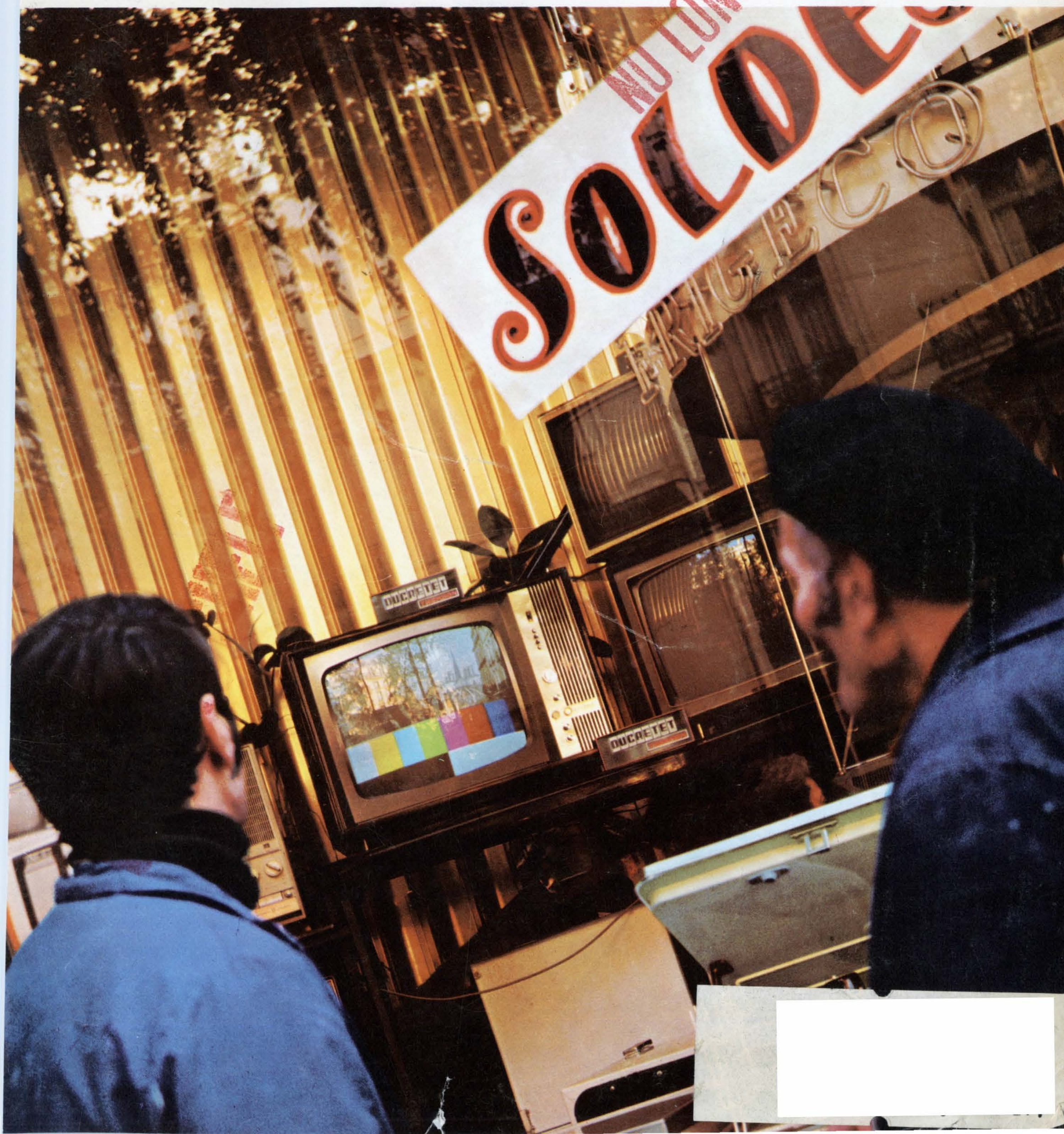
Electronics®

IC's in a military radar: page 58
European electronics markets for 1968: page 71
Designing color-tv for easier repair: page 103

December 25, 1967
$1.00
A McGraw-Hill Publication

Below: Will Frenchmen buy color tv in 1968? page 71



1309-A . . . $325*
- 10 Hz to 100 kHz, sine or square waves
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1311-A . . . $225*
- 50 Hz to 10 kHz in 11 fixed steps
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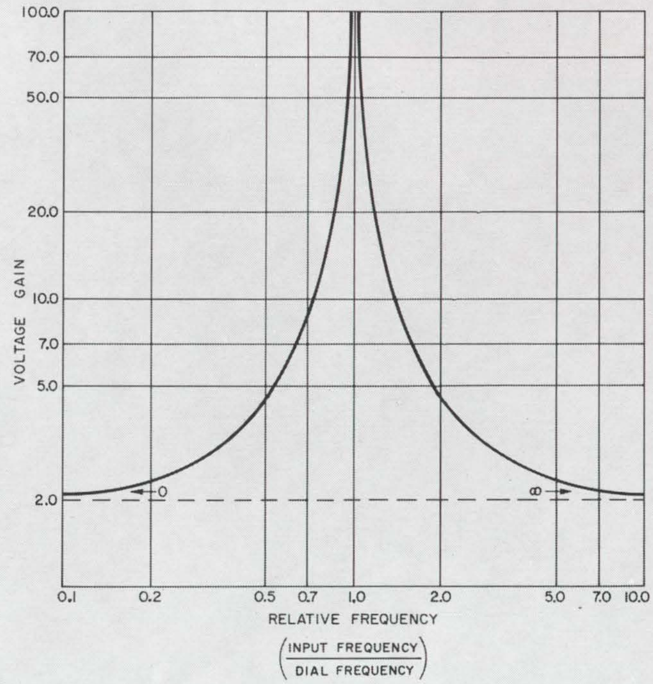
*Prices apply only in U.S.A.



These oscillators function as high-Q filters

While oscillating, three of them can function as tunable narrow-band filters . . . hence they can be used at a variety of frequencies to reduce fm and jitter.

They can also serve as frequency-selective amplifiers with a voltage gain of greater than 100 and with effective rejection of noise and harmonics.

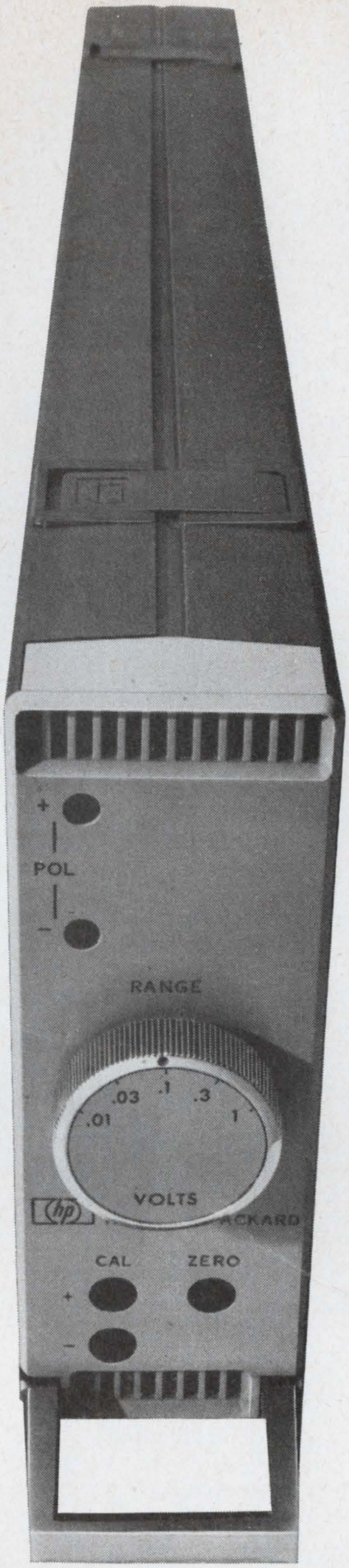
They can be locked to a frequency standard for use as high-stability signal sources at test stations. Or, they can be used as frequency multipliers because they can be locked onto a harmonic as easily as they can be locked to a fundamental. They can also furnish sync signals to other instruments.

How can an oscillator do all this? No big secret . . . these RC oscillators are all equipped with a handy "synchronizing jack" . . . another GR first in oscillator design. Put a signal in (1 volt will do) and out comes the same frequency all cleaned up and amplified; or take out the sync signal and use it to trigger a counter or a scope or even another GR RC oscillator.

One other thing — they're great when used as just oscillators.

GENERAL RADIO
W. Concord, Massachusetts 01781

Circle 900 on reader service card



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Call your local HP field engineer for complete specifications, or write Hewlett-Packard, Palo Alto, California 94304; Europe: 54 Route des Acacias, Geneva.

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06720

Electronics

Volume 40, Number 26 December 25, 1967

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Electronics Abroad

New Products

Technical articles

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Readers Comment

Setting it straight

To the Editor:

Several errors crept into our article "An all-in-one process for building junctions" [Nov. 13, p. 113] during editing.

The main error was the implication that this article was intended to describe vapor-phase growth in general. Instead, it pertained only to the approach used at RCA Laboratories. In contrast, the most widely used growth technique employs $AsCl_3$, which is a liquid and not a gaseous reagent. And typically, p-n junctions are not introduced during the continuous growth process.

Another error was made in calling autodoping "the diffusion of dopants from one portion of the device to another." In the vapor-phase growth of GaAs, autodoping typically is caused by transport of impurities through the gas stream, and not by diffusion.

Leonard R. Weisberg
James J. Tietjen
RCA Laboratories
Princeton, N.J.

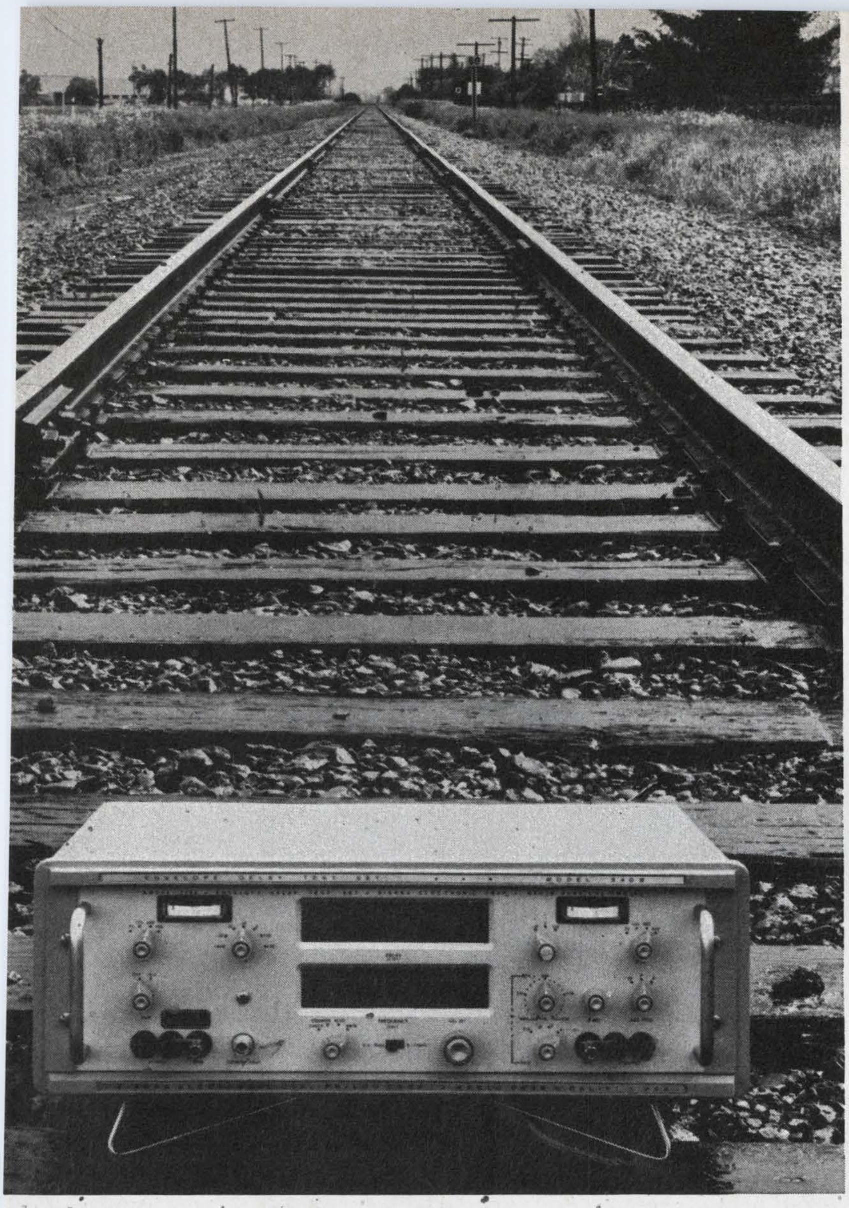
▪ There was a typographical error in the brightness value achieved with the light emitting diode in which RCA's vapor phase process was used to provide a phosphorus-rich layer. Instead of 135 foot-lamberts, the brightness should have been given as 315 foot-lamberts.

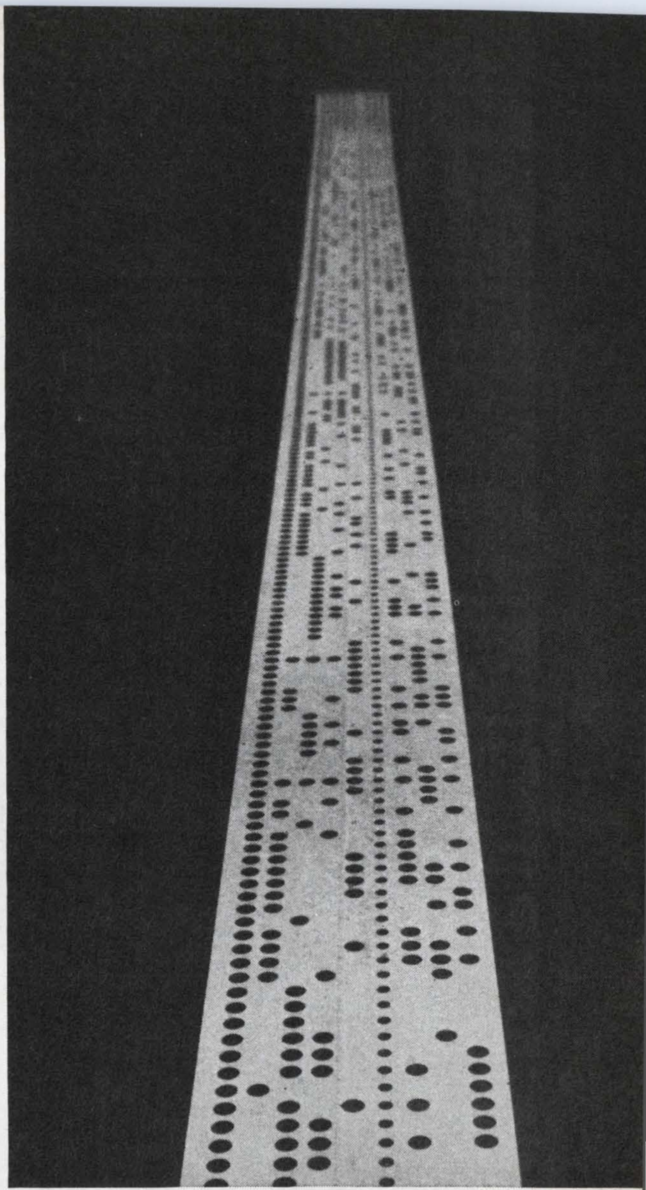
Attainable goal

To the Editor:

I would like to comment on the story "Tape recorder snags space data link" [Oct. 2, p. 26]. The Advanced Space-Ground Link Subsystem program was actually let for bids three times. Responsive bids are believed to have come from at least three companies.

One thing is certain. Orion Products Co. did submit a proposal for the 20-megabit-per-second tape recorder. In fact, we offered 24 megabits. Industry certainly must yield to the decision of contracting offices with regard to the appropriateness of a need. However, I





Tracks down envelope delay...

clears the track for digital data wave trains

Undetected envelope (or group) delay can easily derail a digital data transmission. Bit-by-bit that pristine formation crumples. Down the line, someone ends up with a mess instead of a message. To keep the data train properly coupled, you need precise information about phase-shift-versus-frequency characteristics of your carrier. The kind of information you can get express from a Sierra Model 340B Envelope Delay Test Set.

Model 340B pinpoints relative delay to ±20,000 μsec on a big, direct single-range digital counter. Resolves it to 1.0 μsec. On a second digital counter, it displays frequency with 10-Hz resolution. Range of 300 Hz to 110 kHz spans voice channel through group frequencies. Measurement modes include end-to-end, loop-back, or end-to-end with return reference path.

Modulation frequency of 25 Hz, usable over full range, resolves fine-grain deviations separated by as little as 50 Hz. Alternative 250-Hz modulation resolves delay to 0.1 μsec. Price, with one modulation frequency, $4,750.

Ask for more data, and watch us pour on the coal. Write Sierra, 3885 Bohannon Drive, Menlo Park, California 94025.

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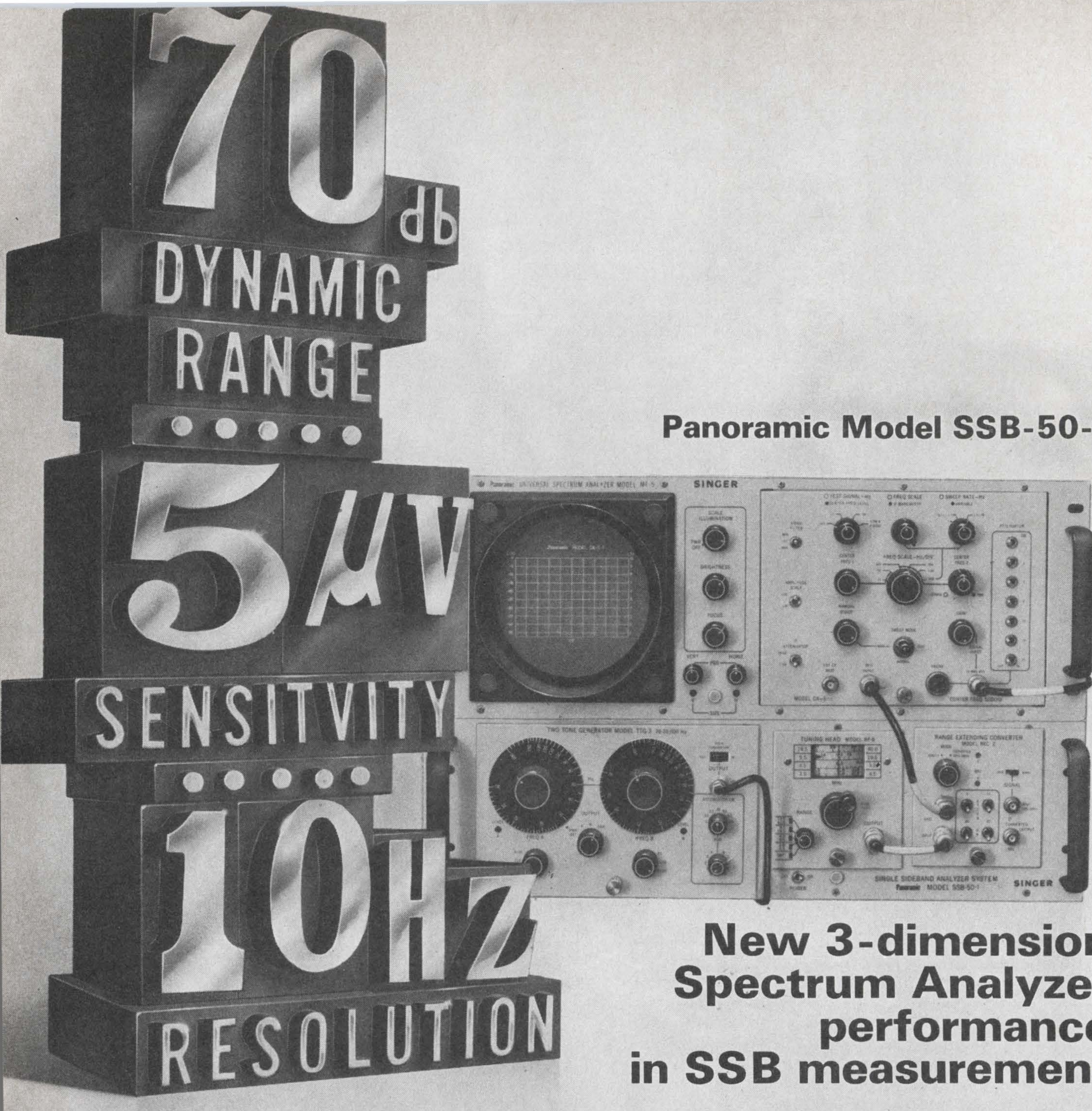
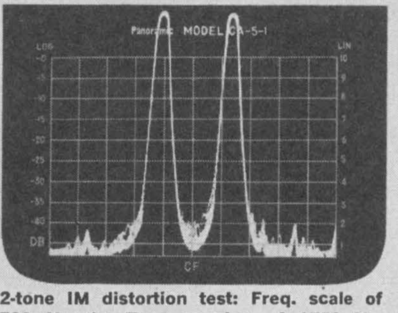


Panoramic Model SSB-50-1

New 3-dimension Spectrum Analyzer performance in SSB measurement

Now you can measure in-band distortion products down to 70 db below peak levels, with the new Panoramic Model SSB-50-1 Spectrum Analyzer.

And, you get this wider dynamic range with uniform 5 μv sensitivity from 2 MHz to 40 MHz; usable to beyond 200 MHz at reduced sensitivity.



2-tone IM distortion test: Freq. scale of 700 Hz/div. Tone spacing of 1750 Hz. Both tones deflected 30 db over full-scale log. 3rd order distortion pips visible at –70 db and approx. –73 db.

The system's high stability permits 10 Hz resolution, with steep skirt selectivity, over the full frequency range.

An image and spurious free up-converter extends the frequency range to 10 Hz and provides unambiguous display of audio, base-band or IF signals. A low-distortion 2-tone audio signal generator supplies modulating signals to equipment under test.

The highly linear response of the completely solid-state Panoramic SSB-50-1 makes it ideal for monitoring and dynamically analyzing odd- or even-order AF/RF components of narrow-band SSB, AM, FM, and multiplexed FSK signals. Its versatility is also increased by the capability to accept other Panoramic plug-in modules for special-purpose measurements.

Call or write, today, for a demonstration or complete technical data.

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THE SINGER COMPANY, METRICS DIVISION • 915 Pembroke Street, Bridgeport, Conn. 06608, U.S.A. • Phone (203) 366-3201 • TWX 710-4533483 should like to emphasize the fact that 20-megabit capabilities do exist within industry.

As a matter of fact, the approach Orion suggested was based upon three technologies of which you may not be aware.

- Instrumentation adaptations of the Newell concept are being developed. Orion is prepared to demonstrate longitudinal tape speeds in excess of 1,000 inches per second.
- Longitudinal pulse-code-modulation bit-packing densities of 24,000 bit per inch and $1/10^7$ reliability have been developed, demonstrated, and reported to the defense community by Orion.
- Magnetic-head technology appropriate for the exploitation of the above two concepts has been developed and evaluated.

Combining the above three provides the key to 20-megabit rates and more. Although I have no knowledge of the priority the Government places upon attaining goals such as these, I do wish to state that this goal can be reached.

Jack K. Willis
President
Orion Products Co.
Sunnyvale, Calif.

Credit is due

To the Editor:

The research reported in "Programable logic arrays—cheaper by the millions" [Dec. 11, p. 90] was sponsored in part by, but does not necessarily constitute the opinion of, the Air Force Cambridge Research Laboratories, Office of Aerospace Research, under contract AF 19(628)-5828.

Also the reference to cellular logic, included in the article as background, should have been credited to Stanford Research Institute, not Stanford University.

Sven E. Wahlstrom
Computer Techniques Laboratory
Stanford Research Institute
Menlo Park, Calif.

Two of a kind

To the Editor:

On page 26 of your Nov. 27 issue, you report that a "mechanically despun antenna, developed at Hughes, was first flown this month on the Applications Technology Satellite 3, and one is being developed by Sylvania for Comsat's Intelsat 3 satellite that is scheduled to be launched next year."

Actually, the ATS 3 and Intelsat 3 antennas are both Sylvania developments.

James J. Lanigan
Sylvania Electronic Systems
Waltham, Mass.

Wrong order

To the Editor:

The article "Picture looks brighter for computer displays," [Oct. 16, p. 165] contains one misinterpretation.

Although the two airline seat reservation systems currently in preparation (by Burroughs for Trans World Airlines and by Univac for United Airlines) will indeed use large numbers of alphanumeric displays, as your story indicates, it is our understanding that the two computer makers plan to build the units themselves. They have not placed any order for such equipment with the Conrac Corp.

Albert L. Landsperger
Conrac Corp.
New York

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People

Five or six years may elapse between development of a theory and its application, "and it's time to narrow the gap," says **O. Hugo Schuck**, new director of the Office of Control Theory and Application at NASA's Electronics Research Center, Cambridge, Mass.


O. Hugo Schuck

Why the gap? "Engineering education is too theoretical, research could be better directed, and theory already on hand too often gathers dust," Schuck feels. He began thinking about the "application gap" while director of research at Honeywell Inc. and became conscious of some of its causes while serving as a visiting professor of aeronautics and astronautics at Stanford University last year. Schuck, who is president of the American Automatic Control Council, notes that "control engineers are among the most restive and articulate" about the gap.

At NASA, Schuck will try to narrow the gap. He wants industry, schools, and Government agencies to allow experienced, promising engineers time for a sabbatical at the space center, where they could absorb the agency's rarefied theory and, hopefully, apply it to down-to-earth problems. Since the center is just across the street from the Massachusetts Institute of Technology, the sabbatical could also include an opportunity for graduate study.

Schuck hopes this exposure will help bridge the applications gap and cites as an example the possible use of fluidics in simple autopilots for light planes. "Flight control in general could profit by studying NASA's techniques of guidance and trajectory analysis," he says.

Schuck feels that "many of the engineers we're turning out today are literally afraid to get their hands dirty—it's time we erased the idea that 'you're safe as long as you stay on paper.' " Instead of

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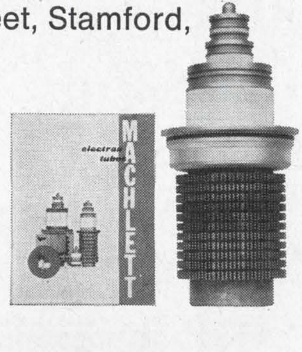

RAYTHEON

THE MACHLETT LABORATORIES, INC.

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Circle 9 on reader service card

People

learning only theory, engineers should be taught to apply it, he says.

In the two years that the Monsanto Co. has been in the electronic instrument field, it has concentrated on digital readout gear, such as counter-timers and digital voltmeters. With the naming of **Philip Emile** as head of a new special development group within its Electronics Technical Center, Monsanto plans to broaden its product base.

Philip Emile

Emile declines to be specific about the new products he is considering, but it's likely, considering his background, that they'll be in the display and high-speed measuring field.

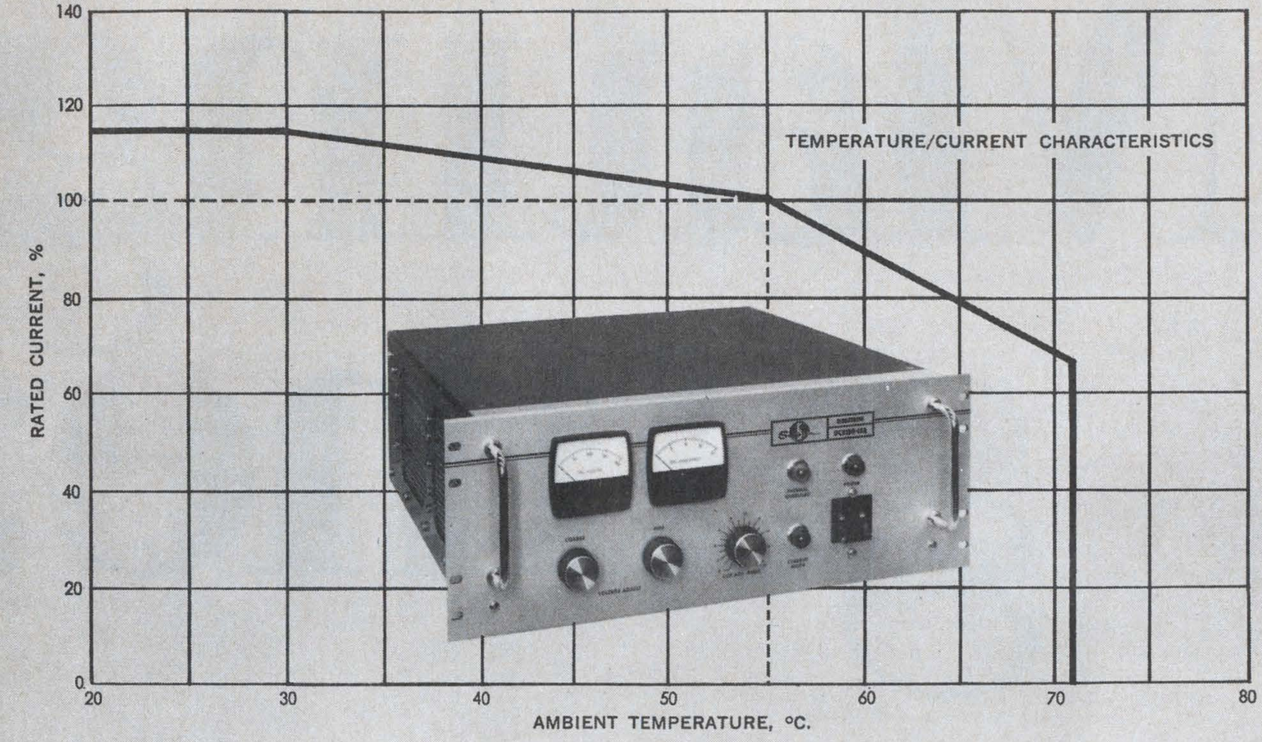
Before joining Monsanto, the 33-year-old Emile was supervisor of nanosecond engineering at General Applied Science Laboratory Inc. of Westbury, N.Y. His background also includes extensive work on oscilloscopes.

Operating principle. His basic task, explains Emile, is to screen out those one-time development projects from Government and industry contracts, find a unique technique developed for them, and try to apply this technique to a new product.

The new group is already carrying out this principle. It is developing a special instrumentation system for the Atomic Energy Commission. The immediate fallout for a possible new product is a device that can slow down any high-speed, single-shot phenomena for processing by a remote display and recording facility.

"What's unique about our work," he explains, "is that our system does it (the processing) at lower frequencies than previously possible."

Another item of major interest to Emile, recently under extensive study at Monsanto, is light-emitting diodes, for either digital or analog displays.



Sorensen DCR Series now with temperature capability to 71°C.

Sorensen Wide Range Power Supplies to 20 kW.

Sorensen's wide range DCR Series has been up-dated and improved. What's new about the DCR's? They are now 100% silicon; ambient temperature capability is now to 71°C. • Four 3-phase models have been added extending power capability to 20 kW; 24 models are now available with ranges up to 300 volts. • Multiple mode programming—voltage/current/resistance. • Voltage regulation, line and load combined, is ±.075% for most models • Constant current range 0 to rated current. • DCR's meet MIL-I-26600 and MIL-I-6181 specifications and conform to proposed NEMA standards. • Front panel indicator for voltage/current crossover. These features of the improved DCR (model numbers will have an "A" suffix) are offered at no increase in price. For DCR details, or for data on other standard/custom power supplies, AC line regulators or frequency changers, call your local Sorensen rep, or write: Raytheon Co., Sorensen Operation, Richards Avenue, Norwalk, Connecticut 06856. Tel: 203-838-6571.

MODEL SELECTION CHART

Voltage	Amps.	Model	Price	Amps.	Model	Price	Amps.	Model	Price	Amps.	Model	Price
0- 20	125	DCR 20- 125A	$1140	250	DCR 20- 250A	$1550	–	–	–	–	–	–
0- 40	10	DCR 40- 10A	360	20	DCR 40- 20A	550	35	DCR 40- 35A	$ 750	60	DCR 40-60A	$ 915
0- 40	125	DCR 40- 125A	1390	125	DCR 40- 250A	2290	500	DCR 40-500A	3750	–	–	–
0- 60	13	DCR 60- 13A	525	25	DCR 60- 25A	850	40	DCR 60- 40A	990	–	–	–
0- 80	5	DCR 80- 5A	360	10	DCR 80- 10A	580	18	DCR 80- 18A	850	30	DCR 80-30A	925
0-150	2.5	DCR 150- 2.5A	360	5	DCR 150- 5A	580	10	DCR 150- 10A	830	15	DCR 150-15A	890
0-300	1.25	DCR 300-1.25A	390	2.5	DCR 300- 2.5A	580	5	DCR 300- 5A	795	8	DCR 300- 8A	890

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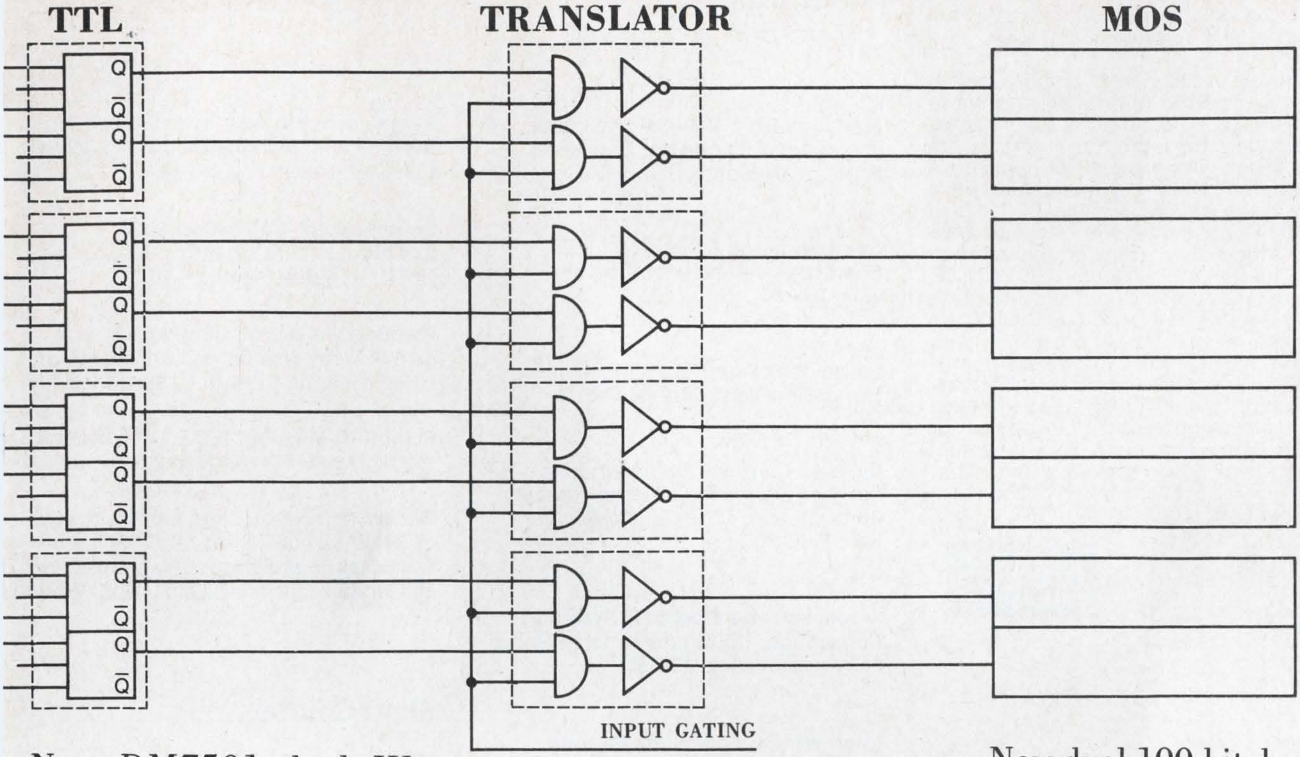
Circle 11 on reader service card

Mating game:



New DM7501 dual JK lip flop used as a TTL shift egister for an 8-bit word.

Monolithic.

Hermetically sealed.

SN5473 equivalent.

Price: $8.80 (100-999), $4.00 for commercial DM-3501 (SN7473 equivalent).

Immediate delivery.

Circle Number 481.

New DM7800 dual voltage translator to change bi-polar logic voltage levels to MOS logic voltage levels.

Monolithic.

Gated inputs.

Input voltage levels DTL- and TTL-compatible.

Output levels variable between +25V and −25V.

Price: $15.00 (100-999), $10.00 for commercial DM-8800.

Immediate delivery.

Circle Number 482.

New dual 100-bit dynamic shift register stores one hundred 8-bit words at 15¢ per bit in electronic "drum" memories.

1 MHz operation.

Price (100-999): $60.00; MM406 full temp, $30.00; MM506 commercial.

Immediate delivery.

Circle Number 483.

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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.**

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

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

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.***

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

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, New York, **March 21-23.**

Joint Railroad Conference, IEEE; Conrad Hilton Hotel, Chicago, **March 27-28.**

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

Business Aircraft Meeting and Engineering Display, Society of Automotive Engineers; Broadview Hotel, Wichita, Kan., **April 3-5.**

Telemetering Conference, IEEE; Shamrock Hilton Hotel, Houston, **April 9-11.**

International Pulse Symposium, International Federation of Automatic Control; Budapest, Hungary, **April 9-11.**

Symposium on Law Enforcement Science and Technology, IIT Research Institute; Chicago, **April 16-18.**

Southwestern Conference and Exhibition, IEEE; Sheraton Lincoln Hotel, Houston, **April 17-19.**

Frequency Control Symposium, U.S. Army Electronics Command; Shelburne Hotel, Atlantic City, N.J., **April 22-24.**

Region III Meeting, IEEE; Fontainebleau Motor Hotel, New Orleans, **April 22-24.**

Relay Conference, National Association of Relay Manufacturers and School of Electrical Engineering, Oklahoma State University; Stillwater, Okla., **April 23-24.**

Short Courses

ECAP workshop, University of Wisconsin's College of Engineering, Madison, Wis., **Jan. 25-26;** $65 fee.

Lasers and their engineering applications, University of California's College of Engineering, Berkeley, Calif., **Feb. 26-March 1;** $250 fee.

Computer-aided instruction, The American University's Center for Technology and Administration, Washington, **April 1-4;** $175 fee.

Call for papers

Seminar in Depth on Modulation Transfer Function, Society of Photo-Optical Instrumentation Engineers; Boston, March 21-22. **Jan. 1** is deadline for submission of abstracts to Modulation Transfer Function Seminar Committee, Society of Photo-Optical Instrumentation Engineers, P.O. Box 288, Redondo Beach, Calif. 90277

Symposium and Equipment Exhibit, Southwest Section of the American Vacuum Society; Los Angeles, May 1-3. **Jan. 1** is deadline for submission of abstracts to chairman of Technical Program Committee, George R. Neff, technical director, Ardel Corp., 619 Justin Ave., Glendale, Calif. 91201

Conference on Nuclear and Space Radiation Effects, IEEE; Missoula, Mont., July 15-18. **March 1** is deadline for submission of summaries to Robert S. Caldwell, 23-72, Radiation Effects Laboratory, Boeing Co., Aerospace Group, P.O. Box 3707, Seattle, Wash. 98124

* **Meeting preview on page 16.**

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Meeting preview

International outlook

In past years, the U.S. has dominated the International Solid State Circuits Conference. This year, though, when the three-day conference opens in Philadelphia, Feb. 14, the foreign engineering community will be presenting 15 of the more than 70 papers.

They will come particularly from Holland, Japan, West Germany, and Great Britain. Foreign engineers will also make up one-quarter of the panelists.

The conference will focus attention on practical applications of linear integrated circuits, particularly in consumer products. J. C. van Vessem, of Holland's NV Philips Gloeilampenfabrieken will deliver a paper on the future of these circuits in such applications, stressing cost factors. And a panel will discuss how IC's can be used more extensively in television receivers.

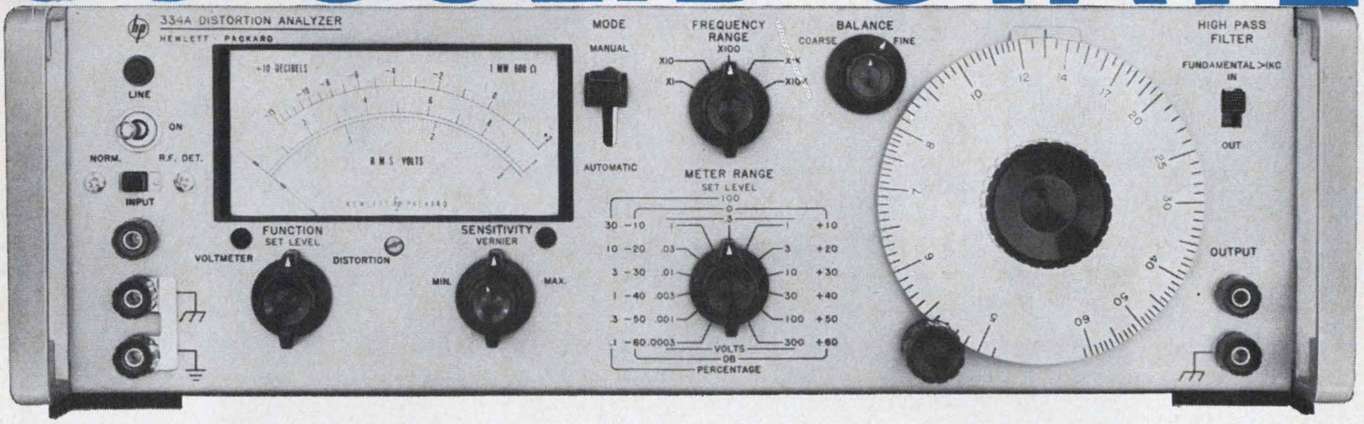
Another consumer topic will be covered in a paper by Alberto Bilotti, an engineer at the Sprague Electric Co., North Adams, Mass. Bilotti will describe a monolithic analog multiplier and its applications as a balanced f-m detector, as a frequency discriminator for automatic frequency control, and as a synchronous detector for color-television demodulation.

Rudolph S. Engelbrecht, head of the microwave IC department at Bell Telephone Laboratories, will present a paper on combining semiconductor bulk phenomena in single structures.

In addition, the conference will cover other microwave topics: control techniques, phased arrays, and signal generation. Also to be discussed is the practical use of microwave IC subsystems, including X- and Ku-band receivers, transceivers, and front-end circuitry.

Among the new devices to be described are a temperature-compensated IC oscillator, a low-voltage breakdown diode element for IC's, and a high-power Gunn-effect oscillator. The conference will also cover high-power voltage regulators, germanium picosecond logic circuits, and metal oxide semiconductor Hall-effect devices.

DISTORTION ANALYZERS GO SOLID-STATE



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332A			√	√	$655
333A	√	√			$825
334A	√	√	√		$855

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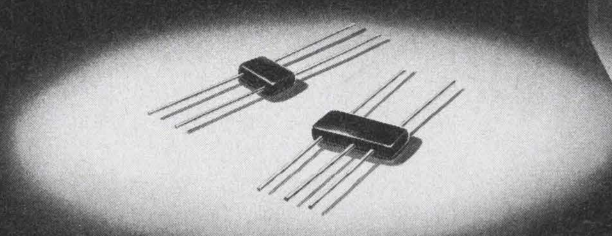

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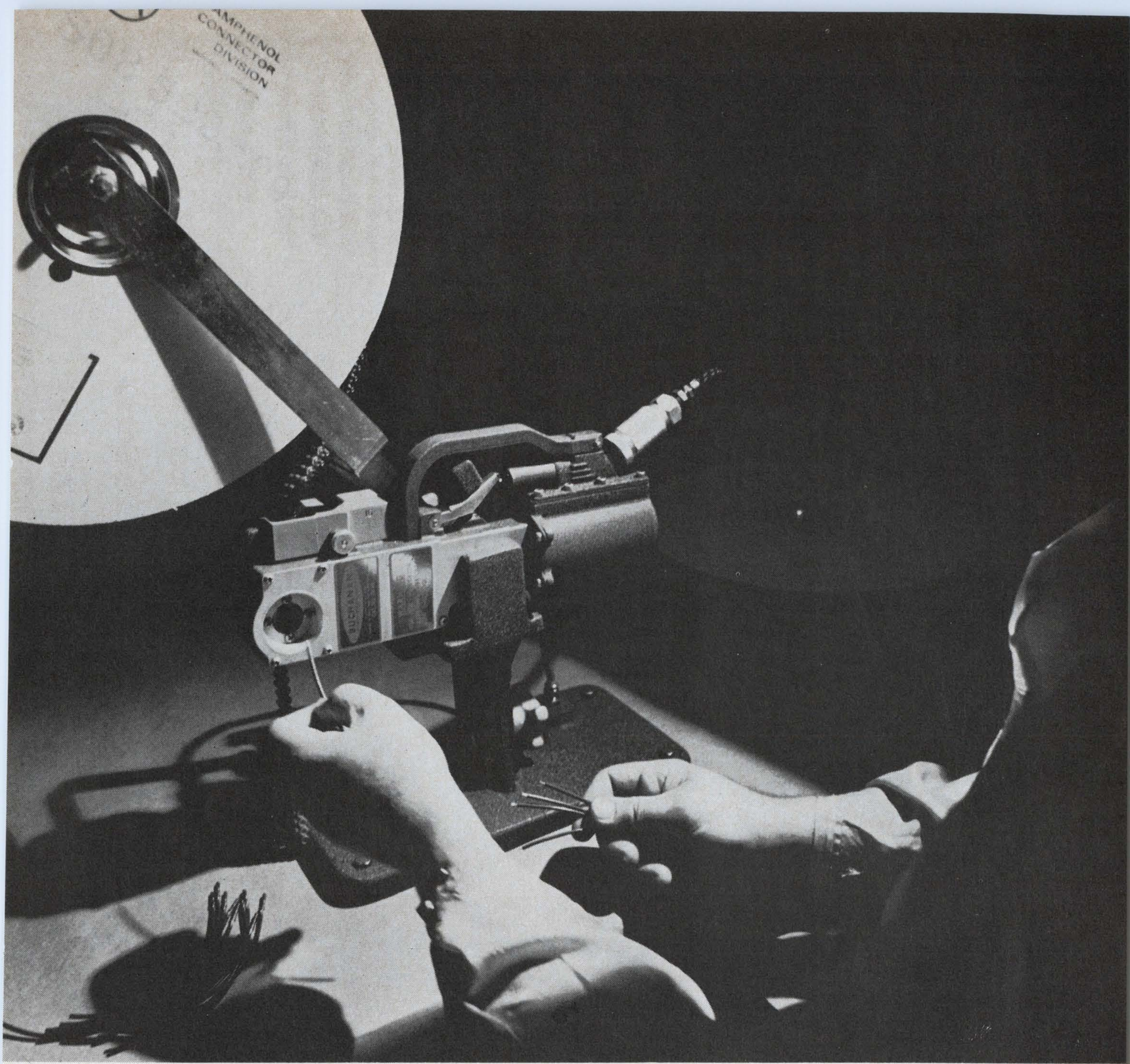

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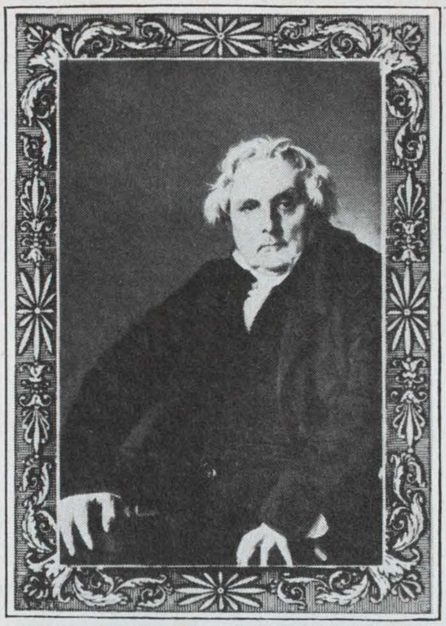

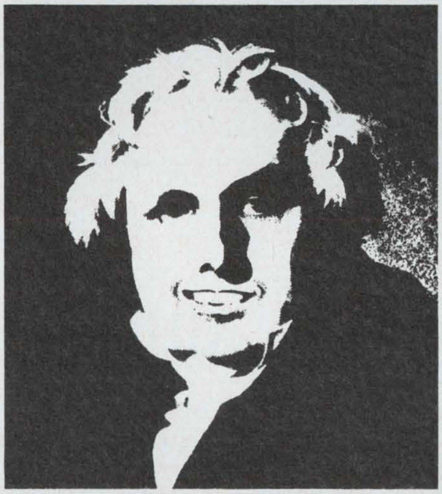

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Commentary

Clouded crystal ball

Not in recent times has predicting markets for a year just ahead been so difficult. Both inside the United States and abroad, forecasters are walking on eggs. In the U.S. there are at least four imponderables, any one of which might change the prospects for 1968 drastically:

- Will President Johnson get his tax increase? How much and when? What effect will it have on buying of consumer electronics products?
- Will the fighting in Vietnam be escalated, de-escalated, or ended? What effect will any of these actions have on purchases of military aircraft with their complex electronic packages, battle communications equipment, surveillance radars, countermeasures gear, or night vision systems?
- What actions will Congress take because 1968 is an election year? Traditionally, Congressmen become particularly attuned to the mood of the public in a presidential election year and are likely to avoid unpopular measures and to approve big spending projects.
- What's in store for the U.S. economy in 1968? Some economists are worried about the round of price and wage increases that are contributing to an inflationary spiral as 1967 ends. Many electronics companies—particularly those that make components for consumer equipment or semiconductors—already have excess capacity. With exceptionally heavy overhead costs, they can't absorb very many higher costs without seriously impairing profits, which were disappointing for many of these companies in 1967.

In Europe, which we analyze in detail starting on page 71, the picture is no clearer. Electronics' survey estimates that the over-all equipment market in Europe will rise 6.5% to $6.4 billion. Still, electronic equipment may be one bright spot in the economic picture because almost all the forecasters believe 1968 will be a sluggish year for most European economies.

The biggest imponderable on the continent is the effect of the devaluation of the British pound. Not until spring will economists really be able to determine if the move has been effective. If it works, most Britons believe the electronics industry will enjoy a good year even though the country will be suffering deflation. If it doesn't work, even a bigger devaluation may be required, as well as severer restrictions on industry that could depress sales of all kinds of equipment, including electronics.

Economies of countries like Denmark, Norway, Sweden, and Spain—in fact the six other members of the European Free Trade Association, sometimes called the Outer Seven in contrast to the members of the European Common Market—are dependent on how things go in England. So the deflation that Great Britain expects is likely to be reflected in these countries too.

In addition, Europe has gone through a year of general economic slowing down. Recession struck in Italy as long ago as 1964; Italy, however, has been recovering since 1966. West Germany saw its spectacular post-war economic growth end in its first recession last year; there are hopes that the decline will be short-lived and has ended.

France rolls along fueled by dreams of national glory. But the bookkeepers, who dream less than the politicians, are worried about some ominous signs in the economy. Tourism, one of France's biggest sources of income, dropped sharply last year mainly because, say some seers, of General de Gaulle's hostile attitude towards the United States and Britain—the two biggest sources of France's tourist trade. Sellers of French exports—most notably perfumes and wines—report growing American buyer backlash.

For almost two years, makers of consumer electronics in Europe have worried about plateauing sales as television and radio ownership approached saturation levels. A hoped-for shot in the arm from color tv has not yet materialized—and the delay was predictable. As long as prices of color-tv sets stay high and the number of hours of color programing stay low, sales of sets will not boom.

Despite the heavy fog on the forecasting front in Europe, American electronics firms can be sure of at least one trend: economic nationalism is still on the rise in Europe. American electronics firms will find it tougher going in many European countries. The governments of England and France will continue to press for mergers of companies in their countries to build capability and prowess to match that of American firms. The trend will be most noticeable in the computer business—which will enjoy the surest and greatest growth of any segment of electronics in Europe in 1968—and semiconductor manufacturing.

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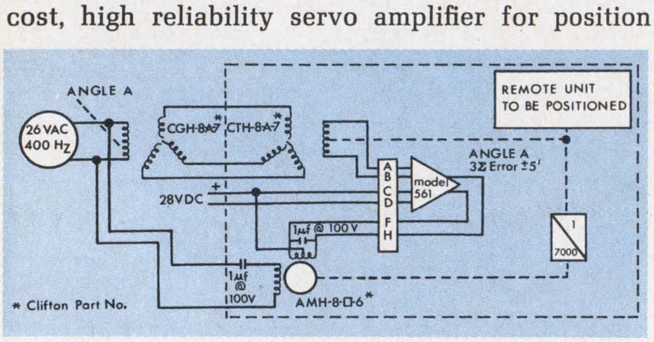

servo systems. It is Model 561. See the typical diagram above. Note also that Clifton rotating components are recommended in this system for their excellent matching qualities with our servo amplifiers (and vice versa).

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Electronics Newsletter

December 25, 1967

Fairchild quitting oscilloscope field

Fairchild Camera & Instrument will not be in the oscilloscope business by next week. A company spokesman was hopeful a buyer could be found for the property and indicated that negotiations were under way with several potential buyers. If a buyer can't be found, the source said, the division, headquartered in Clifton, N.J., will be completely closed down as of Jan. 1.

The division, formerly the DuMont Labs, was once the leader in the scope field; **in recent years it's been in the red and it hasn't introduced a new scope since 1964.** About a hundred engineers are employed at the division.

Autonetics enters the LSI market

Four large-scale integrated devices—three metal oxide semiconductor units and a silicon-on-sapphire diode matrix—are the first commercial products of a program announced by the Autonetics division of North American Rockwell last July [Electronics, July 10, p. 43] **to market some of the LSI chips developed for in-house work.**

Included is an **MOS dual 50-bit dynamic shift register** with a specified speed of 1 megahertz. It performs essentially the same functions as delay lines, Autonetics says, and can be packaged in a TO-5 can or flatpack. Also available are an **MOS quasistatic 100-bit shift register** that functions as a static electronic hold at speeds from d-c to 1 Mhz and can be packaged in a TO-5 or flatpack, and an **MOS 16-channel multiplexer** for such equipment as pulse-code-modulated systems.

The 70-by-96 diode matrix (6,700 diodes) has a resistance of 1,000 ohms and switching speeds of less than 1 nanosecond per diode. Already in use in the Massachusetts Institute of Technology's Project MAC (multiple-access computer) as a character generator, the matrix features a system-memory read time of 200 nsec over the full temperature range specified by the military [Electronics, May 30, 1966, p. 152A].

Tektronix combines FET's and bipolars

The long-awaited combination of junction field effect transistor elements and bipolar transistor elements in a single monolithic structure has finally been achieved—and by an instrument firm. Tektronix, the country's largest maker of oscilloscopes, has produced a three-stage, wide-band amplifier containing bipolars and junction FET's, thus leapfrogging those IC manufacturers pursuing the same goal, most notably Raytheon [Electranics, Nov. 13 p. 25].

The Tektronix IC contains five p-channel junction FET's and 30 npn bipolars in a 50-mil square chip. The company is keeping its diffusion process under wraps, **but says only one extra diffusion step was needed to achieve the combination.**

Raytheon had been aiming for a December introduction of its combination chip, a fully compensated operational amplifier, **but it still hasn't solved all fabrication problems** and now doesn't expect to produce the device until the first quarter next year.

Tektronix' achievement was spurred by the company's desire to improve the input stage of its crt's. The company plans to incorporate the new monolithic in next year's oscilloscope line, **but has no intention of selling the circuit separately.**

Electronics Newsletter

Traffic controller without a computer

The WDL division of Philco-Ford has developed **an electronic traffic controller for individual intersections that does not need a computer.** The development is tied to Philco-Ford's plan to establish a transportation products section.

Oakland, Calif., is already testing a forerunner of Philco's lane occupancy controller, built by the Link group of General Precision Equipment. Howard Carmack, assistant supervisor of the city's electrical department, says flatly that **"this type of control will eliminate computer-controlled systems."**

In the Philco system, the traffic light stays red in all directions until the presence of a car is detected by a buried induction loop some 50 to 60 feet long. The controller then turns the light green for that car. Following cars will keep the light green until a car enters the intersection from the cross street; in that case, the controller keeps the light green only until a preset time limit has been reached. The Link unit has been under test at a heavily traveled intersection in Oakland. **Carmack says that it has appreciably reduced delays.**

Oakland itself pressed for the development of the system. Robert Doble, an engineer at Link, designed the prototype now in use. Later, when he joined Philco, he designed the Philco machine with integrated circuits. Philco has delivered one controller to Oakland and will test a half-dozen others in the San Francisco Bay area in the near future. **Link is also developing an advanced controller.**

F-106 is likely Awacs escort

A new version of General Dynamics' F-106 is expected to be picked by the Air Force as the fighter escort for transport planes carrying the Airborne Warning and Control System (Awacs). Awacs is now in the design and test phase [Electronics, Aug. 7, p. 66].

Shopping for a new avionics system for the F-106X has already started with **Hughes' ASG-18 a strong candidate for the fire-control radar.** The F-106X will also have an improved propulsion system and greater fuel capacity than earlier versions.

Other planes in the running for the award, which will be announced early next year, are the F-12, the F-111, and the F-4.

FAA to propose plane-beacon rule

The FAA is planning to propose that all private and commercial aircraft be required to carry crash-locator beacons. An agency spokesman said manufacturers and potential users will be invited early next year to comment on the proposal. It ordinarily takes another two to eight months after hearings before a ruling is issued.

A decision requiring beacons—which cost $200 and up—**would open up an immediate market estimated at about $20 million a year.** The rule change would also expand the market for direction-finding equipment, which every Civil Air Patrol unit would have to carry to locate beacons.

Support for such a change is hardly unanimous, though. The Aircraft Owners and Pilots Association, **while not opposed to the voluntary use of beacons, is against any regulation making them mandatory.**

Beacons transmit on the international May Day frequency with a range of up to 100 miles, depending on power supply.

On another front, an investigation is under way to determine if air-traffic controllers and others working with FAA radar equipment are being provided with complete radiation detection and protection devices.

