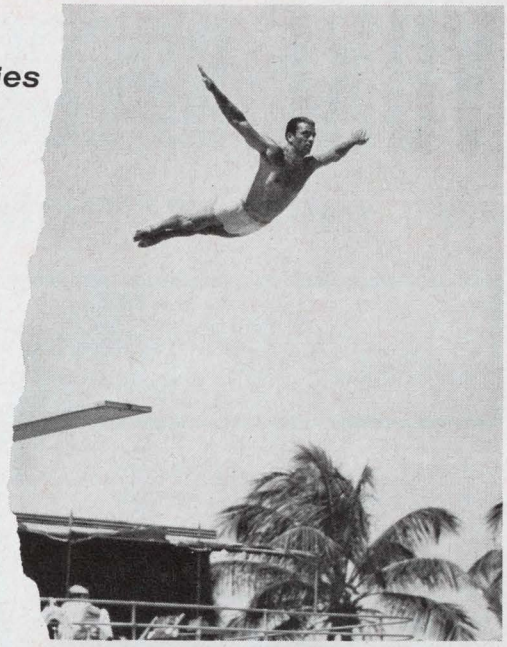

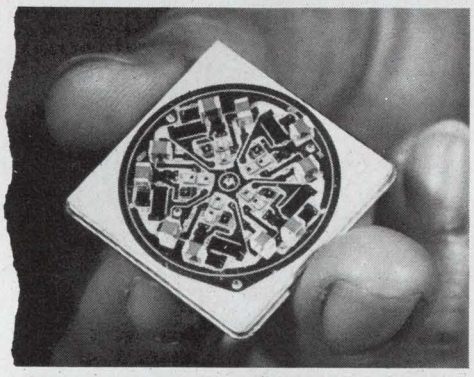

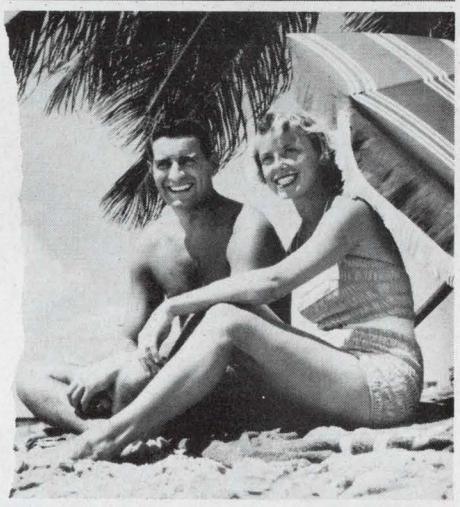

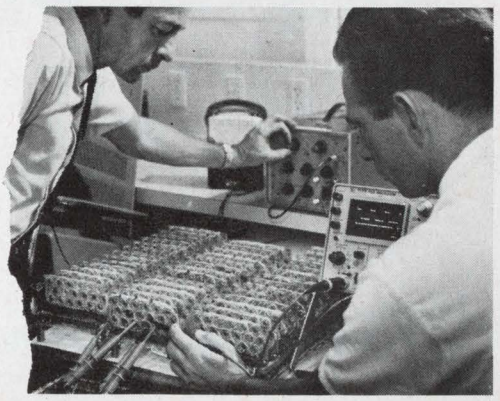

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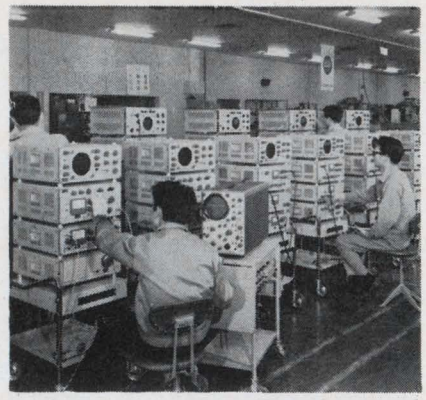
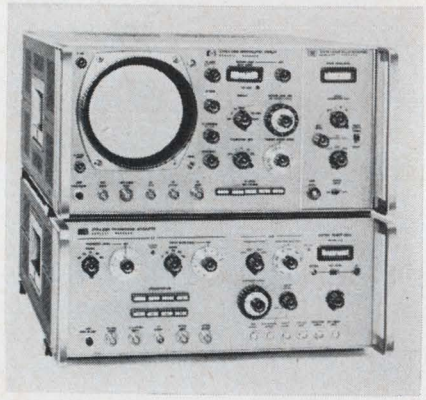


Rolling. Anritsu's test unit is on movable cart for easy access.



Compact. Two equipment cabinets house Hewlett-Packard's test set.

systems it exports. Some of the sets, however, are used by Nippon Electric to test systems in its own factories. Anritsu's other customers include such Japanese communications-equipment manufacturers as Fujitsu Ltd., Hitachi Ltd., and the Mitsubishi Electric Corp.

Domestic. Like Anritsu's set, Hewlett-Packard's unit is modular. Made up of a transmission generator, a demodulator display, and a group-delay detector, the American-made set is designed for use with 75-ohm systems that use the internationally agreed-upon intermediate frequency of 70 megahertz.

Hewlett-Packard's unit generates test signals to drive the communications system and evaluate performance, with both meter and cathode-ray display. Signals can be introduced at the transmitting terminal's baseband input and measured at the receiver terminal's baseband output, or introduced at the i-f level anywhere in the system and evaluated at the i-f level elsewhere, or introduced and evaluated at any combination of i-f and baseband inputs and outputs.

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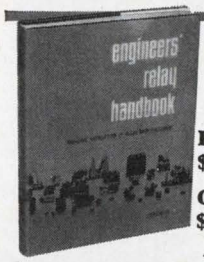

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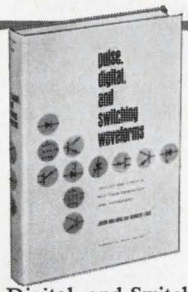

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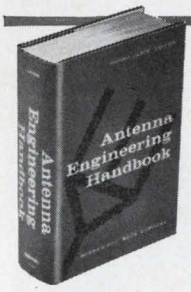

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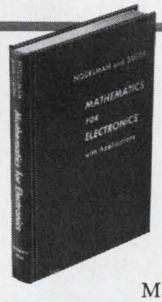

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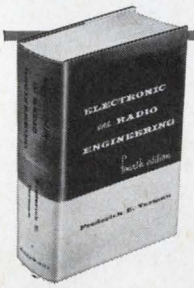

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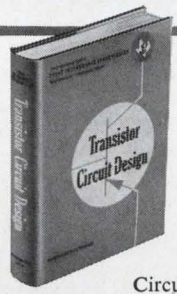

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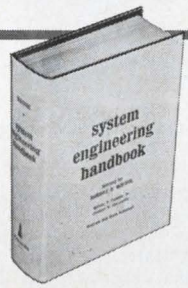

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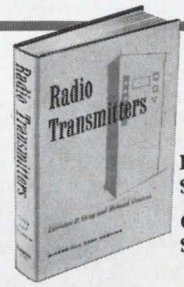

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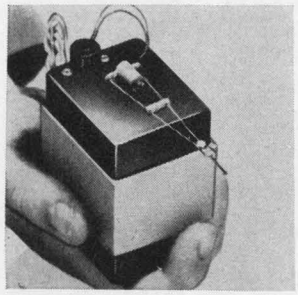
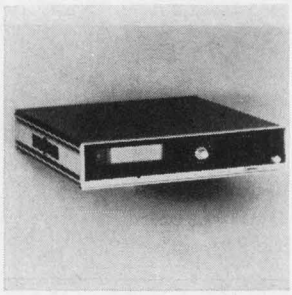
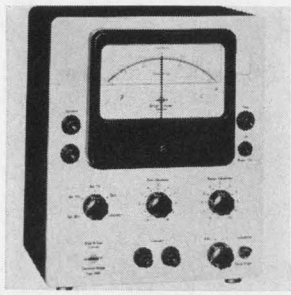


A compact galvanometer pen motor has a sensitivity of 10 mv/mm of stylus deflection and input impedance of 100,000 ohms. It contains an adjustable frequency network incorporating a separate winding for velocity sensing and feedback. The IC pen motors are suited for fields using technical recording equipment. Techni-Rite Electronics, 65 Centerville Rd., Warwick, R.I. 02886. [361]

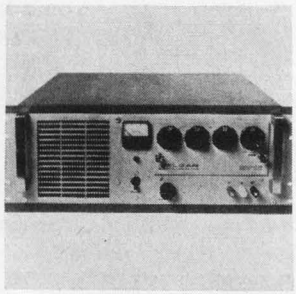


Programable picoammeter model ME-910 is an analog device capable of measuring currents from 3 picoamps to 10 ma full scale with accuracy from ±2% to ±0.2%. It features silicon solid state design, automatic polarity indication, and remote control of range selection, thus suiting it for systems integration. Price is $1,375. EG&G Inc., Box 1912, Las Vegas, Nev. 89101. [362]

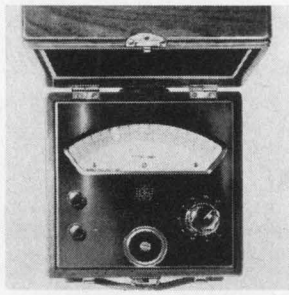


Deviation test bridges series 1500 offer measurement accuracy to 0.03%. Up to 3,600 operations/hr have been reached in production testing. Four models can measure: resistance, 1 ohm to 30 megohms; capacitance, 20 $\mu\mu$f to 2,000 μf; inductance 20 μh to 2,000 henrys; frequency, 100 hz to 100 khz. B&K Instruments Inc., 5111 W. 164th St., Cleveland, Ohio 44142. [363]

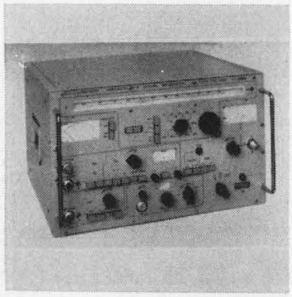
Pulse interval generator 5650 develops a start, and then a stop pulse separated by a digitally controlled time interval, and displays the interval generated on Nixie tubes. Having a stable, internal, 1-Mhz crystal-controlled oscillator, it can generate intervals of 10 μsec to 10^6 μsec with 1-μsec resolution. Electronic Counters Inc., 235 Jackson St., Englewood, N.J. 07631. [364]



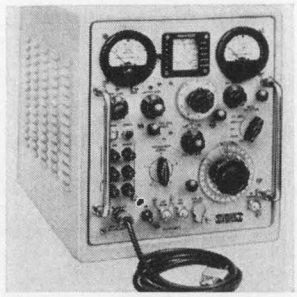
Solid state power source model 500 delivers 0 to 500 v-a, single phase. Maximum operational flexibility is ensured through a family of more than 40 interchangeable plug-in oscillator modules. They offer fixed or variable output frequencies from 45 hz to 5 khz. Accuracies range from ±0.1% to ±0.0001%. Elgar Corp., 8046 Engineer Rd., San Diego, Calif. 92111. [365]



A voltammeter with 0.25% accuracy and 10,000 ohms-per-volt sensitivity is offered with up to 21 independent scales ranging from 1 μa to 1 amp and 0.3 v to 1,000 v full scale. Basic meter movement features a light beam pointer that eliminates parallax error while providing a resolution capability of better than 0.1%. Filmohm Corp., 315 North Ave., New Rochelle, N.Y. 10801. [366]



Frequency synthesizer FSM500 generates a spectral pure frequency from 300 hz to 470 Mhz and offers complete modulation capabilities. In combination with the type FS30, which is used as the driver, a generated signal accuracy to 3 parts in 10^9 per day is produced. The FS30 costs $5,250; the FSM500, $4,925. E. F. Associates Inc., Box 361, Scotch Plains, N.J. 07076. [367]



Vhf signal generator SG-44 is not only for use in aligning receivers and measuring their sensitivity and selectivity, but also for test and calibration of a broad range of r-f/vhf components, networks, and circuits. It covers 10 to 420 Mhz in 5 bands with a calibration accuracy of ±0.5% of full range. Winslow Tele-tronics Inc., 1005 First Ave., Asbury Park, N.J. 07712. [368]

New instruments

Everyman's test set for semiconductors

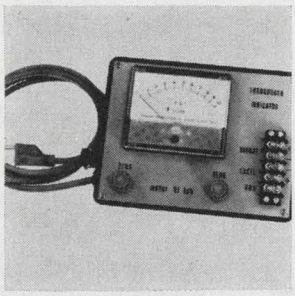
Modular system designed for small-volume work; first module probes field effect transistors

About two years ago, Siliconix Inc.'s equipment division introduced a field-effect-transistor test system called the Monitor II. Developed for the semiconductor company's own production needs, the system performs a wide range of tests and offers plug-in capabilities for data-logging and wafer-probe operations.

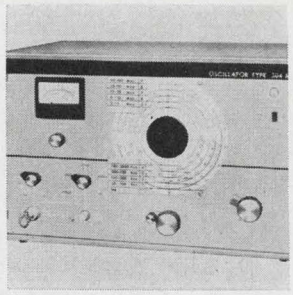
But Siliconix soon found that in small-volume testing for failure analysis, quality control and circuit design, the Monitor II was too much machine. At an average cost of $14,000 it was not only overqualified but too expensive.

Using a similar circuit design and following the modular concept of the Monitor II, division engineers designed a simpler semiconductor test set, smaller than a bench-model oscilloscope, which Siliconix has now used in-house for many months. Because of its broad potential capabilities and price, the division is now putting it on the market, designating it the SI-200 series.

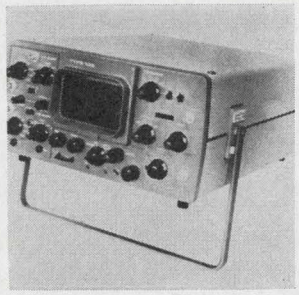
The portable system, designed for small-signal, medium-power field-effect, bipolar, and unijunction transistors, and low-power diodes, is capable of such critical



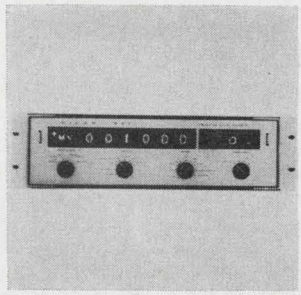
Transducer indicator GT-403, operating from 115-v 50/60-hz power, includes a zener regulated power supply delivering a fixed 5-v d-c excitation into a 350-ohm bridge. Having an input impedance greater than 30,000 ohms, the unit operates with transducers having resistances from 120 through 1,000 ohms. General Transducer Co., 2961 Corvin Dr., Santa Clara, Calif. 95051. [369]



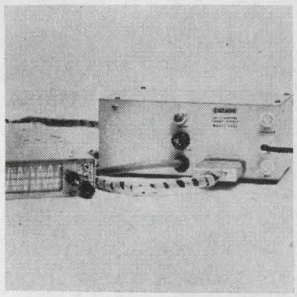
High-power oscillator 304A features stable dual outputs over a 9-band range from 50 khz to 100 Mhz. High-level output of 10 v across 50 ohms can be increased to 12.2 v below 25 Mhz and is stable within ±0.5 and −1 db limits. Variable output is continuously adjustable from 40 μv to 5 v. Winslow Tele-tronics Inc., 1005 1st Ave., Asbury Park, N.J. 07712. [370]



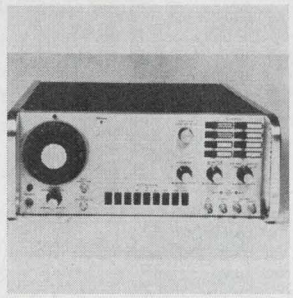
Double-beam oscilloscope EM102, employing silicon and integrated devices, with modular Y amplifiers, operates on either a-c or batteries. Plug-in units from d-c to 15 Mhz are available. The instrument provides variable sweep delay and affords the user the facility of differential measurements. S. E. Laboratories (Engineering) Ltd., Feltham, Middlesex, England. [371]



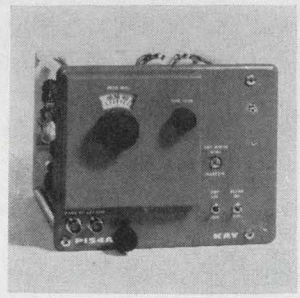
Integrating dvm 521 has full-scale ranges of 10 mv, 100 mv, 1 v, 10 v, 100 v, and 1,000 v. The 10-mv range provides resolution of 1 μv at up to 40 readings/sec. Readings accurate to ±0.01% full scale ±0.004% of reading ±1 μv are visible on a 6-digit display. The unit is suited for use in data acquisition systems. Vidar Corp., 77 Ortega Ave., Mtn. View, Calif. 94040. [372]



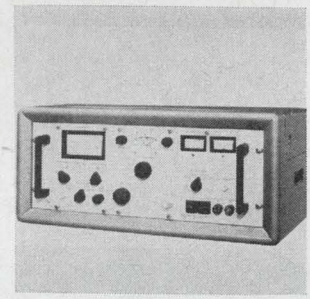
A single-channel scope system utilizes a model 7200 power supply, which may be used with any of 5 scope modules. The modules use 1- x 3-in. crt's and occupy 1⅝ x 4½ in. of viewing and control area. Response is from d-c to 10 Mhz, with vertical sensitivity of 0.1 to 10 v rms/in. in 7 calibrated steps. California Instruments Corp., 3511 Midway Dr., San Diego, Calif. 92110. [373]



Sweep signal generator VS-20 covers the audio and video bands. Tunable frequency range is 500 hz to 25 Mhz with a center frequency adjustment consisting of a 300 to 1 and a 1 to 1 ratio. Sweep width is continuously adjustable over the range. The unit has a 1-v rms output and flatness of ±0.25 db. Price is $1,095. Texscan Corp., 2446 N. Shadeland Ave., Indianapolis, Ind. 46219. [374]



Sweep generator plug-in PC154A is a solid state, beat oscillator with a broad-band output amplifier and a voltage-controlled electronic sweep modulator. It can cover in a single sweep from the low video frequencies to beyond the f-m tuner frequencies or in any portion down to 100 hz of residual. Kay Electric Co., Maple Ave., Pine Brook, N.J. 07058. [375]



Modular f-m signal generator series 1000 offers a selection of r-f, video and metering plug-in units. Ten r-f plug-in units cover 20 Mhz to 2.4 Ghz in tunable bands. F-m peak deviation is up to 1,000 khz; modulation, from d-c to 2 Mhz; metered carrier shift, internal 1 and 10 khz tones. New London Instrument Co., 153 California St., Newton, Mass. 02158. [376]

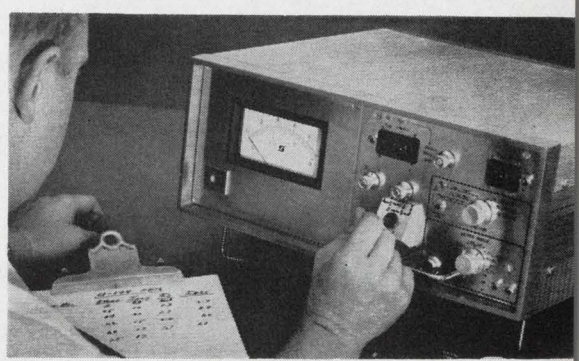
tests as picoampere d-c, differential, high-frequency a-c, and measuring capacitance.

The basic unit, the SI-200, an aluminum case containing nine different power supplies, a taut-band meter readout, and appropriate solid state circuitry, costs $960. The first module, the SI-201 FET tester, costs $1,335.

FET's first. "The SI-200 will accept any plug-in module," says Fred S. Thurmond, division sales manager, "but we developed the FET module first for our own use." On the drawing board are bipolar and high-current pulsed modules.

