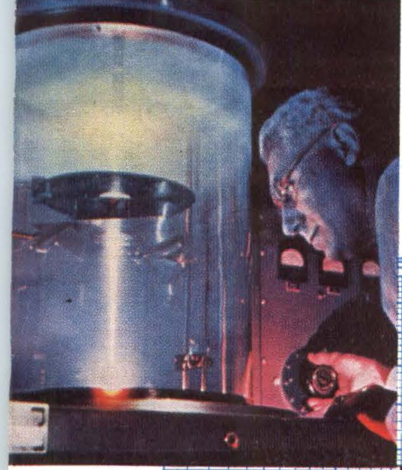
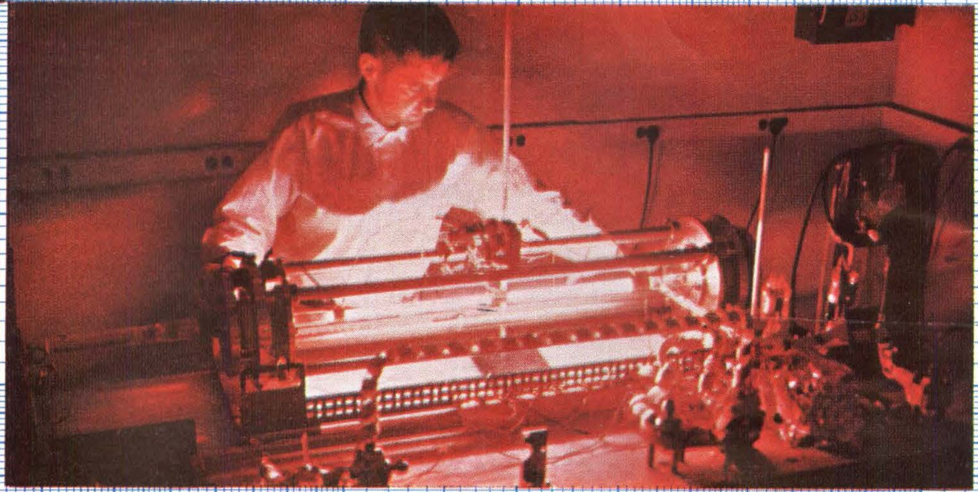
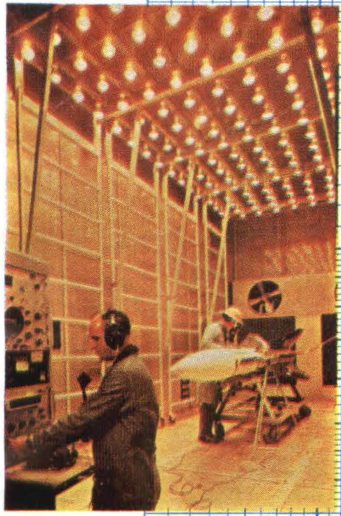
A McGraw-Hill Publication 75 Cents January 4, 1963

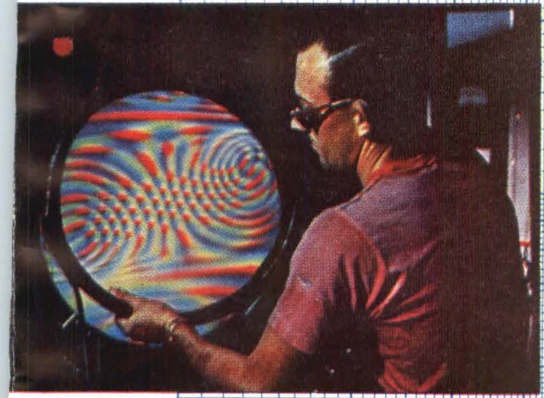
electronics



SPECIAL REPORT ELECTRONICS MARKETS 1963 WHAT THE FUTURE HOLDS







CONSUMER MARKETS

COMPONENTS MARKETS

INTERNATIONAL MARKETS

INDUSTRIAL MARKETS

RAL MARKETS

January 4, 1963

electronics

A McGraw-Hill Publication ***75 Cents***

Contents Continued

electronics

January 4, 1963 Volume 36 No. 1

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

Executive, editorial, circulation and advertising offices: McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y. Telephone Longacre 4-3000. Teletype TWX N.Y. 212-640-4646. Cable McGrawhill, N. Y. PRINTED IN ALBANY, N. Y.; second class postage paid at Albany, N. Y.

Subscriptions are solicited only from those actively engaged in the field of the publication. Position and company connection must be indicated on orders. Subscription rates: United States and Possessions, $6.00 one year, $9.00 two years, $12.00 three years. Canada: $10.00 one year. All other countries $20.00 one year. Single Copies, United States and Possessions and Canada 75¢. Single copies all other countries $1.50.

THE PUBLISHER, UPON WRITTEN REQUEST FROM ANY SUBSCRIBER TO OUR NEW YORK OFFICE, AGREES TO REFUND THAT PART OF THE SUBSCRIPTION PRICE APPLYING TO COPIES NOT YET MAILED.

Subscribers: Please address change of address notices, subscription orders or complaints to Fulfillment Manager, Electronics, at above address. Change of address notices should provide old as well as new address, including postal zone number if any. If possible, attach address label from recent issue. Allow one month for change to become effective.

Postmaster: Please send Form 3579 to Fulfillment Manager, Electronics, 330 West 42nd Street, New York 36, New York.

Audited Paid Circulation

CONTENTS continued

DEPARTMENTS

CROSSTALK

"THERE ARE TWO TIMES in a man's life when he should not speculate," Mark Twain said, "when he can't afford it, and when he can."

Perhaps Twain said this after he lost a fortune by misguided investment of huge sums in a typesetting machine. Twain needed a penetrating market survey and technical counsel before he jumped in with his hard-won money.

In spite of Twain's epigram, the needs of commerce demand intelligent speculation or profits grind to a halt.

Each year that we research the electronics marketplace, it becomes clearer to us what the role of the long-range planner and marketing expert is to his firm.

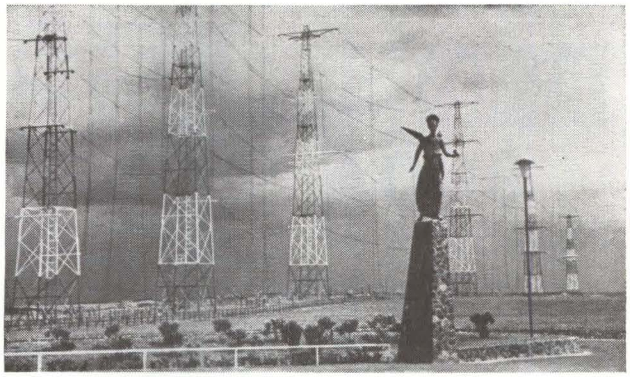
Many of the decisions made, in effect, by marketing men today, were once reserved for the company president and the board of directors. With the high level of technical knowledge needed for intelligent judgments in electronic marketing, judging has become a full profession.

Recommendations by market analysts have become near fiats on the direction a company should take in research, product development, production effort, sales approach, new investments and diversification.

Business planning today must acknowledge such complications as the growing international character of electronics. Competition is no longer a simple domestic affair—rather it includes what businessmen in European, Eastern and indirectly, Soviet-block nations are doing.

Further affecting decisions is the increasing dominance of research and development in the already complex electronics industry. With the aerospace industry, electronics accounts for the greatest share of money spent on research and development in this country. The military indulges in nearly as much Research, Development, Test and Evaluation projects as it does procurement, in electronics.

Thus, marketing men must include a high scientific and engineering competence in their battery of investigative tools. Deep involvement in a given segment of the electronics industry is needed to understand completely the segment's potential and problems. The marketing analyst may also be called on to help make a decision on his firm's activity in an area about which little is known either to himself or to his company.



INTERNATIONAL FLAVOR *of the electronics industry is reflected in this view of transmitting towers at the Vatican's high-power broadcasting site, erected by Telefunken, near Rome. The statue is the Archangel Gabriel*

The tools of marketing men vary, and the demonstrable results as well. Much is gained by a well ordered study of the other guy's experience, and the collection of blue sky expectations by knowledgeable persons.

Statistical market data help, by supplying a base of past sales for the building projections. Government predictions, and industry association statistics enter the mix.

Accuracy depends chiefly on tailoring the quest, for answers to a clearly defined range of questions.

But in the end, a marketing survey is of value chiefly because blended and weighted sets of views are produced by persons devoting full-time to the job.

In the ELECTRONICS marketing report this week, we endeavor to add to the knowledge of persons interested in all aspects of the market. Specific recommendations are limited—general trends are accurately indicated. The tone and health of the industry, what the experts are saying, and why they say it, are organized and clarified as the opinions of those "in the know." Read our report—and join them.

COMMENT

Air Traffic Control

Saw the first of what I am sure will be three excellent articles on air traffic control. Naturally, the article was of extreme interest to many people here and they are looking forward to the next two.

J. C. Forbes
The Mitre Corporation
Bedford, Massachusetts

The first article, by Senior Associate Editor John Mason, appeared on p 37, Dec. 7, and the second on p 46, Dec. 14. The third and last appears in this issue, on p 92.

Those Lab Courses

I most heartily concur with your views in the editorial, Five Years? Or a Better Four? in the December 14 issue (p 3), 1962.

I started working for a B.S. in E.E. at the age of 34 last summer, and have been constantly hearing warnings from upperclassmen about how I will be slaughtered by labs in the years ahead. There have been repeated recommendations to switch to physics because it's more modern, there are fewer labs, the point requirements for a degree are lower, and the degree commands as good a price as the E.E. does. All excellent reasons!

And I may make the change after my freshman program is completed. Time is a precious commodity to me now, and when one works during the day and goes to school at night, there is no room for lost motion. I refuse to waste one minute on the "old discipline" labs that persist today to prolong archaic academic traditions. If labs take up so much time and are so "necessary," why don't they carry more credit?

I even suspect many graduate courses could be included in the undergraduate curriculum, if the latter were modernized by getting rid of a lot of chaff. But then I suppose we mustn't overlook the fact that engineering schools are trying to secure their financial stake in the "education business" by prolonging their program, a distasteful but plausible explanation.

Anyway, industry can count on one less engineer in 1968. He will be me, as I refuse to become a victim of the system.

Robert D. Freed
New York, New York

SiC Junctions For Lasers?

For all the recent attention on the light emission *p-n* junction, I fail to find any mention of silicon-carbide junctions in which the light emission effect in the visible region has been known for years. The material may be valuable for current-pumped lasers.

G. A. May
National Research Council
Ottawa, Canada

Five years ago, researchers were interested in silicon carbide, but they found its efficiency too low. Gallium arsenide, on the other hand, is highly efficient in the conversion of electricity to light. For more information on diode lasers, see p 24, Nov. 16, and p 14, Nov. 23, 1962.

Equation Errors

Your Nov. 30, 1962, issue contains an article entitled Reliability: 1962. On p 63 is a section on Sequential Testing which contains several errors. The *y*-intercept numbers in the equations for the accept and reject lines are numerically wrong in that the intercept in each case should be approximately 590 (slide-rule accuracy).

Further, on p 64, the statement that "The test would have to continue at least 1,800 hours . . ." is not correct, and is not justified or explained in the text.

D. H. Wythe, Jr.
Sunnyvale, California

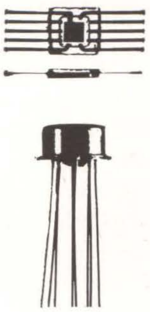
The correct equation for the accept line is $y = 138.62x + 588.8$, while the equation for the reject line should be $y = 138.62x - 588.8$.

The statement on p 64 should read 600 hours, which is three times contract MTBF.

Signetics offers three ways to planar integrated circuits:

STANDARD

DTL
logic
circuits



off-the-shelf

We can give you immediate delivery on any of our standard circuits. Our standard line includes: NAND/NOR Gate, Buffer, Multi-Purpose Flip-Flop, Diode Array, and Exclusive-OR Network. Each of these circuits provides a maximum noise rejection and the highest speed possible on low power consumption. And each is a product of the most refined degree of planar technology today. Your choice of TO-5 can or flat modular packaging. Write for complete details: 680 West Maude Avenue, Sunnyvale, California.

SIGNETICS INTEGRATED CIRCUITS

variFEBS®

customized
digital or
linear circuits

3 weeks

This is the quickest and most economical way to get integrated circuits made to meet your requirements. Here's how it works. Take any of our standard circuits. (They all have 500 MC transistors, 3 nsec diodes, 60 pf capacitors, and resistors up to 20 K.) And redesign the interconnection patterns. Then we'll integrate your interconnection patterns onto the silicon chip. Your choice of TO-5 can or flat modular packaging. Write for complete details to: 680 West Maude Avenue, Sunnyvale, California.

SIGNETICS INTEGRATED CIRCUITS

preFEBS®

custom digital
or linear
circuits

8 weeks

Here's the newest concept in integated circuits. You design your own linear or digital circuit. Breadboard it with individually packaged transistors, resistors, diodes and capacitors from our stock. (These components have their associated parasitic capacitance and will duplicate the performance in the final integrated circuit.) Then return the circuit to us. And we'll integrate it. Your choice of TO-5 can or flat modular packaging. Write for complete details: 680 West Maude Avenue, Sunnyvale, California.

SIGNETICS INTEGRATED CIRCUITS

CIRCLE 5 ON READER SERVICE CARD

sierra

"made-to-measure precision"

Tests Transistor Beta in-the-circuit

TRANSISTOR TESTER — Portable, Battery Operated

- Reads Beta directly in-the-circuit (1-4, 3-12, 10-40, 30-120); no need to unsolder leads
- Measures I_{co}, (0-50, 0-500 μa) & Beta out-of-circuit
- Packaged for portability in ⅓ of a cubic foot; weighs 12¼ lbs.
- Carries its own battery power supply
- Price: $335; delivery immediately from stock

For a free demonstration, more information about the 219B Transistor Tester, or the complete Sierra Quick Reference Catalog, contact your Sierra representative, or write to address below:

SIERRA ELECTRONIC DIV.
OF
PHILCO
A SUBSIDIARY OF *Ford Motor Company*,

Sierra Electronic Division / 3885 Bohannon Drive / Menlo Park 1, California

Megawatt Space Power Source Planned

WASHINGTON—AEC, the Defense Department, and NASA have set up a joint program to develop a nuclear space power unit capable of producing from 300 Kw to 1 Mw of electrical power. The unit, designated Snap-50/Spur, would be used as a power source for communications satellites and other space vehicles requiring large amounts of power.

AEC will manage the program, expected to cost about $250 million over the next 6 to 10 years. The new program brings together bits and pieces of development work by AEC and Department of Defense on nuclear space power sources. The reorganization indicates a more concerted government effort to produce an operational system.

Air Force officials envisage future needs for a source that would provide sustained power for life support systems to keep up to 20 men in orbit, for communications and other electronics systems and for maneuvering a large vehicle in space. A vehicle capable of all these missions would require at least 300 Kw. However, Air Force says that it now has no precise requirement for a unit producing so much power.

Navy Seeks Contractors For Underwater Range

WASHINGTON—Next week, Navy is scheduled to receive preliminary management proposals for prime contracts for the in-air and underwater tracking systems for Project Autec (Atlantic Undersea Test and Evaluation Center).

Funds for the underwater test range at Andros Island in the Bahamas were provided in the fiscal 1963 budget. But construction has been held up because of diplomatic snags in reaching an agreement with the British for use of the area.

Navy, however, plans to enlarge the facility beyond the original concept. This was outlined recently at a meeting with prospective contractors at Newport, Rhode Island. The range is expected to require radar, underwater and optical tracking, telemetry, microwave and communications, computing and data processing equipment.

Airborne Optical System Gathers Missile Data

BOSTON—Airborne system designed to detect and measure characteristic optical radiations from U. S. missiles is now being flight-tested. Called Skyscraper, it's part of Project Press (Pacific Range Electromagnetic Signature Studies).

The instrumentation will measure infrared, visible and ultraviolet radiation at altitudes above 30,000 feet, where atmospheric attenuation is low.

A computer is fed information on aircraft position, missile launch time and predicted trajectory. The computer directs an optical tracker. When the target is acquired, the tracker locks on and controls the aircraft and the line-of-sight optical system. A multiple spectrometer continually samples the radiation and tapes the data for later analysis.

Skyscraper was designed by Air Force Cambridge Research Laboratories and built aboard a KC-135 aircraft. It has been turned over to MIT Lincoln Laboratory, scientific director for Project Press, for evaluation flights.

Infrared Communications Headset Is Developed

DALLAS—Texas Instrument's Apparatus division will be announcing soon that it has developed a battery-powered infrared communication set using gallium-arsenide light sources.

The two-way communication set is contained in two ordinary headsets. The set carries voice over an infrared link between two operators facing each other. Successful conversations have been held over distances in excess of 100 feet.

The demonstration unit uses TI's gallium-arsenide light sources (similar to the SNX100) for the transmitter. Output is amplitude modulated. The resultant voice signal "has good high-fidelity quality at short ranges." Receiver consists of a focusing lens, and a TI silicon photo-voltaic detector (type M7003).

Information capacity of the infrared carrier wave is high. For example, tv broadcasts were transmitted over a similar link, using only a small fraction of available bandwidth.

Set's optics provide a 30-degree beam width for both transmitter and receiver. TI says that for other

Sugar Grove Won't Be a Total Loss

WASHINGTON—Navy has decided to move part of its communications facility from Cheltenham, Md., to Sugar Grove, W. Va. The Navy has been looking for a substitute use for Sugar Grove since it cancelled last year the trouble-ridden project to build a 600-foot radio telescope there.

One reason has been strong pressure by West Virginia congressmen. Another is Navy's bid to temper criticism of the ill-fated telescope project by making some use of the money spent on the project. The area was made virtually free of background disturbances, including construction of an underground lab.

Initially, the Navy plans to move its receivers from Cheltenham to Sugar Grove. That will take a year or more. Money for the move is being included in the fiscal 1964 budget applications, it will be "a simple matter" to come up with "an exceedingly narrow beam, requiring more precise alignment, but allowing long-distance transmission."

Average output of the gallium arsenide light source is 0.5 mw at wavelength of 0.897 angstroms. Efficiency (light power output over electrical power input) is now about 0.1 percent.

Venus Probing Upsetting Solar System Theories

STANFORD, CALIF. Findings from NASA's two-pronged probing of Venusian secrets may upset long held theories about that planet and the origin of the solar system, attendees at the American Geophysical Society meeting were told last week.

JPL's Venus radar bounce experiment indicates that Venus's rotational direction may be opposite to that of earth and all other planets in the solar system except Uranus, baffling proponents of the theory that the planets originally coalesced from swirling gas masses all turning in the same direction. Rotational direction of Venus was determined by analyzing the spread of the return 2,388-Mc radar signal. Further, it appears that Venus rotates only once every 250 earth days.

Mariner's December 14 fly-by has established the mass of Venus at 0.81485 that of earth's—indicated by a two-way doppler measurement. Mariner was slowed 3,000 mph by the gravitational field of Venus.

Initial reduction of data from the probe's 3-axis fluxgate magnetometer gives no evidence of a Venusian magnetic field, but scientists cautioned that solar winds could confine a weak field to inside Mariner's 21,500 mile vantage point. The finding is consistent with theory that planetary fields are partially a function of rotational speeds.

Ranger Launch Scrubbed For Reliability Tests

INSTEAD of being launched early this year, as originally scheduled by NASA, Ranger VI will undergo an autopsy to find out what ailed the first five Rangers.

NASA said that Ranger VI will be "subjected to an exhaustive test program" and design review. Resulting reliability improvements are to be incorporated in Rangers VII through IX.

None of the first five Rangers fulfilled their lunar missions.

Mariner, which evolved from Ranger, had a better batting average. Mariner got to Venus after one launch failure.

Reading System Recognizes 20 Different Type Styles

SYLVANIA REPORTS development of a multifont print reader that can handle 20 different type styles. Rate of conversion from print to punched cards or tape is 700 characters a second. Speeds up to 20,000 characters a second are feasible, the company says.

Material to be read is scanned by a flying spot. Reflections are converted to signals that are compared with coded reference characters. Information provided to the recognition unit is a pattern of 320 elements representing light and dark areas in the character being read. These elements are tested simultaneously for the best match against stored representations of 2,000 characters.

The system is insensitive to type size, automatically compensates for variations in paper and type registration, and scanning is digitally controlled so reading can be programmed.

Flash Detector to Help Guard Eyes from A-Blasts

SPECIAL GOGGLES that will darken an instant after an atomic explosion are to be developed by National Cash Register under a $234,000 Air Force contract. The goggles are to protect aircrew members from blinding light. NCR plans to make the goggles of photochromic materials that darken only when exposed to ultraviolet light. Ultraviolet light will be provided by a source triggered by an electronic flash detector. The goggles are to darken within 75 microseconds.

In Brief . . .

NASA HAS AWARDED graduate training grants for the academic year 1963-64 to 88 colleges and universities. Grants will go to some 800 predoctoral trainees who have chosen a graduate study research program that is space oriented.

RUSSIA'S 12th satellite in its Cosmos geophysical research series is now circling the earth once every 90¾ minutes. This is the first shot in the program since October. The project is designed to study radiation belts, their effect on radiowave propagation and the structural elements of spaceships.

GOODYEAR will develop a high-resolution radar system for the Air Force's new RF-4C photo-reconnaissance aircraft, a modified version of the Navy's Phantom II. Radomes will be made of reinforced fiber glass.

GE'S THIN ROUTE tropo radio-teletype writer communications system is now being used by the Air Force at overseas installations. GE says the system substantially reduces transmission costs for point-to-point communication.

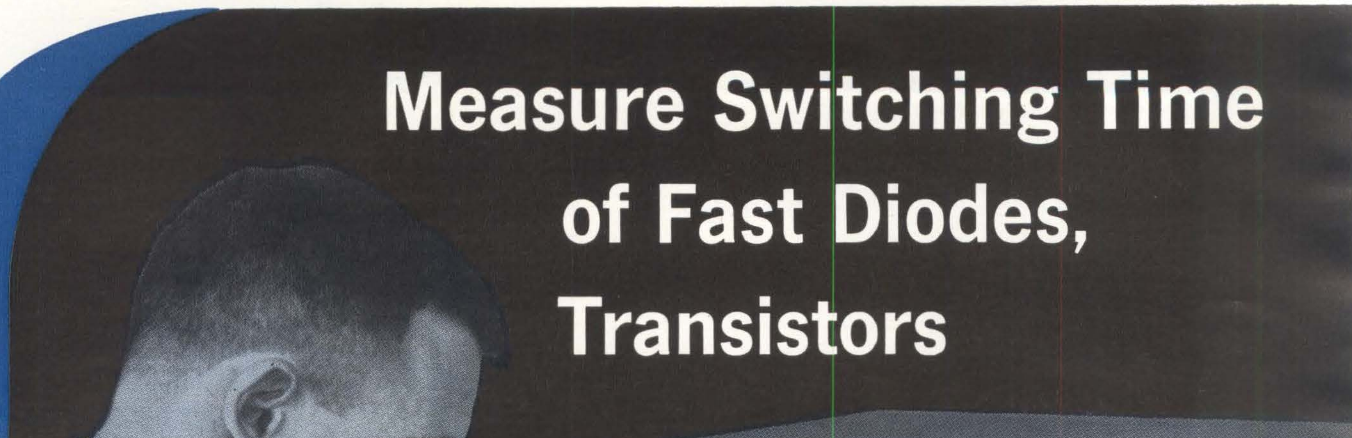
INSTRUMENTATION and control systems for Project Nerva (p 24, Rec. 28, 1962), will be developed by Edgerton, Germeshausen & Grier under a $5.5 million contract with the Space Nuclear Propulsion Office.

VOCALINE will quality test Sonobuoys furnished under BuWeps contracts for the Navy.

IBM WILL DESIGN an advanced data center for the NASA-Marshall Space Flight Center in Huntsville, Ala., that will allow scientists to keep track of the thousands of deadlines associated with manned lunar explorations.

AUSTRIA'S Air Force plans to construct three long-range radar stations that will put the whole of Austrian territory under radar surveillance. First is being built at Koloman Mountain near Mondsee.

Measure Switching Time of Fast Diodes, Transistors



1 nsec resolution with new plug-in test set for (hp) 185 1,000 MC scope

A new "state-of-the-art" plug-in for your (hp) 185 Oscilloscope measures transistor and diode switching time with nanosecond resolution! Just plug in the (hp) 186A Switching Time Tester . . . and all the versatility of the 185 1,000 MC scope is yours for making switching time tests on transistors, diodes and tunnel diodes, or testing pulse response of active and passive networks. The 185 displays switching characteristics of test elements powered and pulsed by the 186A plug-in. And what's more . . . you can use the X-Y output of the scope for making permanent records with a Moseley AUTOGRAF® or other standard X-Y recorder.

The 186A includes all instrumentation needed for fast pulse testing. It provides a test pulse generator, vertical amplifier for the oscilloscope, and two bias supplies for the device under test. Pulses with less than 1 nsec rise time and up to 20 v output are available for many types of switching tests. Component and network testing is easy with a series of quick-change test adapters that plug into the front panel of the 186A.

Because the vertical amplifier in the 186A provides a rise time of less than 0.5 nanoseconds, you retain the remarkable versatility of the basic 185 scope. Test measurements are displayed on the 10 by 10 cm scope screen, and the high rep-rate pulse generator in the 186A insures clear, continuous, flicker-free display.

WASHINGTON OUTLOOK

PROCUREMENT TO LEVEL OFF NEXT YEAR

MILITARY PROCUREMENT is expected to level off under the Pentagon's fiscal 1964 budget that goes to Congress later this month.

New production orders should run about $18 billion and R&D contracting around $7.1 billion, roughly the same as this year. However, electronics orders will probably rise slightly from this year's $4.5 billion for production and $2.1 billion for R&D.

The budget totals some $48.3 billion, up about $2.5 billion from fiscal 1963. But this does not mean more new defense business. The rise reflects major boosts in new orders during the past two years, resulting in more production shipments and completion of R&D projects.

MORE FOR LIMITED-WAR GEAR

LOOK FOR A MAJOR SHIFT in defense contracting emphasis—reflecting recent policy decisions—in the Pentagon's fiscal 1964 budget. The proportionate share of contracts for conventional, nonnuclear arms and equipment will rise substantially over 1963, while the share for strategic weapons systems will drop sharply. Funds for another 150 Minuteman ICBMs are anticipated, but there will be no new money for bombers, except for minor amounts to continue R&D on the RS-70 airplane.

AND MORE FOR MILITARY SATELLITES

DEFENSE COMMUNICATIONS AGENCY is expected to get enough money in the new budget to expand work on military communications satellites. Funds to begin the projects are in the 1963 budget, requests for proposals are about to be issued and contractors will be selected within six months. For a start, a small active repeater will be orbited at an altitude of at least 5,000 miles. Later, a larger, synchronous satellite will be developed.