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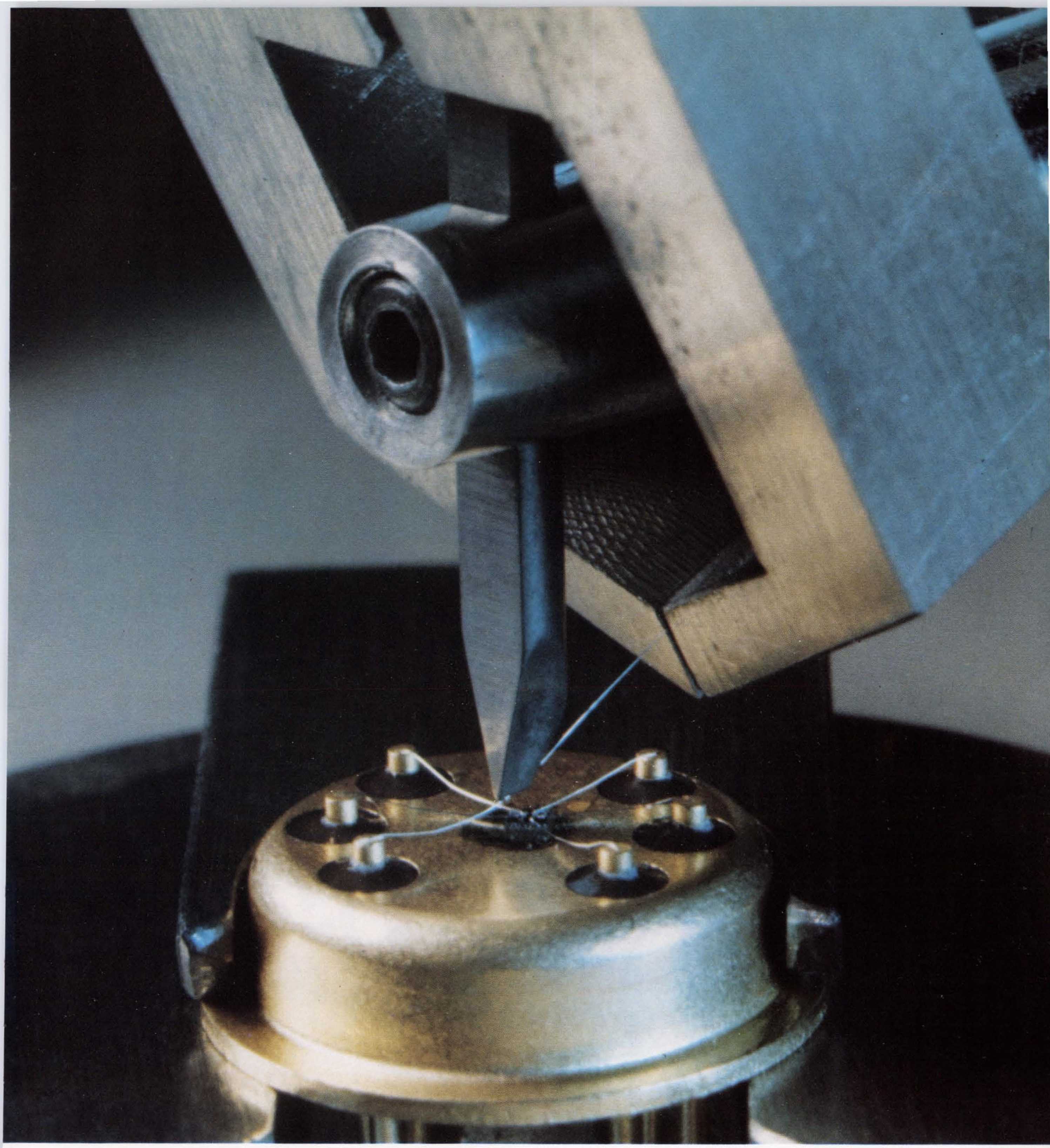

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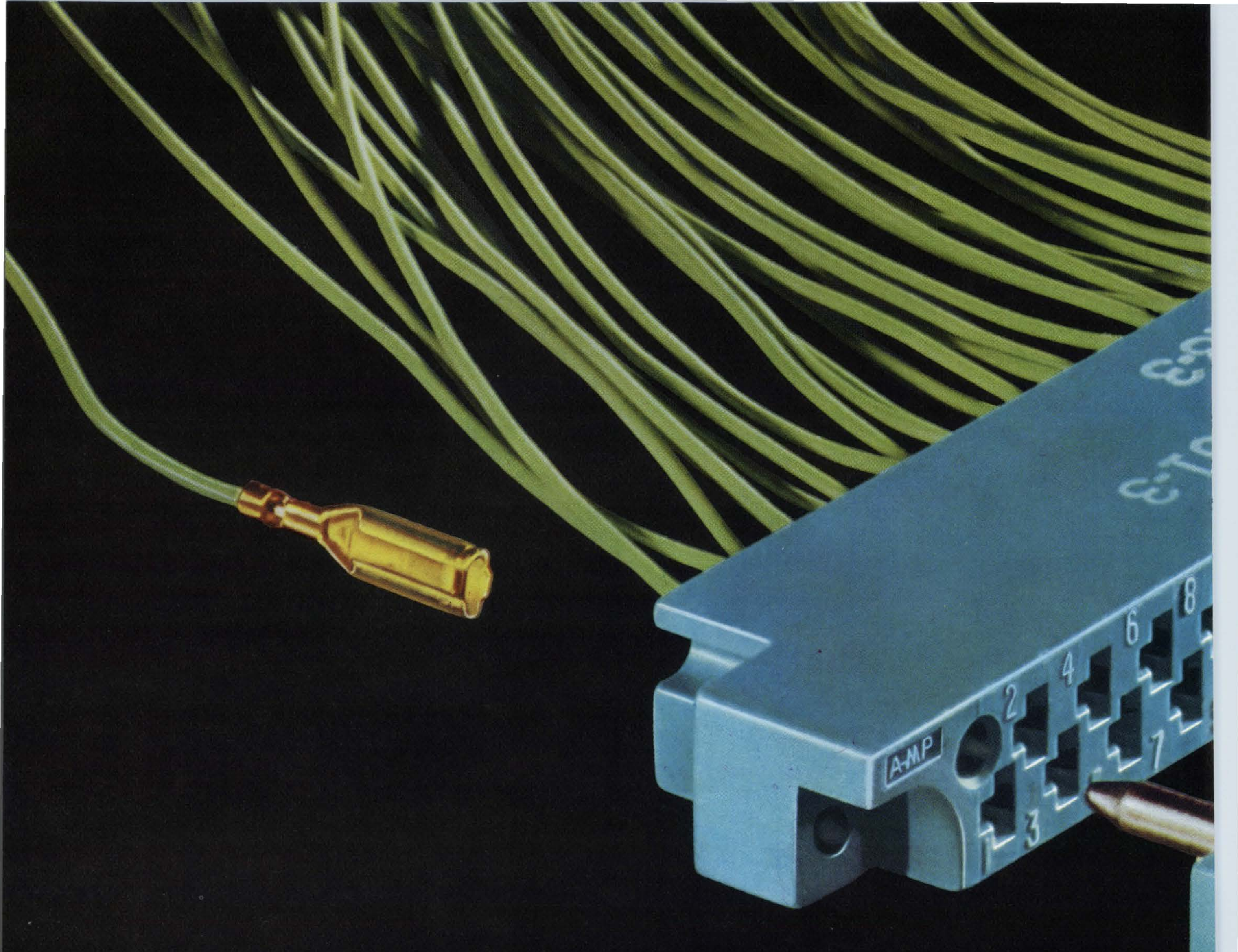

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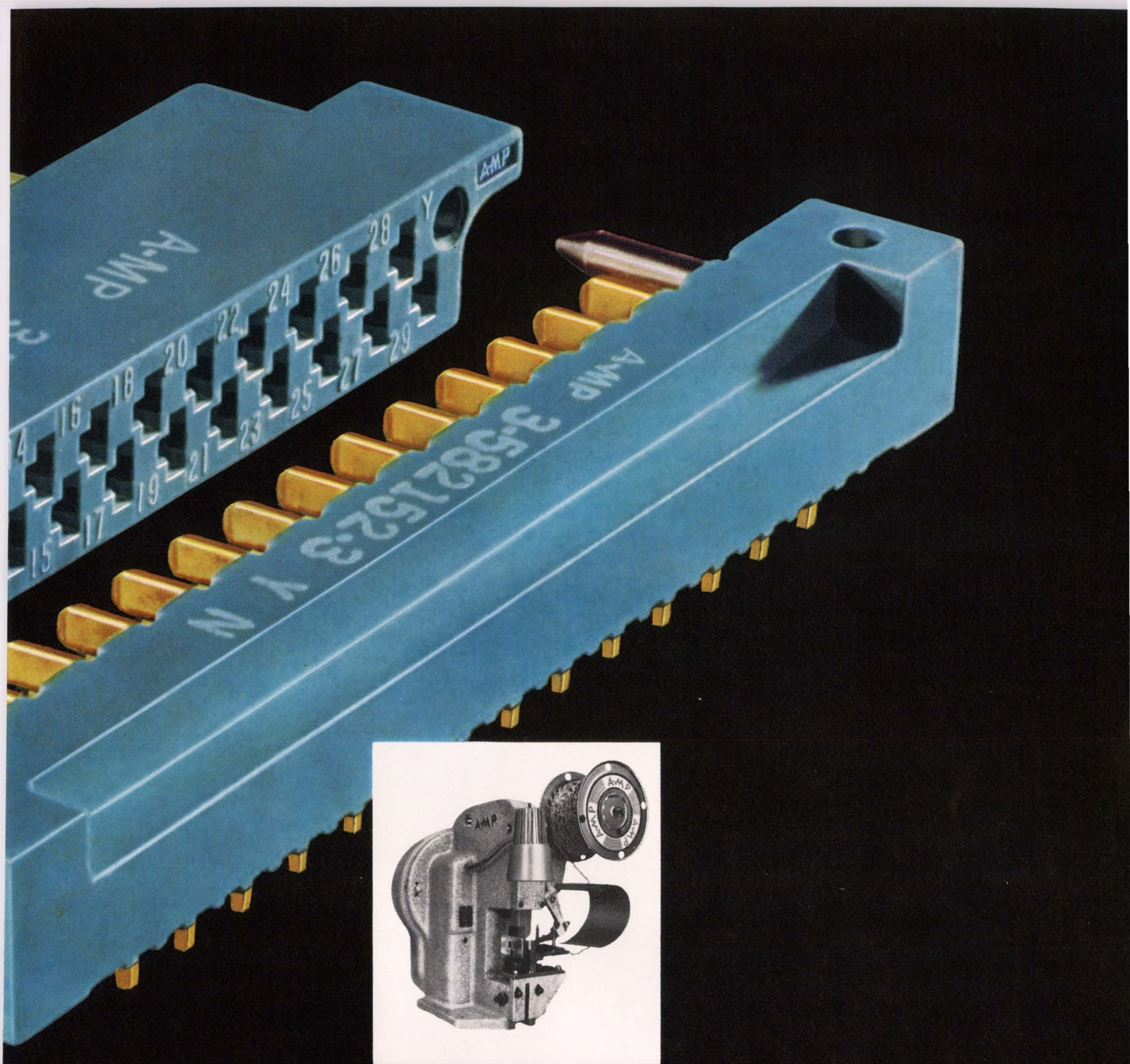

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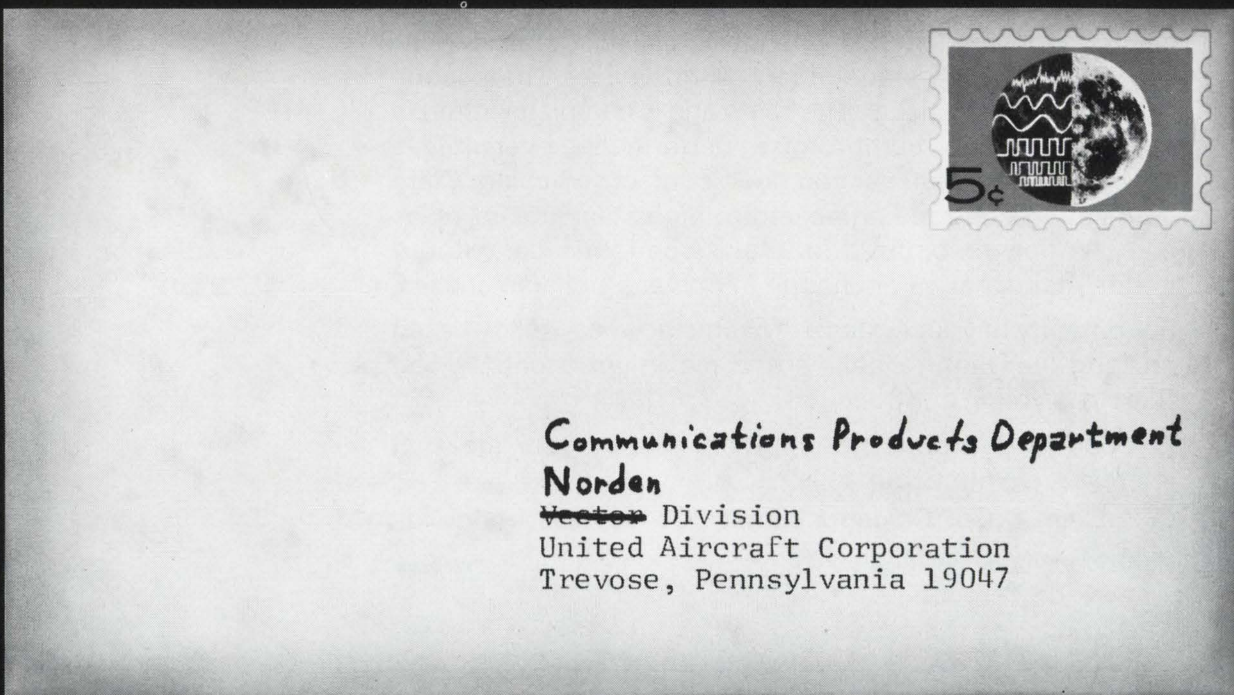

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Research, development and production of Vector telemetry products and systems will continue at the newly expanded United Aircraft facility in Trevose, Pennsylvania. For information, or detailed specifications, call or write the Communications Products Department, Norden Division, United Aircraft Corp., Trevose, Pa. 19047. Phone (215) 355-5000.

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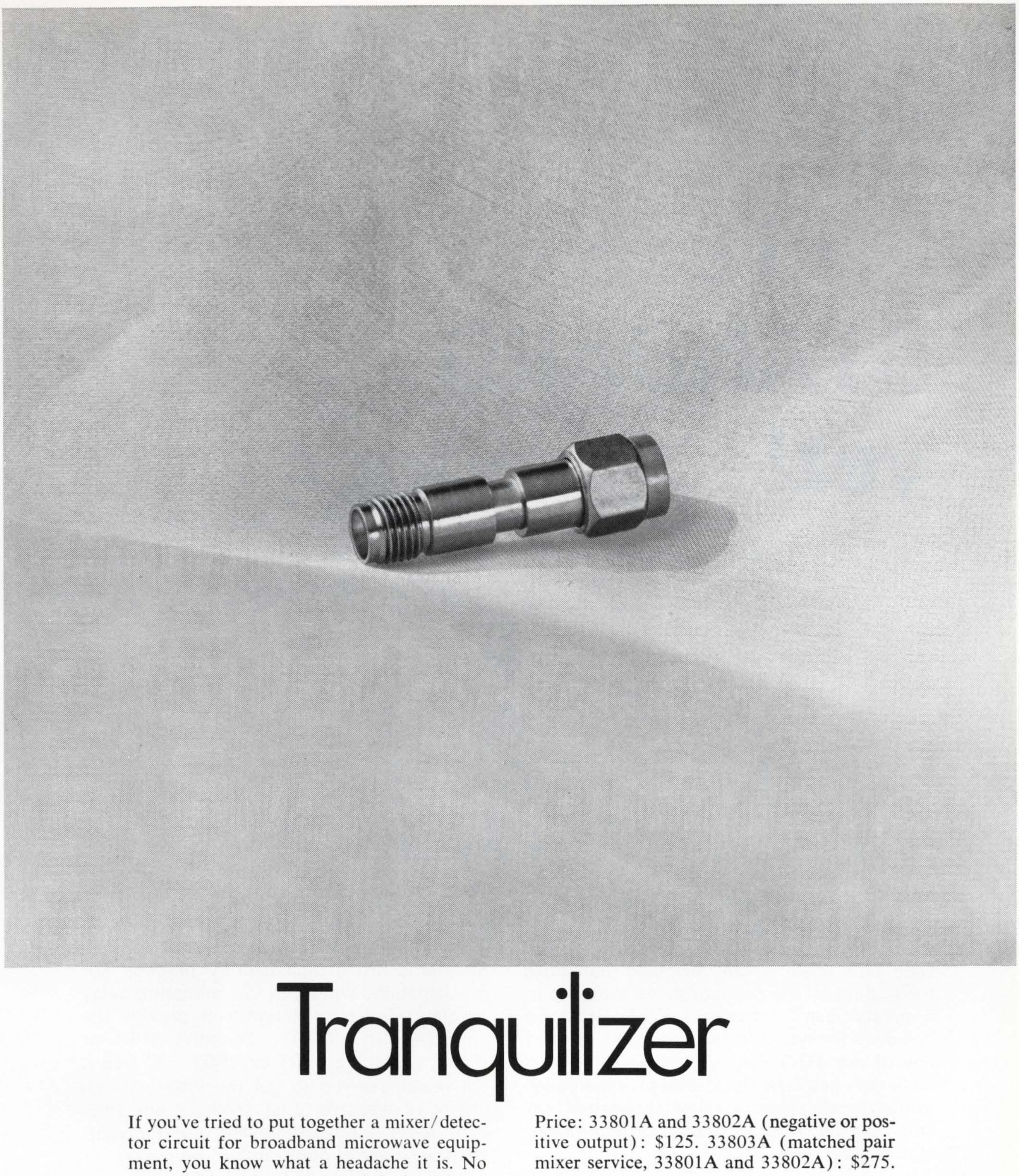

Tranquilizer

If you've tried to put together a mixer/detector circuit for broadband microwave equipment, you know what a headache it is. No more. With HP's new 33800A Series Mixer/Detector modules most of the grief is gone.

Here's why. The 33800A's are miniaturized by hybrid/IC construction for simplicity and convenience. Just plug them in. No fabrication problem. You've got economy for superior performance—there is nothing similar to the 33800A's available.

As detectors, the 33800A's have tangential sensitivity of −50 dBm, 2 to 12.4 GHz; output of 3 mv/μW. As mixers, they display noise figures of 7.5 dB, IF impedance of 100 ohms and VSWR of 2:1.

Price: 33801A and 33802A (negative or positive output): $125. 33803A (matched pair mixer service, 33801A and 33802A): $275.

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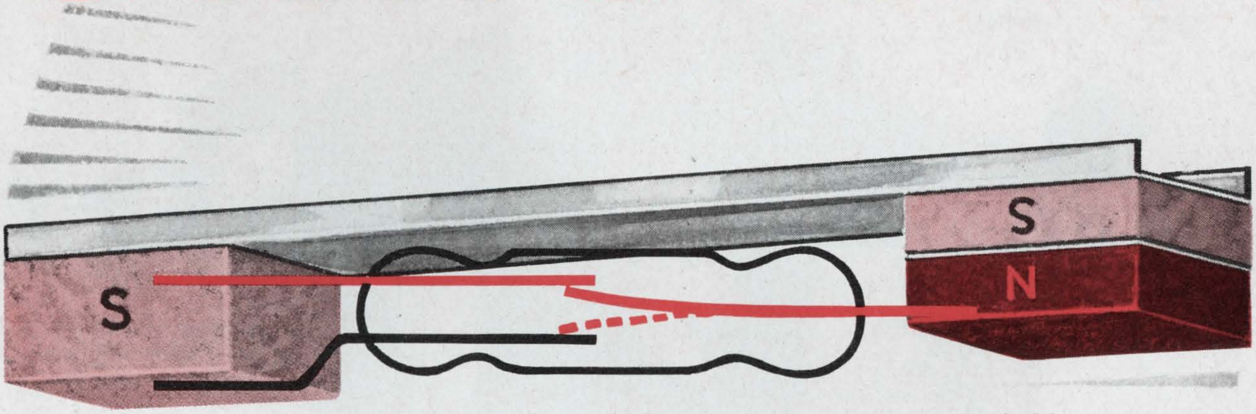

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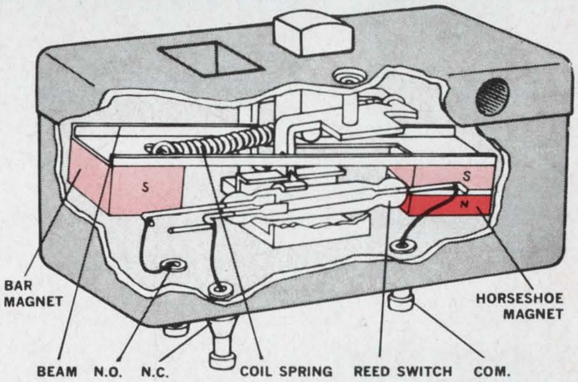

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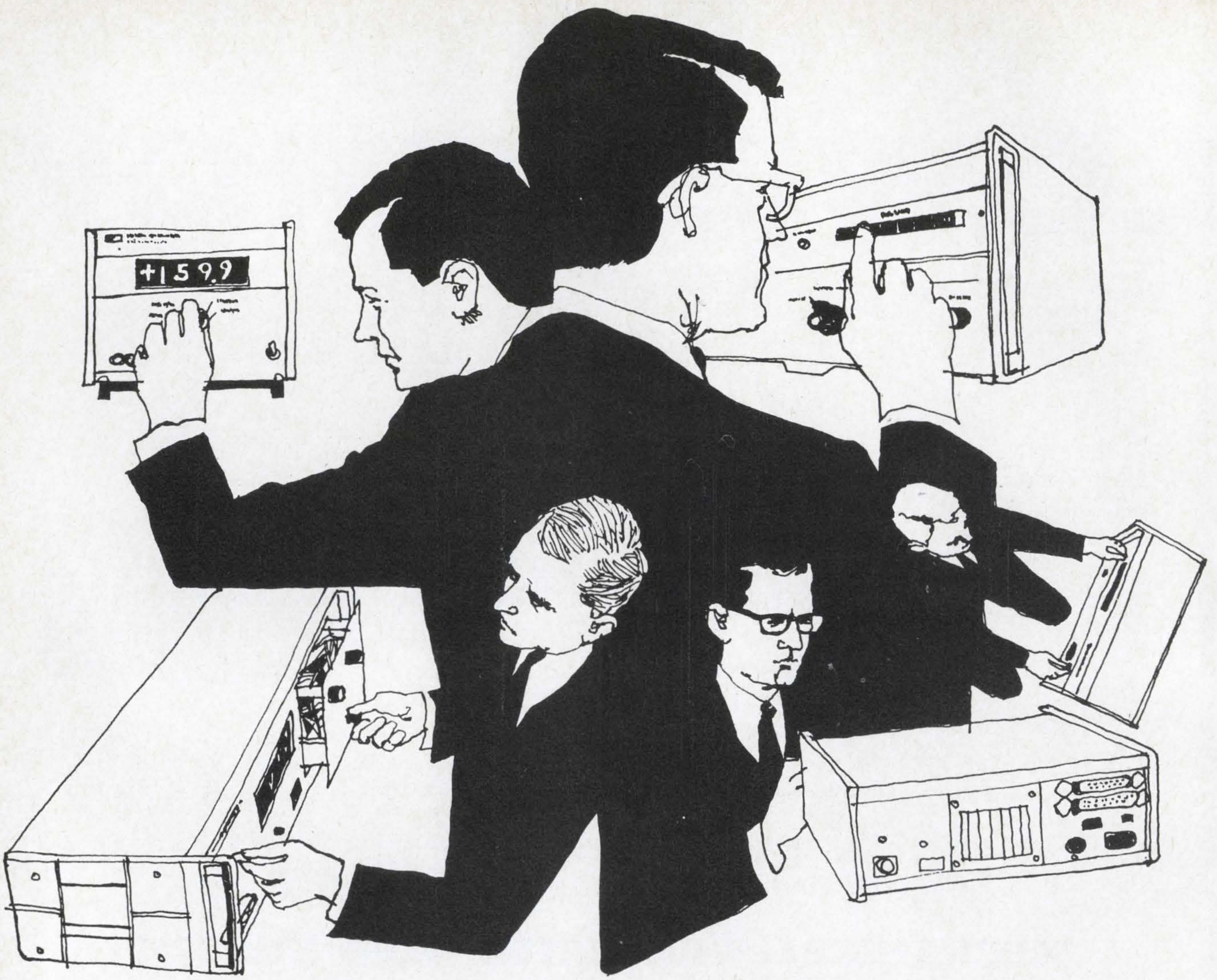

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It's yours with the four-digit hp 3440A. Six plug-ins give ac volts, dc volts, dc current and ohms. Basic dc accuracy is ±0.05% of reading ±1 digit. The 3440A has BCD printer output and rear terminals in parallel. Price: hp 3440A, $1160; plug-ins, $40 to $575. For bench use, get lower-priced hp 3439A (no BCD outputs), $950.

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For laboratory precision and systems speed, try the five-digit (plus a sixth digit for 20% overranging) hp 3460B. It has ±0.004% of reading ±0.002% full scale accuracy. The 3460B has 10μV sensitivity and makes automatic and remote-controlled dc measurements at up to 15 readings per second. The guarded 3460B has high common mode rejection, and >$10^{10}\Omega$ input resistance at balance on the 1 V and 10 V ranges (minimum 10 MΩ). On the 100 V and 1000 V ranges, input resistance is 10 MΩ. Price: hp 3460B, $3600; hp 3459A, (no BCD outputs), $2975.

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Electronics Review

Volume 40
Number 26

Space electronics

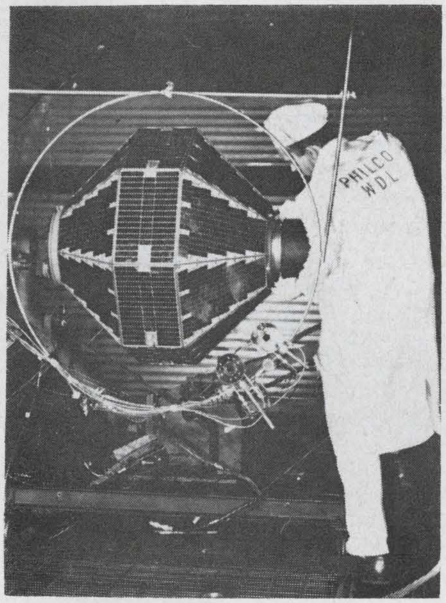
The old reliables

Much to the surprise and dismay of people close to the project, the eight satellites scheduled to be launched in the spring to augment the Initial Defense Communications Satellite System (IDCSS) will be virtually the same as the 19 already in orbit [Electronics, Nov. 27, p. 60].

The Despun Antenna Test Satellite (DATS) lofted with the third group of IDCSS satellites is currently providing some 10 decibels more gain than the others. Despite this fact, and despite the fact Philco-Ford Corp. is building satellites with despun antennas for Great Britain and the North Atlantic Treaty Organization, the IDCSS birds now under construction at Philco do not have directional antennas. The satellite was formerly called IDCSP (P for project).

Keep price down. The decision to go ahead with an old model reportedly stems from the failure of the scheduled second IDCSS launch on Aug. 25, 1966, when the Titan 3C booster had to be destroyed shortly after liftoff [Electronics, Sept. 5, 1966, p. 31]. After that, one source says, Washington pressed hard for the replacement satellites that were cheapest, had the lowest risk factor, and were most readily available. Discussions in the fall of 1966 eventually resulted in a replacement contract last March.

But by that time, the third launch —the second successful one—had already been carried out (in January). In June four more satellites and the DATS were orbited. The last shot was an added starter, to make up for the aborted mission. All of these have been performing beautifully; not one has failed. In fact, Philco claims a mean-time-between-failures of seven years.



Something old. No innovations are planned for the next group of military communications satellites.

Philco is believed to have informally suggested that, in view of the excellent performance of the first 19 satellites (which have been operational since last July 1), the need for improvement was less pressing than had been believed, and that it might, therefore, be better to upgrade the next group of satellites.

The reason for upgrading the system would be to fill in its gaps. At present there are reported to be some outages in north-south communications, and in long-distance east-west communications. Such gaps could be corrected by the higher effective radiated power available from a directional antenna.

Some modifications of the ground system might be necessary to handle a "mixed" system, of high-power synchronous satellites (such as the British and NATO birds) and lower-power near-synchronous satellites (such as the first 19 IDCSS's). The problems are not considered great. In fact, there is some speculation that the DATS, having gone through its test paces, may have been incorporated into the IDCSS.

The traveling-wave tube amplifiers for IDCSS were provided by the Watkins-Johnson Co. and by the Eimac division of Varian Associates. Contracts for twt's for the next series contained some developmental funds, leading to speculation that the tubes may be somewhat higher-powered.

Like a Volkswagen, the birds may be changed inside while showing the same face to the world. But unless the Air Force's Space and Missile Systems Organization (SAMSO) does a complete about-face, the next series of IDCSS birds will not have the advantage of advances in technology made since the first group of seven was orbited in June 1966.

Consumers electronics

Errors of emission

It seemed almost a dead issue and color television set manufacturers were glad of it. Certainly Government reports of some General Electric tv sets spewing out higher-than-acceptable levels of x rays was not a good way to get Christmas shoppers to plunk down their money for a color set. But then, to the dismay of the industry, the issue surfaced again. And this time it could involve all set makers.

First, the U.S. Public Health Service, in a report on GE sets in one Florida county, said 38 out of 131 corrected sets were still emitting radiation above the 0.5-milliroentgen level per hour deemed safe. This time it was not the downward passage of rays from the shunt regulator tubes that was at fault, but radiation from the sides and back of the same tubes, as well as from a new source: high-voltage regulator tubes.

In a report to Congress, the Public Health Service concluded: "Radiation emissions from sources other than the shunt regulator tube indicate that potential radiation exposure may be industrywide."

Then came an article in Consumer Reports Magazine saying that sets made by the Admiral Corp. and Packard-Bell Electronic Corp. also emitted excessive radiation, under certain circumstances.

Whose move? As a result of the surprising findings in Florida, the Public Health Service has asked the Electronic Industries Association "to cooperate in a nationwide evaluation of the potential health hazard" and the National Center for Radiological Health announced it was planning studies of its own.

The question now is who will make the next move. James Secrest, EIA's executive vice president, doubts that EIA will actually get into checking or testing sets, but says that the organization may set guidelines. At the National Center for Radiological Health a spokesman says, "We have no specific plan as yet for the study of other sets but will try to start something in the near future. We will ask the EIA to help."

At Admiral, a spokesman said the company will take no action because it does not consider radiation a problem in its sets. Another Admiral public relations man said the Consumer Reports story talked about a set that is "out of production." He later added that the last one came off the line in November and presumably is on dealers' shelves now.

Lee Robinson, Packard-Bell's director of quality assurance, said sets are continually "checked" in the factory. He said that after the story was published the California Department of Industrial Safety came in and found the sets were meeting the prescribed requirements. Robinson said this is the first radiation check made by a government group—contradicting a statement made before the check by the firm's president, who said sets had been checked for safety and performance "by the government." Packard-Bell is letting the issue rest.

Meanwhile, on other fronts, brickbats are flying. Ralph Nader, the gadfly, who is moving towards the formation of a consumers lobby in Washington, had harsh words for the industry and the Government. "The Government is moving in this area with all the speed of a glacier."

Rep. Paul Rogers (D., Fla.) urged manufacturers to conduct immediate safety surveys of their sets. Rogers' bill on radiation safety is one of two that will be introduced in early 1968 [Electronics, Sept. 18, p. 164].

At the AFL/CIO biennial convention in Florida this month a policy resolution was passed expressing concern over inadequate radiation protection of workers and consumers. In Washington an AFL/CIO staff member, George Taylor, working on the problem of radiation in atomic and electronics industries, predicts that in the next round of Congressional hearings on radiation safety a host of union representatives can be expected to post their grievances and the Brotherhood of Electrical Workers and the International Union of Electrical, Radio and Machine Workers will be heard, he predicts.

Taylor says some unions may bring the question of radiation safety to the bargaining table when national contracts are negotiated.

Computers

Negative thinking

Staid old Westinghouse Air Brake Co. is being pushed by its Melpar division to develop a new type computer, leapfrogging present-day technology. Heading the drive is rail-thin Maurits P. de Regt (pronounced "direct"), the new chief of systems analysis at Melpar. De Regt is pushing the parent company for design and prototype development money for a series of negative-radix-arithmetic computers.

> **The numbers game**
>
> A number written in negative-radix notation assigns each digit a value based on a negative number raised to some power. In conventional decimal notation, the radix is +10; the number 183 means $1 \times 10^2 + 8 \times 10^1 + 3 \times 10^0$, or 100 + 80 + 3. In the binary notation ordinarily used in computers, the radix is +2; the number 10110111 means $1 \times 2^7 + 1 \times 2^5 + 1 \times 2^4 + 1 \times 2^2 + 1 \times 2^1 + 1 \times 2^0$, or 128 + 32 + 16 + 4 + 2 + 1, also equal to 183 in decimal notation. But if a radix of −10 were used, the number 183 would mean $1 \times (-10)^2 + 8 \times (-10)^1 + 3 \times (-10)^0$, or 100 − 80 + 3, or 23 in conventional decimal notation.

For industry. De Regt says the best immediate application for this negative-radix computer—which may be electronic, fluidic, or any other IC—would be for industrial-control processes that require relatively simple, repetitive calculations from sensor data. Negative arithmetic makes simplified, less expensive arithmetic circuits possible and attains higher reliability by reducing the number of special-purpose control modules. These advantages arise because with negative radix a given arithmetic operation is always the same regardless of polarity of the numbers involved. With a positive radix, for example, when a positive number is to be added to a negative number, the operation is really a subtraction.

The disadvantage, of course, is that negative-radix notation would be very difficult for programers to get used to, although it could be made compatible for the user with present computer languages. The output would have to be converted from negative to positive radix for printers and other output devices, and the input would have to be converted the other way. But conversion is intrinsically no more difficult than binary-to-decimal conversion in conventional computers. And, as any programer will testify, getting used to binary notation in conventional computers isn't easy at first either.

But in spite of programing difficulties, according to de Regt, negative-radix computers will give more flexibility, economy, redundancy, and maintenance-free operation to large general-purpose and time-shared computers.

Minus order. These advantages arise from negative-radix notation, says de Regt, because negative numbers can be represented directly without resorting either to cumbersome complement notation, which fouls up arithmetic operations, or to sign-and-magnitude notation, where the extra sign bit interferes with shifting operations. According to de Regt, this means that registers can be chained together indefinitely without regard to sign bits, low-order carry-in bits, or other considerations. As a result, true variable-word-length computer design is possible.

Negative-radix arithmetic also enhances reliability by permitting computers to be built with large-scale integration techniques using chips that include failure-detection circuits, circuits to bypass failed elements, and redundant circuits to replace failed elements.

For example, a simple 12-bit register in a conventional computer would be replaced in the new design with a 36-bit register, only 12 bits of which would be used at any time. Up to 24 bits could fail and be replaced by other positions in the register without affecting the operation of the system. Such a register could be built on a metal-oxide-semiconductor chip with fewer than 1,000 transistors per chip—not unreasonable with today's state of the art.

Since registers can be physically chained together indefinitely if they use negative radix notation, they may also be chained together under program control. This possibility implies sophisticated computers whose performance depends on the job to be done. It also implies low-cost time-sharing, through matching data-processing and number-register capacity requirements to the needs of jobs at hand. The result is that it would be able to handle three low-capacity jobs simultaneously or switch over to one high-capacity job automatically.

Manufacturing

Computer for the mask

There's a lot of tub-thumping about computer-aided design but so far computers haven't been much help to the photomask maker. Manufacturers of large integrated circuits have been trying to automate mask-making, but the best they've been able to do has been to use numerically controlled drafting tables for making art work from 200 to 500 times the real size.

But now the largest U.S. producer of IC masking cameras, the David W. Mann Co., a division of the GCA Corp., Burlington, Mass., has come up with a computer-controlled pattern generator that produces plates 10 times actual size for photorepeaters, using punched tape as its input. The machine sidesteps drafting and photoreduction, steps which have added error to IC masks, and consumed valuable time as well.

Mann's general manager, Burton Wheeler, says the pattern generator's eventual role will be as an extension of a design computer, converting the computer's output into a plate for use in a photorepeater. Even though this type of operation is a year or so away, the pattern generator already makes possible IC artwork with tolerances far more accurate than presently available, he says, and at speeds "much faster" than today's machines allow.

Once upon a time. Early IC's were made by the same semiphotographic process used today. But in more primitive setups a draftsman transferred a design engineer's sketches of IC masks to laminated plastic in a back-breaking session at a drafting table. The laminate would be photographed and reduced in size, then photoreduced again as it was projected onto a master plate. Things haven't changed much since the first IC's came out. Some companies haven't changed their approach at all.

At best, the engineer's sketch now is converted into instructions for a numerically controlled drafting table that creates giant replicas of IC masks, using a thin light beam to paint the pattern on an emulsion. Photoreduction is still necessary and, in Wheeler's opinion, the drafting tables are sources of unnecessary error.

The pattern generator makes possible tolerances up to twice as tight as those possible with drafting and photoreduction, going directly to 10 times real size, with ±40 to 50 millionths of an inch tolerances, compared with ±60 to 80 millionths of an inch.

Light exposure. While the automatic drafting table uses a beam of light to paint the mask pattern, the Mann system arbitrarily divides the pattern into rectangles up to 120 mils on a side and exposes them with pulses from a xenon flash lamp.

Eight-channel punched paper tape contains the X-Y coordinates of each rectangle, the size of each rectangle, rotation angle if necessary (this makes possible diagonal lines), and flash commands. The data can be either in decimal or binary format.

The tape is fed into an optical tape reader, which in turn feeds a PDP-8/s digital computer. The computer stores the data in its 4,096-bit core memory. It uses this data to position a servo-controlled stage beneath reducing optics and to vary slit size for the proper exposure area.

Stepping motors operate the slit, which is 10 times the size of the final rectangle; the slit can be stepped from its smallest to its largest size in .25 second, or stopped at one of its 14,400 apertures.

The optical system, the stage, and the positioning system are the same as used on Mann's photorepeater, which makes positioning tolerance and repeatability as tight as that on master IC masks. Optical quality is about the same, too, and according to Aubrey C. Tobey, Mann's director of marketing, exceeds today's present needs. The optics can resolve up to 650 line pairs per millimeter, he says, making possible line widths as fine as 0.5 mil.

This isn't overspecification,

though. Tobey says the pattern generator was designed with large-scale integration in mind and its specifications will be needed for the very fine geometries that are just over the horizon.

Industrial electronics

Drill commander

Drilling an oil well is an expensive proposition even under the best conditions. But off-shore operations, or those in marshy on-shore areas, can cost more than $100,000 a day, including the lease of a deep-water rig at a daily rate of $6,500 to $8,500.

In an effort to cut these expenses, the Humble Oil & Refining Co. is using a digital computer to calculate minimum drilling costs. With the computer at the rig site, Humble has completed one well in the bayou country of Louisiana and is working on another.

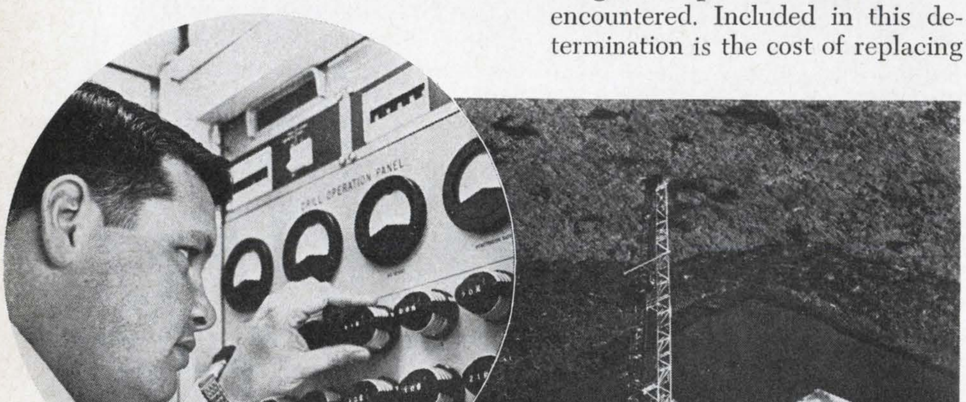
Savings. A company spokesman says that if the use of the computer saves "even a half day on several wells," this will more than cover the cost of the system. And with more experience with the technique and more data on drilling factors, he adds, "we might be talking of saving whole days in the long run."

Humble's Honeywell DDP-116 digital computer must take into account some 40 factors, including the properties of geological formations, the wear rates of various bit bearings and teeth, the weight, operating speed, and over-all cost of equipment, and such geometric parameters as pipe size. Humble has developed a minimum-cost formula based on these factors in conjunction with the Rucker Co.

Some information is fed into the system from a control panel, while signals indicating drill weight, speed, and torque come from sensors on the floor of the oil rig.

Comparisons. The computer periodically requests changes in bit weights and rotary speeds and calculates the resulting rates of penetration. Applying this data and the minimum-cost formula, it then determines the best combination of weight and speed for the conditions encountered. Included in this determination is the cost of replacing the bit.

Constraints are built into the system to prevent the computer from ordering modifications in drilling procedure for unimportant changes in rig operations or geological conditions. Torque-limit safety control is also provided.



New twist. Humble Oil is using a digital computer at Louisiana oil rig site to speed drilling operations and cut costs.

Instrumentation

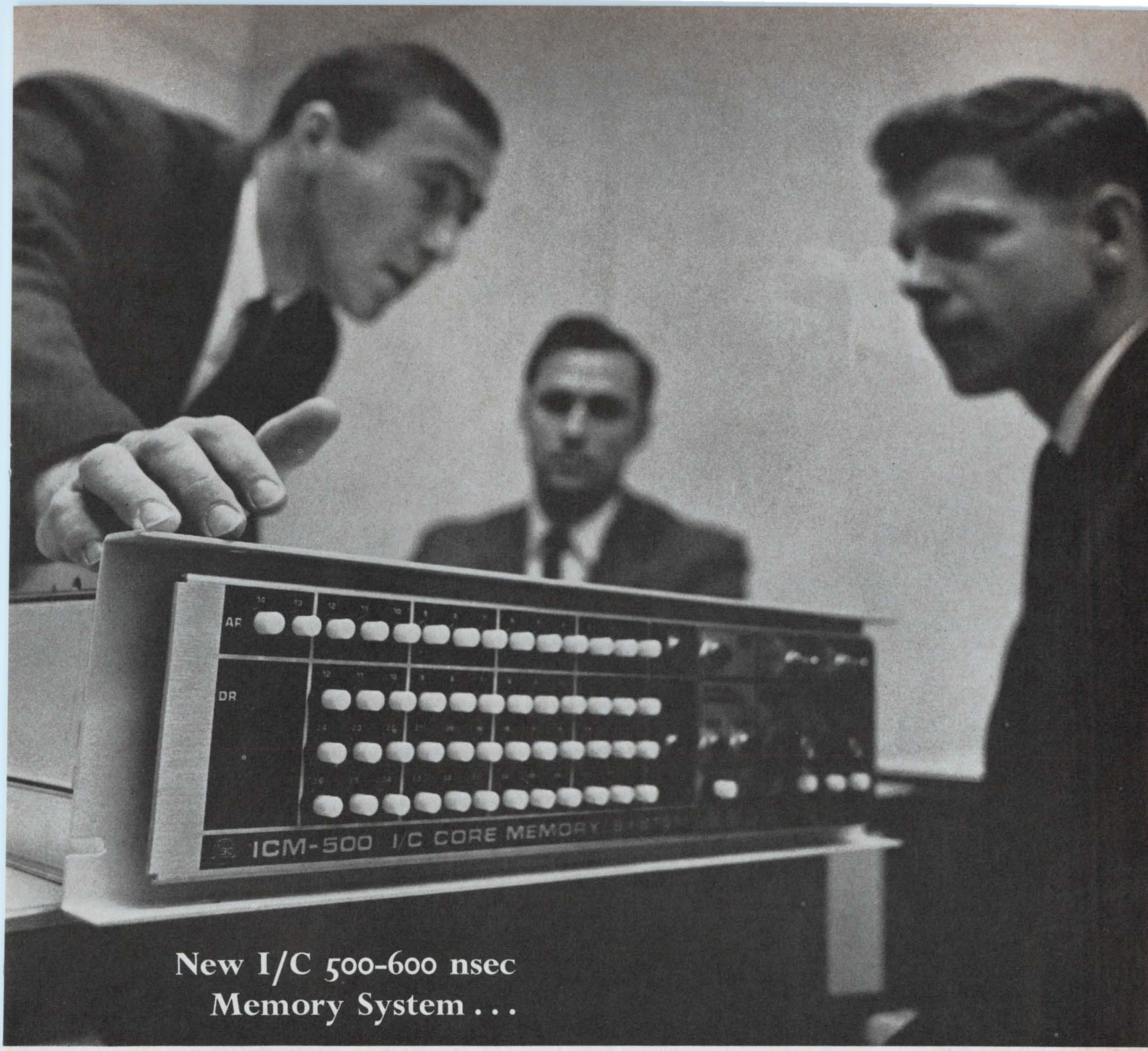
More than a calculator

Secure in its position as a new-product-oriented company with a reputation for quality, the Hewlett-Packard Co. has seldom deigned to comment on rumors about forthcoming instruments. For more than a year, it has blandly ignored reports that it would market a desk-top calculator [Electronics, Dec. 12, 1966, p. 26], confirming only that it was working on a "calculating device" which was "not yet committed to production."

Now it appears that H-P will offer something that is more than a calculator, but less than a computer—a special-purpose instrument about the size of a portable typewriter that will perform a variety of arithmetic and algebraic functions. The instrument, known internally as the series 9000, was reportedly developed in the company's Loveland division, in Loveland, Colo., but will be marketed by the Palo Alto, Calif., division. The latter division, formerly known as Dymec, is rapidly becoming H-P's computer arm.

High class. The new machine is said to perform all functions needed for solving partial differential equations. Its typewriter-like keyboard has keys for trigonometric functions and natural logarithms, as well as square and cube roots and a number of other functions. The display is on a small cathode-ray tube. It is intended for use by scientists. The price tag—said to be well into five figures—takes it out of the desk-calculator class.

The instrument will be built with integrated circuits designed and made at the Loveland division, whose integrated-circuit lab, begun



. . . Stores 1/4 million bits in single 5-1/4″ high unit, features MTBF of 12 years under normal 40-hour week operation

Now you can get the new μ-STORE ICM-500 in standard systems: 600 nanoseonds full cycle time. Special systems: cycle times as low as 500 nanoseconds. Up to 16,384 words with 54 bits/word; or up to 4096 words with 72 bits/word. (Over 3/4 of a million bits in little more than 15″ of vertical rack space — including power supply). You also get I/C construction for all major functions including X-Y current drivers plus a choice of mechanical packaging.

Get the full story. And take advantage of our eight years' experience in solving core memory problems. Write today for our new brochure. Honeywell, Computer Control Division, Old Connecticut Path, Framingham, Massachusetts 01701.

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Honeywell

COMPUTER CONTROL
DIVISION

Circle 43 on reader service card

only last spring, has already produced its first circuit for an H-P instrument [Electronics, Nov. 13, p. 26]. Insiders say that the calculator-computer will be ready by February, but H-P is making no commitment about introducing it at the IEEE show in March.

Avionics

Straighten up, fly right

A helicopter is a queer bird: it wants to turn over and fly on its back. To keep it flying right side up takes a bit of coordination on the part of the pilot.

The National Aeronautics and Space Administration is about to give the overworked helicopter pilot an assist. And the solution, borrowed from spacecraft design, should lead to the development of controls that are both simpler and more automatic. In fact, the space agency says, the development could easily be extended to the vertical or short takeoff and landing craft (V/STOL).

Heading the program is Richard J. Hayes, a recently named assistant director of NASA's Electronics Research Center, Cambridge, Mass. Hayes plans to borrow guidance, control, and navigation gear from Gemini and apply it to helicopters and V/STOL's. His goal is single-stick operation for these complex aircraft, using a computer to close the control loops.

Bring it down. "It's also possible that the Gemini's navigational gear may be more accurate than instrument landing systems," he says. The center plans to use the computer for terminal guidance. The computer would store the characteristics of both the aircraft and the airport in its memory and combine this with attitude and position information from Gemini's inertial guidance instruments and other sensors. By comparing the data in its memory with the sensor data, the computer would be able to guide a plane to a landing in zero visibility, even on a dog-leg course—and without approach radar on the ground.

It's not enough to add a computer and remove some controls. The control panel also must be equipped with new instruments and displays. Hayes has ideas along this line, too. For blind flying, the space center will investigate a computer-controlled holographic display that would allow a pilot to view a landing site in its actual perspective. The plane's position and attitude relative to the airport or helipad would be fed to the computer by an inertial platform and beacon or radar sensors. The hologram would show the site in perspective (and in motion) as the aircraft moved relative to the ground.

Full circle. Meanwhile, Hayes also hopes to improve spacecraft cockpit display and instrumentation. With this aim, the NASA center has borrowed the Gemini capsule from the Smithsonian Institution and will use it as a test-bed for new display ideas and human factors analysis.

By early 1968 Hayes hopes to have a computer hooked up to the capsule's instrumentation and to have engineers in the cockpit flying simulated missions.

The center has the Gemini 2 on the lobby floor of one of its Cambridge buildings and modification should be completed next month. Meanwhile, the Gemini data-handling system is being adapted for V/STOL applications by Electro-Mechanical Research Inc. of Sarasota, Fla. And Honeywell Inc. of St. Petersburg, Fla. is refurbishing Gemini guidance and navigation gear.

Hayes hopes to have a modified helicopter flying next June with Gemini navigation gear borrowed from the Air Force's Manned Orbiting Laboratory project office. Simulations in the Gemini 2 capsule will begin about Feb. 1.

For the record

Heat switch. The Du Pont Co. has developed an unusual crystalline metal that suddenly becomes magnetic at critical temperatures and then becomes nonmagnetic at

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It's called "looking for the particular precision resistors that deliver the exact functional characteristics you need at the lowest possible price."

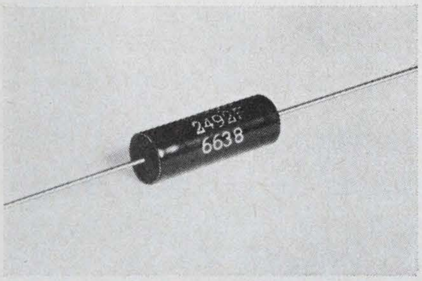
Perhaps this highly sensible method isn't new to you. But it will be to a lot of people. We've been amazed to discover just how many design engineers specify their industrial precision resistors on the basis of arbitrary (and non-functional) labels —such as the fact that the resistors meet certain MIL specs or feature "wire-wound" construction.

Don't get us wrong. MIL-spec resistors are fine—for military applications. But is it really logical to pay a premium for a wider range of environmental adaptability — and more documentation—than your industrial application actually involves?

Wire-wound resistors are fine, too. Even when they're evaluated on a functional basis, they may prove to be better than metal film resistors for certain industrial applications. But if you still assume that wire-wounds are better for every application, you simply haven't been paying sufficient attention to what's been happening in precision resistor technology in recent years.

Thanks in part to important advances by the Speer research and development people, our JXP resistors now are competitive with wire-wounds as far as resistance-temperature stability is concerned. And their statistical reliability is greater. Ditto their power density, when performance is equivalent. And their prices are not only competitive but are in many cases even lower than wire-wounds.

Our JXP metal film resistors, because of our exclusive manufacturing process, can be produced to tighter tolerances than wire-wounds at sig-



nificantly less cost for most resistance ranges. Furthermore, they automatically incorporate faster response and settling times at no additional cost.

You can get JXP's with tolerances and TCs as low as ±0.02% and ±2 PPM/°C, respectively, upon request. These "white room" metal film resistors have other startling functional characteristics that you should also be aware of. Use the coupon, and we'll send you the full details.

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As we've just demonstrated, evaluating industrial precision resistors on the basis of functional characteristics rather than arbitrary labels may change your buying habits.

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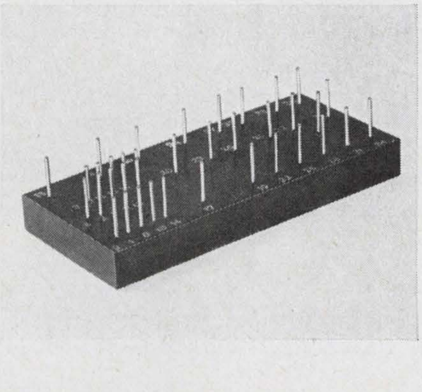
Our JXP precision resistors are available in all kinds of packaged networks and assemblies, needless to say. In addition, we can furnish you



with any network engineering assistance you might need—from prototype preparation to testing and certification. For complete information, mail us the coupon.

How's your frequency on Typical Error #4 in inductor testing?

Continuing our review of the errors often made when measuring inductance and Q (see MIL-C-15305), error #4 is letting your test frequency become inaccurate.

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higher temperatures. Du Pont has yet to determine applications for the metal. In fact, it has sent samples to more than 100 companies in an effort to find applications. But two broad possibilities are seen: as a switch triggered by temperature change and as a core of an inductor of a transmitting oscillator.

The material, chromium-manganese antimonides, can be made to operate in environments between −200° and +150°C. The temperature spread at which the magnetic state turns on and off can be made as narrow as 0.1° and as wide as 100°. The critical temperatures at which the magnetic reaction occurs can also be affected by changes in the pressure and an external magnetic field. Using pulsed magnetic fields, the Du Pont scientists have recorded changes in the material's magnetic field as quickly as 0.3 microsecond.

Life-size holograms. RCA Laboratories scientists have developed a way to generate large holograms with a depth of field of up to six feet; earlier holograms were limited to fields of no more than a few inches. Researchers predict they could eventually make holograms as large as 35 feet across. What gives the RCA holograms these added features is the replacement of the mirror at one end of the laser with a piezoelectric-controlled three-mirror interferometer, which sharply improves the coherence of the output beam over a long path.

Second try. Amphenol Corp. of Chicago, in a second effort to prevent a takeover by Solitron Devices Inc. of Tappan, N.Y., is negotiating a merger with Bunker-Ramo Corp. of New York. In September, Amphenol failed to arrange a merger with Sangamo Electric Co. of Springfield, Ill.

In the courts. The Justice Department has urged the Supreme Court to defer its decision on the application of copyright laws to CATV systems, following a Dec. 4 invitation by the court for an expression of Justice Department views. U.S. Solicitor General Irwin Griswold also said that the court should proceed with a decision on whether the FCC has the authority to regulate CATV.

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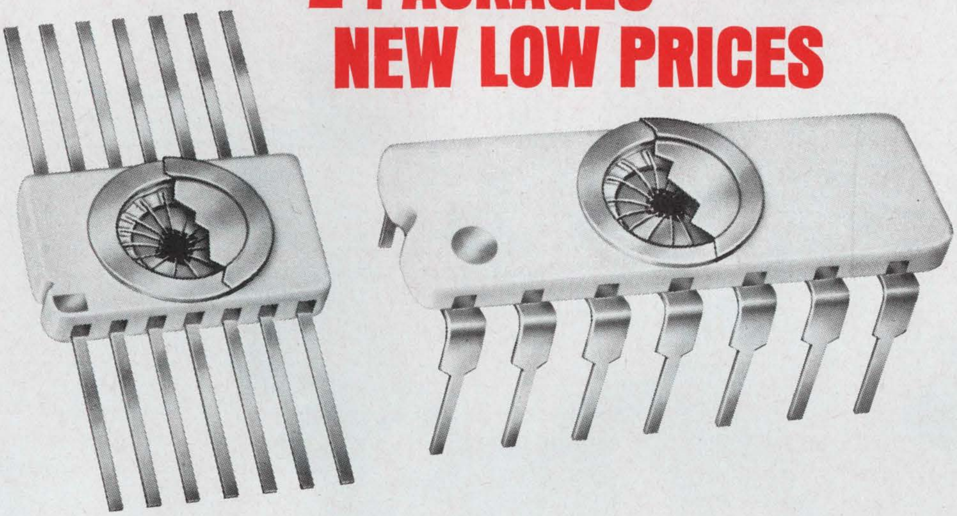

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Quadruple 2-Input NAND Gate	CD2201	CD2201D	$3.30
Dual 4-Input Expandable NAND Buffer Gate	CD2202	CD2202D	$3.30
J-K Flip-Flop; 2 "J", 2 "K", 2 Set and 2 Reset inputs, Split Clock	CD2203	CD2203D	$4.20
Dual 4-Input Gate Expander	CD2204	CD2204D	$2.25
Dual 3-Input Expandable AND-OR-NOT Gate	CD2205	CD2205D	$3.15

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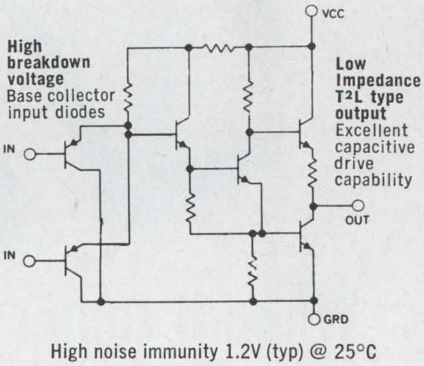
Basic Gate Configuration



High noise immunity 1.2V (typ) @ 25°C

Device dissipation (typ) 2.3mW per Gate —7mW per Flip-Flop. *Full military operating* temperature range— −55°C to +125°C *Flip-Flop* clock frequencies (typ) 3MHz. *Single power supply* +3.8V to +6.3V; 4V optimum. *NAND gates* pin-compatible with popular 930 DTL circuits.

Data sheets and extensive application notes available for both—CD2200 series in 14-lead Flat-Pack and CD2200D series in Dual In-Line package. Call your RCA Sales Representative, your RCA Distributor or write to RCA Commercial Engineering, Section ICN12-4, Harrison, N.J. 07029.

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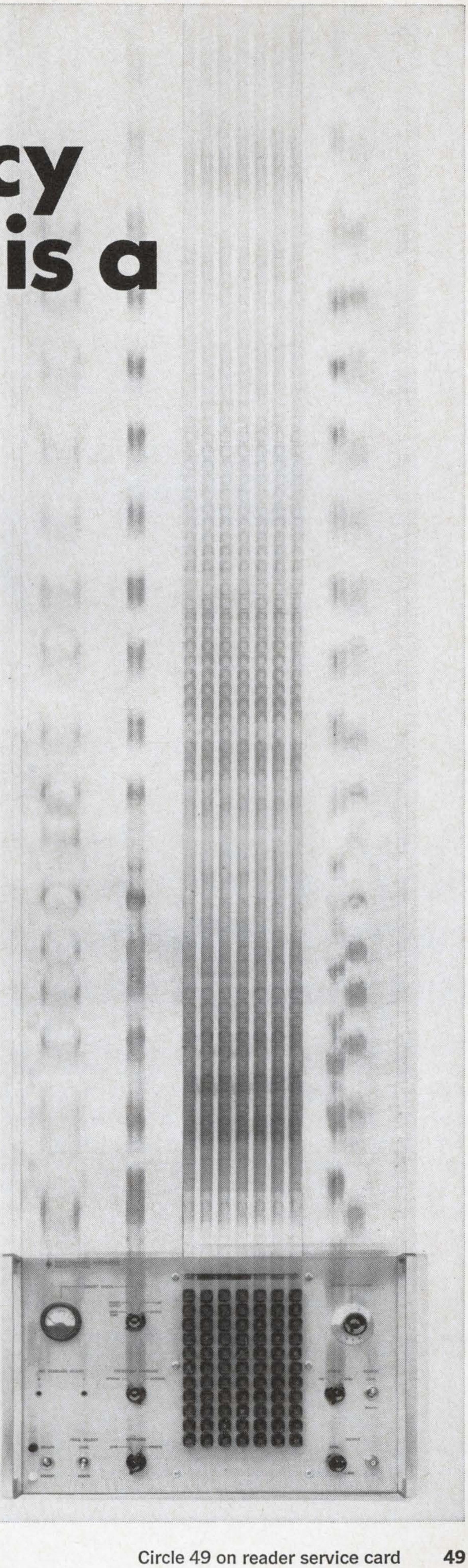

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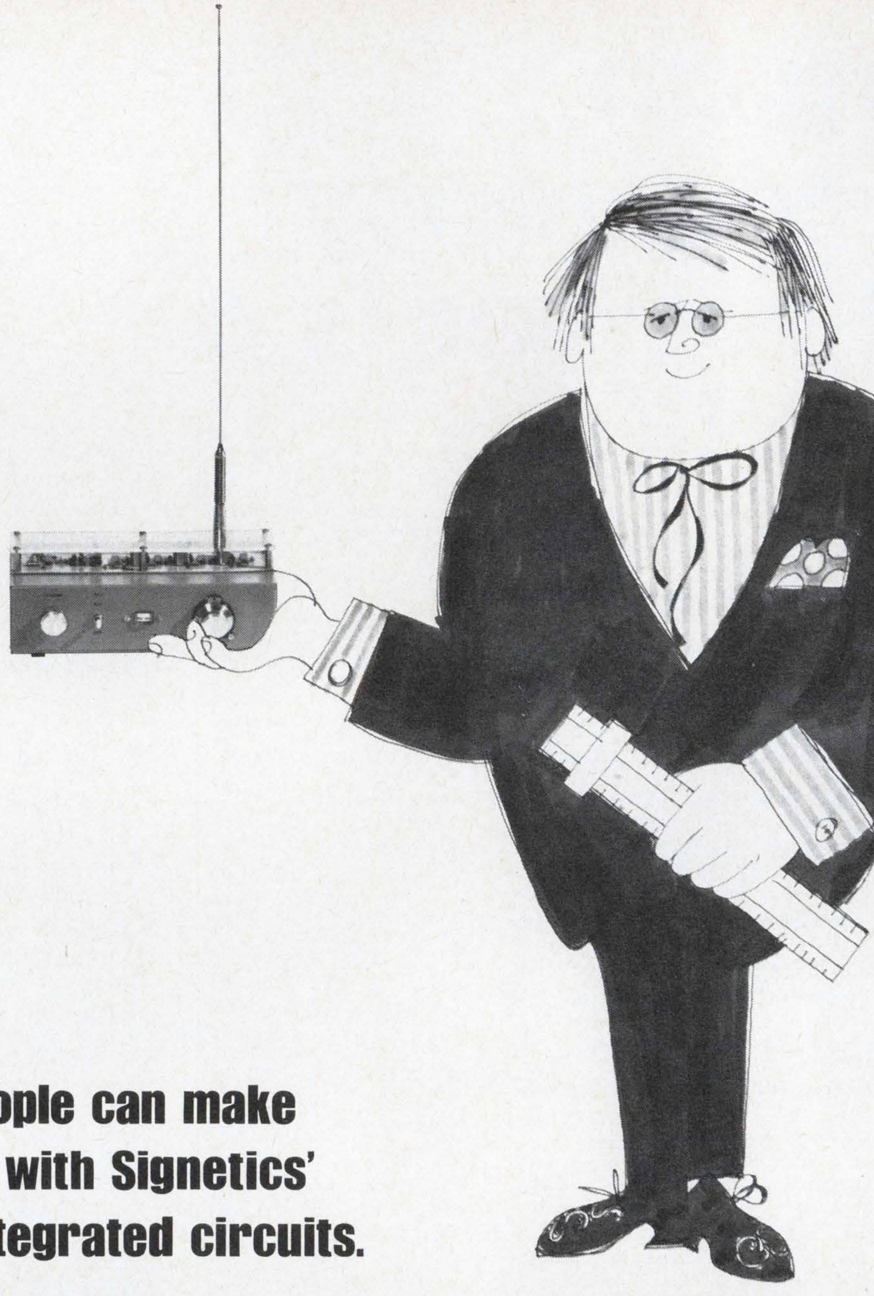

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Like this FM receiver our friend put together. Its IF strip is made up of Signetics' new 510 Dual RF/IF Amplifiers. It will never win a prize for either industrial or electronic design—but then, it wasn't intended to. Does it work? We had it running continuously during the recent WESCON show. Our booth traffic indicator says that some 20,000 engineers saw it, heard it, and thought it sounded pretty good. We know that lots of them can design a better receiver with the same parts. That's their business. Ours is making integrated circuits.

Want to know more about the Signetics' 510 Dual RF/IF Amplifier? Send for a data sheet and a reprint of Ralph Seymour's WESCON paper on its design and applications.

Want to know more about Signetics' other new linear IC's—the 515 Differential Amplifier and 516 Operational Amplifier—or about the field-proven 501 Video Amplifier and 518 Voltage Comparator? Just ask. We'll get data sheets and application notes to you...fast.

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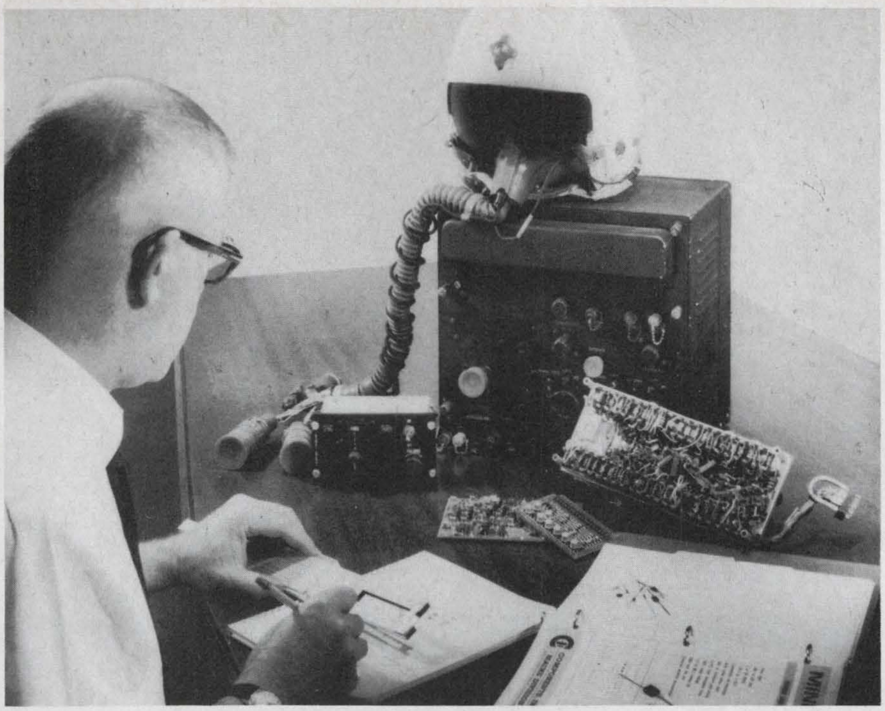

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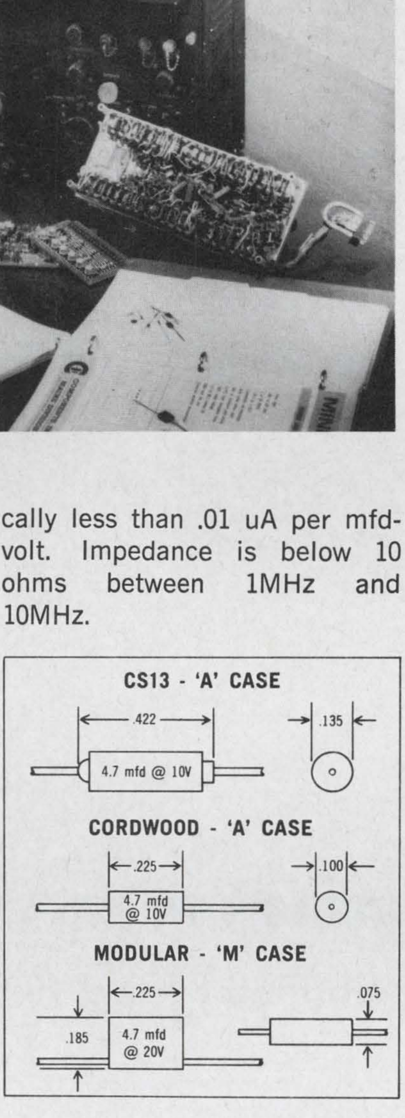

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Washington Newsletter

December 25, 1967

Corsair's 4 Pi gets big plus

The digital computer going into the Corsair 2 aircraft—the Air Force A-7D and the Navy A-7E—was souped up by IBM before it delivered the original unit. The upgraded version of the 4 Pi model TC—called TC 2 —may end up as an off-the-shelf machine in IBM's growing line of avionics equipment.