Siliconix says it has no competition in its price range. There is a FET tester on the market whose basic unit cost is about $600. But Thurmond says that to make tests comparable to the 200-201 combination would require about another $3,700 worth of modules. The reason is that the 200 performs basic types of tests for the 201 FET module, whereas competitive units use a different module for each type of test.

"With the 200 basic unit a circuit designer can keep up with the state of the art by designing his test modules as he needs them," Thurmond says. To help him along, Siliconix offers an SI-000 blank test



Function plug-in. Module for field-effect-transistor tests fits into unit housing power supplies and readout.

. . . in-house instrument goes to market . . .

module, a plug-in chassis with a blank circuit card.

The basic unit includes two pulsed power supplies, ranging from 0 to 100 volts at 100 milliamperes to 1 ampere, that can be digitally programed in 10-millivolt steps. Also included are the following power supplies: 30 volts at 10 milliamperes; +15 volts at 300 milliamperes and −15 volts at 300 milliamperes for amplifiers; +24 volts at 0.5 ampere for a relay driver; +5 volts at 0.5 ampere for an integrated-circuit logic supply, and two unregulated supplies, +40 volts and −40 volts at 0.25 ampere.

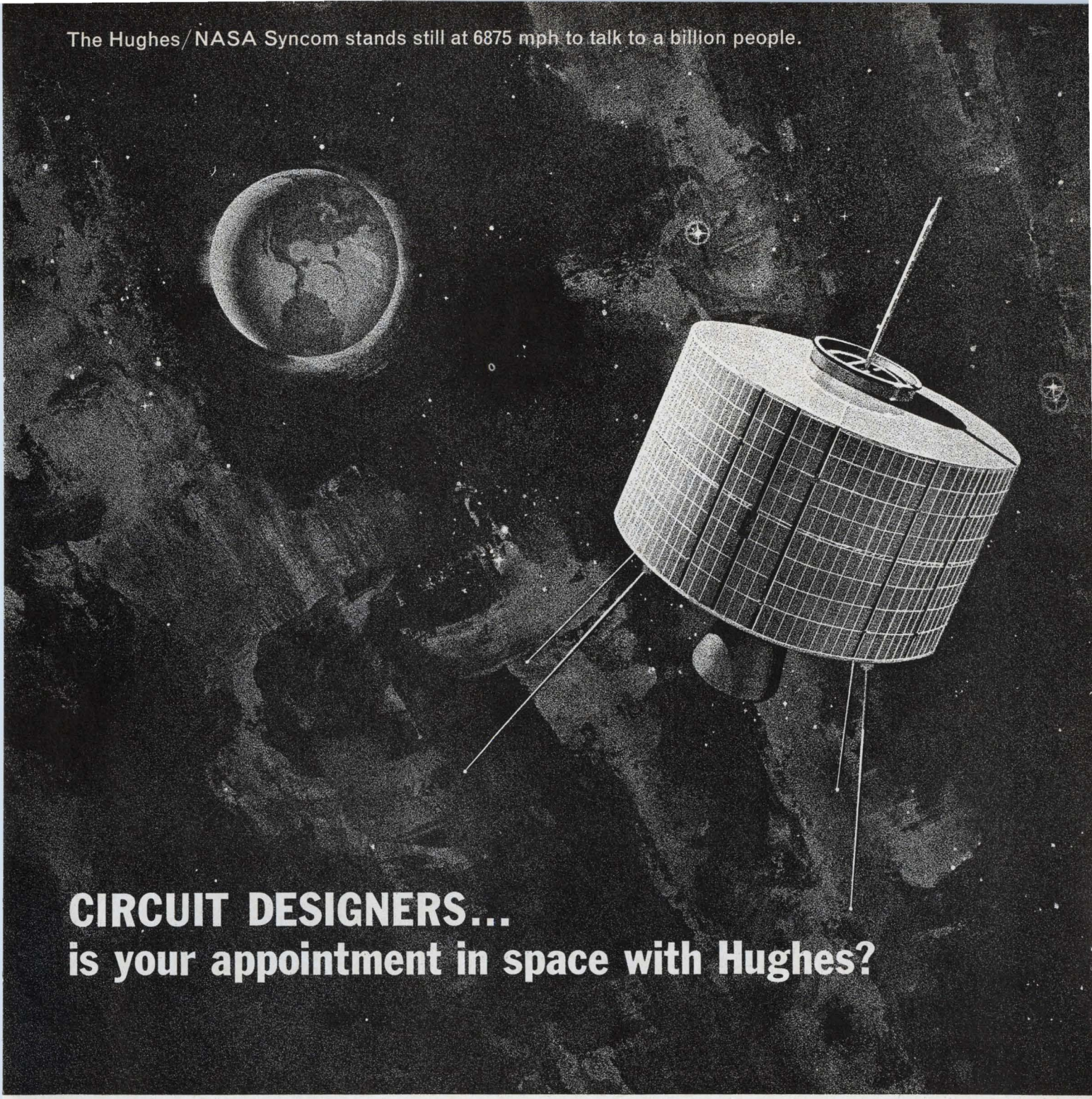
High resolution. Because each module will contain all the d-c excitation and detection circuits as well as the test socket, the system can perform a variety of tests with high accuracy. For example, the FET module gives direct-reading full-scale leakage measurements of 100 picoamps with 2 picoamps resolution. Other sample direct readings are: drain current at 1 kilohertz; gate-source breakdown voltage to 300 volts; drain current from 100 picoamps to 30 milliamperes full scale, and gate-source voltage to ±30 volts under operating conditions. Accuracies vary from 1.5 to 3%. Indirect measurement of IC resistance can be easily set up.

Thurmond expects the SI-200 series to sell better than the Monitor II because "we're first in that market." The series is another example of Siliconix's effort to exploit in-house tools for outside sales. However, outside sales of such items as the Monitor II, the series 200, or the contact printer [Electronics, July 10, 1967, p. 171] don't necessarily mean that Thurmond's 50-man Equipment division is going into broad-base production.

"We're charged first with providing the FET production facility with devices it needs," Thurmond says, "but if as a result of work done there we find we have a marketable product, we can go out and sell it."

The SI-200 with SI-201 module weighs 30 pounds and measures 7½ inches high, 18 long and 17 wide.

Siliconix Inc., 1140 W. Evelyn Ave., Sunnyvale, Calif. **[377]**



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New instruments

Saying sayonara to U.S. testers

First Japanese-made IC probe is similar to those built in U.S.

When it comes to testing integrated circuits, Japan has completely depended on the U.S. Of the 50 or so automated IC testers now used, all are American-made. But this dependence may come to an end with the introduction of the first Japanese-made computerized machine —the Tokyo Shibaura Electric Co.'s (Toshiba) model 1200A.

Toshiba says the 1200A costs less and is more versatile than the Fairchild 4000M, the most widely used tester in Japan. Basic price of the new machine is about $43,000; the maximum configuration, including data logger, multiplexer, and five test heads, sells for about $83,000. The Fairchild machine, a custom-made unit, sells for $70,000.

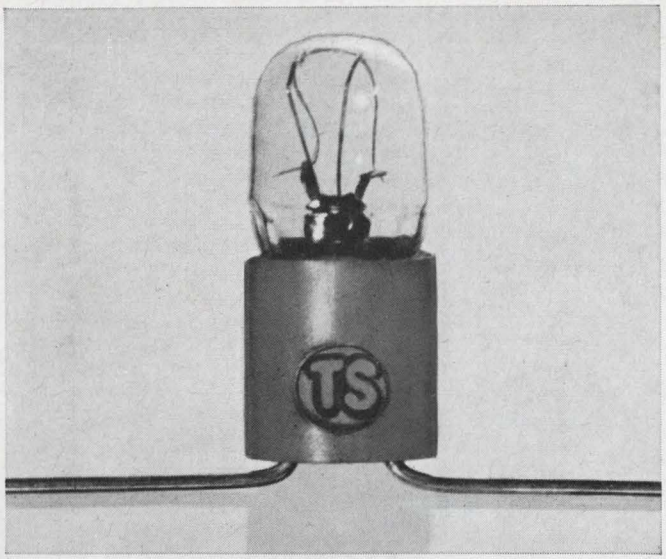
"This is like comparing apples with oranges," says a spokesman at Fairchild Camera & Instrument Corp.'s Instrumentation division. "Toshiba is comparing its new machine to our old one." According to Fairchild, a new tester called the 4000W will be a fixed-cost unit like Toshiba's and this will sell for $48,000.

Unlike Fairchild's newer 4000W, which uses resistor-transistor logic (RTL), Toshiba's 1200A uses diode-transistor logic (DTL). Noise margin of the circuits in the 1200A is about 750 millivolts, against about 300 millivolts in the Fairchild tester.

Big difference. Unlike the Fairchild unit, Toshiba's tester can add as well as divide by a fixed number. Fairchild says this isn't needed.

Drum memory on the Toshiba tester stores up to 600 tests and operates at a speed of 60 tests per second. The company is working on an improved model having a memory capacity of 900 tests and a speed of 200 tests per second.

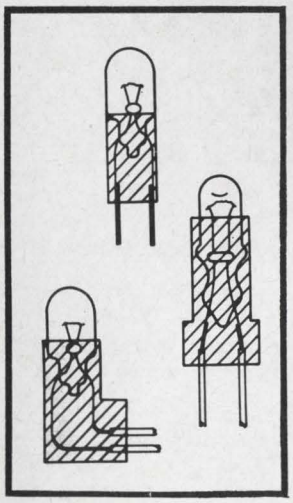
Tokyo Shibaura Electric Co., Tokyo [378]



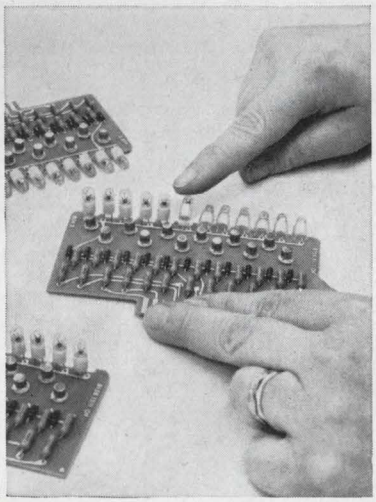
Mounting Flexibility

Tung-Sol Molded Base Subminiature Lamps provide mounting flexibility not possible with the usual cemented-on base and socket installation. Lead wires can be bent sharply at the base without harm to the assembly. Because they are self-mounting, any computer type circuit board provides a fully adequate mount. No more installation is required than with transistors. And like transistors, Tung-Sol Molded Base Lamps may be installed with automated equipment.

The popular Tu-Pin lamp has wide application for instrumentation lighting. For special requirements, the molded nylon base can be formed in a wide variety of configurations. Also, special harnessing can be supplied to customers' specifications. Write for more information about how the flexibility of Tung-Sol Molded Base Lamps can effect economies in the assembly of your equipment. Tung-Sol Division, Wagner Electric Corporation, One Summer Ave., Newark, N.J. 07104.



Molded bases can be designed to meet customers' specifications.



Computer circuit board assembly demonstrates mounting flexibility of Tung-Sol Tu-Pin lamps.

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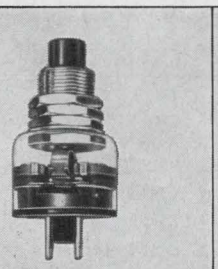

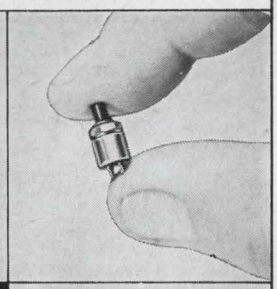

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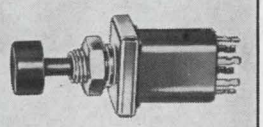

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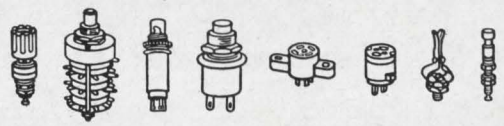

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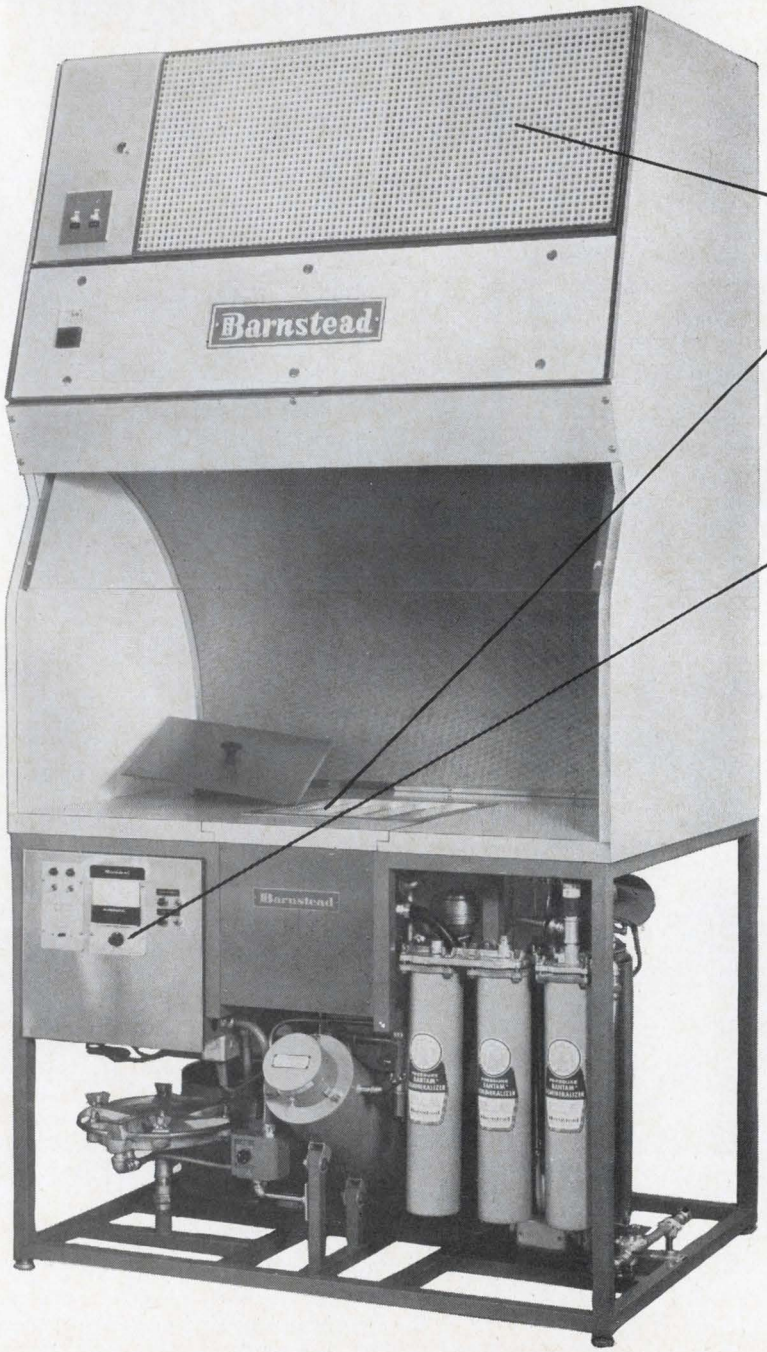

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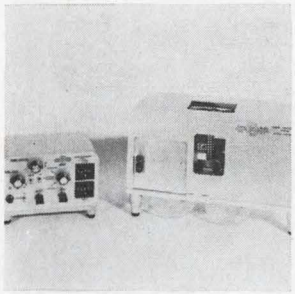
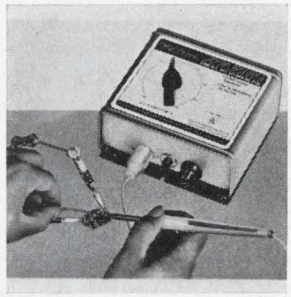
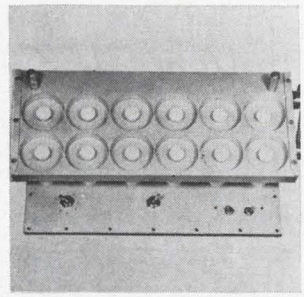


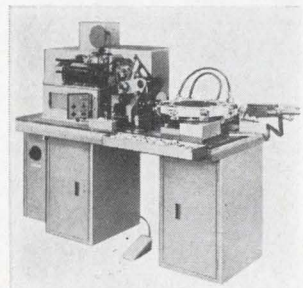
Automatic core handler Ramsey CH-30 moves large ferrite cores through a test position and then deposits each tested core into either an accept or reject receptacle, depending upon the decision of associated signal-analysis equipment. Cores 0.080 in. to 0.500 in. o-d can be handled at rates up to 100/minute. Computer Test Corp., 3 Computer Dr., Cherry Hill, N.J. 08034. [421]



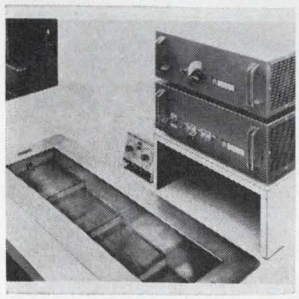
Isolated, low-voltage soldering station model 6970 eliminates damage caused by current leakage at the soldering tip. The transformer steps down and isolates the 120-v a-c line current from the 12-v a-c soldering pen. A tip temperature range of 400° to 900° F is selected by dial. Eldon Industries Inc., 2701 W. El Segundo Blvd., Hawthorne, Calif. 90252. [422]



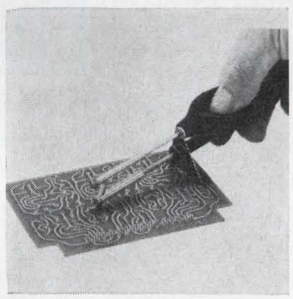
Photoresist spinners model SR3 are for use in the manufacture of semiconductor devices, IC's, and thin-film circuitry. They come in 4, 8, and 12 spindle units, all handling wafers up to 2⅞-in. diameter, ⅛-in. thick. An automatic reset interval timer provides spin cycles up to 60 sec at speeds to 10,000 rpm. K Square Corp., Pennwood and Lamar, Pittsburgh, Pa. [423]



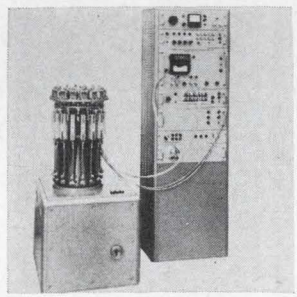
Fully automatic machine model RT winds all types of random wound bobbin coils and single layer solenoids. Wire sizes wound are 14 to 40 depending on coil specifications. Winding range is 8 to 840 turns-per-layer, and winding speeds are up to 3,500 rpm, depending on coil characteristics. Geo. Stevens Mfg. Co., 6001 N. Keystone Ave., Chicago 60646. [424]



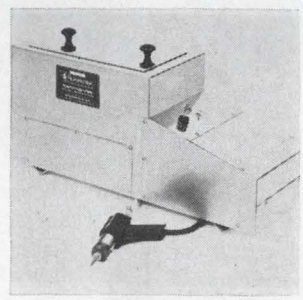
Cascade ultrasonic cleaners are for use with deionized water and most common cleaning chemicals and solvents. The cascade flow virtually eliminates drag-out contaminants. The equipment is available with any number of tanks. Sizes range from 1 to 10 gallons/tank. Two frequencies are available: 25 or 45 khz. Delta Sonics Inc., 12918 Cerise Ave., Hawthorne, Calif. 90250. [425]



Model **SS-18-6** Solder sucker facilitates removing excess solder from circuit boards, plated-through holes, etc. Consisting of a miniature iron to melt the solder, and an attached suction bulb and a reservoir for the removed soder, it has a built-in stand to rest on the bench between operations. Telvac Instrument Co., 18531 Ventura Blvd., Tarzana, Calif. 91356. [426]



An automatic sorter for mica plates or chip capacitors will feed stacked units from magazines, test and sort them, and restack them in magazines at the rate of 3,000 per hour according to high voltage flash, 10 capacitance groups and dissipation factor. Price is approximately $12,000 depending on options. B. Freudenberg Inc., 50 Rockefeller Plaza, New York 10028. [427]



Hot melt system X84300 includes a 2½ gallon supply tank, high pressure positive action pump, internally heated hose and a heated hand gun. It is designed for encapsulating, potting, or other manual electronic assembly operations where high speed application of hot melt adhesives is desired. Price is under $2,500. Spraymation Inc., 52 Sindle Ave., Little Falls, N.J. 07424. [428]

New production equipment

How to stretch the etchant

Attachment for printed circuit board production line regenerates solution to keep concentration constant

"To make etching with cupric chloride economical, we've got to be able to automatically control the process without beating ourselves to death," says Richard Erwin, a sales engineer for Chemlea Corp. He feels his company's new etchant regeneration system can do this job for mass producers of printed circuits.