NASA WANTS $6 BILLION

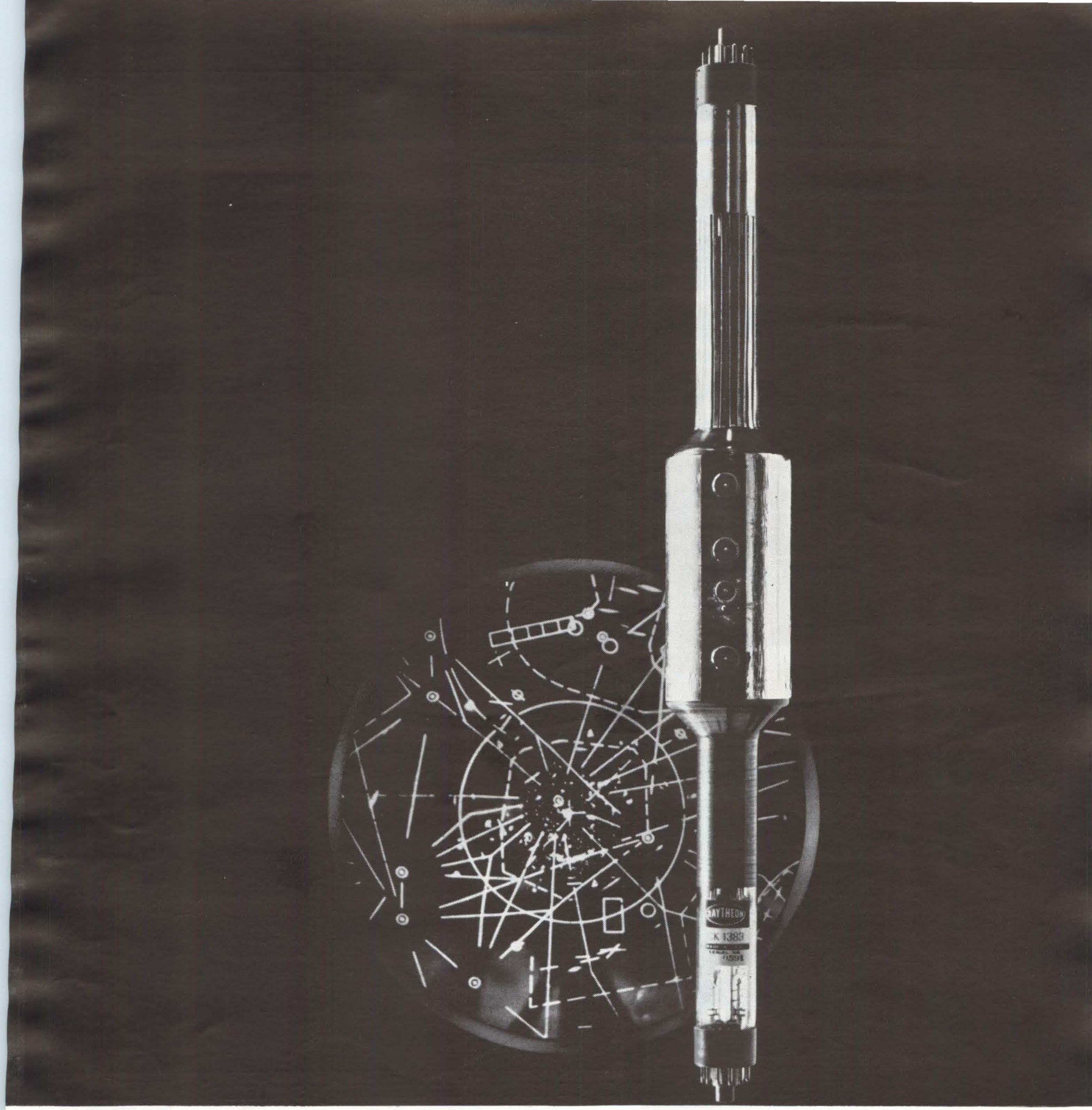
NASA'S FISCAL 1964 BUDGET request to Congress is expected to tally close to $6 billion, compared to the $3.7 billion it got for 1963. More than 70 percent of the new budget is reportedly earmarked for manned space flight projects, including Saturn, Apollo and Gemini. Expectations are that many scientific space programs will be stretched out due to a dollar shortage.

SUCCESSFUL TEST DOESN'T SAVE SKYBOLT

SKYBOLT MISSILE PROJECT is dead, despite the successful test firing last week. Technical factors never really were the prime consideration in Skybolt's demise. The missile's low rating in Pentagon "cost-effectiveness" studies was the major reason.

In the test late last month over the Atlantic near Cape Canveral, the missile was air-launched from a B-52 flying at 40,000 feet. The missile reportedly hit its target 900 miles away. Air Force said it was the first time a ballistic missile was launched from an aircraft to fly a full mission under its own power and guidance.

The Nassau agreement to sell Britain Polaris in place of Skybolt still stands, however. Polaris production will be stepped up, though the number to be sold Britain has yet to be decided.



Raytheon storage tubes

help FAA control air traffic more effectively, improve flight safety

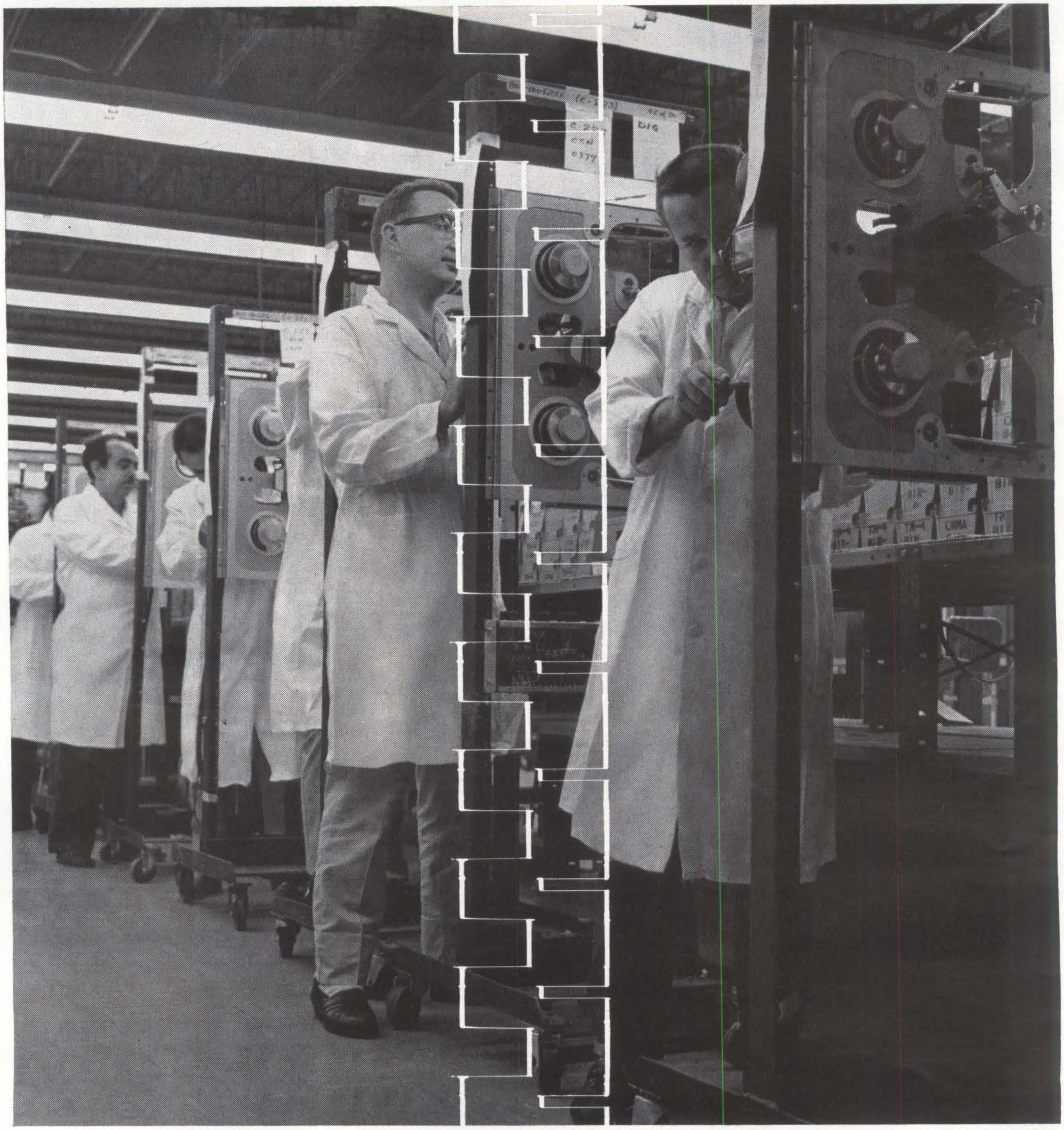
Fifty-one Raytheon "bright display" electronic systems featuring Raytheon CK1383 two-gun storage tubes are being produced for the air traffic controllers of the Federal Aviation Agency. The CK1383 stores radar blips and presents them on a Raytheon CRT CK1381 display tube (Radar/PPI television-type presentation). This way, a continuous picture of a plane's flight path is available. The video can be seen in many areas at the same time, making the controllers' tasks faster and easier. Panoramic displays can depict instantaneously the status of all aircraft in a selected area. In addition, the display itself is bright enough to be seen in a normally lighted room.

Raytheon Storage Tubes are available for many other types of scan conversion and for such applications as stop motion, integration for signal-to-noise improvement, information storage for data processing systems, slow-down video, time delay, and phase shift.

Whatever your storage tube requirements, Raytheon can meet them best. Unmatched capabilities and more than a decade of experience are at your command. For complete details on Raytheon storage tubes and display devices, please write: Raytheon, Industrial Components Division, 55 Chapel St., Newton 58, Mass.

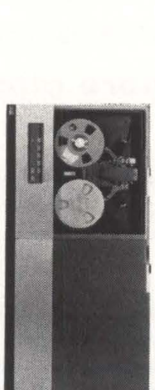
RAYTHEON

CIRCLE 13 ON READER SERVICE CARD



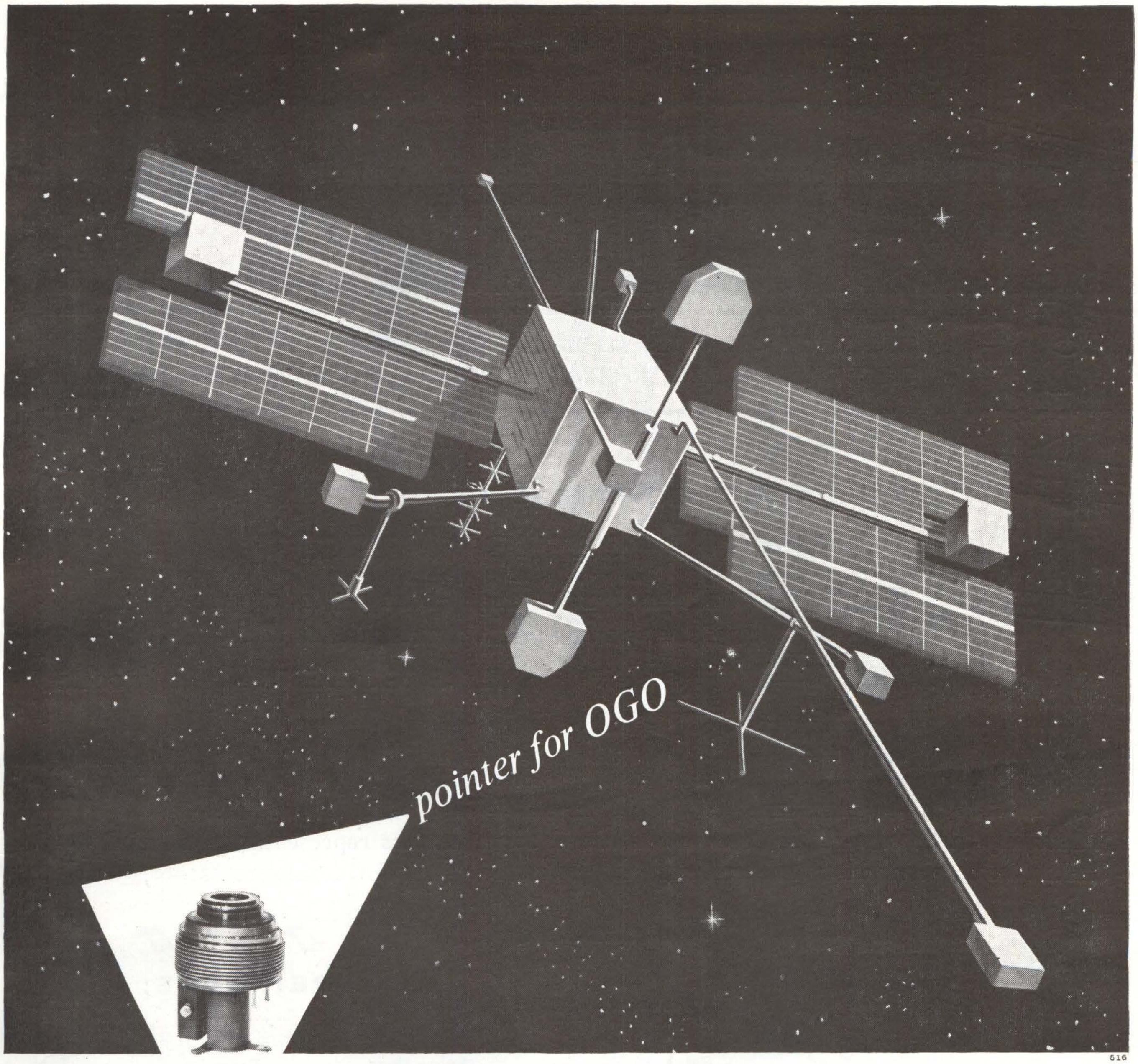
Who says you can get fast delivery on advanced tape memory systems? AMPEX

We took the world's most advanced high speed and medium speed tape units and added solid state electronics. Result: the Ampex TM-2100 and TM-4100 tape memory systems. We can deliver them to you practically off the production line. Performance? The TM-2100 operates at speeds up to 150 ips; the TM-4100 at speeds up to 75 ips. Both systems read, write and check digital data. They're compatible with most computer formats at 200, 556 and 800 bpi. And you can have either system in a 19" rack



mount, a tri-sectional cabinet, or any way you want it packaged. Or you can get either tape transport by itself. (As many as ten transports can operate on one set of electronics.) Ampex Computer Products Co., Culver City, California. A division of the only company providing recorders, tapes and core memory devices for every application: Ampex Corporation, 934 Charter Street, Redwood City, California. Term financing and leasing available. Sales, service engineers the world over.

AMPEX

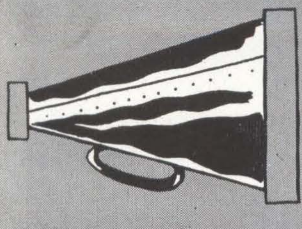


Once in orbit, OGO (NASA's Orbiting Geophysical Observatory) must orient scientific equipment in three directions. Some of its experimental packages must line up perpendicular to the sun's rays. Other experiments must turn to face the earth. Another group must seek a line parallel to OGO's own orbital plane. STL engineers and scientists have produced a hermetically sealed drive mechanism to help solve these orientation requirements. Two mechanisms are used in OGO's attitude control system. One rotates solar arrays in continuous orientation with the sun; a second keeps experiment packages fixed in desired position with respect to the orbital plane. The drive mechanism (shown above) is hermetically sealed to permit use of a conventional high-speed servo-motor without the usual problems of gear lubrication. It does its work by wabble or twist motion at a rate of one degree per second with a final gear reduction of about 24,000 to 1. STL's many projects include building OGO spacecraft for NASA's Goddard Space Flight Center, building spacecraft for Air Force-ARPA, and continuing Systems Management for the Air Force's Atlas, Titan and Minuteman programs. These activities create immediate openings in fields such as: Space Physics, Radar Systems, Applied Mathematics, Space Communications, Antennas and Microwaves, Analog Computers, Computer Design, Digital Computers, Guidance and Navigation, Electromechanical Devices, Engineering Mechanics, Propulsion Systems, Materials Research. For Southern California or Cape Canaveral positions, write Dr. R. C. Potter, One Space Park, Dept. G-1, Redondo Beach, California or P. O. Box 4277, Patrick AFB, Florida. STL is an equal opportunity employer.

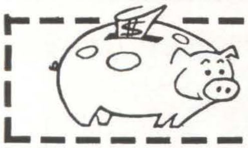
SPACE TECHNOLOGY LABORATORIES, INC.
a subsidiary of Thompson Ramo Wooldridge Inc.

Los Angeles • Vandenberg AFB • Norton AFB, San Bernardino • Cape Canaveral • Washington, D. C. • Boston • Huntsville • Dayton

VISITING LOS ANGELES JAN. 14-FEB. 1? SEE "ART IN SCIENCE" EXHIBIT AT STL'S SPACE TECHNOLOGY CENTER.

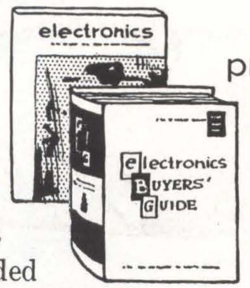


ANNOUNCING FOR 1963
a tremendous
electronics BUYERS' GUIDE Issue



NEW LOW CATALOG RATES ALLOW SUFFICIENT SPACE FOR YOU TO PROVIDE COMPLETE BUYING INFORMATION ON YOUR ENTIRE PRODUCT LINE

Take complete advantage of marketing's MAGIC COMBINATION



electronics every Friday—to create preference for your products...

The 1963 BUYERS' GUIDE to make product preference pay off in buying action

For 22 years this combination has worked magic for thousands of sales-minded companies. It will work for you in 1963 more effectively and economically than ever before. Your **electronics** representative has full information on how this can be accomplished. Look at these new eBG catalog rates:

CATALOG ADVERTISING RATES PER PAGE:

Without "EARLY BIRD" Discounts

Space Used	Rates	Space Used	Rates
1 page	$900	12-15 pages	$545 per page
2-3 pages	740 per page	16-19 pages	495 per page
4-5 pages	670 per page	20-23 pages	465 per page
6-7 pages	630 per page	24 or more	440 per page
8-11 pages	590 per page		

FOR THE SAME PRICE AS 1962, FROM 33% TO 60% MORE SPACE!

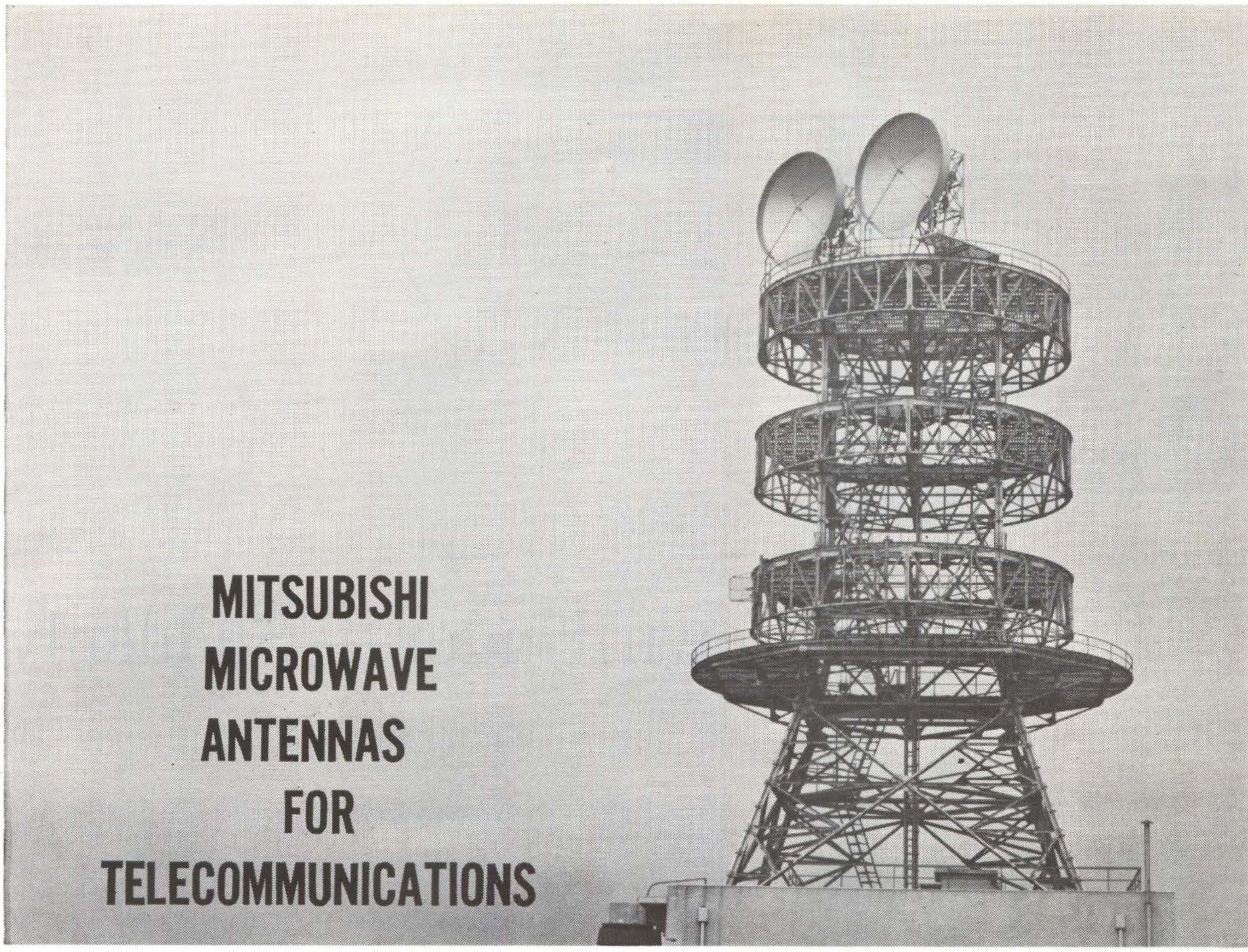
Rates with "EARLY BIRD" Discounts

1 page	$837.00	12-15 pages	$506.85
2-3 pages	688.20	16-19 pages	460.15
4-5 pages	623.10	20-23 pages	433.45
6-7 pages	585.90	24 or more	409.20
8-11 pages	548.70		

"EARLY BIRD" Closing Dates (For Discounts)

Reservations for space Feb. 15th / Copy to set April 16th / Complete plates April 25th

For Complete Information, Contact Local Sales Offices Listed on the Last Page of This Issue



MITSUBISHI MICROWAVE ANTENNAS FOR TELECOMMUNICATIONS

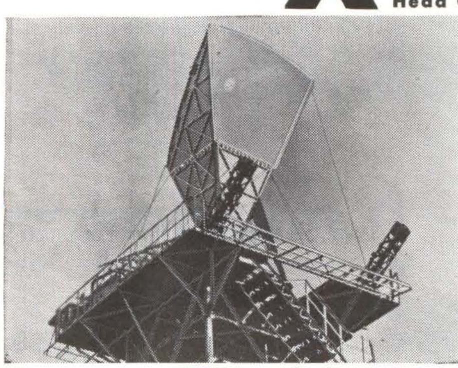
Japan today has the second largest microwave network in the world. Mitsubishi Electric, with the longest microwave antenna experience in Japan, has supplied 90% of the antennas used in the trunk lines of this extensive network. Mitsubishi antenna systems include parabolic, scatter, horn reflector and radar types, as well as a complete line of waveguide components and accessories. Frequencies from 900 Mc. to 24 KMc. are covered. The IU-61, shown above and specified at the right, is typical of the outstanding performance of Mitsubishi microwave antennas. Full technical information on any of these types of antennas is available at your request.

IU-61 6000 Mc. Band Parabolic Antenna

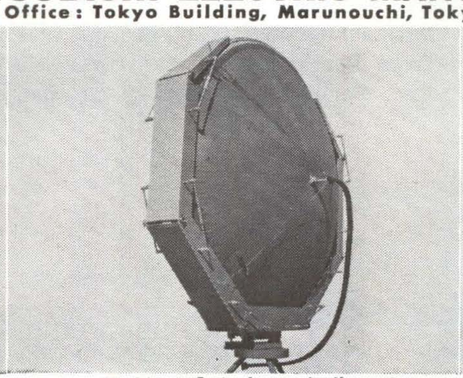
Diameter	4 meters
Frequency Range	5925~6175 Mc/s or 6175~6425M c/s
Feed System	Dual circularly polarized wave
Gain	45 db
Beam Width	0.98 degrees (half power)
First Side Lobe	−23 db
Wide Angle Radiation (over 60 degrees)	−60 db
Front-to-Back Ratio	65~70 db
VSWR	1.02
Ellipticity Ratio	1.1 (power axial ratio)
Discrimination of anti-circularly polarized wave	−30 db
Coupling of Both Arms	−35 db
Guaranteed for Wind Velocity of	60 meters/second
Weight	800 kilograms

MITSUBISHI ELECTRIC MANUFACTURING COMPANY

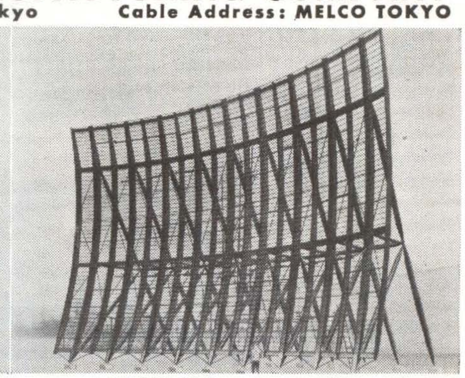
Head Office: Tokyo Building, Marunouchi, Tokyo **Cable Address: MELCO TOKYO**



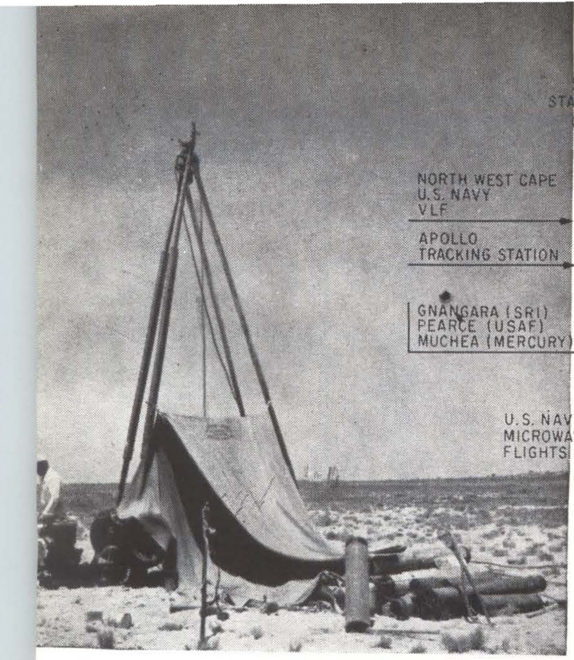
■ Horn reflector antenna



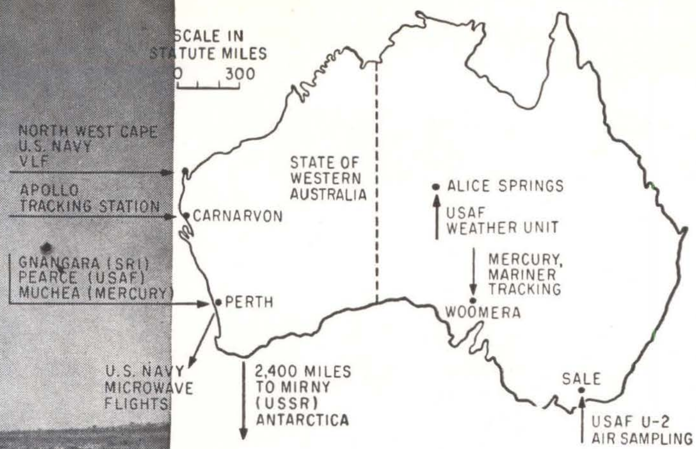
■ Air inflated parabolic antenna



■ 25×16 meter scatter antenna



DRILLING RIG *probes shimmering white limestone salt flat, to insure there will be no caverns under tower foundations at Navy's vlf station*



MOST U. S. RADIO *sites in Australia are strung along the west coast*

Down Under — Suddenly

Australia is breaking out in a rash of U. S. electronics facilities

By LLOYD MARSHALL
McGraw-Hill World News

PERTH, AUSTRALIA—Two factors have combined to make little-known Western Australia suddenly a focal area for U.S. electronic activity. Australia's west coast is almost opposite, on the globe, to the U.S. east coast, and it is relatively free from man-made interference.

In quick succession Australia's west coast has attracted stations for Mercury and Apollo tracking, vlf communications, communications research and l-f basic research.

VLF STATION—The Navy vlf station, similar to one at Cutler, Maine (ELECTRONICS, p 34, July 15, 1960), will cost about $80 million.

The antenna array on the tip of the North-West Cape peninsula (see map) will have inner and outer rings of 13 towers with a central tower reaching up to 1,294 ft.

Near the vlf transmitter are sites for an h-f receiver and an h-f transmitter.

Construction will begin in 1963 and should end late in 1965. The station is to be fully operative with a staff of 300 to 500 men by 1966.

The station will be the first permanent U.S. defense base on Australian mainland soil.

MUCHEA TRACKER — A command tracking station built in 1960 at Muchea (pronounce it M'you-shay) was the first U.S. electronic interest in Western Australia. Strategically situated on the flat, sandy coastal plain 34 miles from Perth, Muchea can cover the first 3 orbits of a Mercury mission, and the last 7 of an 18-orbiter.

It has all the regular features of a Mercury command station. The station is managed and staffed by officers of the Weapons Research Establishment of the Department of Supply. During missions, the staff is 30 Australians, plus American specialists. Expansion of the station is considered inevitable in view of future NASA commitments of Gemini and possibly Centaur.

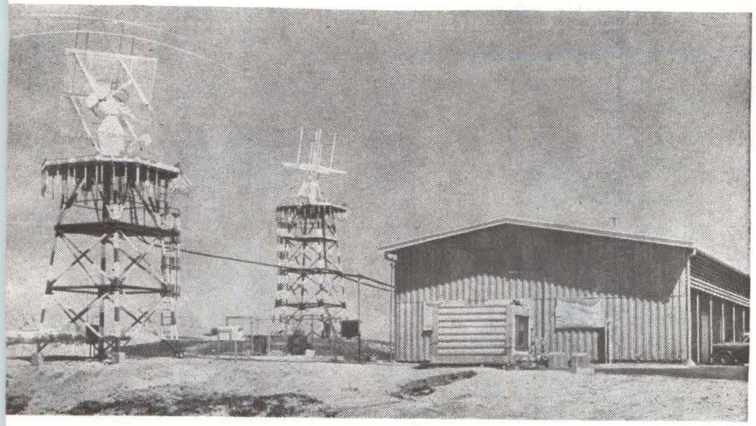
AIR FORCE RESEARCH—Seven miles from Muchea, the U.S. Air Force has a radio communications research station at the Royal Australian Air Force station at Pearce. Considerable security surrounds the establishment.