With a speed of 125,000 operations per second, the TC 2 is twice as fast as the original model. The number of operations is based on 80% add and 20% multiply and divide, which is expected to be the average operational mix of the machine. **IBM did this by boosting the computer's oscillator speed and increasing the memory's 8-bit word length to 32 bits.**

IBM, which wasn't required to improve the computer, did so on its own and offered the new version for the Corsair 2. The offer was accepted and the company has just delivered the first units. Ling-Temco-Vought is building the Corsairs and deliveries are slated to begin late next year [Electronics, Sept. 4, p. 53].

NASA's high hopes deflated by LBJ

NASA is in for harder times next year. **Plans to pump more money into the Apollo Applications Program and such new planetary projects as Voyager are out the window as cutbacks in civilian space spending continue into fiscal 1969.** Space officials now expect the White House to bar them from asking for more than $4.2 billion. To make matters worse, chances are that NASA won't be able to commit much more than $4.2 billion of the $4.6 billion Congress approved this year. This is a far cry from the $5.1 billion NASA requested last January.

The space agency had been hoping for at least $4.6 billion next year. By keeping spending at this level and picking up $500 million from the expected drop in spending on the Apollo lunar landing program—from $2.6 billion to $2.1 billion—there would have been enough money to give the Apollo Applications and unmanned planetary programs a big boost, NASA officials say. But now, James E. Webb, NASA's chief, says he won't spend any money for these new programs unless there are indications of a higher budget for fiscal 1970.

Pentagon anchors Navy's Omega

Navy officials seeking the Pentagon's go-ahead for full-scale deployment of the Omega navigation system got the answer they were afraid of getting: approval, but no funding to implement it. As expected [Electronics, Oct. 16, p. 69], the Defense Department's reasons were based on the crackdown on non-Vietnam military spending. **And the Navy is pessimistic about getting any funds in the fiscal 1969 budget to turn its limited research and development system into an operational worldwide navigation network.**

The Pentagon told the Navy it could give Omega's four present transmitters "operational status"—whatever that means. As one Navy project officer put it: "Your guess is as good as mine." The very-low-frequency transmitters, though officially listed as R&D installations, actually have been operational for more than a year.

Had the Pentagon gone along with full-scale deployment, the Navy planned to double the power of the transmitters and add other equipment at these four sites. It also would have built four more transmitters.

The way things stand now, the Navy says it would welcome an offer by any other nation to build the transmitters.

Backup range radar back in Apollo plan

NASA has had second thoughts about a backup system for the rendezvous radar on the Apollo lunar module. After ruling out the additional equipment several months ago, as part of the effort to keep the lunar-module's weight down, the space agency recently decided it needed the backup and is now going all out to get a system ready in time for the first lunar landing.

RCA, which is also building the primary radar, has just delivered preliminary design studies of the vhf-ranger to NASA. The ranging system will share some hardware with the Apollo vhf voice/data system. Keeping the weight down will be the biggest design problem. Ranger electronics will be in the command module and must not weigh more than 5.5 pounds; the lunar module transponder will weigh 3 pounds.

Comsat may be using Hughes talks to spur TRW Intelsat work

Comsat may be using its current talks with Hughes about buying an upgraded version of the Intelsat 2 satellite to pressure TRW Systems into speeding the development of Intelsat 3. At least that's what observers close to the scene are saying. **The odds, they say, now favor Comsat sticking with TRW and not buying the Hughes satellite as a backup.**

TRW, which has been having problems building the satellite [Electronics, Dec. 11, p. 25], is now guaranteeing Comsat that it will deliver the first Intelsat 3 by Aug. 15. But the company won't promise that the communications subsystem being built by ITT will be ready by this date.

ITT's performance on the Intelsat 3 contract was a major topic at the Dec. 15 meeting of Comsat's directors. Comsat's concern was shown by a board decision directing top management to meet with Harold S. Geneen, ITT president, to discuss ITT's work.

Comsat is about to decide whether to gamble on TRW delivering the complete satellite package in time for a Sept. 1 launch or to accept the Hughes offer.

Panel mulls selling of frequency space

President Johnson's telecommunications task force, hard at work after months of wheel spinning [Electronics, Dec. 11, p. 67], is seriously considering proposals that users pay for frequency spectrum space and that the international operations of U. S. common carriers be merged. The plan for overseas consolidation has already been discussed, and its inclusion in the group's report would come as no surprise, but **the idea of selling frequency space is new and is sure to be hotly debated.**

Air traffic control still up in the air

Industry is finding it difficult to determine what priority the Administration is giving air traffic control. The FAA still hasn't set a firm date for a pre-bidding conference to brief electronics companies on requirements for terminal air traffic control equipment. Postponed several times from its originally scheduled August date [Electronics, Oct. 16, p. 69], the meeting is now slated for "sometime in 1968," according to the agency.

Because the Budget Bureau has delayed the release of fiscal 1968 allocations, the FAA says "there's no use in holding the conference until we know how the pie will be cut." **The FAA had earmarked $7.8 million for terminal automation in fiscal 1968, but that figure could be cut.**

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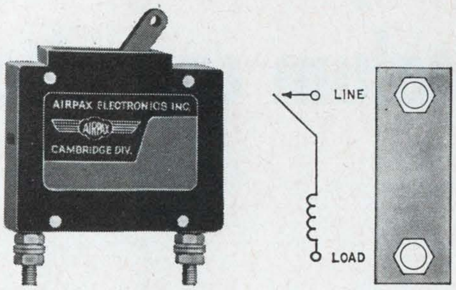
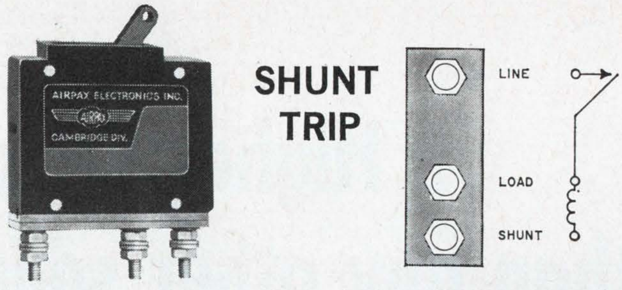
APL CIRCUIT PROTECTORS

SERIES TRIP



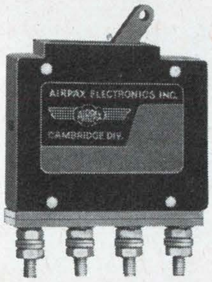
Airpax APL circuit protectors are manufactured in five circuit configurations. Each is available in any of 10 time delays, in any of 16 standard trip levels, and rated for a maximum of either 50 vdc, 250 vrms at 60 Hz, or 250 vrms at 400 Hz.

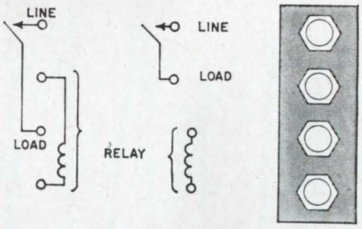
SHUNT TRIP



Shunt trip provides you with several possibilities. You can program an external shunt across the coil to change trip level for different operating modes of your equipment.

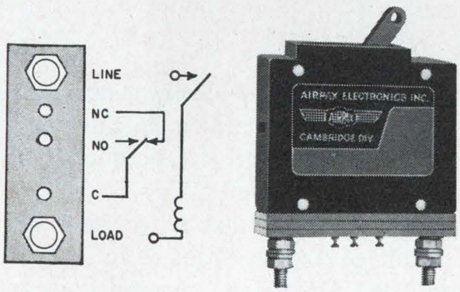
RELAY TRIP



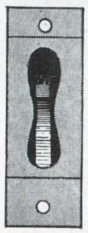


In protector Types APL-4 and -5, coil and contacts terminate at separate pairs of terminals. With this configuration, you can control current in one circuit by a different current in a separate circuit.

REMOTE INDICATION



A switch built into Type APL-RE protector transfers up to 5 amperes in a separate signalling circuit.



To the operator it's an ON-OFF switch. To you it's a design simplifier.

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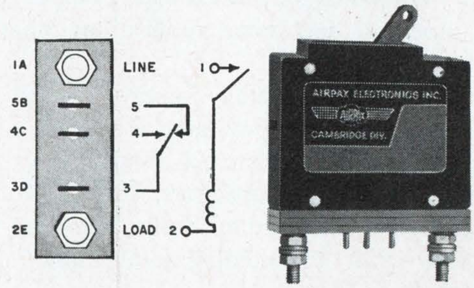

Auxiliary contacts built into Types-RO and -RO1 handle up to 10 amperes. The spdt switch operation is coordinated with the operation of the main contacts. Used to switch a remote load, this feature provides means for interlocking and protecting related loads.

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Technical Articles

Integrated circuits in action, Part 8: Spotting targets on the wing page 58

In a radar that spots moving targets, signal sampling techniques have always looked desirable but they have had to be ignored because so many separate channels and individual components have been needed. The use of integrated electronics changes all that by reducing the cost of components so much that the number of components used no longer is a limiting factor, nor is size. Using range gates and filters (so-called RGF) constructed of IC's, engineers at General Electric have designed an airborne moving target radar whose system performance is very attractive.

Forecast is cloudy but warmer page 71

Electronics' reporters and editors in 13 countries examine the prospects for electronics markets in Europe and detail the technological trends for 1968. The conclusion: the devaluation of the British pound has added a confusing note to an already cloudy picture. In general, however, prospects seem fine for Italy, West Germany, France, and Portugal; but there is worry about recession in Great Britain and the Scandinavian countries. For the cover, Del Mulkey caught two Frenchmen watching a demonstration of color tv. The success —or lack of it—that color tv has may be the difference between good and bad years for the consumer electronics producers of many European countries in 1968.

European markets report: 1968 page 95

Electronics market research manager Milton Drake interviewed over a hundred companies, government agencies and industry associations to compile the most comprehensive statistics on European electronics markets ever published. This year's report analyzes markets in 11 countries.

Annual index page 149

Annual subject matter and author index for technical articles and news stories that appeared in Electronics in 1967.

Coming January 8

- **Annual U.S. market report**
- **Guarding against power fluctuation**
- **How IC's improve a tape recorder**

Integrated circuits in action: part 8 Spotting targets on the wing

With a combination of silicon IC's, thin films and discretes, range gates and filters help eliminate ground clutter in processing radar target returns

By Robert J. Berg and Paul N. Marshall
Defense Electronics Division, General Electric Co., Utica, N.Y.

Detecting a moving target from a moving airplane is much more difficult than detecting such a target from a fixed position on the ground. It's like trying to score a bull's-eye with buckshot, with both the marksman and the target in motion.

In an airborne moving-target-indicator (AMTI) radar the most difficult problem is to filter out the moving target from the motionless clutter—the unwanted echoes in which it is found.

At General Electric this is being done by a noncoherent radar using range gates and filters (RGF), a technique that until recently has been generally ignored. In this approach, a moving target in clutter produces a series of pulses whose amplitudes vary according to the velocity of the target. A stationary target produces constant-amplitude pulses.

The RGF approach to processing the radar's detected video i-f signal has been considered impractical because so many separate channels and individual components are needed. It is attractive from the standpoints of system performance and circuit design. But for airborne use, the radar would be too bulky, unreliable and require too much power.

These objections no longer are valid because of the availability of monolithic integrated circuits and hybrid thin-film technology. So many circuits can be put on a single chip of silicon that size is no longer a problem. Five separate range-gate-and-filter channels fit on a printed circuit board of the same size that previously held only one. In addition, reliability of the IC's is high and over-all power required is low. And by using a selection of both digital and analog circuits made up of silicon IC's, thin films, and discrete components, the best possible characteristics can be obtained.

Most of the resistive elements are made of thin films and almost all of the transistors are on monolithic silicon chips. Discrete components are used where power dissipation is high and where tolerances must be held within narrow limits.

With an RGF video processor in an airborne moving target indicator, the system designer has more flexibility than he has with other techniques in shaping the clutter filter characteristics to match the clutter spectrum. A filter with the proper skirt selectivity, for example, minimizes the lower-frequency doppler clutter returns from fixed targets without degrading the higher-frequency doppler returns from the moving targets.

Such filtering can be done in several ways. Early approaches to AMTI's used video and i-f delay-line cancellers. These are still used in many systems. The delay line serves as a comb filter which rejects the d-c components of the clutter as well as energy near the radar's repetition frequency and its harmonics. Digital and storage tube processors may also be used.

Clutter filtering

But whichever type of processor is selected the filtering process is basically the same. Thus, in a noncoherent radar, in the simplified block diagram, next page, the pulsed oscillator (usually a magnetron) and local oscillator need only be stable enough to hold the mixed-down signal of the i-f within the region of flat i-f gain. The i-f amplifier must be linear because limiting would lose the doppler amplitude fluctuations. If large dynamic ranges in signal level are expected, a logarithmic i-f amplifier is needed. Usually, the i-f amplifier is a combination: a lin-log amplifier.

The detector following the i-f amplifier is conventional because the video signals resulting from the detection of targets in clutter are like that in any radar: the voltages are unipolar, varying at a slow rate determined by the clutter fluctuation and velocity of the moving target. The amplitude detector acts as a mixer—a nonlinear device. Assuming a dominant square-law nonlinearity, the output time function is the input squared.

The power density spectrum in the frequency domain of the detector output is made up of the dominant, or zero-frequency, term and cross-product terms. The amplitude of the first cross-product depends on both the clutter and target amplitudes. Thus, the power output, P_{out}, of the square-law detector depends on the square of the clutter and the cross-product of the target and clutter amplitudes. It is given by:

$$2C^2 + 2\,CT \cos \omega_d t$$

The output of the detector differs according to whether the target is seen in the presence of clutter, or is in a clutter-free region, top page 60. Superimposed on the detected output in these figures is the frequency response of an AMTI clutter-rejection filter.

In the presence of clutter, the detector produces the clutter product, C^2, and clutter-times-target product, C x T, centered in two bands about half the pulse repetition frequency (PRF/2). With the upper cutoff frequency of the AMTI filter at PRF/2, the C^2 clutter return is rejected strongly.

However, when clutter is absent, the filter rejects the clear target, which is at zero frequency. To prevent this, the clutter level is monitored and, when it falls below a minimum threshold, the AMTI video processor is automatically bypassed. Targets are sensed as if the radar were of a conventional design.

It's also necessary to prevent a strong target in the clear from actuating the threshold detector —that is, the target must be routed around the AMTI video processor. This is accomplished by designing the threshold detector so that it isn't actuated by level changes taking place in less than one pulse width of the radar.

Range-gate filtering

The range gate filter channels follow the i-f detector. There are many separate range gates or switches, each followed by identical doppler filter elements. Each gate opens at a time coinciding with a prescribed range, and closes a short time later. The result resembles that of a sampled data system with a bandpass filter removing the clutter between the input samples and the reconstructed output, bottom, next page.

The width of each gate, or channel, is usually

Definition of terms

C = clutter frequency spectrum
T = target frequency spectrum
ω_d = doppler target frequency in radians
$\omega_d = 2\pi f_d$
t = time
f_d = doppler target frequency

$$f_d = \frac{2v}{\lambda}$$

where v = velocity of doppler target
λ = wavelength of radar

$$\lambda = \frac{c}{f_t}$$

where c = speed of light
f_t = radar transmission frequency
$f_{i\text{-}f}$ = frequency difference between transmitter and local oscillator or radar system.

set to equal the pulse width of the radar. If the width is small and the range large, a large number of separate channels are needed to cover the entire pulse-repetition frequency of the radar.

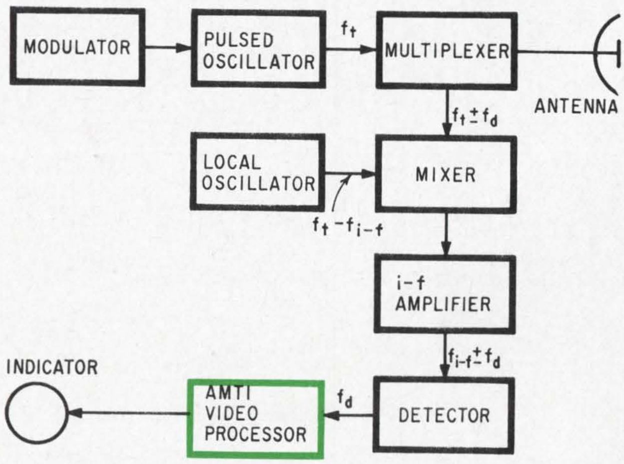
For example, an MTI radar with a pulse width of 1 microsecond and a range coverage of 40 nautical miles would need approximately 495 RGF channels. The number of channels is obtained from the formula:

$$\frac{\text{Range coverage (nautical miles)}}{\text{Pulse width (microseconds)} \times 0.081 \left(\dfrac{\text{nautical miles}}{\text{microsecond}}\right)}$$

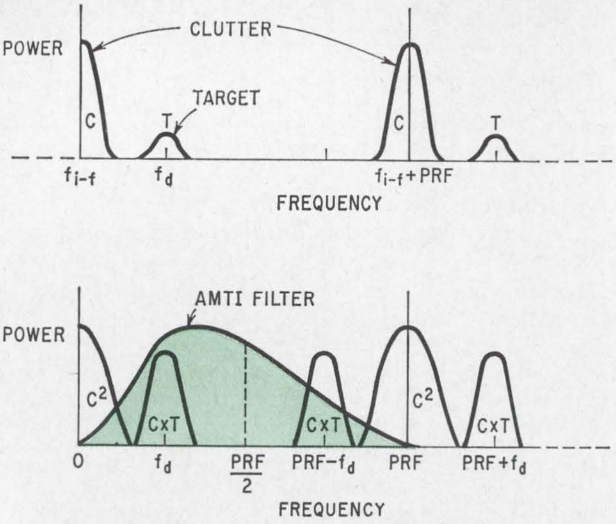
A channel may have as many as 300 components.

Each RFG channel, page 62, includes a ring counter stage which sequences the gating from channel to channel in synchronism with a clock. The counter triggers an input gate, actually part of a boxcar circuit that stores the amplitude of the sample pulse. Output of the boxcar then passes through an active clutter-rejection filter having both high-pass and low-pass sections. A net bandpass characteristic results.

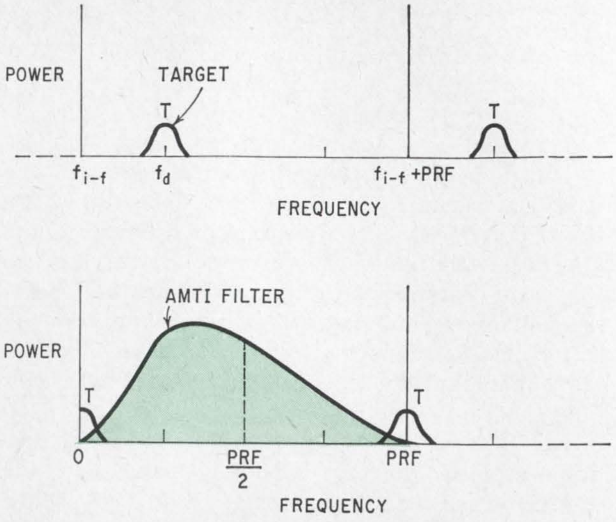
The steep high-pass slope rejects the low-fre-



Noncoherent AMTI. Video processor is added to noncoherent radar system so that it will distinguish moving targets amid clutter.



Target in clutter. Detector input, top, coming from the i-f in noncoherent radar, has target and clutter returns. Detector output has clutter and clutter times target products, bottom. AMTI filter, in color, removes clutter, retains target information.



Target in clear. In a clutter-free region, input to the detector from the i-f, top, contains only target data. AMTI filter, in color, would reject the clear target which, in the detector output, is at zero frequency and at the repetition frequency.

quency clutter components, while passing the higher doppler frequencies from the target. These are amplified and rectified so that the signal is shifted to zero frequency. Thus, regardless of the target doppler, after rectification all target signals can be integrated in a low-pass filter. This filter improves the signal-to-noise ratio by integrating the signal over the beamwidth of the radar system's antenna.

Next follows a gating circuit that adds the channel output to the video output line. The recombined synthetic video then contains only moving-target outputs.

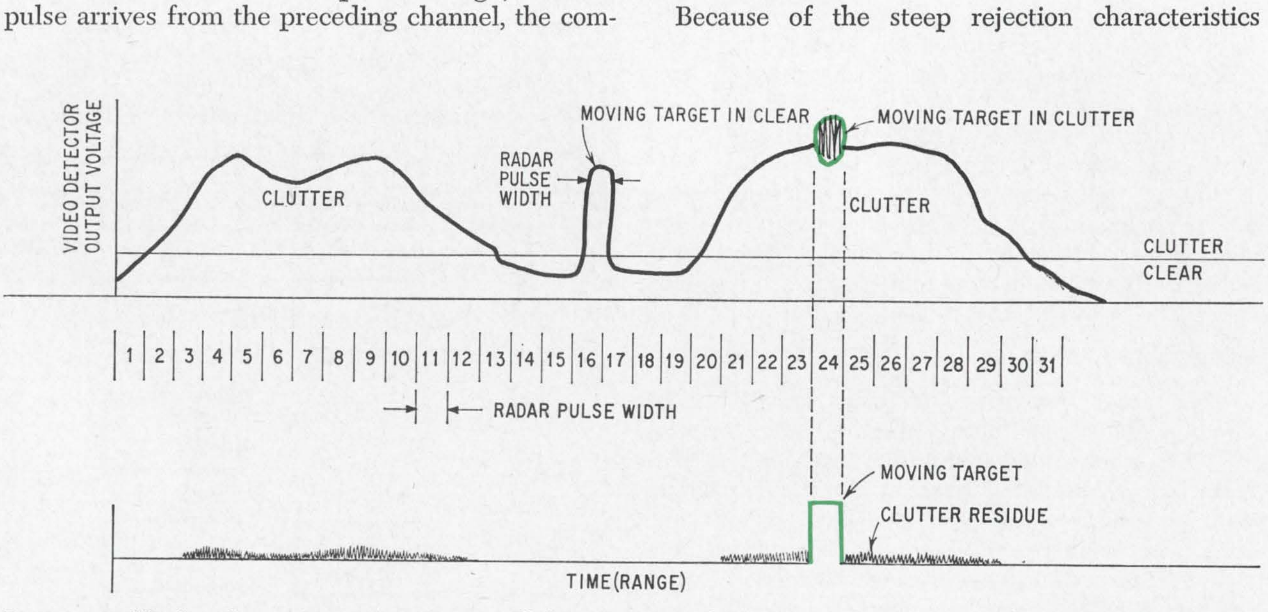
Along with the ring counter, a redundant bank commutator is used to prevent the loss of succeeding blocks of channels, in case a flip-flop in the counter should fail. In one specific design, when no pulse arrives from the preceding channel, the commutator divides the clock pulses by 20 and initiates the gating at successive blocks of 20 channels.

Boxcar

The sample-and-hold boxcar circuit quantizes the range (time) into small intervals and samples and holds the video waveform over the pulse repetition interval. It also attenuates high-frequency components and increases the attenuation of the clutter spectrum at the prf lines.

For a moving target in clutter, the amplitude variation of the pulses appears at the output of the boxcar circuit. For a stationary target, since the amplitude is constant, a d-c voltage appears at the output. The boxcar, therefore, emphasizes the modulation frequency and rejects the radar prf and its harmonics.

Because of the steep rejection characteristics



Range-gate filtering. Separate range gates or switches open at a time coinciding with a prescribed range. Filters following the gates pass the doppler return of the moving target, reject the clutter. Only the target appears at the output, bottom, of this 31-channel processor.

What's an AMTI?

Moving target indicator (MTI) radar systems discern moving targets in the presence of fixed targets whose unwanted radar returns may be many times stronger than those of the moving targets. Their operation is based on the fact that there's a doppler frequency shift when signals are reflected from moving targets. The doppler shift of the return signal is proportional to the velocity at which the target moves.

An airborne moving target indicator (AMTI) has more difficulty than a stationary MTI detecting moving targets because the radar itself is in motion. Its return signals are doppler-shifted, just as those of a moving target with the same relative velocity. But the relative velocity between the radar and target will usually differ from the relative velocity between the radar and clutter. The target may be distinguished from the clutter by this difference in their doppler frequencies.

Another difficulty encountered in both MTI and AMTI radars is that the scanning of the system's antenna modulates the clutter, causing a spectral spreading in the return. Spectral spreading of the clutter is minimal, in the case of an AMTI radar system, when the antenna points in the same direction as the aircraft velocity vector. As the antenna moves off this position, the spectral spreading increases. This reduces the ability of the AMTI radar to distinguish moving targets from fixed targets. Further spectral spreading of the clutter occurs in the processing of a finite pulse train and in instabilities of the radar itself (such as amplitudes and frequency instabilities, pulse and time jitter).

The three types of AMTI radar most frequently used today are the coherent, coherent-on-receive and noncoherent systems. Depending on the system, the frequency shift due to the moving target may be detected as a phase or amplitude fluctuation.

In coherent and coherent-on-receive systems, the principal concern is with the phase information of the doppler return. With phase differences in the return signal to be detected, it is important that very stable reference signals, such as the phase of the transmitter signal, be preserved in the radar. The coherent systems require, therefore, highly stable performance from usually bulky oscillator assemblies.

In the noncoherent AMTI system, amplitude information—not phase—is used to detect the doppler component produced by a moving target. Highly stable oscillators are not required. For this reason, this system offers a simpler approach. It's more attractive where space and weight are limited, such as in an aircraft. And relying as it does on amplitude detection of the doppler return, the noncoherent AMTI radar system is much like conventional radar.

With special attention to frequency, amplitude and time jitter, a conventional radar may be used as a noncoherent AMTI. The only requirement is to add to the conventional radar an AMTI video processor. This processor cancels out the clutter returns that are present in the detected video output of the radar. It acts as a doppler filter, emphasizing the moving or doppler targets, while removing the fixed targets.

prf staggering must be used to fill in the moving target speeds occurring around the prf. This insures that doppler targets near the radar's prf will be detected. However, the staggering must not generate frequencies in the filter passband.

The range, or video, gate switch, S, in the boxcar, bottom, page 64, must open for less than a few hundred nanoseconds and have rise times as low as 20 to 40 nanoseconds. Since the voltage to which capacitor C is charged during the aperture time must be held to within less than 1% droop while the radar is turned off, all current-leakage paths of the capacitor must be kept to a minimum. The impedance of these paths must be on the order of hundreds of megohms. This means that capacitor C must be of very high quality and the input impedance of the buffer amplifier along with the off impedance, R_{SR}, should be high over the temperature range of the equipment. The on-impedance R_{SF} of the gating switch should be small to achieve the rise times required. To conserve power, the range gate circuit driving switch S should have little or no standby current during the interpulse period.

A linear gate switch that has low on-impedance and high reverse off-impedance is the diode quad. Ideally, in any microminiaturization program, transformers and inductors should be replaced by resistors, capacitors and active devices. Theoretically, the diode quad could be driven by active devices. But in most cases thermal drift problems arise, resulting in large standby currents.

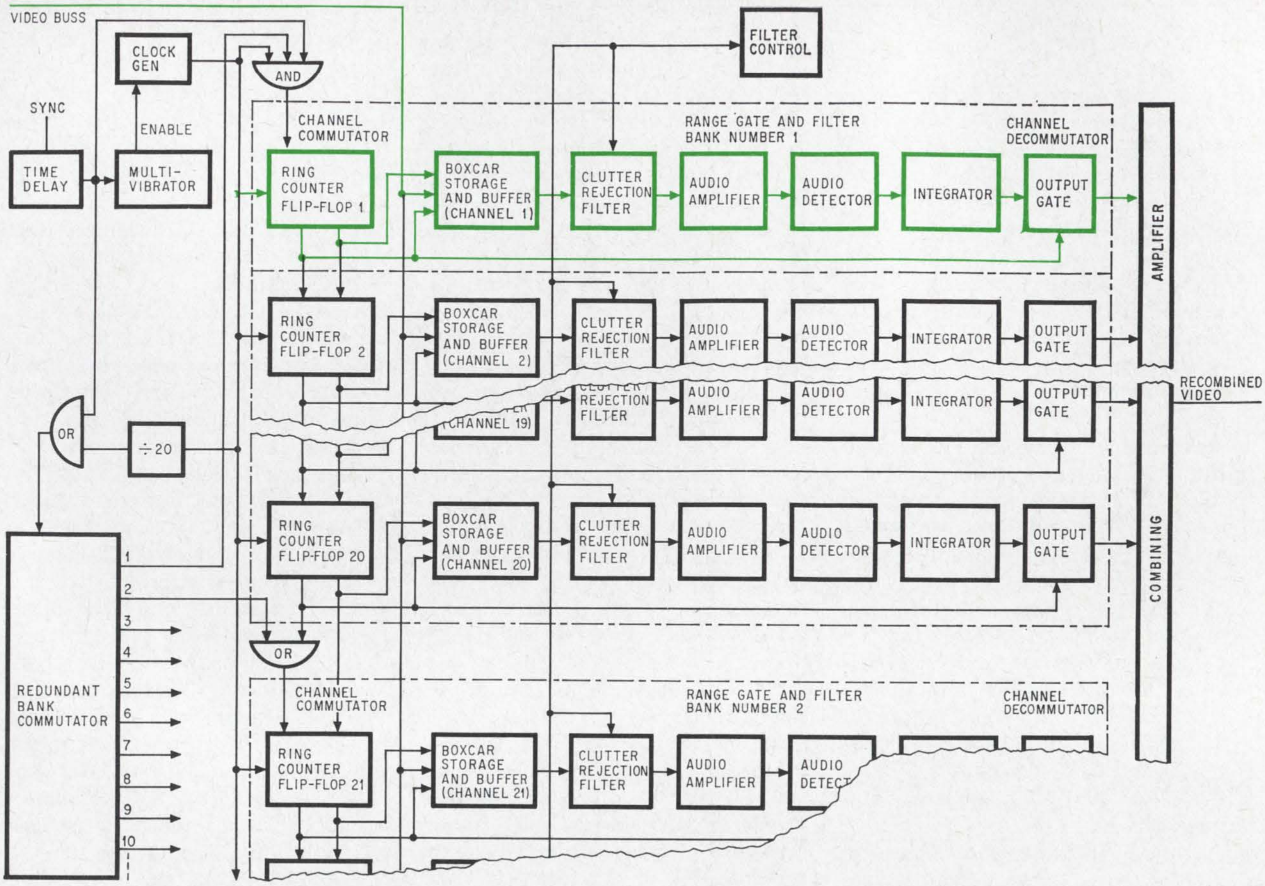
Thus it is more feasible to drive the video gate switch with a transformer. Miniature pulse transformers are available that will support the short pulse-aperture time. A transformer confines the switching currents to an isolated control path and the standby power is zero.

In this area of the RGF channel, the IC designer has yet to produce a device that meets all the requirements of a sample-and-hold circuit. To date, there is no IC that does so and, at the same time, can be easily produced in large quantities.

The diode quads were first made from purchased diode chips. No attempt was made to match them and leakage currents presented a problem as temperature varied. Matched diode quads will be bought in the future from an outside supplier.

Clutter-rejection filter

The clutter-rejection filter (CRF) is a bandpass filter whose bandwidth spreads between the low-frequency clutter spectrum and half of the radar pulse-repetition frequency. For AMTI radars, the PRF is usually within the audio frequency range, so that the filter may be built from either lumped-



Range gates and filters. Video processor for AMTI contains banks of separate filtering channels that are gated open by the ring counter at times corresponding to precise range intervals.

constant elements or linear IC's.

At audio frequencies, an active resistor-capacitor bandpass filter can be easily designed by cascading high-pass and low-pass filter sections. Break frequencies can be readily selected and slopes can be increased by adding filter sections.

Adjusting the lower break frequency of the clutter-rejection filter compensates for the widening of the clutter spectrum as the antenna scans across the aircraft's ground track.

The CRF can be built from silicon monolithic IC's, thin-film hybrids, discrete components, or a combination of all three approaches. A monolithic approach is perhaps the most desirable because it takes up the least amount of room and should be cheapest. However, silicon IC resistors do not yet have close enough tolerances to maintain filter cutoff frequencies within $\pm 10\%$, which was required.

Four different kinds of elements were used in the CRF. Arrays of four transistors on a single silicon chip were built in-house. Three-by-three arrays of transistors were purchased. Pico components were used because the capacitances were so large that, fabricated from thin films, they'd take up too much room. Thin films were used for the resistors.

Low-pass and high-pass sections used in the clutter-rejection filter are on page 65. The break frequency of the high-pass section can be varied most easily by adjusting R_1 and R_2. This is done best with a continuously variable resistor that is insensitive to temperature.

A field effect transistor was considered for the voltage-variable resistor. It was rejected because cutoff frequency was critical and operating temperature would not be held constant. Unfortunately, the field effect transistor did not have stable enough resistance characteristics.

Precise thin film resistors were switched in, since the break frequencies must be varied. The high-pass filter is easily adapted to such switching. So is the low-pass filter, but its characteristics are varied only if the prf of the radar must be changed.

Amplifier and detector

The output of the clutter-rejection filter is applied to an audio amplifier that brings the low-level doppler signals up to the required level for linear detection. The detector converts the bipolar doppler signal to a unipolar signal. The amplifier was built from linear silicon IC's and thin-film circuits. Operational amplifiers in silicon monolithic form are particularly desirable because of the need for zero offset with no input to the channel.

The detector was built from diode chips and thin-film resistors.

Integrator and output gate

The output of the detector was applied to the integrator, which may be a simple RC filter or the same type of low-pass filter used in the clutter-rejection filter. Just as in the clutter-rejection low-pass filter, the integrator may be constructed using silicon IC's, thin-film techniques or discrete components, or a combination of the three.

The output gate reconstitutes the video signal. It has turn-on and turn-off times of the order of 10 to 20 nanoseconds. In the off state it has 40 to 50 decibels of isolation.

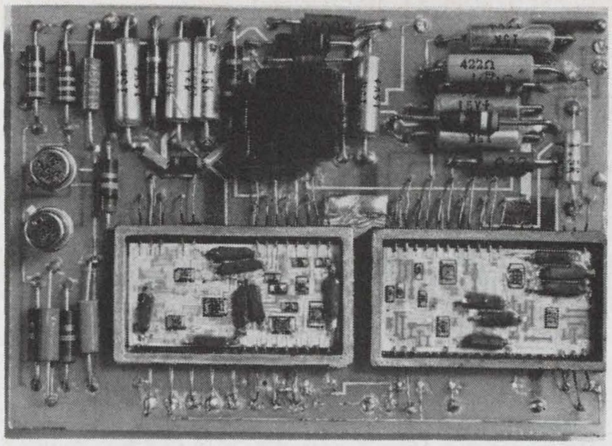
Diode and transistor chips were bought and attached to thin-film resistor elements to make up the output gates. However, off-the-shelf silicon IC's could also be used. They are more economical than custom-built IC's, particularly if quantities are small. In a custom-built unit, the gate would take up only part of the chip. Other sections of the RGF channel would be included on the chip as well.

Logic

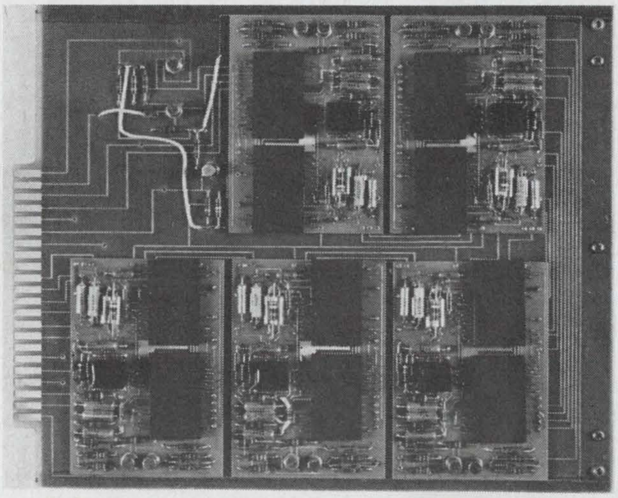
The ring counter, which sequences the gating from channel to channel, was selected from the J-K flip-flops available from many manufacturers. High speed and noise immunity, coupled with low power dissipation, were the major considerations when the choice was made.

Texas Instruments' SN5470 J-K flip-flop, as well as an SN5400—a quad two-input gate—were used. These are transistor-transistor logic elements. Sylvania's SUHL I and II logic could be used too.

Each flip-flop was slaved to a master clock having



Super flatpacks. Each RGF channel fits on a 3 x 5 inch circuit board with most elements housed in flatpacks.



Mother board. Five RGF channels fit on a single 5 x 7-inch printed-circuit board.

Components used in an RGF channel

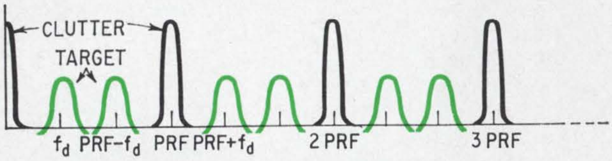
	Discrete[1]					Thin-Films		Pico	Silicon IC's		Transistors			Diodes
	R	C	L	Transistor	Diode	R	C	C	Digital	Analog	Silicon bipolar	Junction FET	MOS-FET	Silicon
Boxcar	3	1	1 transformer	—	1	6	—	2	—	—	2	—	1	4
Clutter rejection filter	4	3	—	2	—	56	—	11	4 (2x2) transistor array	2 (3x3) transistor array	—	—	—	—
Amplifier and detector	1	3	—	—	—	7	—	—	—	1	—	—	—	2
Integrator and output gate	—	1	—	—	—	3	—	—	—	—	1	—	—	1
Logic (ring counter)	—	—	—	—	—	—	—	—	2	—	—	—	—	—
Totals	**8**	**8**	**1**	**2**	**1**	**72**	—	**13**	**6**	**3**	**3**	—	**1**	**7**

Component count does not include power supply decoupling elements (6 resistors, 6 capacitors)

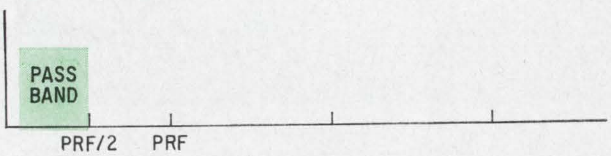
Grand Total: 125 components

[1] External to super flatpacks

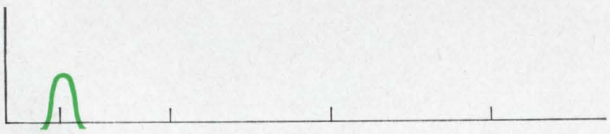
Doppler filtering



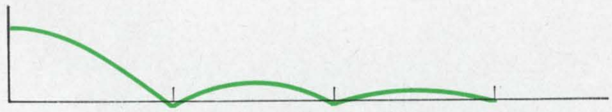
Frequency spectrum of detected video fed into the range-gate-filter channel has the doppler target return mixed in with the clutter.



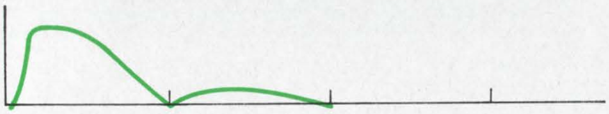
Ideal clutter-rejection filter has infinitely sloped skirts with lower frequency cutoff set to reject clutter around zero frequency, upper cutoff frequency set at PRF/2.



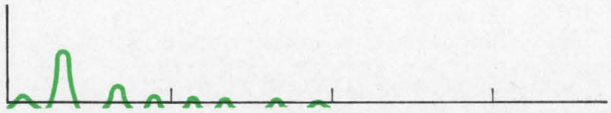
Idealized spectrum, after filtering, would contain target information only.



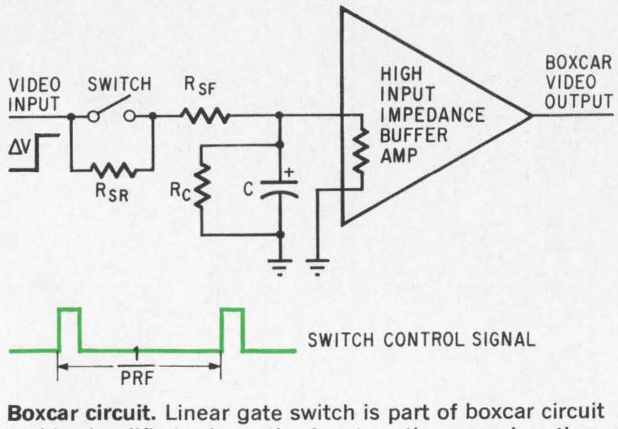
Boxcar filter characteristic has nulls at the PRF lines.



Actual filter characteristic combines responses of boxcar and clutter-rejection filter, which has finite high-pass and low-pass slopes.



Output spectrum of the filter channel has an unattenuated doppler target return which appears with a clutter residue due to the nonideal filtering.



Boxcar circuit. Linear gate switch is part of boxcar circuit in this simplified schematic. Aperture times are less than a few hundred nanoseconds.

a frequency of 10 megahertz or higher. Good noise immunity is an obvious requirement to prevent noise triggers from propagating down through the counter. Low power dissipation is particularly important because of the many separate channels that make up the complete system.

Building the system

A hybrid approach, selecting the best components from silicon IC and thin-film technologies (see table), was used to build the range gate and filter channels. Most of each channel is packaged in two king-size steel packages called "super flatpacks." Each flatpack measures 1.14 x .665 x .145 inches high. This size was selected in part because it would easily hold the ½ x 1-inch alumina substrates on which the thin-film components are placed. Silicon IC chips and discrete components are also placed in the super flatpacks.

Nineteen leads feed out of each long side of the superpack, which is placed on a small 2 x 3 inch daughter board, top, page 63. Five of the small boards, in turn, fit onto a larger 5 x 7-inch mother board, the basic plug-in module of the radar, shown just above the table on page 63.

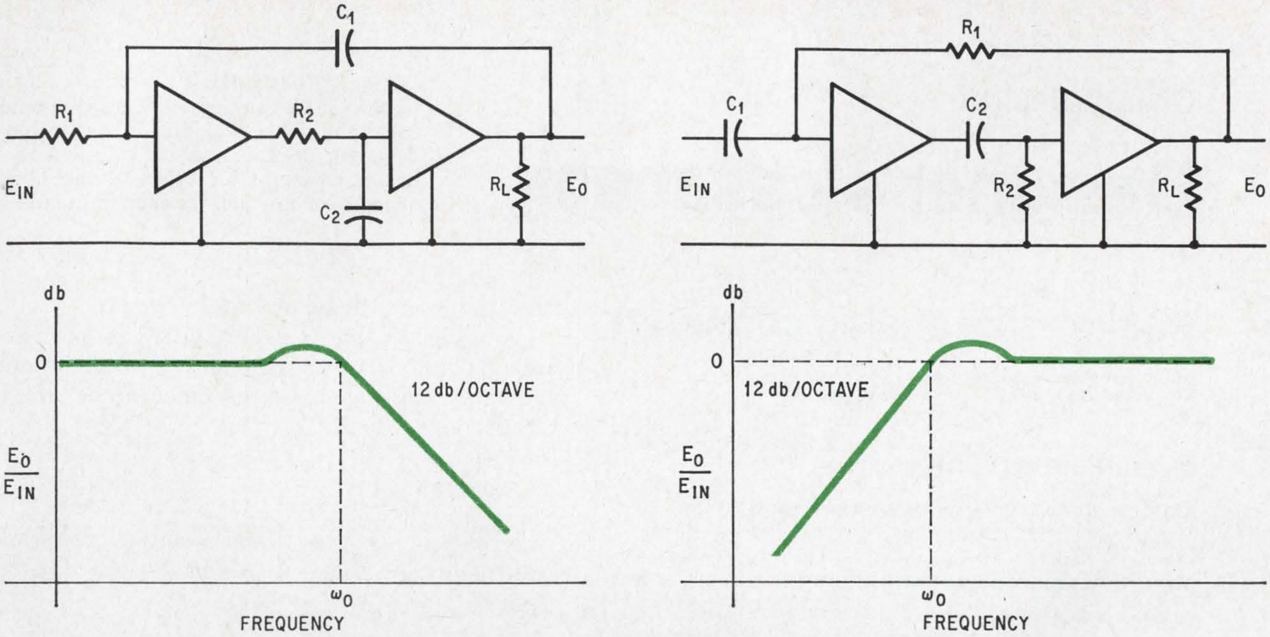
Of the two packs making up an RGF channel, one contains the logic circuitry, the boxcar circuit and three of the seven sections of the clutter-rejection filter. The other contains three more sections of the filter, the audio detector and amplifier, integrator and output gate. A seventh (low-pass) section is on the printed circuit board. D-c coupled low-pass filter sections do not feed each other to avoid adding up the offsets. Power supply voltages are ±6 volts.

Not placed in the super flatpacks is the large precision resistor which sets the gain of the channel, the transformer that is part of the boxcar circuit, and one low-pass section of the CRF filter. Large frequency compensation capacitors—22,000 and 68,000 picofarads—required in the amplifier detector are also not included. Neither are the decoupling components for the power supply. These elements are all placed on the printed circuit boards.

Each component used in the design was chosen because it has the most favorable characteristics. Thin-film resistors were used when low-temperature coefficients and close tolerance control were needed.

Two materials were used: nichrome, with resistivity of 200 ohms per square and 5,000 ohms-per-square cermet. The size of the flatpack limited the practical range of resistances that could be used: from 20 to 10,000 ohms for the nichrome, and from 4,000 to 200,000 ohms for the cermet. Larger values of resistance could be used but there would then be room for fewer components in the flatpack.

Thin-film capacitors would have created a problem because they take up too much room. Also their yield would have been too low. Discrete pico capacitors were used instead. These devices also have the advantage that thin-film resistors and interconnection runs can be put beneath them. The



Filter sections. Low-pass, left, and high-pass, right, filter sections which may be used in the clutter-rejection filter. Characteristics of the CRF are adjusted by varying the number of sections.

only space they require is for their lead bonds.

Silicon IC's provided the high packaging density for most of the active devices. Commercially available units were used except in one instance in the clutter-rejection filter.

Assembling the channels

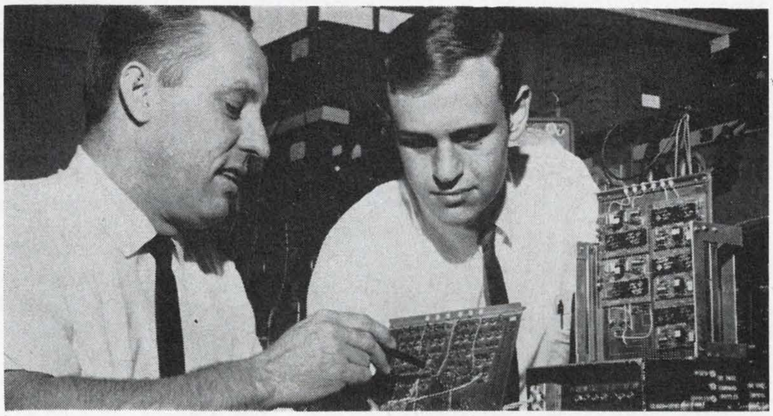
Standard assembly techniques were used to fabricate the range gate and filter channels—the active devices die-attached in place, the interconnection wires from the chips to the substrate thermocompression bonded. Each substrate in a super flatpack has more than 75 interconnections.

However, in selecting the components and laying them out, efforts were made to minimize both the number of chips that had to be die-attached and the number of electrical connections. Using the silicon IC's for the logic and amplifying functions did both of these things. But with separate silicon chips, the clutter-rejection filter would have required too many die-attachments and interconnections; specially designed transistor arrays had to be used instead.

The filter uses 12 individual amplifying and 16 individual bandwidth control transistors requiring 28 die-attachments in all if discrete elements are used. Because the 12 amplifying transistors all have common collectors, it was simple to fabricate them in two 3 x 3 arrays, reducing the number of die attachments from 12 to 2.

Unfortunately, the 16 bandwidth control transistors did not have a common node. They were intergrated in four separate chips. Over-all, then, General Electric's in-house silicon IC capability was able to reduce the die attachments for the complete active filter from 28 to 6, saving not only a lot of space but assembly time as well.

But the in-house silicon IC capability was only one part of the total design approach: choosing the best of the available IC techniques to produce a reliable, high-performance radar system. With further advances in linear and digital silicon IC's, and the use of beam leads, the RGF video processor approach in an AMTI will be even more attractive.



The authors

After six years of circuit design in GE's Aerospace Electronics departments electronic countermeasures group, Robert J. Berg, left, switched a few years ago to radar engineering. There he designs and develops microminiaturized range-gate and filter video processors for ground-based and airborne radars. As a project engineer in his department's microelectronics development program, Paul N. Marshall develops thin-film hybrid and silicon integrated circuits for both analog and digital applications.

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.

Pocket-size analog computer divides and multiplies

By Benjamin Shore
Airborne Instruments Laboratory, Deer Park, N.Y.

Now that operational amplifiers have been reduced to the size of a TO-5 can, analog signals can be accurately multiplied or divided in pocket-size circuits. The two input signals are combined by field-effect transistors operated as voltage-variable resistors for either multiplication or division.

The 0.1% accuracy of the circuits makes them attractive as desk-top computers for solving differential equations with variable coefficients, for generating functions, or for breadboard simulation of systems that can be reduced to an electronic analog. The circuits are much faster than multipliers that require bulky servoamplifiers and are more flexible than analog desk-top computers that could not multiply.

Input signals X and Y must be restricted to voltages below the pinchoff voltage of Q_1 and Q_2 —0.75 volt in the case of the MEM511A's—so the FET's will operate as voltage-variable resistors. It is assumed that the two transistors are matched in the region below pinchoff, but it is not necessary for the two transistors to be linear.

Amplifier A_1 has a gain of 1,000 and drives summing point S_1 to zero potential. With junction S_1 at zero, the currents into junction S_1 are equal. Thus,

$$\frac{-V_{ref}}{R_1} = \frac{X}{R_{ds_1}} \qquad (1)$$

where R_{ds1} is the drain-to-source resistance of transistor Q_1. But $-V_{ref}$ and R_1 are constant so that

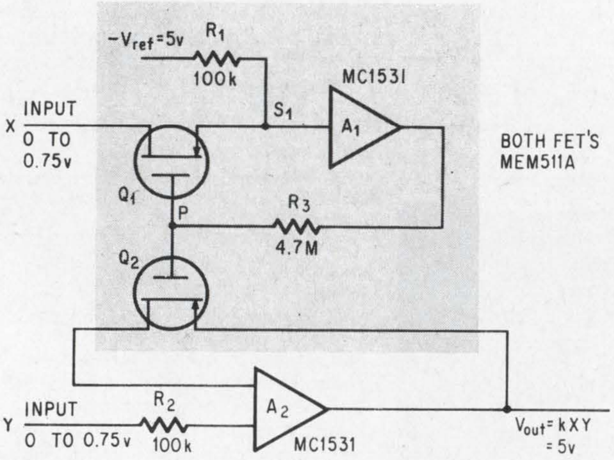
$$\frac{-V_{ref}}{R_1} = \frac{X}{R_{ds_1}} = \frac{1}{C_1} \qquad (2)$$

where C_1 is a constant. Solving for the drain-to-source resistance, R_{ds1}, yields

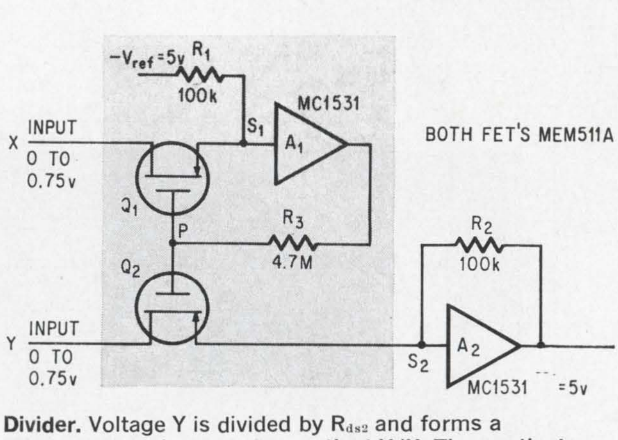
$$R_{ds_1} = C_1 X \qquad (3)$$

Thus, the drain-to-source resistance of Q_1, R_{ds1} is proportional to the input voltage X.

Resistance R_{ds1} is not directly determined by input X. The drain-to-source resistance of a FET is established only by the voltage on its gate when the FET is operated in the region below its pinchoff voltage. Consequently, it is operational amplifier A_1 that makes R_{ds1} proportional to input X. For example, as X increases, the output current for A_1 decreases, making the voltage at point P more positive. As point P goes more positive, the gates of Q_1 and Q_2 also go more positive; this causes an increase in the resistances R_{ds_1} and R_{ds_2} of the n-channel FET's. The increase in R_{ds_1} compensates for the boost in voltage at input X and maintains a constant current from Q_1 into S_1 that exactly off-



Multiplier. Current proportional to the voltage Y flows through the drain-to-source resistance, R_{ds2}. Resistance R_{ds2} is proportional to the voltage X. Thus, an output voltage, kXY is produced.



Divider. Voltage Y is divided by R_{ds2} and forms a current proportional to the quotient Y/X. The quotient is multiplied by feedback resistor R_2 and produces output voltage kY/X.

sets the constant reference current, $-V_{ref}/R_1$, leaving S_1 at zero volts. Since transistors Q_1 and Q_2 are matched below pinchoff,

$$R_{ds_1} = R_{ds_2} = R_{ds} \qquad (4)$$

Thus, a resistance proportional to the input voltage X is introduced to the feedback loop of operational amplifier A_2 by Q_2. The output voltage of A_2 may be given by

$$V_{out} = \frac{Y}{R_2}(R_{ds}) \qquad (5)$$

Inserting equation 4 in equation 5 yields,

$$V_{out} = \frac{(R_{ds})}{R_2} = \frac{Y}{R_2}(C_1X)$$

$$= \frac{C_1}{R_2}(XY) = kXY \qquad (6)$$

and multiplication of voltage X and Y is accomplished.

Division is handled in a similar manner. The output voltage of the division circuit is

$$V_{out} = \frac{Y}{R_{ds}}(R_2) \qquad (7)$$

If equation 4 is inserted in 7, the output voltage becomes

$$V_{out} = \frac{Y}{R_{ds}}(R_2) = \frac{YR_2}{C_1X}$$

$$= \left(\frac{R_2}{C_1}\right)\left(\frac{Y}{X}\right) = k\left(\frac{Y}{X}\right) \qquad (8)$$

so that a quotient of input voltages X and Y is produced.

Operational amplifier overcomes voltmeter loading

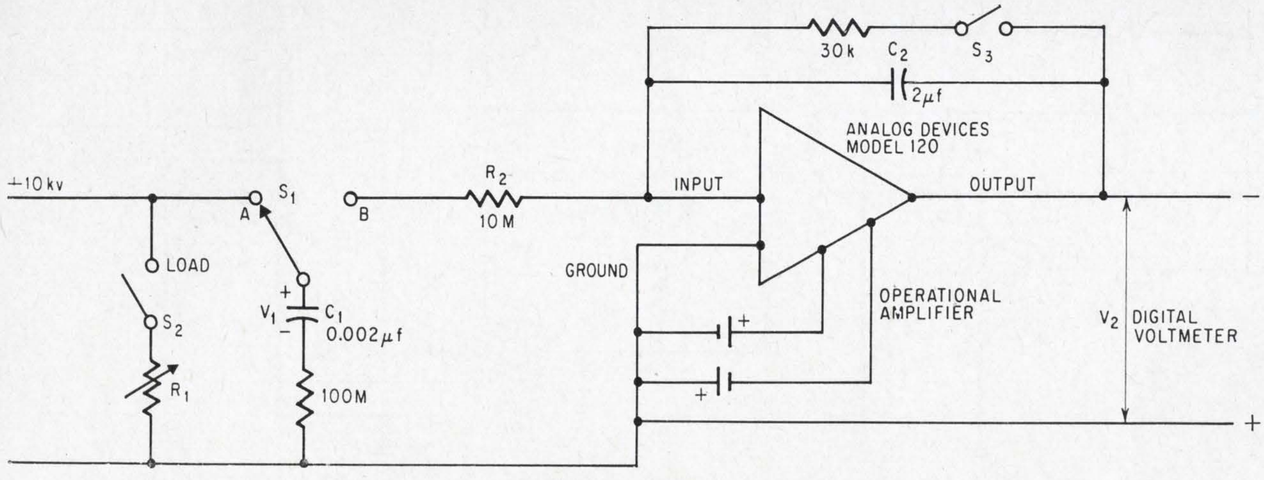
By T.P. Kohler and E.H. Hudspeth

General Electric Co., Syracuse, N.Y.

Current drawn by an electrostatic voltmeter in high voltage tests lowers the measured voltage and consequently limits the accuracy of the measurement. The 2% accuracy of a conventional electrostatic voltmeter causes a significant 200-volt error in a 1-kilovolt measurement. A charge transfer circuit that precisely divides the high voltage and protects the divided voltage from current drain during test keeps measurement error within 0.5%.

The voltage division is accomplished by transferring the charge on a small, high-voltage capacitor to a large, low-voltage capacitor. The large capacitor is the feedback capacitor of an operational amplifier. Any current drawn by the voltmeter during test is replaced on the capacitor by the amplifier.

The voltage to be measured, V_1, charges capacitor C_1 when the switch S_1, is moved to position A. Corona losses are avoided with rounded contacts on both the swinger and position A. By using a glass, oil-filled capacitor for C_1, the error intro-



Voltage conversion. The 1,000-to-1 division of the high voltage, when the charge on C_1 is transferred to C_2, allows the digital voltmeter to measure at 0.05% accuracy. The insignificant current drawn by the digital voltmeter is replaced on the capacitor by the operational amplifier.

duced by dielectric losses is eliminated.

To measure the voltage under load conditions switch S_2 is moved to the load position. The value of R_1 is determined by a calculation when the desired load current is known.

When S_1 is moved to position B, the charge on C_1 is completely discharged into the input of the operational amplifier. The resistor R_2, is placed in series with amplifier to slow the current flow and insure response of the amplifier. The output current of the operational amplifier—equal to the input current—accumulates on C_2 and charges it to a voltage, V_2, that is related to V_1 by

$$V_1 = V_2 \frac{C_2}{C_1}$$

The voltage, V_2, is measured by a digital voltmeter. Since the discharge of C_2 during the measurement is replenished by the operational amplifier, V_2 remains permanently accurate. The voltage V_2 is removed from the capacitor by closing switch S_3, thus allowing the engineer to make further measurements.

Since the C_2/C_1 ratio is involved in the calculation of V_1, it is precisely determined by placing a standard voltage on C_1 and measuring the voltage on C_2 after current transfer.

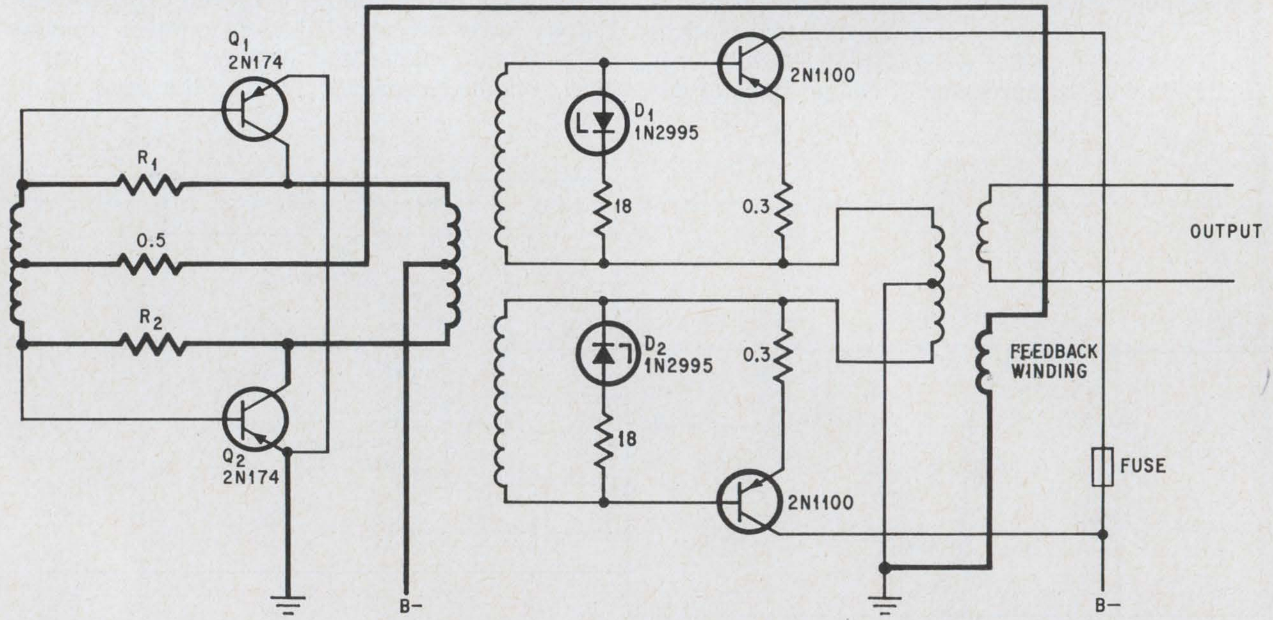
Feedback protects amplifier during load failures

By George S. Lehsten

Alpine Geophysical Associates, Inc.
Norwood, N.J.