The most commonly used technique for making printed circuits begins when copper foil is bonded to nonconductive plates. Circuit outlines are traced with etchant-resistant material over the copper, and the plates are passed through an etching spray or bath that removes the unprotected metal. As copper dissolves, the etching solution weakens and etch rate decreases.

To keep the pieces uniform, an operator controls etching time, usually by changing the speed of a conveyor belt. A continuing problem is how to dispose of the used etching solution.

Better days. Cupric chloride, despite better etching qualities has not been popular. Because it's polluted with dissolved copper more quickly than other etchants, such as ferric chloride, larger quantities are needed. Chemlea sees better

. . . dissolved copper can be reclaimed . . .

cupric chloride. The new system automatically keeps the etchant concentration constant. This means a constant etch rate without an operator. The system regenerates the etching solution, so smaller quantities are used.

"You don't have the expense of etchant storage tanks," Erwin points out. And the waste from the regenerator-assisted process contains enough dissolved copper to make reclaiming of the metal economically desirable.

The Chemlea unit can be attached to most bath and spray etchers. The company says it is applicable in 75% of the etching done for printed circuits.

The system operates in four steps: analysis of the etching solution, chemical injection, dilution, and drainage. A cell detects the amount of dissolved copper in the etching solution. When the level reaches an eighth of an ounce per gallon, the sensing cell turns on a system that releases chemicals into the solution. The chemicals react with the copper to form fresh etchant. When copper concentration drops to a set level, the cell turns off the injector. This process is the key to the Chemlea system.

"We know when to inject, how much, and when to stop," says Erwin.

A specific gravity float controls a water injection system that keeps etchant concentration constant. Another float keeps the solution volume constant by turning an overflow system on and off.

How much. Two units, differing only in capacities, are the basis of the system. The units are the same size, 12 x 36 x 42 inches. One can support an etcher that is dissolving 120 ounces of etched copper per hour. The other handles 300 ounces. The units, in any combination, operate in parallel for larger capacity etchers.

The system is leased, price being based on the number of units used. Rental for each small-capacity unit is $330 per month plus $1 per hour of use. The price goes up to $380 and $2.20 for the larger unit.

Chemlea Corp., 500 Science Park Rd., State College, Pa. 16801 **[429]**

New production equipment

This stripper is a fast changer

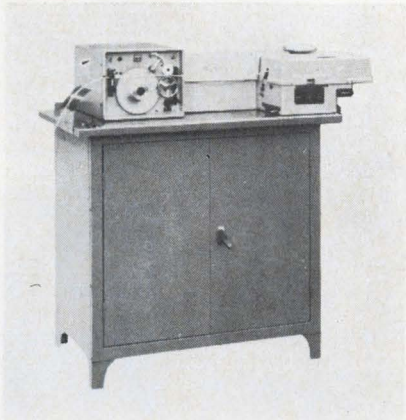
Machine sets up quickly to cut and strip varying lengths and sizes of wire

It takes less than a minute to set up an automatic wire-stripping machine developed by the Artos Engineering Co. It takes an additional minute to change the amount of stripping being done, and a maximum of five minutes to change blades to accommodate different kinds of insulation or wire.

"It'll shine where you have small lots," says Robert Dusel, an engineer who helped develop the equipment. Called the CS-16, the machine is designed for makers of wiring harnesses, particularly those who have to cut and strip leads made of the same wire and insulation but in varying lengths. "We're not pushing this machine for special jobs involving exotic insulating materials and wire configurations," says Dusel.

On the fly. The desired length is set on a dial at the front of the machine, and the wire is belt-fed to the cutting and stripping blades. Lengths from 1¾ inches up to 30 feet can be cut, and changes in length can be made while the machine is running. One or both ends can be stripped from ⅛ to ⅝ inch.

The CS-16 can handle any kind



Triple action. Shown mounted on a bench, the CS-16 measures, cuts, and strips wire in a continuous, automatic operation.

of industrial wire in sizes from 14 to 22 gauge. Different kinds of insulation require the use of different blades, but the company says there are few insulation materials that the machine can't strip. "It even works on Teflon and wax-coated materials," notes Dusel.

Multiconductor leads such as hookup wire can be stripped if the conductors aren't twisted. So can a group of insulated, rectangular-shaped wires with a common insulating cover so long as the orientation of the wire is constant.

Steady feed. The belt feed runs at a constant rate of a little more than 20 feet per minute; the blades are triggered by a solid state switching network. "Continuous feeds are admittedly more susceptible to inaccuracies than mechanical grab units, but this machine can meet normal industrial requirements," Dusel says.

Tolerances vary with length of cut and type of insulation. For small lengths insulated with polyvinyl chloride, tolerance is $\pm 1/32$ inch; for longer leads, it can be as high as $\pm 1/8$ inch.

The CS-16 can be mounted on a bench top. It weighs 200 pounds, occupies an area 2 by 4 feet, and is priced at $2,500. Delivery time is three to four months.

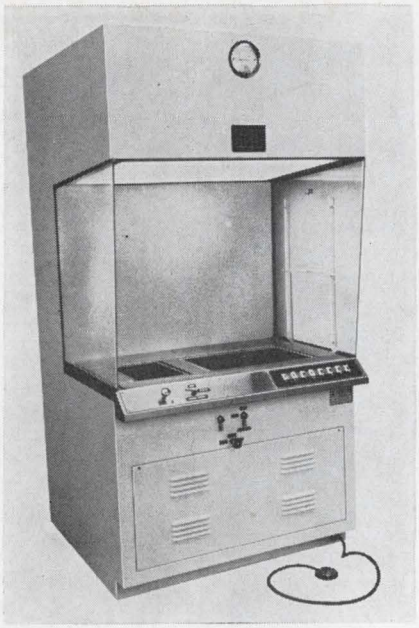
Artos Engineering Co, New Berlin, Wis. **[430]**

New production equipment

One-stop service for wash 'n' dry

Single station combines ultrasonic scrubbing and clean-air drying

Ultrasonic cleaning may well be one of the best methods of degreasing and scrubbing tools, parts, and assemblies. But its effectiveness is limited by the drying operation. Until now, the parts were usually air-sprayed or merely left to dry in free air. Either way, dust or oily film—carried by the air gun or in the ambient air itself—col-



Quick service. Electronic parts come clean at compact work center.

lected, sometimes in sufficient quantities to play havoc with sensitive electronic parts.

Clean Room Products Inc. of Farmingdale, N. Y., however, has come up with a wash and almost-dustless drying system under a single hood. A pressurized flow of filtered air, with dust particles smaller than 0.3 micron, dries the parts in a few seconds.

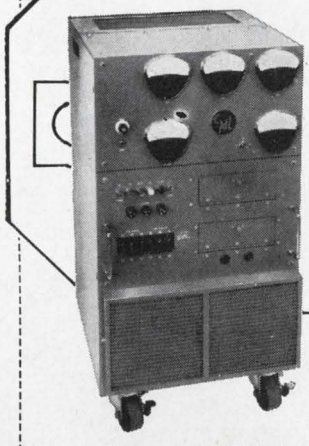
The wash-and-dry station includes a spray nozzle and three tanks—all containing solvents, but only the first and third having ultrasonic generator units that produce uniform cavitation. Any solvent or water-based cleaning solution can be used, including detergents, acids, and alkalines.

Laundry baskets. In one application—for cleaning contacts of subminiature relays at Deutsch Filtors—the first tank has Freon TWD-602 for removing inorganic substances; the second, a vapor solvent for degreasing; and the last, Freon TF for removing organics. Parts are placed in baskets, which are moved from one tank to another, and then solvent-sprayed.

Solvent loss is less than a pint a day for about a 10-gallon volume in the three tanks. Prices of a three-tank station—with blower, ultrasonic generators, pumps, and operation controls—range from $5,250 to $5,500.

Clean Room Products Inc., 55 Central Ave., Farmingdale, N.Y. 11735 **[431]**

DRAMATIC REDUCTION



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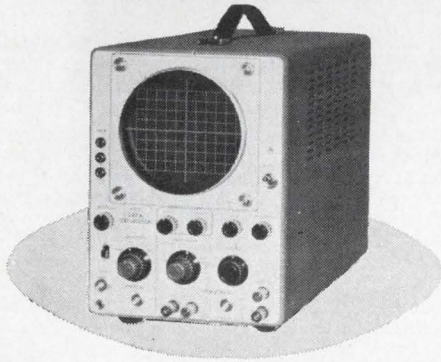
Circle 275 on reader service card

DC~5MHz 20mV/cm

MODEL 557A

5" OSCILLOSCOPE



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Deflection Sensitivity 20mV/cm, AC & DC
Frequency Response
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DC: 0~5MHz within −3dB
Input Impedance 1MΩ, shunted by 30pF
TIME AXIS
Sweep Frequency TV•H, 10Hz~100KHz (4 ranges) & Line Sweep

HORIZONTAL AXIS
Deflection Sensitivity 300mV/cm
Frequency Response 2Hz~500KHz, within −3dB
Calibration Voltage 0.05V, 0.5V, 5Vp-p Square Wave
CRT: 5UP1F
Dimensions 200W×300H×445Dmm
Net Weight 10 kg approx.

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Circle 276 on reader service card

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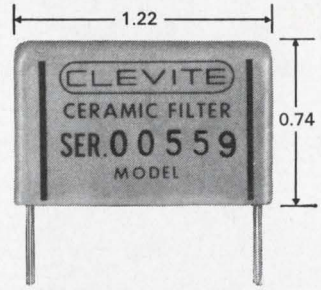
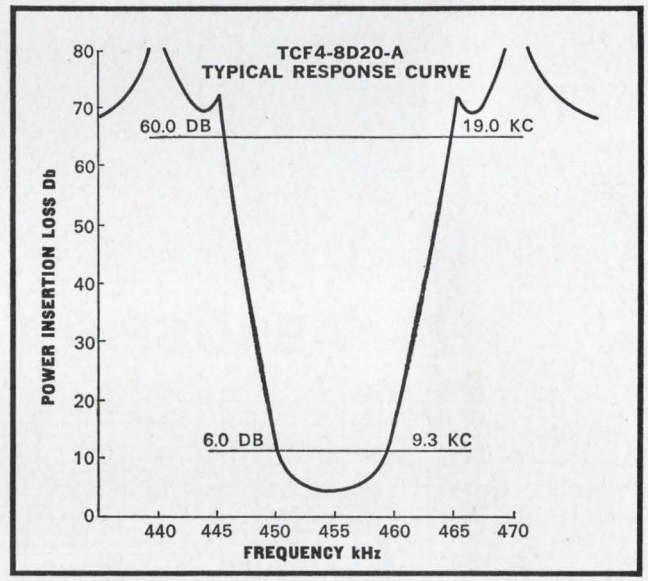


Clevite's computer-designed TCF ceramic filter.



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Center Freq: 455± 1kHz	@ 6db	8db max.	40K ohms	1.5K ohms
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PRICES: 1—$15 ea; 25—$10 ea; 100—$8.50 ea; 500—$6.75 ea; 1000—$6.00 ea; 2500—$5.45 ea.
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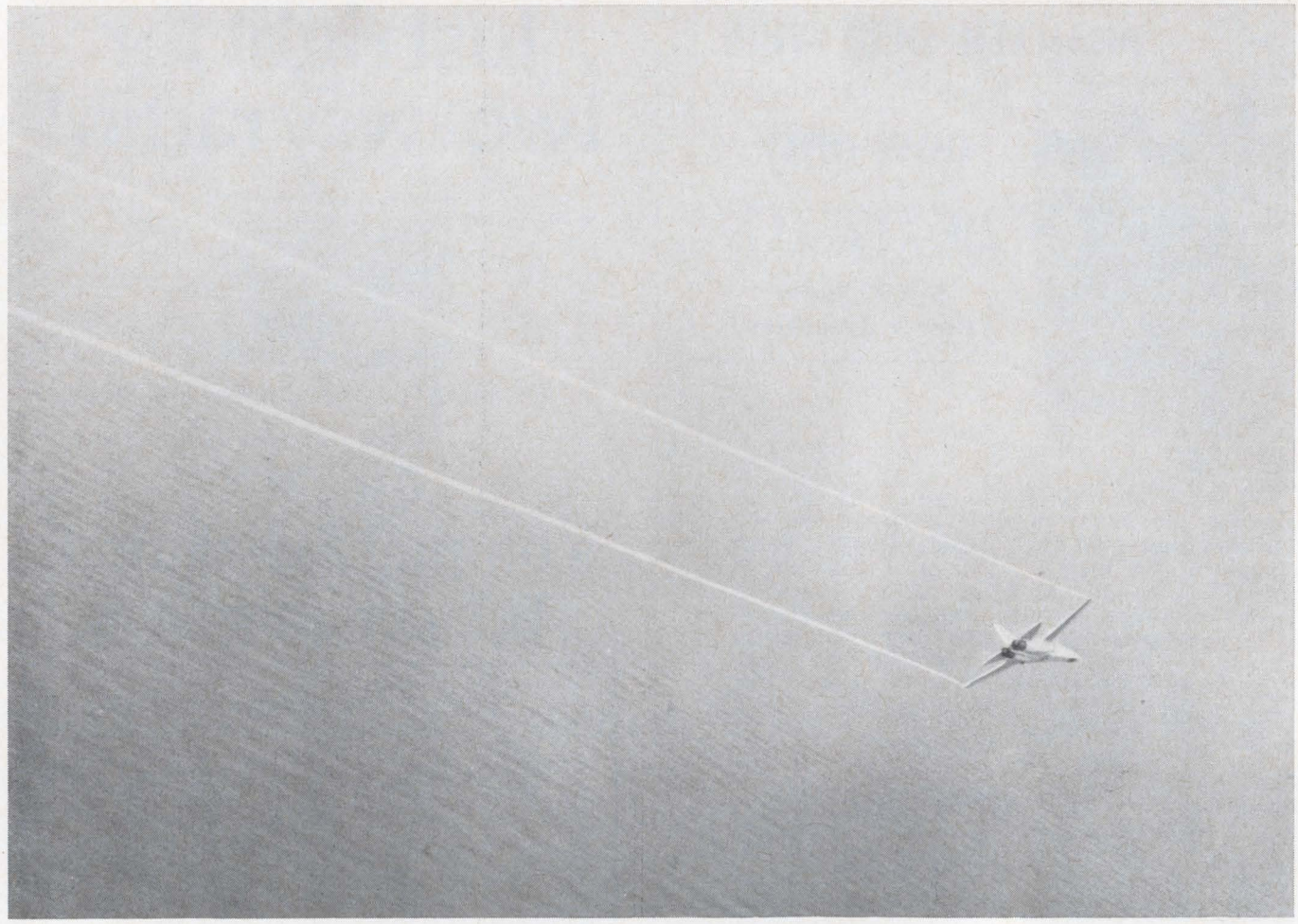
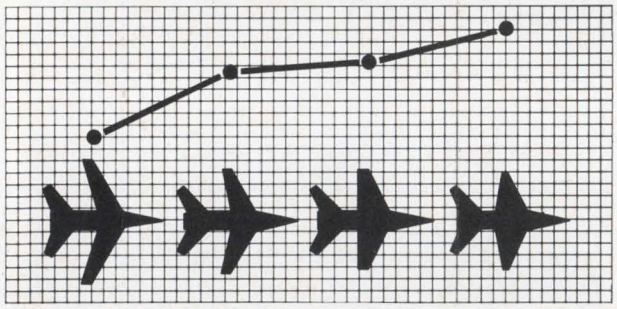
CLEVITE

Circle 215 on reader service card



AEROSPACE TECHNOLOGY



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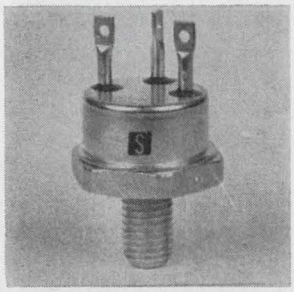
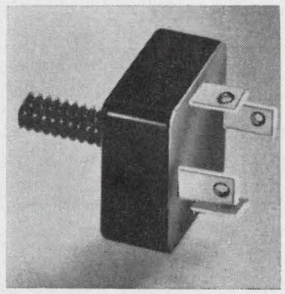
GENERAL DYNAMICS

Fort Worth Division

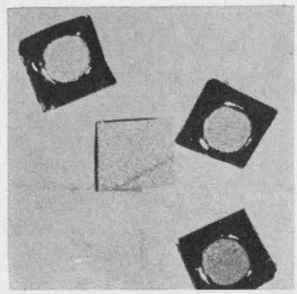
New Semiconductors Review



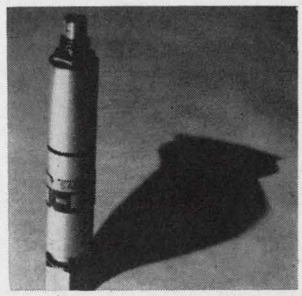
Silicon transistors SDT 8151-8159 are 30-amp units in an isolated TO-61 case. They have sustaining voltages up to 120 v. There are 3 gain categories at 10 amps collector current: 20 minimum, 42-120 and 100 minimum. Saturation is 1 v max. collector-to-emitter and 1.5 v max. base-to-emitter. Solitron Devices Inc., 1177 Blue Heron Blvd., Riviera Beach, Fla. 33404. [436]



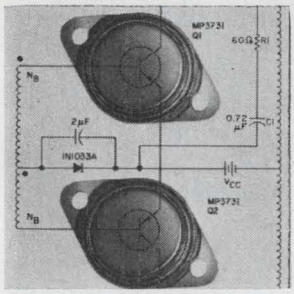
Silicon bridge rectifiers S-6230 are 2-amp units with piv ratings from 200 to 1,000. They can resist a power surge of 120 amps at 25°C. Maximum ambient operating temperature is 140° with heat sink conduction. They measure ¼ in. high and 9/16 in. square. Unit price is $1.47 to $3.47. Sarkes Tarzian Inc., 415 N. College Ave., Bloomington, Ind. 47401. [437]



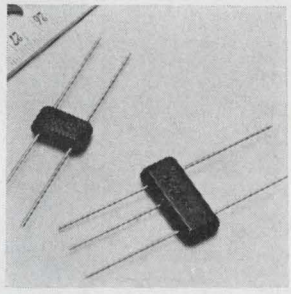
Mesa dice that are silicon glass passivated come in typical computer die sizes of 0.015 x 0.015 x 0.005 in. Electrical specs are less than 2 pf capacitance and recoveries at less than 2 nsec. Devices meet MIL-S-19500 and MIL-STD-202 specs. Price is less than 15 cents each at the 1,000-unit level. Micro Semiconductor Corp., 11250 Playa Court, Culver City, Calif. 90230. [438]