The base, so far, is manned by 14 men. When put on a permanent footing it would have up to 50 men.

The reasons for putting the station at Pearce are the certainty of good weather, calm atmospheric conditions, and relative freedom from tv and radio interference.

The research team is studying space phenomena. Information will be useful in communications satellite programs and is also being

DEBRIEFING *after a Mercury flight. Man with the white shoes is Gordon Cooper, who is to make the next Mercury flight*



ROUGHING IT *at Muchea. This is the telemetry and control facility at the Mercury tracking station*

Mecca for Radio Men

made available to the RAAF.

U.S. Air Force also has a weather observation unit operating from Alice Springs. U-2 upper-air-sampling aircraft are permanently based at Laverton, near Melbourne.

ENTER STANFORD—Latest U.S. entry in W.A. is a l-f radio propagation research station established by Stanford Research Institute in the Gnangara pine plantation about 12 miles north of Perth. The University of W.A. is providing graduate assistance and servicing.

SRI researchers say the installation has nothing to do with the Navy's vlf station. L-f signals are used over long distances and Perth is about as far away as one can get from the U.S. on land.

This trailer-mounted, semiautomated unit has four antenna structures about 400 feet apart and about 20 feet above the ground. They are directional loop antennas, triangular in shape and 20 ft high, and directional capacitor screen type antennas 36 by 16 ft.

Received signals are taped then airfreighted to a similar station in California for comparison.

PROJECT APOLLO—Six hundred miles north of Perth is the small port of Carnarvon, chosen for a Project Apollo tracking station. The final site has not been announced. Negotiations between governments are not ended.

Considerable surveying, soil and interference tests have been carried out on a high, red sandhill at Brown Range, 3½ miles east of Carnarvon. The site gives an unimpeded radar scan to west and to east.

It is likely Carnarvon will have a TPQ-18 tracker (p 26, Dec. 15, 1961). The station will need about 40 staff.

AND A MYSTERY—In February, 1962, a U.S. Navy research aircraft bristling with antennas appeared at Perth Airport to engage in microwave research.

Simultaneously, one of America's very latest guided missile destroyers, *USS Coontz*, berthed nearby at Fremantle, the port of Perth, on a "goodwill" visit.

The aircraft flew a number of times towards Antarctica, ostensibly investigating atmospheric ducts —the phenomena that act like giant coaxial cables.

It was not explained why the aircraft left two men to operate a transmitter from the disused Caversham airstrip, 11 miles from Perth. The men were later embarked on the *Coontz*.

paradynamics

10 WATT

Microwave Swept Sources

1.0-18.0 Gc/s

The pinnacle of power levels, at the highest standard of reliability, is now easily within reach via the Paradynamics Series 858B Swept Signal Sources. Flexibility is a key factor here, too, since these highly versatile units incorporate all of the features of the Paradynamics standard milli-watt, 1, 2 and 5 watt instruments.

With the 858B Series, Paradynamics makes available for the first time standard production 10-watt instruments capable of operating either as stable CW Signal Generators or as Sweeping Oscillators. Maximum reliability with a minimum of heat, space and weight is assured in these units through the use of permanent magnet focused wave tubes for both the BWO and TWT.

Unique features such as remote programming of RF frequency, power and modulation make the 858B Series a natural selection for use in automatic check-out systems, antenna range setups and other similar applications.

- **Power Output Leveling ±0.75 db**
- **May Be Pulse Modulated**
- **May Be Remote Programmed**
- **Panel Height 17¼"**
- **Weight—95 lb**

Catalog available on request

paradynamics
INCORPORATED

10 Stepar Place / Huntington Station, L. I., N. Y. / 516 HA 7-7961

CIRCLE 22 ON READER SERVICE CARD

New DIFFUSION FURNACE
with Kanthal A-1 elements

Many design features utilized in the new Despatch K-36 combustion and diffusion furnace combine to give it broader applications and new dependability for laboratory and production work.

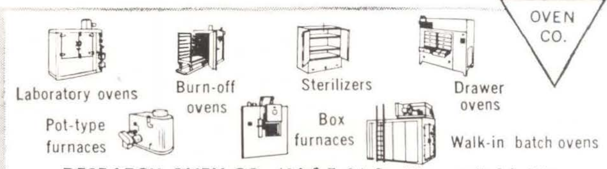
The Kanthal 3-zone A-1 elements are divided into end and center zone heats. The silicon control rectifier and transformer assembly with proper instrumentation provides accurate ±½° F. heat uniformity current control. The all ceramic exterior tubes and the efficient new type insulation, alumina-silica fibers in multiple layers, combine to maintain a cool shell even when the furnace is operated at capacity heat.

The new Despatch K-36 features are well suited to analytical work of semi-conductor deposits, for diffusion involving vapor growth, for combustion carbon determination.

MODEL K-36
Tube Furnace — tube I.D. 2½", end zones 29½", center zone 11"

For complete information write for bulletin 206-6F.

DESPATCH OVEN CO.

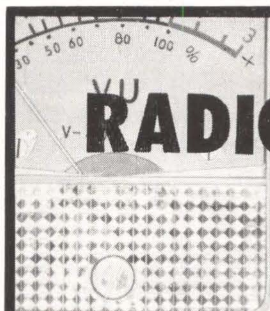


DESPATCH OVEN CO. 619 S.E. 8th St., Minneapolis 14, Minn.

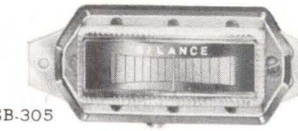
CIRCLE 200 ON READER SERVICE CARD

BEST MINIATURIZED INDICATOR

RADICATOR (TOYO)



V-403



SB-305

R-201

R-101

R-101	Tuning indicaor and Battery residual capacity indicator
F-102	FM tuning indicator
V-103	Audio level indicator
A-104	AM tuning indicator
SB-105	Stereo balancing indicator
B-106	Battery indicator
R-201	Smaller type tuning and battery indicator
V-203	Smaller type level indicator
B-206	Smaller type battery indicator
R-301	Larger type tuning and battery indicator
V-303	Larger type level indicator
SB-305	Larger type stereo balancing indicator
V-403	VU meter
V-403B	Audio level indicator
SB-405	Null indication stereo balancing indicator

ACCEPTABLE SPECIAL DIAL UPON YOUR REQUEST

DISTRIBUTOR

ATAKA NEW YORK, INC.
633 THIRD AVENUE
16TH FLOOR
NEW YORK 17, N.Y., U.S.A.
PHONE: OXFORD 7-7480

ATAKA & CO., LTD.
OHTEMACHI BLDG.
1-CHOME, OHTEMACHI
CHIYODA-KU, TOKYO
PHONE: 201-6411

MAKER

TOYO MUSEN CO., LTD.
75, WAKABAYASHI-CHO, SETAGAYA-KU, TOKYO

CIRCLE 201 ON READER SERVICE CARD

Inner-space, outer-space, or lack of space — wherever size, weight, and shielding of coax is a criteria, Hitemp's new cables provide design advantages not previously available!

Engineering, production, and Q.C. techniques advanced by Hitemp make it possible to hold shielding to a wall thickness of 1.5 mils, or less. For example, on a RG-196A/U teflon insulated coax cable, Hitemp holds the O.D. to .040″ or half the O.D. of conventional wire braid construction (.080″). Subsequently, there's a weight savings of 21%. And this miniaturized cable can be wrapped around a 3/8″ mandrel.

Naturally, the 100% shielded construction improves attenuation characteristics, reduces cross-talk to a minimum, stabilizes capacitance, and lowers VSWR.

100% shielding offers you assembly economies, too. It eliminates many termination problems associated with braided shields, and increases the reliability of the terminations, themselves.

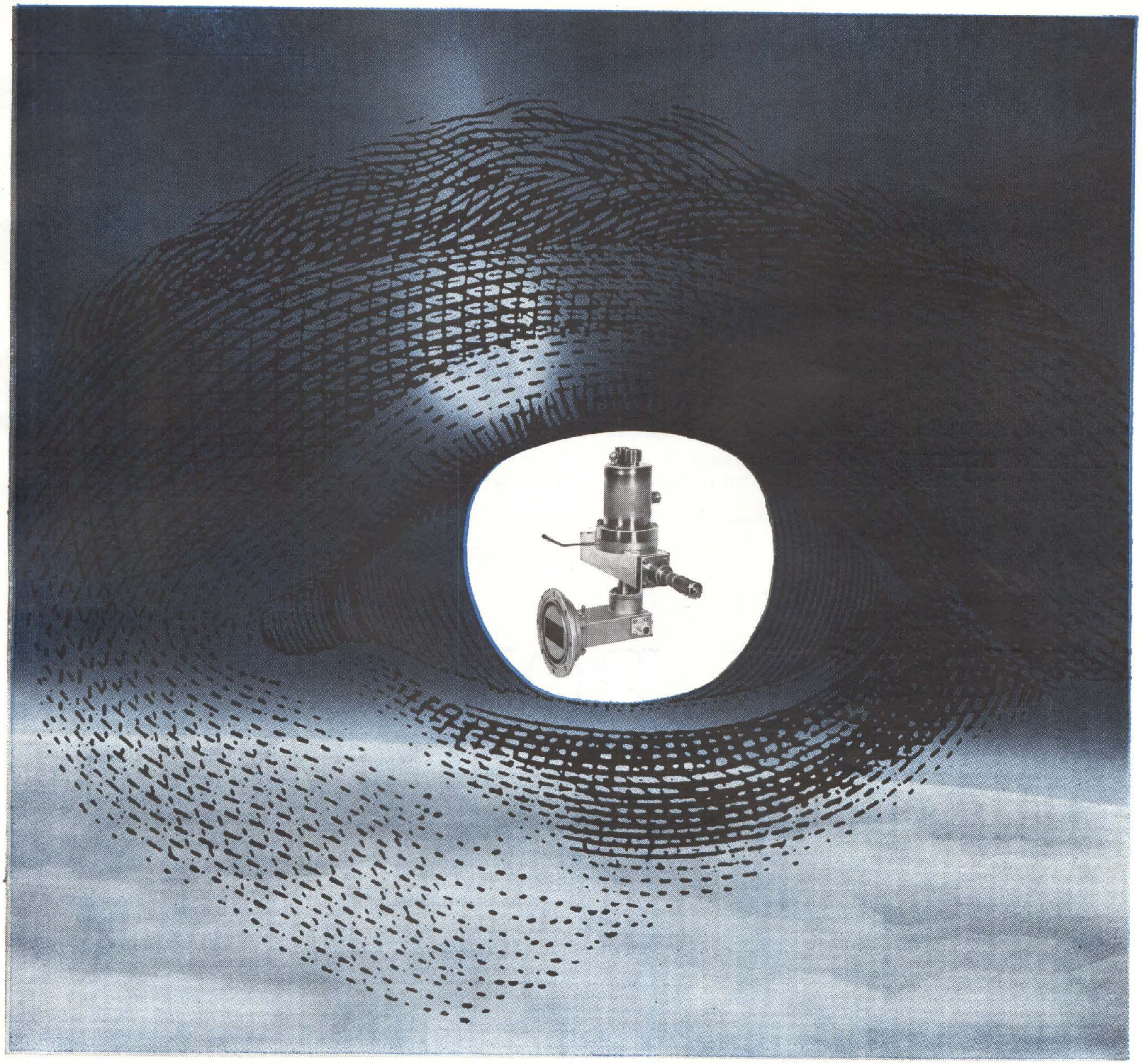
Wherever your circuitry requires lower attenuation, improved VSWR, and so forth — wherever shielding, weight, size, flexibility, *and* reliability are critical, that's where it will pay you to use Hitemp's new miniature 100% shielded.

SEND FOR A SAMPLE if you'd like to run some checks on it yourself. Or, send us a piece of what you're currently using. We'll evaluate it and advise you of the savings you can make with Hitemp's new miniature coax. Why not take advantage of *either* offer today!

HITEMP WIRES CO.

a Division of Simplex Wire & Cable Co.

1200 SHAMES DRIVE, WESTBURY, NEW YORK
1532 S. CALIFORNIA AVE., MONROVIA, CALIF.



TYPICAL PARAMETRIC AMPLIFIER SPECIFICATIONS: *Tuning Range 5.4 - 5.9 Gc; Gain-Bandwidth Product 150 mc minimum; Single Sideband Noise Figure (including Circulator) Uncooled Mode (290°K) 2.3 - 2.7 db; Cooled Mode (80°K) 1.3 - 1.6 db; Pump Frequency 17.5 Gc; Pump Power Requirements 100 mw maximum.*

20/20 TRACKING VISION

Let's look at it this way. In space exploration 20/20 vision of instrumentation and tracking radar is a must. Advanced parametric amplifiers developed by Sperry will reduce minimum discernible target size and up the range of radar systems.

In tests conducted in major military radars, Sperry-designed solid state parametric amplifier systems produced excellent stability and optimum system performance far beyond normal...and at reasonable cost. Furthermore, Sperry has solved cryogenic cooling problems to achieve ultra low noise figures.

The Sperry Model D61C1 is a non-degenerate C-band parametric amplifier designed to meet military specifications. A temperature-controlled model of this amplifier was recently incorporated into a military radar system requiring extreme stability and low noise figure—gain changes of less than 0.5 db per day for temperature changes from -20° to +150°F. were realized.

When incorporated as a complete subsystem, with ferrite circulators to divert the signal path when desired, amplifiers provide an effective, practical technique for improving system performance at economics heretofore unobtainable . . . and with fail-safe reliability features.

Optimum radar system operations can be achieved in single as well as multi-channel amplifier configurations as a result of extensive research and development at Sperry over the past five years.

Why not investigate improvements attainable in your radar using Sperry's extremely low noise, high reliability parametric amplifiers?

Write or call for complete information on integrated packaging for your radar application.

SPERRY

DIVISION OF SPERRY RAND CORPORATION **SPERRY MICROWAVE ELECTRONICS COMPANY** CLEARWATER, FLORIDA

Solid State Devices and Materials • Microwave Subsystems • Microwave Components and Antennas • Microline • Radar Test Sets • Systems Instrumentation

HIGH RESOLUTION, *motorized film viewers for seismic analysis program compare two seismic signals. Digital and analog computers are also used in analysis*

SEISMOMETERS *for earth measurements can be 10 miles away from data-recording station*

BLACK BOX

BLAST DETECTION — HOPE OR HOAX?

Will unattended nuclear detection stations be able to police test ban?

By GEORGE J. FLYNN
Associate Editor

FOR FOUR YEARS U.S. and Soviet representatives have been deadlocked over a proposed ban on nuclear weapons testing.

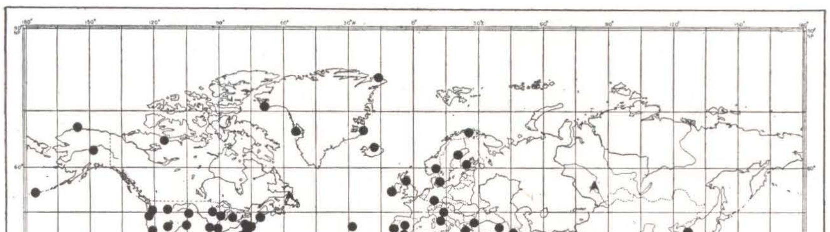
The U. S. has been insisting on an inspection procedure to make sure the ban is not violated clandestinely; we want inspection teams on the spot in the USSR.

The Soviets at first insisted that their word alone be taken that they would comply with a ban. Lately they have proposed policing a ban by unmanned instrument packages —"black boxes."

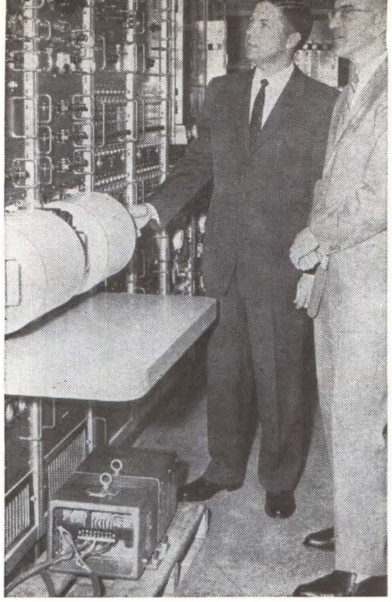
The U. S. is not buying this proposal.

What can the black box do, and what can't it do? Is the truth somewhere between these two conflicting viewpoints?

Last week, William C. Foster, director of the U. S. Arms Control and Disarmament Agency, told 400 scientists on the University of Michigan campus that "at present scientific instruments and techniques cannot reduce the area of ambiguity and risk to tolerable limits. This is why we have con-



TENTATIVE LOCATIONS *of standard seismograph stations furnished by U. S. Coast and Geodetic Survey to universities and research institutions to assist Project Vela-Uniform in earthquake studies and help establish criteria for underground blast detection*



VELA-UNIFORM *station built by Texas Instruments and Geotechnical Corp.*

tinued to include provisions for on-site inspection in a system of checks and balances."

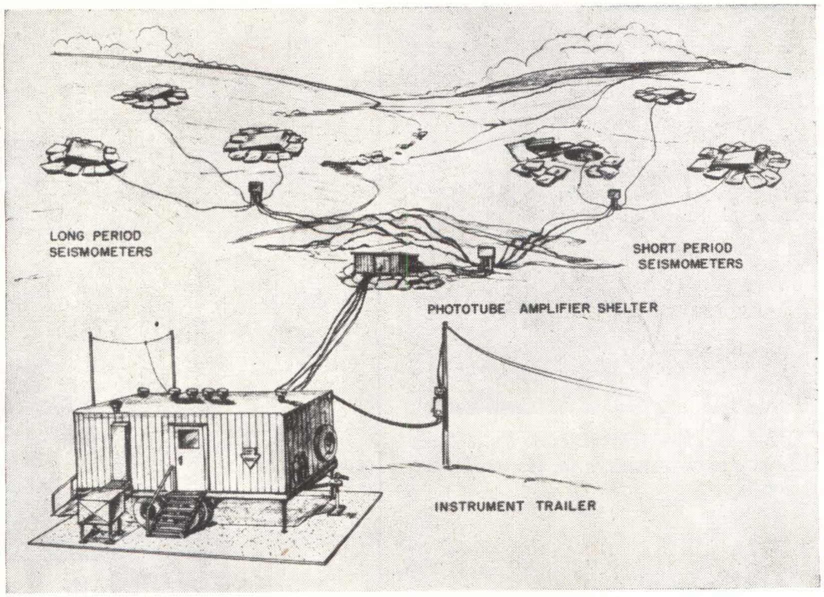
Robert E. Matteson, advisor to the agency, told the same group "nothing U. S. scientists have seen or read leads them to believe that automatic stations can be used to replace a system of manned control posts with suitable arrays of seismic instruments or to significantly reduce the number of necessary, obligatory on-site inspections required to identify seismic events."

He added that 100 black boxes would not eliminate the need for on-site inspection although they would be a helpful adjunct. Even with manned stations having the best instruments, there would still be need for a communications network with standard reporting forms for central data collection, processing and analysis.

Even 100 black boxes probably wouldn't be enough. Another analysis—of the problem of detecting small explosions—shows that it would take 400 to police the USSR's huge land mass. That's a far cry from the Soviet offer of three unmanned stations, an offer rejected recently by the U. S. test-ban negotiators.

STATE OF THE ART—Too little is known about how to tell a nuclear blast from an earthquake. And the simple seismometers of black

Black Box . . . Easy to Spoof



MOBILE *seismograph stations of this type built by Geotechnical Corp. are being used in long range seismic measurements program*

boxes can be spoofed—simply by driving a tractor around the box when a blast goes off. Seismic effects of a blast can be reduced to low levels by setting it off in a salt mine or under the polar ice cap.

Even on-site teams will have trouble. Suppose a detection network could pinpoint suspicious events to within 500 ft. Then the probability of finding radioactive evidence of an underground 20-kiloton blast by drilling five holes is only 26 percent. Digging enough holes to be sure would cost tens of millions a year—and there are 500 seismic disturbances in the USSR each year that might bear looking into.

Nuclear blasts in outer space have characteristics that will probably allow them to be detected unless exceptional shielding methods are used. Even blasts on the far side of the moon could be detected since by the time such testing would be practical inspection or spy satellites of various types will be available.

QUAKE OR TEST? — Detecting underground blasts and distinguishing between them and natural earthquakes is primarily a problem in seismic analysis, although all nuclear explosions also generate an electromagnetic signal. The direct electromagnetic signal is attenuated rapidly by the earth, but signals below 10 Kc may be detectable[1].

Seismic waves traveling through the earth's crust generate a second electromagnetic signal that precedes the shock wave. Neither the direct nor the seismically induced electromagnetic signal can presently be used for detection except at short range, but both have sufficient worth to justify further research.

UNDERGROUND BLASTS — The major problem with seismic signals at present is that they are noisy.

Noise in the seismic signal results from multiple reflections within the earth (ghosting), local earth movements at the seismometer site (called microseisms), and noise from trucks, trains, factories, wind, and ocean and earth tides.

Only the so-called first motion is known to help in identification. For an explosion, this motion is always a compression signal radiated in all directions from the blast.

First motions of earthquakes sometimes have the same pattern and sometimes have a rarefaction pattern. Thus, the most that can be proved with seismic signals alone is that an event is an earthquake and not an explosion.

Neither Western nor Eastern


Who's the big wheel in 1451 cities?
We are. If you think that's bold, you should see our new Skyroad transportation system. Skyroad is an integrated network of trucks, trains and Flying Tigers' airfreight combined to give you door-to-door airfreight service in 1451 cities and towns.
With Skyroad, you can forget your worries about delays in loading and unloading shipments. Freight is never held up because we have a nationwide teletype system that keeps tabs on your shipment from initial pickup to final delivery.
Skyroad simplifies your shipping too. You pay only one flat rate. And you receive only one bill for this combined service. You'll be amazed at how low Skyroad rates are. We never play big wheel with other people's money. See for yourself. Call for details.
first in airfreight with airfreight first FLYING TIGER LINE
FLYING TIGER LINE AIR-FREIGHT SPECIALISTS

 (continued from p 26 and 28)

SEISMOMETER *for use in holes or wells as deep as 10,000 ft improves signal-to-noise ratio as much as 10:1 over surface types*

FILM READER *scans data on 16-mm film. Seismologists can quickly locate events of interest but do not always agree on the interpretation of weak signals*

scientists at the 1958 Geneva Conference of Experts were able to show how shallow underground nuclear explosions could be positively identified[2], and no method suggested since then has been verified.

With the seismic equipment available today, seismologists can reliably identify a first compression motion if the signal-to-noise ratio is 7:1 or better (s/n of 5:1 may be acceptable). But a radial compression pattern cannot be positively determined from only a few scattered seismic stations—clean first-motion signals from a network of stations are necessary.

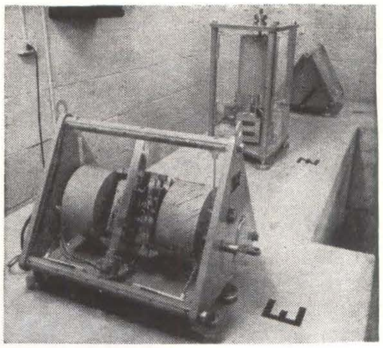
The signal-to-noise ratio is thus a major stumbling block of any unattended inspection system. Since tactical weapons with powers of 5 Kt or less are of interest, signal power is relatively low. Simple decoupling techniques can reduce it by a factor of ten or more. Hanging the bomb in a cage within a cavern can reduce the seismic effect by as much as 300. There is evidence that small explosions deep in arctic snow are completely muffled.

BLACK BOXES — Simple and rugged seismometers able to operate unattended for a month or more can reliably detect the first motion of a 5-Kt blast 100 to 200 miles away. A network to cover the Soviet Union would need 400 or more stations.

The manned seismic stations first proposed at the Geneva Conference are more sensitive and complicated instruments than unattended ones can be and have a range of about 1,000 miles. The Soviet Union now has over 100 seismic observatories of the most modern type.

Seismic stations cannot just be placed on the ground and turned on. A quiet area is needed and the equipment must be directly connected to bed rock. Spoofing is relatively easy. Driving a tractor around a site could bury blast signals in noise.

SPACE BLASTS — At least five different types of ground-based equipment to detect blasts in space appear feasible at this time[3]. Detection methods would be based on



SEISMIC STATION *requires at least three seismometers, power supply, recording system and timing signals with 0.1-second absolute accuracy*

the visible flash, the electromagnetic signal, and soft or long-wavelength thermal x-rays.

Los Alamos estimates that 10^{-6} of the total energy of a 1-megaton blast is given off as visible light over a 30-microsecond period. If the same energy proportion holds for smaller explosions, a 10-kiloton blast would give off 4×10^{7} joules as light.

With an optical system having a 0.2-radian field of view, and phototube with a sensitivity of 0.04 amp per watt, a peak photocurrent pulse of 0.08 microamp would be obtained from a 10-Kt blast 10^{5} Km away. This can be used to obtain a signal-to-noise ratio of 10 to 1, with a false-alarm probability of 1 in 10^{33} seconds.

But if the light pulse is only 0.9 times as much as assumed, the false-alarm probability is 3×10^{7} or about 1 per year. An acceptable false-alarm rate has generally been estimated at 1 per century.

RADIO ENERGY — Electromagnetic energy from the nuclear blast is concentrated in the 10 to 100-Mc band and is relatively insensitive to the size of the blast. The signal from a blast 10^{5} Km away is about 3×10^{-10} watt/m^2. Cosmic noise in the same band is approximately 6×10^{-12} watts/m^2, giving a signal to noise ratio of 100:1. But nonstatistical variations in cosmic noise could occasionally give a spike 100 times the rms level, thereby giving a false alarm.

The x-ray pulse from a nuclear blast lasts from 0.1 to 1 microsecond; thermal x-rays reaching the ionosphere and upper atmosphere from a space blast would cause a nearly instantaneous increase in ionization in these regions. Time for the suddenly increased ionization to dissipate is a function of altitude, initial electron density and time of day. It ranges from hundreds to thousands of seconds.

VLF PHASE SHIFT—The sudden increase in electron density causes an effective lowering of the D layer and a consequent phase shift in vlf signals that travel in the duct formed by the layer and the earth.

A 10-Kt blast 10^5 Km away could cause a phase shift in a 20-Kc signal of 480 degrees in 1 microsecond. This is a much larger rate of phase change than the 0.5-degree-per-second rate for a solar flare and the 0.03-degree rate for sunset and sunrise. The U.S. Navy is now evaluating vlf phase-shift detection methods (ELECTRONICS, p 28, Oct. 19, 1962).

Two other ways of detecting space blasts appear feasible. Lowering of the D layer increases absorption of cosmic noise, and a 10-Kt blast at 10^5 Km is estimated to change the 15-Mc cosmic signal by about 0.1 db. Although the magnitude of change is small, the rate of change is much higher than any caused by natural events, so detection with a fast-acting riometer should be possible.

The other method is based on detecting the air fluorescence that occurs when thermal x-rays excite nitrogen molecules. Approximately 0.25 percent of the absorbed energy is emitted as blue light at 3914 A. An air-fluorescence detector has been operated by Los Alamos Laboratory for 2½ years, and a detection range of 10^5 Km for a 1-Kt blast is believed possible.

REFERENCES

(1) S. D. Abercrombie, Ground Based Detection of Atomic Weapons, Paper presented at 9th IRE-Professional Group Nuclear Science, 1962.

(2) Carl Romney, Commentary on "The Detection of Underground Explosions" (An article by L. Don Leet, Scientific American, June, 1962), Vesiac Bulletin, U. of Michigan, Ann Arbor, Mich.

(3) Cabell A. Pearse, Ground Based High Altitude Detection Systems, Paper presented at 9th IRE-Professional Group Nuclear Science, 1962.

All illustrations accompanying this article were furnished by The Geotechnical Corp., Garland, Texas.