Inductive feedback added to an audio amplifier prevents breakdown and thermal runaway from occurring in the output power transistors during extreme load changes. By limiting the operation of the amplifier's driver stage when shorts and opens appear on the output, the feedback loop keeps drive current from reaching the base of the power transistors. The power transistors are back-biased when no drive signal is present. Thus, the destructive collector current that accompanies a short or high voltage is prevented from flowing.

A short in the output is reflected by the feedback winding into the driver input where it lowers the bias of the driver transistors, Q_1 and Q_2. Instead of operating class A—the desired bias condition at full power output—the driver transistors now operate class B, permitting only half of the input signal to be amplified. Resistors R_1 and R_2, selected with a nominal 200-ohm load on the output, must have values that place the negative peak of the



Breakdown protection. Feedback circuit, indicated by heavy line, reflects high impedances and shorts into the emitter-base circuit of the driver stage. Signal level and biasing in the driver stage are now affected by load charges.

input signal close to cutoff. Response of the circuit to output shorts is therefore quick, since the distance the bias point moves to cutoff is relatively small.

An open circuit, usually sudden, causes a voltage many times greater than the supply to appear at the collector of the power transistors. This open is reflected into the driver-base circuit as a high impedance that reduces the input signal to zero. Since a-c amplification is not taking place in the driver stage, no drive signal is delivered to the base of the power transistors. Consequently, the base of transistors Q_1 and Q_2 remains at ground potential and the transistors are prevented from conducting heavily during the inductive kick.

The zener diodes, D_1 and D_2, are placed in the base circuit of the power stage to prevent emitter-to-base breakdown when high input signals occur.

Varying capacitor charge-up controls multivibrator's range

By Lt. D.H. Reese, Jr.
11th Coast Guard District Office, Long Beach, Calif.

An astable multivibrator's frequency can be varied over a wide range by controlling the charging current through its cross-coupling capacitors. The oscillator is designed as a source of frequency-modulated pulses and maintains good modulation linearity even though the f-m control signal deviates as much as 20% from its carrier frequency. If the control circuitry is modified slightly, the multivibrator's pulse rate can be linearly varied from a point near shutoff to its maximum frequency by adjusting a d-c control voltage.

Constant current transistors Q_3 and Q_3' control the frequency of multivibrator Q_1-Q_2 by determining the size of the charging current through cross-coupling capacitors C_1 and C_2; an increase in charging current speeds up the charging of C_1 and C_2, raising the output frequency. The charging current, I_c, through current sources Q_3 and Q_3', is controlled by transistor Q_4 which functions as a voltage variable resistor in the emitter branches of Q_3 and Q_3'. Transistor Q_4 responds to changes in its base current I_{b4} produced by the modulating signal, e_{mod}. Thus, the expression for charging current I_c may be written as:

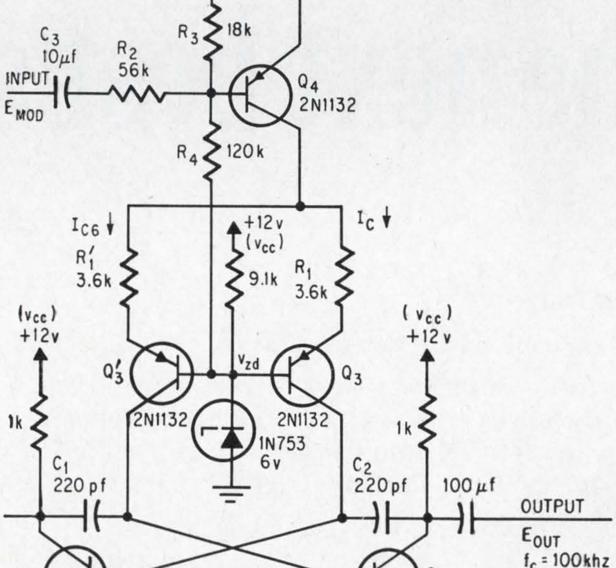
$$I_c = I_{max} - \alpha_3 (h_{fe_4} \cdot i_{b4}),$$

$$\text{where } I_{max} = V_{cc} - (V_{zd} + V_{be_3})/R_1$$

An output carrier frequency of 100 kilohertz with a maximum linear swing of ± 20 khz is obtained with the component values shown. Greater frequency deviations produce some loss of linearity. The circuit also performed equally well when sine, sawtooth or squarewave modulation were applied to the base of Q_4. In all cases, the output waveform showed very little degradation from the modulating waveform when detected by an extremely linear digital discriminator.

Large changes in carrier frequency can be achieved by changing the value of C_1 and C_2, and small changes can be attained by varying the values of resistors R_1 and R_1', or by adjusting voltage divider R_3-R_4.

The control circuit can be modified to permit d-c control of the multivibrator's frequency over virtually its entire operating range; this may be done by replacing capacitor C_3 with a short circuit and choosing resistors R_2, R_3 and R_4 so that Q_4 is off when e_{mod} equals zero volts. In addition, the circuit may be adapted to perform pulse-width modulation by controlling the charging current to only one of the cross-coupling capacitors, C_1 or C_2.



Oscillator. Modulation signal e_{mod} determines the current level through current sources Q_3 and Q_3'.

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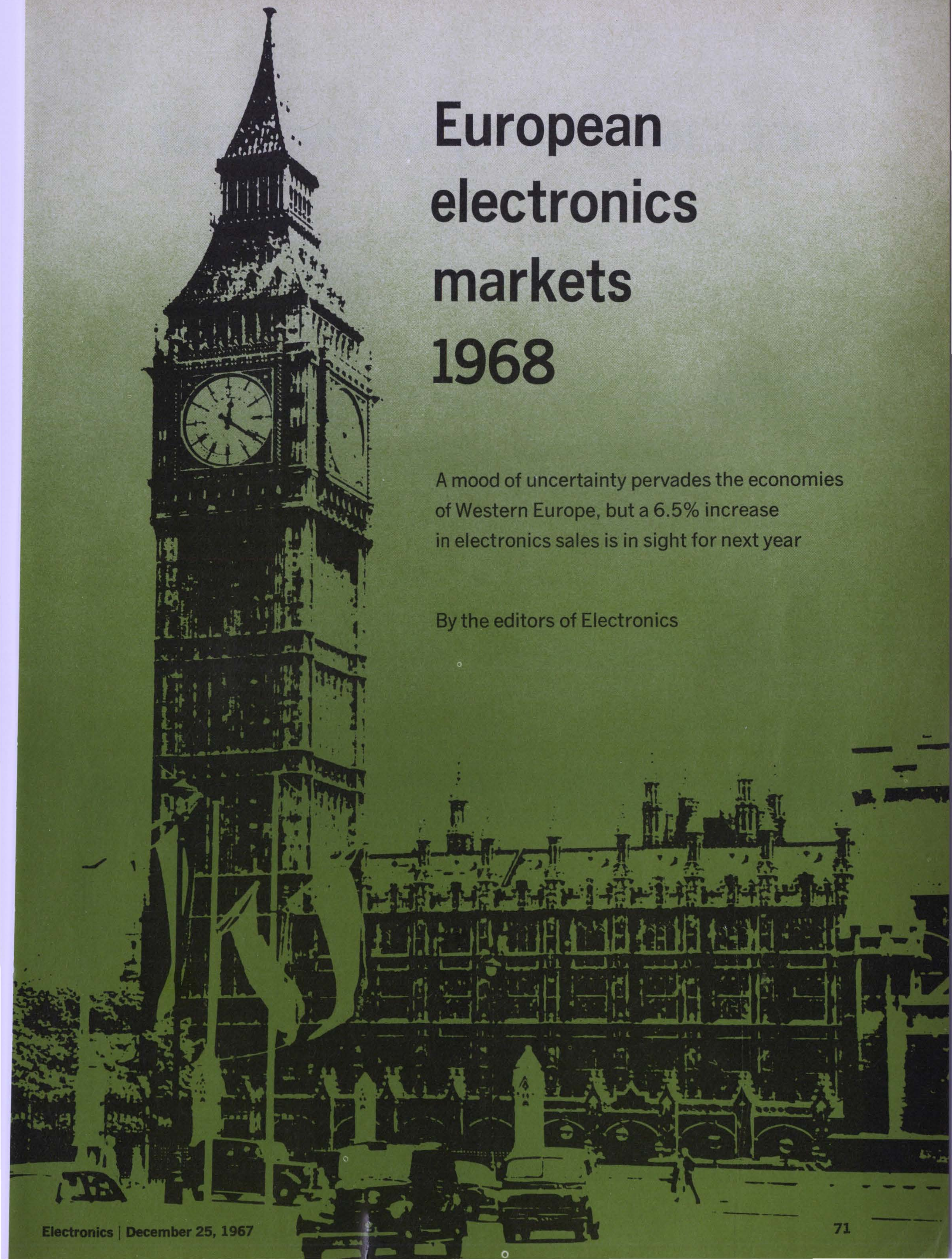
European electronics markets 1968

A mood of uncertainty pervades the economies of Western Europe, but a 6.5% increase in electronics sales is in sight for next year

By the editors of Electronics



Forecast: cloudy but warmer

Questions raised by Britain's devaluation and Germany's incipient economic upturn make prospects hazy, but electronics appears in for a year of solid growth despite sluggish consumer sales

Western Europe goes into 1968 doubly at sixes and sevens. Britain faces a long bout of deflation and doubt as a result of November's devaluation. And as Britain goes, so go—to some extent—the economies of all seven members of the European Free Trade Association.

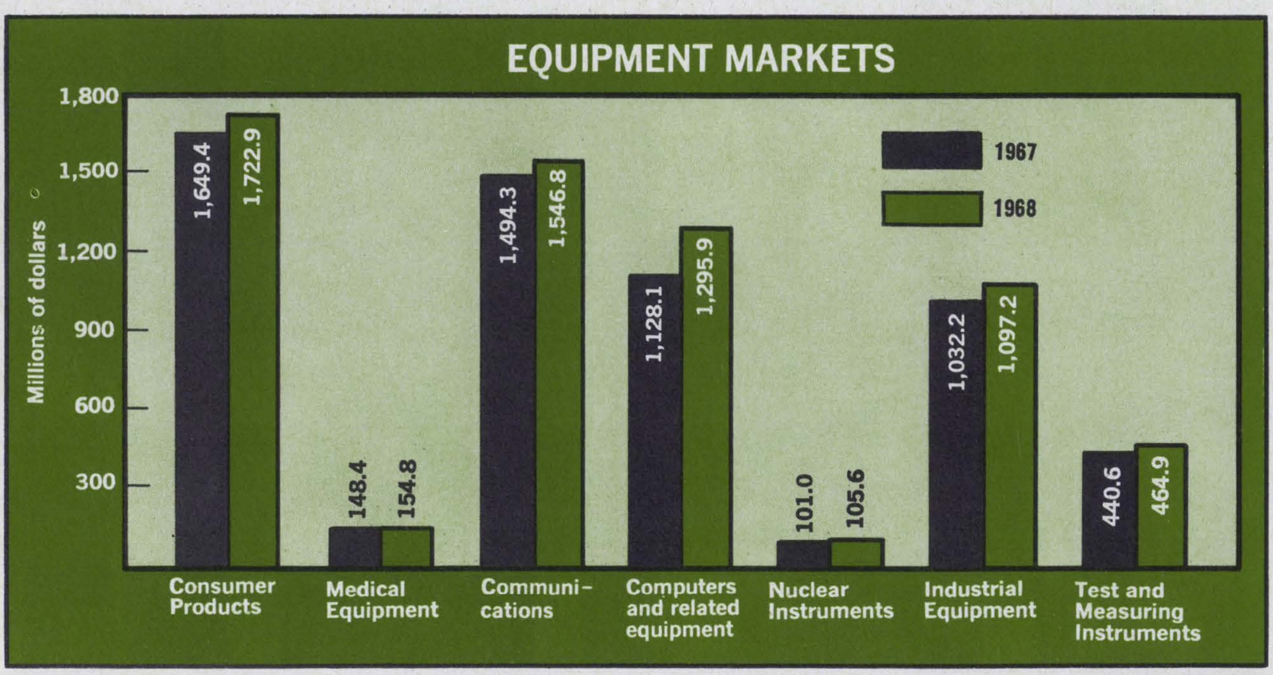
In the six-nation Common Market, by contrast, there's guarded optimism about the key economy, West Germany's, after a year a recession. Business in Germany seems headed up and the rise there inevitably will bolster neighboring Belgium, Luxembourg, and Holland. The French and Italian economies kept climbing even while Germany's languished and they should advance again in 1968.

No one yet knows whether—much less when—the strong measures taken by Britain can cure her ailing economy. And it may be late next year before the West German economy settles into a sure uptrend. Such are the uncertainties that make market forecasting for 1968 unusually chancy.

That understood, Electronics magazine projects an over-all electronics equipment market of $6.4 billion next year in the 11 countries surveyed in detail, up about 6.5% from this year's estimated $6 billion.

For all the economic uncertainties, the forecasts seem a sure guide to the sectors least likely to succeed. Despite the coming of color in Britain, France, and West Germany, there is little luster in the outlook for consumer electronics. That hurts, because radios and television sets are a mainstay of the market. Nor can makers of communications equipment count on much growth. Producers of industrial electronics, too, won't do as well in 1968 as they did in the years just before the slowdown.

A year ago, television-set makers figured the coming of color would touch off a spurt in their sales in 1968. Now most don't see the big lift coming until the early 1970's. Meanwhile, sales of black-and-white sets continue to dwindle. Largely because of this drop in the monochrome market, the forecast



is for a middling rise of 4.5%—to $1.7 billion—in consumer electronics sales. Color-tv sets will account for only $180 million of this total with most of the sales coming in Britain and Germany.

By and large, businessmen have been leery of committing themselves to heavy new plant investments during the slowdown. The industrial electronics equipment market, as a result, won't advance at the pace it held in the early 1960's. The forecast: $1.1 billion in 1968, a gain very near 6% from this year's sales. The big customers for communications gear are governments and most are holding the line on spending. Thus there'll be only slight growth in the communications sector, with sales edging up next year slightly less than 4% from this year to around $1.5 billion.

But there seems to be no checking the fast-growing computer industry. Its sales in the 11 countries surveyed will surge next year as before. The forecast: a $1.3 billion year, a solid 15% rise from 1967's estimated business.

West Germany remains first among West European consumers of electronics hardware. The country's consumption in 1968 should edge just above the $1.7 billion level, according to Electronics magazine's survey. France holds the number two spot with a projected market of $1.3 billion. Credit France's position largely to the hardware that President de Gaulle needs to back up his policy of technological independence.

Actually, Britain would be on a par with France as a market had the pound sterling not been devalued in November. At the new rate of exchange—$2.40 to the pound—the 1968 British market is put at $1.15 billion. All the figures for the United Kingdom, Denmark, and Spain have been revised downward to reflect these countries' new exchange rates, but no further changes have been made to reflect the further impact devaluation may have.

As for components, sales next year should expand at the rate of the equipment market—6.5%—to $2.6 billion in the 11 countries. The figure includes all the hardware that goes into equipment built for domestic markets and for exports as well.

Here again, West Germany is the leader. Its industry will go through $689 million worth of components next year, according to the forecast. But because British electronics producers export heavily, they'll best the French in components consumption.

Prospects for the various categories of components—with two exceptions—are for steady growth. Sales of integrated circuits, though, will soar to $48.6 million, nearly twice the estimated figure for 1967. And the market for receiving tubes will continue its slow decline.

Guide to European electronics markets

Signs of German economic resurgence point to industrial electronics spurt

Anxiety is on the wane in the West German business community.

After a rough year of recession, there are signs that the economy is picking up. Consumer spending has taken an upturn—albeit slight. At the same time, unemployment has started to ease (during the long postwar "economic miracle," West German economists almost forgot what the word meant). And convinced that the economy will be on the rebound next year, businessmen are putting more money into new plant equipment.

Pundits in Bonn expect to see the convalescent economy restored to reasonably good health during the second half next year. They say the country's output of goods and services should be expanding at a respectable rate of 3% or more yearly by the end of 1968. Growth like that would have rated as pretty poor during the boom years of the early 1960's, but coming after a year of stagnation, it's being heralded as the beginning of a new wave of expansion.

All this points to a turn for the better for the West German electronics industry. Like just about every kingpin sector of the economy, electronics fared poorly this year. The lackluster domestic market held the industry's growth to about 2.5%, a far cry from the 4% to 6% most expected. For 1968, Electronics magazine forecasts a market of $1.7 billion, a comfortable rise of 5.5% from the estimated $1.6 billion of 1967. And although it will be months before the full impact of last month's devaluation of the British pound can be accurately assessed, the prevailing first impression is that it will have little effect upon West German electronics markets.

To be sure, next year's gain won't be made across the board. Some markets don't figure to perk up until late in 1968. Radio and television-set

German electronics market forecasts
(millions of dollars)

	1967	1968
Assembled equipment, total	**1,612.7**	**1,702.1**
Consumer products	438.8	453.8
Medical equipment	48.4	49.8
Communications	421.9	427.3
Computers and related equipment	298.2	347.5
Nuclear instruments and equipment	20.7	21.5
Production, control and other equipment	279.2	291.8
Test and measuring equipment	105.5	110.4
Components	**654.1**	**689.1**

makers in particular don't see much chance of an upturn before midyear. And the outlook for avionics firms depends in large measure on how soon the government of Kurt Georg Kiesinger orders the next batch of planes for the Luftwaffe and navy.

But producers of computers will go into 1968 running strong. And sales of industrial electronics hardware seem due for a mild spurt in the spring. By then the effects of the $1.8 billion pump-priming effort launched by the Kiesinger government this year should begin to show.

An early lift also looks likely for components manufacturers, good news for them after nearly two years in the doldrums.

Keen for computers

With West German industrialists preparing for a rise in the country's economy, the sectors of the electronics market most likely to succeed handsomely are computers, control systems, and production equipment. To cash in on the expansion, businessmen will spend heavily to boost their production capacity. But bigger plants are secondary; most of the money is earmarked for hardware to increase productivity. "Between 60% and 70% of all capital investments is expected to go for mechanization and rationalization," says Siegfried Bergmann, an economist for the Central Association of the Electrotechnical Industry, West Germany's electric-electronics trade association.

The push by industry to streamline its operations means a good year for manufacturers of computers and production equipment. Electronics magazine's survey indicates a market jump of nearly 11% next year from 1967 to a total around $639 million.

As in past years, computers will be way out in front. The survey puts next year's market at $347.5 million, up sharply from an estimated $298 million this year. Market watchers see no sign that the demand for data-processing equipment is topping off, and they predict an annual growth of 20% or so for at least another five years.

To keep up with the demand, computer companies are expanding their staffs and production facilities. The International Business Machines Corp., far and away the German market leader, plans to add 1,300 workers to the 1,700 already employed at its computer plant in Mainz. Siemens AG, second right now but making big strides, will go into 1968 with 5,600 people assigned to its computer effort. About the only sour note in this sector is a growing shortage of computer engineers and programers.

The forecast for business-computer sales next year is $212 million. Relatively inexpensive machines apparently will account for the largest share of the market as small and medium-size German companies turn to electronic data processing. "It'll be the small-system maker who'll have good pickings next year," says a computer industry spokesman.

U.S. companies will, as usual, dominate the German computer market. IBM alone will take about two-thirds of the 1968 sales. But other U.S. firms will have to hustle to hold their shares. Siemens, Germany's leading electronics producer, has of late become a tiger. "The progress that company has made is astounding," comments an executive of a U.S. competitor. Siemens and an affiliate, Zuse KG, have cornered about 10% of the domestic computer market.

Another company moving into contention is AEG-Telefunken, which expects to deliver at least four of its large TR 440 computers next year at prices of between $2.5 million and $5 million apiece. Another score or more of TR 440's will be delivered by 1972, say Telefunken marketing men. The company is also counting on a lift from its new TR 8 line of small machines, introduced this year.

Both Siemens and Telefunken stand to get a leg-up from the government. Under a five-year plan that starts in 1968, the Ministry for Scientific Research will dole out $75 million to help German firms develop computers that will come on the market in the early 1970's. In addition, the Economics Ministry has earmarked a five-year total of $94 million for low-cost, long-term loans to finance machines now in development.

Controls coming up

Although there's nothing like the computer boom in the offing for producers of controls and industrial equipment, fallout from the general German drive for higher productivity should push 1968 sales in this sector of the market to $292 million, up 4.7% from this year's estimated $279 million.

A surge is expected in sales of numerical controls for machine tools. Some NC makers say the market will hit $7.7 million in 1968, a third higher than this year's level. Helmut Melcher of the Association of German Machine Tool Manufacturers puts the country's output of NC machine tools next year close to 400 units, a gain of 100 from this year's total. Between 40% and 45% of the German-made machines will be exported. At the same time, some 20% of the German market will be covered by imports, mostly from the U.S.

Another market that seems poised for a takeoff is city traffic-control equipment. Big cities that have tried computer-controlled stoplights on a small scale have begun to add more intersections—and computers—to their systems. And smaller cities are following suit. Bremen, Heidelberg, Heilbronn, and Nuremburg, for example, will have computers controlling traffic lights next year. Siemens, the front-runner in this sector, has already logged 20 orders for traffic-control computers.

Gains are also in store for teaching-machine makers. Peter Koehler, who manages the educational electronics operation at the German subsidiary of Switzerland's Brown, Boveri & Cie., predicts that anywhere from 500 to 700 language laboratories will be sold next year—at a total price of from $5 million to $7 million. By the early 1970's though, the figure is expected to spurt to $60 million or more for hardware alone. And for every dollar's worth of hardware, there will have to be about $10 worth of software.

Counting on color

Hard hit by this year's lull in consumer spending, producers of television and radio sets should fare slightly better in 1968. Electronics magazine puts the consumer electronics market at $454 million, up about 3.5% from 1967.

The gain won't be seen until late in the year, however. "The standstill will last until mid-1968," says Horst Schikarski, manager of product planning and market research for Kuba-Imperial, a subsidiary of the General Electric Co. Few in the industry would quarrel with Schikarski's assessment.

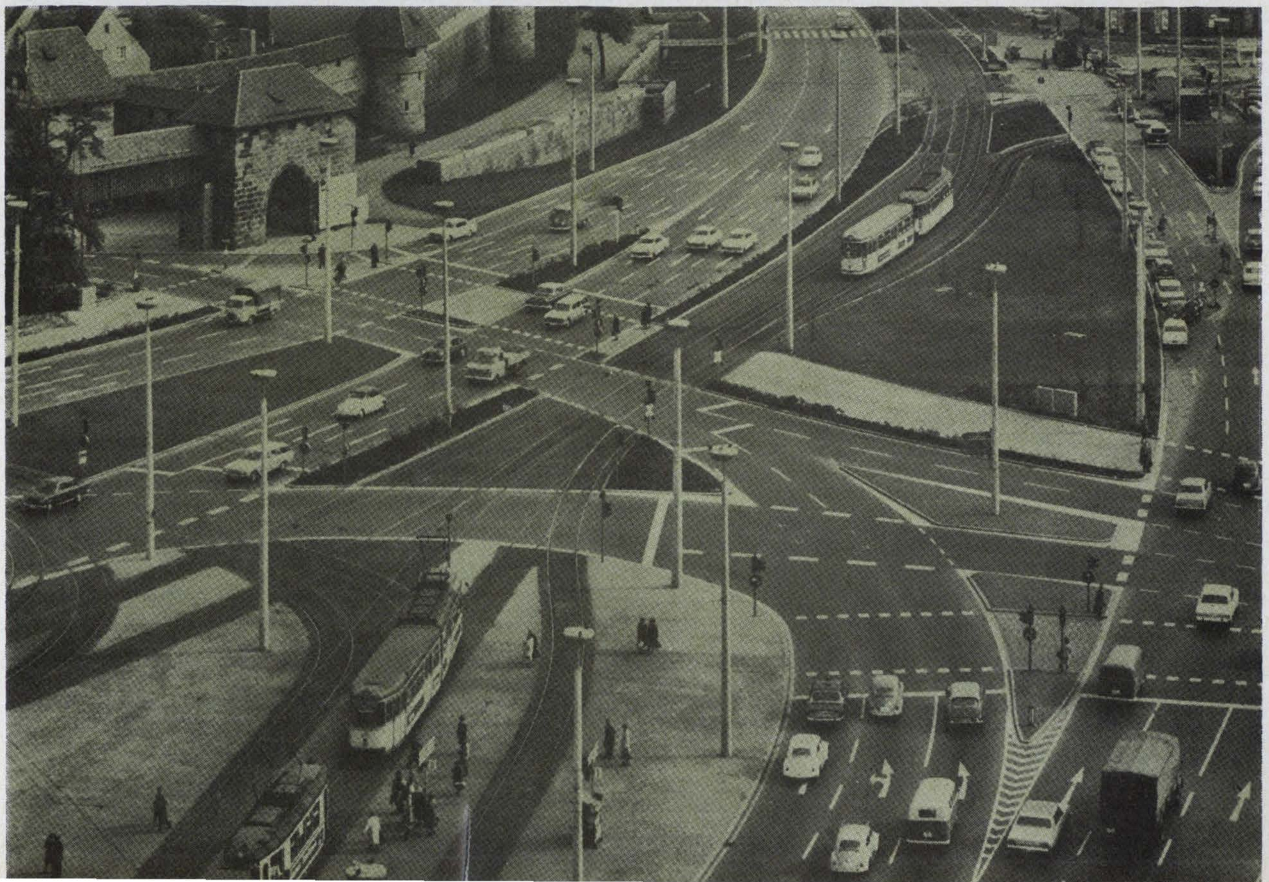
As in past years, black-and-white tv sets will be the mainstay of the market in 1968. But the bellwether for the year will be color-tv sets. With monochrome sets selling for as little as $100, profit margins are scant. "Nobody is making much money anymore in the black-and-white receiver business," concedes one industry official.

Contrary to expectations, the start of color-tv broadcasts this summer didn't throw black-and-white sales into a tailspin. When consumers saw the price tags on the color sets—generally $550 or higher—most decided they had monochrome pocketbooks.

As a result, predictions of 1968 color-set sales vary considerably. Some manufacturers figure on a market as low as 150,000 sets. But Kuba sees a chance for sales of 250,000 to 280,000 sets, and Grundig-Werke GmbH thinks that the figure could run as high as 300,000. Under conditions that make economic seers queasy, Electronics magazine forecasts a color market of $80.5 million in West Germany next year.

There's a general feeling in the industry that set prices will have to drop before the color market can move up sharply. So far, producers have concentrated on 25-inch sets, but most will have 21-inch sets on the market next year, probably at retail prices between $400 and $450. Some say that the 21-inch sets will account for 60% of the

In the cloverleaf. Traffic-control market is on the rise in West Germany as medium-size cities—like Nuremburg here—shift to computer-controlled traffic-light systems.



color-television market next year.

Programs rival prices as a market factor. Burkhard Wiesmann, general manager of the consumer electronics division at Standard Elektrik Lorenz AG, maintains that the number of hours of color programs, more than anything else, will determine next year's color market. "Unless there's more than eight hours a week," he says, "the 300,000-unit mark will not be reached."

An eight-hour weekly ration of colorcasts, however, is what the two government-run tv networks will serve up until October of next year. At that time, each will boost its color programing from four hours to eight or 10 hours.

As for radio sets, the situation is saturation and the market will, at best, mark time next year. Electronics magazine predicts that sales of phonographs and radios will reach about $129 million, down slightly from this year's estimated total. A continuous slide in sales of portables is the main reason for the expectation of a small over-all downturn.

The market for tape recorders, on the other hand, will increase by 5% to 10% from this year. The forecast is for $22 million of sales, with small casette recorders coming on strong.

Integrated circuits will remain a rarity in consumer electronics during 1968. A few IC's did turn up this year. Blaupunkt-Werke GmbH started selling a tv set with an IC in the i-f stage of the sound channel, and Deutsche Philips is marketing the IC pocket radio developed by its parent company, Philips' Gloeilampenfabrieken of the Netherlands. Next year will undoubtedly see the introduction of a few more sets with IC's, but until integrated-circuit prices go down, there'll be no massive swing away from discrete components.

Keeping posted

Communications-equipment makers can look forward to a 1968 market of $427 million, according to Electronics magazine's survey, up only a scant $5 million from 1967. Nonetheless, producers of communications gear are facing the new year with optimism. Their biggest customer, the Federal Post Office, had its budget trimmed by 15% a year ago. This year, the post office picked up $120 million of the Kiesinger government's pump-priming money, and its 1968 budget earmarks some $623 million for hardware, much of it electronic.

Next year, the post office will put into service its fourth small semielectronic exchange, already installed near Stuttgart. No more orders for small exchanges are in the offing, however. The post office is emphasizing development of an advanced large electronic exchange built around integrated circuitry, but this equipment won't go into service until the mid-1970's.

Another long-range development program in the works centers on pulse-code-modulation systems. The post office next year will evaluate pcm prototypes built by Siemens, Standard Elektrik, Telefunken, and TeKaDe-FGF.

Prospects for avionics producers hinge on the Kiesinger government's decisions on aircraft procurement. There's a good chance, many in Bonn think, the Defense Ministry will close a deal early in 1968 for 200 or so Phantom F4 jets. Much—if not all—of the avionics equipment for the Phantoms almost surely will be built under license by German firms. But until the deal is firm and delivery dates set, avionics manufacturers won't know where they stand.

The outlook for space electronics, on the other hand, is better than ever. Under a five-year program running through 1971, the Ministry for Scientific Research plans to spend some $457.5 million on space projects. Another $47.5 million may be pumped into the program between 1969 and 1971 if the government's finances can cover the added expenditure. The total—$505 million—would be about four times the amount West Germany spent on space during the past five years. As before, about 30% of the total outlay will go for electronics equipment.

With the additional money will come new emphasis on national projects in the West German space program and on the Franco-German Symphonie communications satellite. High on the list are a trio of Azur research satellites and a series of solar probes.

Surge for IC's

The upswing in West German electronics markets in sight for next year will shake the country's components industry out of its torpor. The outlook in this sector is for $689 million sales in 1968, a 5.3% advance from 1967.

Semiconductor producers figure to do best. The market for diodes, transistors, and integrated circuits should come close to $90 million next year, about $10 million higher than this year's estimated sales.

By far the fastest growing sector will be integrated circuits. Electronics magazine's survey puts the market at $7.6 million; some in the industry, though, see sales going as high as $12.5 million. Some 60% of these IC's will wind up in computers and industrial equipment. Another 30% will go into military and space equipment, leaving just 10% for consumer products.

With that kind of parceling, digital circuits dominate and will for a long time to come. But linear IC's, especially monolithics, have started to catch on. Last year, about 150,000 linear IC's were sold in West Germany, and the figure is expected to double in 1967 and double again in 1968. Valvo GmbH, another Philips subsidiary, predicts that some 2 million linear IC's will be sold in 1970.

Some Japanese firms have tried to cut themselves into the fast-growing IC market, but they've been virtually shut out by German producers and the U.S. companies on the scene. As a result, the Japanese apparently will change their tactics and push products with IC's in them rather than the devices themselves.

Toujours le meme, de Gaulle's drive for independence boosts French market

President de Gaulle's determination to deck France out in the trappings of grandeur will keep the country's electronics industry thriving in 1968.

Great are the general's aspirations for France and great his gift for expounding them. Equally great is his need for hardware to give substance to his dreams. Some two-thirds of next year's hardware sales—consumer goods excepted—will be to the armed forces, government agencies, the nationalized public utilities, and government-owned companies.

Electronics magazine forecasts a market next year of $1.3 billion—not including components—a 6% surge from 1967 that will establish France as Western Europe's second biggest market, behind West Germany but ahead of Britain. As yet, the French don't expect any significant repercussions in their own market from Britain's November devaluation.

Along with a strong domestic market for military and industrial equipment, the electronics industry will go into 1968 bolstered in other ways by de Gaulle's drive for economic independence. Often after government prodding, always with its blessing, French firms have been joining forces to compete on a more equal footing with U.S. and West German giants.

Next year, for example, two of the Big Three in French electronics—Compagnie Française Thomson Houston-Hotchkiss Brandt and CSF-Compagnie Générale de Télégraphie sans Fil—will start stitching together their 100-odd subsidiaries and affiliates. The year should also see a major merger of semiconductor makers and possibly a shakeout among producers of television and radio sets.

French electronics market forecasts
(millions of dollars)

	1967	1968
Assembled equipment, total	**1,232.7**	**1,307.6**
Consumer products	350.0	353.3
Medical equipment	24.5	25.6
Communications	329.4	337.3
Computers and related equipment	227.2	263.8
Nuclear instruments and equipment	20.6	21.4
Production, control and other equipment	192.2	210.0
Test and measuring equipment	88.8	96.2
Components	**505.0**	**537.7**

For the set makers, though, the urge to merge stems mainly from the state of the market. Although color tv has come to France, it has yet to spark sales and the consumer electronics sector is in for a dismal year.

French components makers, too, have their worries. Components sales will keep pace with equipment sales, but U.S. companies figure to make further inroads, in semiconductors particularly, through their French subsidiaries.

Martial plan

In its 1968 defense budget, the de Gaulle government has put down $2.6 billion for new equipment, nearly half of it for the force de frappe, the country's nuclear striking force.

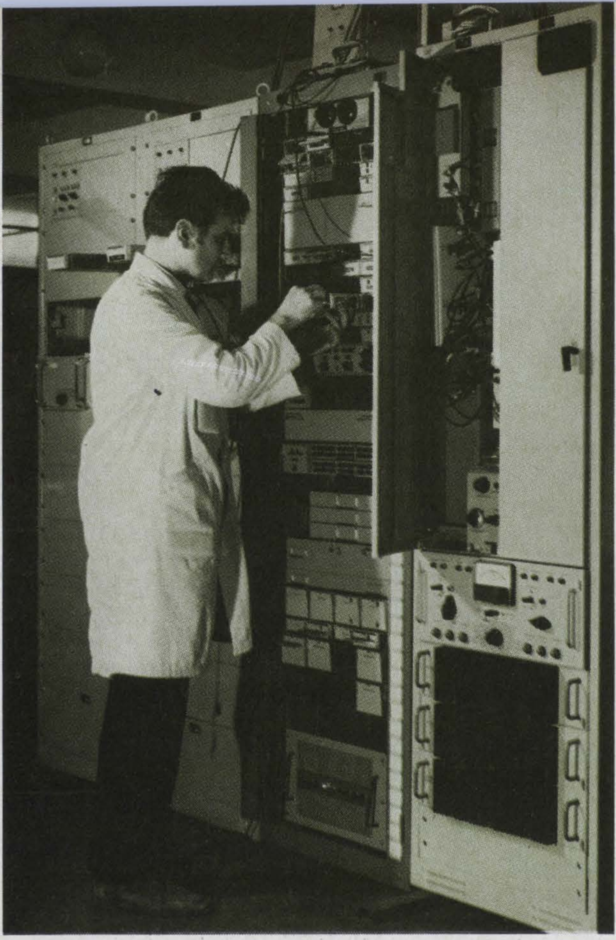
De Gaulle already has a costly enriched-uranium plant to supply the makings for the bombs and the Mirage IV bombers to deliver them. These two items gobbled up big chunks of France's defense money in recent years, so the strong advance in electronics hardware spending next year will come even though the over-all rise in the defense-equipment budget will be slight—about $150 million.

The bombers will provide a major market for avionics makers next year. CSF has a contract to refit the Mirage IV's with its Cobra low-altitude, side-looking radar, and Le Matériel Téléphonique, a subsidiary of the International Telephone & Telegraph Corp., will equip the aircraft with tactical air navigation distance-measuring equipment.

And the Mirage IV's represent just the first generation of the strike force. The air force and navy have started putting together the second and third generations: ground-to-ground ballistic missiles tucked in silos and missile-carrying nuclear submarines.

Air force plans call for a total of 27 intermediate-range missiles located at three silo sites in southeast France. Each site will have extensive tracking and control equipment; the first is scheduled to be in service by 1970. Next year's spending for the silo sites and the Mirage IV retrofit add up to $116 million.

The navy's 1968 budget earmarks $152 million for work on the first two nuclear subs (four have been authorized and a fifth very likely will be added next year). Much of the 1968 money is tagged for missile inertial-guidance systems. SAGEM has the contract for the guidance platforms and Electronique Marcel Dassault the order for the on-board computers. To communicate with the nuclear submarines—the first of which is slated to go into service in 1970 with the next two following at two-year intervals—the French navy plans two very-low-frequency broadcasting stations. The contract



Postmark. High-capacity microwave link between Paris and Bordeaux marks new approach for French post office, which so far has stuck largely to cables for trunk lines in its telephone system.

for most of this hardware will almost certainly go to Thomson-Houston.

Heavy emphasis on the striking force, which like all ambitious military projects will cost more and come later than its planners figured, has relegated the army to a back seat. Its only new major hardware is the AMX-30 tank, currently coming off the production line at a rate of 10 a month. The tank's chassis will be adapted to serve as a mobile launching platform for a nuclear-tipped tactical missile called the Pluton. Because of the spending on the force de frappe, though, funds for Pluton's development have been cut back sharply. Instead of the $42 million originally planned, only $6 million will be spent on the program in 1968.

Faster pace in space

There's grandeur, of course, in space. And to remain the unchallenged leader in space among West European countries, France will spend close to $150 million next year. French electronics companies say about 65% of this money will wind up in their coffers.

Some $100 million of it will go into the national program, the balance into joint and multinational projects. Among the joint projects, the main one is the Franco-German Symphonie communications satellite. The launching is scheduled for 1971 and the price tag at the moment is put at $40 million. About $12 million of this will be spent in 1968, half in each country. French companies most likely to pick up Symphonie business are Société Anonyme de Télécommunications (SAT), CSF, and Thomson-Houston; their likely German collaborators: Siemens AG, AEG-Telefunken, and Rohde & Schwarz.

France, as always, remains a prime mover in international projects (as long as they're predominantly European), and French companies have a stake in all three of the satellites that the European Space Research Organization hopes to put into orbit next year. ITT's Laboratoire Central de Télécommunications is prime contractor for ESRO I, Engins Matra S. A. is the leading subcontractor for ESRO II, and Thomson-Houston is to supply most of the onboard electronics for HEOS (highly eccentric orbit satellite).

As for the 1968 national program, the major preoccupations of the Centre National d'Etudes Spatiales (CNES), the French space agency, will be the D-2 satellite and the construction of a launching complex in French Guiana.

The CNES has 1969 circled on its calendar for the D-2 launch. The satellite will weigh 220 pounds, carry five scientific experiments, and lock on the sun. The budget also includes funds to upgrade the Diamant launch vehicle so it can handle the D-2.

Next year, CNES will pour $26 million into its launch center and should have it ready to go late in the year or by early 1969. This year's Guiana money, $24 million, went mainly for civil engineering. Next year will be electronics' turn.

Quickstep in computers

Like all West European countries, France will have surging computer sales next year. Electronics magazine sees a $264 million market, 16% higher than 1967's.

And, as always, the International Business Machines Corp. and Bull-General Electric will have the market for business computers practically to themselves. But the all-French computer company put together under de Gaulle's Plan-Calcul figures to do well in process-control and scientific machines.

Robert Remillon, vice chairman of this concern, the Compagnie Internationale pour l'Informatique (CII), predicts that the firm's 1968 sales will jump 20% from the 1967 level to $68 million. The sales will be entirely accounted for by computers designed before CII started getting Plan-Calcul money for research and development. One of the mainstays of the company's line is its version of the Sigma 7, made under license from Scientific Data Systems (SDS).

Remillon says the first Plan-Calcul computer, one of a four-model series of medium-size, integrated-circuit machines CII has in mind, will be introduced next year. Deliveries won't start, though, until 1969. Under the Plan-Calcul, which was set up to run through 1971, the company will get more than $100 million in government aid to develop computers. Next year's allotment is $17 million.

A 1969 delivery date for the first Plan-Calcul computers leaves CII with a lot of catching-up to do. But Remillon thinks it can be done. "SDS was late compared to Control Data," he points out, "and Control Data was late compared to IBM. Even IBM has been late on occasion as compared to Univac. So it is possible to catch up."

New tack in telecommunications

For the over-all communications sector, Electronics magazine's survey shows a 1968 market of $337 million, up only slightly from this year. The forecast, though, is at odds with the mood of telecommunications equipment makers, most of whom see good prospects for the year ahead.

Although color tv hasn't buoyed the receiver market, it does mean new business from the government-run broadcasting organization. Guy Salem, sales chief of Thomson-Houston's nonconsumer tv division, sees a market of $4 million for studio color equipment. In addition, the network on which color programs are aired, which reaches only 70% of France, will be extended to cover the whole country next year. CSF stands to pick up most of the business for the transmission equipment.

But most important, 1968 will see the French Post Office try a new tack. Traditionally, this agency has tended to stick with cables for the trunk lines in its telephone system. Next year, CSF and SAT will install an 1,800-channel system linking Paris, Poitiers, and Bordeaux. Along with $3 million for microwave relays, the post office will spend $11 million next year for satellite-communications ground stations.

And telecommunications equipment producers will find themselves with an important new customer next year—the air force. The service late this year decided to set up its own independent microwave network. The system will have 25 primary and 50 secondary links when it's completed in 1970. Thomson-Houston, CSF, SAT, and Télécommunications Radioélectriques et Téléphoniques (TRT), a subsidiary of Philips' Gloeilampenfabrieken, have contracts for the job.

Fewer but bigger

De Gaulle's singleminded pursuit of technological independence should next year lead to another major merger in the electronics industry. All along, the government has been plumping for bigger companies in key industries, mainly so that firms can finance the research and development necessary to keep up in technology.

Now that the Plan-Calcul has given France a reasonably strong computer company in CII, the government will launch its Plan-Composants for components. As with the computer scheme, the government will combine pressure and persuasion—mainly in the form of R&D funds—to get French semiconductor producers together for a crash effort in integrated circuits, a field now dominated by American companies.

Already, two heavyweights have decided to team up on components—La Radiotechnique S. A., a Philips' subsidiary that has gone so native it's generally considered French, and the Compagnie Générale d'Electricité (CGE), France's largest electrical-electronics firm.

Next year, the remaining French semiconductor makers should combine. They are the Société Européenne des Semiconducteurs (Sesco), Compagnie Générale des Semiconducteurs (Cosem), and Société Industrielle de Liaisons Electriques (Silec). Says Edouard Guigonis, a top executive at Thomson-Houston, "Each of the companies is having trouble. The only solution is consolidation, and that's bound to come."

Thomson-Houston holds a controlling interest in Sesco—with GE as a partner—and Cosem is a CSF subsidiary, so the operations of the two semiconductor firms would eventually have been meshed in the parent companies' merger, the mechanics of which will take two or three years to complete. Silec, once a holdout, should fall into line as the merged company stands to pick up strong backing from the government under the Plan-Composants and figures to be the preferred supplier to CII of circuit packages for Plan-Calcul computers.

The trend to fewer and bigger companies also should hit the consumer sector in 1968. More than 100 firms produce radio and tv receivers and few have the financial strength to cope with the current slump in black-and-white tv sales, a slump that has come at a time when investments in color tv are in order.

The first big merger most likely will involve CGE, which is now negotiating with two smaller firms to pool the consumer electronics operations of a subsidiary, Continental Edison, and the Compagnie Centrale d'Electronique et d'Appareils de Mésure (Cocelam). Cocelam is jointly owned by Lebon et Cie. and the Société Lyonnaise des Eaux et de l'Elclairage, and it is with these firms that CGE is negotiating. The proposed merger would produce the third largest set maker in France, behind Thomson-Houston and La Radiotechnique.

Color it drab

Even the big companies are concerned about the lackluster consumer electronics market. The survey puts it at $353 million in 1968, a scant $3 million above the estimated level this year.

Many in the industry would consider the forecast too optimistic, in fact. In the 12 months ended Sept. 1, sales of tv and radio sets slipped 5% from the pace of the year-earlier period. In the view of René Bezard of the radio and tv manufacturers trade association, the decline most likely will continue through 1968. "Stability is all we can hope for," he says.

More than anything else, it's color tv that has hurt this market. The start of color broadcasts in October checked black-and-white sales, but there's scant chance that color-set sales can offset the loss. Until there's a sharp drop in prices, color sets will remain as out of reach for the general populace as the glittering wares at Cartier. The present going price for a color set is $1,000, about a third of the average Frenchman's annual salary.

British outlook hinges on devaluation: bright if it works, dim if it doesn't

British practitioners of the dismal science of economic forecasting are as bewildered these days as Alice in Wonderland. From the devaluation of the pound sterling they've learned what Alice was taught by the Mock Turtle: that Reeling and Writhing are what one begins with and that Uglification, indeed, is a branch of Arithmetic.

The pound, actually, has been reeling for years, continually knocked about by Britain's chronic payments deficit and sporadically jostled by runs on sterling. Eighteen months ago, Prime Minister Harold Wilson tried to right the situation with some stiff deflationary measures, but they did little more than leave the economy writhing in recession. So Wilson in November at long last faced up to the inevitable and devalued.

The straightforward arithmetic of the devaluation is simple. The pound now is pegged at $2.40, or 14.3% less than before. As a result, British goods could cost that much less—and sell better—in export markets. At the same time, imports become dearer—16.7% actually—and should therefore taper off. Both ways improve the balance of payments.

Uglification of this arithmetic is all too easy. Along with the change in the exchange rate, the November fiscal package included a rise in corporate taxes, an end to exporters' tax rebates, and a boost in the bank rate to an all-time high of 8%.

These moves, the government's men in Whitehall say, will trim only 3% off the 14.3% advantage the devaluation theoretically gives exporters. But British businessmen by and large don't agree. Most think the competitive edge derived from the devaluation will turn out to be no more than 10%.

British electronics market forecasts
(millions of dollars)

	1967	1968
Assembled equipment, total	**1,067.8**	**1,150.6**
Consumer products	274.2	313.9
Medical equipment	25.9	26.8
Communications	302.4	311.0
Computers and related equipment	233.7	257.3
Nuclear instruments and equipment	11.8	12.2
Production, control and other equipment	159.3	166.4
Test and measuring equipment	60.5	63.0
Components	**528.9**	**571.0**

Figures adjusted for November, 1967, devaluation

A few even feel that devaluation won't help at all. Britain, they point out, has to import much of what's needed to fuel her economy. They're convinced that higher-priced imports will boost the cost of living, leading to wage rises and thus to higher production costs. Says an executive at Smiths Industries Ltd., "Already we've been notified we will have to pay 15% more for some of the transistors we use."

It will be months, perhaps longer, before the full impact of the devaluation can be gauged. Until this period has passed, pundits won't be making any hard forecasts of how the British economy will fare in 1968.

One thing seems sure, however: the year will begin with several more months of deflation. Until there's solid evidence that Britain has been restored to economic health, the government will hold down consumer spending as much as it can and continue its drive to make British producers more efficient.

Thus radio and television-set makers, who were fairly sanguine about the 1968 outlook before devaluation have had to hedge their forecasts. The recent advent of color tv, though, should help set makers considerably. Computer manufacturers don't see any reason why they shouldn't log a sales increase of some 10%, and the integrated-circuit market should spurt. But prospects for industrial and communications equipment are for only middling gains.

At a time when most market researchers would swap without hesitation their painstakingly gathered data and their computers for a clairvoyant's crystal ball, Electronics magazine pegs next year's British electronics market at $1.15 billion, some $80 million ahead of the estimated total for 1967. The figures for both years have been adjusted to the new exchange rate, but because of the unknowns raised by the devaluation, it's anybody's guess how close to the mark they may be.

Fast color?

British consumer-electronics producers had a pleasant surprise this year. The pundits had predicted that sales would run well below last year's level, but a rise in radio sales offset the drop everyone knew was coming in the black-and-white-tv market, and 1967 turned out to be as good a year as 1966.

Despite devaluation, set makers figure they can hold their own next year in monochrome tv and radio sets. If that happens, the consumer electronics market should perform adequately. Color tv, at long last, came to Britain this fall, and set makers have set their sights on sales of 100,000 to 125,000 color receivers in 1968. Electronics magazine's survey indicates a consumer market next year of $314 million, up $40 million from 1967.

Ordinarily, the prospect of a gain like that would touch off a groundswell of optimism about the long-term outlook. But it hasn't. Many of next year's color customers figure to be well-heeled Britons who'll buy anything new. It will be 1969 or 1970 before the industry finds out whether it can count on color sales for steady expansion. Until the government sees its way clear to start reflating the economy, industry men say, color-set sales most likely will hover around the 100,000 annual mark.

Two or three years of stagnation would be bad news for Britain's half-dozen set makers and her three color-tube producers. The tube companies, particularly, need an annual market of 300,000 sets or more to realize a payoff from their heavy plant investments. Mullard Ltd., a subsidiary of Philips' Gloeilampenfabrieken, was first to get into production and currently has half the market. Thorn-AEI Ltd. ranks second and RCA Color Tubes Ltd.—a newcomer—third. Of the three, the RCA affiliate will be hardest hit by devaluation. Its wares depend considerably on U.S. components supplied by the Radio Corp. of America, which owns two thirds of the company.

Color-set prices in Britain currently average about $700. But this average should edge downward starting next year as 19-inch sets appear on the market. So far, all the British producers but one make only 25-inch sets. Like most people in the industry, J.W.C. Robinson, head of the country's largest tv-renting outfit, expects 25-inch sets will account for at least half of next year's sales.

John Bullish

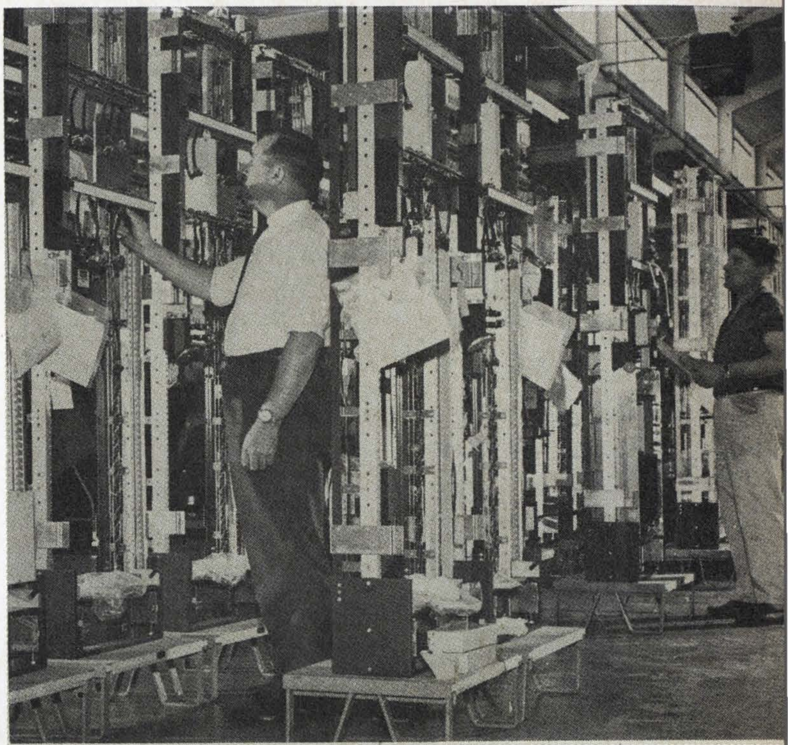
Like the hemlines of miniskirted Chelsea swingers, computer sales figure to rise again next year no matter how chill the climate—economic or otherwise. The market, Electronics magazine's survey indicates, will surge 10% from this year's level to $257 million.

Devaluation could well make Britain a tighter little island for the country's computer producers. They alone among West Europeans have kept the International Business Machines Corp. from romping in their domestic market.

Elsewhere in Europe, IBM is far and away the leader; in Britain, it is running neck-and-neck with International Computers & Tabulators Ltd. Between them, IBM and ICT have some two-thirds of the British market; in most other countries, that's about IBM's share alone.

With the added edge of devaluation, British producers presumably can whittle a little off IBM's slice of the market. All the big machines IBM sells or leases in Britain are imports. Now the company must raise its prices or cut its margins to keep abreast of ICT. In export markets, too, ICT may well profit—at IBM's expense—from the devaluation.

In the jockeying for computer-market positions next year, ICT will have going for it a wide new range of multiaccess software and its top-of-the-line 1907 models. On the other hand, English Electric Ltd., the number two producer in the United Kingdom, has run into production troubles and few of its big third-generation computers—the System 4/70 line—will be delivered in 1968.



On the rack. Microwave equipment is assembled for link between London and Norwich. Ordered by the post office, link will carry 1,920 phone circuits, two tv channels.

Strong as they already are, ICT and English Electric aren't strong enough to suit the Wilson government, which all along has been plumping for a powerful domestic computer industry. Although English Electric has taken Elliott-Automation Ltd. into its fold and thereby bolstered itself considerably in process-control hardware, the government wants a further merger between ICT and English Electric.

The two companies have been talking about joining forces for months and have a good idea of how they would go about it. They've agreed on some common peripherals but would continue to individually produce and market their present mainstay machines—ICT's 1900 series and English Electric's System 4. Research, development, materials buying, and sales operations presumably would be progressively stitched together over the next few years, and this would be followed by the development of a single next-generation computer series. A decision on the merger, which quite likely would be sweetened with government money, should come early next year.

There'll be no easing up in the government's drive to improve productivity. To be sure, Whitehall's blandishments on this score haven't been fully heeded. Many of the country's industrialists have been holding off on new plant investments, waiting for an upturn in the economy. But the drive continues and process-control makers are counting on it to check the downturn in installations this year. Electronics magazine's survey puts the 1968 process-controls market at $67 million, up $3 million from 1967.

Until there are signs that deflation is ending, though, process-controls makers don't see any chance of a surge in their sector. And when the upswing finally does start, there may be some strong new competition. The Plessey Co. has readied a very fast IC process-control computer and may move into the market with it as soon as business picks up.

The jet set

British avionics makers, like barnstormers in balky planes, are wondering how long they can hold their altitude.

Next year they'll be flying reasonably high. The market for navigational equipment, most of it for aircraft, will come to $105 million according to Electronics magazine's forecast. In the works: all the avionics for 70 Hawker-Siddeley Harrier vertical-takeoff-and-landing fighters, most of the electronics for 169 McDonnell Phantom fighters, and the equipment for such passenger jets as the VC 10 and the BAC 111.

But as yet there's little that's substantial on the order books for 1969 and beyond. The project the industry is counting heavily on is the Concorde Anglo-French supersonic transport. To get Concordes into airline service by the 1971 target date, a start will have to be made next year on preproduction aircraft and the first production versions.

There's a good chance that contractors for some of the plane's major electronics systems will be named late next year. But there's no guarantee that British firms will get about half the business as they did on the two experimental prototypes, both of which are slated to make their first flights next year.

The Concorde's builders, France's Sud-Aviation and the British Aircraft Corp., shut U.S. avionics makers out of the bidding for the first two planes. But Sud and BAC are trying to persuade the 16 airlines—several of them American—that have ordered Concordes to accept a single supplier for major systems in order to hold costs down. As a result, the door has been opened to U.S. avionics firms. It's a fairly safe bet, for example, that Litton Industries Inc. will wind up with the contract for the inertial navigation system. But for other systems, there should be considerable carryover from the prototypes to production versions. That gives Ekco Electronics Ltd., Elliott-Automation, Ferranti Ltd., the Marconi Co., and Ultra Electronics Ltd. an inside shot at Concorde business since all supplied hardware for the prototypes.

Both in Britain and abroad, the demand for air traffic control equipment will be on the rise next year, much to the delight of companies like Marconi, Plessey, Elliott, Associated Electrical Industries Ltd., and A. C. Cossor Ltd., the last a subsidiary of the Raytheon Co. in the U.S.

Marconi leads the consortium that will supply $2.8 million in hardware for the Eurocontrol facility at Bretigny, France. And Plessey has a whopping order for displays for the new control center that will cover the southern half of Britain. The contract covers some 50 scan converters and 30 bright radar displays, the first ever ordered for civil aviation purposes in Britain.

Her Majesty's market

There's not much joy in the forecast for communications-equipment makers. The market will reach, according to the survey, some $311 million (the category, it should be remembered, includes navigational equipment and radar sets). That's slightly less than 3% above the estimate for 1967.

The post office, which runs the country's phone network, is a mainstay of the market, but it won't be quite as good a customer next year as it was this year. Its program to replace antiquated exchange equipment with TXE 2 electronic exchanges continues. Some $3 million was spent this year on the new gear and another $3 million outlay looks likely for 1968. There will be a lull, however, in spending for pulse-code-modulation trunk-line equipment. Orders for $15 million of pcm hardware have been placed and the post office will wait to see how the equipment performs before handing out follow-on contracts.

And there will be little in the way of new orders for satellite communications ground stations in 1968. This year, the post office awarded the contract for a second Goonhilly Downs terminal—with a 90-foot-diameter antenna—to Marconi. This facility, now under construction, will give Britain all she needs in the way of big ground stations for civil communications over the next few years. Eventually, the Ministry of Defense will need a new 40-foot dish for its Skynet satellite communications systems, but the go-ahead for this project isn't likely to come next year.

For exports, prospects are brighter. At yearend, the government-owned overseas communications company, Cable & Wireless Ltd., presumably will tap Marconi as the builder of two overseas ground stations. A lot of Commonwealth countries will need stations to work into the first global system of the International Telecommunications Satellite Consortium, scheduled to be in service in the second half of 1968. Nothing is firm yet, but British producers figure they'll get some of the business.

Yankee invasion

There'll be heavy skirmishing in the mushrooming British integrated-circuit market next year as the domestic industry tries to check the inroads of U.S. semiconductor producers like Texas Instruments, Motorola Inc., and Fairchild Semiconductor. Of every pound spent in Britain for IC's, about 15 out of the 20 shillings currently find their way into the coffers of U.S.-controlled companies.

Despite devaluation and droves of new British devices, the American firms should hold their share next year of a market that will zoom, according to the survey, to $20.4 million from this year's estimated $11.3 million.

Though much of the contents of IC packages sold by U.S. firms in Britain is imported, the American producers expect to stay competitive. At Texas Instruments and Fairchild, the top two in the market, the feeling is that the rise in circuit costs due to devaluation can be absorbed in the case of high-volume devices like computer packages. For specials, though, the increase will be picked up by the customer rather than the supplier.

Because it looks as if devaluation won't help British IC producers very much, the Wilson government—as in the case of computers—will almost surely move next year to weed out the weaker domestic producers unless there are some voluntary amalgamations. The companies the government will be eyeing are Ferranti, Elliott-Automation, Marconi, AEI, Plessey, and Associated Semiconductor Manufacturers Ltd., in which Britain's General Electric Co. (not related to its U.S. namesake) and Mullard are partners. Trouble is, nobody yet wants to get out of a fast-growing market.

The government's strategy figures to take the form of some hefty financial aid to two or three companies, leaving the others to specialize or eventually drop out of the IC market scramble. Ferranti looks like a sure bet for such aid; the company is the British leader in this field. Elliott and Marconi, both in the English Electric fold, are meshing their IC efforts, so they are as likely to get help as Ferranti. Plessey, largely because it has developed special circuits for the military, may get some aid.

As for AEI, it is now under the wing of British General Electric, whose managing director, Arnold Weinstock, is a master at shucking unprofitable operations. Weinstock presumably will get AEI out of the IC business completely unless he can shift some or all of the operation over to Associated Semiconductor. Even without AEI on its team, Associated Semiconductor will be no dropout since it has, through Mullard, the backing of mighty Philips.

Surge in computer and communications sales brings la dolce vita to Italian electronics

The prevailing tone of the Italian economy continues fortissimo and the tempo in the country's 1968 electronics markets should be very much allegro.

The prospect for next year is a growth of 5.8% in Italy's output of goods and services. Better still for electronics producers, plant investments by businessmen figure to run 11% higher in 1968 than they did this year, and this translates into a boom in sales of computers and process controls. Electronics magazine's survey puts the over-all electronics market at $695 million, up $48 million from this year's estimated total.

Just about every segment of the industry will contribute to this 7.4% sales spurt. To be sure no other sector will match the pace of computer sales, poised to jump nearly 19% in 1968. But industrial electronics will run strong, as will communications equipment—good news after a couple of disappointing years. Consumer electronics makers think they'll have a middling-good year. The two sectors least affected by the boom will be test instruments and medical electronics; sales of both will only edge up from 1967 levels.

Italian electronics market forecasts
(millions of dollars)

	1967	1968
Assembled equipment, total	**647.4**	**695.2**
Consumer products	267.6	273.7
Medical equipment	9.3	9.9
Communications	106.1	112.3
Computers and related equipment	123.9	147.8
Nuclear instruments and equipment	9.4	9.9
Production, control and other equipment	87.8	95.9
Test and measuring equipment	43.3	45.7
Components	**221.6**	**242.7**

Prestissimo

The computer industry expects to bask in a market growing at a rate of 20% to 25% over the next few years. More immediately, Electronics magazine sees 1968 sales of $148 million, against $124 million this year.

The International Business Machines Corp., inevitably, dominates about three-fourths of the market. Among IBM's big jobs this year and next: a $12.8 million worldwide reservation system for the state-run airline Alitalia and a real-time production control installation at the works of Fiat, Italy's top automaker. The Fiat setup will include three computers, an IBM 360/35, a 360/30, and a 360/20.

IBM's competitors, though lagging, aren't flagging. The Univac division of the Sperry Rand Corp. reworked its management structure in Italy this year to bring it in line with local ways of doing business, and for its trouble landed a contract from Fiat for a data-processing system—based on a Univac 1108—that's being touted as the most extensive ever ordered by an automaker. Univac also has to its credit a two-computer system—Univac 490's this time—for Intalsider, an Italian steel company. Univac's Mario Nutti, who pilots the company's Italian operation, sees a trend toward larger business computers. "The big companies are coming to understand that it's better to have one large installation than many small ones," he says.

It doesn't follow, though, that the market for small computers will languish. Very likely there'll be more sales growth in computer-based process control systems in the next few years than in computers generally. "We still meet a great deal of managerial resistance," says an executive of Honeywell Inc.'s Italian subsidiary, "but we expect the rate of expansion to be enormous in 1969 and to nearly treble by 1970." To make sure of getting a piece of the action, Honeywell is putting together a special software development group to adapt U.S. hardware to European needs.

Few would quarrel with Honeywell's view that the process controls market will boom in 1969 and after. Some, though, see the surge starting next year. Electronics magazine's survey puts this market at $46 million in 1968, 15% higher than estimated 1967 sales.

"The boom in the market for machine-tool controls is getting off the ground right now," says Piero Pomella, who heads the numerical control effort at Ing. C. Olivetti & Co. "We believe Europe is in the same position now, relative to controls, that the U.S. was in 1963-64," he adds, "and we envision the same sharp growth rate." To tap this fast-growing market, Olivetti has dropped its traditional machine-tool operations to concentrate on NC.