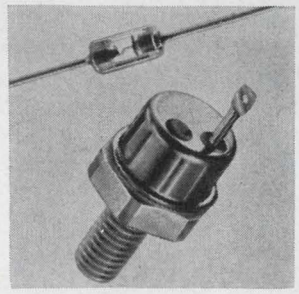
Miniature video detector diode model DX-105 covers 2 to 12 Ghz and provides −48 dbm sensitivity with a 2-Mhz video band width. Typical voltage sensitivity is 700 mv/mw with a 1,000-ohm load. The d-c return is integral. Connectors are ¼-36 miniature, male-in/female-out. Price is $125; delivery, stock to 30 days. Sage Laboratories Inc., 3 Huron Dr., Natick, Mass. 01760. [439]



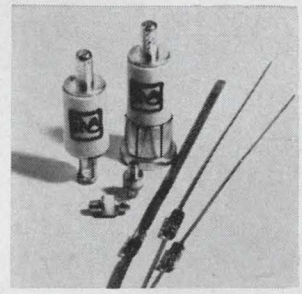
Germanium power transistors MP3730/31 have a thermal dissipation of 1.5° C/w. Breakdown voltages are 200 and 320, and collector currents are 5 and 10 amps, respectively. Gain is 15 at 2.25 amps (min.) for the 3730, and at 6 amps (min.) for the 3731. Prices (100-up) are $1.05 and $1.40 respectively. Motorola Semiconductor Products Inc., Phoenix, Ariz. 85001. [440]



Subminiature, medium power and 3-phase, full-wave silicon bridge rectifiers in the Compac SBR series are suited for versatile packaging. Full-wave bridges range from 1.5 amp, 50-1,000 v to 360 ma, 1,500-3,000 v; 3-phase full-wave bridges range from 2 amp, 50-1,000 v to 500 ma, 1,500-3,000 v. Semtech Corp., 652 Mitchell Road, Newbury Park, Calif. 91320. [441]



Two radiation resistant, power recovery diodes are planar epitaxial units. The 1-w version is packaged in glass, the 10-w unit is in a modified TO-59 stud package. Both are relatively low voltage devices with breakdowns of about 100 v and working voltages of 70 v. Recovery times are less than 100 nsec. Continental Device Corp., 12515 Chadron Ave., Hawthorne, Calif. 90250. [442]

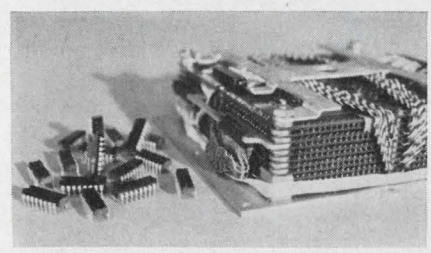


Schottky-barrier junction diodes MA-4850 cover the range of 2 Ghz to 5 Ghz with maximum noise figure of 9 db and c-w burnout of 1 w. Designed for use as broadband mixers, they are mounted in low-loss packages and are r-f characterized at 3,060 Mhz to assure premium circuit performance. Microwave Associates Inc., Northwest Industrial Park, Burlington, Mass. 01803. [443]

New semiconductors

Doubling-up IC amplifiers makes sense

Two-on-a-chip series for memory-logic interface provides circuit economy, design flexibility



Variety. Six types of dual-sense amplifiers can be used to link computer logic to 4,096-word memory, at right.

Memory and logic, two key elements of a computer, are easily and inexpensively bridged by integrated-circuit sense amplifiers. The task can be further simplified and the cost further reduced with IC dual-sense devices that convert the coincident-current memory readout to the saturated digital levels of the two most widely used logic families — diode-transistor and transistor-transistor.

Texas Instruments is offering a series of six dual-devices, SN752ON to SN7525N, that costs from 30% to 40% less than two separately packaged single-sense amplifiers, provides a variety of circuit configurations and threshold sensitivities, and has a high degree of integration—there are 17 transistor elements and 17 resistors in the basic

. . . devices compatible with both TTL and DTL . . .

structure. Encased in dual-in-line plastic packages, the IC's are priced at about $10 (average) in lots of 100-999.

Twins. Calling the dual arrangement unique for sense amplifiers, the company also claims the devices are the industry's first monolithics with multisense channels in a single package. Says a linear-circuits engineer at TI: "Their compatibility with both DTL and TTL operating levels meets the design needs of both today's and tomorrow's computers."

The dual units contain multiple differential-input preamplifier stages, gating and output circuitry, an internal reference amplifier arrangement that controls the threshold levels of the multiple inputs, and are d-c coupled. They detect bipolar differential-input signals—low-level pulses generated in magnetic core memories—and translate them into drive signals for standard TTL and DTL circuits.

D-c coupling avoids some of the problems that plagued earlier capacitive-coupled sense amplifiers, including long overload-recovery time, threshold shifts, and frequency-dependent instabilities. In TI's new devices, a TTL gate achieves the strobe function by providing a threshold action. This enables the amplifier to perform time discrimination, thus sharpening signal detection in noisy environments.

Wide range. The SN7520N and SN7521N are dual-preamplifier-sense units in a common-output circuit consisting of two cascaded TTL NAND gates. Each unit has two strobe inputs. Differential input threshold level range for the "20" is 11-19 millivolts; for the "21," 8-22 mv. These units can also be used to perform the functions of a flip-flop or a register that responds to sense-and-strobe inputs.

The SN7522N and SN7523N differ from the "20" and "21" only in that they have an open (uncommitted) collector output stage. These units can provide the exclusive-OR function or be used to supplement the "20" and "21."

The other circuits in the series—

Circle 218 on reader service card

SN7524N and SN7525N—each contain two independent sense channels in single packages. Both devices have variable threshold levels and each unit's two channels can be adjusted simultaneously by a single reference voltage.

Input threshold levels are the same for the "20," "22," and "24," as are those for the "21," "23," and "25." All six IC's have high-speed operation: typically, 25 nanosecond propagation delay for input to output, and 15 nsec delay for strobe to input. Noise margin is 1 volt, overload-recovery time is typically 20 nsec; logic-1 output voltage is 3.9 v with a 400-microamp load, and logic-0 output is 0.25 with a 16-milliamp sink.

Requiring power supplies of ±5 v, the devices are capable of operating in current-sinking as well as current-supplying modes. Prices (in quantities of 100): SN7520N—$13.20; "21"—$10.10; "22"—$12.65; "23"—$9.50; "24"—$11.90; "25"—$8.90.

Texas Instruments Incorporated, Semiconductor-Components Division, Dallas, Tex. **[444]**

New semiconductors

Current, currency —a dual gain

80-amp power transistor doubles usable gain, costs a third less

"Make it better, make it cheaper" —that's what Transitron Electronic Corp. set out to do with its new line of silicon power transistors. And to some degree, it has succeeded.

The company claims its ST140-11, ST14012, and ST14013 transistors outperform similar devices at their maximum ratings, and cost about a third less.

Both Solitron Devices Inc. and the Silicon Transistor Corp. offer power devices. Their 60-volt, 70-amp transistors cost about $330 each in lots of 1-999. Transitron's ST14011, however, a 60-volt, 80-amp device, sells for about $200

ThermaTab records surface temperatures

Apply pressure-sensitive ThermaTabs to any type of equipment (from diodes to diesels) that is subject to overheating. Calibrated to specific temperatures in 10° increments, ThermaTabs provide a permanent record of temperature level by turning black within an accuracy range of ±1%.

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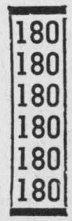

Each package contains 10 ¼ x 1" strips all rated for the same temperatures. Each strip may be cut into units of whatever size & shape are required for the application. Order from a selection of 36 temperatures in 10° increments from 100° through 450°F.

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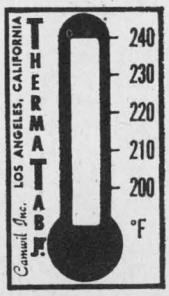

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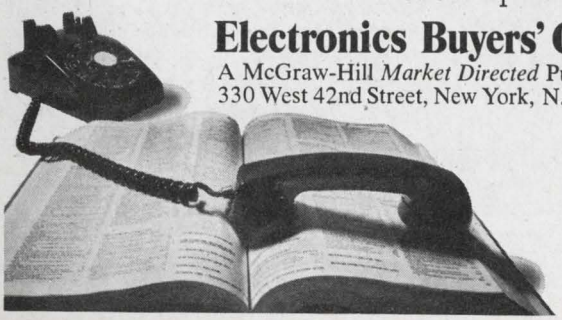

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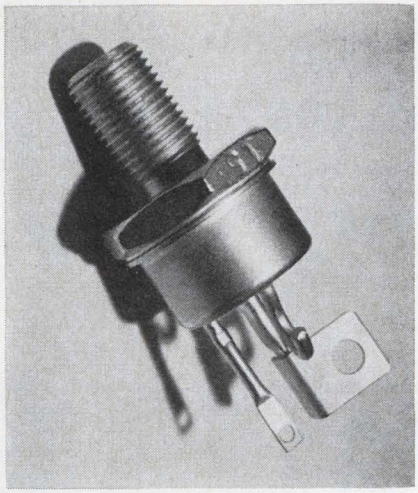

Gainful. Silicon power transistor holds gain even at high amperage.

each in lots of 100.

Sales pitch. Despite the price advantage, Transitron considers device performance the main selling point. Transistors designed for converters or regulators must have usable gain under specified conditions. Unfortunately, as amperage increases, current gain generally decreases until, at 70 to 90 amps, it has fallen to about 4 or 5. This is the case with most devices rated in the 80-amp range, says Philip Stevens, a senior product marketing engineer at Transitron. The company claims its new transistors have twice that gain—8 to 10 at 80 amps.

Unlike Solitron and Silicon Transistor, which only offer their devices in the MT49 package, Transitron offers both MT 49 and TO 63 packages. Power dissipation is about the same for both—200 watts at 100° case temperature. The difference is size: the MT 49 is more than an inch in diameter and the TO 63 stud-mount is only 7/8 inch.

Fast on, off. Although switching speeds of 3 or 4 microseconds is fast enough for most applications, the new devices switch on in about 1 to 2 μsec, and off in 2 μsec. "Fast switching reduces heat buildup at the junction," says Stevens. "And the less heat we have, the less we have to dissipate. That's how we can use a smaller package."

Transitron also claims low leakage for its silicon epitaxial planar devices; about 10 microamps and 1 μamp typical at peak voltages.

Transitron Electronic Corp., Wakefield, Mass. 01881 **[445]**

New Books

The waiting's over

Analysis and Design of Integrated Circuits
David K. Lynn, Charles S. Meyer, and Douglas J. Hamilton, with contributions from other engineers at Motorola Inc.'s Semiconductor Products division
McGraw-Hill Book Co., 545 pp., $16.50

The integrated circuit has started a revolution in electronics without benefit of a written manifesto. Disciples have been attracted by the Word as set down in trade publications, data sheets, conference proceedings, and advertising brochures. But they have had no little red book to return to after their conversion. Handbooks and design manuals can sustain or even inspire the zealot, but too often they reflect the prejudices of author or sponsor and have been slanted toward one company's product line.

Came the revolution and now comes the book. This volume contains the clearest and most thorough treatment of the subject yet. Though it is written by engineers from a leading IC manufacturer, it is an unbiased presentation of the over-all state of the art and of the entire technology—fabrication, processing, design, analysis, parameter considerations, and applications of both logic and linear IC's.

But the feature that raises this book above the usual tract is that it can be read from a strictly parochial point of view—and relished—by device engineer, circuit designer, or systems specialist. Also, the theoretical foundations it outlines transcend current technology and will apply in the coming era of large-scale integration and the eras following that.

Descriptions of IC characteristics include fabrication constraints, element models, nonlinearities, and parasitic effects. The six chapters devoted to digital circuits discuss logic functions, emitter-coupled logic, direct-coupled transistor logic, diode-transistor logic, and transistor-transistor logic, and include comparisons of the logic families.

The chapters on linear IC's cover small-signal characteristics, d-c and differential amplifier circuits, high-frequency tuned amplifiers, and frequency-selective circuits. An overview of the analog-IC field stresses the impact of these circuits on systems and on packaging techniques.

The audience for this book should be the broadest possible. Students on both graduate and undergraduate levels, engineers outside the field, users of IC's, and designers will all find something to learn here. It's a book to hold on to.

More than a hand-me-down

Electronic Designer's Handbook: A Practical Guide to Transistor Circuit Design
T.K. Hemingway,
Business Publications Ltd.,
296 pp., $7.50

This is not a handbook in the usual sense, but is more aptly described by its subtitle, "A Practical Guide to Transistor Circuit Design." It is aimed at beginning engineers who have completed courses in electronic circuit theory and received their bachelor's degree, but who have little or no practical design experience. It would also help experienced engineers interested in some of the special, recent-vintage circuits.

The book is divided into three sections. The first discusses basic diode and transistor characteristics, considering five network types: linear sweeps, constant current sources, simple amplifiers, negative feedback arrangements, and d-c amplifiers. The second, which is devoted to special circuits, consists of a description and analysis of more complicated networks, namely: complementary circuits, voltage-controlled oscillators, ultra-high gain stages, transistor pumps (step generators), and transistor cascodes. The third is devoted to intra-stage and interstage design techniques, such as bootstrapping, and includes a chapter on prototype testing. This chapter is especially useful; it provides many practical pointers such as on proper grounding techniques, avoiding undesirable turn-on transients—these measures often are learned only through expensive, time-consuming laboratory work.

However, the quality of the dis-

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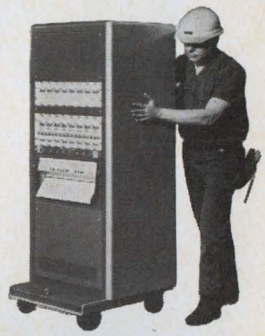
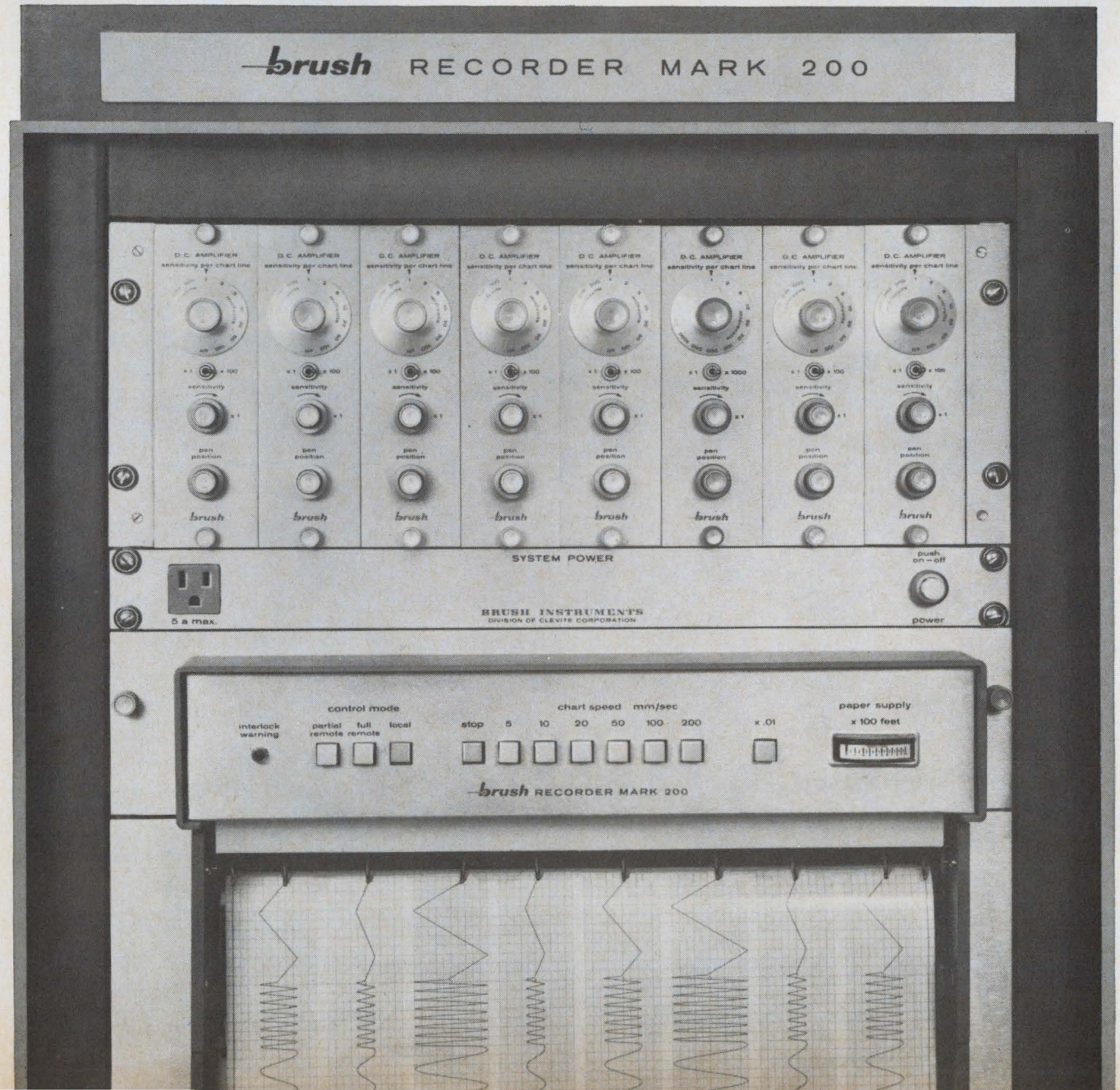




New Books

cussion is spotty; and there are even some errors. The only linear equivalent network discussed, for example, is the T-circuit, and no mention is made of the useful h-parameter and hybrid-π models.