GROUND CONTROLS *bring unmanned helicopter in for landing*

Navy Tests Drone 'Copter

Unmanned helicopters could spy on enemy and deliver undersea weapons

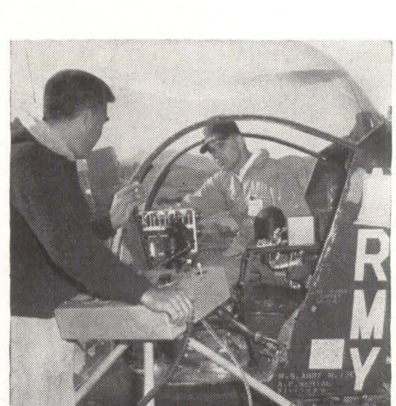
DALLAS—Bell Helicopter has successfully demonstrated the capability of a remote-control helicopter drone system, in two unmanned flights at the Naval Ordnance Test Station, China Lake, Calif. Bell believes the system could expand the use of helicopters on hazardous military missions, such as:

- Using drones as decoys to probe and expose enemy firepower.
- Providing radar or tv spying platform above a battlefield. Held stationary at 7,000 to 8,000 feet, such a helicopter could broadcast a continuing picture of enemy troop and equipment positions and movements. In Navy use, drones could safely scout shorelines and ship movements.
- Flying into contaminated areas with radiation detectors to measure the effect of nuclear explosions.
- Reducing the hazard of delivering antisubmarine underwater missiles and depth charges.

The present system can stabilize on four axes. This unit activates servomechanisms that control pitch, roll, yaw and collective axes by hydraulic manipulation of a dual control system.

Control signals are telemetered from a 17-by-13-inch ground-control panel to the autopilot through a pulse-amplitude-modulation data-link system. An encoder mixes multi-channel control commands for single-channel broadcast to the helicopter by an f-m transmitter. A decoder in the craft converts the telemetered commands into channel signals acceptable to the autopilot. Lag time between command and reaction is measured in microseconds.

The recent tests at China Lake involved an 11-year-old Army OH-13E helicopter. It was flown 72 minutes over a prescribed course. After the first flight, it was refueled, checked and reflown on a second 48-minute unmanned flight. Flight altitudes ranged up to 2,000 feet, maximum speed was 70 knots, and maneuvering distance 6 miles.



TRIPOD-MOUNTED *ground control panel is checked out*

KNOW OF A
SMALL, RUGGED
METAL-CERAMIC TRIODE
WITH **HIGH P_o**
THROUGH 1600 MCS?

HAVEN'T YOU
HEARD?-

COME ON. YOU CAN'T **HEAR**
PICTURES

THIS ONE IS **WORTH LISTENING TO.** IT'S GENERAL ELECTRIC'S **NEW** ZP-1026, a triode amplifier with the highest known power-handling capability of any tube its size through 1600 mc. Its peak power capabilities include 2 KW at 0.02 duty, and 750 watts at 0.03 duty.

This G-E triode was designed for use in applications such as TACAN, IFF, steerable arrays, Doppler radar and altimeters, and is only one of a complete line of metal-ceramic tubes General Electric has for a variety of military applications. Its features include long pulse and high duty capabilities, long life, small size and heat-sink cooling.

HERE ARE SOME CHARACTERISTICS OF OTHER TYPICAL G-E TUBES . . .

	ZP-1030 METAL-CERAMIC TETRODE	ZP-1016B METAL-CERAMIC TRIODE	ZP-1029 METAL-CERAMIC DIODE
TYPICAL APPLICATION	AM and CW Communications, SSB, Satellite Communications, Tropo-Scatter	Series Regulator	RF Switching
BRIEF DESCRIPTION	100 W carrier linear amplifier @ 225-400 mc; 300 W CW @ 225-400 mc; 200 W CW @ 900 mc.	$E_b = 10$ KVdc; $\mu = 10$; $P_p = 300$ W.	Heat-sink cooled; $I_b = 0.300$ Adc; PIV = 5500 v.

SOUNDS LIKE
A PICTURE
WORTH HEARING
ABOUT

ELECTRONICS
PROGRESS IN MICROWAVE TECHNOLOGY

INCLUDING IGNITRONS, HYDROGEN THYRATRONS, MAGNETRONS, METAL-CERAMIC TETRODES, TWT's, HIGH-POWER DUPLEXERS, HIGH-POWER WAVEGUIDE FILTERS, KLYSTRONS AND THERMIONIC CONVERTERS. FOR INFORMATION ON THESE PRODUCTS, WRITE SECT. 265-23, POWER TUBE DEPT., GENERAL ELECTRIC CO., SCHENECTADY, N. Y. OR TELEPHONE TODAY: SCHENECTADY, N. Y. FRanklin 4-2211 (Ext. 5-3433) • WASHINGTON, D. C EXecutive 3-3600 • DAYTON, OHIO BAldwin 3-7151 • LOS ANGELES, CALIF BRadshaw 2-8566
SYRACUSE, N. Y. 652-5102 • CHICAGO, ILL. SPring 7-1600 • CLIFTON, N. J. GRegory 3-6387 • NEW YORK, N. Y WIsconsin 7-4065 • ORLANDO, FLA GArden 4-6280

GENERAL ELECTRIC
POWER TUBE DEPARTMENT

265-23

MEETINGS AHEAD

MILLIMETER AND SUBMILLIMETER CONFERENCE, IRE-Orlando Section; Cherry Plaza Hotel, Orlando, Florida, **Jan. 7-10.**

RELIABILITY & QUALITY CONTROL SYMPOSIUM, IRE-PGRQC, AIEE, ASQC, EIA; Sheraton Palace Hotel, San Francisco, Calif., **Jan. 21-24.**

INSTITUTE OF ELECTRICAL & ELECTRONICS ENGINEERS WINTER GENERAL MEETING & EXPOSITION, IEEE; Statler and New Yorker Hotels, New York City, **Jan. 27-Feb. 1.**

MILITARY ELECTRONICS WINTER CONVENTION, IRE-PGMIL; Ambassador Hotel, Los Angeles, Calif., **Jan. 30-Feb. 1.**

QUANTUM ELECTRONICS INTERNATIONAL SYMPOSIUM, IRE, SFER, ONR; Unesco Building and Parc de Exposition, Paris, France, **Feb. 11-15.**

INFORMATION STORAGE AND RETRIEVAL SYMPOSIUM, American University; International Inn, Washington, D. C., **Feb. 11-15.**

ELECTRICAL & ELECTRONIC EQUIPMENT EXHIBIT, ERA, ERC; Denver Hilton Hotel, Denver, Colo., **Feb. 18-19.**

SOLID STATE CIRCUITS INTERNATIONAL CONFERENCE, IRE-PGCT, AIEE, University of Pennsylvania; Sheraton Hotel and U. of P., Philadelphia, Pa., **Feb. 20-22.**

PACIFIC COMPUTER CONFERENCE, AIEE; California Institute of Technology, Pasadena, Calif., **March 15-16.**

BIONICS SYMPOSIUM, United States Air Force; Biltmore Hotel, Dayton, Ohio, **Mar. 18-21.**

IEEE INTERNATIONAL CONVENTION, Institute of Electrical and Electronics Engineers; Coliseum and Waldorf-Astoria Hotel, New York, N. Y., **March 25-28.**

ENGINEERING ASPECTS OF MAGNETO-HYDRODYNAMICS SYMPOSIUM, IRE-PGNS, AIEE, IAS, University of California; UCLA, Beverly, Calif., **April 10-11.**

OHIO VALLEY INSTRUMENT-AUTOMATION SYMPOSIUM, ISA, et al; Cincinnati Gardens, Cincinnati, Ohio, **April 16-17.**

INTERNATIONAL NON-LINEAR MAGNETICS CONFERENCE, IRE-PGEC, PGIE, AIEE; Shoreham Hotel, Washington, D. C., **April 17-19.**

ADVANCE REPORT

RADIO FREQUENCY INTERFERENCE NATIONAL SYMPOSIUM, IRE-PGRFI; *Bellevue Stratford Hotel, Philadelphia, Pa., June 4-5, 1963. March 1 is the deadline for submitting a 250-word abstract to: Albert R. Kall, Technical Program Chairman, c/o Ark Electronics Corp., 624 Davisville Road, Willow Grove, Pennsylvania. Symposium theme is "new dimensions in rfi." Papers in the following rfi areas are specifically invited: instrumentation, suppression; system compatibility analysis; communications; special problems above 10 kmc; measurement problems in the vvlf range. After selection of papers, authors will be requested to submit a 1,000-5,000 word summary for publication in the PGRFI Symposium Transactions.*

SOLID STATE IN *Electronics*

Men of vision thrive here. And it takes men of vision to cope with today's electronics and space problems. Space in more ways than just up. Space problems of a different nature plague the manufacturer who must expand, but hasn't the land to expand on.

Here in Florida we have the space, the climate, the work force. Florida has more to offer electronics firms than any other area on earth. Men think better where life is pleasant, where off hours can be devoted to just plain *living*—and to just plain *thinking*.

Yes, Florida is a Solid State in Electronics. Already the sun, Mother of Life, shines on over sixty thriving electronics firms in our busy state.

Cape Canaveral is here, too, with its massive, awesome missiles blasting off to make space history. Electronics makes possible every thrust into the universe. Every hope of getting to the moon depends upon electronics—and the first American to the moon will definitely soar to history from Florida.

Engineers and their families dream of living here in Florida. Give them this dream by moving your plant here. Nurture the brains that will give your business a greater and greater stature in this, the Electronics Age.

For complete details of the many advantages Florida offers the Electronics Industry, write us. Let us tell you why some of the greatest names in electronics have impressive plants here in Florida.

FLORIDA'S ASSURANCE POLICY

"You have my personal assurance of a sunny business climate here in Florida. You have positive assurance of every aid and assistance possible from our Florida Development Commission and from the overwhelming majority of our businessmen, industrialists, and financiers. We have everything to make your large or small enterprise healthy and successful. Write, wire, or phone us TODAY. The only thing better than a FLORIDA vacation is having your plant here."

FARRIS BRYANT
Governor

Investigate

Florida

...A 10 BILLION DOLLAR MARKET

Ask about free film "Profile of Progress"

FLORIDA FOR CONVENTIONS— Write for free information on Florida's wonderful facilities for your group meeting.

Mr. Wendell Jarrard, Chairman
FLORIDA DEVELOPMENT COMMISSION
Box 4247D, Tallahassee, Florida

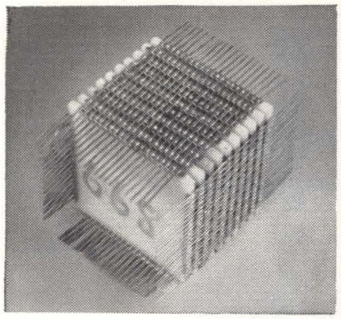
Please send me brochure, "Why Your New Plant Should Be Located In Florida," containing the facts about FLORIDA's opportunities for New Industry, the 10 BILLION DOLLAR CONSUMER MARKET, Labor, Climate, Schools, Natural Resources, Favorable Tax Structure.

Name.................................

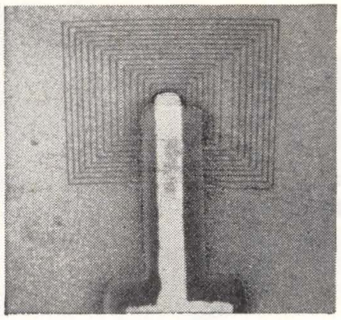
Firm Name.................................

Address.................................

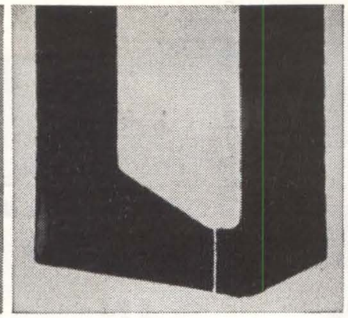
City.......................Zone........State..........



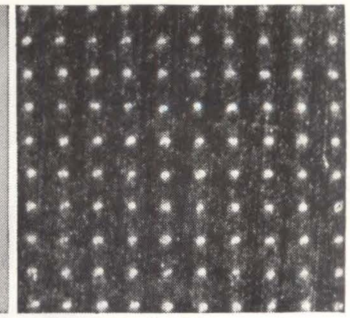
Micro assemblies of 0.030-inch thick alumina wafers with riser wire interconnections welded by a new Hamilton Standard electron beam technique.



Thin film inductor, consisting of titanium film on an aluminum oxide wafer, scribed by high-power density Hamilton-Zeiss cutting equipment.



Ferrite memory core, 0.005-inch thick, with slots cut by electron beam. Slot widths: 0.0005- to 0.001-inch.



Grid screen of .003″ diameter holes on .010″ centers drilled in .020″ stainless steel sheet.

NOW—THE FIRST COMPLETE MICROMINIATURE PRODUCTION TOOL

The new Hamilton-Zeiss Electron Beam CW-1 Cuts, Welds, Drills, Scribes

The new Model CW-1 Electron Beam Cutter-Welder is the most advanced machine yet developed for work in microminiaturization. With CW-1 equipment, you can fabricate complete microminiature assemblies, cut, scribe and drill thin film and solid state components. You can also weld necessary leads without distorting the workpiece. And the vacuum chamber provides a contamination-free environment with a bonus in "free" vacuum for hermetic encapsulation operations. Almost all metallic elements and many nonmetallics including aluminum oxide, quartz, and ceramics, can be processed by the CW-1.

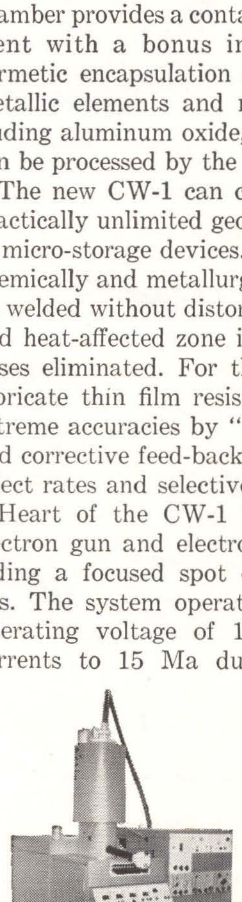
The new CW-1 can cut and drill shapes of practically unlimited geometries for fabrication of micro-storage devices. All materials that are chemically and metallurgically compatible may be welded without distortion or contamination, and heat-affected zone is for all practical purposes eliminated. For the first time, you can fabricate thin film resistors and capacitors to extreme accuracies by "in-process" monitoring and corrective feed-back, thus eliminating high reject rates and selective assembly techniques.

Heart of the CW-1 is a highly developed electron gun and electron optical system providing a focused spot diameter of .0005″ or less. The system operates at a maximum accelerating voltage of 150 KV and provides currents to 15 Ma during pulsed operation providing nearly 10,000 megawatts per square inch at the workpiece. Such extremely high power densities permit the cutting of any material known today.

UNIQUE FEATURES OF THE MODEL CW-1

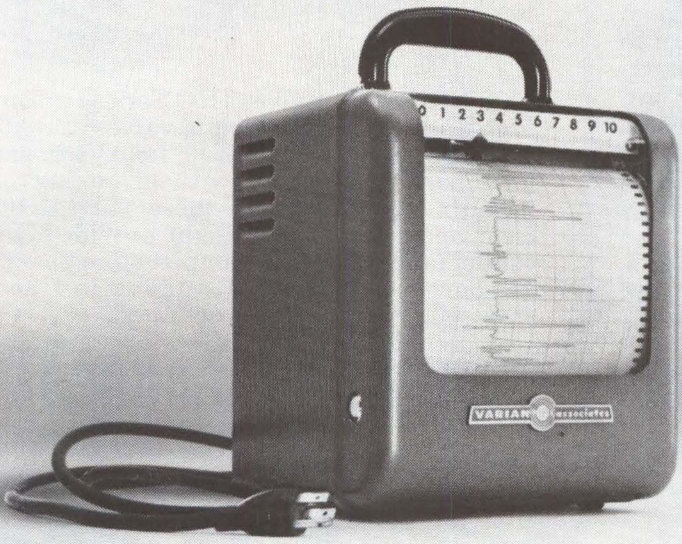
- *A Zoom Type Binocular Optical Viewing System* (14X to 40X) provides stereo-effect microscopic examination of the workpiece at all times permitting precise positioning and eliminating the need for removal of the workpiece for inspection. Fabrication and inspection can be combined in one operation.
- *A Precision Beam Deflection System* permits programming of the beam (workpiece stationary) over the workpiece in any preselected pattern using electronic programming* and simple external control knob adjustments.
- *A Precision Work Table* with all backlash eliminated provides positioning accuracies to .0002″.
- *Polished Stainless Steel* is utilized on the inside of the work chamber and on all apparatus exposed to the work chamber, thus providing an extremely clean workpiece environment free from corrosion, outgassing and extraneous contamination.
- *Tape Controlled Programming.** Operation of the CW-1 can be fully automated. Beam deflection and table position can be programmed on tape using conventional industrial numerical controls.

*With optional equipment at extra cost.



For complete information on the Model CW-1, contact: Sales Manager, Electron Beam Machines, Hamilton Standard, Windsor Locks, Conn.

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION



It's just like buying a custom-built recorder!

With so many standard options from which to choose, it takes a bit of extra effort to buy a Varian G-11A recorder. But most of our customers don't seem to mind at all. After all, where else could they buy a compact, reliable potentiometer recorder custom-built to their exact specifications at such a reasonable price?

Here are just a few of the many options which the G-11A offers: you have a choice of input circuits for measuring voltage, current or temperature; a choice of one, two or four chart speeds from 1/8"/hr up to 60"/min; a choice of voltage spans from 10mv to 100v—temperature spans from −200°C to +1500°C; a choice of reference voltage — mercury cell or zener diode; and a choice of many other options including ink or inkless writing, event markers, zero center scale, field span adjust, and rack mounting.

Best of all, no matter which options you select for your G-11A, you still have a light-weight, reliable recorder with 1% limit of error and a pen speed of 1 second full scale.

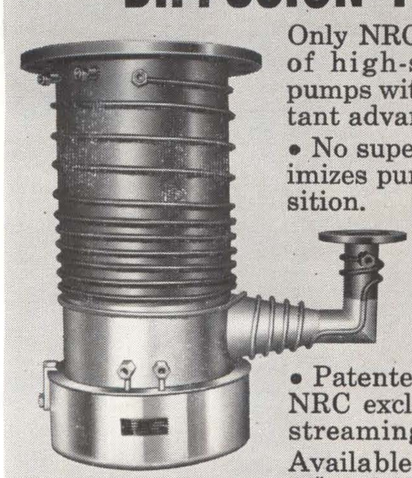
Wouldn't you like to have your next recorder custom-built? For complete information on prices and all available options, see your Varian Recorder Representative or write the INSTRUMENT DIVISION.

VARIAN associates
PALO ALTO 1, CALIFORNIA

PUMPS • VALVES • BAFFLES • GAUGES

VACUUM COMPONENTS

DIFFUSION PUMPS



Only NRC offers a full line of high-speed diffusion pumps with all these important advantages:

• No super-heating... minimizes pump fluid decomposition.

• Fractionating jet assembly... constantly purifies pump fluid... lower pressures can be held longer.

• Patented Cold Cap*... an NRC exclusive... cuts backstreaming 98%.

Available now in 4", 6", 10", 16" and 32" sizes for all your high vacuum testing and production applications, where performance and reliability really count.

**Licensed exclusively from Edwards High Vacuum Limited. U. S. Patent No. 2919061.*

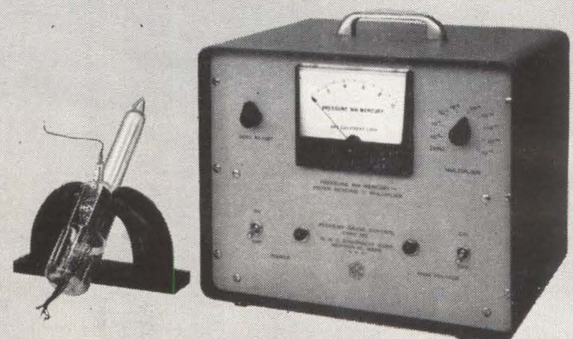
SLIDE VALVES

New NRC Slide Valves (HC Series) are *very-high* and *ultra-high* vacuum valves at *conventional* prices. Pressures of 10^{-8} to 10^{-10} torr range have been produced... without baking... in vacuum systems using these valves. 100% clear opening and low height provide highest conductance. Double-pumped stem seal cuts gas bursts 99%. They're available in 4" and 6" sizes, either hand or air operated.

CRYO AND MOLECULAR BAFFLES

Now, your high vacuum system can be operated at lowest pressures for extended periods of time *with no detectable trace of hydrocarbons reaching the chamber!* The reason: NRC's Circular Chevron Cryo Baffle and the all-new NRC Molecular Sorbent Baffle (which utilizes three full trays of zeolite) virtually eliminate back-migration of pump fluid vapors. Yet, they provide exceptionally high conductance for maximum *useful* pumping speed.

VACUUM GAUGES



Get accurate, reproducible direct-readings to 10^{-13} torr with the new NRC Model 752 Redhead Magnetron Gauge! The only really satisfactory gauge commercially available for measurements below 1 x 10^{-9} torr. Increased current readings provide 50 times the sensitivity of hot-wire ionization gauges. Because there's no hot filament, it's magnitudes less "gassy", can't become contaminated by vaporizing of gauge elements. And the 752 Gauge is not X-ray limited.

NRC's full line of vacuum gauges and controls also includes an improved Bayard-Alpert type gauge, Model 751, for accurate, reliable measurement in the 1 x 10^{-3} to 10^{-10} torr range.

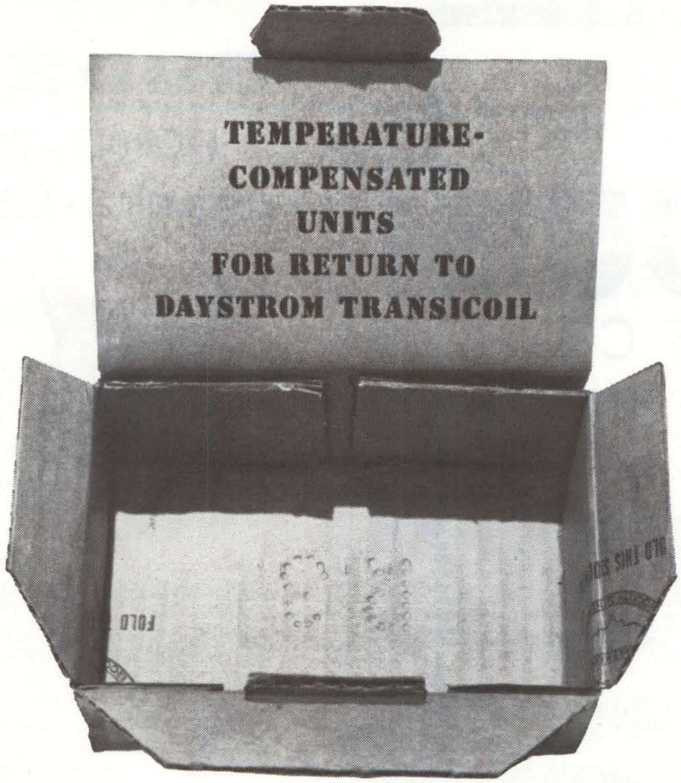
NRC EQUIPMENT CORPORATION

A Subsidiary of National Research Corporation

160 Charlemont St.
Newton 61, Massachusetts
Area Code 617, DEcatur 2-5800

All of the above components are stock items. Write today for product data sheets. Let us show you how NRC components can improve the performance of your high vacuum system.

MANUFACTURING PLANTS IN NEWTON, MASSACHUSETTS AND PALO ALTO, CALIFORNIA

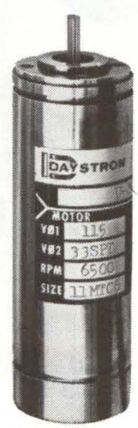


A Month's Rejects

Transicoil delivers highest volume with lowest reject rate on precision temperature-compensated motor tachometers.

Daystrom Transicoil's claims to lowest reject rate rest squarely where such claims are proven: at the customer's incoming inspection. Coupled with this reliability, moreover, is our ability to deliver on schedule in volume. In fact, Daystrom Transicoil is the largest known producer of temperature-compensated motor tachometers.

In recent months, systems requirements have become increasingly stringent for component reliability. Our Size 11's have successfully met this challenge in such systems as the F-104, A3J, Pershing, Hound Dog, Mirage, and a number of other systems as yet not even officially designated by name. Most delivery promises have been met . . . and even bettered. Why don't you check the specs at right, then find out for yourself how our temperature-compensated motor tachometers can meet your own requirements?

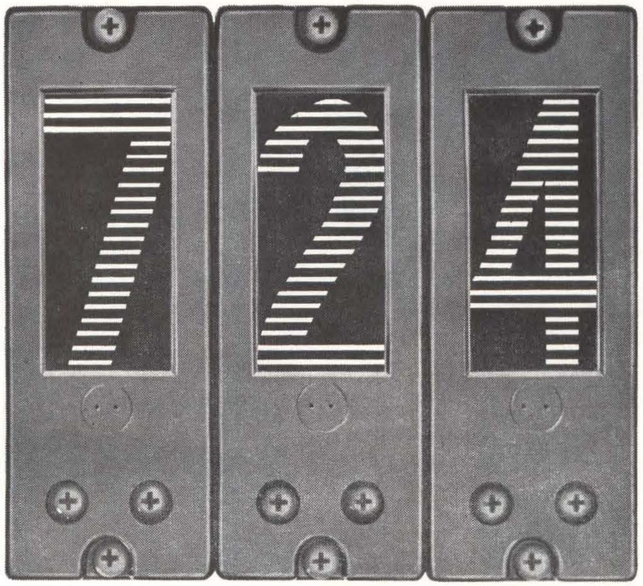


DAYSTROM, INCORPORATED
TRANSICOIL DIVISION
WORCESTER, PENNSYLVANIA
TELEPHONE 215-584-2421

SIZE 11
TEMPERATURE-COMPENSATED TACHOMETER
ELECTRICAL CHARACTERISTICS

INPUT VOLTAGE (V)	115	
INPUT POWER (W)	5.5	
INPUT IMPEDANCE (OHMS)	1500	
INPUT CURRENT (A)	0.077	
OUTPUT IMPEDANCE (OHMS)	5000	
OUTPUT VOLTAGE (V/1000RPM)	2.75	
MAX. NULL RMS (VOLTS)	0.020	
LINEARITY (%)	0.07	
SIGNAL TO NOISE	140	
PHASE SHIFT AT 25°C (DEG.)	**0±0.5°**	
SCALE FACTOR VAR. W/TEMP.	**±0.5%**	**−55°C to +100°C**
PHASE SHIFT VAR. W/TEMP.	**±0.5°**	

NEW READOUT
SELF-DECODING NUMERICAL READOUT AND PULSE COUNTER



QUANTITY PRICES FROM $40.00 EACH

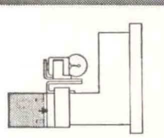
■ The new Kauke readout is a simple, rugged, visual display unit that converts 1-2-4-8 code, parallel input, into numerical characters. ■ It is electro-mechanically operated, with enclosed construction, and features single or grouped front panel mounting with exceptionally wide-angle viewing. ■ Simple and inexpensive accessories broaden its use to provide a wide variety of applications and special conditions.

DESIGN Character is changed by simple stepping motor . . . can be used as **decoder** or **counter** (up to 50 steps per sec.)

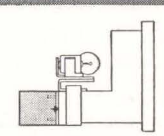
MEMORY Once the displayed character corresponds to input code, the character is retained indefinitely.

POWER Low drive power, only 200 ma at 24v. No drive power is used while character is being displayed.

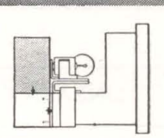
APPLICATION FLEXIBILITY



Plug-In Adapter
Allows for 4-line parallel input from low level logic.



Count Module
Provides carry pulse, simultaneous zero-set, and verification.



Buffer Storage
Accepts microsecond logic input while previous input appears.

■ *Write today for complete detailed specifications.*

KAUKE and COMPANY, INC.
E-M Products Division
1632 Euclid Street • Santa Monica, California

BUDELMAN
POINT-TO-POINT
Economical • Reliable • Effective

2KMC

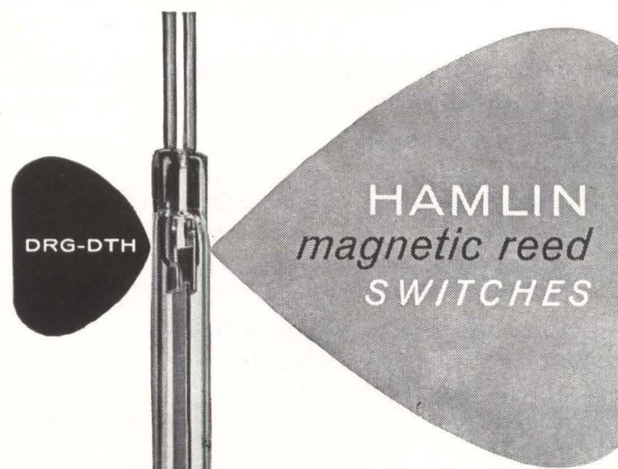
Type 14C Microwave Radio Terminals

provide needed communication and data transmission for railroads, telephone companies, public utilities, public safety services and the armed forces. Whether for a "thin-route" gap filler or a 48-channel multi-hop system, Budelman Type 14C, 1700-2300 MC Microwave and Speech Multiplex equipment **"proves in" where others cannot.**

Write for Spec-sheets, Engineering Analysis or Systems Proposals... without obligation.