Up the scale

Next year will find the market for communications equipment in Italy on the upswing and almost sure to hold that course for the next few years. Electronics magazine's survey indicates a market of $112 million, up $6 million from this year's estimated total.

Telecommunications prospects have taken a particularly reassuring turn for the better. A year ago, telecommunications equipment producers were fretting because the Ministry of Posts and Telegraph was dragging its heels on contracts to implement its five-year plan to strengthen the country's network of telephone trunk lines. This year the ministry let the first contracts, and the industry now sees a chance that the $96 million budgeted for trunk-line improvements over the 1967-1972 period will be doubled.

Also buoying the communications outlook for the next five years is the $1 billion investment plan of Società Italiana per l'Esercizio Telephonica (SIP), the firm—controlled by a government holding company—that runs the local telephone systems throughout Italy. Most of the money will go for conventional telephone hardware but there'll be plenty of electronics fallout.

Another growing, though still small, market for telecommunications equipment is the state-owned public utility Ente Nazionale per l'Energia Elettrica (ENEL), which plans an $18 million outlay for communications hardware between 1967 and 1970.

The long-term outlook for communications is bolstered, too, by the as yet untapped market for land mobile equipment. Italy has only about 1,000 radio-equipped taxis, and there's no "calling all cars" in many small cities because the patrol cars don't have radios. There are no automobile radiotelephones in use yet although SIP is looking into several systems.

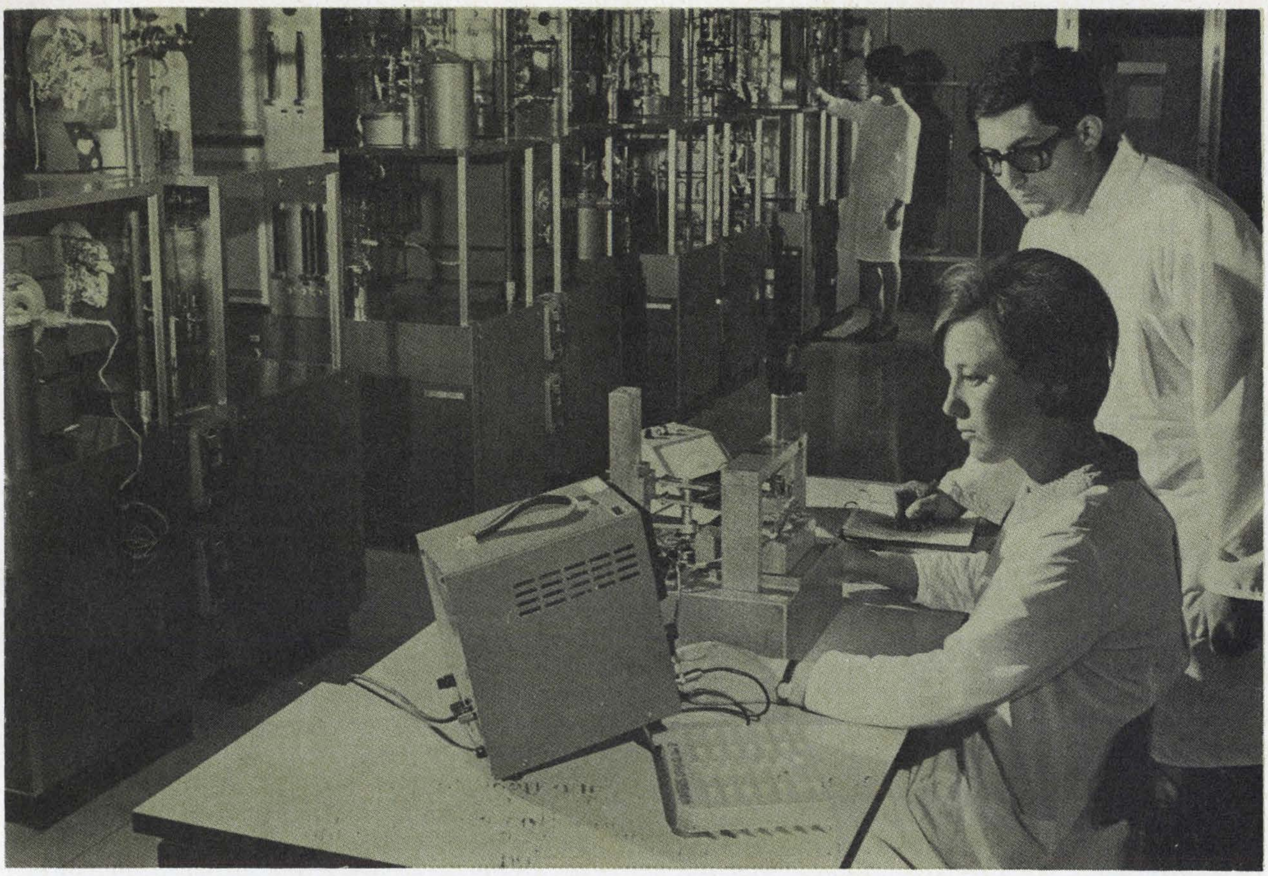
The land mobile market won't start to zoom, however, until the Ministry of Posts and Telegraph eases up on vhf licenses, and this isn't likely to happen next year. The ministry may also keep the wraps on another big potential market—data-transmission equipment. SIP and the ministry are currently squabbling over who should control data-transmission lines (the ministry is now responsible for the interurban telephone trunk lines), but no one expects the government to settle the matter until well after next spring's elections and perhaps not until 1969 or 1970.

All in all, there'll be an 8% annual growth in domestic telecommunications sales during the next few years, predicts Aldo Gardarelli, who heads the Italian subsidiary of the General Telephone & Electronics Corp. Even so, Italian producers of communications hardware will depend heavily on exports. The industry leaders count on selling anywhere from 45% to 75% of their output abroad; the figure at GT&E, for example, is about 60%. But Italians keying on export markets next year will be running into stiffer competition because the already-aggressive British communications-equipment makers can shave their prices as a result of the sterling devaluation.

Premature dirge

Consumer electronics manufacturers figured they would take a beating this year largely because Aldo Moro's coalition government late in 1966 decided to put off the introduction of color television until 1970. But things may not have turned out all that badly. Sales of tv sets this year ran slightly above 1.1 million units, some 10% higher than people thought they would at the outset.

Electronics magazine's survey pegs the 1967 consumer market at $268 million and forecasts a modest rise to $274 million next year. Contrasted with the outlook a year ago, that's pretty good.



A way with wafers. Italian semiconductor producers, such as SGS-Fairchild shown here, have a brisk market in the offing.

But there are signs of softness in the market for black-and-white sets. Italy is fast running out of potential first-set buyers, and a market that depends on replacement buying is notoriously vulnerable to customer whim. The state of the market is reflected in increasing sales of 11-inch transistorized portables and in price cuts on larger sets. The General Electric Co. is now selling a 23-inch "portable," with a wheeled stand thrown in, for $158. The going list price for 23-inch sets from other makers is anywhere from $16 to $35 higher.

Although the government remains adamant about initiating color broadcasts in 1970, the tv industry continues to urge an earlier start. Both Philips' Gloeilampenfabrieken and the Radio Corp. of America have readied plans to produce shadow-mask picture tubes in the country when the color market opens up. Meanwhile, Fabbrica Italiania Apparechi Radio, the GE affiliate best known as FIAR, has started producing 11-inch color sets for export. Output is now 200 sets a day but FIAR can boost the figure to 300 anytime it wants.

Upbeat

Italian components producers can look forward to another good year in 1968. The forecast is for a market of $243 million, up nearly 10% from this year's estimated $222 million.

Semiconductor makers, however, aren't quite as optimistic at this point as they were last year. They expected a marvelous year in 1967 and only had a good one. Nearly all these firms depend on exports and their great expectations were partly quashed by the economic slowdown in West Germany and Britain. Besides this, notes SGS-Fairchild's marketing manager, Giuseppe Fontana, some of the brand-new markets they were counting on didn't come through.

One of these was color tv, another was appliances. It was generally expected that by the end of 1967 some of the country's major appliance makers would switch to solid state controls, especially for washing machines. It turns out that these production runs won't start until next fall at the earliest. Even then, only the controls for the turning tub will be electronic. Washers with fully electronic controls—time, temperature, and tub rotation—apparently won't get into production until 1970.

Despite the setbacks, semiconductor makers will have a brisk market next year. The forecast is for sales of $29 million, up more than 25% from 1967. There's a general rush to get into production of integrated circuits, especially since profit margins on transistors are under heavy pressure. But the IC market, for all its well-publicized potential, is still small. Although it will more than double next year, it will reach only $3.3 million.

Color tv is 1968 Dutch treat for Philips

Around Eindhoven, where the Dutch masters of a sizable slice of the West European electronics industry are holed up, there's an undertone of optimism these days. The word at NV Philips' Gloeilampenfabrieken: "a better outlook for 1968 than for 1967."

How much better? Electronics magazine forecasts a Dutch electronics market of $307 million next year, 7% higher than this year's estimated $286 million.

Holland, though, is just one of many markets for Philips. The Dutch giant's worldwide network of subsidiaries and affiliates this year rang up some $2.4 billion in sales, a gain of 7% from 1966.

Down-to-earth businessmen that they are, the firm's economists tend to the conservative. As always, they won't disclose their projections, but their subdued optimism suggests 1968 company sales on the order of $2.6 billion.

How close Philips will come to this figure depends to some extent on the impact on world markets of last month's currency devaluation in Britain and a score of smaller countries. Even before the Wilson government cut the value of the pound from $2.80 to $2.40, British electronics firms were tough competitors. Philips' economists figure the devaluation will mean lower prices on British goods in many export markets but they doubt the cuts will be anywhere near the 10% some Britons expect.

Consumer comeback

With the economies of West Germany and the Benelux countries showing signs of picking up, Philips expects a surge in color-television sales in Western Europe, its principal market. J.F.C. Lamet, Philips' manager of commercial planning, puts this year's European color-tv market at about 150,000 sets, and figures this should burgeon to something like 1.5 million sets annually over the next couple of years.

Other forecasters agree. They peg 1968 West European sales at 450,000 sets at the least, and estimate that Philips will wind up with 30% to 35% of this market, compared with its 20% to 25% share of the West European black-and-white market.

Philips' brass has readied the company for the expected spurt in color-tv sales. However, executives stress that there will be "extremely careful" production planning. In light of what happened in the U.S. last year, when many set makers geared up for a boom that didn't quite come off, the company is wary about overproduction.

As for color-set prices, Philips thinks they'll stay fairly high. Right now, the going price for a color set in Holland is about $850. F. C. Romeijn, deputy manager of Philips' central development bureau, holds that advances in technology, rather than market forces, will be the prime cause of any future price cutting.

Along with its prospects for set sales, Philips has a strong position in color-tv studio equipment.

As for black-and-white sets, Lamet thinks the sales decline will be checked next year and that a slight upturn will follow. Electronics magazine's survey bears Lamet out, for northern Europe particularly. The forecast for Holland itself puts 1968 sales at $21.6 million, up a bit from an estimated $21.3 million this year.

And Philips sees growing monochrome sales in countries like Portugal, Spain, and Greece, where the tv market is largely untapped.

Where the action is

As in most of Europe, computers will be the 1968 market pacesetters in the Netherlands. Electronics magazine forecasts sales of $53 million, up nearly 24% from 1967.

For all its dominance in Dutch electronics, Philips is just another competitor in the computer field. But that situation figures to change in the next year or so. Philips has been easing into the computer business "internally" for several years and presumably will be lining up its first outside customers next year for 1969 deliveries. The company most likely will concentrate on process-control computers at the outset, but it does plan to tackle the business-machines market eventually. Philips sees a Western European computer market of some $4 billion anually up for grabs in the near future and it intends to get in on the action. The company is counting on computers, along with telecommunications and industrial electronics—areas where it is already strong—to keep the nonconsumer side of its business growing at a 15% rate over the next few years. Consumer goods now account for two-thirds of Philips' sales, but the company, while not spurning

Dutch electronics market forecasts
(millions of dollars)

	1967	1968
Assembled equipment, total	**286.3**	**307.0**
Consumer products	40.8	42.3
Medical equipment	7.6	7.9
Communications	72.4	74.5
Computers and related equipment	43.5	53.3
Nuclear instruments and equipment	8.8	9.3
Production, control and other equipment	66.9	72.0
Test and measuring equipment	46.3	47.7
Components	**154.6**	**159.1**

radios, tv sets, and the like, is increasingly emphasizing nonconsumer equipment.

Unlike U.S. companies, Philips has little in the way of a domestic military market. The total Dutch defense budget for 1968 is set at some $890 million, essentially the same as this year's.

Around $23 million in avionics will be purchased over the next two years for the 105 Northrop F5 fighters the Dutch air force has ordered. Most of this business will go to NV Hollandse Signaalapparaten, a Philips subsidiary making fire-control equipment. Apart from F5 avionics, there's little going in defense electronics. The navy is getting three minesweepers and will convert two frigates to minesweepers. The army is shopping for new tanks that presumably would be equipped with Dutch electronics, but there's no firm decision to buy yet.

Belgians mark time waiting for defense orders

Belgium's Flemings and Walloons long have been locked in a bitter linguistic struggle. But when it comes to sizing up the 1968 outlook for electronics, everyone talks the same wistful language.

At first glance, things don't look too bad. A year ago, the prevailing word in the forecasts of Belgian economists was stagnation. The term in vogue now is "slight growth." There'll be an expansion of about 3% next year in the country's economy, most seers agree.

As is usually the case, the electronics industry will move at a faster clip than the economy generally. Electronics magazine pegs the 1968 market at $296.5 million, a respectable rise of nearly 6% from this year's estimated $280 million.

But what people in the industry have been hoping for is a return to the heyday conditions of the early 1960's, when a backlog of military orders and a strong television market kept sales on the upswing. Although sales of computers and process controls will post gains next year, both military and consumer-goods business figure to remain bogged down through 1968. Like just about everybody else in the industry, Jacques Lagrange, managing director of Manufacture Belge de Lampes et de Matériel Electronique (MBLE), sees practically no chance of the long-awaited resurgence in these areas next year.

Wait till next year

There's little in the offing to bolster sales of military hardware in 1968; nonetheless, the year should see some decisions that will make prospects brighter for 1969 and after.

The Belgian army has ordered 300 Leopard tanks from West Germany under an offset deal that eventually will mean $14 million of business foı Belgian electronics producers. But the details of the transaction still have to be pinned down and chances are the contracts won't be let in time to do anybody much good next year.

After it has the tank situation in hand, the Belgian government presumably will make up its mind about a new complement of planes for its air force. The airframe makers seemingly best-placed to land the order—when it comes—are the Northrop Corp., France's Avions Marcel Dassault, and Sweden's Saab AB. No matter who gets the order, there will be avionics business for Belgian producers; but again, it's hardly likely that any will be forthcoming in 1968.

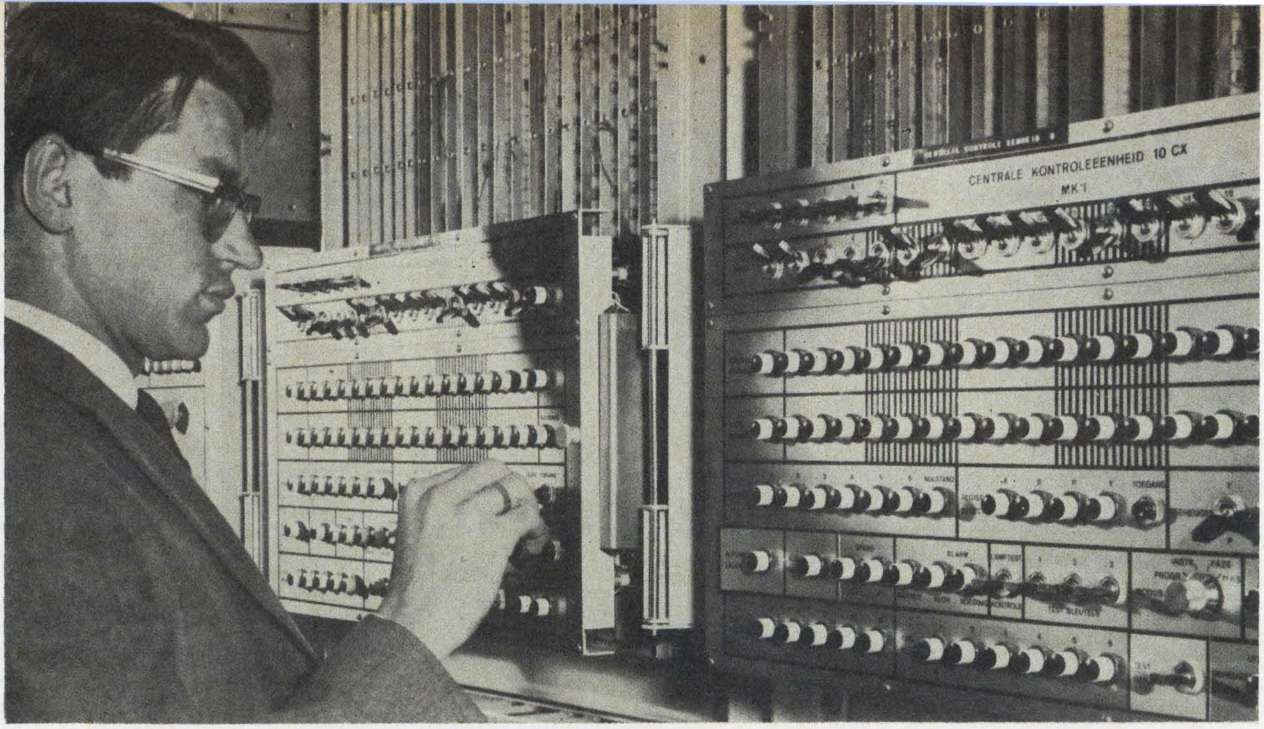
Also up in the air is Belgium's slice of the $300 million that the North Atlantic Treaty Organizations is spending for its NATO Air Defense Ground Environment (Nadge) early-warning network, Western Europe's largest-ever military electronics project. A consortium headed by the Hughes Aircraft Co. has the business. No Belgian company is in the consortium, but there should be $12 million forthcoming in subcontracts as compensation for Belgium's contribution to Nadge. There's nothing definite yet, though, and no one is counting much on Nadge business for 1968.

NATO, however, may have some good news for Ateliers de Construction Electriques de Charleroi. ACEC is in a consortium, with Siemens AG, AEG-Telefunken, and Marconi Ltd., that is expected to get the contract for the ground stations the organization needs for its $45 million tactical satellite communications project.

Belgian makers of sophisticated hardware face a

Belgian electronics market forecasts
(millions of dollars)

	1967	1968
Assembled equipment, total	**280.1**	**296.5**
Consumer products	44.2	44.6
Medical equipment	8.5	9.0
Communications	65.6	73.3
Computers and related equipment	46.2	50.8
Nuclear instruments and equipment	8.8	8.6
Production, control and other equipment	77.8	80.2
Test and measuring equipment	29.0	30.0
Components	**91.3**	**98.0**



Changing exchanges. Belgium's first computer-controlled telephone exchange is getting its field trials at Antwerp. The unit handles 1,000 lines.

lull in space business, too. So far, ACEC, MBLE, and an ITT subsidiary, the Bell Telephone Manufacturing Co. (BTM), have had two principal customers for space gear—the European Launcher Development Organization (ELDO) and the European Space Research Organization (ESRO). Both organizations began their activities with a heavy emphasis on scientific satellites. But space officials in most West European countries—Belgium included—think the time has come to switch to communications satellites. ESRO already has veered in that direction and is currently designing a satellite for the Conférence Européenne des Télécommunications par Satellites (CETS), a group that includes all 10 ESRO countries plus four others.

Another possibility in this area is the Franco-German Symphonie project, in which Belgium and Italy may join. But as with Belgian military projects, nothing yet is firm. Says Georges Bell, BTM's sales manager for military and space hardware, "the gap in space contracts is likely to continue in 1968."

Forward march

Gaps are nowhere to be seen, however, when you turn to computers and process-control systems. Electronics magazine sees a $5 million jump from 1967 to $51 million next year in computer sales, and a $1.5 million climb to $38 million in sales of process controls.

U.S.-controlled companies, as before, will garner most of the computer market, but ACEC will hold its own in controls. The company delivered an automation system to a Belgian cement works this fall and now has a $1 million order for control equipment to regulate the output of two power plants. On top of that, 1968 will see ACEC engineers working on a data-transmission system that will link all of Belgium's power stations.

Another noteworthy bit of ACEC hardware: equipment that automatically inserts subtitles on television film. Small as it is, Belgium has two tv networks, one for Flemish-speaking citizens and the other for French. Since much of the program material is film from Britain and the U.S., subtitling is a substantial chore.

Communications equipment, too, should sell well in Belgium next year. The survey indicates a 10.5% sales climb to $73 million.

Even so, the big Belgian producers of communications hardware will be hustling in export markets, from whence comes much of their business. About three-quarters of BTM's sales of radio links, for example, are to customers outside Belgium.

Although they'll face rougher price competition from British firms because of the devaluation of the pound, the Belgians think they can hold their own in the fast-growing telecommunications markets of Africa and Latin America. "We're optimistic about maintaining our share next year," declares Etienne Reygaerts, the assistant manager of BTM's line and radio transmission division.

For electronic telephone exchanges, too, BTM is optimistic about long-term prospects. The firm's first computer-controlled exchange, a 1,000-line unit, has been put into service in Antwerp by the government-run telephone network.

There's no chance for follow-on orders from the telephone network until the Antwerp exchange has operated successfully for a year or more, but people at BTM aren't particularly perturbed about the lull. Says one executive, "Electronic systems are now industrially feasible and we are just now entering a changeover period that will be spread over perhaps 10 years. But because of our work in Belgium, we can expect an upward turn in the export market in the next year or two."

Slowdown in set sales sobers Swedish outlook

A certain somberness marks the mood of the Swedish electronics industry these days.

The country's affluent economy has the long-haul staying power of a Nordic cross-country skier, but its pace of growth slowed this year and it has yet to catch its second breath. The slowdown has stalled the consumer electronics market and there's no quick upturn in sight. Then, too, the government has reined in defense spending.

The gloom lifts considerably when you turn to other sectors. Although things won't go as swimmingly as they would if the economy were advancing strongly, markets for computers and industrial electronic equipment will register good gains next year. Swedish medical electronics producers consider their prospects bright, as do semiconductor companies.

All told, according to Electronics magazine's survey, the 1968 market in Sweden will run close to $276 million, up from an estimated $258 million this year. Good as this 7% growth seems at first glance, it's a far cry from the expansion pace the industry enjoyed in the early 1960's.

Saab story

Last year, producers of military hardware got the bad news that the 1966-67 defense budget would be trimmed by $50 million, dropping it to $900 million. The government is watching its military spending very closely and presumably will hold the line at an annual $900 million for the next four years.

Hardest hit by the cutback was Saab AB's Viggen—Swedish for thunderbolt—swing-wing fighter project. Instead of the hoped-for 800 planes, the air force will get only 100 as things stand now.

Production should start early in 1968, and heavy spending for the Viggens—ticketed at about $3 million apiece, with about 30% of this going for electronics—will cause a squeeze on other programs over the next three years. Says Gunnar Holmberg, a high-ranking defense ministry official, "The companies involved in the Viggen system will, in general, continue to receive about the same level of business as before, but contractors in other military areas will lose some business."

This prognosis, however, may change after the parliamentary elections next fall. Many believe the cuts in defense spending were made to satisfy the increasingly vocal left wing of the party in power, the Social Democrats. If the party is voted out of power—and many think it will be—defense spending may be boosted. All the opposition parties except the Communists favor higher defense expenditures.

The combination of a saturated tv market and a generally sluggish economy clouds the outlook for Swedish set makers. Laments Erns Hildebeck, head of RTM Marknads AB, a radio-tv marketing concern: "Next year is very uncertain. We have never been so much in doubt about what will happen."

About the best the consumer electronics industry can hope for is to hold its ground. The survey made by Electronics magazine resulted in a consensus projection of a $51 million market, up a scant $2 million from 1967. But to many in the industry, any gain at all will come as a surprise.

There's no relief in sight for tv manufacturers over the next year or two. The government still hasn't set a starting date for colorcasts, but the advent of West German color programs, which can be picked up in the southern part of Sweden, touched off a brief flurry of color-set sales in the latter part of 1967. But earlier expectations of 1968 sales of 30,000 to 40,000 color sets now seem vastly overoptimistic. A second tv network is scheduled to go on the air late in 1969, and many viewers will need new sets to receive it, but this won't spur sales for some time.

Fine footwork

By and large, Swedish firms have shown admirable agility in adapting to the hard times that have come to the consumer and military electronics markets. One of the hardest-hit companies was AGA AB, which pulled out of tv-set manufacturing last year. (Svenska Philips AB now makes sets sold under AGA brands.) AGA was also hurt by the military belt-tightening.

But AGA has recouped some of this lost ground with an aggressive push to build up its educational and medical electronics operations. A video tape recorder for school use has just been given the stamp of approval of the national board of education. And AGA's thermovision infrared camera,

Swedish electronics market forecasts
(millions of dollars)

	1967	1968
Assembled equipment, total	**257.9**	**275.7**
Consumer products	49.2	51.0
Medical equipment	6.9	7.2
Communications	57.6	59.1
Computers and related equipment	45.5	53.2
Nuclear instruments and equipment	6.1	6.5
Production, control and other equipment	58.8	63.0
Test and measuring equipment	33.8	35.7
Components	**98.3**	**102.5**

used to aid medical diagnoses, is selling well.

Saab, which has also been hit by the defense slowdown, has likewise been expanding its medical electronics business. One example here is its Medela computer system. With it, a doctor simply pushes buttons to communicate characteristics of an X ray to a computer, which then types out the diagnosis. According to Anders Boman, sales manager for the instrument division of Saab's electronics department, "We are all very interested in the medical field. I have a feeling it will grow very, very rapidly." Most Swedish medical electronics firms are registering gains of around 20% a year.

Stepping out

Another sector that's moving up sharply is computers. Electronics magazine forecasts volume in this area of $53 million next year, a rise of 15% from 1967. Saab has moved into this market, too. The company started delivery of small and medium multipurpose computer systems late in 1963 and has since come on fast. Gunnar Lindstrom, manager of the company's Datasaab division, says the firm has 30 systems installed and another dozen on order.

Sales of process controls will also continue upward next year and those of data-transmission equipment should spurt. Sales of the latter gear, says Birger Lovgren, an official of Arenco Electronics AB, are rising several hundred percent a year. "We are in this field today just where we were in computers 10 years ago," he states.

There's a strong 1968 market in sight for semiconductors, too. Electronics magazine's forecast: $12.6 million of sales, up nearly 13% from this year. Glenn Marshall, sales manager of the Swedish subsidiary of SGS-Fairchild, looks for an even greater gain in 1969 when Viggen production will be in full swing.

Marshall says his company will start producing monolithic integrated circuits in Sweden next year, making it the first firm to do so. He predicts that IC sales will surge to about $1.4 million next year from this year's level of between $800,000 and $900,000. In 1969, he adds, the IC market will run close to $2.5 million.

Swiss will clock a slow, steady advance

The Swiss electronics market will make steady, unspectacular progress next year.

Electronics magazine forecasts an over-all market of about $209 million in 1968, up by $11 million—or 5.5%—from the estimate for this year.

The communications sector looks very strong, largely because the Swiss don't stint when it comes to hardware to defend their towering Alps and placid valleys. Sales of process-control equipment figure to hold their high level as the country's industrialists strive to keep labor costs in line. And there's action in the offing for integrated circuits. By contrast, the outlook for consumer electronics is lackluster.

Swiss electronics market forecasts
(millions of dollars)

	1967	1968
Assembled equipment, total	**197.8**	**209.1**
Consumer products	45.1	46.4
Medical equipment	5.0	5.2
Communications	57.9	62.2
Computers and related equipment	35.7	38.2
Nuclear instruments and equipment	6.5	7.0
Production, control and other equipment	37.6	39.3
Test and measuring equipment	10.0	10.8
Components	**62.4**	**66.6**

Swiss movement

For Fabrication des Semiconducteurs S.A. (Fasec), 1968 may well be the year it finally happened. The Swiss four years ago mounted an industrywide effort to develop an electronic wristwatch; prototypes of integrated-circuit timepieces were completed this year. These are not the "ultimate" electronic wristwatch with a display rather than moving hands. But they're an advance over movements with tuning-fork-controlled transistor oscillators. Officials at the industry's Horological Electronics Center, which developed the IC watches, say the new movements are fantastically accurate.

The watch industry is still wrangling over plans for production and marketing of the watches, but Fasec apparently is preparing to turn out the circuits next year. The company, a joint venture of Philips' Gloeilampenfabrieken and some leading Swiss firms, has shifted its operations from Neuchâtel to a Philips production plant in Zurich.

Integrated circuits already are part of the scheme of things at Brown, Boveri & Cie., Switzerland's best-known electrical-electronics manufacturer. The company has on the market an IC numerical control system for machine tools that it's touting as the first such by a European company. Other Swiss controls makers surely will follow suit and IC sales should climb as a result. Electronics magazine's survey shows they'll double next year to a total of $800,000.

Nothing for the navy

Switzerland's small but well-equipped armed forces will tonic the 1968 communications market, which will rise to $62 million, according to the survey, from this year's estimated $58 million.

This category includes navigational equipment, for which there will be heavy spending mostly to equip Mirage III fighters. The planes are French, but the Hughes Aircraft Co. is fitting them out with tactical navigation systems. Hughes also has the contract for an early-warning system. The word—not official—from Berne is that the system will cost about $60 million. The two Hughes projects will run for the next two or three years.

Swiss defense officials keep their development work fairly hush-hush, but it's a reasonable guess that they're spending about $8 million annually on R&D. It's known that there's advanced tactical communications equipment in the works, the prototypes of which are scheduled to be completed next year. And Contraves AG, one of the companies in the Oerlikon-Buhrle group and a specialist in military electronics, is leading a team developing an antiaircraft tank that may further buoy the military market in the years ahead.

The market for nuclear instrumentation also continues strong. Two nuclear power plants are under construction and more will follow.

Pale hue

Sales of consumer electronics will show, at best, only a slight gain next year. The forecast puts the market at $46 million, up just $1 million from estimated 1967 sales.

As in so many other countries, the market seems unlikely to surge until color tv catches on. Sets priced at about $750 are on sale; though Swiss colorcasting isn't due until 1970 or 1971, West German programs can be picked up. But the prevailing feeling is that few color sets will be sold next year. "The Swiss are waiting," says a major distributor, "for cheaper sets and better programing."

It's plain in Spain: austerity will curb year's market gain

A serious attack of economic growing pains besets Spain. This year, the Franco government's drive to transform the country's antiquated agricultural economy into a modern industrial one was checked by a recession. Now, to prevent a further slide, the government has instituted an austerity program and devalued the peseta.

Spanish electronics market forecasts
(millions of dollars)

	1967	1968
Assembled equipment, total	**173.3**	**187.2**
Consumer products	87.8	91.1
Medical equipment	4.3	4.9
Communications	23.4	26.5
Computers and related equipment	21.8	26.0
Nuclear instruments and equipment	2.7	2.8
Production, control and other equipment	27.7	30.0
Test and measuring equipment	5.6	5.9
Components	**54.3**	**58.9**

Figures adjusted for November, 1967, devaluation

All this could mean a shakeout in the country's electronics industry, which only a year ago seemed poised for a great leap forward. In consumer electronics, particularly, the going will be rough. Many of the smaller producers may fall by the wayside.

The survey for Spain, made before the economic downturn showed signs of turning into a slump at yearend, puts the over-all electronics market at $187 million, up $14 million from 1967. This forecast almost surely will turn out to be on the high side. The figures have been adjusted downward in accordance with the new exchange rate—70 pesetas to the dollar—but they haven't been further reduced to reflect the other effects of the November devaluation and the austerity measures that came with it.

Color it later

In better days, Spanish television-set makers figured 1968 would be landmark year for them—the year the government had picked to start color broadcasts. Now it's certain that there'll be nothing but black-and-white tv until 1970 at least.

And there's little help in sight from the monochrome market. The forecast pegs it at $72 million, but chances are that it will fall short of this mark. Some 45 companies are vying in the tv market, and even some of the bigger ones have hit heavy weather.

General Electric Española S.A., an affiliate of the General Electric Co., had to shut down its plant for a month this summer to keep its inventory in hand as sales slid. That cost it the number-two spot among Spanish producers, a position now filled by Iberia S.A., a firm wholly owned by Spanish interests.

The market leader, with about 25% of total tv sales, is a Philips' Gloeilampenfabrieken subsidiary, Philips Iberica S.A. The company figures to stay on top and hold its market share. But the other two at the top will have to hustle to stave off challenges by Marconi S.A. and Telera S.A., the Spanish licensee of the Zenith Radio Corp. Marconi is a joint venture of the International Telephone & Telegraph Co., a state investment agency, and a Spanish bank.

Short of the mark

The recession has also checked the growth of the computer market. Instead of the whopping 33% gain predicted for this year, computer sales were held to a rise of about 13%, according to industry estimates. Electronics magazine forecasts a 1968 market of $26 million, an 18% increase from this year's estimated $22 million. But many in the industry would be surprised by even such a modest advance.

Military hardware will be another hard-hit sector. Even before austerity, the government had trimmed its projected outlays for military equipment.

Portugal's lures may turn country into a Hong Kong

Tourists with an eye for a bargain started flocking to Portugal long ago. Now some of the world's biggest electronics companies are following suit.

In a bid to transform the country's backward agricultural economy into a modern industrial one, Dr. Antonio Salazar's regime will launch its third five-year development plan next year. The program includes sizeable inducements to foreign manufacturers to locate in the country, lures so enticing that one American electronics executive on the scene says Portugal may soon become another Hong Kong.

Under the third five-year plan, all the major electronics firms in Portugal will make whopping investments. The industry leader, Standard Electric Portuguesa, has a $30 million plant-expansion program in the offing. The other three heavyweights in the industry, the Portuguese affiliates of Philips' Gloeilampenfabrieken, Britain's Plessey Co., and West Germany's Grundig Werke GmbH, plan capital outlays of about $15 million each. The General Instrument Corp., too, is likely to spend heavily for a new plant.

Looking out

Electronics magazine sees a Portuguese electronics market of about $41.5 million next year, up 11.5% from 1967. Despite this lusty domestic growth, producers in Portugal are counting on exports for the bulk of their 1968 sales.

Standard Electric, for example, expects to export more than 90% of the approximately 30 million semiconductors it will produce next year. The company, a subsidiary of the International Telephone & Telegraph Corp., projects a 50% sales gain next year from this year's estimated $10 million.

Some firms produce exclusively for export, operating in Portugal only because of the availability of low-cost labor and the tax incentives offered exporters. One such is General Instrument, which is producing color-television components for export to the U.S. Another is Fabricação de Conjuntos Electronicos, a joint venture of ITT and the Advance Ross Corp. Prospects are that between 70% and 80% of the electronics hardware produced in Portugal during the next five years will be sold abroad.

Looking in

The development plan, however, will also be felt in the modest domestic market. Some $4 million has been earmarked for telecommunications equipment for the country's airports. And the government apparently plans to expand its television network and the Portuguese microwave-relay system. Next year's market for communications equipment, according to the magazine's survey, will come to $10 million.

The drive to industrialize should indirectly benefit producers of consumer electronics; agricultural workers turning to jobs in plants become more affluent consumers. The full impact of the latest drive, though, won't be felt in this sector next year. The forecast indicates only a slight advance in consumer electronics sales to $12.4 million from this year's $12 million.

Danes melancholy about tv picture in view for 1968

Danish electronics men can expect a respectable gain in their domestic market and continued strong export sales, particularly in Eastern Europe. If there's something rotten in the state of Denmark's industry, it would be prospects for color television broadcasting, the pace of consumer electronics sales, and growing unemployment.

According to Electronics magazine's forecast, the over-all market next year will rise 7% from 1967 to $121 million. Although this figure has been adjusted to represent the new rate of exchange—7.5 krone to the dollar—it does not reflect the impact of the country's recent currency devaluation on the economy. And ay, there's the rub.

There will be some melancholy Danes next year among television-set makers. Black-and-white sales

Danish electronics market forecasts
(millions of dollars)

	1967	1968
Assembled equipment, total	**113.0**	**120.7**
Consumer products	26.7	27.5
Medical equipment	4.0	4.1
Communications	25.2	27.3
Computers and related equipment	24.C	26.3
Nuclear instruments and equipment	2.7	2.9
Production, control and other equipment	22.3	22.8
Test and measuring equipment	8.1	8.8
Components	**40.8**	**42.6**

Figures adjusted for November, 1967, devaluation

are bogged down at a level of about $14 million annually, and there's no substantial lift from color sales in sight. Although Denmark doesn't plan to begin colorcasting on a regular basis until the early or middle 1970's, Bang & Olufsen is producing a color set for those in the southern section of the country who want to pick up German programs. Priced at $1,000, the set is well out of the reach of the average Dane, and efforts to sell it in Germany have so far been disappointing.

The results of these attempts to export the color set are not typical of exports generally. Industrial electronics firms have been selling up to 85% or more of their products abroad, with Eastern Europe being the fastest growing market. RegneCentralen, a Danish computer maker, recently sold one of its machines to Poland and has mounted an active sales compaign in other Eastern-Bloc countries.

Yugoslavia's rein on credit, imports stalls electronics

Whether he's a consumer with a yen for a new television set or a factory director with expansion plans, the average Yugoslavian finds himself in the same bind—getting credit.

The continuing credit squeeze is bad news for the country's electronics producers. Coupled with other moves by the Tito government to bolster the dinar, it has brought a fast-expanding industry to a temporary standstill.

Next year, the Yugoslavian electronics market will rise a scant $3 million from the estimated 1967 level to $106 million, according to Electronics magazine's survey.

When the brakes are put on consumer credit, the television market usually is the first to skid. And skid it has in Yugoslavia, where the cheapest set costs about $150 and the average citizen earns some $60 a month.

Yugoslavians last year snapped up 286,000 sets. This year, it's estimated, sales came to about 200,000 units. The state of the market is such that the country's top set producer, Electronics Industries of Nis (EIN), raffles off a car every month among its customers. Even so, EIN has at the moment a staggering inventory of 40,000 sets and faces the prospect of a further decline of 10% in the market next year.

Sales of radios, record players, and tape recorders, however, figure to run strong, and they'll partly offset the drop in tv sales. But the over-all consumer electronics market will slip by $2 million to $56 million in 1968, the survey indicates.

Double trouble

The government's campaign to strengthen the dinar has brought still other woes to electronics producers. The country's railroad system, for example, has a massive modernization program in the works that includes considerable electronics hardware. But the business most likely will go to foreign suppliers because Yugoslavian firms can't arrange the long-term credits rail officials want.

Especially annoying are the government's tight restrictions on foreign exchange. Generally speaking, producers can spend for imported components only about the same amount of foreign currency their exports bring in, and this leads to a vicious circle. Without crucial imported components, some producers can't build their hardware for export, and they can't buy the components until they've earned the foreign exchange from exports.

Kresa Piskulic, director general of Radio Industries of Zagreb (RIZ), says his organization has a $2 million annual market for small, high-frequency radio-link equipment but that it turned out only $300,000 worth this year because it couldn't buy all the imported components it needed. Both RIZ and EIN have been forced to forsake most of their profit margins on the tv sets they sell in export markets because they need the foreign exchange to get what's necessary to build profit-making products.

Teaming up

But in one important way, the industry's current difficulties have had a salutory effect. In the past, there's been a lot of costly duplication in components production among Yugoslavia's four leading electronics companies. Largely because of the squeeze, RIZ and two of the other leaders—Iskra and Rudi Cajavec—have agreed to pool their components production, with each concentrating on certain items. And their biggest competitor, EIN, has worked out the same sort of deal with a group of smaller concerns.

Russia emerging as customer for electronics

Gradually and quietly, the Soviet Union has become an electronics market. British avionics gear is going into the supersonic transport plane nearing completion outside Moscow. The French Secam system is the basis for color telecasts. Italian automation systems will help to mass-produce automobiles at a huge plant to be built on the Volga.

And this is just a start. In the immediate future the hottest import items figure to be computers, computer equipment, and electronic instruments. But the Russians make it clear they're looking for long-term arrangements under which they can sell as well as buy. Declares Vladimir Alekseevich Kirillin, chairman of the State Committee on Science and Technology: "We are very serious about trade and technological cooperation. These things are included in our long-range plans, and we must be sure we can depend on deliveries."

Reciprocity is stressed by Kirillin, the country's research-and-development chief. "It is impossible that one country is the most advanced in every field. That is fantasy."

Kirillin, a 54-year-old thermal physicist who chain smokes American L&M cigarettes, represents the internationalist faction now controlling Soviet science and technology. "My personal view is that science cannot develop fruitfully without international contacts," he says. "This committee's goal is to stimulate such exchanges."

Not quite shut out

As long as Soviet-American relations remain strained, choice positions in the race for the Russian market will be held by Japanese and West European companies—including, paradoxically, many affiliates of U.S. concerns. One knowledgeable Western diplomat in Moscow estimates that one-third of all Soviet imports from capitalist countries involve either U.S. affiliates, U.S. products, or U.S. licenses.

For American companies, the biggest obstacle to direct negotiations remains the U.S. embargo on strategic exports to the Soviet Union. To be sure, in 1966 only 166 applications for U.S. export licenses were rejected—3% of the 5,500 requests made. But the mere existence of the requirement is a deterrent to trade; many companies simply don't bother to apply.

The Americans' dilemma has been voiced most articulately by a West German whose business relations with the Russians preceded World War II. "You must be able to decide on the spot here; the Russians can't wait two or three months to find out whether it's all right to make a deal. When a Soviet trade official finally receives both permission and money, somebody here also has a plan to fulfill and the trade man must act. To protect himself when dealing with uncertain sellers—notably Americans—he also deals simultaneously with the Germans and Italians and Swedes."

Computers should stay at the top of the Soviet shopping list for several years. Domestic production is slow, and most Soviet-built digital machines are notoriously unreliable. While they're interested in central processors, the Russians are excited about peripherals. In the few recent sales by Western computer companies, nearly 50% of the over-all price has covered peripherals.

Long-term pacts

The trend is toward close, long-term agreements with big foreign companies such as Plessey of Britain and Olivetti of Italy. Plessey's present five-year agreement provides generally for exchanges of delegations and information—not sales—but the British company obviously hopes the contacts will result in profits. Olivetti is active here in the small-computer and desktop-calculator fields. One problem for the Italian company is its tie to the General Electric Co. of the U.S. When Olivetti won a $2.4-million Soviet order for data-processing systems to be installed in the Fiat plant on the Volga, the sale had to be cleared with Washington.

Rated near computers in importance is instrumentation. Soviet aircraft and airports already make use of British instruments, and Japanese and West German instruments are finding increasing application in Soviet laboratories.

When a planner on Kirillin's committee was asked to list some of the 246 "priority research areas" with which the group concerns itself, he put "instruments for measurement and control" immediately after computers. Other sectors mentioned included solid state and particle physics, microbiology, and nuclear power.

This report was compiled by Arthur Erikson, Electronics Abroad editor. The forecasts came from Milton Drake, director of research, who surveyed more than 100 industry associations, government agencies, banks, and companies to gather market estimates for 1967 and predictions for 1968. The forecasts represent a consensus of their predictions.

Reports on market trends came from John Gosch, Bonn; Peter Kilborn, Paris; Michael Payne, London; Jack Star, Milan; Richard Shepherd, Brussels; Dave Jenkins, Stockholm; Laura Pilarski, Zurich, Dominic Curcio, Madrid; Barry Edgar, Copenhagen; Martha de la Cal, Lisbon; Joe Peters, Belgrade; and Howard Rausch, Moscow.

Reprints of this report are available at $1 each.

European electronics markets 1968

COMPONENTS, in millions of dollars[1]	Belgium-Luxembourg		Denmark		France
	1967	1968	1967	1968	1967
Antennas	1.1	2.5	1.8	1.8	20.0
Cabinets and racks	3.3	3.6	0.5	0.5	15.1
Capacitors, fixed and variable	5.7	5.9	3.0	3.1	47.3
Coils (including intermediate frequency)	0.9	1.0	0.3	0.3	11.2
Connectors	1.0	1.1	1.3	1.3	23.5
Crystals and crystal filters	0.4	0.5	0.7	0.7	2.6
Delay lines	0.7	0.7	0.1	0.2	1.2
Electronics hardware	4.1	4.3	0.9	0.9	16.4
Ferrite devices	1.2	1.4	0.5	0.5	3.3
Filters and networks (except crystal)	0.6	0.6	0.3	0.3	4.8
Loudspeakers	2.5	2.7	0.5	0.5	7.6
Magnetic tape	2.2	2.5	1.1	1.2	8.1
Potentiometers	1.0	1.3	1.2	1.3	10.5
Power supplies (OEM type)	2.3	2.4	1.4	1.5	8.1
Printed circuits	2.7	2.6	1.3	1.2	9.4
Relays	4.2	4.4	2.7	2.7	29.2
Resistors, fixed	3.9	3.9	1.1	1.2	21.0
Semiconductors, diode[2]	2.5	2.5	0.9	1.0	14.2
Semiconductors, integrated circuit and hybrid	0.5	1.7	0.2	0.4	7.0
Semiconductors, transistor	4.5	5.0	3.1	3.3	45.6
Semiconductors, special[3]	2.0	2.4	0.9	1.0	13.3
Servos and synchros	0.8	0.8	0.2	0.2	4.7
Subassemblies	8.3	8.1	2.0	2.1	35.5
Switches, manual	1.2	1.3	0.8	0.9	9.2
Transducers	1.5	1.5	0.6	0.6	10.9
Transformers and chokes	7.2	7.4	3.9	4.0	21.0
Tubes, receiving types	3.6	3.2	1.2	1.1	21.2
Tubes, power types	2.0	2.0	0.7	0.7	20.0
Tubes, picture	7.1	8.2	3.7	4.0	33.6
Wire and cable (for electronics)	4.3	4.5	2.1	2.1	18.5
Other components	8.0	8.0	1.8	2.0	11.0
TOTAL CONSUMPTION, components	**91.3**	**98.0**	**40.8**	**42.6**	**505.0**

NOTE: Figures for Denmark, Spain, and the United Kingdom are adjusted for devaluation but do not reflect changes in markets that the d

1—Includes components used to produce equipment both consumed domestically and exported.

2—Diodes rated 200 milliamps or less.

3—Includes diodes rated higher than 200 ma, silicon controlled rectifiers, light-emitting devices, etc.

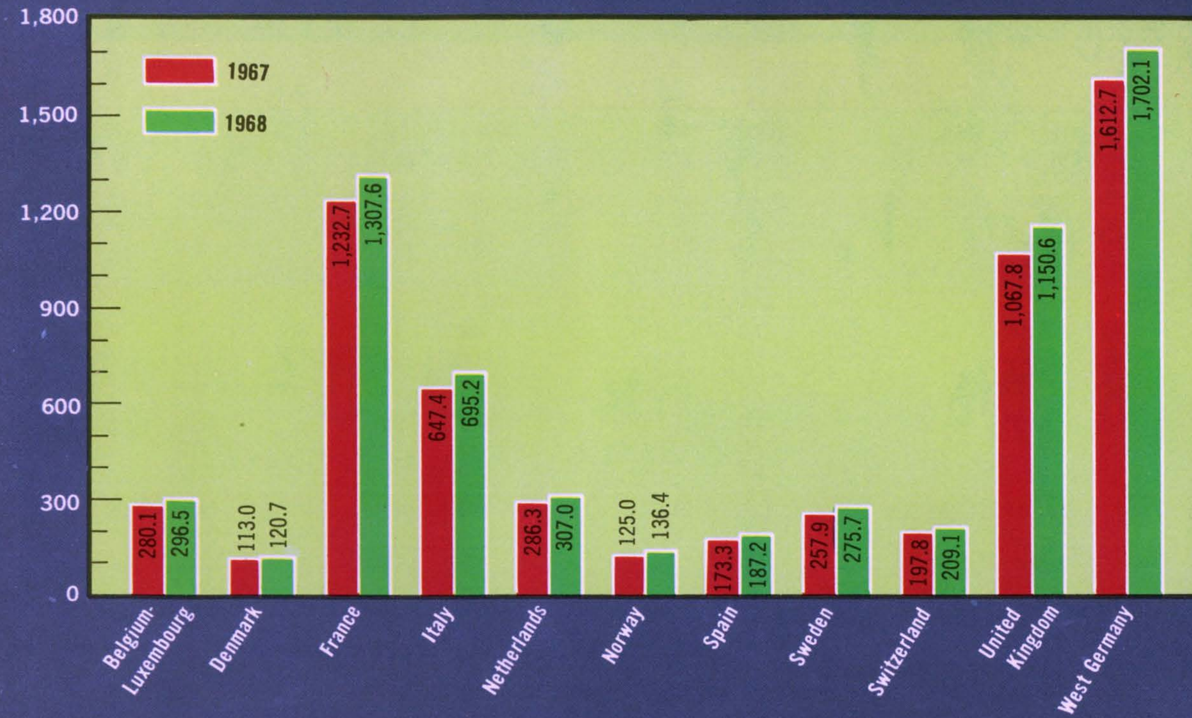
* Less than $0.075 million.

8

Sweden		Switzerland		United Kingdom		West Germany		TOTALS	
967	1968	1967	1968	1967	1968	1967	1968	1967	1968
49.2	51.0	45.1	46.4	274.2	313.9	438.8	453.8	1,649.4	1,722.9
4.0	4.2	8.8	8.9	25.1	23.8	28.4	29.6	128.9	130.2
6.6	6.4	8.5	8.3	36.4	33.0	105.5	99.5	288.3	274.4
3.2	3.4	2.3	2.5	9.5	9.3	21.8	22.2	64.3	67.0
32.1	33.6	20.3	21.1	150.0	144.0	180.0	170.0	958.9	935.6
0.3	0.2	*	0.1	14.6	64.3	53.1	80.5	77.2	179.8
3.0	3.2	5.2	5.5	38.6	39.5	50.0	52.0	131.8	135.9
6.9	7.2	5.0	5.2	25.9	26.8	48.4	49.8	148.4	154.8
1.3	1.4	1.1	1.1	4.5	4.6	9.5	10.0	25.4	26.7
0.1	0.1	0.1	0.1	1.4	1.4	2.8	2.9	7.0	7.2
0.3	0.3	0.3	0.3	2.1	2.2	2.6	2.8	9.8	10.2
1.2	1.2	0.9	1.0	4.7	4.9	7.2	7.5	30.5	32.2
2.2	2.3	1.6	1.6	8.5	8.7	16.3	16.6	44.2	45.5
1.8	1.9	1.0	1.1	4.7	5.0	10.0	10.0	31.5	33.0
57.6	59.1	57.9	62.2	302.4	311.0	421.9	427.3	1,494.3	1,546.8
8.1	8.0	7.0	7.2	17.6	18.9	16.8	17.4	116.8	127.8
0.3	0.3	0.2	0.2	3.5	5.4	4.8	5.5	16.0	19.5
3.6	3.7	2.8	2.9	17.7	18.4	46.5	48.0	112.4	117.6
5.5	5.7	1.1	1.2	21.2	25.5	54.4	53.8	130.5	138.3
3.0	3.2	0.6	2.6	25.2	25.7	23.0	23.6	96.5	104.7
28.4	29.5	40.0	42.0	101.1	104.6	151.5	150.0	584.0	583.2
3.1	3.0	2.1	2.0	44.1	41.6	68.2	69.7	198.0	205.6
1.5	1.6	1.5	1.5	20.2	22.5	15.7	17.3	74.0	81.0
0.1	0.1	0.1	0.1	4.7	5.5	6.0	7.0	16.5	20.0
4.0	4.0	2.5	2.5	47.1	42.9	35.0	35.0	149.6	149.1
45.5	53.2	35.7	38.2	233.7	257.3	298.2	347.5	1,128.1	1,295.9
1.0	1.2	0.5	0.3	4.4	5.3	6.5	8.6	23.3	28.9
0.2	0.3	0.1	0.1	2.0	3.3	2.5	3.0	10.3	14.8
31.1	36.4	26.0	28.5	158.6	173.5	178.8	212.0	698.5	809.6
0.6	0.7	0.4	0.5	12.3	12.9	8.4	9.6	77.8	89.9
3.3	3.7	3.0	2.5	8.1	9.0	15.3	20.5	56.4	66.4
2.5	3.0	1.7	1.7	15.4	16.9	18.8	20.3	69.1	76.1
1.8	2.1	1.0	1.1	8.0	9.0	22.9	25.0	52.2	58.3
5.0	5.8	3.0	3.5	24.9	27.4	45.0	48.5	140.5	151.9
6.1	6.5	6.5	7.0	11.8	12.2	20.7	21.5	101.0	105.6
0.8	0.8	1.5	1.5	2.2	2.4	3.6	3.7	18.5	19.4
1.3	1.3	1.0	1.1	1.9	1.9	3.1	3.2	16.4	17.3
1.2	1.3	1.0	1.1	2.2	2.2	4.2	4.5	18.4	19.7
1.0	1.0	1.2	1.3	2.1	2.1	3.2	3.6	16.1	16.8
0.3	0.4	0.3	0.4	0.4	0.6	1.6	1.5	7.1	7.5
1.5	1.7	1.5	1.6	3.0	3.0	5.0	5.0	24.5	24.9
58.8	63.0	37.6	39.3	159.3	166.4	279.2	291.8	1,032.2	1,097.2
0.6	0.6	0.5	0.5	4.4	4.5	6.5	6.8	19.8	21.0
1.4	1.5	0.7	0.7	5.1	5.3	9.7	9.9	27.3	28.8
2.7	2.9	1.5	1.6	7.5	7.9	23.6	24.5	61.2	65.4
8.5	9.0	3.2	3.3	17.6	19.5	31.9	33.4	120.9	130.4
5.5	5.8	3.5	3.6	11.1	11.6	25.0	27.5	85.7	92.8
0.9	0.9	0.2	0.3	2.7	2.7	6.2	6.4	15.0	15.9
8.7	8.9	4.5	4.7	17.1	18.3	21.6	22.1	111.0	117.8
26.6	29.0	19.8	20.5	64.3	66.9	98.0	102.0	430.8	456.5
0.4	0.6	0.5	0.6	3.8	4.0	6.7	7.2	19.9	24.5
3.5	3.8	3.2	3.5	25.7	25.7	50.0	52.0	140.6	144.1
33.8	35.7	10.0	10.8	60.5	63.0	105.5	110.4	440.6	464.9
0.2	0.2	*	0.1	1.0	1.1	2.6	2.9	7.2	7.8
1.7	1.8	0.5	0.6	2.5	2.7	4.1	4.2	19.0	20.0
2.1	2.3	0.3	0.4	1.3	1.5	3.8	4.1	18.9	20.5
2.2	2.3	0.5	0.5	3.1	3.4	3.2	3.4	19.3	20.6
1.1	1.2	0.4	0.4	4.2	4.5	8.0	8.4	30.2	32.0
5.7	6.0	1.1	1.2	4.8	4.9	11.9	12.6	50.3	53.4
1.2	1.2	0.3	0.3	1.9	2.1	4.3	4.5	17.3	18.1
5.9	6.4	1.8	1.9	14.8	15.2	18.5	19.6	84.4	89.4
3.0	3.1	0.9	0.9	3.4	3.4	6.8	7.0	34.2	35.4
2.9	3.0	1.2	1.3	4.4	4.7	8.2	8.6	42.8	44.5
2.3	2.4	0.8	0.9	4.7	5.1	5.6	6.0	27.6	29.5
0.3	0.3	0.2	0.2	1.5	1.5	3.5	4.1	9.2	10.4
5.2	5.5	2.0	2.1	12.9	12.9	25.0	25.0	80.2	83.3
57.9	275.7	197.8	209.1	1,067.8	1,150.6	1,612.7	1,702.1	5,994.0	6,388.1

EQUIPMENT MARKETS

Millions of dollars



	Italy		Netherlands		Norway		Spain	
1968	1967	1968	1967	1968	1967	1968	1967	1968
21.0	5.0	5.2	2.6	2.6	2.1	2.3	5.9	6.6
15.7	6.8	7.1	4.2	4.3	0.6	0.6	0.6	0.7
49.8	12.5	13.0	8.9	9.2	3.6	3.8	4.2	4.5
11.2	4.0	5.0	2.1	2.2	0.4	0.4	0.9	0.9
24.6	8.2	8.7	4.1	4.3	1.6	1.7	2.7	3.0
2.7	1.4	1.5	1.0	1.0	0.6	0.7	0.3	0.3
1.2	0.8	1.0	0.8	0.8	0.2	0.2	0.1	0.1
16.6	8.0	8.5	5.0	5.1	2.4	2.6	1.8	2.0
3.6	2.5	2.8	2.0	2.2	1.0	1.1	0.3	0.4
4.5	1.6	1.6	0.9	0.9	0.6	0.6	0.2	0.2
7.9	2.2	2.3	5.2	5.3	1.2	1.3	1.7	2.0
8.4	3.1	3.2	2.1	2.2	1.8	1.9	1.1	1.3
11.2	4.0	4.2	2.2	2.3	1.4	1.5	1.7	1.9
8.5	7.5	9.0	6.3	6.4	2.1	2.3	1.1	1.2
9.2	2.0	1.9	1.4	1.3	1.7	1.9	0.3	0.3
30.6	11.1	11.6	5.8	5.9	3.2	3.5	2.3	2.6
22.1	8.4	8.9	4.6	4.8	1.1	1.2	1.9	2.1
14.8	3.0	3.5	2.0	2.1	0.5	0.6	0.5	0.6
10.0	1.4	3.3	1.3	2.5	0.1	0.2	*	0.2
47.5	14.5	17.4	8.1	7.7	3.2	3.5	3.4	3.7
14.1	3.6	4.5	3.5	4.9	1.4	1.6	0.2	0.3
4.9	1.5	1.6	2.5	2.5	0.1	0.1	0.2	0.2
35.0	14.0	15.0	10.8	11.2	1.2	1.3	0.3	0.3
9.6	2.2	2.3	1.2	1.3	1.7	2.0	1.0	1.1
11.5	3.7	4.1	1.9	1.9	2.9	3.2	0.3	0.3
22.0	10.3	11.9	9.4	9.7	4.5	4.8	4.3	4.5
20.3	17.4	17.8	12.3	11.2	0.5	0.4	1.5	1.4
21.6	11.9	12.7	7.4	8.1	0.4	0.5	1.9	2.0
47.0	31.6	33.5	23.8	23.9	1.3	1.5	8.9	9.2
18.6	9.4	10.6	6.2	6.3	2.8	3.0	2.6	2.7
12.0	8.0	9.0	5.0	5.0	2.0	2.2	2.1	2.3
537.7	221.6	242.7	154.6	159.1	48.2	52.5	54.3	58.9

evaluations might cause.