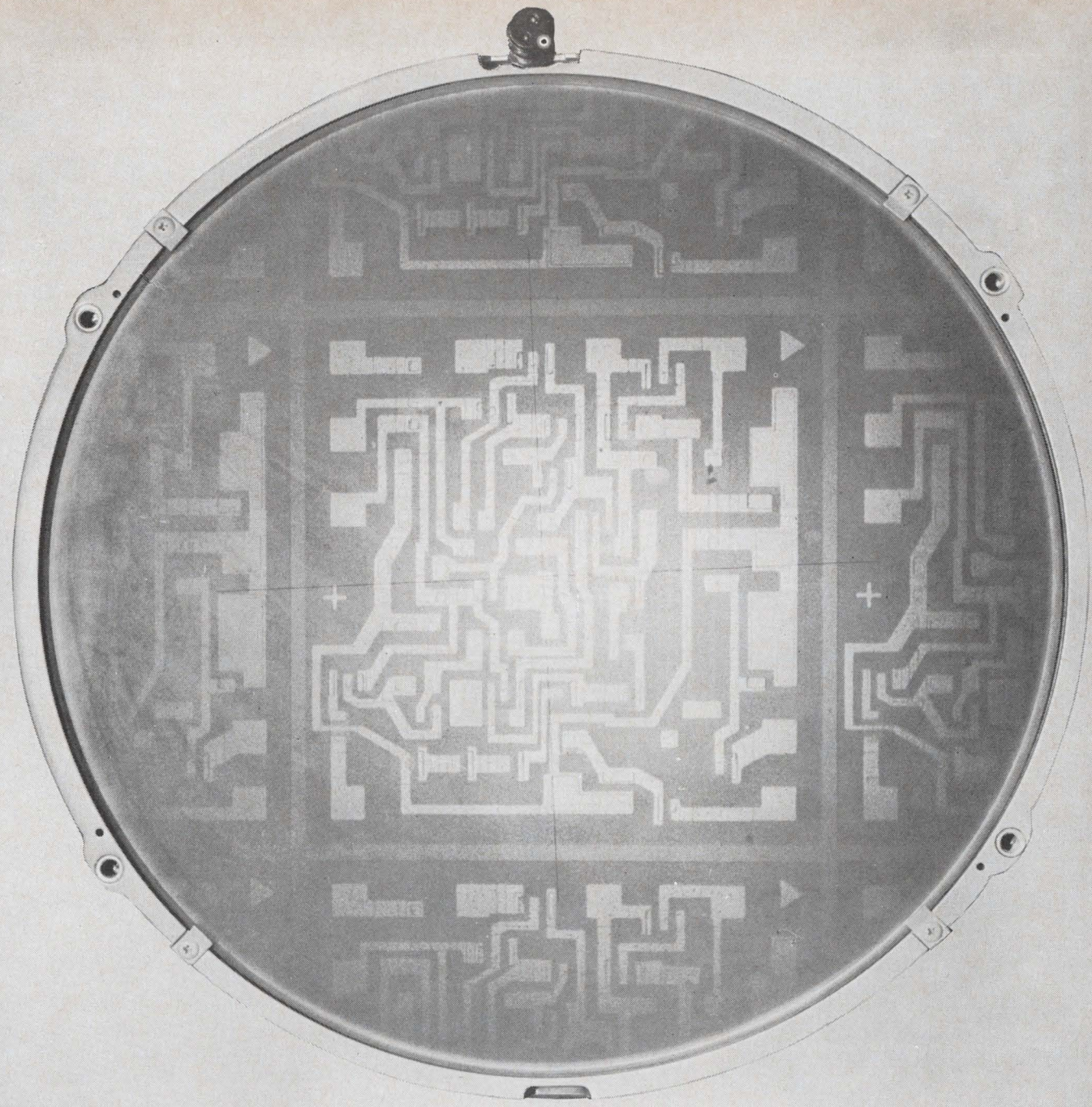
The discussion of high-frequency effects is sketchy and, in the case of the input impedance, erroneous. Using the T-circuit and the variation of α with frequency, the author comes to the incorrect conclusion that the input impedance is β_o/g_{mo}, independent of frequency. Here the use of the hybrid-π models would show that the input impedance decreases with frequency.

A discussion of power transistors mentions only allowable dissipation, and says the rest of the linear power amplifier design is essentially the same as that for simple voltage amplifiers. For reasons unknown Hemingway has chosen to ignore the considerations of transformer coupling, or of class-B operation. The chapter on feedback considers only one type of feedback circuits, the simple operational amplifier, and the discussion of the differential amplifier seems unduly complicated.

The various circuits described are essentially independent of each other, so that a designer interested in a particular topic may profitably focus on a single chapter. However, this is not an exhaustive handbook of circuit design. Many important circuits, such as broadband amplifiers, tuned amplifiers, class C operation and logic circuits, are not mentioned at all.

Perhaps the best feature of Hemingway's book is that it is more practically oriented than many books on circuit design. The emphasis is on the design of stable, high-performance circuits, using transistors whose parameters vary with temperature and from unit to unit. Other valuable features for the novice are the use of realistic values for transistor parameters and the use of only those parameters which appear on data sheets.

Joseph Frank, P.E.
(Electronics system consultant and member of the City College of New York staff, department of electrical engineering.)



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Technical Abstracts

Linears for logic

A family of linear integrated circuits for data systems
Marvin B. Rudin, Richard L. O'Day, and R.H. Jenkins
Fairchild Semiconductor
Palo Alto, Calif.

Digital data-processing equipment requires low-cost devices for analog data acquisition, display, and control to complement the digital IC's already being used. Linear integrated circuits provide a way to make digital-to-analog (d-a) and analog-to-digital (a-d) converters that meet performance specifications to satisfy many users; the IC's can be produced in quantity to assure low manufacturing cost.

While both type converters have much in common, there are distinctions that must be considered in developing a family of units. Generally, the a-d converter encodes—one-by-one—a plurality of time-multiplexed analog measurements; but the d-a converter restores only one digital output for each analog equivalent. A-d converters generally operate bit-sequentially, but d-a's use the more complex bit-parallel operation.

Using major conversion techniques as a guide, a design centered around a bipolar current-summing d-a converter was chosen as the approach which could be met by off-the-shelf linear IC's. The technique satisfies the specifications of speed, temperature performance, long-term stability, and logic levels and power supply voltages required for compatibility with most standard data equipment.

The final specifications are:

- Conversion rate, words/sec
  - Digital-to-analog: d-c to 50,000
  - Analog-to-digital: d-c to 100,000
- Resolution, bits
  - Digital-to-analog: 8-10
  - Analog-to-digital: 10
- Accuracy, % of full scale
  - Digital-to-analog: 0.20
  - Analog-to-digital: 0.05

The required functional blocks for making a d-a converter are, typically, an impedance-transforming amplifier, a combination logic-buffer, current switching network, current sources, voltage references, and a data register.

The a-d converter design contains a digital programer, a holding register, a d-a converter reference, a current-setting resistor array, and two standard linear integrated circuits—an operational amplifier and a comparator.

All blocks can be constructed from off-the-shelf logic and linear products—for example diode-transistor-logic registers and programers, μA722 D/A converters, and the μA709, μA715, and μA734 linear series—and a few external resistors and capacitors. These IC elements are compatible in terms of operating levels at the logic-linear interface, and discrete semiconductor level-shifting elements are not needed.

Presented at the 1967 Fall Joint Computer Conference, Anaheim, Calif., Nov. 14-16.

Changing with the wind

An adaptive multiple-access system
C.E. Sampson
IBM Federal Systems Division
Center for Exploratory Studies
Rockville, Md.

Future satellite communication systems serving many users in different locations will probably operate at millimeter wavelengths. However, above 15 gigahertz, atmospheric attenuation becomes a problem. If these systems adapt to local atmospheric conditions by taking energy from strong channels and giving it to weak channels, they can get along with less power. A hypothetical 45 gigahertz system with 40 channels that must be available 99.8% of the time would use 20 times less power than a comparable nonadaptive system.

A typical system might time multiplex signals and then modulate them with random sequences of bits. Known as pseudonoise modulation, this technique makes it simple to derive timing information at the ground terminals and also offers message security.

Each ground station would transmit in time slots assigned to the station it wished to reach. Pulse trains from each ground station would be combined into a higher-speed train at the satellite and then relayed back to the earth where each receiver would pick out its

Technical Abstracts

messages by looking only at its own time slots.

Periodically, a user would check the strength of the transmitted signals and then transmit the results of his measurements to a central controller. His job would be to dictate the duration of pulses sent from each terminal. If a user's signal were being attenuated, he'd be told to increase pulse duration, thereby increasing his transmitted power. If his signal were stronger than necessary, he'd be told to decrease pulse duration. If too many fades happened simultaneously, users would have to reduce data rates to prevent widened pulses in different time slots from interacting.

Presented at IEEE Eastcon, Washington, Oct. 16-18.

Not just any memory

Main-frame memory technology—a debate

Improvements in multiprocessor, time-sharing computer systems depend largely on improved memories. Newer semiconductor memories now compete with the older magnetic ones, but each type has its advocates. Position papers by four panelists discuss the competitive factors of new planar and cylindrical magnetic-film memories, large-scale integrated semiconductor memories, and refinements in magnetic memories.

▪ Planar magnetic-film memory cells switch rapidly; the access and cycle time of the complete memory depends not on the individual device but mainly on the array parameters and circuit and packaging designs. Planar film memories have relatively low drive currents, low impedances and, consequently, low power. This permits the use of high-speed drive and sense circuits. In addition, array packing densities approach 10^4 bits/in^2, leading to relatively short drive and sense lines with relatively large numbers of bits per line.

The highly integrated structure is somewhat more complex to process. However, simplified packaging and reduced number of intercon-

Technical Abstracts

nections will far outweigh this disadvantage.
Q.W. Simkins, IBM Corp., Essex Junction, Vt.

▪ Plate wire appears to offer advantages in memories. Because air gaps in magnetic memory elements generally are nuisances, there is a strong trend in planar film memories to close the gap. In this case, a single plating operation on a continuous cylindrical substrate should result in a significant advantage for plated wire.

The continuous substrate manufactured and tested plated wire memory element provides for improved yields also. Perhaps the main advantage of the plated magnetic cylindrical thin film memory element is its nondestructive readout capability, which allows flexibility of memory and system organization and operation.
G.A. Fedde, Sperry Rand Corp., Philadelphia.

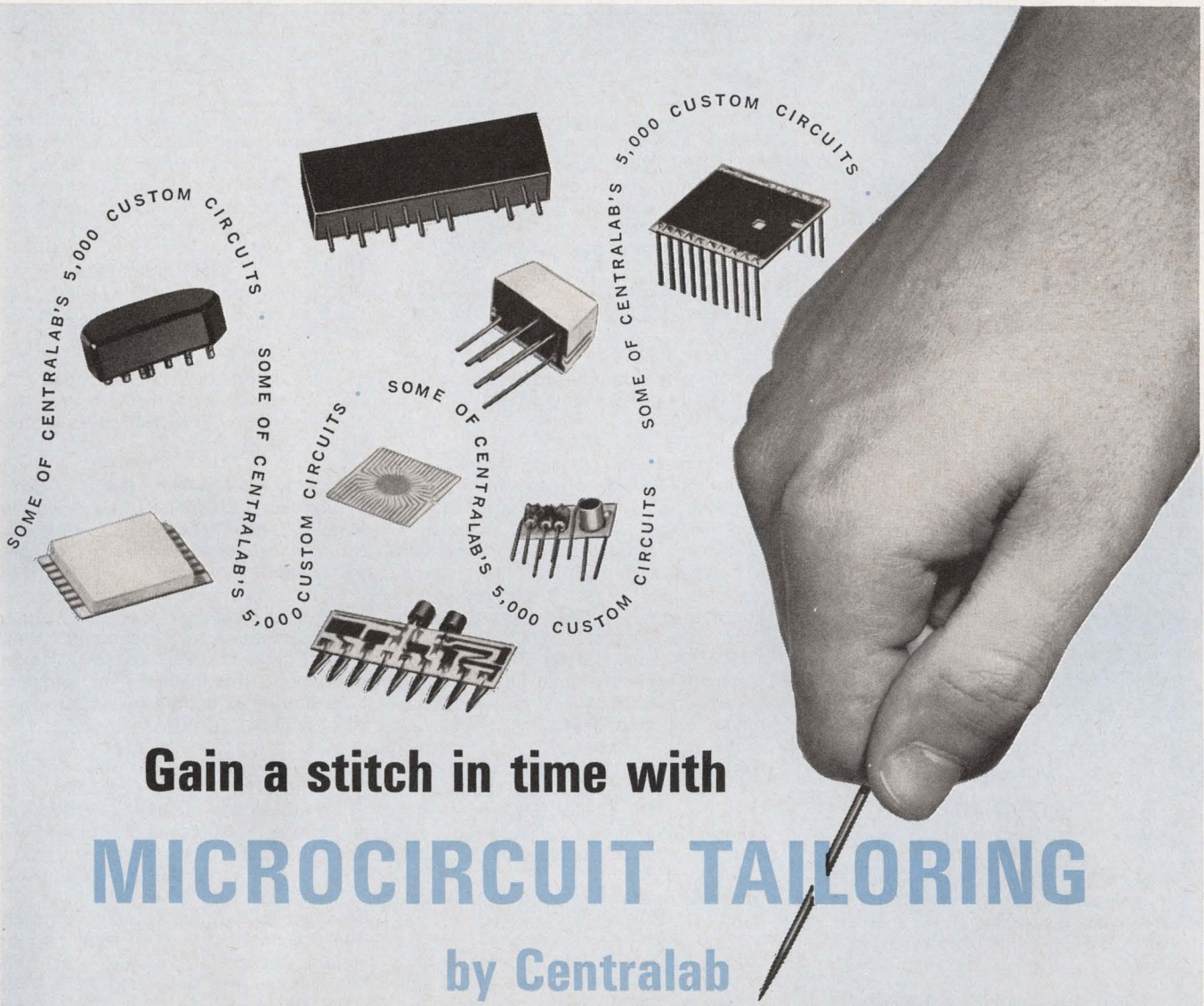
▪ Large-scale integration of active semiconductor memories permits several thousand memory cells to be interconnected on a single substrate. It also allows drivers, decoders, and sensing to be integrated with the memory matrix, reducing the number of array connections, increasing packing density, and reducing internal noise.

The most economical use of LSI bipolar array would be for memories larger than 5,000 bits. The next level will be several such arrays on a circuit board. However, bipolar main frame active memories probably will not find commercial use until 1970 when 5,000 bit arrays are available in volume.
R.S. Dunn, Texas Instruments Incorporated, Dallas.

▪ Magnetics is still the best choice for computer main memory. Toroidal ferrite cores have predominated because of their relatively low cost and the economies from coincident-current operation.

During the last five years batch-fabricated magnetic structures have received increased attention because they promise to lower memory array cost and increase speed.
R.J. Petschauer, Fabri-Tek Inc., Edina, Minn.

Presented at the 1967 Fall Joint Computer Conference, Anaheim, Calif., Nov. 14-16.



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New Literature

Functional analog modules. RO Associates, 917 Terminal Way, San Carlos, Calif. 94070. A six-page folder contains descriptions and applications of a line of functional analog modules for systems application.
Circle **446** on reader service card.

Schottky-barrier diodes. Microwave Associates Inc., Northwest Industrial Park, Burlington, Mass. 01803. Technical bulletin 4049 describes a series of Schottky-barrier junction diodes covering the frequency range from vhf to L band. **[447]**

R-f connectors. Applied Engineering Products, Division of Samarius Inc., 26 E. Main St., Ansonia, Conn. 06401. Subminiature, coaxial r-f connectors that meet MIL-C-22557 are described in bulletin 167. **[448]**

Magnetostrictive delay line. Sealectro Corp., 225 Hoyt St., Mamaroneck, N.Y. 10543. Product bulletin DT-24 includes electrical, environmental and operating specifications for the LD-50 adjustable magnetostrictive delay line. **[449]**

Keyboard assemblies. MicroSwitch, a division of Honeywell, 11 W. Spring St., Freeport, Ill. 61032. Brochure 84-20001-0 describes solid state encoded and wired keyboard assemblies. **[450]**

Numerical-control system. Digital Systems Inc., 1078 E. Edna Place, Covina, Calif. 91722, offers a brochure on the model 3050 N/C tape programer and inspection system for p-c board applications. **[451]**

H-v power supply. Hamner Electronics Co., P.O. Box 531, Princeton, N.J. 08540. A 3,000-v power supply for operating radiation detectors is described in technical bulletin NV-19. **[452]**

Surge comparison tester. Aerospace Electrical Division, Westinghouse Electric Corp., P.O. Box 989, Lima, Ohio 45802. A booklet describes a surge comparison tester for detecting and locating insulation faults and winding dissymmetrics in motors, generators, and many types of transformers and coils. **[453]**

Two-wire transducers. Fischer & Porter Co., Warminster, Pa. 18974. Specification 50EM/ET3000 describes solid state millivolt-to-current and thermocouple-to-current two-wire transducers. **[454]**

Tunnel-diode amplifiers. Radio Engineering Laboratories, 29-01 Borden Ave., Long Island City, New York 11101. Tunnel-diode amplifiers operating in the 1-, 2- and 5-Ghz frequency bands are described in a technical data sheet. **[455]**

Color videotape recorder. Ampex Corp., 401 Broadway, Redwood City, Calif. 94063. An eight-page brochure describes features, specifications and operation of the VR-2000B high band, color videotape recorder. **[456]**

Electronic control tachometer. Airpax Electronics Inc., P.O. Box 8488, Fort Lauderdale, Fla. 33310. Bulletin F-5 discusses the Tach-Trol line of industrial electronic tachometers, which convert frequency, rpm or speed into high level output current ranges that are linearly proportional to the input signal. **[457]**

Indicating controller. Sigma Instruments Inc., 170 Pearl St., Braintree, Mass. 02185. Standard indicating controller 9221 is described in bulletin 1171. **[458]**

Multiplexer. Beckman Instruments Inc., 2200 Wright Ave., Richmond, Calif. 94804. Bulletin 2216 covers a digital instrument multiplexer that provides time-sharing capability for five or more input sources. **[459]**

Infinite resolution pots. New England Instrument Co., 281 Billerica Rd., Chelmsford, Mass. 01824, offers an eight-page instruction book that shows designers how to make their own infinite resolution potentiometers. **[460]**

Ceramic substrates. Coors Porcelain Co., Golden, Colo. High-alumina ceramic substrates for thick- and thin-film circuits are described in bulletin 7012. **[461]**

Circuit-deck switches. Beckman Instruments Inc., 2500 Harbor Blvd., Fullerton, Calif. 92634. Data sheet 671521, on the circuit-deck series 1390 Cermet switches, contains information on a design that combines resistor and capacitor networks with the switch itself. **[462]**

Test-point connectors. Continental Connector Corp., 34-63 56th St., Woodside, N.Y. 11377, offers an eight-page catalog covering test-point connectors for printed-circuitry applications. **[463]**

Microminiature chopper. Solid State Electronics Corp., 15321 Rayen St., Sepulveda, Calif. 91343, has published a bulletin on the solidly encapsulated, model 30 Microchopper, a low-level spdt switch for operation from —55° to +90°C. **[464]**

Ultra-high-vacuum products. Edwards High Vacuum Inc., 3279 Grand Island Blvd., Grand Island, N.Y. 14072, has available data sheets describing 25 new ultra-high-vacuum products. **[465]**

Straight cable plug. Sealectro Corp., 225 Hoyt St., Mamaroneck, N.Y. 10543.