BUDELMAN ELECTRONICS CORP.
A Subsidiary of General Railway Signal Co.
375 Fairfield Ave., Stamford, Conn. • 203 FI 8-9231

CIRCLE 202 ON READER SERVICE CARD



the largest selection ever offered . . .

The use of magnetic reed switches has been increasing by leaps and bounds, and Hamlin engineers have set the pace with the greatest selection. All standard varieties, of course, plus . . .

- **DRM-001** High Voltages (up to 5000 v)
- **DRG-DTH** Double Throw (Form C)
- **DRR-5** Heavy Duty (up to 50 v amp.)
- **DRS-5** Heavy Thrust (in-rush to 15 amp.)
- **HRC-1** No-Bounce (Mercury wetted)

and many more designed for special requirements . . . **YOUR** specifications. Send for literature.

SEE IT! HEAR IT!

FREE CARD
with magnet and switch

HAMLIN INC
Dept. EL • LAKE AND GROVE STREETS • LAKE MILLS, WISCONSIN

CIRCLE 203 ON READER SERVICE CARD
CIRCLE 41 ON READER SERVICE CARD →

THE REAL DIFFERENCE IS INSIDE

That's right — we cut the can away . . .

You are looking at the most critical area of Motorola's PNP germanium epitaxial mesa transistor — the die itself. Magnified over 50 times, this unretouched photograph enables you to see clearly the emitter and base stripes and their lead wires.

Most engineers have never seen the inside of a Motorola transistor. Clean, isn't it? Critical controls must be maintained in order to produce such units . . . controls that have a significant effect on the ultimate reliability of a transistor.

Notice the sharp, uniform metallic deposition of stripes . . . the precise control of stripe area, definition, and spacing. Motorola controls these dimensions to within one ten-thousandths of an inch. This care and skill is indicative of that taken throughout all phases of Motorola mesa transistor production, from the growth of epitaxial layers controlled to millionths of an inch to literally controlling the number of molecules of surface moisture necessary for optimum transistor performance.

Such precision may not be required to build a transistor that merely meets minimum performance standards. However, it is essential for the production of devices that will provide the continued reliable operation that has become synonymous with the name Motorola Mesa.

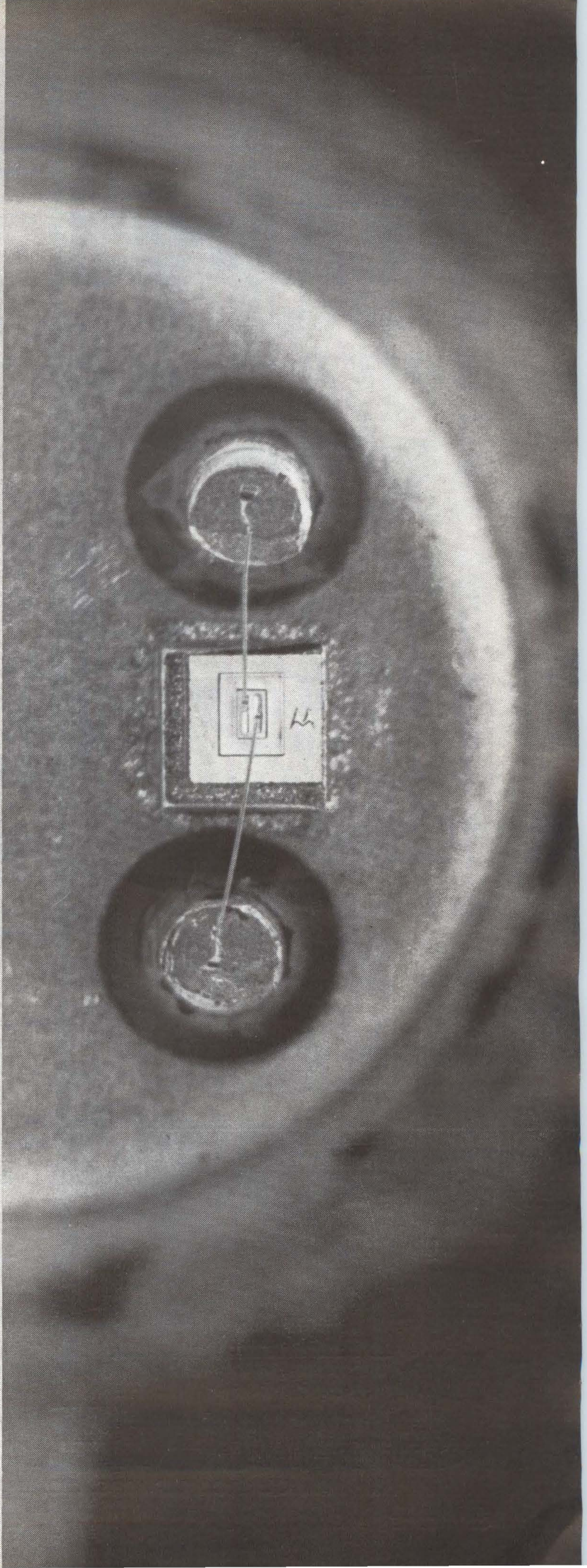
But, don't take our word for it . . . the next time your Motorola representative calls, have him open one of these mesa devices for you. Compare its obvious mechanical perfection with that of any other transistor on the market today.

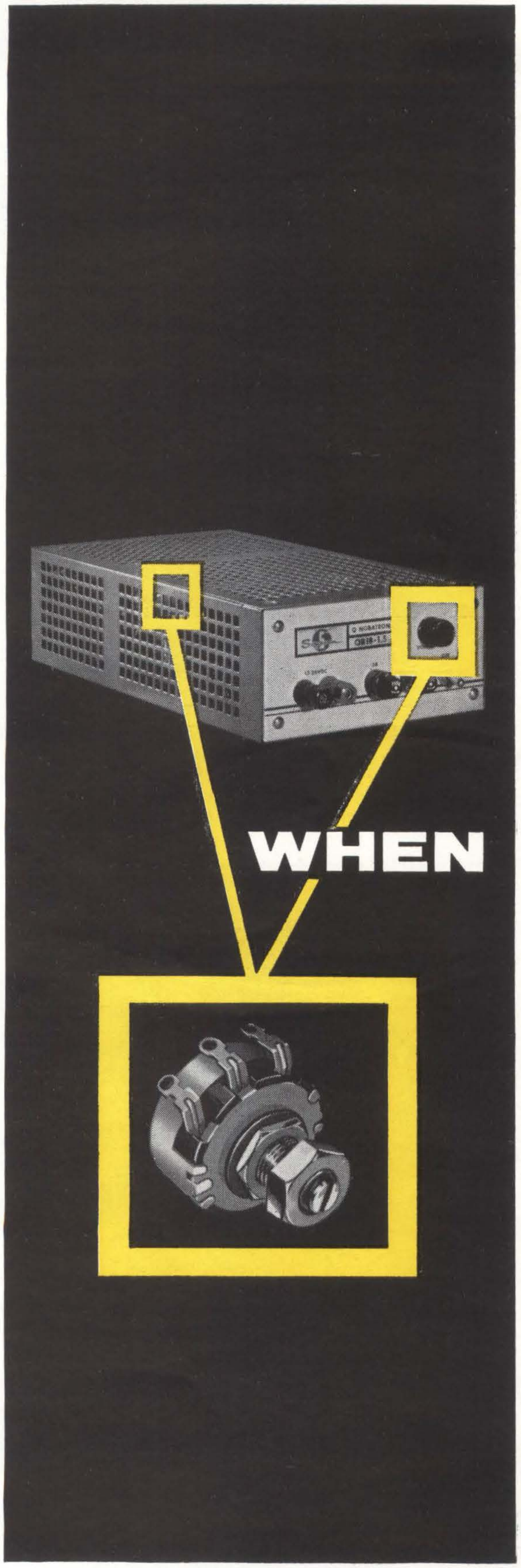
You'll discover for yourself why Motorola high-frequency germanium mesa transistors were chosen to meet the highest reliability level of any transistor used in the critical Minuteman missile program . . . and are currently specified in applications demanding the most stringent reliability and performance requirements to date.

Compare it with others . . .
THE REAL DIFFERENCE IS INSIDE!

MOTOROLA
Semiconductor Products Inc.
A SUBSIDIARY OF MOTOROLA INC.

5005 EAST McDOWELL ROAD · PHOENIX 8, ARIZONA





WHEN GREAT NAMES GET TOGETHER...

. . . something good is bound to happen . . . like the introduction of Sorensen's QB Series transistorized low-voltage dc power supplies.

This great-name firm wanted to deliver the best. They used the best: Clarostat Series 43 2-watt wire-wound potentiometers.

Clarostat Series 43 pot was a natural selection. Long a favorite of industrial equipment manufacturers, the Series 43 offers a wide variety of mounts, terminals and shaft configurations. Available in resistance tolerances of ± 10% or closer from 1 to 50K ohms, the Series 43 is designed to do its job . . . and then some! It is an obvious choice of great-name manufacturers who **will not compromise with quality.**

Sorensen, a unit of Raytheon Company, wanted — and got — the finest . . . Clarostat. If you're a great name (or would like to be one) contact Clarostat . . . today.

CLAROSTAT

CLAROSTAT MFG. CO., INC. DOVER, NEW HAMPSHIRE

ELECTRONICS MARKETS 1963

WHAT THE FUTURE HOLDS

By LEON H. DULBERGER Associate Editor • BEN ANELLO Mgr., Market Service Dept.

REPRINTS AVAILABLE
SEE READER SERVICE CARD

IN A NUTSHELL: • Industrial products lead profit parade. Data communications and reduction, industrial controls and computers show strength • More color-television programming boosts consumer interest in sets • Key points in military buying: big command and control systems, equipment for limited war • Microminiature techniques sweep into components industry • Foreign competition grows, so do opportunities for sales abroad

ELECTRONICS MARKETS 1963

INTRODUCTION

THE FUTURE HOLDS CONTINUED GROWTH for all segments of the electronics industry, on an increasingly selective basis. The combined impetus of space exploration, industrial needs, increasing military preparedness and consumer product demand, will produce increasing sales. International markets and competition are growing factors in electronics. Government contracts are being awarded with care, and overcapacity is besetting some segments of the industry, notably components.

INDUSTRIAL ELECTRONICS APPLICATIONS are burgeoning in industrial control, data processing and data communication. Jobs once done mechanically are now done increasingly with electronics. Test, measurement and control instruments are being used in new industries. High-volume communications systems are multiplying. Ultrasonics, cryogenics, lasers and teaching machines are opening new markets. New navigation systems for aircraft and ships are under development.

SPACE RESEARCH is creating markets for ground tracking gear, telemetering systems, guidance and checkout equipment. Research to achieve space goals is creating a host of new components and technologies that find use on earth too.

MILITARY SPENDING is aimed at increasing limited-war capability, creating command and control systems for hardened missile sites and portable operations. More communications facilities are a must, and procurement for missiles, surveillance equipment, tactical aircraft and phased-array radar is increasing. Antimissile and antisubmarine research is continuing, and reliability and electromagnetic compatability of equipment is receiving greater attention.

Air-traffic-control spending is up, and nuclear reactor control and instrumentation devices are selling faster.

CONSUMER ELECTRONICS is receiving a boost with increased demand for color television, and more firms building color tubes and sets. Stereo f-m is growing, as well as high-fidelity sales. All-channel tv—providing vhf and uhf coverage—will improve future b&w receiver sales.

COMPONENTS are phasing into microminiature production techniques, with military R&D leading the way. Integrated circuits, thin films and molecular electronics are receiving attention. Transistor unit sales are up, and military and industrial uses of vacuum tubes continue level. The military is trending toward greater use of transistors, and planning more microelectronic circuits in future projects. Overcapacity in the component industry is causing some concern.

INTERNATIONAL SALES by American electronic firms to all parts of the world is rising; but foreign competition is viewed as an increasing problem by many U. S. firms. Imports of consumer electronic products, from Japan and other countries remains high. Exports of U. S. industrial and military equipment will go up, especially, computer and data processing systems.

MORE EFFICIENT MANAGEMENT of electronic firms, particularly those dealing with the military, must evolve in the next seven years. Because of growing competition, profit margins are shrinking in government contracts. It will be the job of management to cut costs, to realize a full allowable profit. Observers believe that profits in the future can actually be higher than in the past.

ELECTRONIC TELEPHONE EXCHANGE (inset), developed by Automatic Electric Co., a subsidiary of GT&E, is compatible with electromechanical switching equipment. Magnetic switches in hermetically sealed capsules (above) are used in switching matrix

PRECISION D-C and A-C VOLTAGES are generated by Ballantine Laboratories calibrator (left) shown providing stable reference standard in oscilloscope calibration. Standards instruments and devices represent a maturing market

INDUSTRIAL PRODUCTS

TEST INSTRUMENTS—Sales of test instruments for measuring electrical parameters are burgeoning. The market for instruments for industrial and scientific use is also growing rapidly.

The cornerstone for achieving market penetration is designing increased measurement precision, accuracy and repeatability into new instruments. Contemporary instrumentation and system requirements, for both industry and the military, demand better measurement performance than previously acknowledged. Frequency heads the list of parameters that must be measured more accurately. In industrial and scientific instruments temperature and pressure measurements are desired with improved precision and repeatability.

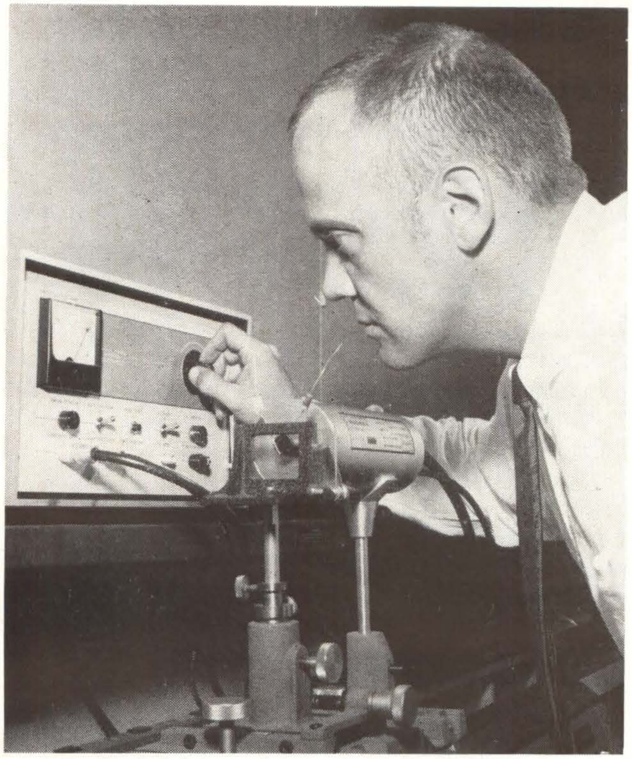
TEST STANDARDS—A new and active market is developing for instruments and components designed to perform calibration checks to maintain the increased accuracies of new measuring instruments. While still only a fraction of the dollar volume of the test instrument business itself, test standards show promise of being a profitable area for new sales efforts.

These test standards range from accurately measured capacitors and inductors to accurate frequency and voltage-generating devices.

Standards labs are springing up across the U. S., contracting to maintain the accuracy of a plant's entire complement of test equipment. These firms perform periodic checks and recalibration of instruments, based on historical knowledge of when to service each instrument. A standards lab may earn several hundred thousand dollars a year from a single account.

Digital readout for instruments is enjoying rising popularity. Advantages cited include greater facility of use by semitechnical personnel, nonambiguous display; and in printed readout devices, records of each reading.

Among the digital readout methods, the largest number of instruments employ numerical glow tubes, followed by electromechanical devices, and electroluminescent (solid-state) devices. There is rising interest in



LASER WELDING promises to be one of the most fruitful applications of this new device. A Hughes Aircraft Company scientist prepares to fire a forced-air-cooled, ruby laser in a welding experiment

LORAN NAVIGATION equipment is favored by maritime operators. Position coordinates of ship at sea are obtained by officer using Sperry Gyroscope Co. receiver and world-wide loran network. Commercial loran C receivers are predicted

MOST PROFITABLE

electroluminescent digital readout and General Telephone and Electronics Laboratories Inc. predicts extensive instrument applications of el devices during the coming year.

While several transistor operated test instruments have appeared during the last few years, general opinion seems to reflect moderate enthusiasm for such instruments unless portable operation, small size and low primary power drain are important requirements. Vacuum tubes lend themselves directly to the solution of most instrument design problems without specialized design techniques and environmental qualifications demanded by transistors—some instrument designers declare.

One of the greatest opportunities for profitable introduction of a new instrument line lies in industrial and scientific instruments. An example is the nuclear scintillation counter. It may be used to measure energy level of a radiation tracer introduced into a material for evaluation of wear; as in tire studies. The instrument uses electronics for its operation, but measures a non-electronic variable.

MEDICAL ELECTRONICS—The big money maker in medical electronics is still x-ray equipment, both for diagnostic and therapeutic applications.

The growth of other aspects of the medical electronics market is healthy, but industry observers no longer speak of immediate spectacular sales gains. Attempts to achieve volume markets for patient monitoring systems still await acceptance by medical leaders, and further R & D. One industry spokesman points out that psychological resistance by patients, already sick and often old, against being instrumented physically with necessary sensors, is a problem. Also, the varying sizes of human organs require that sensors be developed to comfortably fit all variations encountered.

The possibility of using remote pickup techniques, such as infrared devices to measure a patient's temperature, remote sonic systems for breathing rate, or mattress sensors, have been suggested as a promising avenue of research.

The concept of instrumenting a patient while he is being operated on, and the information obtained is vastly important, has the charm that the patient is not conscious and objecting to this instrumentation. Equipment for this use is expected to find great application.

Computer analysis of electrical recordings of heart and brain-wave patterns as well as x-ray negatives, will come into greater use in the future.

Remote diagnosis based on such records will be done by computer analysis at medical centers, and may in time lead to development of a medical tape history of all children from birth, which will be kept up to date and referred to when illness develops. This is a long way off, however.

A small market will develop for specialized medical electronic devices, for both diagnostic and therapeutic tasks. One possibility is equipment to take an infrared profile of the human body as a means of detecting tumors, which would show up as a hot spot. More use of fiber optic devices to allow inspection through body openings is expected. Ultrasonics for therapeutic use is receiving more attention, and lasers for eye surgery will become more common.

Remote manipulators for x-ray systems will see wider application, as a means of reducing radiation hazards to medical personnel, in many new medical x-ray installations. Also, much work is being done on faster x-ray films, for greater safety and picture definition.

Electronic industry experts believe that marketing men must consult with medical experts in the field before developing instruments for them. It has been cited that the electronic stethescope does not serve a real need, as doctors do not use the traditional acoustic type to gain acoustic sensitivity. Rather it is an esthetically more acceptable technique to their patients than the ear-to-the-chest-method, and prevents the spread of disease. Thus, electronic stethescopes serve no real need, many doctors claim, and therefore have not found major acceptance.

INDUSTRIAL CONTROL—Applications of industrial control electronics are expanding rapidly, and this field represents one of the brightest areas for profitable growth in the entire industry.

Telemetering and control systems for oil and gas pipelines are still being perfected, though there are several installations, and growth is expected at an increasing rate.

Numerical control for machine tools is receiving greater attention, and those aspects of industrial control generally thought of as automation are becoming more prevelant.

However, firms using industrial control systems are becoming more realistic about their purchasing standards. There is no longer a desire to prefer electronic solutions to problems, rather than mechanical or electromechanical ones, unless the electronic equipment does the job better. Reliability of systems must be demonstrated in advance, and some observers feel this places companies with a healthy history of performance in industrial electronic control in the best position for future business.

Buyers insist that a firm be able to get behind the systems they sell, and maintain them efficiently.

Several industrial experts agree that automation and industrial control techniques have often been applied, in the past, where a human might have actually done the job more efficiently, or at lower cost. This has led to a more careful look at the jobs within plants, and a tendency to employ controls selectively, without going overboard. It is predicted that in the long run, this will engender greater use of electronics, and cause increased acceptance among those still enamoured of using mechanical or pneumatic techniques to do the job; because automation projects using electronics will have established a record of success.

However, when a man can do the job best, planners will be more receptive to his use over any kind of control system. This will not retard the growth of industrial controls, rather assure that they will be applied where they are really needed.

DATA PROCESSING—Strong growth is predicted in the data processing field, including greater use of data communications. It is expected that major emphasis will be on information storage and retrieval, with a variety of new methods offered for storage of bulk material.

Most observers feel that data processing represents one of the best areas of profitable operations in electronics, for those firms with the requisite experience. A drop out is believed to be probable for some firms now engaged in marginal operations in this field. One type of marginal operation might be the attempt to sell to industry designs originally conceived and marketed to the military, such as a special-purpose computer, unsuited for industrial applications without extensive redesign. Often the firm promoting such a product lacks the large engineering staff required for redesign.

Oversell in data processing systems, has given rise to the phrase "garbage-in, garbage-out" to denote the cases where extensive data-reduction systems have been bought by industry (and the military) to do jobs that might better be handled with simpler manual operations. A greater sophistication in selection of data processing in the future is certain, with the customer demanding solid experience and the ability of the manufacturer to recommend optimum equipment for a job.

DIGITAL COMMUNICATIONS—Most electronics planners feel that one of the strongest areas of future growth lies in the digital communications field. One estimate places the number of business data machines of all types now transmitting over circuits at 6,000; with over ten times that number expected in similar service in four years.

Data communications may well be the largest single market in the 1960's.

COMPUTERS—Increased use of thin-film memories, and new and higher speed ferrite memories will be employed in new computers. For high-density applications, techniques such as thermoplastic recording will receive attention.

Computer applications abound, many of them linked with industrial process-control.

Several banks have installed on-line computers to handle savings accounts. Important advantages to the customer include being able to deposit or withdraw at any branch of the bank. Waiting time at a teller's window has been cut to a minimum, and the customer can go to any teller, instead of having to go to a certain group of windows. Advantages to the bank include time saved in balancing cash at the end of the banking day.

COMMUNICATIONS—Both radio and wire communications will continue to grow in volume throughout the world. The desire to achieve practical satellite communications will see increased effort by major firms and the government to produce high-volume, 24-hour-a-day, systems.

Right now some 500 circuits are available to carry voice by cable or high-frequency radio from the U. S. to overseas points.

By 1970, General Telephone and Electronics Corp. estimates, 3,000 circuits will be needed to satisfy the demands of voice, data, and image traffic, not including international television.

Data communications will be one of the fastest growing areas of the electronics industry. It will be a common thing for computers and other business machines to "talk to each other."

Millimeter wavelengths will see development exploiting untouched areas of the radio spectrum and handling specialized applications such as plasma sheath penetration in space operations.

Microwave communications will expand, with foreign markets opening rapidly for systems operating in this frequency range.

Optical communications techniques will see active research and systems development, with the great bandwidth capabilities of this medium attracting planners with high information density requirements. Among others, General Electric is exploring this field, with a closed-loop optical television link possessing a five-mile range.

ULTRASONICS—The applications of ultrasonic techniques in industry are expanding rapidly, and assure specialists in this field an excellent market.

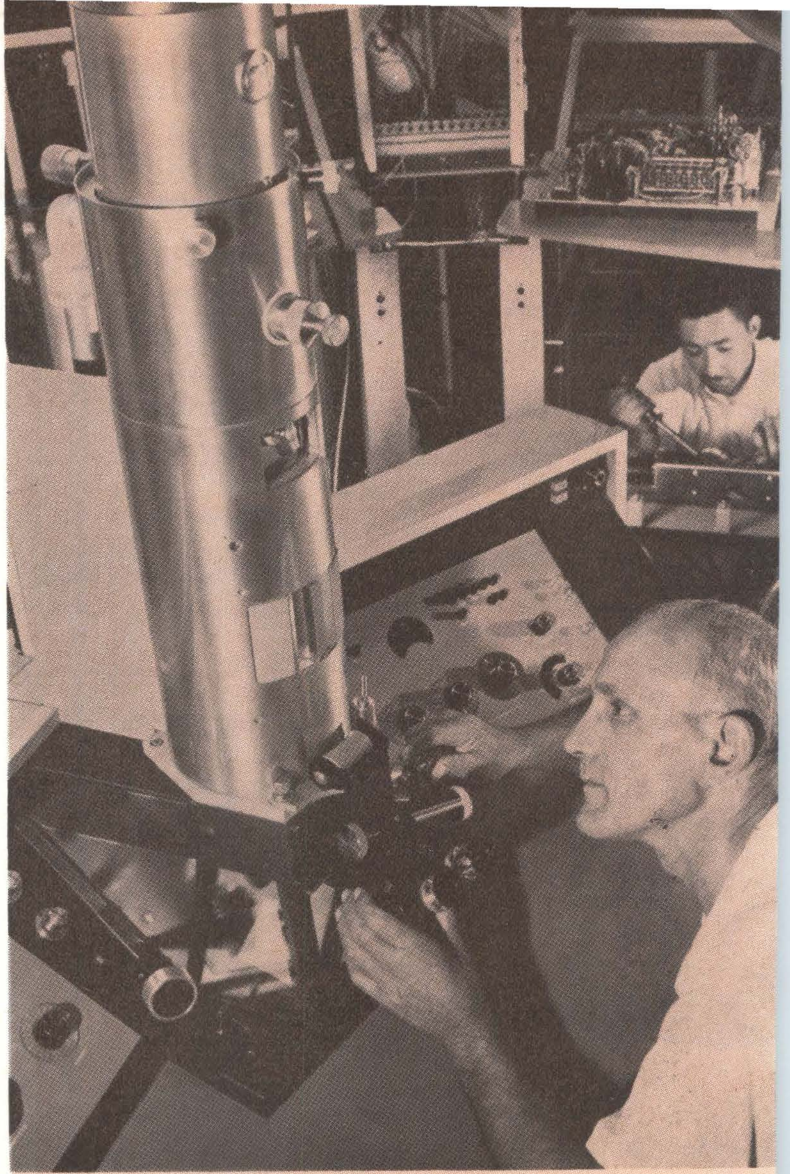
New research is being carried out in various techniques from microdeburring of microminiature components to control of solid rocket propellant burning rates. In the electronics industry itself, ultrasonic cleaning is now firmly entrenched, according to R. L. Jeffery, president of National Ultrasonic Corp. He explains that white-room concepts now prevail in the industry, and final cleaning of components, subassemblies and micromodules by ultrasonics, is prevalent.

Jeffery indicates that cold welding using ultrasonics is of growing importance to avoid damage to sensitive components, and that ultrasonic plating to achieve a fine deposition of precious metals, and also for printed circuit work, is getting attention. Ultrasonic removal of dust, dirt and oxides from magnetic tape helps to eliminate much of the costly information "drop out" problem.

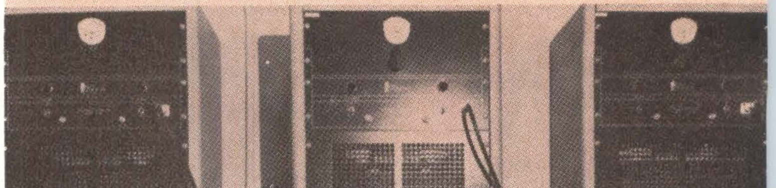
Liquid-level sensing; thickness testing; drilling of easily damaged parts; defoaming in liquid flow or filling operations; drying of granulated, porous or fibrous materials; are other areas of research or growing application.

Ultrasonics is finding application in counting of objects, such as automobiles entering or leaving parking lots, where nonambiguous counting is a must. Medical use of ultrasonics is also growing.

OCEANOGRAPHY—The present interest in oceanographic research by physical scientists and antisubmarine warfare researchers will produce a fallout of techniques



ELECTRON MICROSCOPE under final assembly at RCA. The instrument is widely used in medical and scientific research. It employs 50 vacuum tubes, allows photographing objects one million times thinner than a human hair.



ULTRASONIC CLEANING equipment installed in white room, shown in use on missile components. These 500-watt generators by National Ultrasonic Corp. drive barium-titanate transducers at Martin-Marrieta Corp. installation and equipment designs that will spark strong industrial activity undersea.

We are engaged in a general age of ocean explorations, leading to an understanding of this environment; and finally to increased commercial operations in the medium, using electronics. Right now, some $15 million is spent each year in commercial electronic oceanography.

The studies now being conducted of ocean currents and the development of instruments to measure them, will find use in ship salvage operations. There are many wrecks on the ocean bottom, containing still valuable cargo.

Salvage operations will be effected in the future with the help of undersea handling equipment, positioned with sonar and optical sensors, including tv.

Exploitation of undersea mineral and food supplies in the future will lead to a mining and perhaps farming industry carried on beneath the surface. A general knowledge of the character of the ocean, gained with the aid of oceanographic instruments will increase yield, a spokesman for Loral Electronics Corp., states.