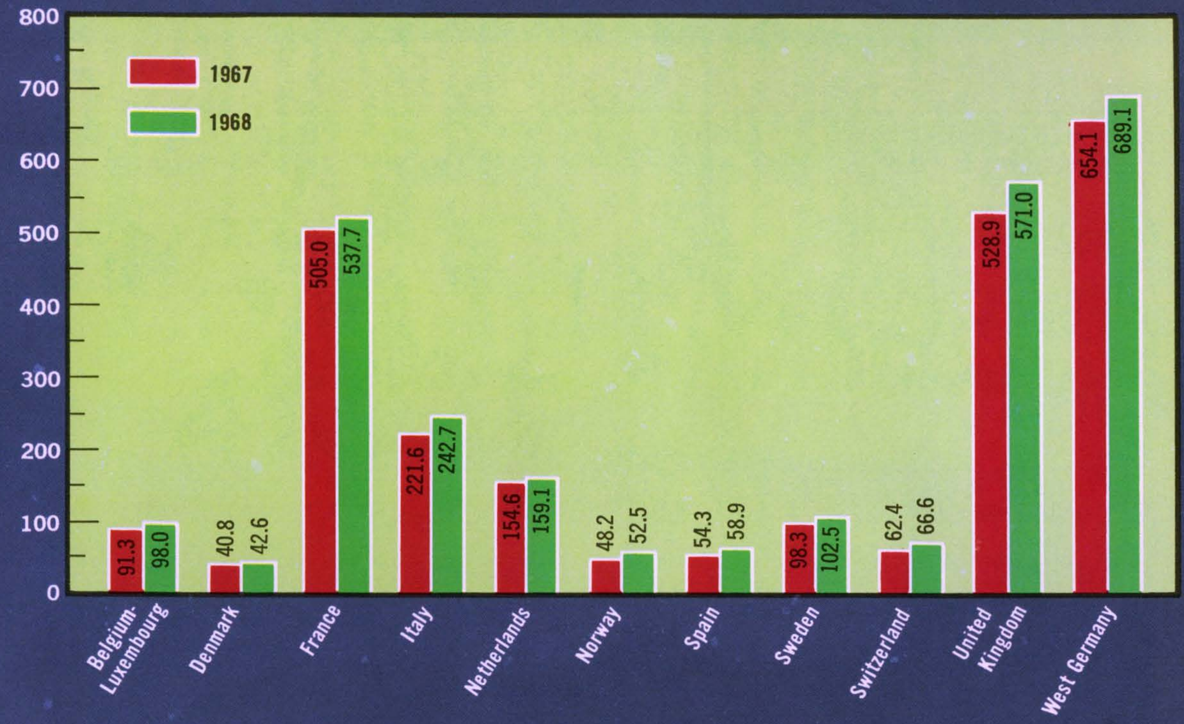
ropean electronics markets —196

Italy		Netherlands		Norway		Spain	
1967	**1968**	**1967**	**1968**	**1967**	**1968**	**1967**	**1968**
267.6	**273.7**	**40.8**	**42.3**	**25.0**	**25.3**	**87.8**	**91.1**
21.7	21.5	4.8	4.9	1.8	1.9	4.7	4.5
37.4	36.9	8.0	7.7	5.5	5.3	13.0	12.9
6.5	7.3	1.9	2.0	2.2	2.3	0.8	0.9
196.0	202.0	21.3	21.6	13.5	13.8	68.6	72.0
*	*	0.8	1.9	*	*	*	*
6.0	6.0	4.0	4.2	2.0	2.0	0.7	0.8
9.3	**9.9**	**7.6**	**7.9**	**4.0**	**4.4**	**4.3**	**4.9**
1.5	1.6	1.2	1.2	0.6	0.7	0.3	0.4
0.3	0.3	0.3	0.3	*	*	0.3	0.3
0.6	0.6	0.5	0.5	0.1	0.1	0.4	0.4
5.2	5.5	1.6	1.7	0.7	0.8	2.0	2.1
0.7	0.7	2.0	2.1	1.2	1.3	0.3	0.4
1.0	1.2	2.0	2.1	1.4	1.5	1.0	1.3
106.1	**112.3**	**72.4**	**74.5**	**32.4**	**36.0**	**23.4**	**26.5**
10.4	11.7	4.7	5.0	5.2	6.0	5.8	6.4
2.1	2.4	0.5	0.5	*	0.1	0.2	0.2
6.0	6.6	4.8	4.9	1.7	2.0	1.6	1.9
8.9	10.5	4.7	4.6	1.8	1.9	1.5	1.8
9.1	11.0	3.7	4.0	1.9	2.1	1.3	2.1
45.0	40.0	37.2	38.1	16.7	17.9	6.5	6.9
16.5	21.5	5.5	5.7	2.2	2.4	4.5	5.1
1.9	2.4	0.5	0.3	0.8	0.9	0.3	0.4
0.2	0.2	0.3	0.4	0.1	0.5	*	*
6.0	6.0	10.5	11.0	2.0	2.2	1.7	1.7
123.9	**147.8**	**43.5**	**53.3**	**28.4**	**31.7**	**21.8**	**26.0**
2.2	3.0	1.0	1.2	0.9	1.0	0.7	0.9
0.8	1.5	0.8	0.9	1.3	1.5	0.3	0.4
81.0	99.0	25.0	30.0	18.0	20.0	13.7	16.3
5.4	6.2	2.0	3.0	2.0	2.4	1.0	1.2
2.9	3.1	3.0	4.0	3.5	3.5	0.9	0.9
8.4	9.5	2.3	2.6	1.1	1.3	0.4	0.5
3.2	3.5	1.9	3.1	0.6	0.7	0.5	0.7
20.0	22.0	7.5	8.5	1.0	1.3	4.3	5.1
9.4	**9.9**	**8.8**	**9.3**	**2.9**	**3.5**	**2.7**	**2.8**
1.5	1.6	1.8	1.9	0.5	0.6	1.0	1.0
1.4	1.6	1.0	1.1	0.7	0.8	0.3	0.3
1.7	1.9	1.8	2.0	0.4	0.5	0.4	0.4
1.0	1.0	2.0	2.0	0.4	0.5	0.4	0.4
0.8	0.8	0.7	0.8	0.3	0.4	0.1	0.1
3.0	3.0	1.5	1.5	0.6	0.7	0.5	0.6
87.8	**95.9**	**66.9**	**72.0**	**22.6**	**24.8**	**27.7**	**30.0**
1.7	1.8	0.8	0.8	0.3	0.3	0.3	0.3
1.8	1.8	1.8	1.9	0.3	0.4	0.4	0.4
5.1	5.3	3.0	3.2	0.7	0.7	0.7	0.8
11.5	11.9	8.9	9.2	3.4	3.7	2.6	2.8
5.5	5.6	8.0	8.4	1.2	1.3	2.7	3.1
1.0	1.0	1.1	1.2	0.3	0.3	0.1	0.2
9.7	10.5	9.6	10.0	3.3	3.5	3.1	3.4
40.0	46.4	28.2	31.5	11.5	12.7	13.5	14.1
1.5	1.6	1.0	1.1	0.1	0.1	1.1	2.0
10.0	10.0	4.5	4.7	1.5	1.8	2.6	2.9
43.3	**45.7**	**46.3**	**47.7**	**9.7**	**10.7**	**5.6**	**5.9**
0.5	0.5	0.6	0.6	0.1	0.1	0.1	0.1
2.0	2.2	3.1	3.2	0.4	0.4	0.3	0.3
2.1	2.2	2.9	3.1	0.6	0.7	0.2	0.2
3.0	3.2	1.8	1.9	0.3	0.4	0.3	0.4
3.2	3.3	2.5	2.5	0.6	0.7	0.2	0.3
3.9	4.2	7.0	7.2	2.4	2.6	0.1	0.1
1.2	1.4	1.6	1.6	0.3	0.3	0.3	0.3
7.4	7.8	7.7	7.9	1.6	1.7	1.1	1.2
3.3	3.5	4.3	4.5	0.8	0.8	0.6	0.6
5.0	5.1	6.7	6.6	1.3	1.4	0.9	0.9
4.0	4.2	3.1	3.2	0.6	0.7	0.5	0.5
0.7	0.8	1.0	1.2	0.2	0.3	0.1	0.1
7.0	7.3	4.0	4.2	0.5	0.6	0.9	0.9
647.4	**695.2**	**286.3**	**307.0**	**125.0**	**136.4**	**173.3**	**187.2**

s might cause.

COMPONENTS MARKETS

Millions of dollars



Sweden		Switzerland		United Kingdom		West Germany		TOTALS	
1967	1968	1967	1968	1967	1968	1967	1968	1967	1968
3.7	3.8	3.5	3.6	11.4	11.6	34.3	36.4	91.4	97.4
2.5	2.6	0.9	0.9	13.3	13.6	19.5	18.2	67.3	67.8
8.1	8.4	6.0	6.4	49.0	51.8	66.6	69.9	214.9	225.8
1.1	1.1	0.5	0.5	12.3	12.8	17.2	18.3	50.9	53.7
2.7	2.8	3.6	3.8	26.7	27.9	23.5	24.6	98.9	103.8
0.8	0.9	0.9	1.0	6.7	6.9	2.1	2.1	17.5	18.3
0.5	0.5	0.2	0.2	1.8	1.9	3.1	3.2	9.5	10.0
3.6	3.7	1.2	1.3	14.9	15.8	21.8	22.5	80.1	83.3
1.0	1.1	1.0	1.1	10.7	11.8	5.2	5.6	28.7	31.6
0.8	0.8	0.5	0.5	5.6	6.9	5.9	6.3	21.8	23.2
0.7	0.8	0.5	0.6	6.8	8.1	14.5	15.6	43.4	47.1
2.3	2.4	2.0	2.1	6.8	7.1	9.0	9.2	39.6	41.5
2.0	2.0	1.4	1.5	10.7	11.3	18.5	19.1	54.6	57.6
2.9	3.0	2.1	2.1	7.0	7.4	13.2	13.4	54.0	57.2
3.2	3.3	1.4	1.4	9.0	9.3	11.1	10.7	43.5	43.1
6.5	6.7	4.0	4.3	23.6	25.5	17.0	18.0	109.6	115.8
2.2	2.3	2.0	2.1	19.6	21.6	29.1	29.4	94.9	99.6
1.8	2.2	2.6	3.0	10.3	9.4	16.5	17.7	54.8	57.4
0.9	1.5	0.4	0.8	11.3	20.4	4.7	7.6	27.8	48.6
5.7	6.0	5.0	5.3	43.0	41.3	46.5	49.0	182.6	189.7
2.7	2.9	0.3	0.4	21.1	23.1	12.6	14.5	61.6	69.7
1.2	1.2	1.0	1.0	2.8	3.1	7.0	7.1	22.0	22.7
4.7	4.6	0.5	0.6	29.1	30.3	44.9	42.6	151.3	151.1
2.2	2.3	1.4	1.5	14.0	14.6	15.5	15.7	50.4	52.6
2.3	2.3	1.5	1.6	8.5	8.7	15.8	16.3	49.9	52.0
7.8	8.0	5.7	5.9	21.0	22.1	40.8	41.5	135.9	141.8
3.3	3.1	1.3	1.2	26.9	25.8	24.3	23.6	113.5	109.1
2.0	2.3	1.5	1.6	42.9	45.7	26.4	27.5	117.1	124.7
8.6	8.8	3.0	3.4	33.4	45.4	37.0	48.5	192.0	233.4
5.5	5.7	4.0	4.2	20.1	20.4	30.5	32.0	106.0	110.1
5.0	5.4	2.5	2.7	8.6	9.4	20.0	23.0	74.0	81.0
98.3	102.5	62.4	66.6	528.9	571.0	654.1	689.1	2459.5	2620.7

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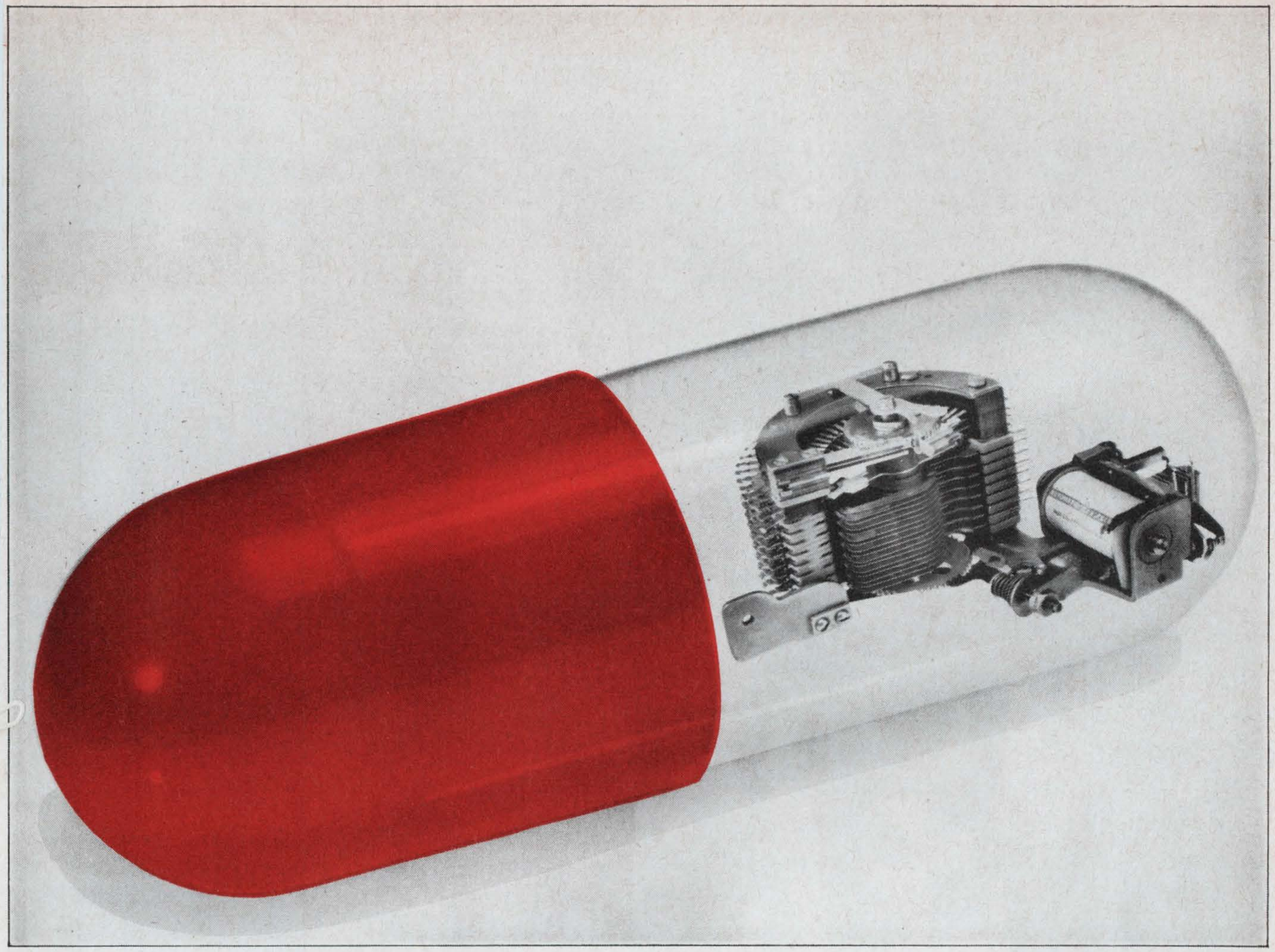
ASSEMBLED EQUIPMENT, in millions of dollars[1]	Belgium-Luxembourg 1967	Belgium-Luxembourg 1968	Denmark 1967	Denmark 1968	France 1967	France 1968
CONSUMER PRODUCTS, total	**44.2**	**44.6**	**26.7**	**27.5**	**350.0**	**353.3**
Phonographs and radio combinations	5.7	5.7	1.8	1.9	22.1	23.3
Radios	8.5	8.2	4.4	4.3	54.5	51.9
Tape recorders (for home use)	1.4	1.5	2.3	2.5	12.4	13.1
Television sets, black and white	23.0	23.2	14.1	14.3	240.0	220.0
Television sets, color	0.6	0.8	1.8	2.0	6.0	30.0
Other consumer products	5.0	5.2	2.3	2.5	15.0	15.0
MEDICAL EQUIPMENT, total	**8.5**	**9.0**	**4.0**	**4.1**	**24.5**	**25.6**
Analytical laboratory equipment, electronic	1.2	1.3	0.6	0.6	3.6	3.8
Diathermy (short wave) equipment	0.2	0.2	*	*	1.5	1.6
Electrocardiographs and electroencephalographs	0.5	0.5	0.1	0.1	2.3	2.4
Hearing aids	1.5	1.6	1.0	1.1	4.5	4.8
X-ray equipment, medical	2.9	3.1	0.9	0.9	7.6	7.8
Other medical electronic equipment	2.2	2.3	1.4	1.4	5.0	5.2
COMMUNICATIONS, total	**65.6**	**73.3**	**25.2**	**27.3**	**329.4**	**337.3**
Broadcast equipment	7.0	10.8	3.7	4.0	30.5	32.4
Closed circuit television	0.6	0.8	0.2	0.3	3.6	3.8
Intercoms and sound systems	3.3	3.6	1.9	2.1	22.5	23.5
Land mobile	3.2	3.4	2.8	3.1	25.4	26.8
Microwave relay systems	3.7	3.9	0.8	0.9	24.2	25.6
Navigational equipment, air and marine	27.8	28.6	9.8	10.6	120.0	115.0
Radar	4.0	4.0	2.9	3.1	44.9	47.5
Telemetry	2.4	2.6	0.7	0.8	28.5	30.7
Telephone switching, electronic	0.1	0.1	0.1	0.1	4.8	6.0
Other communications equipment	13.5	15.5	2.3	2.3	25.0	26.0
COMPUTERS AND RELATED EQUIPMENT, total	**46.2**	**50.8**	**24.0**	**26.3**	**227.2**	**263.8**
Analog and hybrid computers	1.6	1.5	0.3	0.3	4.2	5.6
Converters: analog-digital, digital-analog	0.5	0.7	0.1	0.1	1.7	3.0
Digital computers, business types	28.2	31.7	18.1	20.2	120.0	142.0
Digital computers, military types	2.0	2.2	1.1	0.1	42.6	50.3
Digital computers, scientific types	2.7	3.0	1.4	1.6	12.3	14.6
Memories	1.0	1.3	0.7	0.8	16.8	18.2
Readers and readout devices	2.2	2.4	0.5	0.6	9.6	10.1
Other computer-related equipment	8.0	8.0	1.8	1.8	20.0	20.0
NUCLEAR INSTRUMENTS AND EQUIPMENT, total	**8.8**	**8.6**	**2.7**	**2.9**	**20.6**	**21.4**
Accelerators	1.0	1.0	0.4	0.4	4.2	4.5
Analyzers	1.7	1.7	0.5	0.6	3.5	3.7
Radiation monitoring equipment	1.6	1.6	0.4	0.5	3.5	3.7
Reactor controls	1.5	1.5	0.3	0.3	3.0	3.1
Semiconductor and other detectors	1.0	0.9	0.2	0.2	1.4	1.4
Other nuclear instruments and equipment	2.0	1.9	0.9	0.9	5.0	5.0
INDUSTRIAL EQUIPMENT, total	**77.8**	**80.2**	**22.3**	**23.8**	**192.2**	**210.0**
Dictating machines	0.9	0.9	0.2	0.2	3.6	4.3
Industrial X-ray equipment	1.2	1.2	0.4	0.5	4.5	5.2
Infrared equipment	3.6	3.7	0.7	0.8	12.1	14.0
Machine tool controls	8.3	8.5	3.4	3.6	21.6	25.5
Motor controls	8.5	8.6	1.8	2.0	12.9	15.3
Photoelectric devices	0.3	0.4	0.2	0.3	2.0	2.2
Power supplies (for production and control equipment)	10.1	10.4	2.8	2.9	20.5	23.1
Process controls and systems	36.5	38.0	11.0	11.6	81.4	83.8
Welding equipment	0.4	0.5	0.2	0.2	3.6	6.6
Other production and control equipment	8.0	8.0	1.6	1.7	30.0	30.0
TEST AND MEASURING INSTRUMENTS, total	**29.0**	**30.0**	**8.1**	**8.8**	**88.8**	**96.2**
Amplifiers, laboratory type	0.3	0.3	0.1	0.1	1.7	1.8
Calibrators and standards	1.0	1.0	0.3	0.3	3.1	3.3
Components testers	1.5	1.6	0.5	0.6	3.6	3.8
Counters	1.6	1.7	0.3	0.3	3.0	3.1
Electronic voltmeters and ammeters	2.5	2.6	0.4	0.5	7.1	7.6
Microwave test and measuring instruments	3.2	3.5	2.0	2.1	8.2	9.0
Oscillators	1.5	1.5	0.3	0.3	4.4	4.6
Oscilloscopes	4.5	4.7	1.4	1.5	19.7	21.5
Power supplies, laboratory type	2.9	3.0	0.6	0.6	7.6	8.0
Recorders	3.2	3.2	1.0	1.1	8.0	8.6
Signal generators	1.3	1.4	0.4	0.4	4.3	4.7
Spectrum analyzers	0.5	0.5	0.1	0.2	1.1	1.2
Other test and measuring instruments	5.0	5.0	0.7	0.8	17.0	19.0
TOTAL CONSUMPTION, assembled equipment	**280.1**	**296.5**	**113.0**	**120.7**	**1,232.7**	**1,307.6**

NOTE: Figures for Denmark, Spain, and the United Kingdom are adjusted for devaluation but do not reflect changes in markets that the devaluation

1—Factory prices; imports valued at cost—insurance—freight

* Less than $0.075 million



Remedy for nightmares: AE's Type 45NC stepping switch with "shorting" levels.

Many of today's complex switching circuits look like an engineer's nightmare. Why not simplify them? You can replace whole groups of components with an AE Type 45NC "stepper."

This switch has normally closed ("shorting") levels. It's designed so that pairs of contacts *open* successively when the rotor is stepped.

The Type 45NC can solve almost any circuit-transfer or testing problem.

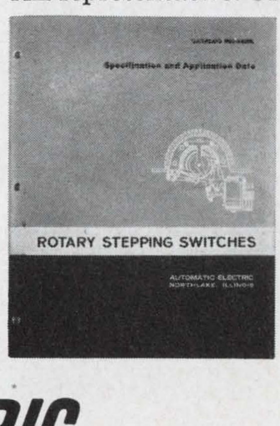
It's ideal for self-interrupted hunting, and you don't need auxiliary relays.

You get one or two electrical levels of either 26 or 52 point normally-closed contacts. For extra versatility, you can specify additional levels of *normally-open* contacts—on the same switch.

Contacts are gold-plated phosphor bronze. Contact resistance: a maximum of 50 to 100 milliohms, measured at 6 volts 100 milliamperes.

When you specify AE rotary stepping switches, you get the benefit of our continuous research—in design, in metals and insulating materials. All this plus *positive positioning* – a unique AE design feature that locks the rotor and makes overthrow impossible.

Find out more about AE rotary stepping switches—an economical, rugged and reliable way to simplify switching circuits. There's a lot of helpful application information in our new reference circular 1698-L. To get your copy, just ask your AE representative. Or write to the Director, Relay Control Equipment Sales, Automatic Electric, Northlake, Illinois 60164.



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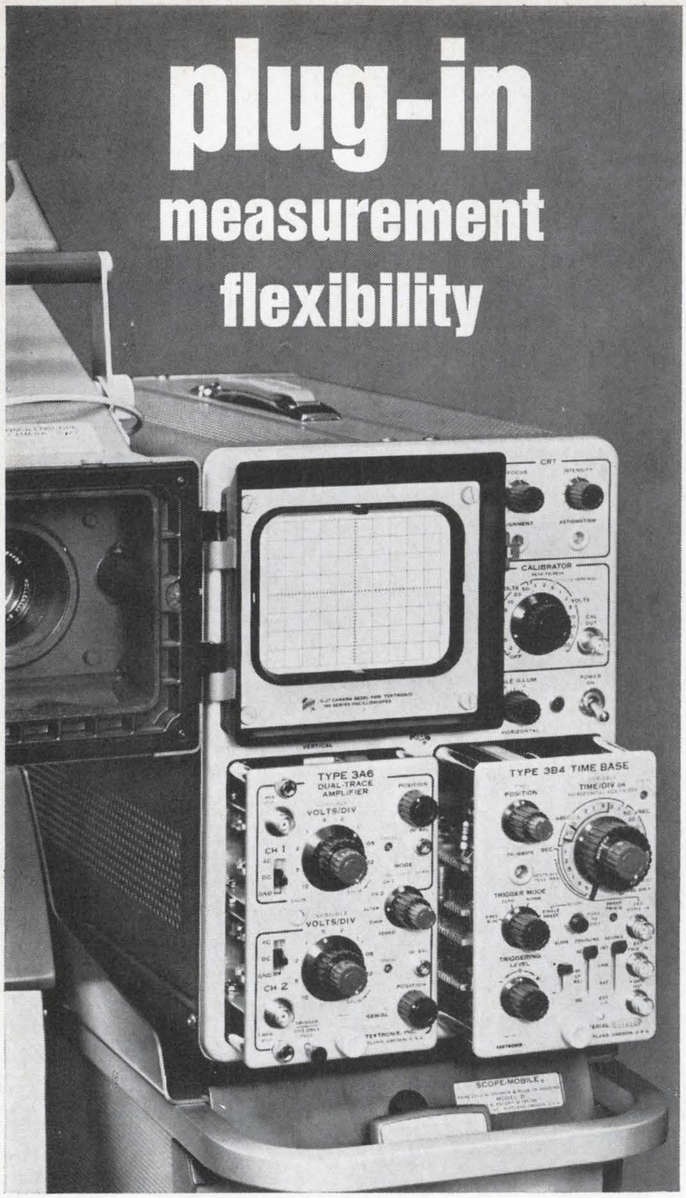
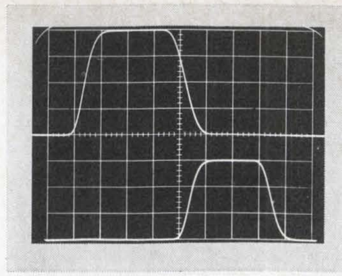
plug-in measurement flexibility



multi-trace

Make dual-trace measurements from DC-to-10 MHz with 35-ns rise-time capabilities and a 10 mV/div to 10 V/div deflection factor.

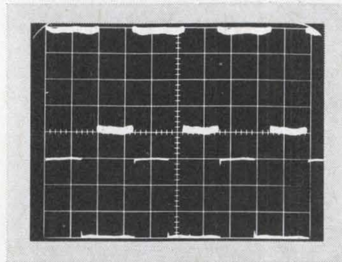
Type 3A6 Plug-in............$525



differential

Make dual-trace differential measurements from DC to 500 kHz with a 100 μV/div deflection factor and a 50,000:1 common-mode rejection ratio.

Type 3A3 Plug-in............$825

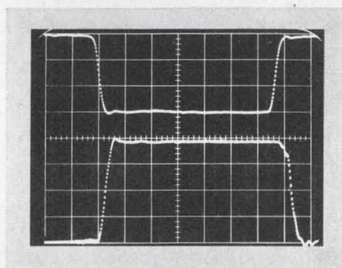


sampling

Extend your dual-trace measurement capabilities to 1 GHz with 350-ps risetime, internal triggering and sweep rates to 20 ps/div.

Type 3T77A Time-Base ......$ 690

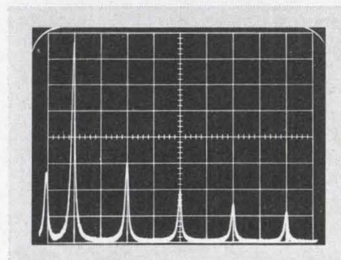
Type 3S1 Amplifier..........$1150



spectrum analysis

Analyze the frequency spectrum from 50 Hz to 1 MHz with calibrated dispersion and calibrated deflection factors.

Type 3L5 Plug-in...........$1100



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.

Type 561A Plug-in Oscilloscope	$530
Type RM561A Rack-Mount Oscilloscope (7″ high)	$580
Type 564 Split-Screen Storage Oscilloscope	$925
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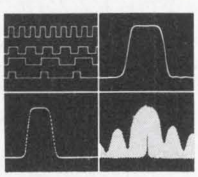

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Probing the News

Consumer electronics

Tv design—the repairman's headache

Part of the blame for inefficient and high-priced color-set servicing must rest with those makers who cut corners at the expense of reliability

By John D. Drummond
Consumer electronics editor

Television repairmen resent the public's assumption that they're to blame for the shoddy, high-priced servicing of color-tv sets. That's predictable. What's surprising is the fact that many tv manufacturing executives are in their corner.

Says one: "While repairmen aren't the most brilliant electronics minds we have, makers' economies and shortcuts multiply their problems. Competition in the industry is fierce and color tv is still relatively expensive, so anything that we can do to cut $40 to $50 from the price of a set is done. Trouble-free service must be a secondary consideration. Chalk it up to the rules of survival."

Another, less sympathetic, executive puts it this way: "A skilled repairman who keeps up with the new developments and techniques and has an aptitude for electronics should be able to do the job. But the combination of an ever-changing technology, bad packaging, and dishonest competitors forces him to indulge in the bill-padding game."

I. Built-in trouble

The same theme runs through all conversations on the subject: if the manufacturers weren't so willing to trade off reliability for economy, servicing would be a lot easier. Among the problems the repairman has to contend with are:

- Printed circuit boards that are too thin and of poor quality.
- Test points that couldn't be found by a bloodhound with an engineering degree.
- Chassis that are accessible only if the repairman is a contortionist.
- Tuning systems that are sales gimmicks rather than engineering advances.
- Elaborate, impractical circuit layouts.

Let's take them one at a time.

Circuit boards. While the XXXP circuit board is standard in the industry, some manufacturers insist on using paper-thin material with an uneven expansion coefficient and poorly bonded copper laminate. Why? It's cheaper. What happens? The board warps and the lamination peels off the first time it's confronted with a soldering iron. Of course, the problem is compounded by the inability of many repairmen to master the art of desoldering on p-c boards.

Test points. The test points so clearly indicated in schematics are hard to find on the p-c board. The solution is color coding, used for years in point-to-point wiring and well known to servicemen and manufacturers alike. Signal test paths could be assigned one color, supply voltage another, sync pulse path another, and so on. Also, placing a foil pattern on the component side of the p-c board to provide an X-ray view of the circuit—a practice already followed by Admiral, Heath, and a few others—facilitates circuit tracing and could be adopted by all makers.

Accessibility. Ever try to reach adjustment controls behind the set and watch the image at the same time? It's easy if your arms are 12 feet long. Many chassis designs make adjustment points so hard to get at that it's difficult to see how they were conceived. For example, one early Magnavox design forced the repairman to dismantle the cabinet to get at the chassis. Servicemen often complain about the frustrations involved in testing a set that has to be completely dismantled and needs an auxiliary picture tube as a test jig. One way out is provided by Heath's hinged vertical chassis with a tilt-out front panel convergence board. The set can be repaired without removing the chassis from the cabinet. In an approach standard in many of Zenith's 1968 color models, the convergence board is exposed by removing the grill and speaker in front.

Voila. Zenith makes convergence panel easily accessible to the serviceman.

Tuners. Instead of loudly trumpeting the dubious advantage of "instant-on" sets, which maintain a keep-alive voltage when the set is turned off as long as it is plugged in but add nothing to performance or reliability, more manufacturers could add automatic fine tuning. This recently developed feature has already been incorporated in some sets made by Emerson, RCA, Admiral, and Sylvania. The consumer who lays out $500 or more for a color set doesn't want to watch it with both hands on the fine-tuning, contrast, color, and tint knobs. He wants a good picture when the set is turned on. A recent Consumer Research Center study showed that the reluctance of many people to buy a color set is based on the belief that it's difficult to operate, that the picture is generally of poor quality, and that it's unreliable and expensive to keep in top working trim.

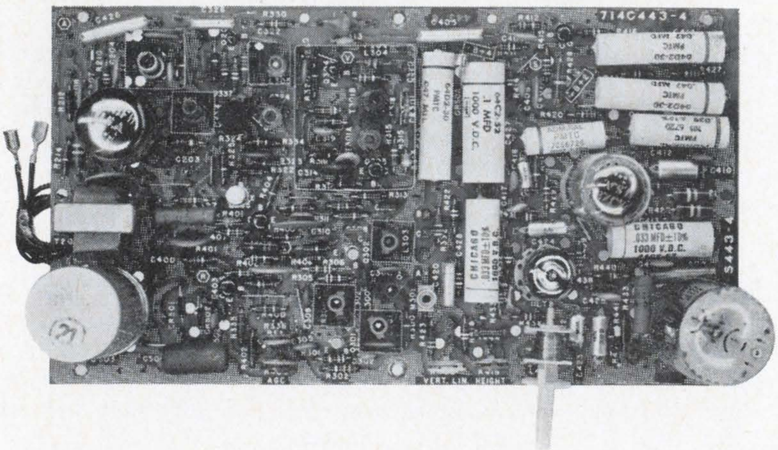
Circuit design. Printed circuit boards are here to stay, so why not design them so that they can be broken up into easily removable and replaceable links interconnected by jumper wires? This innovation would make sets easier to service; individual circuits could be isolated by clipping a lead. Although manufacturers are fully aware of the service advantages of this approach, they argue that it would result in higher production costs. Interestingly, Zenith, which never switched to p-c boards, has parlayed its "handcrafted" slogan and word-of-mouth advertising by appreciative repairmen into a valuable sales asset.

Additionally, multiple cables and wire harnesses could be equipped with connectors and breakouts for testing. More checks could be made in less time, and subassemblies such as the tuner and deflection yoke could be removed without completely dissassembling the set. With standard connectors, the repairman could prepare a number of extension leads in advance to minimize disassembly and cut down on service time.

One answer. Motorola's introduction this year of a solid state color tv designed around plug-in circuit panels is believed by some industry insiders to be the first major servicing breakthrough. When one of these sets fails, the repairman makes a few simple checks to isolate the malfunctioning circuit board, which he replaces. He then must send the board back to Motorola, which repairs it for a fee. If the set is still covered by warranty, of course, the repairs are free, but if the serviceman attempts to repair the board, the warranty is voided. A number of Motorola's rivals concede that the modular plug-ins eventually will be generally adopted—but with modifications to reduce production costs.

II. Do it yourself

A manufacturer always has the option of forming his own service organization. It can establish a firm on the lines of the giant RCA Service Co. or the smaller Packard Bell organization. Or it can set up a network of factory service centers that also sell parts to independent repairmen. The latter course avoids the economic hazard faced by a fledgling service organization such



No puzzle. Admiral has clearly marked parts locations and test points on this circuit board. Foil pattern imprints ease circuit tracing.

About that black eye

Electronics magazine's article about the shortage of honest and competent color tv repairmen ["Service—color tv's black eye," Nov. 27, p. 127] attracted a small flood of letters from independent repairmen and spokesmen for their industry. Here's a representative selection of their comments.

▪ We read with interest the article "Service—color tv's black eye," and although we agree with the article in part, we must take major exception to it.

Exposes such as those conducted by Consumer Reports and several attorneys general are as phony as $3 bills and have been thoroughly discredited. Obviously, all were intended for personal gain—headlines or magazine sales.

But let's consider what has caused problems in the service industry. In their greed for volume, most set producers have prostituted distribution by bending in every way to discount houses and other merchandisers whose idea of marketing is to peddle sets by any means.

This has produced insane warranty policies that rob the servicer of needed profit on parts sales while burdening them with far more costs and with paper work that the factory allegedly uses for quality control. As part of this unsound economic practice, the factories set up rates for warranty work that meet only a small part of legitimate costs.

All this is palmed off to servicemen with promises of volume business and procurement of customers without advertising cost. Volume can result, but one can hardly succeed on the principle of "we lose money on every job but we make up for it with volume."

Our recent study shows that even a highly qualified service agency spends twice as much to render cut-rate warranty work as it is paid. The theory that customers are attracted has been repeatedly discredited. These schemes force the service agency to methods far from desirable.

You state that most manufacturers are in, or are planning to enter, service at retail through factory branches because the public has not been properly or honestly served.

We challenge anyone to prove that the incidence of dishonesty and/or incompetence in tv-radio service, considering the millions of sets in use and the intangible nature of such service, is of real consequence.

It is mighty strange that factories plan to institute intelligent design only after they take over retail service, which, according to surveys such as by Roper, has been rendered to the satisfaction of the public.

Several years ago, Natesa recognized the growing service problem and offered a multiphase program to remove it before it became critical. The plan called for realism on compensation, intelligent service training, negation of false accusations, buildup of earned respectability, and security for servicemen. Rather than point fingers at independent service, it would be more productive to ask broadcasters, factories, component producers, distributors, etc., why they have not cooperated more fully with independent service, which all have used as a productive ally for the past 45 years or so.

Frank J. Moch
Executive Director
National Alliance of
Television & Electronic
Service Associations
Chicago

▪ It is about time we faced up to the fact that tv service is not cheap. The basic trouble is that most servicemen have felt they could not charge what their time was worth. To stay in business they had to pad parts bills. Most tv men I have recently talked to want no part of color tv.

Convergence, hell! The local furniture shops unload the set and hook it to the antenna. If there is a picture, it's okay and off they go.

Lyman E. Greenlee
Engineering Labs.
Anderson, Ind.

▪ Independent servicemen have tried for many years to become organized into an effective group to handle, among other problems, the impossible warranty situation. In many areas distributors set up rival service organizations to frustrate and defeat any real effort at gaining strength or a national voice.

The Radio Corp. of America fought the color fight for 10 or more years and the independent serviceman was reasonably successful in delaying color acceptance for six or eight of those years. In similar fashion, Zenith exploited the independent's reluctance to service printed boards into the greatest sales pitch of all history.

Acceptance of color by the independent in recent years was based on the high reliability of the round tube and the color sets in general originally produced or developed by RCA.

But the quality of color sets was terrible! When demand is at a fever pitch, quality control has a tendency to suffer.

If factory service is supposed to make the independent toe the mark on warranty of schlocked-up sets, it won't work. Any manufacturer can "bad-mouth" independent service all he wants. Independent servicemen couldn't care less. They are too busy tending to good, cash customers. As for manufacturers' problems—it couldn't happen to a more deserving group.

Frank L. Gronert
Gronert Electronics
Des Moines, Iowa

▪ A manufacturer who regularly spends millions of dollars for advertising can obviously outtalk unorganized service shops. Servicemen, as an industry, are not more to blame for the tv business's problems than the manufacturer. Customers are misinformed about reliability by the manufacturer.

Motorola's step to modules is one that good engineers foresaw many years ago. Etched copper circuitry in home entertainment devices has been falsely advertised as "space age electronics". The difference is in expendability of the module. Replacing these boards was thwarted by making them unobtainable. Theoretically, they should be easy to repair in the set, but the interconnecting wiring is too confusing. How about using insulated wire that does not have thermo-plastics or a weakness to "cold-flow?"

It is the little automatic frills that raise the number of complaints about repair costs.

Joseph A. Kucher
Whitney Point, N.Y.

Direct line. Some set makers try to enhance market position with service.

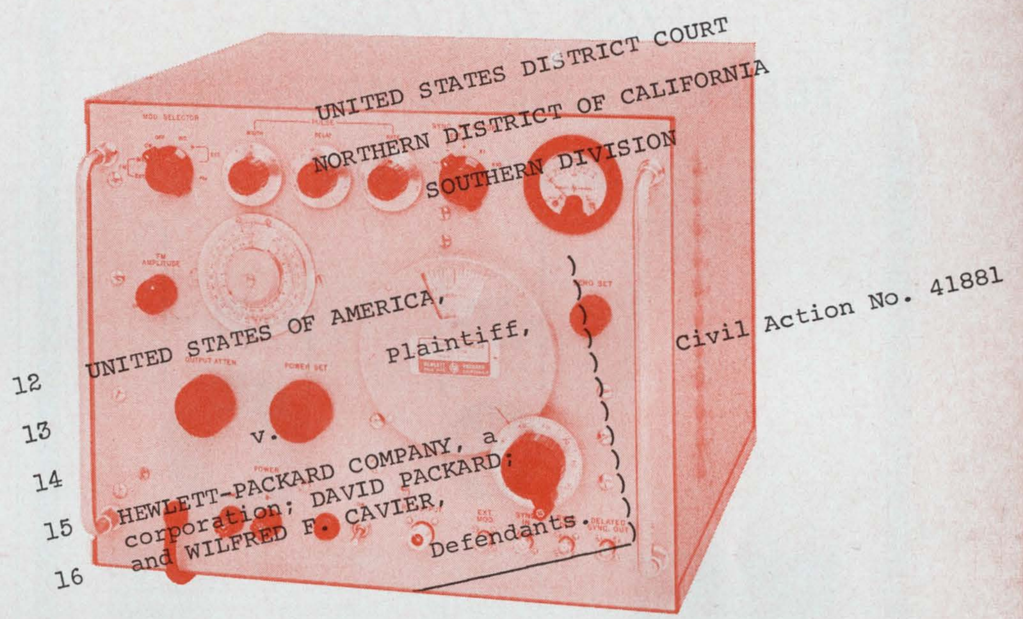
as the one recently launched by Sylvania: the refusal by independent operators to buy replacement parts from the "offending" manufacturer.

It's easy to understand the anger of independent repairmen when a manufacturer moves a service operation into his backyard. Consider the expense of setting up and maintaining a three-man shop. To go into business requires an initial $5,000 for office equipment, test gear, and spare tv parts. Add to that monthly operating costs averaging nearly $3,000 and you have a considerable outlay for a small businessman.

Zenith and GE operate their own factory service installations in some places but use independents in others. But Admiral, Emerson, Westinghouse, Philco-Ford, and a few others prefer to stay out of the service business. Instead, they maintain training facilities and conduct regular seminars for dealers and independent technicians, who are considered authorized factory servicemen after completion of their courses.

Inside the velvet glove . . .

Although the GAO has softened its policy since Hewlett-Packard refused to reveal cost data in 1962, industry knows that the agency can still wield its iron fist and force public disclosure of company pricing



Five years ago, the issue was crystal clear. The electronics industry, among others, was fed up with the General Accounting Office, Congress' watchdog for the Government's financial dealings. Almost to a man, industrial leaders felt the agency was overstepping its bounds with its torrent of harshly worded reports assailing industry for "overcharging, waste, and mismanagement."

Even more distasteful was the GAO's demand that industry provide detailed cost records for catalog items supplied to the Government—whether computers or shoelaces—a demand the agency insisted was its legal right. It made no difference whether the items were developed without Government funds. Not only did the agency demand this confidential data, but it also claimed the right to publish it.

Many firms, including the Hewlett-Packard Co., stoutly objected to this demand. But, because most firms feared Congressional repercussion, the GAO got its way—with everyone, that is, except Hewlett-Packard. In 1962 David Packard, the firm's board chairman and chief executive officer, said flatly: "No!" The agency promptly hauled Hewlett-Packard into court and the two have been battling it out ever since—with the company losing every bout, the last only a month ago when a Federal appeals court upheld the GAO. Now, David Packard is faced with another decision: yield to the GAO's demands, or appeal once again, this time to the Supreme Court.

I. A long, long time

Ironically, though, the issue that was so clear in 1962 has since become hazy. Much has changed.

For one, the GAO has modified its stance. In 1965, for example, the so-called Holifield hearings (Rep. Chet Holifield, D., Calif.) were conducted—largely because of loud complaints from the California aerospace industry. While the GAO insisted it was uncovering waste and financial legerdemain, industry called it harassment.

Don't fight. Both positions were probably correct, the legislators decided, and after some negotiations, many changes in GAO policy were approved. The GAO promised:

- To review its reports with the companies involved before releasing them publicly;
- To include companies' comments in the reports;
- To work with companies to keep proprietary matter, such as cost-of-production data, out of the reports wherever possible;
- To change the titles of the reports to make them sound less accusing.
- Not to issue reports on individual companies, unless the circumstances were extraordinary, but to send "private" letters to the Federal agency dealing with the firm.
- Not to release a torrent of reports on the same issue, thus preventing valid complaints from being blown up out of proportion.

Shortly thereafter, Joseph Campbell, a free-wheeling but dedicated investigator, retired as GAO boss.

Here to stay. As a result of these modifications, most industry leaders softened their outspoken hostility to merely a general malaise.

As one company president frankly put it: "I no longer worry that a reporter from the Wall Street Journal is going to call me one night and ask me to comment about a GAO report that accuses us of cheating the Government out of $10 million."

II. Different—but the same

To be sure, not all industry leaders agree that the charges have been sufficient to ease their fears of Government snooping. In fact, some doubt there has been a change in aim—just a change in tactics.

These executives still fear Gov-

Decision. David Packard must decide whether to take case to Supreme Court.

ernment disclosure of a company's closely guarded pricing secrets. "And with each Blue Book [called that because of the reports' blue covers] costing only $1, it is clearly one of the biggest bargains for a competitor interested in another company's pricing," says a lawyer close to the Hewlett-Packard case.

Name one. But ask the same lawyer for some recent examples of where confidential material has been released or to name a company that has been financially hurt by such a report, and he says: "Well, five years ago the GAO reported. . . ."

In fact, ask an industry association spokesman for records of recent complaints from his membership, and the best examples are sure to be three or four years old.

What, then, is behind David Packard's fight with the GAO? And why has he continued in light of the agency's policy changes? Packard won't say; he refuses to comment publicly on the issue.

III. Shadows from the past

The answer, which other companies will admit but won't voice publicly: a threat still hangs over industry.

Although the GAO has, in fact, mended its ways, it can always revert to its former policy of cranking out scores of reports blasting individual companies. With its 4,300 staffers (2,300 of whom are investi-

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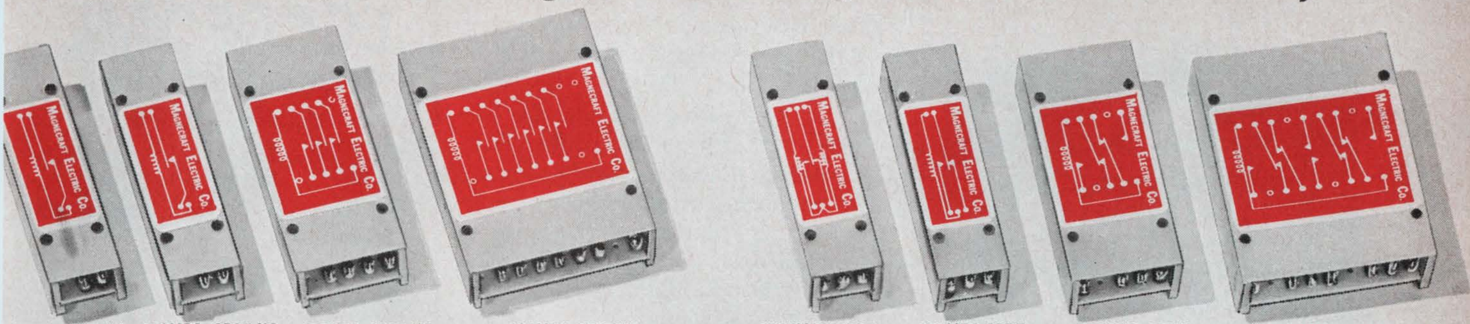

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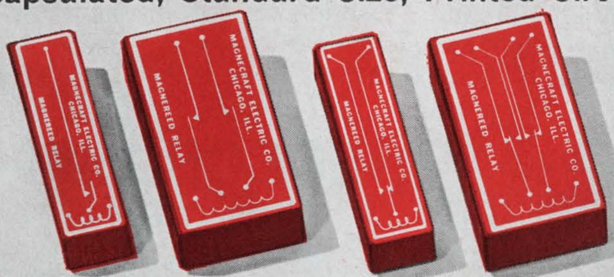

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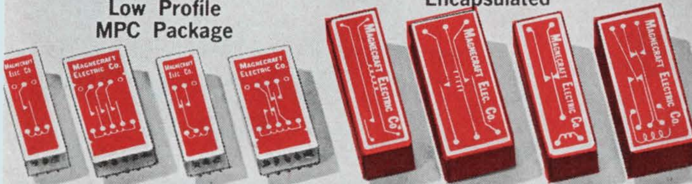

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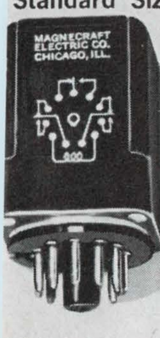

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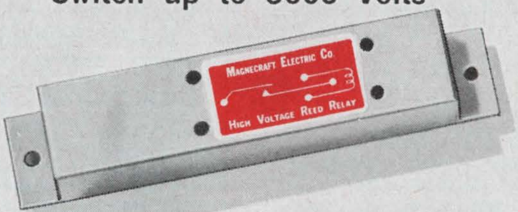

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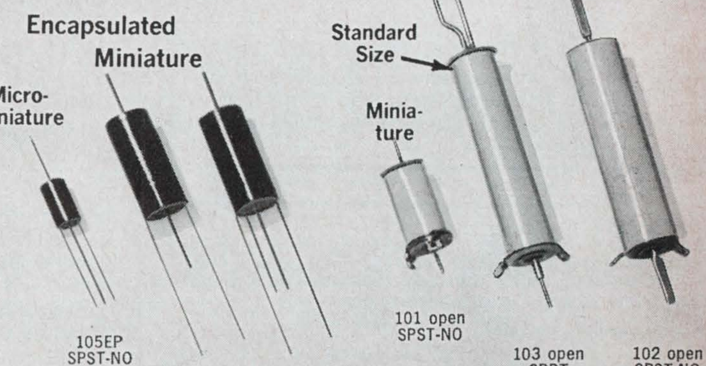

105EP SPST-NO | 101EP SPST-NO | 104EP SPDT | 101 open SPST-NO | 103 open SPDT | 102 open SPST-NO gative auditors), the agency certainly has the manpower to do the job. Despite its policy shift, its legal authority hasn't been diminished; the laws granting the agency its powers are still on the books. The only thing that stands in its way, says the head of an industry contractors' association, is the agreement that followed the hearings.

Soft ground. "I'd hate to be in the position of having to depend on the good will of a Government agency," a West Coast corporation lawyer says. Adds the association spokesman. "Sure, our problem with the GAO has diminished—but not to the disappearing point. If Staats [Elmer B. Staats, who succeeded Campbell as U.S. comptroller general, the GAO's top official] wants to make public cost information from a company that he feels he must, or should, there's nothing to stop him—not a damn thing."

The fact is, the GAO concedes, the agency must issue confidential reports to individual Congressmen when they're requested.

"There's nothing that says a Congressman can't disclose information if he wants to," says the association representative. "Let's face it, companies fear this—but so far I can't put my finger on any cases."

It'll go away. One reason such examples are hard to come by is obvious: why would a company, named unfavorably in a report, knowingly squawk? If it's in the wrong, all it will accomplish is to call attention to itself.

There have been several instances where Congressmen have, on the floor of the House or Senate, without naming the company, disclosed "overcharging" and other irregularities.

There's little doubt that industry is nervously watching Hewlett-Packard, waiting for word on whether it will appeal to the high court. "The issue," one lawyer notes, "involves rather narrow legal points, a bit too narrow for the Supreme Court to review." In essence, this would be tantamount to upholding the GAO.

The reporting for this article was done by Robert Skole in Washington and Walter Barney in San Francisco. It was written in New York by Stanley Zarowin.

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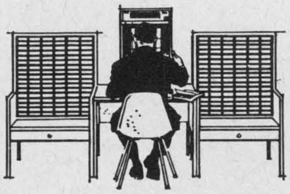

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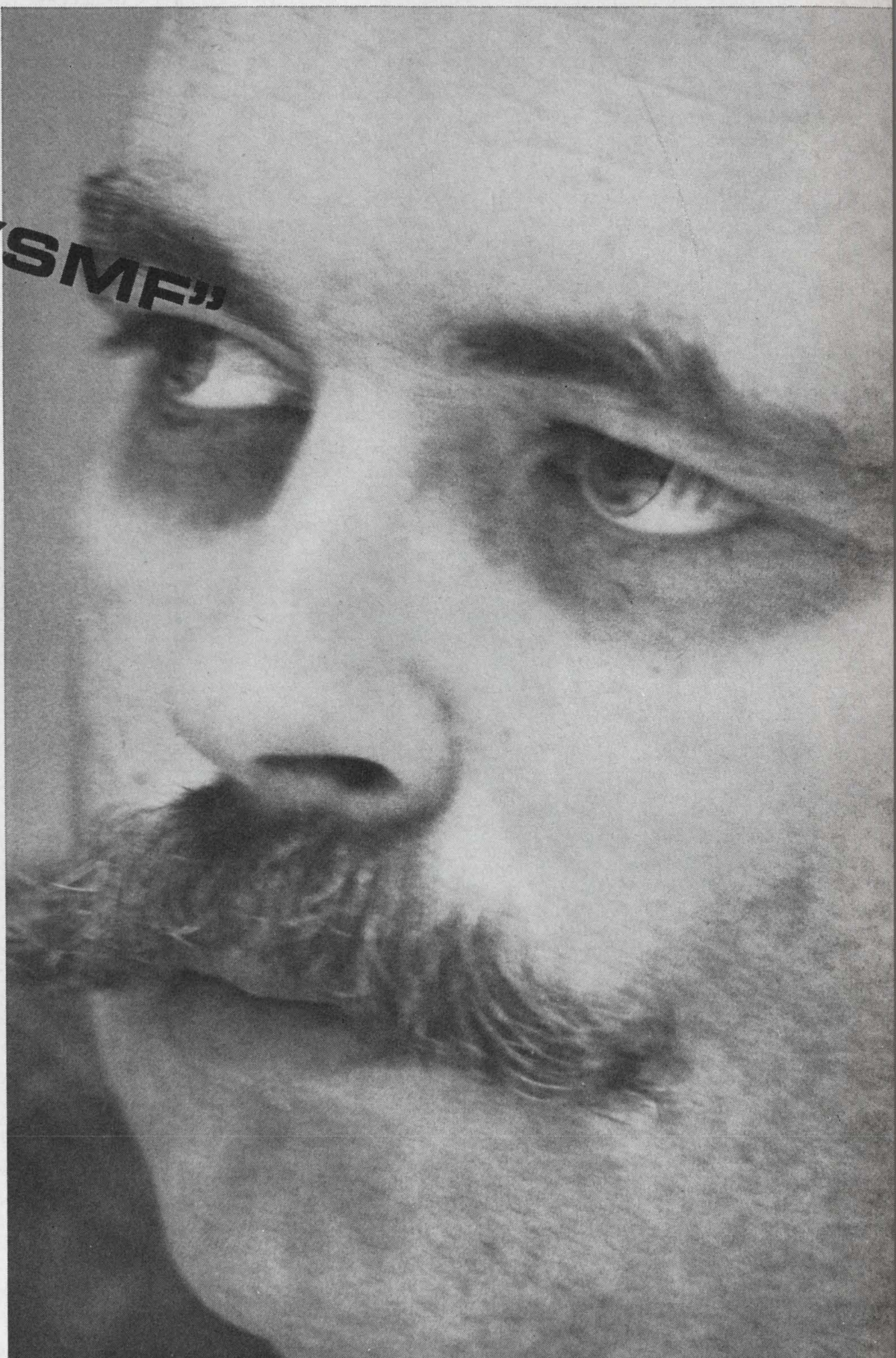

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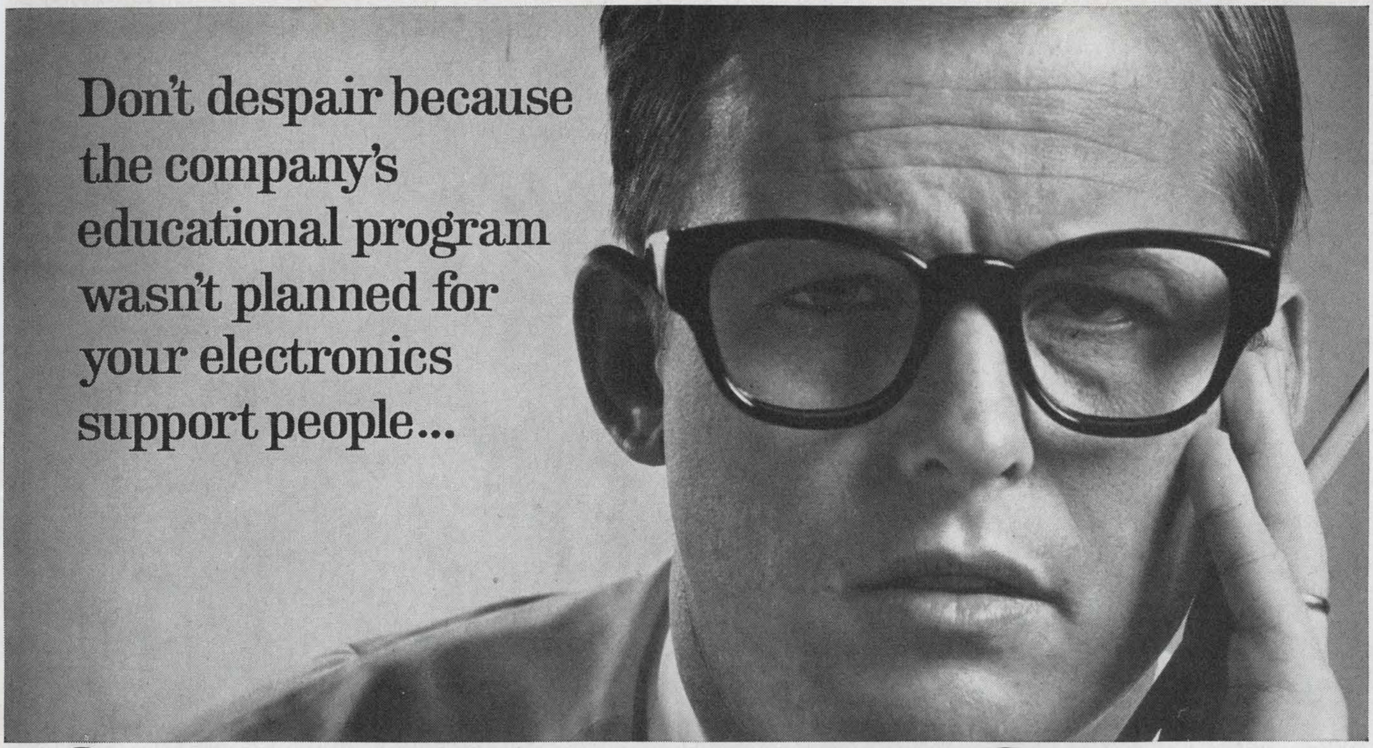

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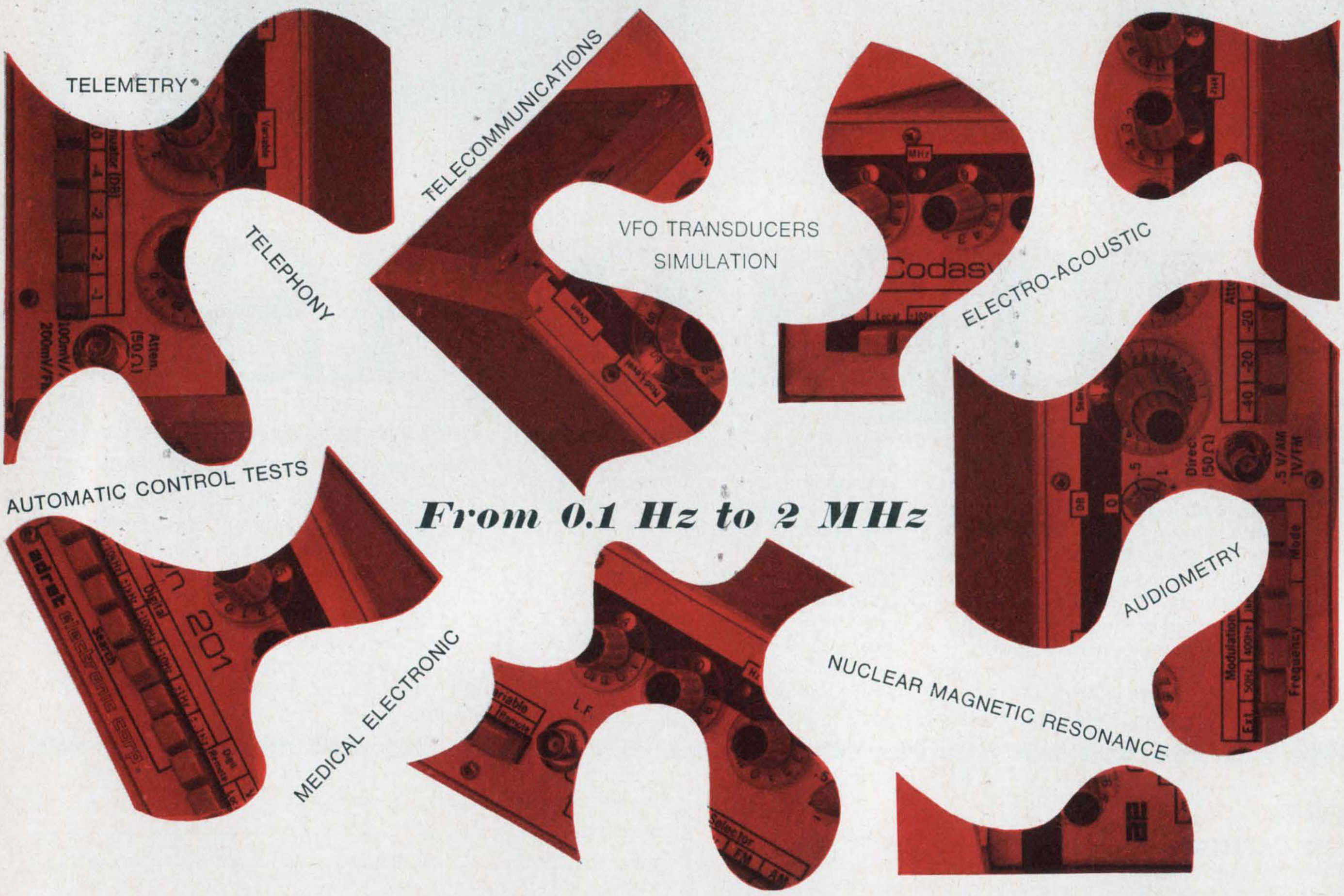

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New Products

New instruments

Lab-precision readings beef up automated tests

Digital a-c voltmeter that reads out true rms values of waveforms fills gap in computerized measurement

Squinting at a dial is still necessary to get true root-mean-square measurements of circuits and device waveforms, the all-important clues to energy content of a-c signals. And when a test engineer has to take time out to read a meter, he can hardly boast of having an automated instrumentation system.

But this won't be the case much longer, says the John Fluke Mfg. Co., which is about to introduce an automatic a-c digital voltmeter that reads, with standards-laboratory accuracy, the true rms value of an input waveform. The energy content is sensed directly, not calculated.

"We can now think of getting true rms values in an automatic measuring system," says Richard Van Saun, who headed the voltmeter project at Fluke. Like d-c, resistance, capacitance, and frequency measurements, the rms values of waveforms can be fed into an instrumentation-system computer.

With an accuracy of ±0.05% of reading (+0.015% of range), Fluke's dvm, called the 9500A, has a five-digit display—four full plus one overranging. Its resolution is 0.01% of range—equivalent to 10 microvolts per digit on the most sensitive scale; frequency range, 20 hertz to 700 kilohertz; and voltage range, 1 millivolt to 1,100 volts. The instrument will sell for $2,485, about the same as the rms to d-c converters used in most rms-measuring systems—which also require dvm's.

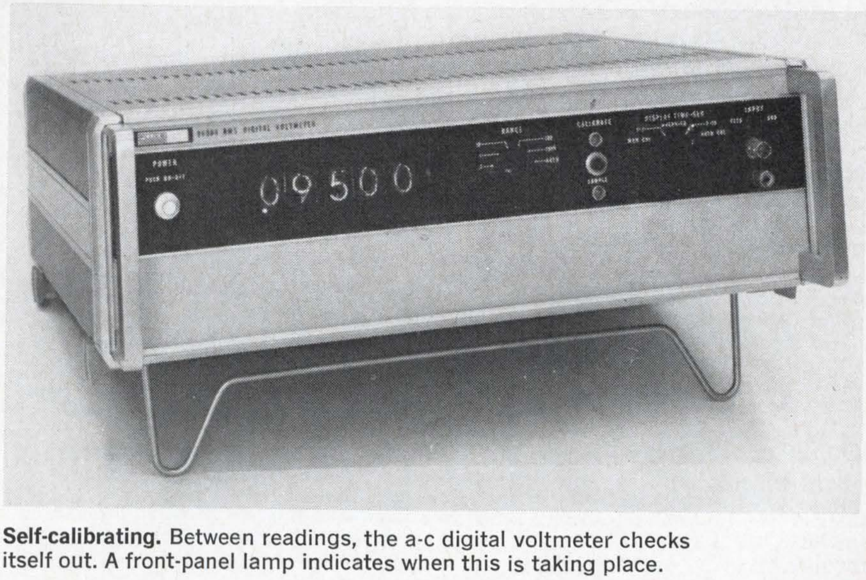
No conversion. Unlike the 9500A, virtually all other direct reading a-c voltmeters are calibrated to indicate rms voltage, and do not measure it directly. Peak-reading voltmeters, for example, use a mathematical relationship to convert the peak value of a waveform to the rms value of a pure wine wave. But since there are no pure sine waves, even the slightest distortion causes large measurement errors. This is true, too, for the most popular of the a-c voltmeters—the average-responding type.

A third technique measures a-c waveforms with voltmeters that incorporate square-law detectors and logarithmic scales to approximate the rms function. However, an instrument using this technique usually has accuracies of only ±1% or ±2%. And even the most accurate a-c instrument, the a-c to d-c transfer voltmeter has drawbacks: its input impedance is low—typically about 200 ohms—and the instrument itself is complex and slow, requiring several minutes to complete a measurement. (The 9500A has a three-second response time.) Furthermore, transfer voltmeters are costly because of the necessary peripheral equipment.

Essentially, Fluke's instrument is an electronic tracking system that continuously seeks a null. Readout is achieved by sampling the state of balance at predetermined times.

I. Independent processors

The a-c input signal is processed by two amplifiers—range and digit—which are independent of each other. The range amplifier, with 20-decibel (10:1) gain steps, is an operational-type device whose gain is controlled by metal-film feedback



Self-calibrating. Between readings, the a-c digital voltmeter checks itself out. A front-panel lamp indicates when this is taking place.

resistors and compensating capacitors. The digit amplifier, whose gain is continuously varied by its feedback resistor, drives a current proportional to the applied input voltage through a thermocouple heater. Since the value of the feedback resistor is inversely proportional to the count displayed on the instrument's front panel, the current into the a-c thermocouple is a constant. This eliminates the linearity and sensitivity problems usually associated with operating thermal devices. Gain controls of both amplifiers are electronic.