Product bulletin CX-105 describes a new 50-ohm, snap-on straight cable plug. **[466]**

Computer. Digital Equipment Corp., 146 Main St., Maynard, Mass. 01754, offers a brochure that shows and explains its PDP-8/1 computer, a fast integrated-circuit system selling for $12,800. **[467]**

Precision resistor alloy. The Kanthal Corp., Wooster St., Bethel, Conn. 06801. Nikrothal LX precision resistance wire, which is stable at temperatures up to 300°C, is described in a 12-page booklet. **[468]**

Instrument transformers. James Electronics Inc., 4050 N. Rockwell St., Chicago, Ill. 60618. A 12-page, master instrument transformer catalog provides technical data, performance tables, mechanical dimensions and drawings, frequency response curves and formulas, and complete specifications and test techniques. **[469]**

Test equipment. The London Co., 811 Sharon Drive, Cleveland, Ohio 44145. Electronic test equipment for laboratory, quality control and production applications is described in a six-page color brochure. **[470]**

Power relays. Magnecraft Electric Co., 5575 N. Lynch Ave., Chicago, Ill. 60630. Eight-page power relay catalog 567 contains specification data, dimensional drawings, and prices of a complete line of heavy-duty power relays. **[471]**

Amplifiers. C-Cor Electronics Inc., 60 Decibel Road, State College, Pa. 16801. A 28-page catalog presents complete detailed data on a wide range of small, economical amplifiers for breadboard, laboratory, or system use. **[472]**

Computer tape. Audio Devices Inc., 235 E. 42nd St., New York 10017. A technical data sheet describes the Audev K-68, an extended reliability magnetic tape for modern digital computers. **[473]**

Rotary thumbwheel switches. Engineered Electronics Co., 1441 E. Chestnut Ave., Santa Ana, Calif. A 54-page catalog, including 16 pages of application information, describes the company's complete line of rotary thumbwheel switches. **[474]**

Aircraft flight control. General Precision Systems Inc., 808 Western Ave., Glendale, Calif. 91201. An aircraft flight-control system is described in an eight-page brochure on the L-193 head-up display. **[475]**

Coaxial attenuators. Meca Electronics Inc., 459 E. Main St., Denville, N.J., has issued a 32-page catalog covering a broad range of coaxial attenuators. **[476]**

Indicating lights. General Electric Co., Schenectady, N.Y. 12305. Bulletin GEA-

New Literature

8119A provides features and outline drawings with dimensions and complete ordering information for the four lines of CR103 type H indicating lights. **[477]**

Diode selection. Motorola Semiconductor Products Inc., P.O. Box 955, Phoenix, Ariz. 85001. Publications SG3 and SG4 make possible easy, quick identification and selection of virtually any zener or temperature-compensated reference diode. **[478]**

Molded mica capacitors. Electro Motive Manufacturing Co., Willimantic, Conn. 06226. A 12-page catalog covers the El Menco MM series of molded mica capacitors that have capacitance ranges from 1 pf through 51,000 pf. **[479]**

Indicating controller. Sigma Instruments Inc., 170 Pearl St., Braintree, Mass. 02185. Bulletin 1167 provides performance, electrical, environmental, and physical specifications on the model 9223 subminiature indicating controller. **[480]**

Transducer. Taber Instruments, 455 Bryant St., North Tonawanda, N.Y. 14120, has issued product sheet P672103 on the series 2103 transducer designed for applications where accurate low-pressure readings must be taken after high overloads. **[481]**

Photoresist spinner/dispenser. Headway Research Inc., 3713 Forest Lane, Garland, Texas 75040, offers a six-page technical bulletin on the AHT-SRD photoresist spinner with complete automatic fluid-dispensing system. **[482]**

Differential operational amplifiers. Analog Devices Inc., 221 Fifth St., Cambridge, Mass. 02142. A 14-page application note discusses techniques that have led to a generation of differential operational amplifiers with maximum drift specifications down to 0.75μv/°C. **[483]**

Coaxial hybrid couplers. Microwave Development Laboratories Inc., 87 Crescent Road, Needham Heights, Mass. 02194. Bulletin HK-3 provides data on coaxial hybrid couplers for use in microwave subsystems such as mixers, duplexers, phase shifters and power dividers. **[484]**

Printed circuits. Photocircuits Corp., 31 Sea Cliff Ave., Glen Cove, N.Y. 11542, offers a 12-page technical bulletin on printed circuits manufactured by the CC-4 process, which retains the broad applicability of the etching technique at less total cost. **[485]**

Power modules. Electronic Research Associates Inc., 67 Sand Park Road, Cedar Grove, N.J. 07009. Catalog sheet 147A covers the LC series of low-cost, wide-range power modules. **[486]**

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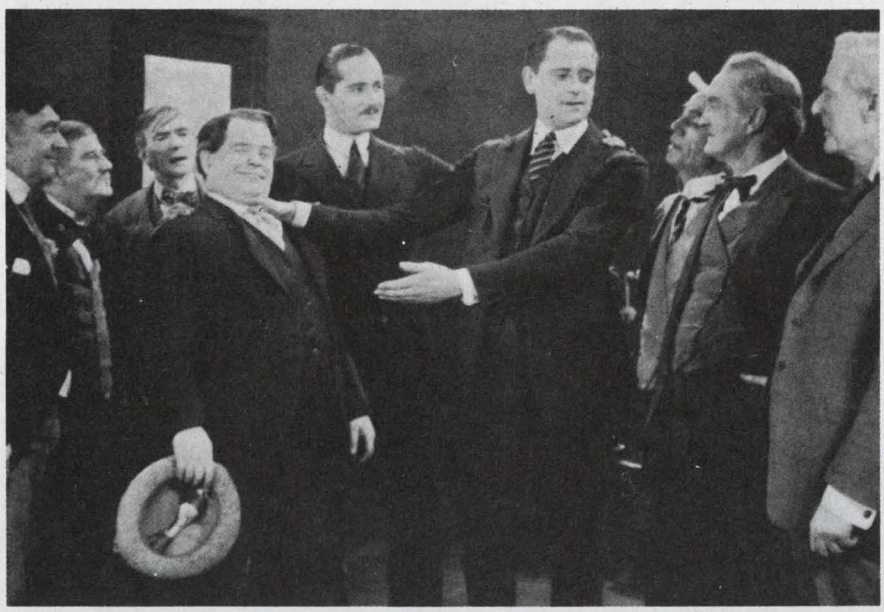
Circle 287 on reader service card



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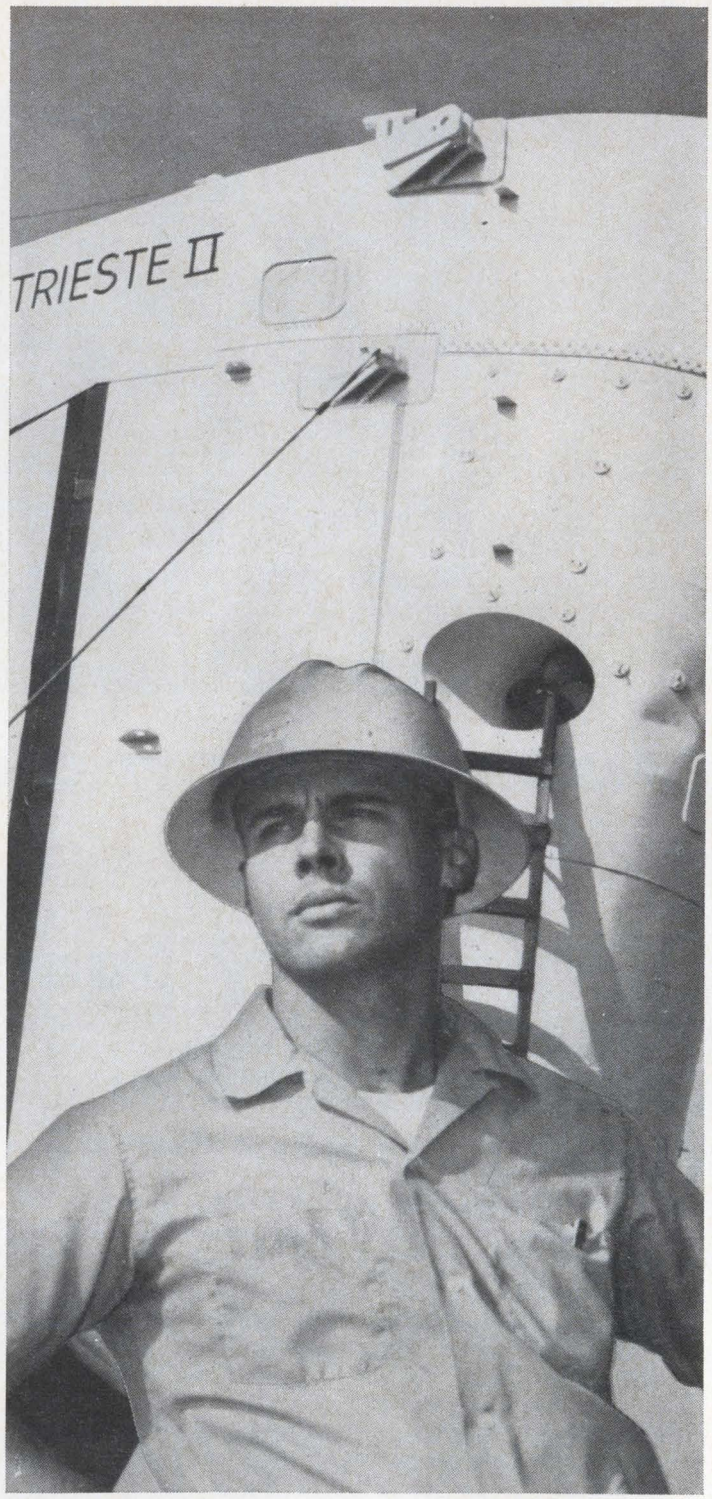

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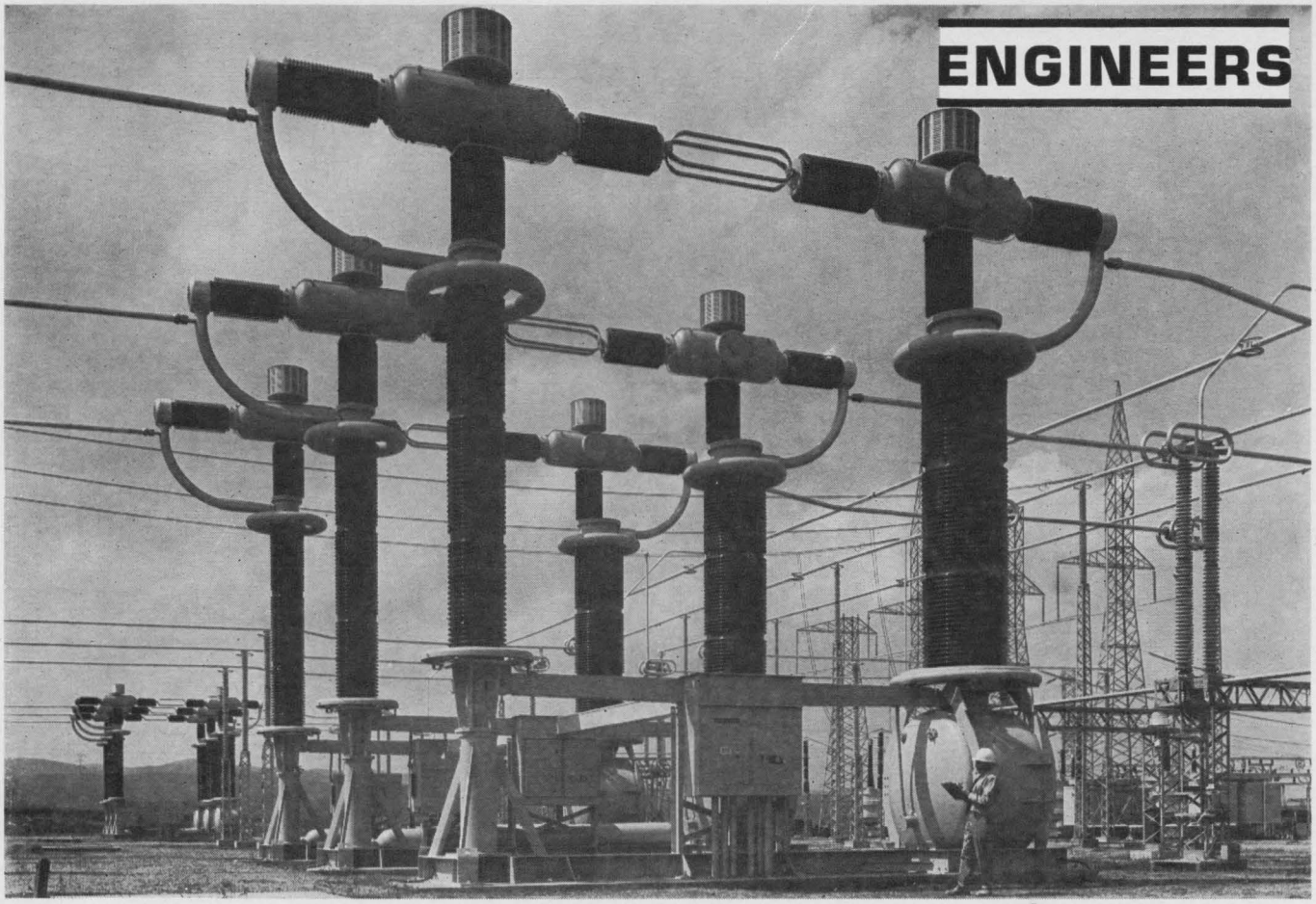

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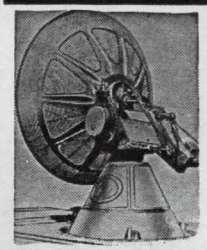

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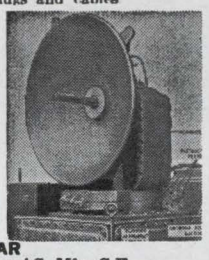

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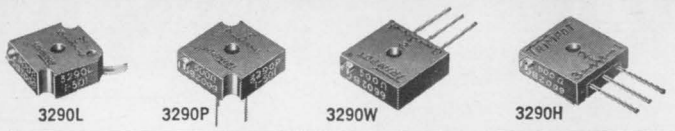

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Resistance Tolerance	±5% Standard
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Newsletter from Abroad

January 8, 1968

Mitsubishi pushes Gunn oscillator to record output . . .

A new high for continuous-wave output from a Gunn oscillator—470 milliwatts at about 7 gigahertz—has been logged by the Mitsubishi Electric Corp. The highest previously reported c-w Gunn power was the 340 mw recorded by Nippon Electric.

Along with the new high in power, **Mitsubishi claims a mark for efficiency—better than 13% and thus close to the theoretical limit.** Shigeru Mitsui, who led the research effort, attributes the record performance to improved ohmic contacts and closer coupling to the oscillator cavity.

Mitsubishi built its oscillator from a slab of bulk gallium arsenide lapped to a thickness of 25 microns. Heavily doped layers about 5 microns thick are formed at top and bottom and are nickel plated to serve as ohmic contacts.

The threshold level of the oscillator is 6 volts. Efficiency hits a maximum at 8 volts with output power of about 400 mw. At 10 volts, power output rises to roughly the 470-mw mark but efficiency falls to around 12%. **Mitsui says the device probably could be pushed to even higher power levels but only at a further sacrifice in efficiency.**

. . . and shines twice with (Ga,Al)As diode

Watch Mitsubishi, too, for displays based on gallium-aluminum-arsenide diodes. Company researchers have already performed more than 500 hours of severe life tests on the devices, which glow either as electroluminescent diodes or lasers.

With the tests, Mitsubishi joins the International Business Machines Corp. as a front runner in gallium-aluminum-arsenide technology. The material's main attraction is that diodes can be fabricated of it by liquid-phase epitaxial techniques, which are less costly than the gaseous-phase process required for phosphorous-based diodes.

Mitsubishi has been running its life tests with the diodes working at a current of 50 milliamperes, or 250 amps per square centimeter. **Only 20 ma is needed to make the diodes emit a bright, red light.** Depending on composition, the electroluminescent wavelength can run between 0.65 and 0.9 micron.

Electroluminescent applications figure to come first for the diode. **However, at 30 amps it works as a room-temperature laser with an output between ½ and 1 watt at a wavelength of 0.78 microns.**

U.S. firms recast overseas plans

President Johnson's foreign investment curbs will force a fast reshuffling of the overseas plant expansion programs of U.S. electronics companies.

Most firms have yet to gauge the full impact of the restrictions on their foreign operations, but the prevailing first impression is that there will be increased emphasis on investments outside of Europe. The mandatory program to overcome the U.S. payments deficit hits the Continent hardest, with a moratorium on new capital outflow to that area. For Britain, the limit is 65% of the average investment during 1965 and 1966. In the developing countries, though, outlays can run to 110% of the 1965-66 average.

Paradoxically, the companies with the biggest overseas operations could turn out to be the ones least affected by the new curbs. Firms like IBM and ITT, old hands in world markets, should have an edge in lining up

local investment money, on which there is no U. S. restriction. And the companies that have gone in heavily for overseas operations will benefit most from the right to reinvest the profits of their Continental subsidiaries in amounts up to 35% of average 1965-66 capital investments.

Soviet color tv: low volume for '68

Russian economic planners have assigned a low priority to color television this year. Despite the fanfare that marked the start of colorcasts during last fall's celebrations of the Bolshevik Revolution's 50th anniversary, **the 1968 target is a mere 15,000 color sets. Only 2,000 sets were produced last year.**

A big push in color-set production, however, is scheduled to get under way in 1969. K.Y. Sergeychuk, the Soviet Union's second-ranking communications official, says next year's goal is 90,000 sets and that 1970's will be 200,000.

Hitachi and RCA in computer deal?

A large-scale computer, to be developed jointly by the Radio Corp. of America and Hitachi Ltd., may be in the works. **The two companies have set an early-1968 date to start talks aimed at a closer working arrangement in computers.** Hitachi already produces a slightly modified version of the RCA Spectra 70 but wants to contribute to the technology of any future computers it builds under license.

East Germans slate computer output rise

Heavy emphasis on data processing by the Ulbricht government will send East German computer production soaring this year. **The country's 1968 budget schedules output of $23 million worth of Robotron 300 computers, a strong gain over 1967.** The machines, roughly equivalent to the IBM 1401, will be used mainly for industrial planning.

The budget also calls for sharply increased production of electronic accounting machines, a big export item for the East Germans. The goal is $19 million worth, a gain of 19% from last year. And 1968 will see the **start of mass production of silicon-planar and silicon-planar-epitaxial transistors, with the target set at more than $7 million worth.**

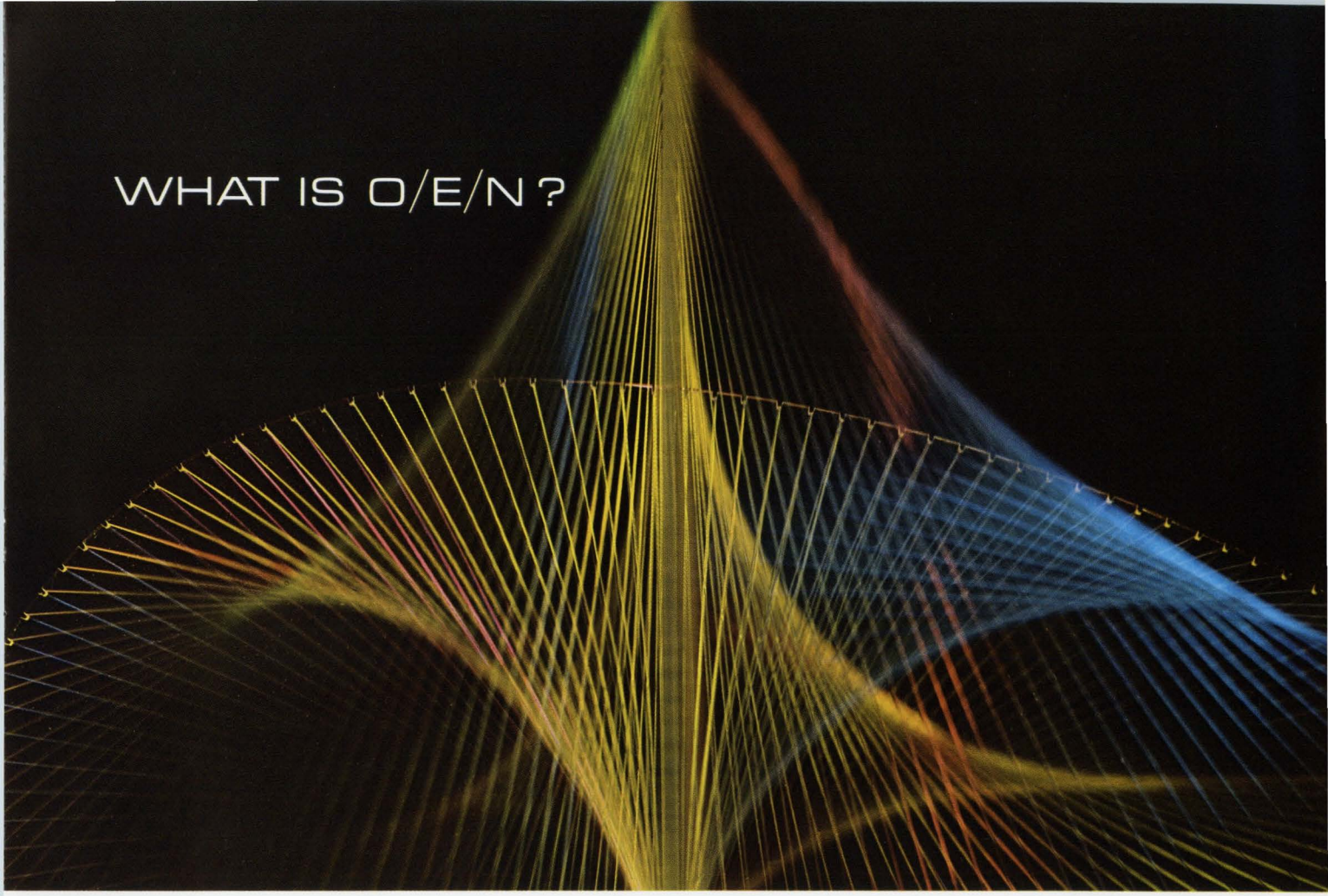
British simplify NC programs

Programs that can be run on medium-size computers to generate tapes for numerically controlled machine tools will be available in Britain starting next month.