Loral expects that their line of undersea one and two man craft, heavily instrumented with electronic sensors, will find application in this field.

Underwater equipment maintenance of offshore oil rigs and dock facilities will foster development of salinity and corrosion measuring instruments.

The growing problem of nuclear waste disposal will require development of oceanographic techniques, using electronic devices, to monitor ocean currents and radioactive leakage.

ANALOG COMPUTER in use to simulate a complete metal rolling metal in the mill, drives, regulators and control system on large

NAVIGATION SYSTEMS—Commercial application of navigation systems will probably see its largest increase in airborne systems. Jim McSweeny of Sperry Gyroscope Co. predicts development of inertial navigation systems for use by commercial airlines in time to meet the requirements of supersonic airliners now being developed. This may occur by 1968. He points out that inertial navigation with its inherent high accuracy will be needed to obtain maximum utilization of airspace. It will give instantaneous readout of position, important at speeds in excess of Mach one.

These systems will use an inertial platform, gyros, accelerometers and computers. They will obviate the need to shoot the stars and make radio contact to get a d-f fix. No ground-support equipment is required for an inertial navigation system. About two to three more years of military experience with such systems is required to allow development of a suitably inexpensive equipment for commercial use to begin.

Maritime use of inertial navigation systems is not apt to come about, Mr. McSweeny believes, as shipping firms do not have the time saving requirement faced in the air. Instead, loran coverage of shipping lanes will increase, and commercial loran C receivers will be developed. These receivers will read out directly in latitude and longitude, but must be inexpensive to find acceptance.

NASA is talking about a commercial navigation satellite of lower accuracy than Transit for use by both aircraft and ships. However the price of a receiver for use with such a satellite may prove to be too high for commercial use.

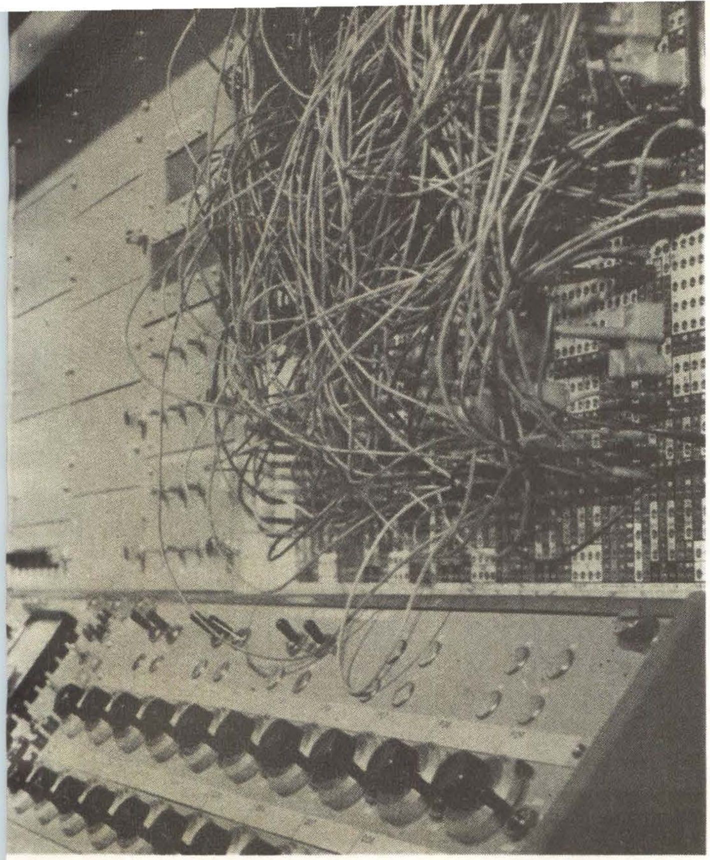
An upsurge of radar applications for harbor control seems certain, to avoid the present high accident rate normally associated with operations in ports. A ship identification system, similar in concept to iff, but much simpler will be used as part of increased collision avoidance operations in harbor control.

Land navigation systems are apt to prove expensive, and find no civilian market demand, Mr. McSweeny feels. The military has a land navigation requirement for tank and troop carrier operations beyond established roads. Such systems cost $40 to $50 thousand dollars each, which prohibits civilian land vehicle use.

TEACHING MACHINES—A spokesman for Loral Electronics Corp. predicts a steady growth for the teaching-machine industry, but cautions that only a small portion of the actual material and equipment sold is electronic. One estimate of the total market's size by 1967 is $100 million including softgoods, with about $20 million worth of electronics tucked inside that figure. Much of the development required before teaching machines become prevalent as a technique, is the development of good programming material, which is a slow job. In the strictest sense, a programmed textbook with a graphite pencil scoring system is a teaching machine. In a more sophisticated system, employing programming logic, switching and relay equipment, slide display and perhaps audio devices, the entire aid may cost $1,200, exclusive of the programming softgoods.

The student is taught a bit at a time, and his knowledge reinforced by questions and exercises programmed according to his grasp of the subject.

An outstanding advantage of teaching machines is that they enable a single exceptional instructor to reach many



process. General Electric personnel simulate the rolling mill, scale computer

students. Certain subjects lend themselves naturally to audio teaching machine systems, such as the study of language. Experts feel, however, that any subject at all may be taught better with a teaching machine than by the conventional personal student-instructor relationship.

Acceptance by educators is expected to be slow, and some observers feel that this relatively new concept will be best advanced by introducing it into teaching schools, to provide new teachers with knowledge of its potential. It is recommended by market planners that electronics firms team up with publishing companies to be in the best position to profit from a teaching-machine venture.

LASERS—Among the markets receiving major attention by industry planners, and much research and development effort, are lasers. With the recent introduction of a class of gallium-arsenide diode lasers, which require only d-c pulses as a pumping source, the future form of this research effort may be altered.

The diode laser pumped by d-c, is a much simpler device to instrument, than a light-pumped solid-state laser, or a light or r-f pumped gas laser. It should also prove easier to modulate.

LASER WELDING AND CUTTING—Informed observers feel that it is in the area of welding and cutting metal that the laser will find its widest and most profitable industrial application.

Welding with the laser does not require a vacuum chamber for carrying out the operation as an electron-beam welder does. Many firms are actively researching these applications, including Hughes Aircraft Company. This firm expects to see metal welding, cutting and melting techniques revolutionize metal processing within five years. Most laser experts agree that this is possible.

COMMUNICATIONS—Communications between cities, using laser transmitters and receivers, in a form that will compete with microwave and wire facilities is in the future. However, it has been pointed out by many long-term planners, that until there is a direct traffic need for such installations, they will not come into being. They are microwave and wire links that now serve the nation's needs, and until these become written off as investments, or outmoded in information-handling capacity, they will be kept in service. But wide bandwidth of laser communication systems, and advances in modulation techniques by many researchers, probably mean tests with complete experimental systems will take place during the next few years.

SENSORY ELECTRONICS—Future developments will allow eventual electronic duplication of all five of the human senses with great facility. This includes work in visual (character recognition) and audio (speech recognition) techniques, which are moving ahead rapidly.

Industry observers predict that a practical voice-operated typewriter could result from this research in the near future. However, a machine that can handle the entire vocabulary used in business correspondence may need a decade of development, other critics feel. Ability to process speech in different languages, and extensive use of electronic translating machines, is also in the future.

Character recognition has received great impetus in systems designed to process bank forms; with rapid gains expected in other character-reading systems, such as devices to read books to the blind.

CRYOGENICS—Experimental use of cryogenic materials will find employment in new areas ranging from computers to particle accelerators. Devices such as lasers promise to bring cryogenic techniques out of the laboratory and into use for field application. However, this view is held by only an optimistic portion of industry observers.

Most feel that cryogenics directly applied to the electronics industry's field operations, will not achieve a volume dollar level sufficient to qualify it as an important market. They cite activity in many laboratory applications, but point out that field-operated or airborne systems pose problems not readily solved. These include reliability considerations encountered with the relatively unstable techniques, even in computer memories.

However, the use of liquified gases in space shoots, steel processing, food storage, and similar industries should cause a sharp increase in cryogenic applications.

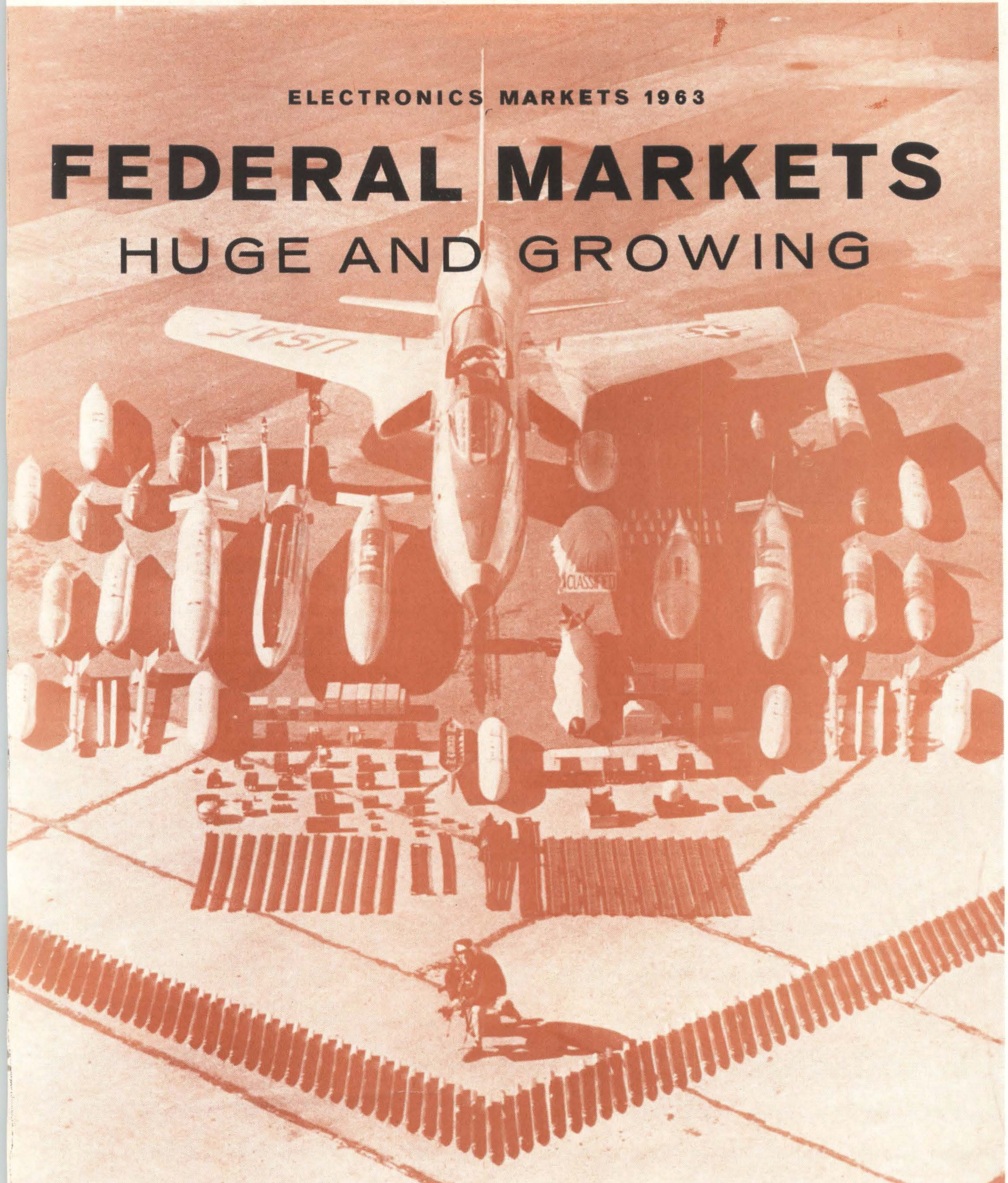
AUTOMOTIVE—The development of transistor ignition systems is receiving much attention, and some predict a large market for this field when customer demand will allow the inclusion of these systems in most new vehicles.

City traffic control electronics is experiencing an upsurge, with New York City alone planning a $10 million dollar project to install computer regulated signal light systems, throughout the metropolis.

ELECTRONICS MARKETS 1963

FEDERAL MARKETS

HUGE AND GROWING



FIGHTER-BOMBER F-105D built by Republic Aviation Corp., with armament display. Mach-2-plus aircraft uses Sidewinder air-to-air and Bullpup air-to-ground missiles. Electronic content in dollars of missiles is 65 percent

TRACKING ANTENNA designed for Air Force by Radiation, Inc., with receiving bandwidth of 100-2,300 Mc, is part of a $1.5-million contract. Antenna systems will be installed at both the Atlantic and Pacific missile ranges

TRANSMITTER-RECEIVER undergoing field tests by U. S. Army. Built to provide dependable 300-mile range, the Sylvania Electric Products set has 10-watt power output, can be strapped to infantryman's back

THE FEDERAL GOVERNMENT is responsible for the overwhelming share of sales in the electronics market. Federal expenditures in space and military electronics continues to rise, as it has for the last several years.

An increasing portion of sales to these markets is essentially research and development—rather than production—contracts. What is being sold is essentially a service. It demands demonstrated ability to conceive and carry out ideas, against the older standard of performing on tangible criteria, as in hardware production.

MARKETING ABILITIES—A company selling to this market requires strong technical competence within its marketing staff to sell the firm's R&D capability. Scientific, engineering and management components of a company must be of high caliber. And some private investment in company facilities is required to be able to perform on these R&D contracts adequately.

OVERCAPACITY SCORED—Profit margins on government contracting are shrinking, due partly to overcapacity, and thus fierce competition, within the electronics industry. Firms often bid for research, development or production contracts knowing that a reasonable profit is not possible at their bid price. Reasons for this bid pattern are varied, including a desire to maintain volume operations, gain government confidence, retain a full technical staff, and desire to obtain additional experience in a given area. The result has been to force strongly competitive bidding by electronics manufacturers.

NATURE OF CONTRACTS—Sales to the government are facing more penetrating scrutiny by federal officials. Government middle and high-level planners and military personnel in decision making positions are highly trained, more intelligent, and display greater ability than in the past.

Contractors dealing with the federal government will be selling equipment and services to astute persons who demand proof of a project's worth on a high technical level, before a contract is let.

There will be a trend to larger, but fewer, prime contracts in the future. Examples are Apollo, Minuteman, Polaris and the "L" systems. It is expected that the marketing efforts of many firms will shift away from military and NASA procurement agencies and move toward the larger potential prime contractors.

MILITARY SALES—Any attempt to forecast the military electronics market must allow for constantly varying geopolitical conditions throughout the world. Ultimately our nation's defense posture, and thus military electronics appropriations, are determined by geopolitical factors. An enemy's actions and goals in a hot or cold war, and the battlefronts selected or forced upon us, produce overriding determinants.

Several strong market demands have been stated by military observers to be evident. These include: electronic equipment for limited-warfare; command and control systems for the three services and the government itself; development of military space capability; surveillance equipment of varied nature; research systems to provide antimissile and antisubmarine capabilities.

Military marketing experts place the future command

AMBIENT LIGHT SURVEILLANCE system for Army allows tv camera to view tank in the dark. Image intensifier at pick up requires only starlight, moonlight and skyglow

and control market in the front rank for sales through 1970.

MILITARY BUSINESS CLIMATE—Next year's Department of Defense (fiscal 1963) RDT&E budget is expected to equal that of last year's. For the following fiscal year, 1964, it may go down a slight amount. This is due to the phasing out of large systems now reaching the end of their construction phase; and the beginning research on new projects.

FORM OF CONTRACTS—Much of today's military contracting is in research, development, test, evaluation, and to a lesser extent, operations and maintenance. The nature of modern warfare has shifted procurement quantities of electronic systems from thousands or hundreds; to tens, or even one of a kind, in weapons or support systems.

EFFECTS OF CUBAN CRISES—The Cuban situation has focused sudden interest on the needs of military service leaders requesting more limited and general war capability for U. S. fighting forces. Not yet resolved are requests that would boost the budgets of all three services. The Army wants more close support aircraft and antimissile capability. Navy desires increased attention on ASW developments; and fast surface craft for support operations. Air Force seeks more missiles and aircraft, greater emphasis on the RS-70, and a beef up of their air reconnaissance ability; proven so important for detecting offensive weapons build up by the overfly and oblique photos of Cuba.

Estimates run to as high as an extra $4.5 billion on top of the present $48 billion defense budget for fiscal 1963 and 1964. Some feel $2 billion is more likely.

COMMAND AND CONTROL—The front-running military market through 1970, will be command-and-control systems. They impose severe technical demands on the electronics industry. The most capable scientific, engineering and management minds will be enlisted to meet the challenge. Solutions will employ computers, data reduction, communications, and display techniques.

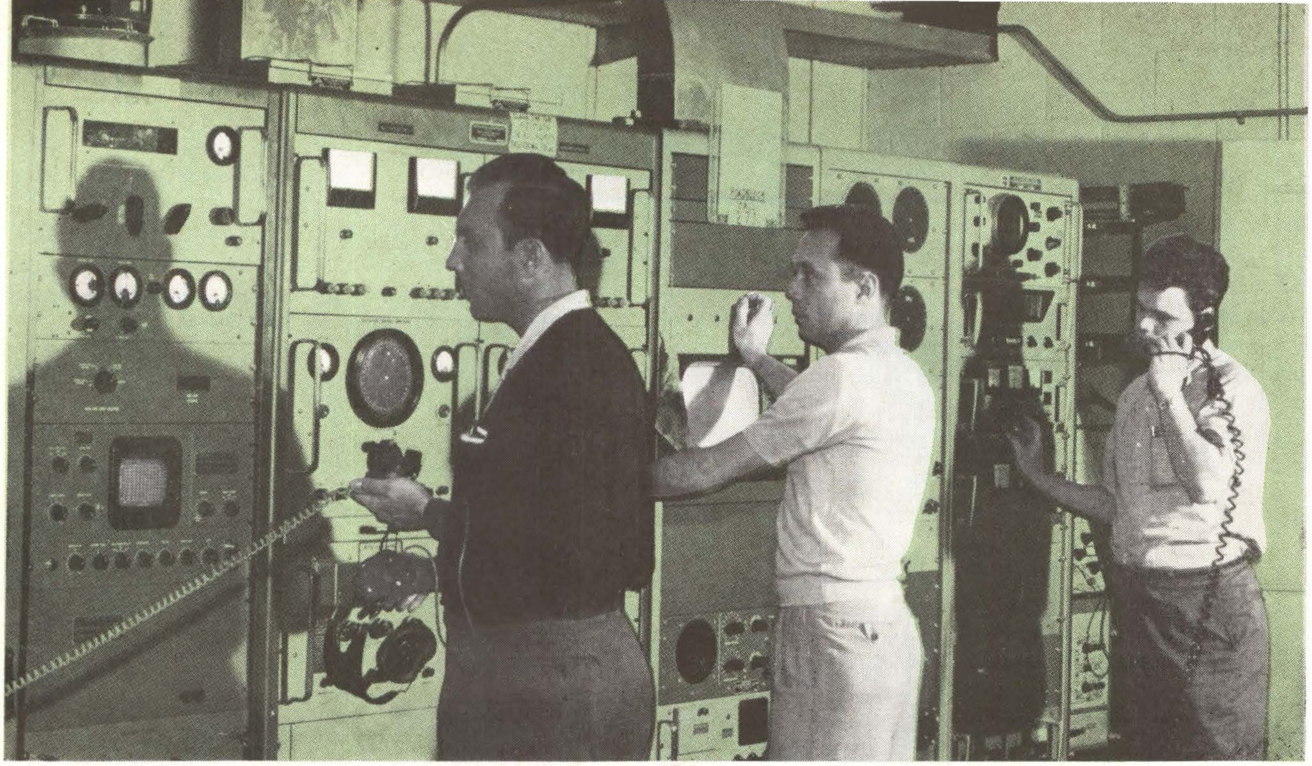
Command and control for military use includes input sensors such as surveillance radar, communications nets using tropospheric and ionospheric scatter equipment, and digital-computer data-processing equipment. Also required are display techniques, including digital and analog readout systems.

Reliable and fast command and control between government and national military command centers is needed to allow international and local control of aircraft dispatch, submarine direction, and missile-launch commands. Portable command and control systems are needed for tactical operations in all three services by local commanders.

An important problem is command of the huge retaliatory missile force this country is building up. Command ability is required to order strikes from hardened and soft sites, as well as roving launchers, such as Polaris submarines. The command and control systems must be hardened, technically fool proof, spook proof (impervious to sabotage), and fast acting.

The systems must be designed with ability to determine by radar and computers within brief moments which retaliatory missiles would be hit first in an attack so that these may be fired first. Such systems demand a high order of sophistication in information handling, using extensive electronics.

LIMITED WARFARE—Activity in electronics for lim-



TRACKING WEATHER SATELLITE at receiving station operated by NASA. Tiros satellite may be tracked when within 1,500 miles of antennas operated by console equipment

ited warfare will be high during the coming years. It has recently received much greater priority by the DOD.

The procurement picture for walkie-talkies, surveillance equipment such as ir devices, and also equipment modification contracts, is on the upswing. This last includes such projects as conversion of radar equipment from fixed to rapid tuning, to achieve anti-jamming capability.

According to Sylvania Electronic Systems, a unit of GT & E, limited warfare electronic sales will burgeon as equipment bought in the early 1960's and built with standard electronic techniques is gradually replaced with equipment using microelectronics, by 1970.

Engineering talent and industrial efforts applied to the design of limited-war electronics has not always been of the highest order, the government says. The DOD points out that an important market awaits electronics firms catering to limited-war needs. Suggested as an example; a firm developing an efficient, tiny, hand-held radar for battlefield use, by independent research or government contract; would find themselves in a position to cash in on a high volume procurement market.

One industry expert notes that the limited-warfare market is the most talked about and the least performed on in the field of electronics. He feels however, that it is with good reason, for the best scientific management and engineering minds, as well as most of the money, is required for development of strategic weapons systems such as command and control of retaliatory forces.

COMMUNICATIONS—During the last year, Department of Defense expenditures for communications rose, at the expense of radar procurement. Within the broad category of military communications lies the greatest single area of future electronics expenditures. This is a market trend that is unassailable. Military communications are an integral part of command and control, and are discussed elsewhere in that context.

There is a firm trend toward increasing use of single sideband for military communications. Jonas Shapiro, vice president of communications engineering at Manson Laboratories, Inc., a subsidiary of Hallicrafters, Co., underlines this, and says it will replace standard techniques in the next ten years as traffic density increases. Single sideband will also move up into uhf communications.

RADAR—Many military electronics observers feel that phased-array radar will be an increasingly important part of the future radar market. They hold that search and tracking functions can be easily combined using this technique. Wherever movement of a physically large antenna would be required, phased-array radar offers advantages.

However, government planners doubt that phased-array radar will ever achieve the statute of a large market. Instead they expect a year of peak sales in the future with completion of projects now planned, but do not feel it will represent a constant high sales area.

Radar is much in demand for varied surveillance tasks, including satellite tracking and antimissile defense activities. Actually, system radar is an input sensor for modern command-and-control systems, and is increasingly discussed in that context by planners.

MILITARY SPACE APPLICATIONS—One of the first big military space applications will be development of communication systems using space satellites. It represents one of the real needs of the military. This capability is certain to be achieved as part of the military command-and-control network now being developed.

OTHER SATELLITES—Air Force purchases of satellites similar to Midas early warning units which detect ICBM infrared radiation, and Samos reconnaissance satellites, will achieve volume proportions in the future. Emphasis will be on reliability, as space replacement is an expensive chore. Estimated rate of failure techniques will be used to determine replacement time of equipment orbiting in space.

Bambi, a space-based system for boost-phase intercept of enemy missiles will receive attention, but will probably be preceded by a ground-based intercept system first.

Weather satellites are a needed military facility, and will see increased attention. Navigation satellites for use by aircraft, ships, and perhaps land vehicles are receiving research and development attention. This work will lead to operational systems.

ADDITIONAL SPACE MISSIONS—However, beyond this point, space operations for the military are not firmed up. The DOD believes that it must first be made clear what is needed in space for the military. They ask what advantages there are in military space operational ability, what the nature of the threat they will be called on to counter really is; and feel that it is not clear at this time.

Certainly knocking down each others surveillance satellites will be in order, but what else? The day when dogfights in space are a reality, seems a long way off.

NASA AND MILITARY—The trade off of information and research activities between the Department of Defense and NASA is extensive. Some DOD laboratories are used by NASA regularly in their work; and the Air Force mans many of the space tracking stations that NASA uses in scientific shoots.

There is close liaison between administrators of DOD and NASA, at all levels.

AIR FORCE'S VIEW—The Air Force feels a vested interest in space, and while it accepts the fact that cooperation between themselves and NASA is a real and useful operation, look beyond the present to develop their own view of the military role in space.

Air Force holds that this is a reasonable strategic anticipation of the direction the arms race will take, and they want to be ready for it in advance.

ADDITIONAL FUNDS—The Air Force is asking for additional funds to develop space weapons, and to make rapid steps toward a manned maneuverable space craft. This craft would begin with R&D on the two-man Gemini capsule, and lead to a craft which can take off from earth. It would accomplish a mission in space such as neutralizing an enemy satellite or space craft, and return to earth; all under control of a space pilot.

In discussing beam-directed energy weapons which may some day be used in space, an Air Force official points out that such weapons could obsolete the ICBM. Fast acting weapons aboard an enemy maneuverable space craft could give them ability to pull the teeth out of our ICBM nuclear deterent. Only an equal space military ability would prevent an imbalance of power, he states.

The Air Force is currently investigating their antisatellite ability, by testing various existing missiles in an effort to produce a working missile system for this application, using missiles in existence.

ANTIMISSILE WEAPONS—Right now the nation is without an effective antimissile system in operation. The Nike-Zeus ground-to-air missile, not yet in production and with no firm plans to implement production, is the only demonstrated hardware we have. At best it is considered a half-way measure by military experts, though perhaps worth effecting in lieu of nothing.

Much attention and many dollars—the amounts classified—are now focused on radiation weapons as a possible means of defense against missiles. The Air Force and Navy are known to be exploring the possibility of such weapons carefully.

One possible type of radiation weapon would take advantage of the intense energy contained in a focused, high-power laser beam; or a bank of lasers operating in phase. It is known that metal can be vaporized at long distances in a vacuum, using these devices. Space laser operation provides vacuum operation, without the attenuating effects of the atmosphere. Additionally, high-power electron beams, artificial lightning, gamma and other energy beams are under consideration. But it is the laser, able to operate from infrared through ultraviolet (the last a recent development) that is the prime contender for the antimissile role, many technical persons hold. Others argue that even allowing for the ability to punch a hole in the skin of a nose cone, there is no assurance that effective damage to the warhead, or ability to explode it harmlessly, will be achieved.

MISSILES—Military procurement of missiles is continuing at a high level of interest with controversial effort on Air Force's Skybolt air-launched ballistic missile; Navy's third generation of the Polaris, and Minuteman. Guidance and control of an IRBM or an ICBM is roughly forty percent of total cost. Estimates of the electronic content of guided missiles are sixty-five percent for short-range missiles.

ANTISUBMARINE WARFARE—A sharp rise in antisubmarine warfare equipment procurement awaits a technical breakthrough. Traditional sonar techniques are now aided by magnetic anomaly detection methods, but both leave much to be desired. A submarine can still effectively hide beneath the surface if sea conditions are propitious, experts say.

Right now Navy buys sonar equipment, data processing gear, guidance and gun-laying electronics for attack weapons, magnetic-anomaly detectors; and spends heavily on R&D for new weapons.

Much research is being conducted on the ocean environment to facilitate prediction of sea state, bending of sound rays, other variables.

The sea is transparent, under most conditions, to sound. This accounts for continued applications of sonar to ASW. Sonar systems today are complex, include target discrimination equipment. However, temperature, pressure and other ocean variables cause bending and attenuation of sound. Submarines can hide beneath thermoclines caused by these anomalies. Dunk sonar, where a hydrophone is lowered by cable beneath the thermocline, helps to ferret them out. High-power sonar offers advantages, still suffers from range limitations.

Sensitive dunk sonar from ships and helicopters and magnetic anomaly readings from aircraft are used extensively.

The possible use of light undersea, perhaps from a laser; chemical evaluations of the sea, and other advanced concepts are being explored in hopes of achieving the desired breakthrough.

SPACE PROGRAM ACCENTED—This nation is committed to a vast space program to achieve uncontested leadership in the field. Markets are being created for a host of new electronic components and systems.

Since NASA's electronic facilities are greatly augmented by the use of military facilities and equipment, it is important to judge space activities as a joint civilian-military venture.

At present it is roughly true that 90 percent of NASA's money goes to industry; and 50 percent of this is spent for electronics. For unmanned space craft, some 70 percent of the cost is for electronics, not including the launch vehicle.

The electronic portion of a launch vehicle, in dollars, is estimated at 50 to 60 percent.