The d-c output voltage from the a-c thermocouple is compared to an equal and opposite voltage from a d-c thermocouple, with the difference between the two amplified by a null detector—a magnetic modulator-type d-c amplifier.

Double task. The null detector's output is used to determine whether the a-c thermocouple output is above or below the null point to control the position of the up-down switch. Also, the output controls a voltage-controlled oscillator whose output frequency is proportional to the input voltage. Using a vco instead of a fixed-frequency clock speeds response time despite the use of relatively slow thermocouples; the further the control loop is from null, the faster the vco runs.

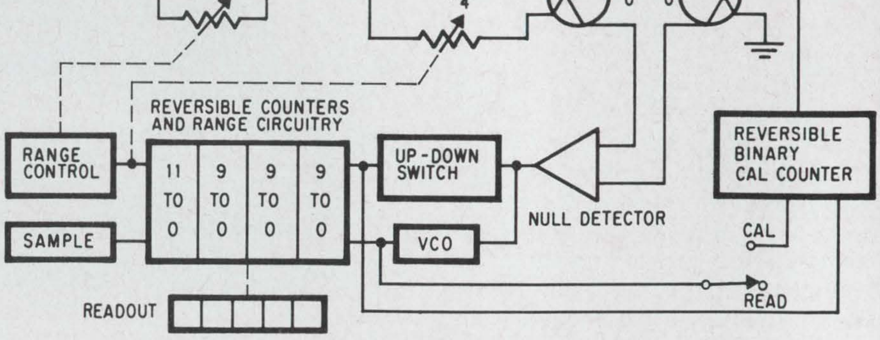
The up-down switch and vco signals are then fed to four serially connected reversible decade counters. Finally, the main control loop is closed by arranging the reversible decades to control the value of the digit amplifier's feedback resistor.

To prevent blinking, a sample oscillator is used to periodically transfer the count from the counters to the readout.

II. Automatic ranging

Automatic range control is achieved by sensing the count in the reversible counters. When the count reaches its maximum—11,999—the vco input is interrupted and the range control sets the range amplifier to the next highest range. If after a short delay the control loop still hasn't achieved null, the range control steps up one more range, and then another until it does. The same process is used for downranging.

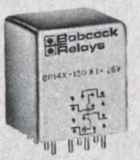
Accuracy of the instrument depends on the range and digit amplifiers having stable gains and sufficiently low temperature coefficients, and the two thermocouples and the reference zener together with its associated resistors being stable with time and temperature. How-



Opposing outputs. Heating effect of input is compared to heating effect of reference. Voltage difference between a-c and d-c thermocouples drives counters until resistor R_4 is adjusted so thermocouple outputs are equal.

Now, your Babcock 10 amp. full size crystal can relay will also switch dry circuit with the same set of contacts. These exclusive universal contacts have greatly simplified your relay stocking requirements. You can order one model to meet a given set of performance parameters without concern for load requirement *—at no cost premium*. Get complete information about this versatile relay, and the entire Babcock line, all with universal contacts.

Write Babcock Relays, Division of Babcock Electronics Corporation, 3501 Harbor Boulevard, Costa Mesa, California 92626; or telephone (714) 540-1234.



The Babcock Model BR14 provides 4-pole, dry circuit to 10 Amp. operation in a small package . . . with time-tested reliability in aerospace applications.

SPECIFICATIONS

SIZE: 1.3000" h. x 1.075" 1. x 1.000" w.	PULL-IN POWER: Low as 400 mw.
WEIGHT: Approx. 3.0 oz.	LIFE: 100,000 operations, min.
OPERATE TIME: 7.5 - 8.5 ms.	TEMP. RANGE: —65°c to +125°c

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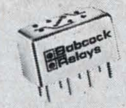
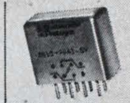
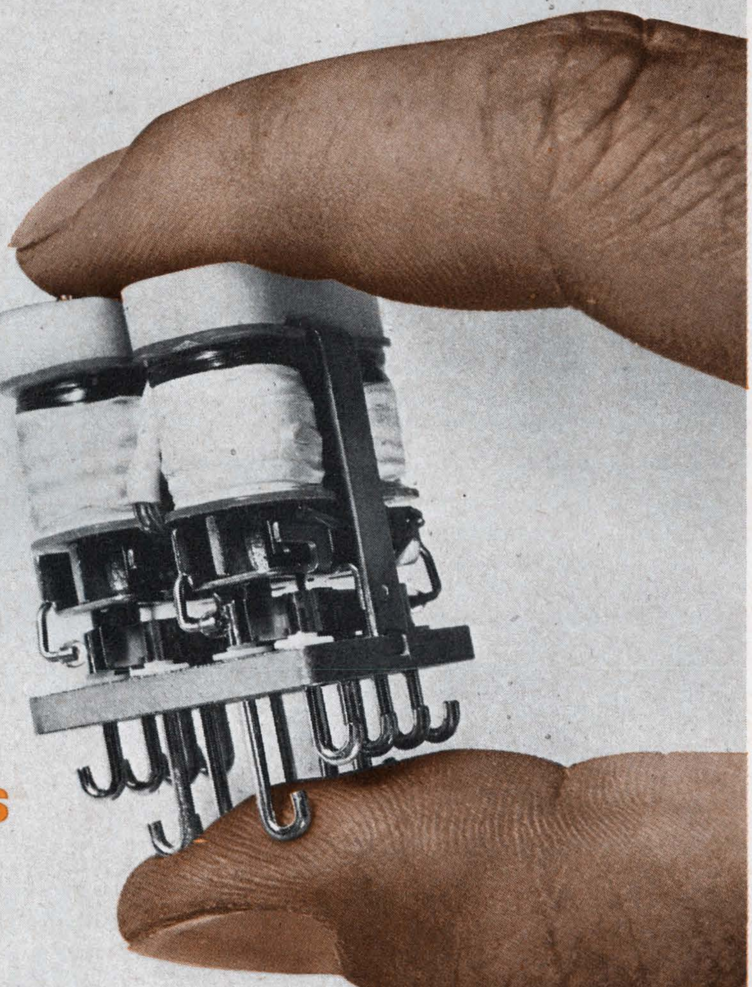




TWICE SIZE	FULL SIZE	HALF SIZE	SIXTH SIZE
4PDT	DPDT	SPDT & DPDT	SPDT & DPDT
dc to 10 Amps.	dc to 10 Amps.	dc to 2 Amps.	dc to 1 Amp.

Babcock Model BR 14 four-pole, dry circuit to 10 amp. relay... with universal contacts



Circle 117 on reader service card

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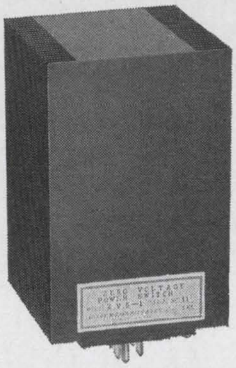
A RELIABLE THREE-PHASE ZERO-VOLTAGE POWER SWITCH



6" x 4" x 3"

A New Solid-State Zero Voltage Power Switch:
- FOR Computer and missile site equipment.
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- FOR switching all load types, including inductive, up to 7-1/2 H.P., 3ϕ.
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A New Solid State Zero Voltage Power Switch:
- ☐ In 4 models: 3ϕ (SPST); 1ϕ (SPST), (SPDT), and (DPST).
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ever, since it isn't possible to achieve the stability characteristics and sufficiently low temperature coefficients of the thermocouples, a control loop that performs an a-c/d-c transfer-type calibration is included.

Counter with memory. To initiate calibration, switch S_1, as shown in the diagram, is closed, sending a d-c current into the a-c thermocouple. The null detector's output causes the vco to alter the count in the reversible binary calibration counter, which subtracts or adds a current to the d-c thermocouple current. This causes the output voltage from the d-c thermocouple to be adjusted until a null is achieved. The calibration counter retains its count in the operating mode, thus holding the reference current at its adjusted level.

When setting up the instrument, however, calibration is also necessary. This is achieved by applying a calibrated a-c signal to the input and setting the calibration counter to the center of its range. Resistor R_2 is adjusted until the readout is equal to the input voltage. At this point, the output of the null detector is at zero. The instrument is then switched to the calibration mode, which applies the d-c calibration current to the a-c thermocouple and R_1 is adjusted to again obtain a null. This produces a calibration current, I_{cal}, that has a heating effect on the a-c thermocouple equal to that of the a-c current obtained when the count in the decade counters equals the value of the input waveform.

For manually controlled calibration, a push-button switch is available on the front panel and a blinker light indicates when null is achieved. In the automatic mode, the instrument is switched into the calibration mode for a short period of time—typically 500 milliseconds—after each display.

The 9500A is available with a variety of options. One digital output option provides five digits plus range in a 1-2-4-8-coded output. Another provides the same in a 1-2-2-4 code. Also available is a print command synchronized with the sample signal. Included with the digital options are remote range, sample, and calibrate capabilities.

John Fluke Mfg. Co., P.O. Box 7428, Seattle, Wash. 98133 **[338]**

Dial Direct-and Save

Introducing the direct-dialing Bourns KNOBPOT® Model 3650 — a digital dial, knob, and 10-turn precision potentiometer in a single assembly. At $25, this integrated unit costs you <u>less</u> than a precision potentiometer and digital dial bought separately, yet gives you <u>greater</u> accuracy. Correlation between dial and wiper output is <u>guaranteed</u> accurate to 0.1 per cent!

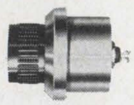
There are no phase-it-yourself problems with the Model 3650, either. Each unit is phased at the factory. You save time, trouble and expense!

Settings are fast and easy, thanks to the large, clear numerals that show turns, tenths of turns and hundredths of turns. Calibration marks beside hundredth-turn numerals allow settings as fine as 1/1000 turn or 1/10,000 of the total applied voltage.

Reliability is enhanced by extensive in-process inspection, 100 per cent final inspection, the Bourns Reliability Assurance Program, and by such outstanding construction features as the exclusive SILVERWELD® termination — the strongest in the industry. For value you can count on, specify Model 3650. Write today for complete technical data.

MODEL 3650 1¼" dia., 10-turn
STANDARD SPECIFICATIONS

Dial accuracy (correlation of dial reading and output, including linearity)	±0.1% (50K and above)
Repeatability of dial reading	±0.05%
Power rating	2.5W at 25°C
Humidity	MIL-STD 202 Method 103
Resistance Range	100Ω-500K



unit shown 1/4 actual size

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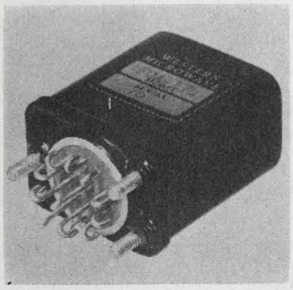
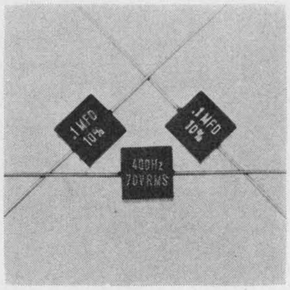
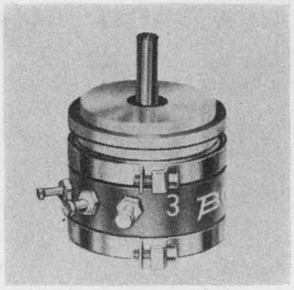
Circle 120 on reader service card



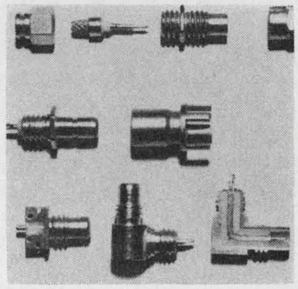
Active filter module FOA-Z74 features adjustable poles (Q's to 500) and zeros. Zero locations can be adjusted anywhere in the plane and are independent of the pole locations. Q and center frequency can be adjusted independently, giving wide ranges, tunable, constant bandwidth or constant Q responses. Western Microwaves, 1045 DiGiulio Ave., Santa Clara, Calif. 95050. **[341]**



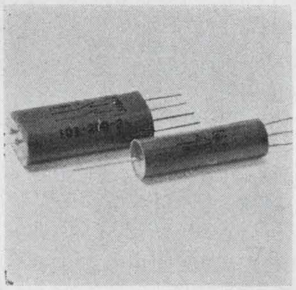
Ceramic capacitors (C19 Servocaps) come in 400 hz, 70 v rms and 1,200 hz, 70 v rms versions. For the former, values vary from 0.01 μf (size 0.3 x 0.3 x 0.1 in.), to 10 μf (size 0.7 x 1 x 0.4 in.). The 1,200-hz units have values of 0.01 to 4 μf. Units withstand a-c current surges encountered in phase shift uses. U.S. Capacitor Corp., 2151 N. Lincoln St., Burbank, Calif. 91504. **[342]**



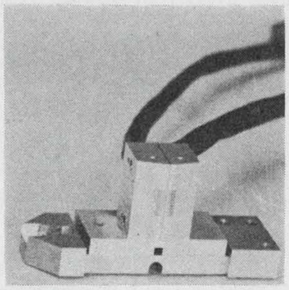
Bushing-mount 3536 and servomount 3586 single-turn pots feature a conductive plastic element and provide essentially infinite resolution. Resistance range is 100 ohms to 1 megohm; resistance tolerance, ±5%; linearity (independent), ±0.5%; power rating, 1 w at 70° C; operating temperature, —55° to +125° C. Trimpot Div., Bourns Inc., 1200 Columbia Ave., Riverside, Calif. 92507. **[343]**



Miniature r-f coaxial connectors called Mi-Kro Grip are easy to assemble and require no special tools. They take 3 mating forms: screw-on, push-on, and slide-on. All units meet or exceed MIL-C-22557. Nominal impedance is 50 ohms; voltage rating, 500 v peak; frequency range, 0 to 10 Ghz; vswr, 1.3 to 1 max. Mi-Kro Connector Corp., 40-09 21st St., L.I.C., N.Y. 11101. **[344]**

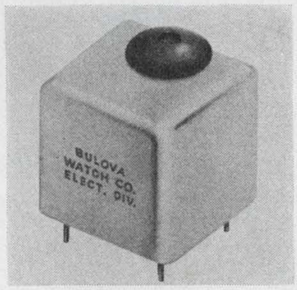


Reed relays series 103 offer high-speed switching of low-power circuits. Rugged epoxy encapsulation with low internal stress construction is impervious to harsh environments, and will withstand temperature shock from —40° to 100° C. Nominal power consumption is 140 mw. Response time is in the low milliseconds. Triridge Corp., Drawer A, Aliquippa, Pa. 15001. **[345]**



Magnetic tape read/record head 203-9 is a dual gap, 9-channel unit that is compatible with IBM 360 computer format. It features 0.150-in. intergap spacing and provides packing densities of up to 1,600 bits/in. at tape speeds of up to 150 ips. The all-metal-faced head also features very low crosstalk. Magnusonic Devices Inc., 68 Toledo St., Farmingdale, N.Y. 11735. **[346]**

A two-stage vaneaxial blower puts out 37 cfm at 8 in. of H_2O static pressure. High pressure-to-volume ratio is achieved by using compressor staging. The 200 v a-c, 400 hz, 3-phase unit has a minimum life of 1,500 hrs at 70° C continuous duty and meets stringent MIL environmental specs. Globe Industries Division of TRW Inc., 2275 Stanley Ave., Dayton, Ohio. 45404. **[347]**

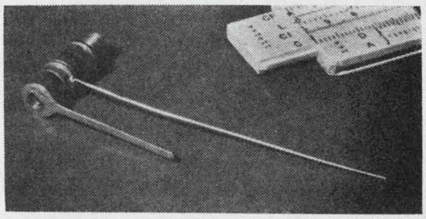


Crystal oscillator model XO-101 is a 1-cu-in. unit that meets Mil-E-5400, -4970, and -16400. It weighs 3 oz and can provide a stability of ±0.0005% at 25° C from 80 khz to 100 Mhz. Output is 5 v peak-to-peak square wave or 1 v p-p sine wave into a 5-kilohm load (typical). Price per unit is $150. Bulova Electronics, 61-20 Woodside Ave., Woodside, N.Y. 11377. **[348]**

New components

Taking the shakes out of tuned circuits

Dual variable capacitors working as trimmers are immune to aircraft, missile vibration



Shockproof. Glass-dielectric capacitor's value is unchanged by vibration.

Tuned high-frequency circuits take some of the worst punshment from missile and aircraft vibration, and signal degradation can result.

The capacitors that trim the circuits are usually made of metal plates separated by air or by a dielectric material, such as mica. Because of the gap between the plates, they may vibrate severely, causing the capacitance to change. In addition, the leads that couple adjacent capacitors act as lossy elements when they radiate at high frequencies.

Vibration and lead problems are overcome in a device called a dual trimmer capacitor, developed by engineers at the Voltronics Corp. The device has two sections, each consisting of an internally threaded piston and two concentric glass tubes separated by a metal layer.

The piston, precisely fitted to the

inner surface of the glass tube, acts as one capacitor plate. The metal layer is the other plate. Because there is solid glass between the plates, vibration won't affect the separation and change the preset value. Two rods prevent the piston from rotating and thus eliminate another degree of motion.

The two capacitors are adjusted independently by turning a threaded shaft. They are internally connected in series, with the common lead externally accessible. Thus one external connection is eliminated and its unpredictable characteristics remain constant from unit to unit.

High Q. While almost any combination of capacitance values are possible, five standard units are offered. These have tuning ranges, respectively, of 5 to 30, 2 to 15, 5 to 50, 4 to 12, and 2 to 4 picofarads. All units have a Q (reactance divided by resistance) of 700 at 1 megahertz, and 600 at 20 Mhz.

One design problem, says Voltronics, was how to get through the outer layer of the glass and make contact to the metal layer. Because of the thinness of the glass, normal cutting techniques could not be used. The tool that proved most successful was a diamond-tipped saw. It can be controlled precisely without cracking the glass.

The Voltronics capacitors are supplied with one ribbon lead, one wire lead and a threaded hollow stud. Any combination of leads may be ordered. With the non-rotating piston, the tuning screw does not move in and out, providing advantages in reliability and size. Linearity is $\pm 1\%$ with no capacitance reversals. Temperature coefficient is ± 100 parts per million per degree C. Capacitance change with temperature cycling is 0.08 picofarad.

Both ends of the unit are sealed and, at 25°C, have an insulation resistance of 10^6 megohms. They meet the military environment specifications of MIL-C-14409B.

The dual trimmers are priced at $14 each and vary in length according to tuning ranges. The smallest is about $\frac{5}{8}$ inch long, $\frac{19}{64}$ inch in diameter. The largest is $1\frac{13}{64}$ inch long, $\frac{7}{8}$ inch in diameter. The units can also be furnished for mounting on printed-circuit boards.

Voltronics Corp., West St., Hanover, N.J. 07936 **[349]**

Wide-awake idea for sleeping ease

Plastic thermistors can smooth out those bumpy electric blankets

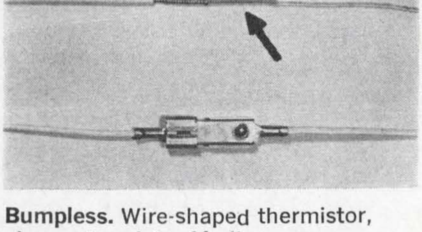
Electric blankets have given many a user some sleepless moments. True, the blankets provide warmth, but they also give that bumpy feeling—because of the bulky temperature sensors sewn into the blankets. These bumps are no longer necessary with a plastic thermistor developed by Japan's Matsushita Electric Co.

Made with polyvinylchloride, a flexible material, the thermistor can be molded into any shape. In the form of a wire, it can be used as a temperature sensor covering a large area, such as an electric blanket or a heating pad.

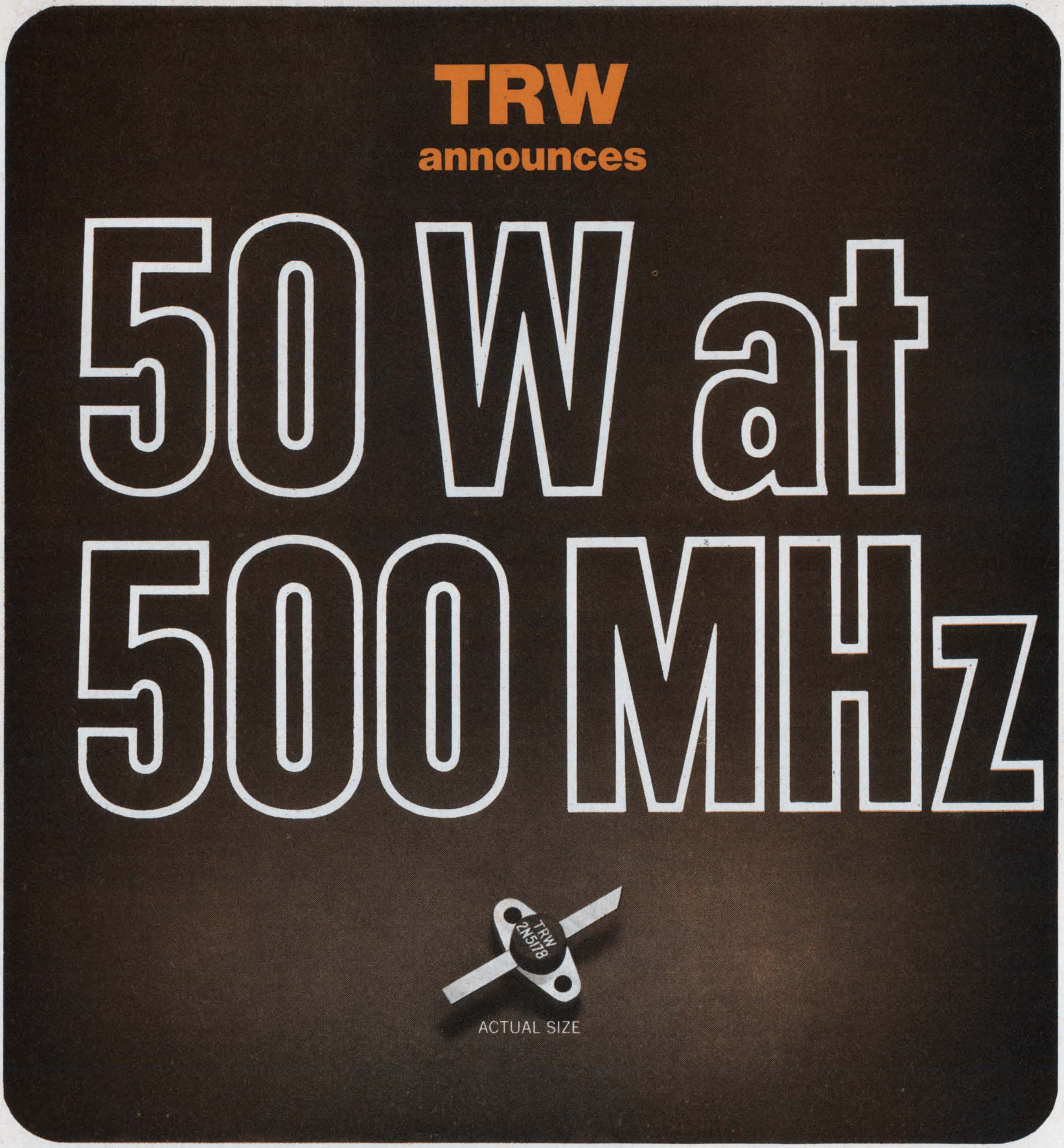
Matsushita first tried mixing a conductive powder with an antistatic agent, and then combining this mixture with a plastic base. But this didn't work. The mixture's electrical characteristics didn't lend themselves to precise temperature control. It wasn't until the company combined a semiconductive material and the plastic that it came up with the desired characteristics. Volume resistivity, resistance-temperature coefficient, and reproducibility make the thermistor extremely sensitive to temperature change.

However, the device does have some drawbacks. It can't be used as a small area bead-type sensor, it works only below 100°C and only with alternating current.

Matsushita Electric Co., Tokyo **[350]**



Bumpless. Wire-shaped thermistor, above, does job of bulky sensor.



28 Volts...5dB Gain...60% Efficiency!

TRW announces a major breakthrough in communication transistor technology with the introduction of this high efficiency, high gain 50 watt/500 MHz device.

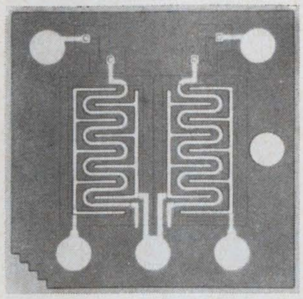
In high power military aircraft transmitters, a single 2N5178 will do the job formerly requiring vacuum tubes or multiple-transistor circuits. The 2N5178 is also well suited for use in radar pulse circuits.

This state-of-the-art device employs a patented cellular construction in a grounded emitter stripline package comparable in size to the TO-37. A 25-watt version, type 2N5177, is also available.

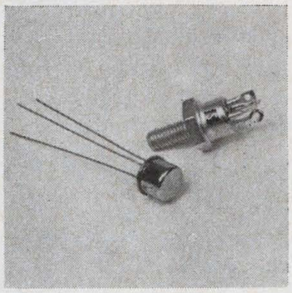
For evaluation quantities and complete technical details, contact any TRW distributor or TRW Semiconductors, 14520 Aviation Blvd., Lawndale, Calif. 90260. Phone: 679-4561, TWX: 910-325-6206. *TRW Semiconductors Inc. is a subsidiary of TRW INC.*

TRW®

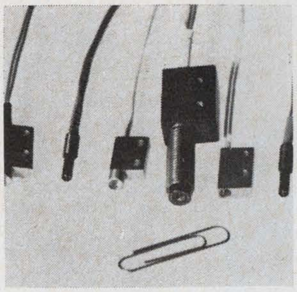
New Semiconductors Review



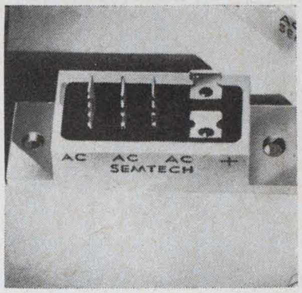
MOS-FETs FT704 and FT701 have an integrated gate protection circuit consisting of diffused resistor-diode network that wards off damage due to voltage transients. The 704 offers feedback capacitance of 0.7 pf, leakage of 0.5 na max. The 701 provides on-resistance of 600 ohms max., gain of 1,200 μmhos min. Fairchild Semiconductor, Mtn. View, Calif. 94041. [436]



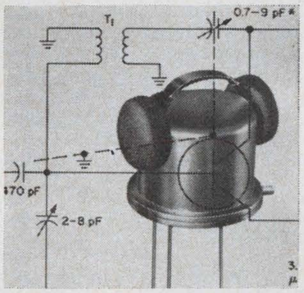
Silicon power transistors, designated the SDT7470 and 7B00 families, come in TO-5 and TO-11 packages and have 10-ampere capability. Since all elements are isolated from the case, these devices will solve many packaging problems. Primary use is in switching circuitry such as inverters. Solitron Devices Inc., 1177 Blue Heron Blvd., Riviera Beach, Fla. 33404. [437]



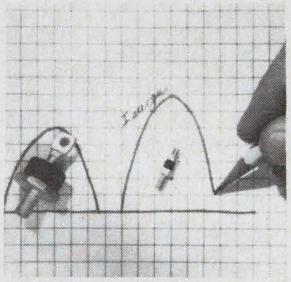
Tiny photodetectors (using photodiodes) and light sources include types for use with incident and reflected light. Light transmission utilizes fiber optic and lens systems that are incorporated to derive object definition approaching 0.005 in. Light sources have 40,000-hr life at rated voltage. Skan-A-Matic Corp., P.O. Drawer 68, Skaneateles, N. Y. 13152. [438]



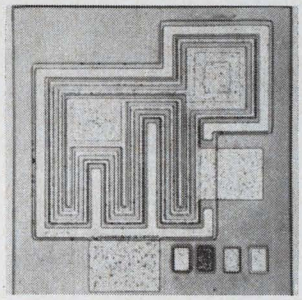
Silicon 3-phase bridge rectifiers Alpac-3 are aluminum-cased for max. thermal conductivity, simple and compact installation. Universal terminals provide 3 ways for electrical connection: fast disconnect, wire wrap-around, and hole wire insert for soldering. Piv ranges are 50 to 600 v; average output, 25 amps. Semtech Corp., 652 Mitchell Rd., Newbury Park, Calif. 91320. [439]



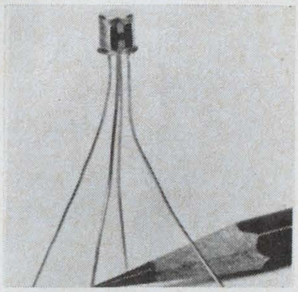
Germanium transistors series MM-5000-5002, fabricated utilizing the SME (selective metal etch) process, are for sensitive, front end r-f circuits. They have a noise figure of 1.6 db maximum at an operating frequency of 200 Mhz. The TO-72-packaged units also furnish up to 24 db minimum power gain at 200 Mhz. Motorola Semiconductor Products Inc., Phoenix, Ariz. 85001. [440]



A stud-mounted zener diode provides a 10-w continuous rating and a 350-w surge rating in a package about the size of a conventional 1-w zener. It uses the same basic void-free, glass-sealed, metallurgically-bonded structure as all the company's diodes, but a larger junction area. Price is $4.50 (1,000 and up). Unitrode Corp., 580 Pleasant St., Watertown, Mass. 02172. [441]



Dual gate MTOS (metal-thick-oxide-semiconductor) FET type MEM 554 is useful for r-f amplifier, mixer and i-f applications. Transconductance is 12,000 μmhos; input capacitance, 5 pf; reverse transfer capacitance, 0.02 pf. Power gain and noise figure at 200 Mhz are 18 db and 3.5 db respectively. General Instrument Corp., 600 W. John St., Hicksville, N.Y. 11802. [442]

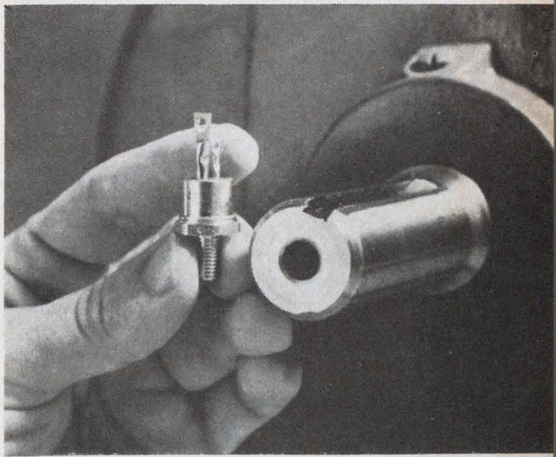


Silicon Darlington transistors 2N-2723 -4 and -5 consist of 2 transistor chips mounted in either a 3- or 4-lead TO-12 package. Single devices offer base-to-emitter voltage controlled within 0.2 v; collector-to-base breakdown voltage, greater than 85 v; and emitter breakdown voltage, greater than 12 v. Hughes Semiconductors, 500 Superior Ave., Newport Beach, Calif. 92660. [443]

New semiconductors

Fast-moving triacs break into midfield

25-amp devices are specifically designed for medium-power-range proportional control



Middleman. Rated at 25 amps, triac fills the gap between low- and high-power solid state a-c controls.

The only two-for-one deal in the power control field is the triac: it replaces two silicon controlled rectifiers in a-c applications. Designers of low- and high-power systems have been able to take advantage of these devices, but those interested in medium-power systems—15 to 25 amperes—have been out of luck.

First to bridge this gap are Texas Instruments' 2N5273, 2N5274, and 2N5275 triacs. These units, capable of conducting 25 amperes, have ratings of 200, 400, and 600 volts respectively. The TI devices pro-

. . . cost reduction is expected soon . . .

vide switching and phase control of a-c power up to 10 kilowatts in industrial applications, including light dimming, temperature regulation, and motor-speed control. These devices can also be used in solid state relays and contactors, and in solenoid valve operation.

With a typical voltage-rise rating of 300 volts per microsecond, the triacs provide a high degree of circuit protection against false turn-on before gate triggering. This turn-on can be especially troublesome when inductive loads are involved. The triacs are protected by a peak anode surge current rating of 400 amps.

Boom is on. Production of triacs today is comparable to that of SCR's three years ago; their use in high-volume items is just emerging. According to William Heye, manager of TI's triac program, substantial cost reduction for triacs is expected in 1968. At present, the market is in the neighborhood of $3 million a year, and by 1970 it is expected to soar to $20 million. The reasons for the anticipated boom: triacs do a better job than SCR's, and they do it at a lower cost.

Unlike SCR control modules, which use three resistors, two SCR's, a capacitor, a pulse transformer, and a complex trigger such as a unijunction transistor, a triac module needs only a resistor, a capacitor, a triac, and a simple trigger diode. Not only does this reduce cost, but it cuts down on the space requirements. This is particularly important for power tools, home appliances, air conditioners, and lighting controls. "Most of these devices have been untouched by electronics," says Heye.

Specifications

Current	25 amps rms
Voltage	200; 400; 600
Gate voltage	1.7 v peak
Gate current	150 ma
Holding current	100 ma
Surge current	400 amps peak
dv/dt	300 v/μsec
Temperature range	−40° to +125°C
Price (100-999)	$5, $10.20, or $16 depending on voltage

Texas Instruments, Box 5012, Dallas. [444]

Meet our newest V.I.P.*

model CS-32A

A V.I.P.* to us of course and also to users of electronic desk calculators all over the world who are anxious to become acquainted with our newest model—CS-32A. This one, with 22 ICs, does more, much more, using less parts, in half the space previously needed (only 14.5 lbs. light).

Unsurpassed stable performance at lower operation cost; milli-second noiseless functions; trouble-free operation and ease in maintenance – vip features of the V.I.P.* by Sharp.

The CS-32A is for V.I.P.s who need their time to think and choose to leave the calculating to our V.I.P.*

☐ 16 digits ☐ 8 decimal places ☐ 2 memory registers Error preventers ☐ Rounding off device ☐ Ultra-modern design

*Very Important Product

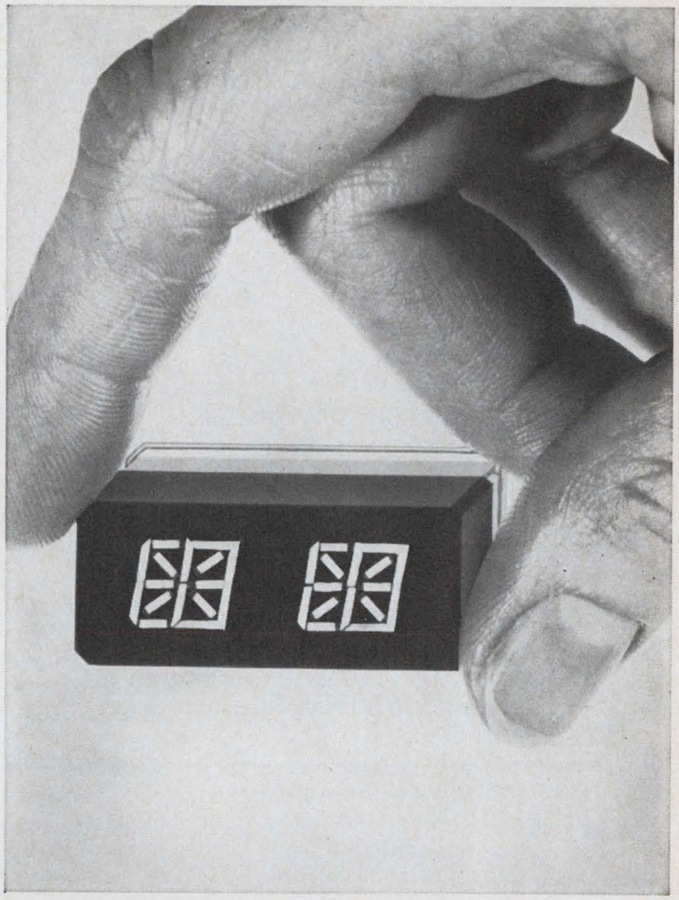
Sharp SHARP

HAYAKAWA ELECTRIC CO., LTD. Osaka, Japan

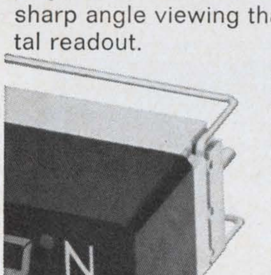
U. S. Subsidiary: SHARP ELECTRONICS CORP. 178 Commerce Road Carlstadt, New Jersey

Circle 172 on reader service card

NEW, high visibility alphanumeric readout



The 16-segment bar configuration of this new Tung-Sol readout, provides a potential of 65000 letter/symbol displays. This unit offers the same high visibility, clarity and sharp angle viewing that characterizes the Tung-Sol digital readout.



In addition to full alphanumeric display, fixed letter/symbol messages may be displayed in selected digit areas.

This new readout is compatible with the standard Tung-Sol digital unit. Use of the same lamp banks, voltages and mounting techniques, permits intermixing the readout blocks.

Write for detailed technical information. Tung-Sol Division, Wagner Electric Corporation, One Summer Ave., Newark, N.J. 07104.

TUNG-SOL®

ALPHANUMERIC READOUT

® REG. T.M., WAGNER ELECTRIC CORPORATION

Circle 127 on reader service card

If it's so great, how come it's so cheap?

It's only $5,000 because you said that's what it ought to cost. Our market research boys told us there was a tremendous need for an IC tester specifically designed for QC, QA, reliability testing, and everyday engineering evaluation. They also told us we could sell four times as many at $5,000 as we could at $7,500.

So we gave our design department a list of functions, a $5,000 pricetag, and locked the door. Here's what came out: A $5,000 IC tester that:

- Performs both pulse and dc parameter tests as well as functional tests without external equipment.
- Has a measurement accuracy of 1% (0.1% with an optional digital readout DMM.)
- Can be operated by a bright girl with half-a-day's training.
- Programs with thumbwheels in less than 60 seconds for most IC's.
- Has power supply accuracy of 0.1% ±1mv. (All supplies have adjustable current or voltage limiting and will both source or sink current.)
- Has Kelvin connections to the device under test.
- Has self powered, line-isolated modules.
- Has a complete line of device adaptors available.

How were we able to deliver so much machine per dollar? It was a snap. All we did was make every damn penny do a dime's work. We did it by committing to an annual agreement wherever there was a price advantage.

We did it by cutting out the fat. If a function was non-essential, it went. (This is one ungilded lily.)

We did it with painstaking project engineering. For example, the loads module: We could have made 1% capacitive loads. But it would have cost three times as much, and no one knows what to do with capacitive accuracy of better than 5% anyhow. Another example: the thumb-wheel switches. We found a great one, but discovered the price included $2 each for a pair of stainless-steel screws. We bought them knocked-down, assembled them ourselves and used 6¢ screws instead.

Or the pulse generator. Ours is equivalent to two single-channel output units like the ones that Datapulse sells for $775. They're great, but by sacrificing separate control and adjustment (which isn't necessary in our tester anyway) and the fancy case cut the price in half.

We found a terrific $15 digital switch. But we didn't use it. We built one without superfluous extras for a buck and a half apiece.

We're handling the AC-switching with 32 controlled planar devices. This saves 192 reed relays, that is to say, greenbacks.

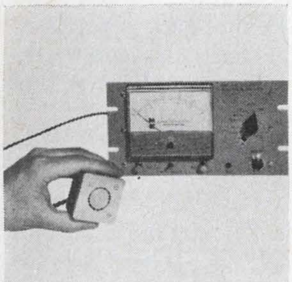
One thing we did was hardest of all. We cut the profit margin. We're honest-to-gosh taking only ¾ the typical profit.

One more thing. The 990 turns out to cost $4,950 instead of $5,000. Use the extra $50 to take the little woman out to a show and dinner.

Write for complete technical data, or if you're in a hurry, call us collect.

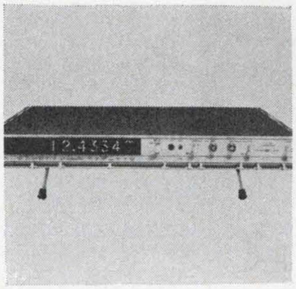
Redcor's 990 IC tester

Redcor Corporation/7800 Deering Avenue/Canoga Park, California/(213) 348-5892/TWX 910-494-1228



Electrostatic millivoltmeter model 147 Isoprobe features a small remote probe permitting stable, noncontacting d-c potential measurement in the 0.001-to 10-v range. A feedback-driven probe-technique acting as a voltage follower and special circuitry provide accuracy of 0.1% with drift less than 5 mv/day. Monroe Electronics Inc., 5 Vernon St., Middleport, N. Y. 14105. [361]

R-f random noise generator NS-LB covers the frequency range from 100 hz to 500 Mhz. It provides accurate noise figure measurements for receivers, amplifiers and radiometers. It features an output servo stabilized to better than 0.05 db and resettability within 0.05 db from 90 to 130 v a-c. Aerospace Research Inc., 130 Lincoln St., Boston, Mass. 02135. [362]



Universal counter-timer 6034 is a 10-Mhz unit with an over-all panel height of 1¾ in. Standard readout is 6 digits with automatic decimal point and units annunciator, all with display storage control. Stability of the internal oscillator is better than 3 parts in 10^7 per week. Price is $1,650; availability, 30 days. Systron-Donner Corp., 888 Galindo St., Concord, Calif. 94520. [363]

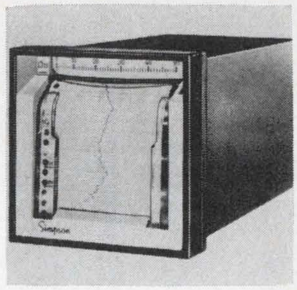
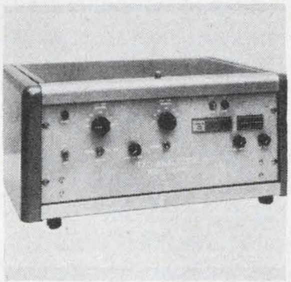
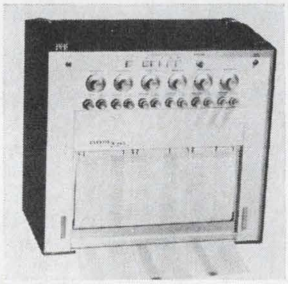


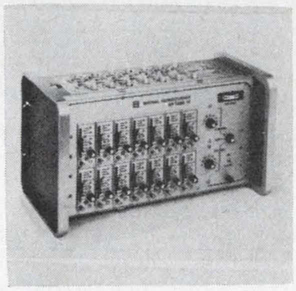
Chart recorders series 2750 occupy 3¾ x 3¾ in. of panel space. Besides recording, they provide continuous edgewise meter indication. The taut band movements result in ±1.5% recording and indicating accuracy. Each unit will record for over 32 days at 20 mm/hr without changing paper. Prices start at $140. Simpson Electric Co., 5200 W. Kinzie St., Chicago 60644. [364]



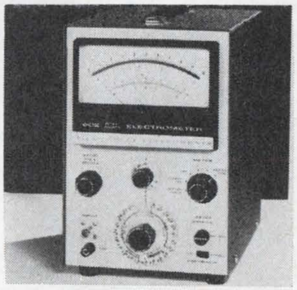
Temperature-characteristic analyzer TCA-1070 measures temperature coefficients of frequency and effective resistance of quartz crystals. It is furnished with an accessory crystal chamber and is designed to test crystals operating between 50 khz and 100 Mhz, in accordance with MIL-C-3098. Price is $1,490. Winslow Tele-Tronics Inc., 1005 First Ave., Asbury Park, N. J. 07712. [365]



Direct-writing recorder Mark 260 offers six 40-mm analog recording channels, 4 event-marker channels, a 1-sec timer, and servo-controlled accuracy of 99.5%. Built-in solid state amplifiers provide usable measurement range from 1 mv to 500 v. The unit makes traces in 2 colors. Price is $4,500. Brush Instruments Div., Clevite Corp., 37th & Perkins, Cleveland, Ohio, 44114. [366]



Portable signal conditioner model NY1200 will accept data from a variety of transducers, condition and/or analyze it, and provide an analog output for data recording systems. The unit consists of an input power supply, a bridge excitation source, and a series of plug-in wideband, differential amplifiers. Nytron Inc., 795 San Antonio Road, Palo Alto, Calif., 94304. [367]

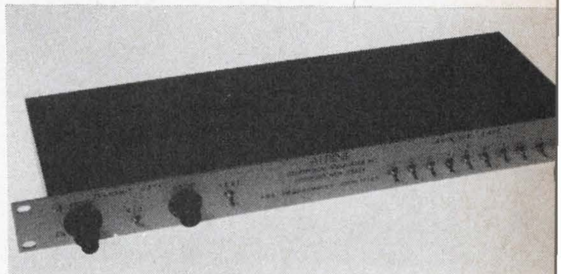


Electrometer model 602 features zero-drift of less than 1 mv per day. It performs as a voltmeter, with 50-mv resolution; an ammeter, with $\pm 3 \times 10^{-15}$ amp resolution; an ohmmeter, with 1-ohm resolution; a coulombmeter, with 10^{-14} coulomb resolution; and as a d-c amplifier. Price is $675. Keithley Instruments Inc., 28775 Aurora Rd., Cleveland, Ohio 44139. [368]

New instruments

Turning a deaf ear to clutter

Data programing amplifier for ocean-depth measurements turns on recorder for meaningful signals only



Sampler. Data amplifier locks onto strong signals, ignores noise.

Submarine-hunting ships and oil-hunting geologists may find their echo-ranging tasks eased by a new data programing amplifier developed for studies of the ocean floor.

Alpine Geophysical Associates Inc.'s model 485 was designed as a result of its engineers' experience in oceanographic work. "We wanted an automatic ranging system that would operate only when meaningful information was being received," says George Lehsten, Alpine's chief engineer. The model 485 prevents from being recorded pulses below the amplitude level of the bottom echo. This reduces clutter from weak signals reflected from schools of fish and other unwanted targets.

Echo ranging at sea is usually done with a programer, transceiver and recorder. The programer turns on the receiver only when desired signals are being reflected, but the operator must have a general idea when to expect these returns. He manually sets the gating times.

If approximate depth—and therefore time of returns—is known, this technique is satisfactory. But if there are sudden changes in the depth, the receiver may be off when desired signals are reflected.

The Alpine programer continuously samples the return signals and locks onto the strong return from the ocean bottom. Thus it automatically follows the ocean floor. It also prevents recording the wrong information from other strong signals. However, any signal stronger than the bottom return will get through.

Pulse divided. Model 485 is made of six subassemblies: decade counter, process amplifier and receiver gate selector, signal amplifier, keying amplifier, power supply, and test oscillator.

Time scaling is done with the decade counter, a collection of two-to-one binary dividers. These dividers expand the basic input pulse period by a specific number.

The process amplifier and receiver gate selector divide this new period into an equal number of receiver gate segments. Basically, the circuit consists of a series of 10 position counters, each controlled by its own independent gate toggle switch. The processing amplifier samples its input signal and determines which individual segment has the desired information. This enables the gate selector to select the required interval of the original transmit pulse ratio by operating a toggle switch. Therefore, only that time segment containing useful information is recorded.

The signal amplifier accepts the input information in continuous format and gates this information to the recorder according to the settings of the receiver gate switches. Signals in excess of 10 volts can be accommodated, enabling almost any recorder to operate with the programer.

The test oscillator enables the person studying the records to see the programing sequence used, when started, and when terminated.

Alpine Geophysical Associates Inc., Oak St., Norwood, N.J. 07648 **[369]**

Filter out back purifies signal

Amplifier separates noise from signal information and provides 160-db gain

It's what's up front that counts, says the cigarette advertisement—calling attention to the tobacco, not the filter. But for Teltronics Inc.'s newest amplifier, the slogan could be turned around: it's what's out back that counts, meaning the filter.

Called the model 300-A, the unit can separate a received signal obscured by as much as 56 decibels of background noise. This separation is achieved by a lock-in, coherent amplifier stage.

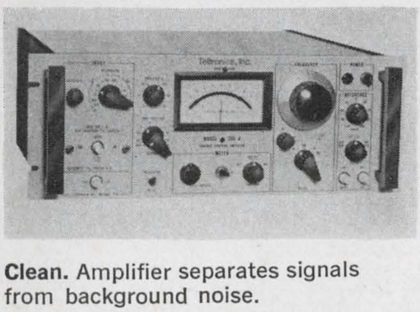
A plug-in preamplifier picks up the signal and, depending on whether it's a high- or low-input source, converts it to a waveform that can be accepted by the unit's Q filter. This filter eliminates some of the background noise. But if the noise is still too high, the coherent amplifier filters it out even further.

In the coherent amplifier, the modulation of the signal is switched by a reference-channel signal to a d-c output meter. The reference signal is provided by either a built-in chopper or an external source.

Signals from 1.5 hertz to 200 kilohertz, and varying from 100 nanovolts to 100 millivolts can be processed by the amplifier. The minimum output bandwidth of the unit is 0.0025 hz, and it has an available gain of 160 db. The Q filter is variable from a broadband setting of 0 to a high selectivity value of 25.

The unit's price is about $1,900.

Teltronics Inc., Box 466, Nashua, N.H. 03060 **[370]**



Clean. Amplifier separates signals from background noise.

Will the right Celanese Nylon please stand up!

Now, there's a right Celanese Nylon 6/6 molding or extrusion compound for just about any product application. Introducing, from left to right: Celanese Nylon 1000, a general purpose automotive and industrial molding resin. 1003, a heat stabilized form of 1000. 1200, a high viscosity extrusion resin for tubing, rod, film, etc. 1500 and 1503, glass reinforced compounds of low creep, high stiffness and high heat resistance. And Celanese Nylon 1000, 1003, 1503 are available in black resin.

All of these Celanese Nylons are fully competitive in meeting established specifications for physical, electrical, chemical, molding and extrusion properties.

This means that you now have a new, dependable, volume source for a complete line of 6/6 nylon. And isn't that welcome!

Celanese Nylon is available right now. With more to come. Like more resins. More advanced nylon technology. More molding and marketing assistance.

Send for the complete facts about Celanese Nylon. To: Celanese Plastics Company, Dept. 233-J, P.O. Box 629, Linden, New Jersey 07036.

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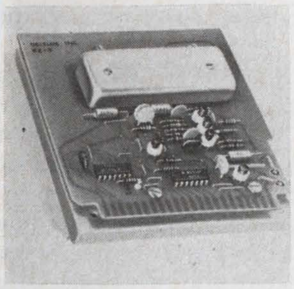
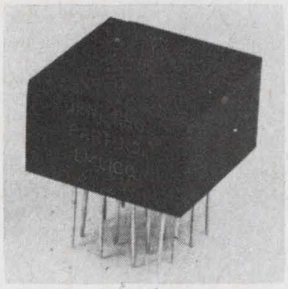
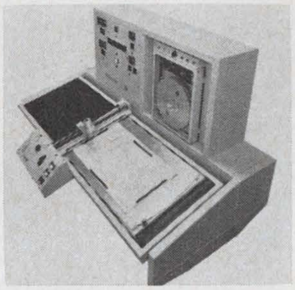
Export Sales: Amcel Co., Inc., and Pan Amcel Co., Inc., 522 Fifth Ave., New York 10036.



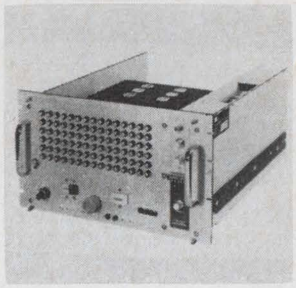
Delay module Deltime 190A/RZ-9 is fully compatible with DTL and TTL circuitry. Maximum delay is 1 msec at a prf of 1 Mhz. Delay drift is 0.15 μsec. Power requirements are +10 v d-c ±10%, 56 ma; − 10 v d-c ±10% at 20 ma; +5 v d-c ±10% at 35 ma. Operating temperature range is 0° to 50° C maximum. Sealectro Corp., 225 Hoyt St., Mamaroneck, N.Y. 10543. [381]



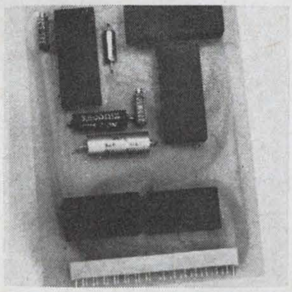
Low profile plug-in ladder networks series L14L10Q feature accuracies of better than ½ the least significant bit over all temperature conditions. They use wirewound film and hybrid circuit components to achieve up to 14 bits in a compact package. Response time is better than 1 μsec and approaches 100 nsec. General Resistance Inc., 430 Southern Blvd., Bronx, N.Y. 10455. [382]



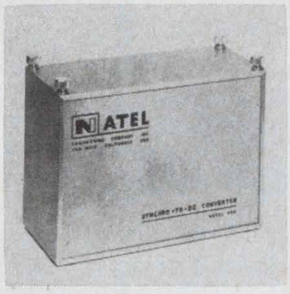
Digigraf CP-1000 digitizes graphic data and records it on computer-ready tape. The data is carried on a table top that moves horizontally parallel to the x-axis. Digitization is by use of a laterally fixed, vertical-motion, lightbeam curve follower. The operator can convert charts at varying speeds. Keltec Industries, Div. of Aiken Industries Inc., Alexandria, Va. 22314. [383]



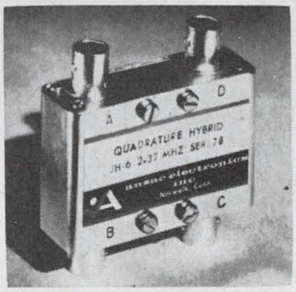
Low level multiplexer SSM-204 samples 88 channels of analog data. It offers a continuously adjustable system gain in ranges from 10 to 1,000 with a minimum discernible signal of 1 μv. Channel-to-channel offset scatter is ±30 μv over a 0° to +50° C temperature range. Crosstalk is less than 0.01%. WEMS Inc., 4650 W. Rosecrans Ave., Hawthorne, Calif. 90252. [384]



An analog-to-digital converter weighing 3 oz can be used without buffering since it has a 100-megohm input impedance. It accepts analog inputs from 0 to +5 v and provides 8 parallel binary outputs. Encoding is accomplished in less than 65 μsec with 0.03% linearity and 0.1% stability from −20° to +85°C. Avco Corp., 2630 Glendale-Milford Rd., Cincinnati, Ohio 45241. [385]



Synchro/d-c converter 406 accepts output from a 3-wire ungrounded stator and produces a d-c voltage proportional to the rotor shaft angle from 0 to 360°. It features an accuracy as low as ±3 minutes of arc and a unit size of 2 x 3 x 4 in. D-c output voltages of 0 to +5 v, or 0 to +10 v are available. Natel Engineering Co., 7129 Gerald Ave., Van Nuys, Calif. 91406. [386]



Quadrature hybrid JH-6 covers the entire 2- to 32-Mhz band, and measures 2.3 x 1.5 x 0.8 in. (excluding connectors). A signal fed into it divides equally within 0.5 db between the unit's two output ports. Outputs exhibit a 90° ±3° relationship over the band. Insertion loss is less than 0.8 db. A/R-Anzac Electronics Co., 121 Water St., South Norwalk, Conn. 06854. [387]

Amplifier M5000L offers linear amplification of low-level signals from 10 khz to 220 Mhz with no tuning or bandswitching. It consists of distributed amplifier modules cascaded to give more than 30-db power gain across the 15-octave portion of the spectrum from high audio to low microwave frequencies. Instruments for Industry Inc., 151 Toledo St., Farmingdale, N.Y. 11735. [388]

New subassemblies

Pick your voltage—fast

Programable power supply switches values with only slight increase in ripple

Versatile. Programable power supply operates in standard or high-speed modes with low ripple.

In the era of automated testing of integrated circuits, the low-volume user must either acquire expensive equipment or put together his own conglomeration of power supplies and voltmeters, and suffer with slow speed.

A third choice is offered by the Sorensen Operation of the Raytheon Co. in the form of a high-speed programable power supply designated the QRD. With some additional switching circuitry and a digital voltmeter, the QRD gives an IC user a complete test station for a modest sum. Testing of IC's

. . . low ripple without capacitors . . .

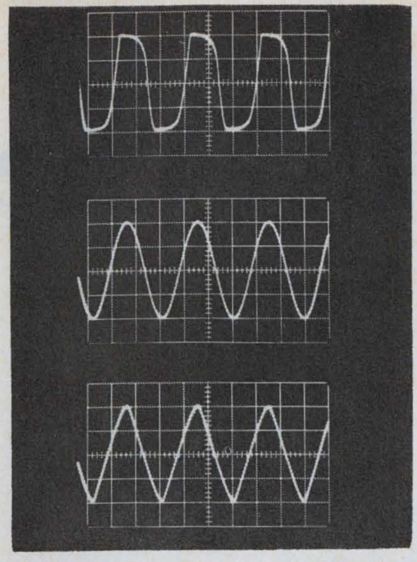
is only one major application of the unit.

Conventional d-c regulated power supplies are limited in their switching speed by the output capacitor and the capacitor in the sensing network. The large output capacitor serves as the main stabilizing component of the supply. When changing from a high voltage to a lower value, the output voltage can't fall faster than the capacitor can discharge, even though the regulator cuts off. So the programing speed is limited to about 1 volt per millisecond. The sensing capacitor functions in an exponential decay, also limiting the output response.

At a price. If the capacitors are eliminated, undesirable effects are introduced. Eliminating the output capacitor decreases the stability because it removes the dominant lag of the system. It also results in the loss of a good low-pass filter across the load terminals, causing more noise to be supplied to the load. Removal of the sensing capacitor makes the unit more susceptible to pickup at the feedback loop input stage. The over-all result is a more sensitive system having greater output ripple and poorer transient response, which leads to poorer regulation.

In the Sorensen QRD series two modes of operation are available. The unit operates as a regular d-c power supply or, by removing a rear terminal link and thus disconnecting the capacitors, high speed operation on the order of 25 microseconds is achieved. Because of improved circuit design and a steady rolloff of about 6 decibels per octave, there is only a slight degradation of ripple and transient response. The company says the high speed ripple is equal to or less than that in most supplies operating in one normal mode, when the measurements are made under worst-case conditions.

Worst-case conditions occur when a low output voltage is measured across a low resistance load by a wideband voltmeter. Under these conditions, the QRD is rated at 150 microamps root-mean-square ripple for regular speed, and 300 μa for high speed operation—about ten



Response. Characteristics of power supply are indicated by square, sine, and triangular waves at 10 khz.

times better than regular units.

Either constant. Programing for either mode can be accomplished in two ways. At constant voltage the program constant is 100 ±0.5 ohms, or 1 volt per volt. At constant current for a 1-amp supply, the constant is 1 kilohm per amp or 1 volt per amp. These programing constants are a trade-off between resolution and drift characteristics.

Programing time, defined as the time for the output to move between 10% and 90% of the maximum voltage range, depends on whether the programing is up or down. To go from zero to maximum voltage the time is 25 μsec., and to go from maximum to zero it is 10 μsec. This enables the supply to be used with relatively fast computers for automatic, sequential testing.

The power supply series consists of seven units ranging from 30 to 90 watts and from 15 to 60 volts.

Specifications

Model	QRD 30-1 (0-30 volts, 1 amp)
Mode	high speed
Current regulation	±(0.01% + 125μa)
Voltage regulation	±0.005% or ±0.75 mv
Ripple voltage	300 μv rms, 8mv p-p
Ripple current	300 μa rms, 2 ma p-p
Transient response	70 μsec
Voltage drift	0.025%
Current drift	0.1% + 50 μa
Voltage resolution	0.01% E_{max}
Current resolution	0.015% I_{max}
Programing	100 ohms per volt
Input power	105-125v, 47-440 hz
Price	$178
Delivery	stock

Sorensen Operation, Raytheon Co., Richards Ave., Norwalk, Conn. [389]

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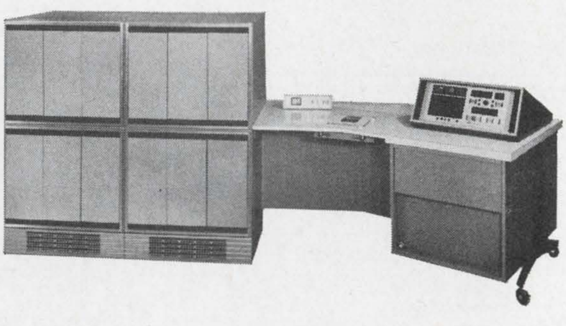
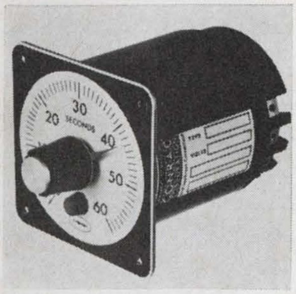
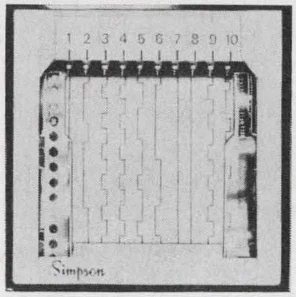


TEXAS INSTRUMENTS
INCORPORATED

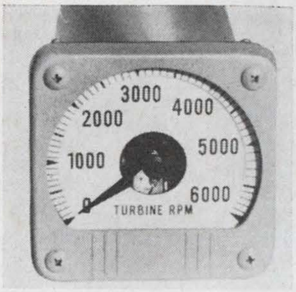
529



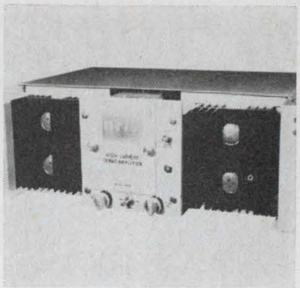
Multipurpose industrial reset timer 3823 can be converted to a time delay relay or an interval timer. The solid state unit has time ranges from 1 sec to 5 minutes, accuracy of ±2%, and a life of 10 million operations. Its spdt switches are rated at 10 amps. Recycle time is 30 msec; warm-up time, zero. Price is $28. Conrac Corp., Cramer Div., Old Saybrook, Conn. 06475. [421]



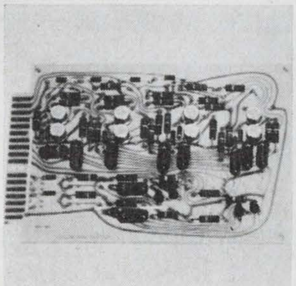
Compact, 10-channel event recorder 2755 can operate for over a month without changing the chart paper. It uses 3¾ x 3¾ in. of panel space. Built-in chart speeds are 20 and 120 mm/hr and other speeds can be added. Recording is inkless on non-fade pressure-sensitive paper that is 2.56 in. wide. Price is $175. Simpson Electric Co., 5200 W. Kinzie St., Chicago, 60644. [422]



Solid state electronic tachometer type J incorporates a 250° switchboard panel mounting meter for monitoring the rpm of industrial equipment. Power and signal connections are made to a barrier strip mounted at the rear of the frequency/rpm measuring instrument. Accuracy of measurement is within 1.0%. Airpax Electronics Inc., P.O. Box 8488, Fort Lauderdale, Fla. 33310. [423]



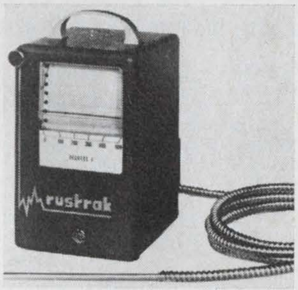
Linear d-c servo amplifier model 4500 provides up to 40 amps peak to 24-v d-c motors and torquers. Three summing inputs are provided to the amplifier, which has a total open-loop gain of more than 100 db. Frequency response is d-c to 2,000 hz. Ambient temperature range is 0 to 55°C. Price is $2,350. Nuclear Research Instruments, 2800 7th St., Berkeley, Calif. 94710. [424]



Logic controllers HS-080 (shown) and HS-090 convert sine-waves or random d-c square-wave pulses into the correct excitation sequence for driving 2-, 3-, or 4-phase stepper or synchronous motors. Phase sequence is controlled by application of the input signal to the proper input gate. Harowe Servo Controls Inc., Westtown Rd. at West Chester Pike, West Chester, Pa. 19380. [425]

A servo strain gauge indicator is a self-contained unit requiring only signal input and electrical power for operation. Any strain gauge between 50 and 500 ohms can be used as an input. The indicator is in a 3-in.-diameter, flange-mounted case per MS33638 with zeroing knob on lower right hand corner. Gap Instrument Corp., 17 Brooklyn Ave., Westbury, N.Y. 11590. [426]

Motor-speed control Minatrol M-22 for series-wound a-c/d-c motors permits continuously variable full-wave control from 0 to 100% full speed. Built for motors drawing 2.2 amps or less, it has a regulation adjustment to maintain speed when increased loading tends to slow down the motor. Price is $39. Minarik Electric Co., 224 E. 3rd St., Los Angeles 90013. [427]

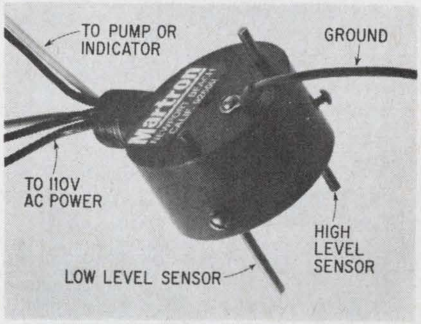


Temperature recorder 155 needs no external amplification. A choice of ranges is available using appropriate thermocouple, either iron-constantan or chromel-alumel. Minimum span is 500°F or 300°C with 2% of full-scale accuracy. Size is 5⅝ x 3⅝ x 4⅛ in. Price of $135 includes appropriate probe. Rustrak Instrument Co., Municipal Airport, Manchester, N.H. 03103. [428]

New industrial electronics

Coffee, tea, or an empty cup?