The British programs, developed under the aegis of the government-owned National Engineering Laboratory (NEL), are simplified versions of the APT system (for automatically programed tools) developed in the U.S. With APT, a computer with an internal store of at least 65,000 words is needed. **The British scheme cuts the computer requirement to 16,000 words but cannot handle shapes as complex as can APT.**

The first British program covers shapes—like cams—that can be milled by keeping two axes of a milling machine under continuous-path control and the tool axis under linear velocity control. Ferranti Ltd. developed the program for NEL. After the first version—for a Univac 1108 computer—has been finished, Ferranti will follow up with versions for the ICT 1904, the English Electric KDF 9, and the Elliott-Automation 4100 series.

NEL's next series of simplified APT programs probably will cover pattern drilling and straight-line milling.



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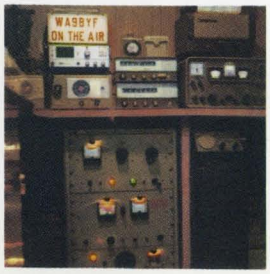

AEROSPACE

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COMPUTERS

INDUSTRIAL CONTROLS

January 8, 1968

Electronics Abroad

Volume 41
Number 1

Japan

Memorable memory

Designers of computer memories now have a new speed mark to shoot at—200-nanosecond full-cycle time and 100-nsec access time.

The record, set with a woven-wire memory developed at the Electrotechnical Laboratory run by the Ministry of International Trade and Industry, eclipses the 500-nsec cycle time achieved by plated-wire memories at the Sperry Rand Corp.'s Univac division and the 800 nsec of rod memories built by the National Cash Register Co.

More later. Electrotechnical's memory, built around woven-wire planes produced by Toko Inc., which shared in the work, has a capacity of 4,096 50-bit words. The development is a big step toward the 200-nsec, 128,000-word memory intended for a large, fast computer the government hopes to have ready by March, 1971 [Electronics, June 27, 1966, p. 93]. Like the prototype, the bigger version will have 50-bit words.

Basically, the memory is similar to those made by Toko in Japan and by General Precision Inc. in the U.S. The thin-film plating on the wires of the new memory, though, is only 0.7 micron thick.

Unchecked. The prototype has planes that handle 128 words each. For the large memory that will follow, the planes will undoubtedly be larger.

Although an increase in size tends to slow a memory, Electrotechnical expects to maintain the 200-nsec cycle time largely by switching from the destructive readout used for the prototype to nondestructive readout. In the latter mode, no time is wasted writing in what has been read out.

Theoretically, read time should be halved. Electrotechnical, however, doesn't expect to do that well. It anticipates a speed-up of about 1½ times. This together with improvements in technology, the Japanese believe, should enable them to reach their goal without too much difficulty.

The laboratory has already started to design a prototype memory with nondestructive readout. The main difference between the two types will be in the plated wires used. And the drive circuits will, of course, be reworked to suit the new operating mode.

An eye for curves

The batteries of chart recorders installed in highly automated production plants all too often become little more than high-priced waste-paper generators. It simply takes too much time and trouble to read and analyze the miles of analog curves the recorders churn out.

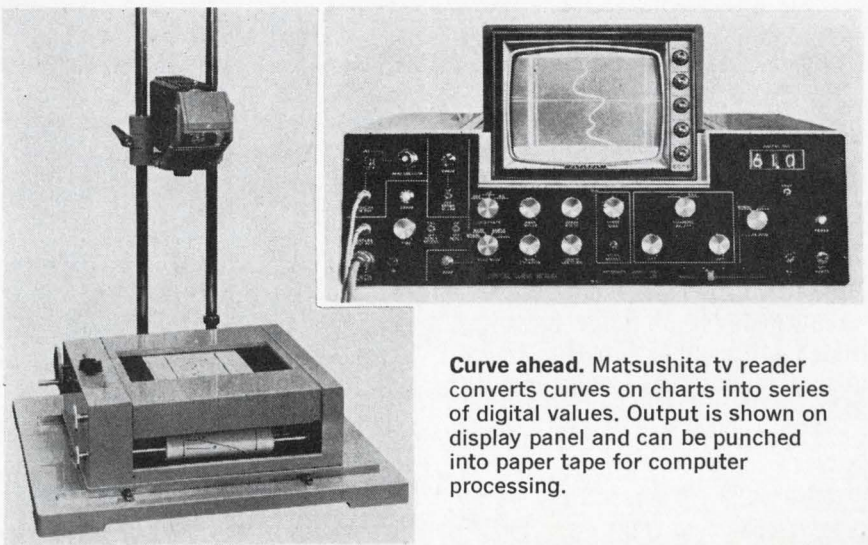
The Matsushita Communication Industrial Co., though, has come up with equipment to take on this tedious task. Matsushita's reader scans charts with a television camera at speeds up to about 1 foot per minute, and then converts the curves into digital data. The data can be printed out, read off an indicator, or punched into paper tape for analysis by a digital computer. There's also a digital-to-analog converter for those who want to analyze the information with an analog computer. A tv monitor tucked into the readout equipment indicates where the curve is being read at any moment.

Matsushita Communication, a subsidiary of the Matsushita Electric Industrial Co., builds the readers to order. Prices run from $11,100 to $19,450 depending on the number of extra features requested.

On the line. Excluding accessories, the reader consists of a vidicon tv camera mounted atop a chart transport, and a main unit housing camera drive circuits, control and counting circuits, the digital-to-analog converter, and the tv monitor.

The camera is much like those found in low-cost, closed-circuit tv systems, but it has been modified to synchronize the vertical-sweep frequency with the line frequency. Also, the scan isn't interlaced; each frame is made up of one 314-line field at 50-hertz line frequency.

Although the chart can be stopped at any point for a digital readout, the reader normally runs continuously, taking readings at prerecorded time markers on the



Curve ahead. Matsushita tv reader converts curves on charts into series of digital values. Output is shown on display panel and can be punched into paper tape for computer processing.

chart. Only one scan line in each frame is "active." This line, near the center of the raster, is intensity-modulated so that it appears on the monitor as a light white line indicating where the curve is being read.

During the scan of the active line, the camera output is gated onto counting circuits. The scan produces one pulse when the camera hits the "zero" reference line on the chart, a second when it reaches the curve, and a third when it hits the "100%" reference line. The count between the first and second pulses corresponds to the digital value of the curve and is fed to a readout register.

Between active-line scans, the system keeps itself constantly calibrated, holding the number of counts between the zero-line pulse and the 100% pulse at 400 by varying the frequency of the oscillator that sets the clock rate for the count. Logic circuits determine the exact frequency between 10 and 20 megahertz needed to maintain this spacing.

Plain and fancy. The curve displayed on the monitor can either be a straight tv reproduction of the one on the chart or a synthesized image. The latter is derived by mixing pulses clipped from the curve reading, the synchronizing pulses for the monitor, and the pulses that show the active line. Correspondence between the synthesized curve and that on the chart show that the pulses used to make the digital readings are correct.

West Germany

Bright tune

High-fidelity buffs, unless they're unusually well-heeled, generally have to make do with a field-strength meter to judge how well their equipment is tuned in to frequency-modulation broadcasts. Indicators showing when stations are tuned in dead center are, with few exceptions, the mark of stereo receivers selling for $400 or more.

Engineers at Grundig Werke GmbH, however, have come up with a tuning-indicator circuit that's suitable for medium-priced receivers. And where most others have settled for meters, Grundig has managed to power lights. What's more, the lights make possible an unusual muting circuit, based on a photoresistor, that keeps the receiver quiet when shifting from station to station.

Red and white. Grundig has put the tuning indicator circuit into its latest stereo receiver, the RTV 600, which sells for just under $300 in West Germany. The front panel has three small lamps—a white one flanked by red ones on either side. When a station is tuned exactly and there's adequate field strength, the white light stays on. If the tuning is off, one of the red lamps glows to show the listener which way to turn the tuning knob. Both red lamps glow if the signal is too weak.

Input to the indicator circuit comes from a conventional symmetrical ratio detector. The voltages across R_1 and R_2, then, are equal and opposite when the set is precisely tuned. They are fed to a pair of trigger circuits. One, with npn transistors (Q_1 and Q_2), handles positive voltages; the other, with pnp transistors (Q_3 and Q_4) handles negative voltages.

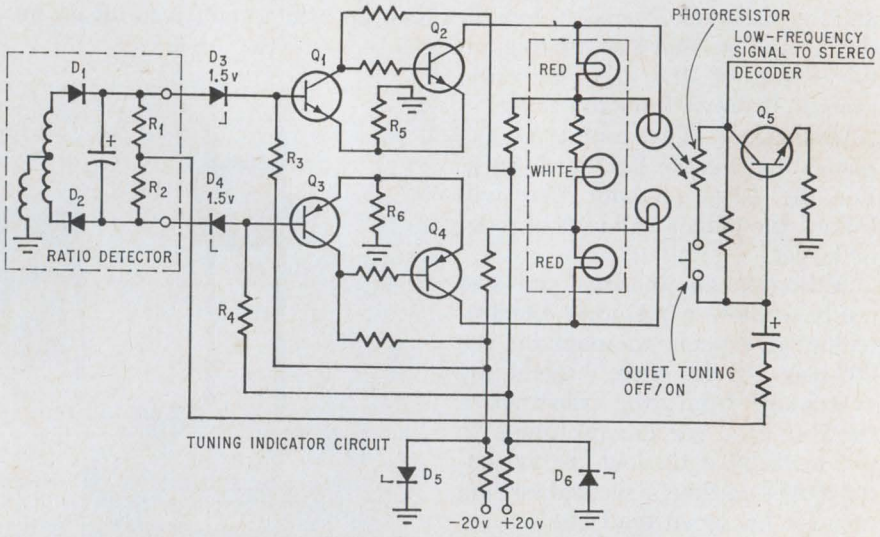
Off and on. Unless there's adequate field strength, the voltages fed to the input transistors (Q_1 and Q_3) are not high enough to turn them on. As a result, the base voltages of the output transistors (Q_2 and Q_4) are so high that they conduct and the red lamps light.

When the set is precisely tuned to a strong station, however, both input transistors turn on. The voltage across their collector resistors then drops enough to turn off the output transistors. This, in turn, causes the red lights to go out. At the same time, current flows to the white lamp.

Detuning on a strong station shuts off one of the two input transistors and, as a result, the associated red lamp lights.

Silenced. For muting, the circuit uses two small lamps, in parallel with the red indicator lights, and a photoresistor. When either small lamp goes on, the resistance of the photoresistor drops from a high value to a few hundred ohms. The sharp rise in negative feedback that follows reduces the amplification of the stage (Q_5) that feeds the ratio detector output to the stereo decoder.

The two small lamps that actuate the photoresistor are packaged in a light-tight housing along with the photoresistor and the components of the trigger circuits. The light-tight packaging prevents spurious muting. And there's a "hold" range for the white lamp, so that



White is right. Grundig tuning indicator circuit powers white lamp if station is tuned in precisely. Detuning causes a red lamp to glow, showing the listener which way to turn the knob.

very small changes in signal level and slight mistuning won't cause the red indicator lamps to switch on and the receiver to mute.

Top grade

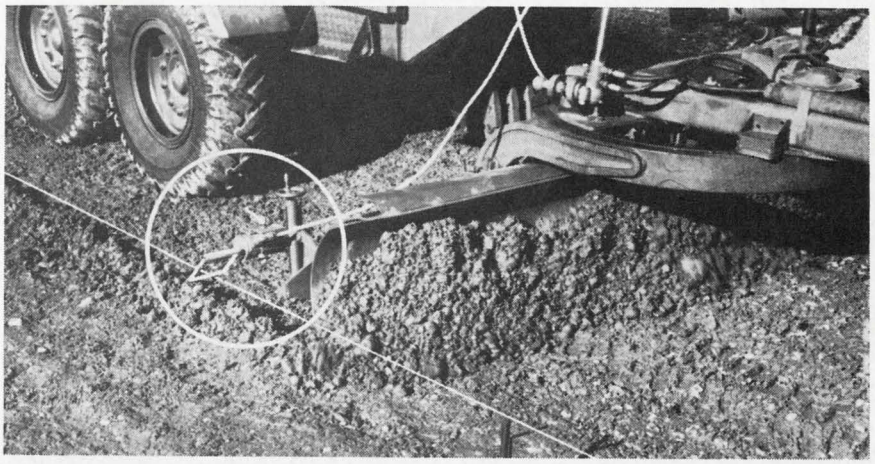
Grading new road surfaces before paving them can be a time-consuming job. To level off bumps and fill in dips, grader operators usually have to run their cumbersome machines back and forth several times.

Many late-model graders make the job easier with an electronic control system that holds the transverse slope of the grading blade constant. But that still leaves the operator with two things to do at once—steer the machine and fiddle with a manual control to maintain proper blade height.

This fiddling, though, is over for operators of a new grader built by Eisenwerk Gebr. Frisch KG. Along with the transverse control, Frisch's machine has a "Nivomatic" system that keeps the blade within 0.2 inch of a reference surface. Frisch claims the two-way control can reduce the time needed to fine-grade a roadbed by as much as two-thirds.

Straightforward. The Nivomatic blade-control system is relatively simple. Its two control loops—one for slope and one for height—each have an input sensor, an amplifier, an error-detection circuit, and solenoid-operated valves to feed the hydraulic cylinders that move the blade. The operator sets the values of height and slope on a control unit next to his steering wheel, and the control loops keep the blade in the indicated position. Most of the electronics were supplied by the German subsidiary of Honeywell Inc.

For blade-height control, a taut wire strung parallel to the grader's line of travel serves as the reference surface; a follower on the height sensor attached to the blade rides this wire. Any up-and-down blade movements change the setting of a potentiometer in the sensor, and this upsets the balance in a bridge circuit in the control unit. The resulting error signal is amplified and then applied to the height-control solenoid valves, which cause the blade to be lowered or raised until the bridge circuit is balanced again. The error signal developed across the bridge also drives an indicator that shows any deviations from the preset blade height.



Tight-wire act. Follower traveling along taut reference-level wire senses deviations in grader's blade height. Up-and-down movements upset the balance of control-circuit bridge.

Working an angle. The sensor for the transverse-slope control loop is a pendulum mounted on the frame that carries the blade. This loop holds the blade slope to within 0.1% of the preset value; for a blade about 10 feet wide, the error works out to less than ⅛ inch.

Both sensors are liquid-damped to withstand vibrations. The grader operator also uses the system's indicators to judge just how fast he can move his machine along without overtaxing the blade-control system.

France

Freeing the freeway

As in most big cities, traffic jams in Paris extend from the congested downtown neighborhoods all the way out to the "autoroutes"—express highways—intended to move traffic swiftly into and out of the city.

No one has come up with a workable solution for the harrowing traffic problem in downtown Paris, but one French electronics firm thinks it has an answer for the three autoroutes that lead to the city. The firm, Compagnie Générale d'Automatisme, is testing on the Autoroute du Nord an analyzer that spots bottlenecks as fast as they develop. In a full-fledged system, such analyzers would show road police where traffic buildups were imminent and could even control traffic lights ahead of trouble spots.

Patterns. The analyzer gauges the flow of traffic by counting groups of 16 cars. The company chose 16 for the size of the group because the counting circuits are binary. The other two possible choices were 8 or 32. Eight, CGA felt, would be too small a number; 32, by contrast, would have made the cycle too long.

Input data is picked up by a pair of induction loops spaced 6.5 feet apart in the roadway. They feed three counters in the analyzer, mounted alongside the road. One counts the cars. A second records the time it takes for the group to pass over the loops. A third registers the average speed of passage of the cars.

After 16 passages, the information picked up by the counters is transferred into a "time" memory and a "speed" memory and all the counters are reset to zero. The information is then passed from the memories into a diode matrix that compares the speed and time values against a dozen preestablished flow patterns. The output of the matrix drives signal lamps that

show if traffic is flowing freely (green), starting to slow down (orange), or blocked (red). The green light, for example, stays on as long as the average sped is higher than 35 miles per hour. The red light flashes on when the speed drops below 12 mph.

Building block. Production versions of the analyzer will cost somewhere between $3,600 and $4,000 a copy. In a complete system, they would be spotted at intervals of a few hundred yards in heavy-traffic sections of autoroutes and every mile or so in less-traveled sections. Instead of lighting lamps on the roadside unit, however, the output of the comparison matrix would be transmitted to a central control panel that would show how things were going along a stretch of autoroute.

Building a full-fledged system, CGA maintains, wouldn't be difficult. Selling one to the French government, which the company is trying to do, seems to be another matter. France still has a lot of catching-up to do on its network of autoroutes and the government is hard-pressed to finance the road-building.

CGA is one of the group of data-processing, automation, and computer companies co-owned by CSF-Compagnie Générale de Télégraphie sans Fil and the Compagnie Générale d'Electricité through a subsidiary called Compagnie pour l'Informatique et les Techniques Electroniques de Contrôle.

Great Britain

Torrid zones

A Lilliputian weatherman, perhaps, could tackle the job with ease. But for Gullivers, plotting the hot spots on tiny semiconductor devices is a harrowing task.

Stuck with Gullivers, Associated Semiconductor Manufacturers Ltd. has put together an infrared microscope to pinpoint the torrid zones on transistors and integrated circuits. The instrument checks temperatures over a range of 200°C with maximum resolution of 0.5°C. The spot checked on the semiconductor is normally 30 microns square, but Associated says it can get the area down to 15 microns square.

The company uses the microscope mainly as an aid in the development of new devices rather than for production-line testing. By locating hot spots, device designers can decide whether and how layouts can be reworked to improve heat dissipation. Associated is a joint venture of Mullard Ltd., a subsidiary of N.V. Philips' Gloeilampenfabrieken of the Netherlands, and of the British General Electric Co., a firm not connected with GE in the U.S.

Screen test. The optics in the infrared microscope are basically quite simple. There's a single mirror objective, an eyepiece, and a transparent mirror. The mirror's reflecting surface is a thin film of gold that deflects infrared wavelengths but passes light.

The light comes from a small lamp fitted with a filter that blocks out wavelengths of 2 microns or more, and it is picked up by a television camera so that the semiconductor area being checked can be viewed on a monitor screen. Scanning directly through the eyepiece, Associated found, is awkward.

As the visual image is being displayed, a detector picks up the infrared radiation from the sector under scrutiny. The detector cell is adjusted laterally so that visual and infrared images coincide. The cell used is a Mullard RPY51 indium antimonide detector mounted in a dewar flask and held at 77°K by liquid nitrogen.

Chopped. Temperature readings obtained with the microscope are displayed on a digital readout and a meter. In both cases, the readings give the deviation from a preset mean temperature.