APOLLO PROGRAM—It is on the Apollo program to land men on the moon, that NASA will use the greatest amount of electronics out through 1967 to 1968. Selection of the lunar orbit rendezvous technique indicates areas where electronics will be applied.

The LOR (Lunar Orbit Rendezvous) program will carry three men into orbit around the moon, and land two on its surface. Finally, all three men will be returned to earth. A transfer craft will carry the two men from the command module in lunar orbit, to the moon's surface. Both space craft will employ rendezvous and docking radar systems, transponder systems and optical devices.

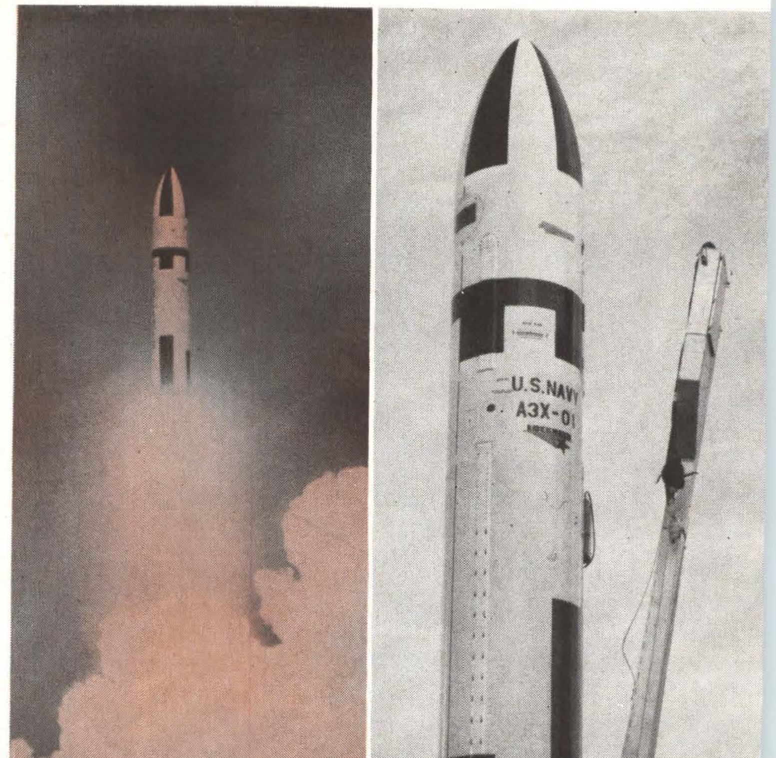
The entire project calls for communications gear, guidance control systems and scientific instrumentation for lunar investigations. Guidance techniques include space sextant, inertial guidance, and radio command from earth.

In addition to the man in space programs, which will account for the major electronic expenditures in the future, NASA is engaged in a wide range of other activities that employ electronics.

Communications satellite developments are being carried forward, with interest in both active and passive systems. Projects include Syncom 24-hour orbit narrow-band active system, being developed with DOD, and Relay wide-band active repeater satellites.

Meteorology research is continuing with Nimbus weather satellites using infrared scanners and tv cameras, with increased effort on the project slated for 1963. The eventual development of a global meteorological

HAWK GUIDED MISSILES on mobile loader which carries missiles to launching site. Army's Hawk is built under Raytheon Company prime contract, is designed for surface-to-air-use



NAVY'S POLARIS A-3 missile in test shot. Third-generation missile has 2,500 nautical mile range, is designed for launching from submerged submarine. Will be operational in 1964 weather system is predicted, employing these satellites. The U. S. Weather Bureau will fund the service through NASA.

COHERENT LIGHT IN SPACE—Coherent light techniques for communications appear promising for future space applications, NASA states. From 1967 and beyond, it is expected that these techniques will receive strong attention and refinement. The laser is a ready source of coherent light, but other devices may be developed by 1970 for generation of such light, it is suggested. Above about 35,000 feet there is no attenuation due to clouds. A microwave relay system might be employed to relay signals from earth to a point in space where optical communications would take over.

Radar-like systems, using lasers are being developed for space ranging and tracking tasks. RCA plans to develop a 10-megawatt laser radar, using a 20-inch diameter receiving antenna, for tracking of the S-66 satellite at an altitude of 600 miles.

ELECTRIC PROPULSION — Research into electric space propulsion techniques will receive greater funding in the future. These systems will be used for a variety of space missions during the period from 1967 to 1975.

Included are vernier corrections of satellite orbits and space vehicle trajectories, transportation of heavy payloads to planets within the solar system. Under study are various types of electric propulsion such as arc-jet, ion-jet and magnetohydrodynamic (MHD) jet.

TRACKING NETWORK UPDATED — The growing complexity of future spacecraft will lead to increased spending to update tracking facilities. More complex orbiting observatories require ability to handle larger amounts of data. Additional command and control equipment for satellites, as well as, data-reduction gear including analog and digital computers will be procured. New support equipment needed for the manned space flight program will be purchased.

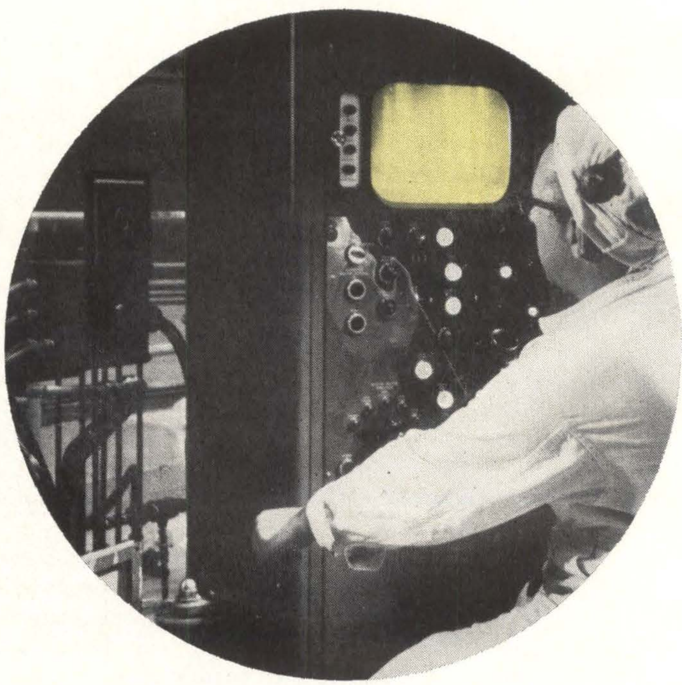
Masers are to be added to existing equipment, and automatic checkout gear to reduce flight preparation time is sought. Various standards equipment such as microwave and time standards will be installed; and to handle the increased flow of data between ground stations, additional communications including video systems are needed.

FLIGHT CONTROL—The Federal Aviation Agency will spent $1½ billion by 1975 to build an airspace control system to keep pace with the growing civil and military air traffic. The new National Airspace Utilization System will evolve from the $1-billion system we are now using. The major overhaul will occur in wide scale automation and new electronic displays. Aircraft position will be determined by ground radar—new long-range radar is needed—and secondary radar (beacon transponders). The beacon system will also transmit automatically the plane's altitude and identity. One problem not yet solved is economical production of small light-weight altitude-transmission equipment (SLATE) for general aviation planes. 3-D radar is still being tested but without too much enthusiasm.

The weather portion of the new system will be extensive. It calls for new sensor gear, data processing, displays, and communications.

Voice communications will continue to be the principle technique for control.

PLAN-POSITION DATA DISPLAY console built by General Precision Inc. is part of FAA's engineering model for testing new system design for air-traffic control. Direct-view storage tube is by Hughes Aircraft Co.



NUCLEAR REACTOR FOR GENERATION OF COMMERCIAL POWER is loaded by technician with aid of television cameras submerged in 25 feet of water. System, built by RCA, monitors loading of 120 fuel elements into reactor core

AEC PROJECTS—Most of the projects being advanced by the Atomic Energy Commission make extensive use of electronic controls and instrumentation. The AEC is also developing a series of compact nuclear power supplies to generate electric power for space and other applications.

The SNAP series of radioisotope and compact reactor electric generators will supply power for satellites and spacecraft, as well as remote electronic operated gear such as automatic weather stations located in the Arctic. Radioisotope versions of SNAP have already been used to supply part of the power for Navy's Transit navigational satellites, along with solar batteries. SNAP units for space applications are being developed with electric generating ability ranging from a few watts to a megawatt or more.

The higher power units will be suitable for powering communications, television and radar satellites, and to supply energy for ion or electric propulsion of space vehicles.

Research in high-energy physics by the AEC is producing a market for electronic equipment at a rapid rate. Projects such as Stanford University's linear accelerator are an example.

Growing use of nuclear reactors to generate commercial electric power is apparent, with electronic equipment used for monitoring, control and safety devices.

Materials study by AEC is being advanced and commercial manufacturing processes using nuclear tracer techniques are standard in many industries, largely through AEC's efforts.

Research programs in mathematical and computer sciences are under way at AEC, will employ extensive computer and data-processing facilities.

ELECTRONICS MARKETS 1963

CONSUMER GOODS

STRONG DEMAND

A STRONG DEMAND for consumer electronic products is expected during the coming year, with much impetus expected from color tv, stereo f-m, educational tv, and a beginning rise in uhf tv set production.

COLOR TELEVISION—Color television may see up to a two-fold increase in sales during the coming year some observers feel, with an increase in color programming by major networks a strong factor. The current rate of unit production, roughly four hundred thousand sets in 1962, resulted in a stock pile of unsold receivers. About half that number of sets found their way into customer's homes, with price given as the major deterent to sales.

Many broadcasters expect black-and-white television broadcasting to be merely a vestigal service, by 1975. Increasing competition promises to force the retail price of color receivers down, which will result in increased customer acceptance.

Opinion is varied on the possibility of the single-gun color picture tube being able to aid this price decrease. Some industry leaders are convinced that a one-gun tube would lead to simpler circuitry within the receiver, as well as effect a saving on the tube itself.

The so-called two-color system of achieving a three-color picture, using two monochromatic (standard b&w) picture tubes, is not expected to produce any impact as a commercial system, though there has been some interest in the approach overseas.

Another strongly voiced opinion holds that the three-gun tube has been sufficiently refined to allow economical production of the tube itself, and that much catching up in mass production technology would be required to make the single-gun tube competitive. However, observers note that the single-gun tube provides greatly increased brightness, but they doubt that it is an important factor at this time. Reducing the cost of the three-gun tube, is considered the direction to head, and most agree, the direction the industry seems to be taking, with at least three new manufacturers expected to start production of the tubes this year.

It is expected that 90-degree, 21-inch, color tv tubes could be prominent in 1963, with some manufacturers showing rectangular color tubes by 1965, including 25 inch types.

Receiver circuitry simplification, and thus cost reduction, can be achieved by engineering refinement without deserting the three-gun tube, some feel. Unless a major breakthrough in receiver engineering is achieved, the color tv market during the next few years—perhaps five, one expert feels—will be roughly twenty percent of the total tv receiver market.

A strong push by advertisers for color tv programming as a means of displaying their products in color, is reported, and may have been responsible for the increased programming now scheduled.

ALL-CHANNEL TELEVISION—Recent passage of the government's all-channel television legislation, which calls for complete vhf and uhf coverage in all tv receivers to be manufactured in the future, promises to spark b&w sales over the coming years. A three-year grace period will pass before the government enforces the ruling, but manufacturers are expected to begin some production of these receivers immediately.

The time lag is provided to permit design of new tuners, and tooling for their production. It will take 2 to 3 years for uhf television to become an important market.

About a $30 increase in receiver price to the customer is predicted initially with a drop until it is completely absorbed in the price, as volume production gets under way. Greatest impact of sales of the receivers is expected in rural areas, where vhf coverage is slight. There is talk of a court test of the legislation's legality, but most feel the law will hold.

Many believe that the new uhf ruling will spur educational television across the country. Several industry leaders and educators, however, note that the proposed 2,500-Mc bands for educational tv use now under consideration by the FCC, will prove best for interschool applications.

BLACK AND WHITE TELEVISION — Volume production of truly portable tv sets will be realized in the future, industry observers feel. The availability of planar and epitaxial transistor types will help boost this market. Instant warm-up, low drain cathode ray tubes will be in demand.

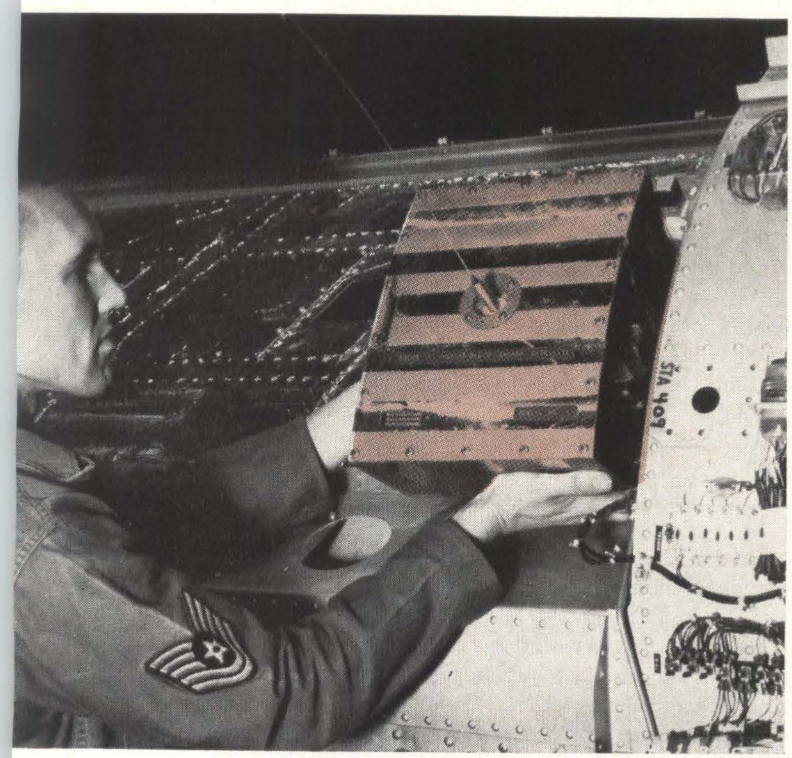
Full transistor compliment tv receivers for home use awaits less expensive transistors. It is looked upon as a way to achieve longer life sets, through reduction of heat which affects other components, as well as the intrinsic long life advantage of semiconductors.

The use of hand wiring in construction of television sets has been reinstituted by several manufacturers reportedly as a means of gaining reliability and reducing service problems.

A television market that will grow out of the needs of businessmen will be telephone with closed-circuit television. Possibly using laser communication links, with their wide bandwidth capability, and small-screen tv at each office telephone, businessmen will be able to show each other documents, including letters and graphs, while speaking of commercial matters. The market here should develop by 1970.

STEREO F-M—Continued strong market growth is expected in stereo f-m, and an increase in broadcasting services in this mode is predicted.

The Federal Communications Commission anticipates that roughly 25 percent of operating f-m broadcasters will be transmitting f-m stereo at the beginning of 1963, or a total of 250 stations. Harold L. Kassens of the FCC says that 300 stations could be registered for this service when another year is out. He feels that the extensive monaural record library found in large existing stations, impedes conversion. However, new stations not faced with this problem are apt to be stereo.



AMATEUR RADIO BEACON installed in Discoverer satellite provided ham radio operators with a chance to study propagation phenomena. The amateur constructed, 144 Mc package was launched into orbit from Vandenberg Air Force Base

TRANSISTOR PIANO operates from a-c or battery pack. Wurlitzer instrument uses steel reeds in polarized field to generate tones, varistors to modulate vibrato system. Fast response time of instrument is for jazz.

HIGH FIDELITY—Sales of high-fidelity reproducing instruments are being fostered at a growing rate by interest in stereo. Prerecorded tapes have come down in price, with tape machine sales climbing rapidly. The phonograph business, including renditions not truly high fidelity, is essentially all stereo today. In teen-age record sales, manufacturers make monaural disks, which are played on stereo instruments.

Single instruments with the speaker in the cabinet are preferred to separate components in quality home instrument sales. There is still a good market for simple phonographs, although it has been shrinking with the preference for high-fidelity equipment.

TRANSISTOR RECEIVERS—Radio receiver sales draw heavily on imported sets in the small transistor receiver class of instruments. However, in the case of high quality a-m transistor receivers, American manufacturers are doing well. To date the cost of f-m transistor receivers has been too high to encourage domestic manufacturers to enter this field heavily.

Foreign competition is continuing to grow in the transistor receiver field with most American manufacturers apparently content to relegate the market to overseas firms, based on a labor cost difference in their favor. Some American firms have set up overseas subsidiaries, or have stock in foreign firms, gaining some profit through this measure.

HOME ELECTRONICS—The home will see more use of electronics during the next ten years, with many of the more fanciful present speculations turning into realities. Data communications and data processing is considered almost certain to lead to consumer store purchasing systems where the housewife never leaves her home. She would order over a telephone system using an electronically coded charge plate and make her item selection aided by closed circuit television, to the store or supermarket.

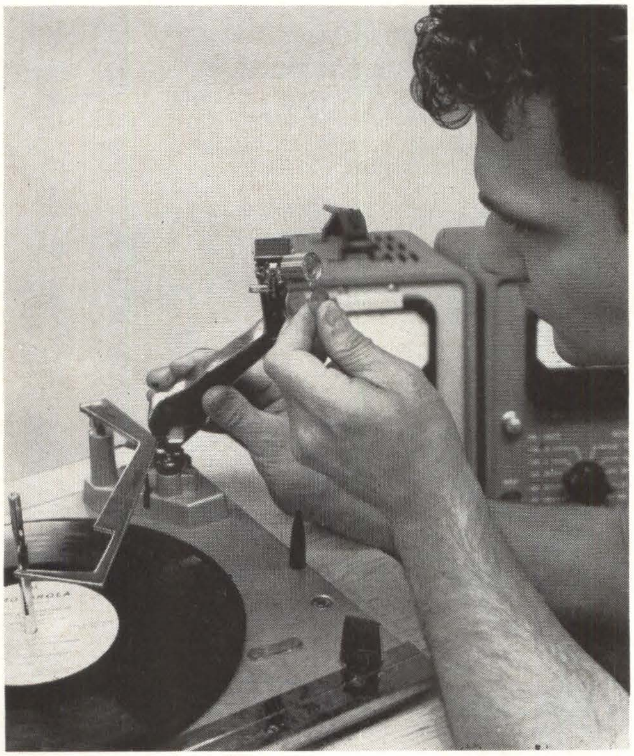
A drop in prices for such systems equipment will probably come about due to increased competition, and the fact that much of the needed engineering will have been done on similar industrial and military systems.

Radar ranges will be installed in many new homes, and are certain to become an important facet in restaurant operations. The advantage in the latter service are avoidance of food spoilage by allowing restaurant owners to keep food frozen until orders come into the kitchen. Frozen fare can be cooked in moments, precluding the need to carefully predict peak ordering loads on the kitchen.

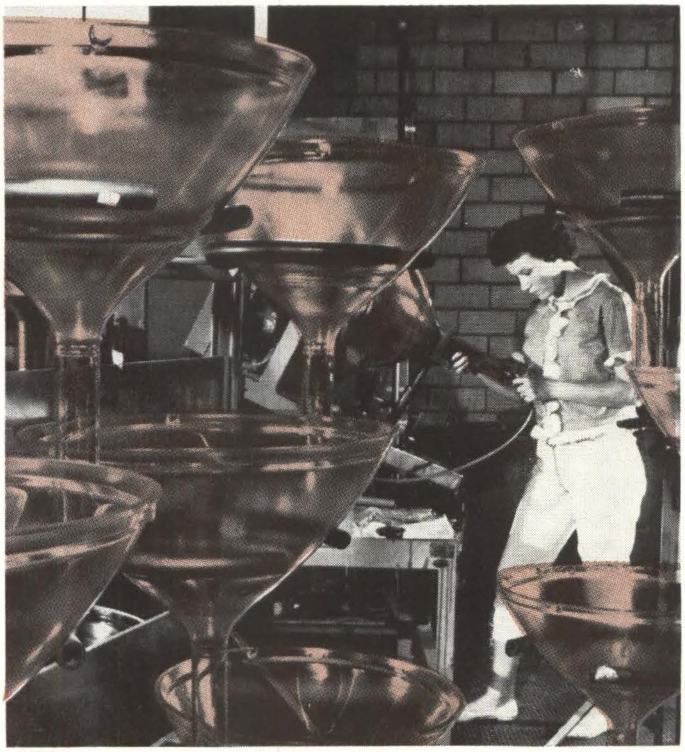
AMATEUR RADIO—Activity in amateur radio is high, and is now reaching into space. Recently a radio package dubbed Oscar, weighing ten pounds and operating in the two meter band was included in a satellite and placed into orbit.

Radio operators will check antenna efficiency, signal propagation and Heaviside layer effects, at worldwide locations, using this satellite package.

Estimates of money spent last year by amateur radio enthusiasts run to slightly over $38 million not including citizens' band equipment. This is based on an average expenditure of $155 per year by each ham, for equipment and components. There are now roughly 240,000 hams in the U. S.



STEREO CARTRIDGE is examined under magnifying glass to assure correct seating of stylus, and positioning of diamond point in Motorola high fidelity instrument

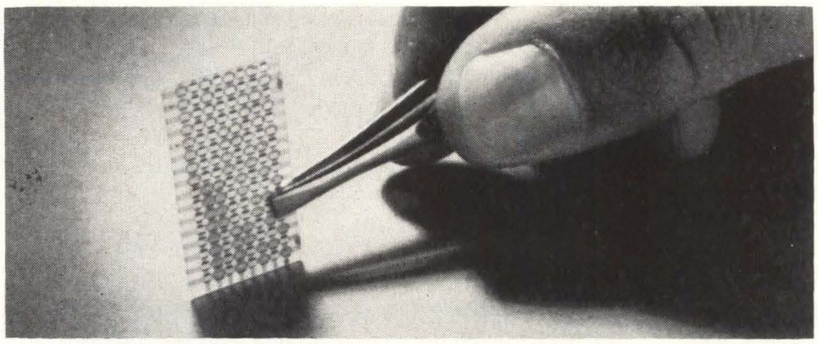


COLOR TV PICTURE TUBES on 24-hour-a-day production schedule at RCA's second factory for manufacturing color tubes. Black coating is applied in neck during this initial production step

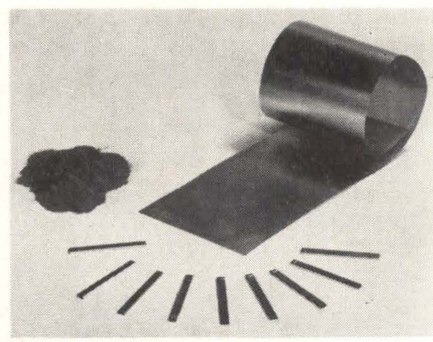
COMPONENTS

MICROCIRCUITS COMING

CONSUMER PRODUCT USE is the design goal of this new low-cost silicon controlled rectifier developed by General Electric. Applications include household, automotive and light industrial use

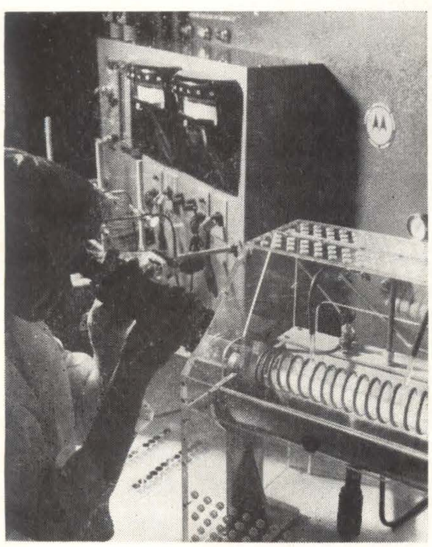


THIN-FILM TECHNIQUES are receiving much attention. Diode logic matrix of 64 diodes by General Electric is designed for use in telemetry system

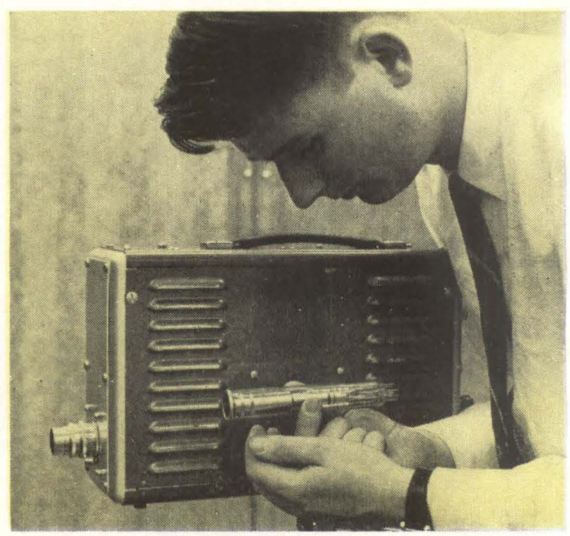


VACUUM TUBE RELIABILITY and performance are improved by powder-metal strip cathode. Sylvania Electric Products rolls carbonyl nickel powder and additives into thin strip for cathode sleeves

DIODE BURN-IN to improve semiconductor reliability at Sperry Rand Corp. Units are subjected to many hours of electrical stress. Diodes will be used in Polaris missile



SILICON WAFERS are checked with optical pyrometer for exact temperature during growth of epitaxial layers, Motorola



SLOW-SCAN VIDICON TUBE developed by Westinghouse Electric for use in tv systems operating at a rate of one picture every eight seconds. High resistivity photoconductive target is used

MANUFACTURERS of components are stepping up efforts to apply microelectronics in production runs of military, industrial and consumer equipment. Most components men hold that the future for their segment of the industry lies in this activity.

Techniques ranging from micromodules and thin films, through integrated and molecular circuits are receiving attention.

Both growing domestic competition and increasing foreign component imports, are leading to profit pressure. Industry pulse watchers note that there is overcapacity in the components industry, perhaps to a greater extent than in other segments of the electronics industry. Some observers expect a shake out of manufacturers during the coming year.

Microelectronic techniques, in particular thin films, are expected to give American component manufacturers an advantage in competing with foreign competition. These techniques will lead to automatic production, and reduce the advantage of less expensive labor enjoyed by foreign manufacturers, such as Japan.

On the other hand, several international business men state that it would only be a matter of time before foreign competitors achieved the same microelectronic capability, due in part to royalty and licensing arrangements with American firms. Also it has been noted that British, German and Japanese scientists are following the microelectronic field carefully, will be ready to function in this area readily. Also the Dutch based Philips companies are known to be actively engaged in their own development work in this field.

All experts agree however, that it is imperative that American industry gain an early lead in microelectronics, and strive to maintain it. Unless this is done, problems of international competition are apt to be even more severe.

However, most observers agree that in order for microelectronic techniques to become a commercial reality in the U. S., extensive military application is needed. All agree that the three military services and NASA will be first to fully exploit the technology of thin films and molecular circuits.

The form that microelectronics circuits will take is open to speculation, but most experts believe it will be a combination of thin films and semiconductor techniques. Integrated circuits, using thin films deposited on semiconductor substrates, and also semiconductor circuits will be strong in the 1960's. In 1965, ten percent of the components market will be molecular, experts state.

However, it will require initiative on the part of industry to bring microelectronics to commercial fruition, in addition to the advances wrought by the military.

The ultimate of reliability and financial saving will be realized when single material—functional (molecular) circuit—techniques are worked out, a leading scientist says. He points out that the hybrid form (integrated circuits) of microelectronics will not be the final form. The day will come when a chemical mixing beaker will contain the compound that ultimately constitutes a complete circuit, it is predicted.

Increasingly, equipment manufacturers are becoming producers of components. This trend will find its apex in the concerted effort of equipment makers to develop in-house capability in microelectronic technologies. It will reach a point where firms that make only equipment may be nonextent. Another trend that is clear is the growing ability of component manufacturers to produce complete equipment and systems. The present deliniation between component and equipment makers is likely to disappear completely, with both types of firms able to perform in all areas of electronic development and production.

Another reason for equipment manufacturers entering into component production, will be to protect the proprietary nature of their design from other manufacturers.

One of the requirements in developing microelectronic circuits is the selection of materials with inherent stability. General Telephone and Electronics is carefully choosing materials which avoid temperature, frequency and voltage instability.

An advantage of molecular electronics is the ease with which redundancy in circuits can be achieved.

MILITARY COMPONENTS—There is a strong requirement for military command systems with twenty-year reliability. So called "mummified" command and control facilities for hardened sites, where the total environment is impervious to massive attack.

It is expected that Russia will continue with efforts to perfect the big-blast nuclear bomb of 30-40 Mt and improve still further her guidance system accuracies. This poses a threat to hardened sites that do not really fulfill the letter of their name.

Toward this end, modern components must afford radiation and shock resistance.