Solid state sensor eliminates moving parts in controlling liquid vending machines



Compact. Complete power supply and control equipment are encapsulated to prevent damage from corrosion.

Did you get cheated out of a full cup the last time you got coffee from a vending machine? If you did, it was probably because the level sensor was not operating properly.

The most common types of sensor in vending machines are either float valves or timers, and problems in either can lead to a bad cup of coffee or just a trickle of hot water. Sometimes float valves corrode and stick after long use, and timers work properly only when line pressure is constant. Offering a third choice, Martron Inc. has developed a solid state sensor with a resolution of 0.0001 inch. It sells for $20 each, or $10 in quantity.

The sensor, which has no moving

. . . triac triggers pump to control level . . .

parts, consists of two conductive probes which go in the liquid to be measured, a groundwire, and an electronic switch. The switch controls the liquid level by actuating a pump. It consists of a triac, a trigger diode and a silicon controlled rectifier. The probes operate on 5 volts from a high impedance source, so that there is a current of less than 2 milliamperes on the probes.

The sensor ground must be connected to a metal tank, or to a ground wire, with one end deep in the liquid. The two probes detect the desired upper and lower levels.

The triac is actuated by the trigger diode which is connected between the triac and a high-impedance, low-current power source that supplies less than 3 milliamps to the diode. The diode itself is controlled by the SCR which is hooked up to the same power source in parallel with the diode.

Turning on. When both probes are covered by the liquid—the level is at its upper limit—2 milliamps flow between the probes and the ground. This current is fed to the SCR which is in parallel with the diode. It turns the SCR on, causing the trigger diode to be bypassed, thus turning off the triac which switches off the pump.

Because the turn-on current of the SCR is greater than its holding current, as the liquid drops below the level of the upper probe, there is still enough conductivity from the lower probe to keep the SCR operating, and the triac remains off. But when the liquid drops below the lower probe, current to the SCR is cut off, the diode triggers the triac, and pumping is resumed. The level then rises until both probes are again covered, when there is sufficient current to gate the SCR on again. The lower probe, in effect, is a holding probe that keeps the SCR in its open or closed position, depending on whether the tank is being filled or emptied.

The sensor can also be used to detect a gas-liquid interface or the interface between conductive and nonconductive liquids.

Martron Inc., 875 West 15 St., Newport Beach, Calif. 92660 **[429]**

If you don't have one... let's hope you never need it

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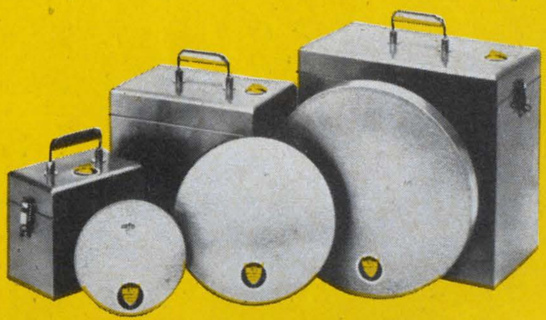

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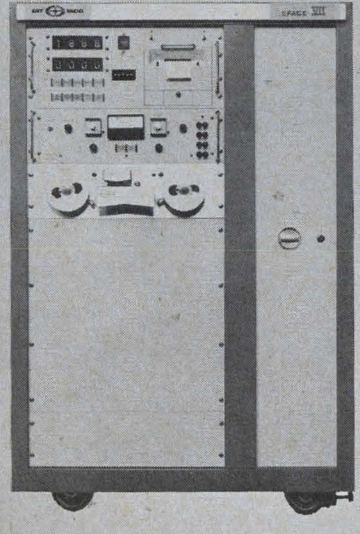

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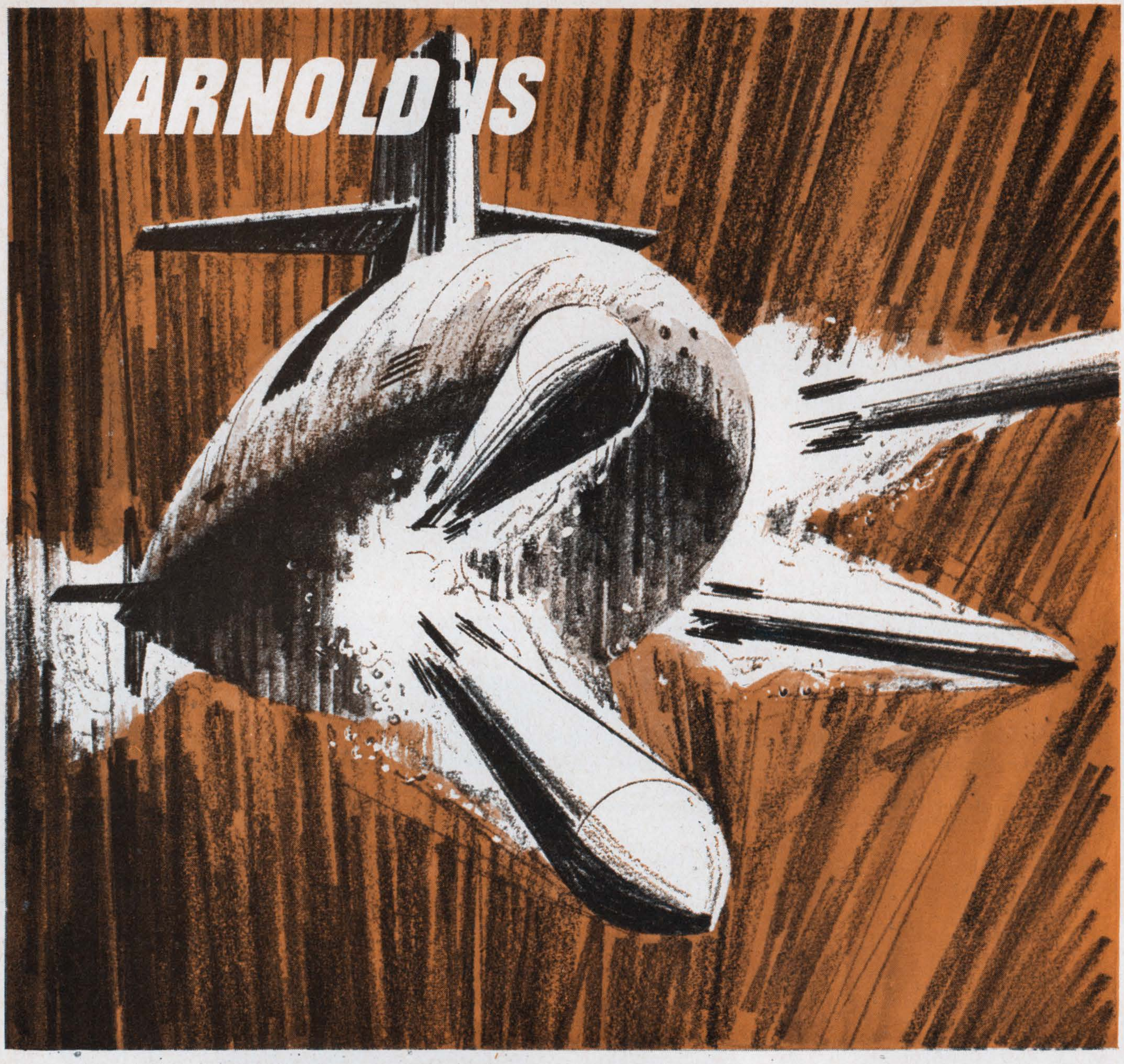

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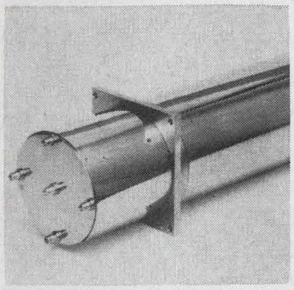
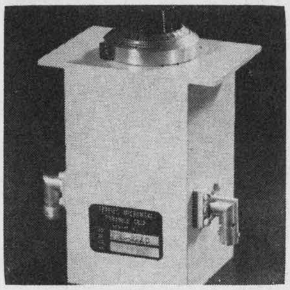
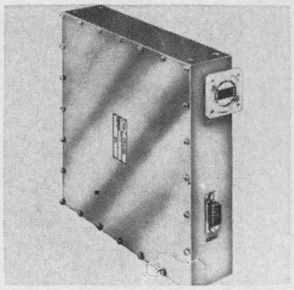
New Microwave Review



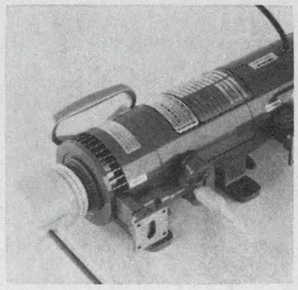
Five-channel rotary coupler model 7700 offers all channels with octave or greater bandwidths and complete coverage from d-c to 18 Ghz. It is available with miniature TNC or type N connectors. Overall length is 18½ in.; diameter, 3½ in.; and weight, 15 lbs. Unit price is approximately $13,500; delivery, 90 to 120 days. Kevlin Manufacturing Co., 24 Conn St., Woburn, Mass. 01801. **[401]**



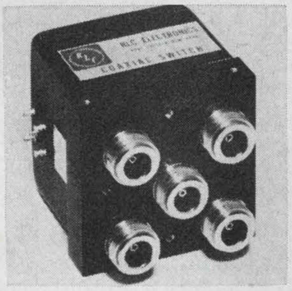
Single-knob-tuned, telemetry bandpass filters offer an interchangeable package covering all uhf bands: 910 to 1,000 Mhz, 1,435 to 1,535 Mhz, 1,700 to 1,850 Mhz, and 2,150 to 2,350 Mhz. Each assures low insertion loss, high selectivity, constant bandwidth and low vswr, regardless of tuning range. Applied Microwave Dynamics Corp., 287 Sherman Ave., Newark, N.J. 07100. **[402]**



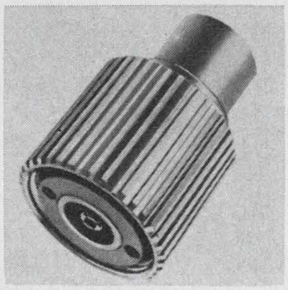
Four modules including the source, amplifier, X8 multiplier, and Ku-band tripler are packaged into Ku-band source 5000-9200. Typical specifications are: frequency, 16.5 Ghz; output power, 50 mw minimum; temperature range, 0° to 120°F; frequency stability, ±0.005%; size, 7 x 7 x 2 in., excluding projections. Trak Microwave Corp., Tampa, Fla. 33614. **[403]**



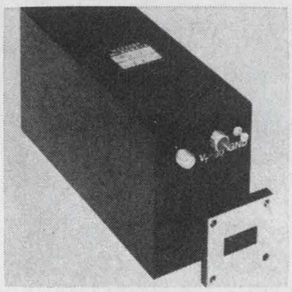
High-power, pulsed twt 750H features 40% efficiency at the 25–30 kw level at X band. It has a gain of 45 db. Designed to meet MIL-E-5400 Class 1A specs, it measures less than 20 in. long and weighs less than 27 lbs. It utilizes Alnico permanent-magnet focusing and air cooling. Electron Dynamics Div., Hughes Aircraft Co., 3100 W. Lomita Blvd., Torrance, Calif. 90509. **[404]**



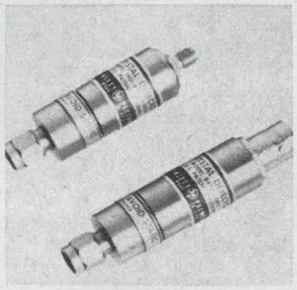
Remote coaxial switches (SR-3, SR-4 and SR-6) are single-pole, multiposition units with frequency ranges of d-c to 12.4 Ghz. They offer 50-ohm impedance; 1,000,000 cycles minimum life; and insertion loss of 0.3 db max. from d-c to 7 Ghz, and 0.6 db max from 7 to 12.4 Ghz. Prices: $165 to $190. RLC Electronics Inc., 25 Martin Place, Port Chester, N.Y. 10574. **[405]**



Coaxial termination model TA-5HA offers full band frequency coverage of 0 to 18 Ghz with a maximum vswr of 1.15. For partial band coverage, over 0 to 12.4 Ghz, maximum vswr is 1.10. Power rating is 2 w. Supplied with an APC Amphenol 7-mm connector, over-all length is 1.2 in., weight is 1.3 oz. Price is $65 each. Microlab/FXR, 10 Microlab Road, Livingston, N.J. 07039. **[406]**



Microwave sources have a tuning range from 16 to 16.5 Ghz. Power output is 10 mw minimum; tuning voltage, 8 to 40 v; power flatness, ±1.2 db. Spurious response in-band is greater than 75 db below the carrier; out-of-band, 40 db below the carrier. The unit measures 5.5 x 1.3 x 2.5 in. Western Microwave Laboratories Inc., 1045 DiGiulio Ave., Santa Clara, Calif. 95050. **[407]**



Coaxial crystal detector 8472A is for systems uses. Frequency range is from 10 Mhz to 18 Ghz and response over the full band is better than ±1 db. Units measure 9/16 in. in diameter, 2½ in. long (including connectors). The 8472A is for 0.141-in., and the H01-8472A for 0.086-in. coaxial lines. Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304. **[408]**

New microwave

Instant bandwidth spans five octaves

Power amplifier for signal generator requires no tuning or band-to-band switching for test and calibration work

Wide coverage. One unit replaces many in providing amplification for high-frequency signals.

Testing antennas or receivers across a broad range of frequencies usually requires switching between two or more amplifiers, or, at the very least, using some kind of tunable amplifier. The reason: signal generator power is limited, and amplifiers now available span relatively narrow bands—one to two octaves maximum.

The bandwidth problem is about to be overcome by a solid state, broadband amplifier having an instantaneous bandwidth of five octaves without tuning or band switching. It soon will be put on the market in several models.

Developed by the Bunker-Ramo Corp.'s Defense Systems division, the device, called the BR-630, spans the 10-to-450-megahertz range—

. . . impedance matched down to 5 ohms . . .

thanks to five cascaded broadband transistor stages in a hybrid microstrip configuration. Although designed primarily for radio-frequency testing that requires output power up to 3 watts, the amplifier can be used in calibrating wattmeters, testing filters and components, and measuring attenuation.

Zeroing in. The amplifier will sell for about $1,000, and its principal markets will probably be Government laboratories, military communications and radar installations, and universities.

Low-attenuation coupling between the five transistor stages results in the instantaneous wide bandwidth. The coupling provides a wide band impedance match at levels to less than 5 ohms.

Other features include automatic overload protection circuitry for the output stage, and automatic level control to prevent the unit from instantaneously exceeding the collector current on the final stage.

Overload protection is provided by a very fast wideband loop that cuts off the power before the transistor is damaged—a resistor monitors the collector current and a silicon controlled rectifier removes the power supply voltage.

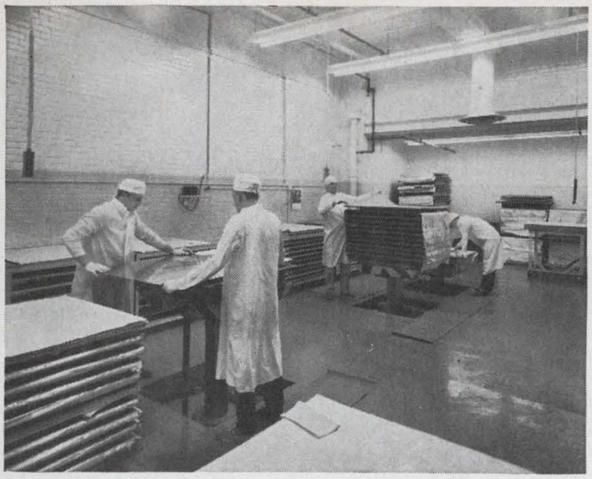
Automatic level control is achieved by regulating the collector current to the first three stages. A flat frequency response is obtained through a leveling circuit, which accommodates an input variation of ±15 decibels while maintaining output within ±1 db.

The amplifier is packaged for use as a bench-mounted item. An optional adapter plate enables it to be mounted into a 19-inch rack or cabinet.

Specifications

R-f calibration	0.2 v increments on 3 v full scale setting (increments of 5%)
R-f output	12 v rms max across matched load of 50 ohms with accuracy 5% of full scale
R-f input	0-1 v rms, power input 1 milliwatt
Impedance	50 ohms nominal for both input and output
Noise	—47 db below maximum output for full bandwidth
Power	105-125 v, 60 hz, 45 w

Bunker-Ramo Corp., Defense Systems Div., Canoga Park, Calif. **[409]**



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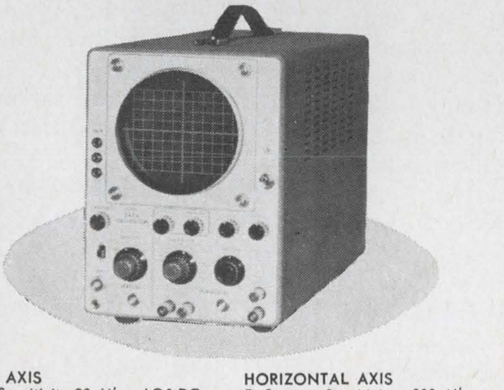

VERTICAL AXIS
Deflection Sensitivity 20mV/cm, AC & DC
Frequency Response
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DC: 0~5MHz within −3dB
Input Impedance 1MΩ, shunted by 30pF

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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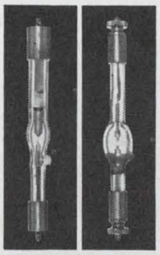
PEK

is the standard of reliability in High Intensity Light Sources



Across a power range of 35 watts to 30KW in xenon, and 100 to 500 watts in mercury, PEK high intensity arc lamps are noted for long life, maximum arc stability, dependable glass-to-metal seals. These are the qualities that have made PEK arc lamps the standard of reliability in applications ranging from photography to solar simulation, from microscope illumination to long-range projection.

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New Books

Closing the gap

Techniques of System Engineering
S.M. Shinners
McGraw-Hill Book Co.
498 pp., $14

Between sessions at control systems meetings, engineers and mathematicians are often seen in animated "discussions"—shaking their heads. They're probably talking about how they can get the control systems applications people to communicate with the control theorists. A gap, they say, exists between the two groups.

Control mathematicians are accused of investigating problems that don't really exist, while the applications group appears unwilling to grapple with higher-level mathematics. And because there are more application-oriented people, an "anti-intellectual" feeling has prevailed.

But two major changes have recently occurred. Industry has assigned better-educated engineers to oversee their instrumentation and control needs, while computers and control-oriented programs have alleviated the computational chores in analyzing, designing, and implementing complex control schemes. The control gap thus finally seems to be closing.

In this volume, Shinners tells how and why this has been happening. He describes real systems: modern, complex, extensive, mathematically-characterized control theories are actually being used by practical engineers in many fields.

Shinners' book should help narrow the gap still further. It will prove informative to engineers who want to raise their level of competency in control and systems theory. Not only does it serve as a compendium of basic and advanced control concepts, but it gives a detailed treatment of many subjects that will prove useful in actual system design.

By the numbers

Electronics Counting Circuits
J.B. Dance
American Elsevier Publishing Co., Inc.,
390 pp., $16.75

Here is a book on counting circuitry that lacks but one element: a section on integrated circuits. Apart from the omission of counting networks constructed of IC's, Dance's work may be the most comprehensive reference on the subject, covering high- and low-frequency circuits, and designs for military, industrial, and computer applications as well.

Counting circuits were largely confined to data-processing equipment until the nuclear physics technology emerged the late 1940's. One now finds the circuits in many other jobs, ranging from instrumentation for radio isotope systems to automation equipment in factories. Much of the electronics industry relies on counting circuits for control, data-processing, timing, and many other functions. Despite their importance, a comprehensive guide to counters has not appeared until now.

With Dance's book, any engineer, even one not particularly versed in the subject, can acquire a practical working knowledge of the circuits. In addition, the work is neatly arranged by type of component used, enabling the reader to quickly find a circuit to fill a particular need.

Topics include the fundamental principles of counting circuits and how the various types work. Among these are tube, electromagnetic, discrete semiconductor, beam switching circuits, and others. Supplementary information is given on readout devices, scaling and ratemeter circuits, and nuclear radiation detectors.

The application-oriented material comes from many sources—users, vacuum tube and semiconductor makers, and other specialized component manufacturers. Practical values for the circuit components are specified and there is an extensive reference list.

Recently published

Analysis and Design of Integrated Circuits, David K. Lynn, Charles S. Meyer, and Douglas J. Hamilton of Motorola Inc., Semiconductor Products Division, McGraw-Hill Book Company, 545 pp., $16.50

Ranges over the A-Z of integrated circuit technology, from fundamentals of physics and fabrication, through design and parameter behavior, into application. A balance is struck among the disciplines of systems, circuits and devices, to present a three-dimensional view of the subject. Both digital and linear IC's are examined.

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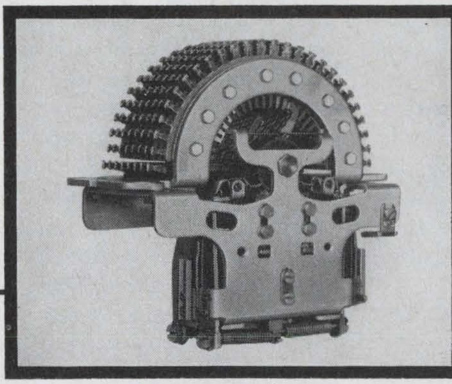

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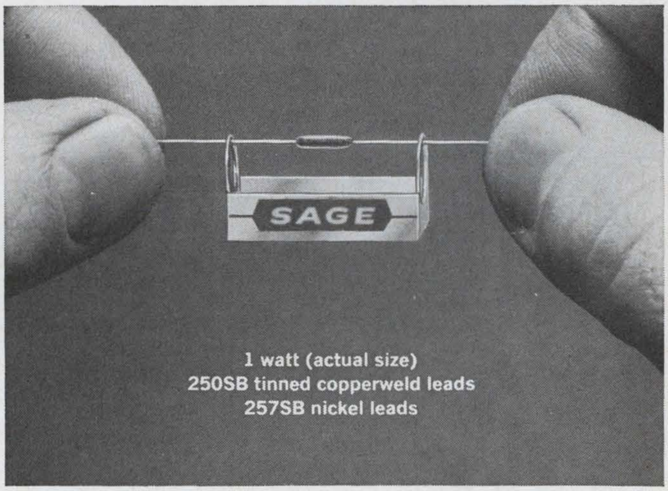

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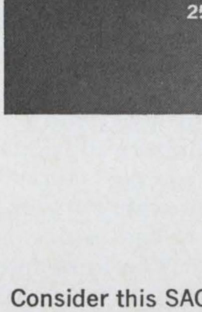

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Technical Abstracts

Integrating counter

The Iadic: a hybrid computing element
James I. Crawford and Morris J. Bodoia
Martin Marietta Corp., Orlando, Fla.

The Iadic—integrating analog to digital converter—is used at the interface between analog and digital portions of a hybrid computer. With an analog integrator operating on the analog input in real time, it provides a digital output.

The Iadic is a hybrid device, having both analog and digital characteristics. Like analog computing devices, the Iadic integrates continuously, in real time, and in parallel: its output at all times represents the integral of its input, without waiting for any sequence of events. But, like digital computing devices, its output is digitally precise and does not have to wait for hold and reset operations that some conversion devices require.

The Iadic integrates the input until the magnitude of the integrator output exceeds a preset level. At that point it resets the integrator to zero and adds 1 to a counter. The counter output thus is a digital quantity representing the integral of the analog input.

The Iadic integrator output continuously increases when the input is positive, and continuously decreases when it is negative. Therefore the circuit compares the integrator output with both positive and negative reference levels, using two comparator circuits. The counter is bidirectional; the positive comparator adds 1 to it and the negative comparator subtracts 1. In general, the number in the counter must be scaled to a reasonable value representing the input analog quantity; this scaling requires a multiplication by the value of the switching level and is performed in the digital computer.

Significant errors in the Iadic output may be caused by instability in the switch that resets the integrator or instability in the pulse passing through this switch or stepping the counter. The pulse instability in turn may arise in the pulse generator or in the control logic. These error sources appear to be controllable to within 0.025%. Drift errors in the components can be controlled by proper design of the positive and negative switches, the integrator, and the comparator.

Presented at the Fall Joint Computer Conference, Anaheim, Calif., Nov. 14-16.

Combining technologies

An integrated circuit operational amplifier using junction field-effect input devices
J.E. Thompson
Motorola, Inc.
Phoenix, Ariz.

A major limitation on the use of integrated circuit operational amplifiers is that present processing technology restricts the circuit designer to only npn bipolar transistors. This results in two inherent weaknesses in the circuit. The large input bias currents can cause high drifts and the low gain-bandwidth products can be overcome only with large-value compensation capacitors in the external feedback loop. These limitations can be overcome by using differentially connected field-effect transistors with the bipolar transistors.

In a redesign of the operational amplifier, p-channel type field-effect transistors on a separate chip are used in the input circuit, with the output applied to an npn differential amplifier through a Darlington stage. High-impedance current-source loading on the FET's and the Darlington input connection for the npn differential amplifier combine to give high gain.

One current source, which serves both FET's, improves common-mode rejection. Two other current sources, connected to the drains of the FET's, act as loads and can be easily achieved with the ordinary npn transistors. For the common current source, pnp devices must be used because of the current direction. Such devices are difficult to build with conventional processing methods. Recently developed lateral pnp devices, however, can be used even though their betas are close to unity.

A typical amplifier provided a gain of 55,000, offset of less than 15 millivolts with 20 $\mu v/°C$ drift, and 92 decibels common-mode rejection. If the amplifier is near unity closed loop gain, it will provide a usable gain-bandwidth product of 10 megahertz.

Presented at Nerem, Boston, Nov. 1-3.

Shrinking limit cycles

The control of oscillatory nonlinear systems
J.D. Ferguson and Z.V. Rekasius
Northwestern University, Evanston, Ill.

Ten years ago, Prof. Rufus Oldenburger of Purdue University reported that oscillations in nonlinear control systems—called limit cycles—could be stabilized by injecting at the input a periodic signal of at least 10 times the limit-cycle frequency. Since most controlled systems are low-pass filters, the injected signal forces the system to oscillate at a high frequency that is severely attenuated at the system output. Thus, the system isn't truly stabilized; it oscillates around the set point at a much lower amplitude, accomplishing, to a certain extent, what conventional compensation methods aim for.

Extending the concept in a nonlinear oscillating system, a high harmonic of the output signal can be fed back to the input. A strong nonlinear element—a relay, for instance—has the property of generating harmonics, which can then be fed back through an equalizer. This feedback equalizer could be a simple bandpass filter tuned to a harmonic at least 10 times greater than the limit-cycle frequency.

Specifically, with a feedback signal 11 times the limit-cycle frequency, the system with an equalizer can always be made as effective as a system with an external stabilizing signal. Also, the equalized system exhibits less ringing at the output in response to a step change input.

The equalizer method is not restricted to systems where the system response is taken at the output of a low-pass filter. It is possible to design an equalizer to control oscillations at the output of a band-pass or high-pass filter. Further, the equalizer need not be a narrow band-pass filter.

Presented at ASME Winter Meeting, Pittsburgh, Nov. 12-17

New Literature

Operational amplifiers. Analog Devices, 221 Fifth St., Cambridge, Mass. 02142. The third issue of Analog Dialog, an engineering magazine devoted to the fundamentals and applications of operational amplifiers, is available.
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Silicon power transistors. Motorola Semiconductor Products Inc., P.O. Box 955, Phoenix, Ariz. 85001. A convenient reference folder covers more than 100 silicon power transistor types, including Thermopad plastic encapsulated types. **[447]**

Radar reflectors. Emerson & Cuming Inc., Canton, Mass. 02021. Many different types of passive reflectors of radar energy are described in an illustrated four-page folder. **[448]**

Indicating digitizer. Barber-Colman Co., Rockford, Ill. 61101. Model A20D indicating digitizer, a null balance instrument, is described in bulletin 1710 DB 3. **[449]**

P-c boards. Photocircuits Corp., Glen Cove, N.Y. 11542, has available a 12-page technical bulletin containing complete information on p-c boards manufactured by the NT-1 process. **[450]**

R-f power measurement. Bird Electronic Corp., 30303 Aurora Rd., Cleveland, Ohio 44139. Catalog GC-68 is a comprehensive reference of r-f measurement instrumentation from 25 mw to 250 kw. **[451]**

Transducer. Solid State Electronics Corp., 15321 Rayen St., Sepulveda, Calif. 91343. Model PF-1001 pressure-to-frequency transducer is illustrated and described in a single-sheet bulletin. **[452]**

Transformers. Abbott Transistor Laboratories Inc., 5200 W. Jefferson Blvd., Los Angeles 90016, offers a brochure describing a complete line of Mil-Spec miniature power transformers designed for 400-hz airborne application. **[453]**

Laser topics. Korad Corp., 2520 Colorado Ave., Santa Monica, Calif. 90406, has available Laser-Fare, a four-page quarterly publication on general laser topics. **[454]**

Digital integrating recorder. Datex Division of Conrac Corp., 1600 S. Mountain Ave., Duarte, Calif. 91010. A 14-page brochure covers the model DIR-1 high-precision digital integrating recorder. **[455]**

Multipliers. GPS Instrument Co., 188 Needham St., Newton, Mass. 02164, has available a brochure describing a series of six high-speed, solid state multipliers featuring up to 1-mv accuracy. **[456]**

Data communications. Digital Equipment Corp., 146 Main St., Maynard, Mass. 01754. A 30-page handbook describes the various techniques used in data communications in the technology of computer hardware and software. **[457]**

Soldering tips. Hexacon Electric Co., 161 W. Clay Ave., Roselle Park, N.J. 07204. A 24-page catalog illustrates and describes a line of Durotherm nonfreezing, long-life soldering tips. **[458]**

Motor controllers. Bodine Electric Co., 2500 W. Bradley Place, Chicago 60618. Bulletin 1050 contains complete specifications and suggested applications for a new line of motor control units. **[459]**

Environmental test chambers. Blue M Engineering Co., 138th & Chatham St., Blue Island, Ill. 60406. A four-page bulletin describes selected examples of the company's line of environmental test chambers. **[460]**

Semiconductor dopants. Corco Chemical Corp., Tyburn Rd. and Cedar Lane, Fairless Hills, Pa. 19030. Technical bulletin No. 7 describes Uni-Dopes, which are unit dosage packages (glass ampoules) of semiconductor dopants for vapor-phase diffusion. **[461]**

Uhf tv antenna. Connector Corp., 6025 N. Keystone Ave., Chicago 60646. Type AT100, long life uhf tv antenna, which attaches easily and can be rotated in many different planes for optimum performance, is illustrated and described in data sheet 45A. **[462]**

Military-type relays. C.P. Clare & Co., 3101 Pratt Blvd., Chicago 60645. Manual 701 describes in detail six military-type (crystal can) relays. **[463]**

Video tape. Ampex Corp., 401 Broadway, Redwood City, Calif. 94063, offers a four-page brochure on the 142 series, 2-in.-wide, helical scan video tape. **[464]**

High-frequency chopper. Solid State Electronics Corp., 15321 Rayen St., Sepulveda, Calif. 91343. A single-sheet bulletin illustrates and describes the model 26 high-frequency, solid state chopper. **[465]**

Snap-acting switches. Unimax Switch Division, Maxson Electronics Corp., Wallingford, Conn. 06492. Fourteen different models of the LM series subminiature snap-acting switches with ratings to 10 amps are described in technical data sheet 216. **[466]**

Reflow solder system. Sippican Corp., 34 Barstow St., Mattapoisett, Mass. 02739. Bulletin 135 describes a mechanized reflow soldering system for flatpack of dual-in-line leads. **[467]**

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Newsletter from Abroad

December 25, 1967

TI, Japan seen ending IC hassle

Word could come any day now that Texas Instruments and Japan's Ministry of International Trade and Industry have finally settled their long-standing integrated-circuit dispute. **The deal paves the way for TI's entry into the country as an IC producer.**

People privy to the involved negotiations say TI will get a 50-50 joint venture at the outset, with Hokushin Electric the likely partner. MITI presumably will let TI step up to full ownership 3½ years later. **Meanwhile the U.S. firm will grant licenses on its IC patents to Japanese companies.**

It was largely because of its strong patent position that TI had been holding out for a wholly owned subsidiary. But in Japan, joint ventures are the rule for key industries like electronics. The U.S. firm had refused licenses and **threatened to block exports of products with Japanese-made IC's, much to the consternation of export-minded Japanese producers.**

But of late, TI has had to soften its stance. Among other things, the company found itself faced with a possible ban of its devices in Japan. The Nippon Electric Co. has the Japanese license for Fairchild Semiconductor's planar process, crucial in the production of IC's. Although Fairchild and TI have a cross-licensing agreement, it excludes Japan.

Once the settlement between TI and MITI becomes official, look for a rush by Japanese manufacturers, led by Hayakawa and Sony, to get products with IC's onto the U.S. market. Hayakawa is poised with new lines of desk calculators [see story on p. 161] and small television receivers built with IC's. Sony will return with the miniature IC radio it introduced this spring and then withdrew because of the patent hassle.

Britain may cut F-111 fighter buy

Britain may partly renege on its commitment to buy 50 F-111 swing-wing fighter-bombers from the U.S.

The once-sacrosanct F-111 order, the Wilson government has now made clear, will come under scrutiny in the drive to hold the line on government spending. The move is part of the devaluation package devised in November to bolster Britain's economy.

A decision on the F-111's isn't likely before February. But chances are that Britain will either take fewer F-111's or stretch out the deliveries. **A drastic slash in the number of planes, though, is unlikely.** Under the offset deal in which the planes were bought, British companies already have picked up $178 million worth of U.S. defense business out of the $325 million agreed on.

French skimp on IC program

The de Gaulle government's effort to give France a strong domestic integrated-circuit industry won't be nearly as ambitious as the country's semiconductor firms had expected.

For its Plan Composants, the government has earmarked only $4 million a year for 1968 and 1969. And there's little chance that the annual allotments will go up after that. The industry had been hoping for much greater support—something like the $100 million in R&D money the regime will spend for its Plan Calcul to bolster the computer industry.

As it stands now, the IC money will be split between two groups of

companies that have pooled their semiconductor efforts. One is La Radiotechnique-Compelec, a new concern that combines the semiconductor operations of La Radiotechnique and the Compagnie Generale d'Electricite. The other candidate for Plan Composants aid is the firm, still to be formed, that will consolidate the semiconductor divisions of CFS-Compagnie Generale de Telegraphie sans Fil, Compagnie Francaise Thomson Houston-Hotchkiss Brandt, and the Societe Industrielle de Liaisons Electriques [Electronics, Aug. 21, p. 185].

Officials of both groups doubt that the $4 million a year—split two ways—will be enough to make them competitive with U.S. companies producing IC's in France. The French companies are also fretting over the "guidance" they'll be getting as to what kinds of IC's to develop. The components plan is tied to the computer plan, so the circuits will have to be designed with Plan Calcul machines in mind.

'Buy British' drive will benefit ICT

Another indication that the Wilson government intends to steer electronics contracts to British companies whenever pressure and persuasion can turn the trick is **a report that International Computers & Tabulators has been tapped for a multimillion dollar order** for a multicomputer network linking the major offices of Cooperative Wholesale Society Ltd., a nationwide consumer-goods distributor.

The government intervened—presumably with both pressure and the promise of some financial help—when the contract appeared headed to either the International Business Machines Corp. or Honeywell Inc. ICT, in fact, at one time had dropped out of the bidding. Although neither U.S. company will comment, **insiders say both IBM and Honeywell have been told they are no longer in the running.**

The computer maneuver marks the second time in recent months that the Wilson government has stymied foreign companies on big contracts. Nippon Electric apparently was eased out of a contract for a ground-station last fall [Electronics, Oct. 30, p. 159].

Luftwaffe has jet waiting in wings

The West German Defense Ministry might pull another set of jet-fighter blueprints out of its briefcase should the U.S. call off joint development of an advanced vertical short takeoff and landing plane.

Entwicklungsring Sud GmbH (EWR), a Munich-based group of companies, and the Fairchild Hiller Corp.'s Republic Aviation division are **expected to get the word shortly on whether there'll be a go-ahead for the project. But the word in Washington is that the chances are slim and that Bonn couldn't go it alone.**

Meanwhile, the ministry is studying preliminary design concepts for tactical jets submitted by EWR and Vereinigte Flugtechnische Werke GmbH (VFW), a joint venture of three other companies. **The new jet, temporarily labeled the NKF, would replace the Luftwaffe's Fiat G-91 in the mid-1970's.**

EWR's design calls for a swing-wing craft; VFW proposes a fixed-wing design. Design study contracts have not yet been awarded.

Addendum

Honeywell Inc. is about to become the third U.S. firm making computers in West Germany. IBM and Univac already have plants there, and **Honeywell will start construction next year on a $2 million facility at Heppenheim, near Frankfurt.**

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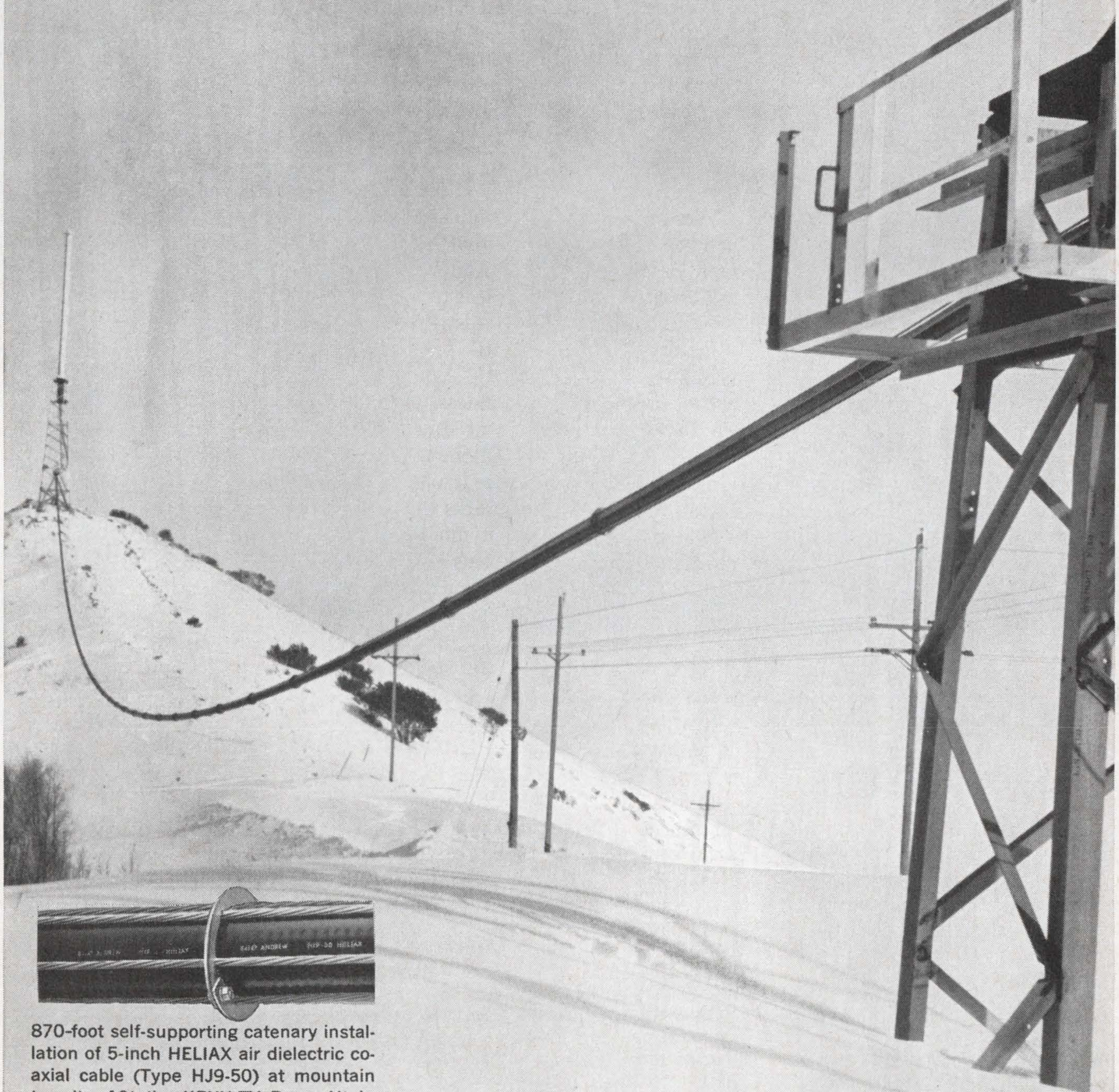

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Electronics Abroad

Volume 40
Number 26

International

Backtalk

Europeans have stood by in frustration for many years as American industry built near-monopolies in important fields. But the latest threat from across the Atlantic —communications satellites—has prodded a number of European governments to assign top priority to a competitive communications satellite program.

Three factors are behind the new European attitude. First, Europeans complain that the Comsat-controlled International Telecommunications Satellite Consortium (Intelsat) takes seven times more in assessments than it returns in contracts. Second, industry prefers communications spacecraft to satellites for other applications because their profitability is easier to demonstrate. Third, government policy makers are amenable to homegrown communicators because they fear that American—or, for that matter, Russian—satellites would eventually be able to beam propaganda right into citizens' homes.

The French—who else?—made the first move 20 months ago when they announced they would build a communications satellite on their own if need be. West Germany since has joined the project, called Symphonie, as a full partner; Belgium and Italy are negotiating for roles as junior partners. Symphonie is slated to be put into a fixed orbit in 1971 and a twin is slated for 1972. Michel Bignier, external relations director of the French space agency, says France would willingly move the satellite into an international control group—"if an effective European organization can be put together."

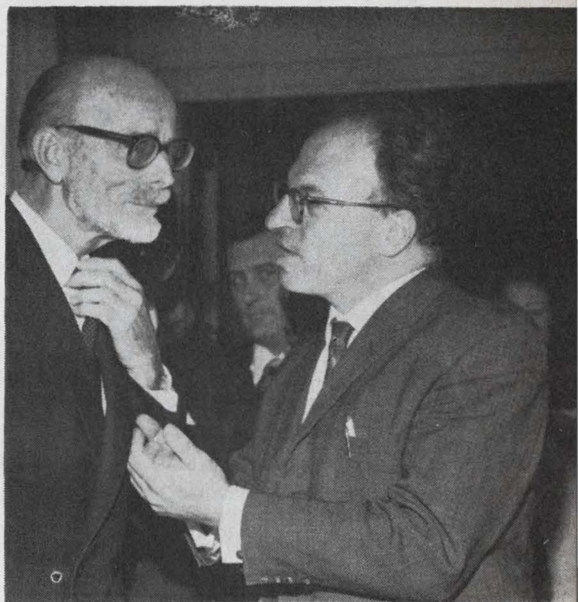
Ready to bloom. Europe is expected to solidify its space challenge before next summer. The command post will be the European Space Research Organization (ESRO), whose members are France, Britain, West Germany, Italy, the Netherlands, Belgium, Denmark, Spain, Sweden, and Switzerland. Some financial commitments already are definite, with $350 million earmarked through late 1971 for multinational communications-oriented projects. Another $90 million is about to be added.

ESRO's mission has been basic research. But now it looks as if space-exploration projects will become secondary and communications satellites the agency's prime concern. And a merger with the seven-nation European Launcher Development Organization (ELDO) could be forthcoming.

Meanwhile, ESRO is reorganizing to get ready for an expanded role in Europe's space effort. The effort is led by Hermann Bondi, a Vienna-born British astronomer, who became the agency's director general last month. Says Bondi, "We want to get big enough to serve the needs of our customers, the scientists of Europe." But rather than see a new European agency established for space communications, as some have proposed, he adds, "It would clearly be better business for ESRO to build applications satellites."

Understandably, the scientists who have been running ESRO aren't overjoyed by the new commercial element being superimposed on their organization. Engineers, heretofore second-line staffers, are being put on an equal footing with the scientists, and more and better engineers are being hired to assure ESRO a top-drawer engineering capability.

To keep pace with industrial knowhow and head off delays before they occur, ESRO will become prime contractor for half its future satellites. Industry formerly did all prime contracting and ESRO merely checked out finished hardware.



Space men. Hermann Bondi (right), new director general of ESRO, explains a point to Pierre Auger. Bondi moved into the job when Auger retired.

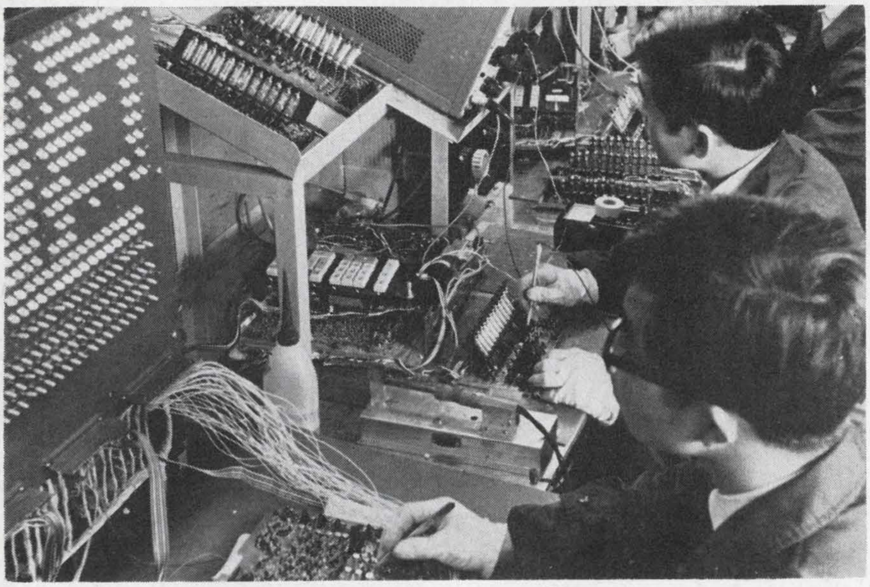
Designing. The first communications project will be a design developed under contract to the Conférence Européenne des Télécommunications par Satellites (CETS), which includes the ESRO members plus Austria, Ireland, Monaco, Norway, and the Vatican.

New European space authorities expect the CETS plan to call for a triaxial craft stabilized by an active attitude-control system. It would carry both telephone and television channels.

Japan

Countdown

The Hayakawa Electric Co. has long been itching to jump into the U.S. market with its integrated-circuit desk calculator. But wary about a run-in with Texas Instruments Incorporated over IC patent



On the counter. Hayakawa technicians check out display circuits on MOS integrated-circuit desk calculator with Digitron readout tubes.

infringements, Hayakawa has been waiting and carefully watching.

This fall, the company was on the verge of running TI's patent blockade [Electronics, Sept. 18, p. 157], but had second thoughts. Now, Hayakawa thinks an end to the impasse over IC patents is imminent. Texas Instruments, they're convinced, will drop its long-standing demand for a wholly-owned subsidiary in Japan and soon set up a joint venture with a Japanese partner. And with the joint venture will come licenses for Japanese companies on TI's integrated-circuit patents.

So sure is Hayakawa that IC licenses will be forthcoming soon—perhaps in the next fortnight—that it now has nothing but IC machines coming off its desk-calculator production lines. The output currently is 2,000 machines monthly and the company plans to boost that figure to 5,000 by next spring. At those rates, Hayakawa must export to the U.S. or risk going broke.

Yankee version. The company has even started a production run on a 12-digit machine designed with the U.S. market in mind. It's a simplified version of the Compet CS-16A calculator—with metal-oxide-semiconductor circuits—that Hayakawa started selling in Japan in mid-December.

Hayakawa isn't the first to put an MOS integrated-circuit calculator into production. After being plagued by technical difficulties for two years, the Victor Comptometer Corp. managed to start deliveries on one in October. But the Compet CS-16A does have the distinction of being the first machine to have the radically new Digitron readout tubes developed jointly by Hayakawa and the Ise Electronics Co. [Electronics, May 29, p. 212].

For the desk calculator, the digit patterns of the tubes were redesigned for better readability. The "0", for example, has only half the height of other digits. That way, the string of "0's" before the first significant number in the display is no longer a nuisance and there's no need to blank them out.

Except for the shift from conventional cold-cathode display tubes to Digitrons, the production version of the Compet CS-16A differs only slightly from the prototypes Hayakawa unveiled last spring [Electronics, March 20, p. 241]. Besides their MOS logic circuits, they were notable for their time-sequential display drive, which slashes the number of circuits needed to drive the readout tubes.

The redesigned calculator uses a total of 59 MOS packages together with 46 silicon transistors and 400 germanium diodes. Of the IC packages, produced by the Nippon Electric Co., 52 are used in the basic calculator and the other seven for the memory. The prototypes had 50 MOS packages, all in the basic calculator.

Hayakawa has priced the calculator at $639 for the Japanese market. The company has yet to set a price for the U.S. version, or Compet CS-17A. It has no memory but otherwise differs little from the Japanese models.

Video chip

In the lexicon of circuit designers at the Matsushita Electric Industrial Co., "Jungle A" means the gaggle of direct-current amplifiers a television set needs for the first video stage, the automatic gain control amplifier, and the noise-canceling circuit.

The jungle growth has been cut down in a 6-inch transistorized black-and-white portable that Matsushita now sells in Japan. The first video stage and agc amplifier are on a single integrated-circuit chip. The video amplifier doubles as a synchronizing-pulse amplifier and because of its noise-limiting characteristics serves as a noise-canceler as well.

Setting the stage. With its "Jungle A" circuit, Matsushita becomes the first tv-set maker to go into production with a receiver having an IC in the video stages. IC's, though, are fairly common now in tv sound i-f stages. It's been nearly two years, in fact, since the Radio Corp. of America pioneered with a chip in the sound channel [Electronics, March 21, 1966, p. 137].

Matsushita engineers say they, too, could have put an IC in the new set's sound channel. They claim, though, that the circuits they've packed onto a single chip are better candidates for integration since all their components can be included. A sound i-f amplifier, the Matsushita men point out, needs an external transformer. But pressed, they concede that their choice of what to integrate was not entirely technological. As much as anything else, they wanted to do something that their competitors hadn't.

Quartet. The first video stage uses four of the seven transistors on the chip. Two (Q_1 and Q_2) function as a differential amplifier. The inputs: the video signal from the second detector and a video gain control signal.

Output of the differential amplifier passes to an emitter-follower stage (Q_3), off which is picked the signal that is fed to the sound i-f input. After another stage of amplification (Q_4), the video signal leaves the IC headed for a discrete video output stage and the sync separator.

Because of the limiting action of the IC video amplifier circuits, no external pulse noise can get through to the sync separator. For inputs lower than 1.5 volts peak-to-peak, the amplifier output is linear. Anything outside this narrow range is clipped.

Trio. The agc amplifier, too, uses two of its transistors (Q_5 and Q_6) as a differential amplifier. The third transistor (Q_7) and a diode form a constant-current source. This amplifier has a gain of about 7 and it also has a clipping action on output signals that top 1 volt peak-to-peak.

All in all, the "Jungle A" IC has seven transistors, 10 resistors and one diode on a chip 1.5 by 1.25 millimeters square.

The circuit is produced by Matsushita Electronics Corp., a joint venture of Matsushita Electric and Philips' Gloeilampenfabrieken of the Netherlands.

West Germany

On the right track

The West Germans are going all out to make their new satellite tracking and control center a showcase for state-of-the-art design. Now under construction at Lichtenau, 25 miles southwest of Munich, the center will be the hub of the nation's expanding space program.

After coming up with a new look for their communications satellite ground terminal now abuilding at Raisting [Electronics, Oct. 30, p. 169], the West Germans will carry on at the Lichtenau center with a highly accurate tracker capable of around-the-clock, seven-days-a-week automatic monitoring.

"Nowhere else, to my knowledge," says Werner Fogy, project manager, "are such operations fully automatic."

Made in U.S. The German Aerospace Research Establishment is constructing the center with $3.5 million from the Ministry of Scientific Research. Some of the money will be used to equip a data and control center at nearby Oberpfaffenhofen. About $2 million will be spent on electronics, much of it to come from U.S. manufacturers.

The Lichtenau center is scheduled to be operational in 1969, in time for the scheduled fall launching of the first West German satellite. Azur, or the 625 A-1 satellite [Electronics, March 21, 1966, p. 222], will be boosted into space by a U.S. Air Force Scout launcher at the Western Test Range in California. The 132-pound satellite will measure the concentration and energy spectra of protons and electrons for a year in a near-Polar elliptical orbit ranging from 180 to 1,800 miles.

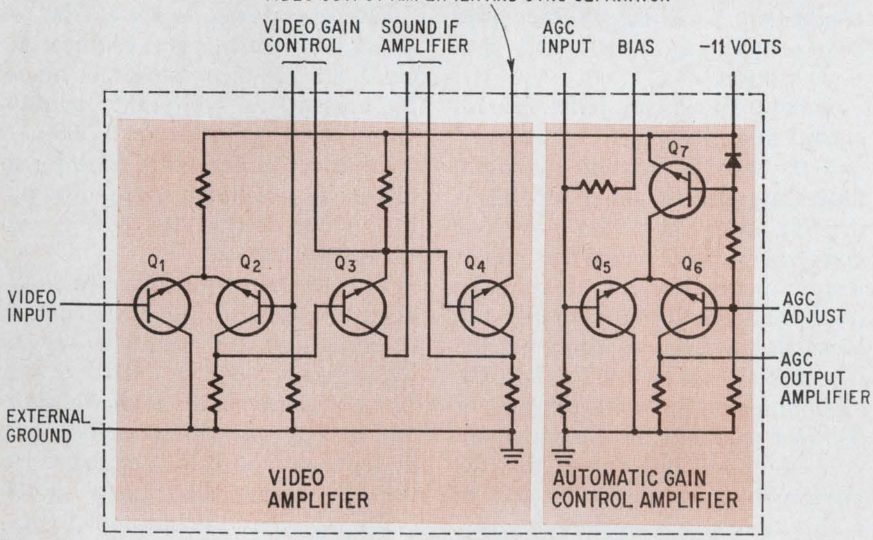
Steering by tape. All antennas at the Lichtenau center will have tape-controlled steering. These tapes will come from a computer programed with satellite orbit data from NASA's worldwide Standan tracking network. Other computers at the Oberpfaffenhofen center will process and evaluate data from orbiting satellites.

Initially, the tracking center will have three telemetry antennas. A 36-foot diameter master antenna will receive real-time and tape-stored telemetry data from a satellite at 136-to-138-megahertz frequencies. Another 36-foot antenna will be slaved to the master unit and will transmit telemetry commands to a satellite in the 147-to-156-Mhz range. The third antenna, operating in the 136-to-138-Mhz band, will be the same type as those to be installed at other stations in the West German tracking network.

The master antenna is being designed by the German Aerospace Research Establishment's Institute for Avionics and Microwaves and will be made up of 48 turnstile dipoles. It will handle all types of modulation and all polarizations. Gain will be 22 decibels. Over-all accuracy of the station's two main antennas will be ±0.2°, using monopulse radar tracking for high precision.

To avoid the high-frequency noise caused by any electrical drive system, the West Germans chose a hydraulic drive.

Once the master antenna has found a satellite in the programed controlled search, it will hold its target in an autotrack mode. Azimuth and elevation data furnished by the antenna and satellite radial velocity (relative to the tracking center) will be combined to refine



Intimate. Matsushita packs first video amplifier stage and automatic gain control amplifier side-by-side on a single integrated circuit.

satellite orbit path predictions. The radial velocity will be determined from the doppler effect of the satellite's radio beacon as it passes by.

Network hub. Lichtenau will be the center of an intercontinental monitoring network stretching from Alaska to Northern Europe. Telemetry stations will be built at Lindau, Germany; Kevo, Finland; and Fort Churchill, Canada. West Germany's Rohde and Schwarz will supply antennas for these sites. Antenna steering control data for the outlying tracking stations will be supplied once a week by the Oberpfaffenhofen data and control center. It will be sent by aircraft rather than by teletype because the West Germans worry about the errors that could occur in teletype transmission. Also in the network will be existing telemetry antennas at ESRO stations at Fairbanks, Alaska, and on Spitsbergen, an island in the Arctic Ocean.

The Lichtenau facility will work with future West German satellites after Azur and will help in future NASA and ESRO satellite monitoring programs.

Sweden

Sweeping change

Hydrographic surveys are costly propositions. And much of the expense comes from the equipment needed to precisely position the ships conducting the survey.

In the U.S., for example, the Naval Oceanographic Office figures it costs about $50,000 for a vessel's positioning gear. Now, Sweden has come up with a method and equipment for surveying that will allow nine boats to be controlled with $60,000 worth of hardware. At the same time the Swedish system makes for faster and more comprehensive surveying.

New standard. A Navy official says the equipment is "remarkably simple in concept and design" and could replace the standard method of oceanographic surveying where a single ship is guided from a shore facility. He also sees it being used for other marine activities, including minesweeping and private surveying by the major oil companies.

The method, developed by the Swedish Board of Shipping and Navigation, is to position nine craft —rather than one—in a line and sweep a specific area. The key is simple but precise equipment that allows a shore-guided mother boat to do the positioning for eight daughter boats, four on either side of her, as they collect data and feed it to her.

Svenska AB Traadloes Telegrafi of Stockholm developed the distance-keeping equipment and will go into production next April. Prototype equipment has been tested in Sweden and late last month was demonstrated to the U.S. Naval Oceanographic Office on Chesapeake Bay.

Signals. The equipment consists of one transmitter and nine receivers. The transmitter unit on the mother ship is controlled by an electronic timer that sequences two pulses. One pulse is sent underwater from an ultrasonic transmitter (50 kilohertz) and the other is a radio signal (27 to 29 megahertz).

The radio signal is delayed as long as it takes the ultrasonic signal to reach the imaginary line on which the smaller boats travel. The two signals are then compared in the daughter ship's receiver. If they're received at the same time, a needle on a display meter stays dead center to indicate that the ship is on station.

Should the radio pulse be received first, a capacitor is charged and the needle drifts to the right, indicating that the daughter ship is drifting away from the line. The converse is true when the underwater pulse arrives first. The helmsman on the boat simply follows the needle. A knob on the transmitter can be set to align the eight ships on lanes 80, 160, 300, or 600 feet apart. At the Navy demonstration, it was determined that the equipment was doing its job to within about two feet of accuracy.

While the Swedish government has been the only buyer thus far, a U.S. Navy official says the Navy is "very interested." He points out that for the $10,000 additional the Swedish system would cost, a lot more oceanographic surveying could be accomplished at a relatively low cost.

Great Britain

Filling a vacuum

British users of high-frequency communications agree that the mandate from the International Telecommunications Union to switch to single-sideband transmission by 1970 [Electronics, Nov. 27, p. 190] imposes requirements for accuracy and reliability not easily met by existing inexpensive equipment.

It's to be expected that Britain's leading makers of general-purpose gear will start moving into the breach as soon as possible. But they've been beaten to the market by a firm that isn't considered to be a leader in the field—GEC (Electronics) Ltd., a subsidiary of the British General Electric Co. (not connected with its U.S. namesake).

In the ballpark. GEC hasn't come up with anything new. Rather, in the words of a competitor, it has produced a receiver-synthesizer that's "an advance on what's available in general-purpose, inexpensive gear."

The GEC device costs $2,750 for integrated receiver and synthesizer, or $1,800 for the synthesizer alone. By contrast, a lab-quality synthesizer costs upwards of $7,000. A synthesizer is necessary in order to obtain an oscillator frequency stable enough so that the receiver can be left unattended.

To keep the price low, GEC sacrificed resolution. The device has a resolution of 100 hertz; a typical high-quality device, 0.01 hertz. The company claims high stability: one to five parts in 10 million and better than 5 hz at 30 megahertz for the entire unit; three parts in 100 million per day in continous operations at the 4.8 Mhz internal crystal frequency drive standard.

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