To get the kind of accuracy needed for thermal mapping, Associated opted for a-c signal processing. The infrared radiation from the device under test passes through a mechanical chopper—a rotating disc with 16 slits—before it hits the detector cell.

The cell's 800-hertz signal is amplified in a high-gain a-c amplifier and fed to a phase-sensitive rectifier whose reference signal comes from a photocell. For precise phasing of the photocell's output signals with those of the detector cell, the mechanical chopper also interrupts the light beam that activates the photocell. Thus, variations in the chopper's rotating speed can't affect the phase relationship.

Output of the phase-sensitive rectifier is compared with a d-c feedback signal picked off a precision potentiometer. This yields a servo difference signal that is chopped, amplified, reconverted to d-c in another phase-sensitive rectifier, and finally amplified again to obtain a signal for the motor that drives the potentiometer toward the null position. The digital readout counter is geared to the potentiometer drive.

For readout by the meter, the potentiometer and motor-drive circuits are switched out of the loop, and the output of the second phase-sensitive rectifier is switched onto the meter.

The meter covers the 0°-to-200°C temperature spread in four ranges —0° to 15°, 10° to 45°, 20° to 80°, and 45° to 200°. This breakdown represents a compromise Associated had to make because the spectral distribution of the heat emitted by the device under test changes as the temperature rises. This means that the output of the infrared detector cell cannot be linear over a wide temperature span. Since resolution is considerably lower in the upper ranges on the meter, Associated generally sticks with the digital readout.

Around the world

Japan. Tokyo Shibaura Electric Co. (Toshiba) has a 12-inch shadow-mask picture tube well along in development and should have it in production during the first half of the year. The smallest shadow-mask tubes currently in production in the country are 16-inch sizes.

Soviet Union. The Russians plan to set up a far-flung communications satellite network for socialist

countries, according to Boris Petrov of the Moscow Aviation Institute. Russia's partners in the network would be Bulgaria, Czechoslovakia, Hungary, East Germany, Poland, Rumania, Cuba, and Mongolia.

Italy. Complementi Elettronici S.p.A. is installing a five-array antenna field for the Australian Post Office at Darwin. Each array is made up of two log-periodic dipole planes, vertically polarized. The arrays are highly directive and have a voltage standing-wave ratio of 1.35 over the full band—7 to 26 megahertz. Power-handling capability is 500 kilowatts average and 2,000 kw peak.

Japan. A yearend spurt in color television sales has caused set makers to raise their estimates of the 1967 domestic market once again. Last fall, the figure was jumped from 500,000 sets to 750,000 [Electronics, Oct. 16, p. 236]. Now it looks as if 850,000 sets will be the total for 1967.

Luxembourg. An institute to train air-traffic-control specialists is scheduled to be operating in the Grand Duchy by late 1969. The facility will be run by Eurocontrol, the international organization responsible for aircraft movements in the upper air spaces over most of West Europe.

Bahamas. The Broadcasting and Television Commission has a go-ahead from the government to start television broadcasts in 1969. Work on the main network production center at Nassau will be handled by a Montreal consulting firm, N.J. Pappas & Associates.

Iran. Two extensive microwave networks are planned for Iran. The country's post office has ordered a $28-million system from the Nippon Electric Co.; the National Iranian Oil Co. will get a $12-million system from Philips' Gloeilampenfabrieken. Nippon's system will stretch out over some 2,400 miles. Philips' will cover 1,750 miles.

Australia. Fujitsu Ltd. has become the first Japanese computer maker to take a fling at the Australian market. The company reports it has had "plenty of inquiries" since it set up shop in Sydney several weeks ago.

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January 8, 1968

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F.J. Eberle, Manager

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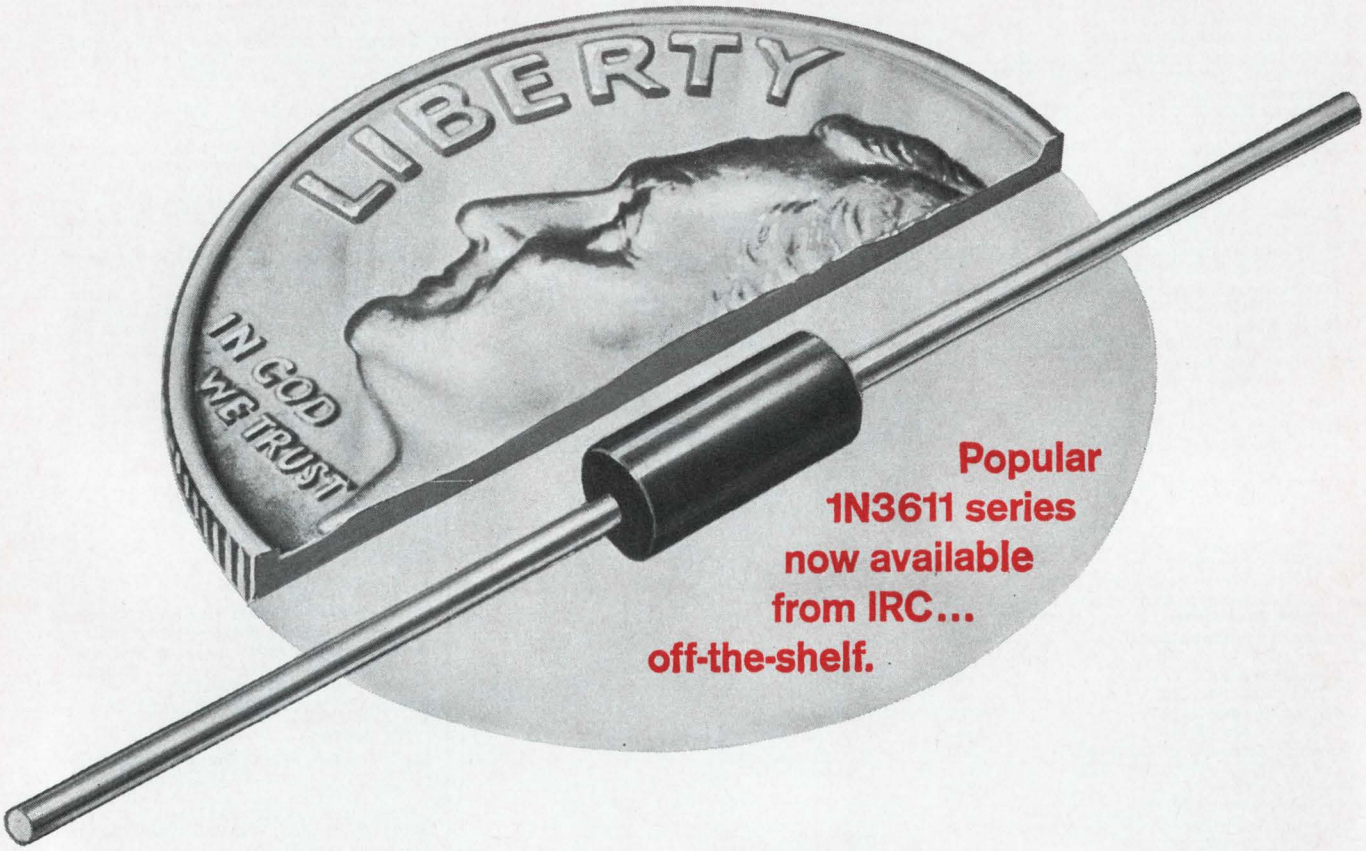


Up to now these units were available only from one source and at nearly twice the cost. Now, IRC (the resistor people) offers a Poly-Sil rectifier that's a real money saver for all your low-power MIL applications. Check these prices.

TYPE	1-99	100-999
JAN 1N3611	$1.49	$ .99
JAN 1N3612	1.95	1.30
JAN 1N3613	2.70	1.85

Commercial versions at lower cost

These units have a single-cycle surge rating of 20 amps.

Tough and durable, Poly-Sil completely surrounds all internal parts. This solid construction is stronger than comparable glass packages.

A great combination of low cost and superior performance, the 1N3611 series is available off-the-shelf in production quantities. See your IRC representative or write for data. IRC, Inc., Semiconductor Division, 727 Lynnway, Lynn, Mass. 01905.

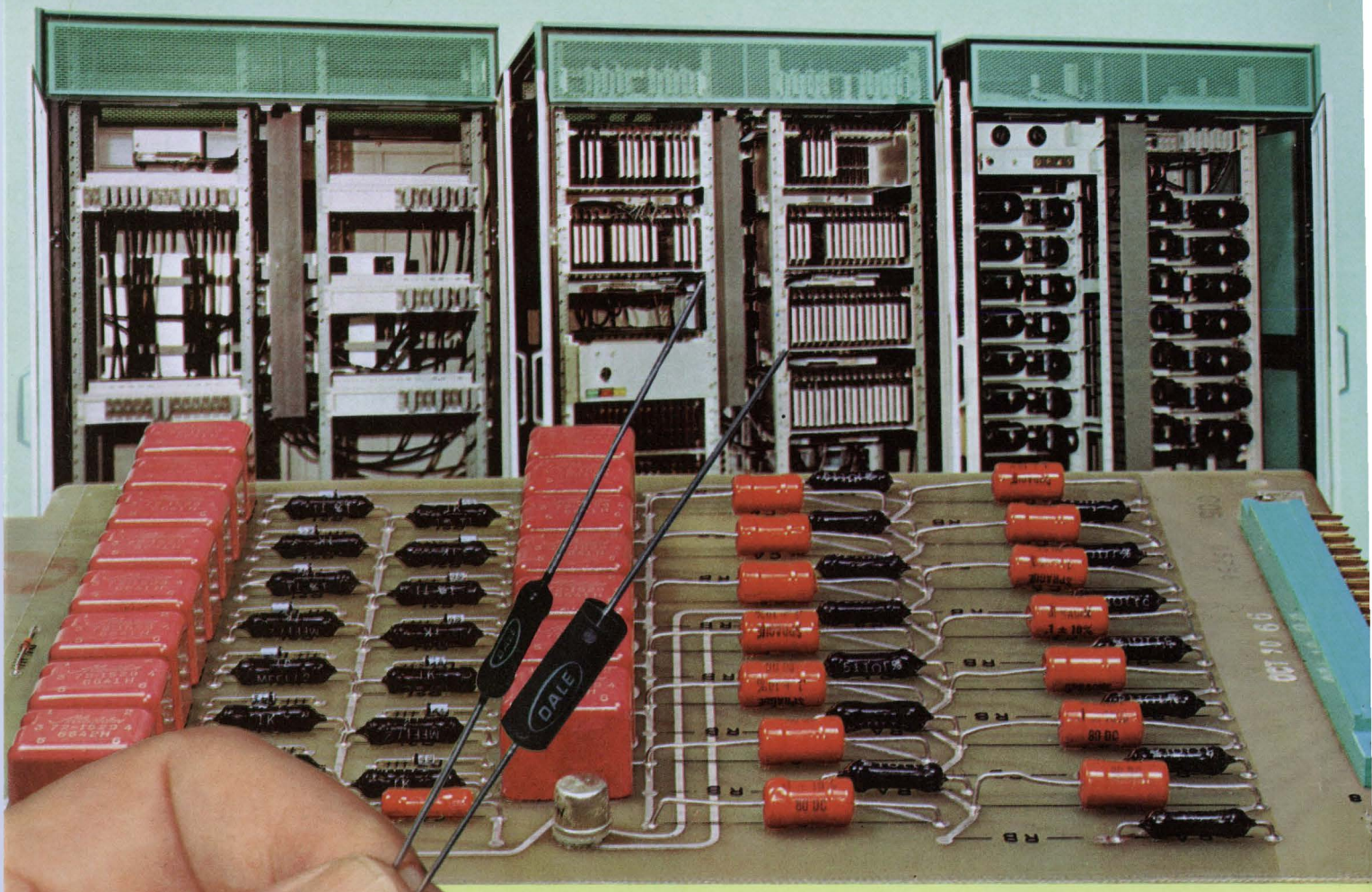
SPECIFICATIONS

ACTUAL SIZE

MIL	Meets MIL-S-19500/228D
RATINGS	2A @ 25° C
	1A @ 100° C
	0.3A @ 150° C
VOLTAGE	200, 400, 600
TEMP. RANGE	
operating	—65° C to 150° C
storage	—65° C to 175° C

IRC

SEMICONDUCTOR DIVISION



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GENERAL SPECIFICATIONS
TYPE MF* MIL-R-10509F

DALE TYPE	MIL. TYPE	125°C RATING (Char. C & E)	70° C RATING (Char. D)	RESISTANCE RANGE (Ohms)
MF50	RN-50	1/20 w	1/10 w	30.1 to 80.6K
MF-1/10	RN-55	1/10 w	1/8 w	30.1 to 301K
MF-1/8	RN-60	1/8 w	1/4 w	10 to 1MΩ
MF-1/4	RN-65	1/4 w	1/2 w	10 to 1 MΩ
MFS-1/2	RN-70	1/2 w	3/4 w	10 to 1.5 MΩ
MF-1	RN-75	1 w	–	25 to 2.6 MΩ
MF-2	RN-80	–	2 w†	100 to 10 MΩ

*Also available in conformal coated (MFF) styles. †Char. B.
Tolerance: ±1%, ±.5%, ±.25%, ±.10% standard.
Characteristics D, C, or E apply depending on T.C. required.

Computers for industrial process control demand long resistor life. To insure this, Dale Metal Film resistors are used extensively in the versatile Westinghouse PRODAC System. Value analysis dictated the choice—with the long life characteristics of metal film winning over the lower price of carbon and carbon composition types. Dale verifies this reliability with long-term load life tests (see below). Delivery is reliable, too. Expanded production facilities can put quantities up to 50,000 in your plant in 2 weeks (1% tolerance units). We'll prove it—call 402-564-3131 today.

NEW METAL FILM LOAD LIFE DATA

Dale MF resistors have undergone 16,320,000 hours of load life testing without a failure (100% rated power, 70°C; failure defined as ΔR>1%). Based on these tests, the MF resistor has a proven failure rate of .004% per 1,000 hours (60% confidence at 50% power, 70°C ambient). Write Dale for complete test data.

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DALE® *for optimum value in industrial resistors*

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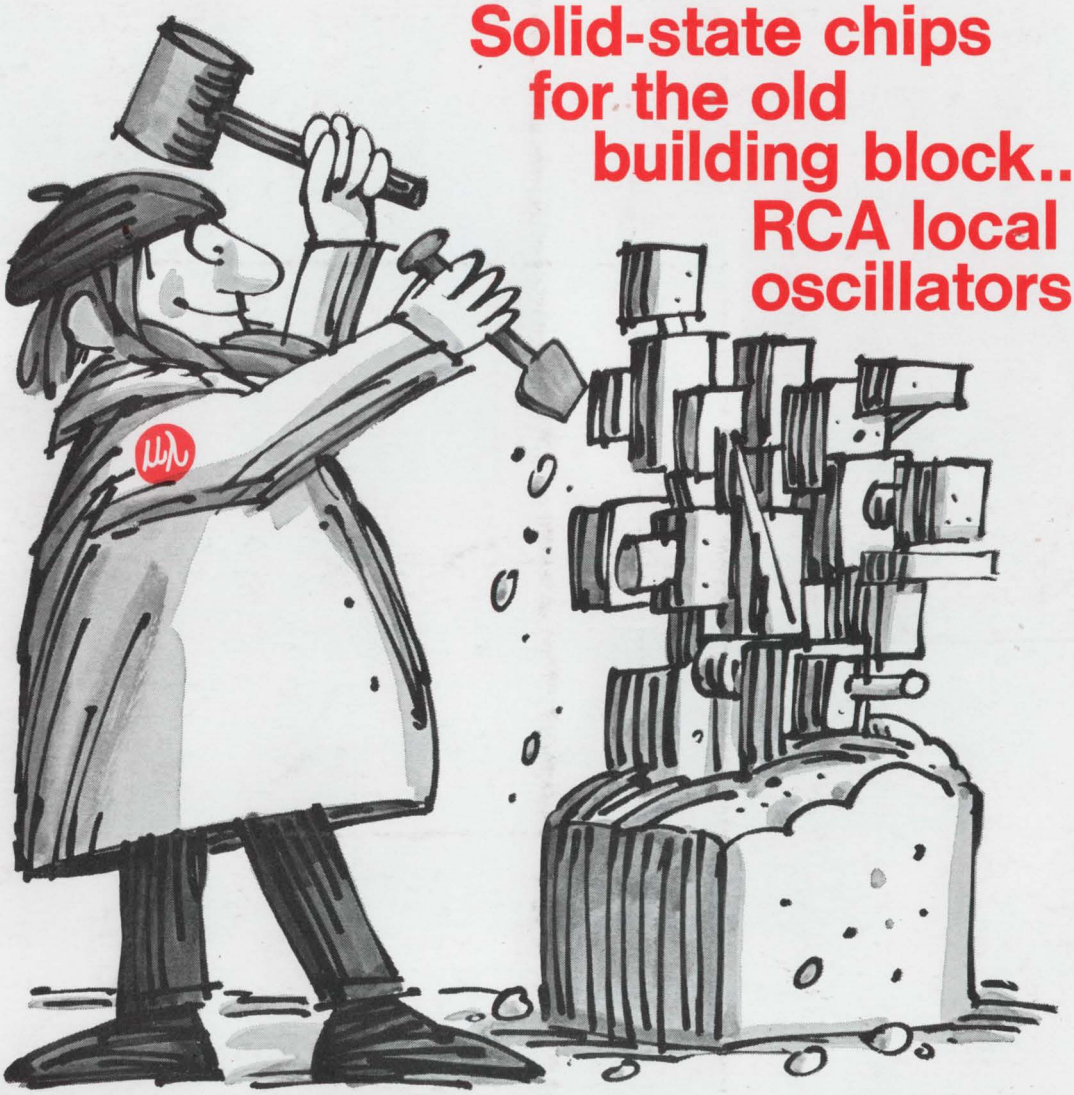
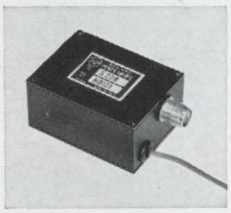
Solid-state chips for the old building block... RCA local oscillators





Now you can cover the microwave spectrum from 1.2 GHz to 13.3 GHz with newly designed RCA solid-state oscillators. Available in a series of units with standard and custom specifications, these devices can fill the local-oscillator building-block requirement in a wide range of communications and radar receivers.

You can choose from a variety of simple, mechanically-tuned variants of RCA's famous S190. All are low in cost.

If you prefer, RCA also offers a series of voltage-tuned local oscillators. These low-cost units feature simple tuning and step-recovery diode-filter chains. They can be adapted for AFC and FM requirements.

Phase-locking or injection-locking techniques may be applied to these units to provide devices with crystal stability.

Consult the chart for a quick run-down on RCA's line of local oscillators. For more information, including RCA's work on Gunn local oscillators for X-band use, see your RCA Representative. For technical data on specific types, write: RCA Commercial Engineering, Section A19Q-1, Harrison, N.J. 07029.

MECHANICALLY-TUNED L.O.'s

Type	Factory Pre-set Center Freq. Range	Tuning Range	Power Output
S190 Variants	1.2-1.9 GHz	±20 MHz	10 mW

VOLTAGE-TUNED L.O.'s

Type	Tuning Range MHz	Power Output mW
Available Now:		
S208	1930-2170	50
S206	3930-4260	5
S207	5865-6455	5
Coming Soon:		
S212	3620-3930	5
S213	5390-5530	5
S214	6455-7045	5
S215	7045-7600	5
S216	7600-8100	5
S217	8100-8560	5
S218	9335-9475	5
S219	10,480-11,630	5
S220	11,630-12,630	5
S221	12,630-13,320	5

RCA Electronic Components and Devices

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