Robert J. Brown, General Manager, Defense Programs Operation of General Electric Company, suggests that firms develop radiation resistant components for use in potential military environments with both steady and transient radiation levels, thus also achieve a line of space compatible electronic components and circuits while doing military R&D. They will then be ready to compete with the mechanical and chemical components now used in space when they are called on for space operations in the future. Brown states that military radiation resistant electronic components are a must; the fact that they are also useful in space operations is a bonus.

Techniques for applying thin films to military electronics are progressing rapidly. The Navy is putting on a big push for microelectronics, with the Air Force and the Army following.

TRANSISTORS FOR THE MILITARY — Transistors will take over many military applications now performed by vacuum tubes. This has already been the pattern, but is now expected to occur on a greater volume basis. The exception will be in high-power and special-purpose applications where the vacuum tube will remain the primary device. By 1970, transistors will constitute roughly 90 per cent of the units, and 70 percent of the dollars, in filling sockets in the manufacture of military equipment.

Unit sales of transistors are climbing, but profits are smaller. Transistors are finding greater application in hi-fi equipment, partly on what is called "snob appeal." However in television, vacuum tubes are still favored for price, and design factors. It has been pointed out that in the tv sockets where the most trouble occurs, high voltage, damper, horizontal deflection; the semiconductor device is at present no better suited.

NEW APPLICATIONS—A wide range of new applications for semiconductor components are being found. Home appliances now include semiconductors as the control element in timing cycles, where bimetal strips and similar electromechanical devices were used.

General Electric Company has just introduced a series of consumer priced silicon controlled rectifiers for use in automatic clothes dryers, and automobile alternators.

Ignition systems now employ transistors, and some automobile experts expect commercial trucking will soon standardize on transistor systems. Reduced maintenance and easier cold weather starting are obtained.

Miniature portable transistor tv sets, such as Sony's eight pound receiver which can operate from battery pack or an auto battery, through the cigar lighter socket, are receiving attention. It is expected that an increasing number of American firms will begin marketing similar tv receivers, based on the Japanese firm's success.

The development of a transistor operated piano by the Wurlitzer Co. marks another home-instrument victory for the transistor. The eighty-pound piano is able to operate from a-c and battery pack, has a 64-note keyboard. Steel reeds vibrate in a polarized electric field to produce the tone, with pickup plates, amplifier and loudspeaker.

Bulova's transistor operated wrist watch, employing a tiny tuning fork to achieve accuracy, provides another example of semiconductors invading a new field.

VACUUM TUBES—Receiving-tube sales are trending down, based on industry unit counts. Military tube sales have held up, over the past three years, and less use of tubes by consumer and industrial electronic manufacturers is responsible for the down trend in sales. This is due to the longer life of vacuum tubes today, and the use of multipurpose tubes—several in one envelope. Also new circuit developments permit doing a job with fewer tubes. This has come about through development of better tube types. Transistor sales are increasing, and are a factor in the drop off of tube sales.

Total receiving tube sales will drop some ten percent in the next five years.

Tubes have not yet reached their ultimate in reliability, and a factor of two improvement is predicted. Improvement in filaments are being made. Methods of using nickel in fabricating cathodes are leading to lower and more predictable cathode interface levels.

ELECTROLUMINESCENT DEVICES—The greatest use of electroluminescent devices in the electronics industry during the next year will be in digital readout.

Use of nonlinear resistive devices for switching and display will be developed. The equipment will translate digital information to analog information for electroluminiscent display. It will employ electroluminescent and photoconductive devices.

General Telephone And Electronics hopes to develop a flat black-and-white tv display. They hold that a color picture tube is possible. Within the next three years, specialized crt's for lower definition display will be using electroluminescent cross grid techniques.

It is possible that a flat, wall type picture tube may develop out of work on electroluminescent tubes. The techniques would employ a piezoelectrical material, such as the Yando device, developed at General Telephone and Electronics.

STANDARDIZATION—Industry experts state that our competitive international position would be improved if standardization were brought to the many varieties of components now being manufactured, quantities would go up, costs down. An example are tv receiver tubes. There are now 100 to 120 types, which might be replaced by 10 without impairing performance.

Trade associations are not considered effective enough in bringing this standardization about. Fear of government antitrust laws are weakening some efforts at standardizing.

FOREIGN TRADE

DURING the first six months of 1962, United States electronic exports spurted up 32 percent over the previous year, reaching $370 million, the Department of Commerce reports.

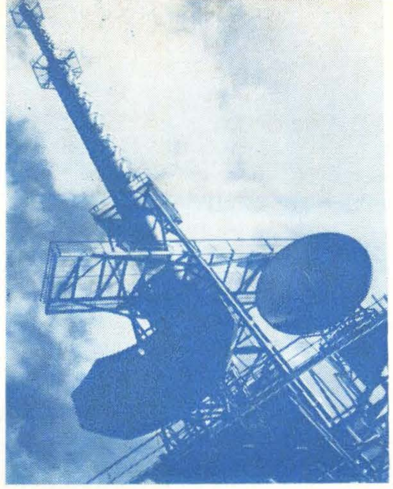
Our government's efforts to foster foreign-trade expansion is aimed at a further increase in exports during the coming year. The electronics industry will share in the gain, if it occurs. In spite of the slowing economy of western Europe, the coming year is expected to at least equal the present level of electronic exports.

EUROPEAN MARKET—A downturn in the European economy has been noted, but is not thought to affect U. S. export trade to these countries, by present indicators.

Technology advances in the world electronics market are expected to come mainly from the U. S. over the near term. However, European (and Japanese) firms are expected to develop advanced research and development capabilities in the future, to maintain commercial leadership within their specialties. In components, the U. S. will always maintain a lead, due to advanced R&D work in areas funded by DOD.

Europe enjoys a technical lead in the area of lower microwave band, communications equipment. One huge

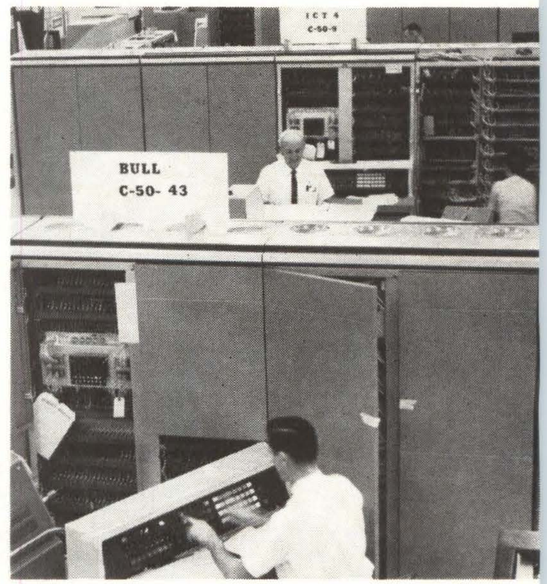
MOBILE RADIOS will be supplied to London motorcycle patrolmen and other United Kingdom police forces by Cossor Communications Co., Ltd. a subsidiary of Raytheon Co.



TELEVISION TRANSMITTER in Austria will radiate German language programs to four and a half million tv screens. Telefunken engineers erected equipment, Austrian, Swiss and German engineers will operate it

TRANSISTOR TV CAMERA built by Tokyo Shibaura Electric Co., Ltd. is designed for field or studio use,. Instrument provides 525 line, 30 frame, scanning

FLIGHT INFORMATION SYSTEM employing transistor operated control network is built in Switzerland. Tele-Norm Autophon equipment is shown at New York International Airport; similar systems are installed in European stock exchanges, industrial plants and banks



COMPUTERS FOR FRENCH AND ENGLISH firms, built by RCA, undergoing final test before overseas shipment. RCA has multimillion dollar agreements to sell data-processing systems to European companies

THREAT OR OPPORTUNITY?

European firm has developed a kit of transistors suitable for use in home television, which may prove technically superior to U. S. types designed for tv service.

AUTOMATION IN EUROPE—There is strong stimulus for automation applications in Europe, due to shortage of skilled help and climbing labor rates. Steel mills and similar factories are trending toward automation rapidly. U. S. manufacturers of electronic automation equipment, including computers, will find a ready market throughout most of Europe during the next five years.

NATO nations, and to a lesser extent SEATO nations, will provide international military electronics in the future to aid in the huge job of achieving military preparedness for treaty organization members. This will increase competition for U. S. military suppliers. Small guided missile production in France is rising, and the country is exporting to the U. S. and NATO countries at increasing rates.

The requirements of America's military and space efforts have produced test equipment of advanced and specialized design which finds a ready foreign market. Both Germany and England export sophisticated test equipment to the U. S., but both countries, plus the rest of the international market place, are part of the growing market for U. S. built test equipment. Most European countries do not have volume requirements for specialized test equipment and measuring instruments, thus have not developed extensive manufacturing capacity for such equipment.

Production of radio and television sets are responsible for much of the electronics sales in Germany, with industrial electronics, including data reduction and process control becoming increasingly important.

JAPAN—Already assured of a strong consumer electronics product capability, Japan is now seeking to develop industrial, space, and to some extent, military equipment capability.

Sales of consumer electronics are approaching saturation for the local market, with 60 percent of Japanese families owning tv sets; practically all have radios. A general downtrend of electronic sales is partly due to a slowing down of the entire Japanese economy, which some feel expanded too fast.

By switching to the production of transistor radios with six or more transistors, and to high-fidelity units, Japan has succeeded in raising her export level to the U. S.

The nation is expected to become a future leader in international color tv production, largely because of a strong demand developing within their own country.

Several industry observers expect electronic toys to become a big market in the future, and when it does they look to Japan to become the leader in this field.

The nation is well on its way to developing an extensive industrial electronic capability, but that growth too, is slowing down. Industrial sales are a small portion of the electronic industry.

Computer development is receiving strong attention from Japanese industrial firms. Additionally, a Japanese government subsidy of $278 million has been allocated for research to develop large electronic computers. Right now, Japan is a large importer of U. S. built machines, both analog and digital. Japanese companies are forming joint effort groups for rapid computer development. They are aided by large numbers of engineers being trained on government subsidies. In time they will be less dependent on licensing arrangements with the U. S. in building computers, as these engineers create original equipment. Local use, as well as export volume is expected for the Japanese-built computers.

Japanese scientists are interested in microelectronic techniques, attend U. S. professional conferences devoted to this subject regularly, and are engaged in their own R&D. Wage levels are rising in Japan, and automation techniques plus microelectronics will undoubtedly help the country offset these in the future. However, because Japan does not have a large military electronics effort, microcircuits are not expected to achieve commercial applications soon.

The Japanese are doing advanced research on translating machines, speech operated typewriters, thermoelectric devices, and communications techniques. They have instituted a space research program, firing sounding rockets with instrument packages into the upper atmosphere and space. Some of the ground tracking equipment, instrumentation and rockets are being exported.

The nation is also cooperating with the U. S. in communications satellite developments, has signed an agreement with NASA to construct a ground station for handling satellite signals.

Medical electronic equipment is expected to become a growth area for Japan, with small precision equipment, and perhaps electron microscopes among the products.

Because of little local need for military electronics, Japan has developed few sophisticated systems of this type.

Strict quality control of electronic exports is a feature of the nation's trade operations, and has contributed to their international success.

Japan is striking out for the Latin American market strongly, expects to be a major supplier to countries south of our border. Additionally she seeks to capture India, Burma and Pakistan as markets.

LATIN AMERICA—Future development of the Alliance For Progress Program will strengthen the economy of Latin America, and hence the electronics market in these countries.

At present Latin America has a relatively low income per capita level, and thus consumer purchasing power is limited. However, the citizens of these countries exhibit a strong desire for radio and television receivers plus a need for communications equipment of all types. Microwave systems to accommodate mountainous terrain are much in demand.

Much of the Latin American electronic equipment now in service is of World War Two vintage, and there is a brisk trade in supplying replacement components to maintain this gear.

The Latin American Free Trade Area which is an affiliation of countries below the border, is apt to figure strongly in the future of their electronics industry. Major aims include enlargement of marketing ability of member countries, and encouragement of trade between them. A tariff reduction between LAFTA countries, and a complementation of manufacturing resources to flesh out the product lines of LAFTA as a whole is contemplated. Some American observers are fearful that this might lock out some electronic equipment now sold to LAFTA members, because of future tariff levels.

Mexico is achieving some sufficiency in supplying itself with electronics, and relative to the rest of Latin America, is experiencing a healthy growth in electronic manufacturing capability. Many foreign companies, such as Siemens, are setting up production facilities in Mexico. Both Brazil and Argentina have healthy beginnings on electronic operations.

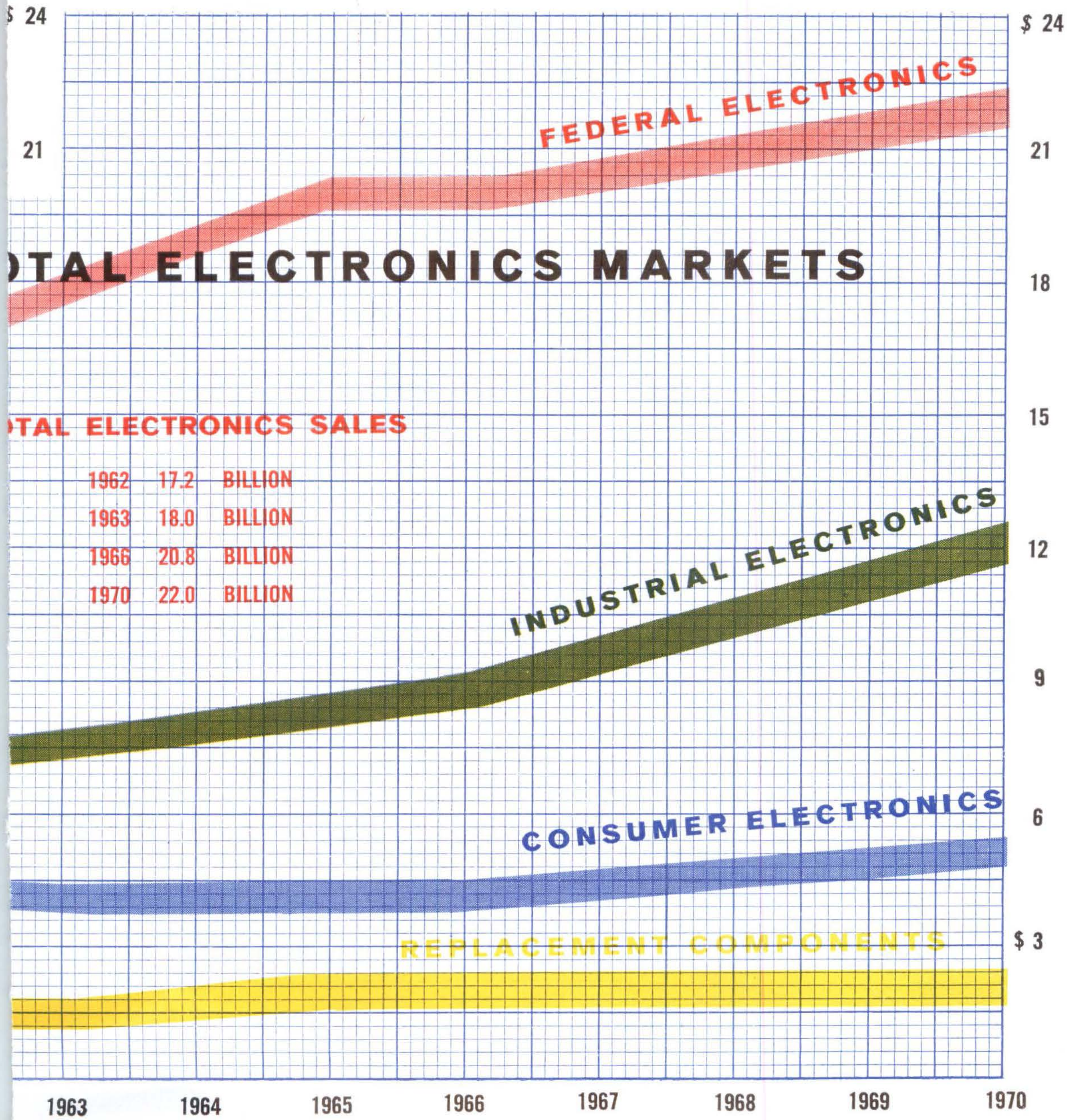
European and Japanese firms are striving for a greater share of the Latin American electronics market, and many feel that their sales techniques are in some ways superior to those of Americans in dealing with Latin American customs and mores.

Political unrest in Latin American countries has to some extent put a damper on plans by some American firms to invest or set up facilities below the border.

CANADA—The future of the Canadian electronics market will depend heavily on the ability of Canadian firms to produce more original equipment for the export market. The nation is strong in manufacture of communications and navigation equipment, but must branch into other sophisticated areas of electronics for healthy growth.

ELECTRONICS MARKETS

1962 1963 1966



ELECTRONICS

TOTAL ELECTRONICS INDUSTRY

	1962	1963	1966	1970
	(Millions of Dollars)			
TOTALS	17,200	19,049	21,817	22,000
CONSUMER	2,584	2,564	2,548	3,500
INDUSTRIAL	3,211	3,485	4,433	6,500
FEDERAL	9,905	11,500	13,100	10,000
REPLACEMENT COMPONENTS	1,500	1,500	1,700	2,000

SOURCES: Electronics Div., BDSA, U.S. Department of Commerce
Electronics Industries Association

Prepared by the Market Services Department of **electronics** magazine

CONSUMER ELECTRONICS PRODUCTS

	1962	1963	1966
	(Millions of dollars)		
CONSUMER ELECTRONICS TOTAL	2,584	2,564	2,548
TV Receivers Total	**1,029**	**1,026**	**938**
Monochrome	910	864	750
Color	119	162	188
Table	35	50	75
Console	84	112	113
Radio Sets Total	**390**	**385**	**395**
A-M	180	150	125
F-M	50	70	100
Auto A-M	120	110	100
Auto F-M	40	55	70
Phonographs Total	**495**	**435**	**435**
Monaural	50	45	45
Stereophonic	445	390	390
Tape Recorders Total (Monaural & Stereo)	**80**	**85**	**100**
Records & Tape	**260**	**275**	**275**
High Fidelity Total	**75**	**78**	**85**
Amplifiers	15	16	19
Tuners	13	15	17
Loudspeakers	13	13	13
Turntables & Cartridges	11	11	11
Packaged	23	23	25
Amateur Equipment (incl. CB)	**65**	**70**	**80**
Organs, Electronic	**150**	**165**	**180**
Kits	**40**	**45**	**60**

FEDERAL ELECTRONICS EXPENDITURES

	1962	1963	1966
	(Millions of Dollars)		
FEDERAL ELECTRONICS TOTAL	9,905	11,500	13,100
Department of Defense	**9,200**	**9,450**	**10,500**
Procurement	4,900	5,540	6,100
Aircraft	1,500	1,800	1,600
Missiles	1,500	1,950	2,300
Ships	500	500	600
Mobile & Ordnance	200	100	300
Electronics & Communications	1,200	1,300	1,300
Res., Dev., Test & Eval.	3,000	3,000	3,200
Operations & Maintenance	1,300	1,800	2,200
National Aeronautics & Space Adm.	**500**	**770**	**1,300**
Procurement	300	570	800
RDT&E	200	200	200
Federal Aviation Agency	**135**	**200**	**200**
Procurement	76	135	150
RDT&E	59	65	50
Atomic Energy Commission	**35**	**40**	**50**
State Department	**35**	**40**	**50**
Procurement	15	18	20
USIA	20	22	30

The figures are listed so that the amount shown after each heading is the **total** of its subdivisions; all **totals** read upwards

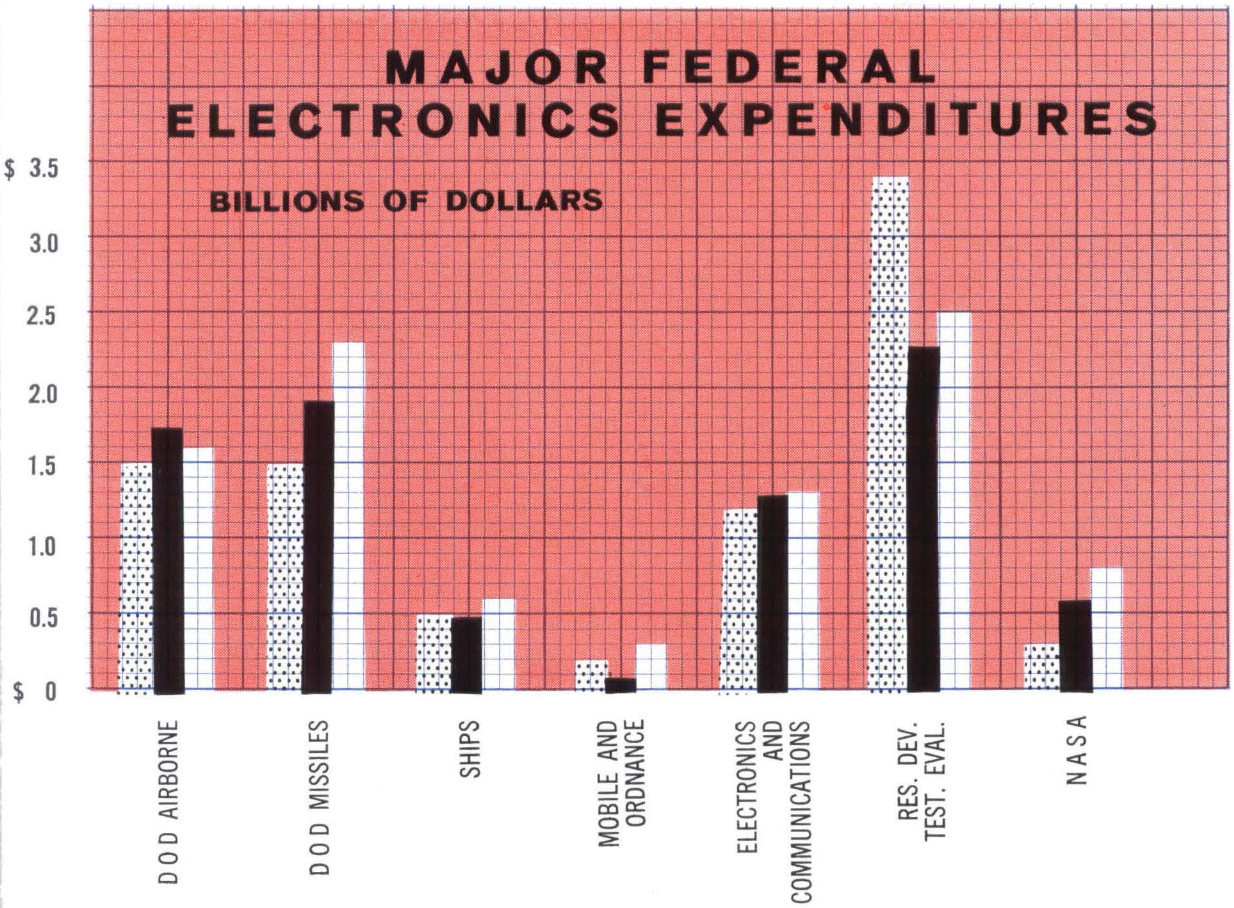
MARKET TABLES 1962

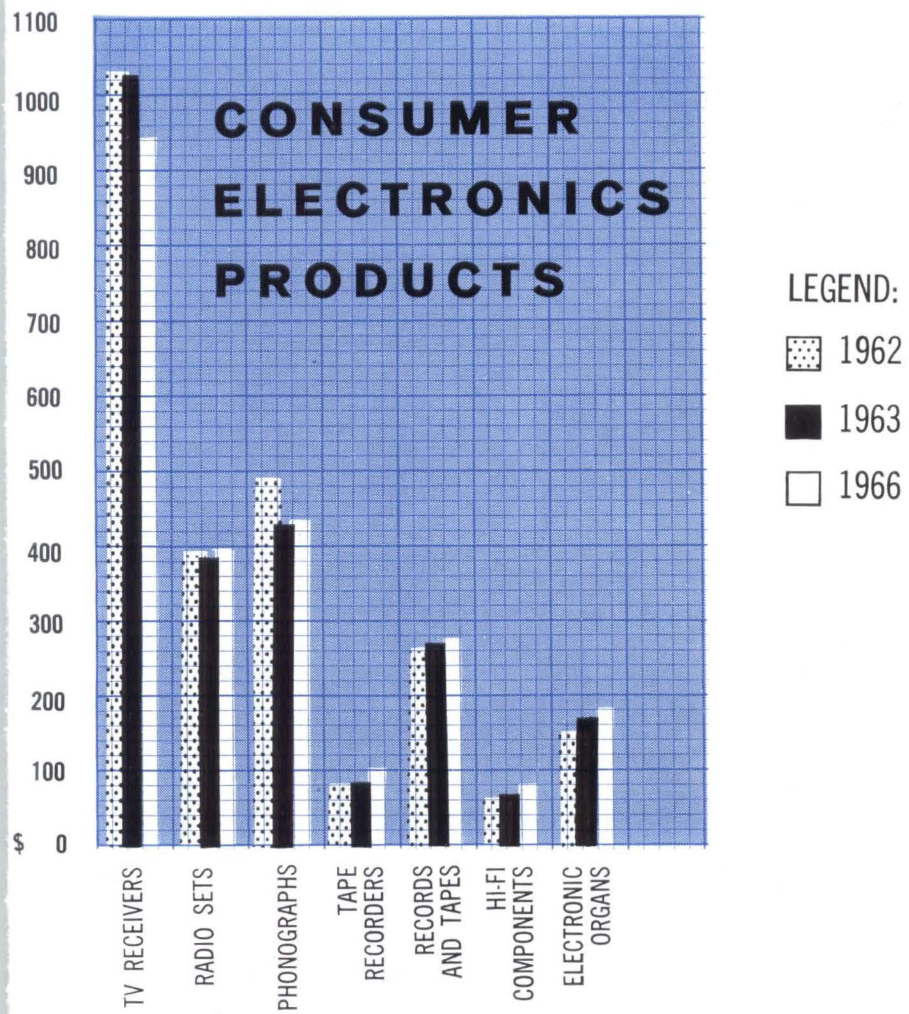
ELECTRONIC COMPONENTS

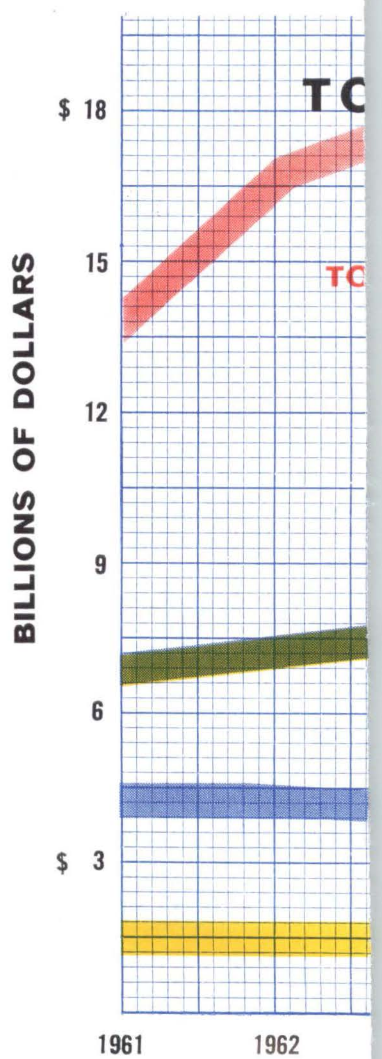
	1962	1963	1966
	(Millions of dollars)		
Antennas & Hardware	**230**	**235**	**250**
Capacitors Total	**310**	**320**	**350**
Paper & Film	100	95	100
Electrolytic, Aluminum	50	50	55
Electrolytic, Tantalum	70	75	80
Mica (incl. glass & vitreous enamel)	25	25	25
Ceramic	35	35	40
Variable	30	40	50
Complex Components[1] (incl. microminiature)	**80**	**95**	**200**
Connectors Total	**190**	**220**	**250**
Coaxial	26	30	40
Standard	15	16	20
Miniature	11	14	20
Cylindrical	70	75	75
Rack & Panel	54	60	65
Printed Circuit	16	20	30
Special Purpose	24	35	40
Delay Lines	**18**	**20**	**30**
Electroluminescence	**7**	**8**	**12**
Electron Tubes Total	**880**	**890**	**930**
Receiving Tubes	320	300	280
Miniature	224	210	200
Standard Glass	84	80	70
Other (metal, ceramic, etc.)	12	10	10
Power & Special Purpose	300	320	350
High Vacuum	70	75	85
Gas & Vapor	28	28	30
Klystrons	53	55	60
Magnetrons	43	44	48
Traveling Wave Tubes	49	54	60
Light Sensing, Emitting	31	35	36
Storage	13	15	17
Other	13	14	14
TV Picture Tubes	260	270	300
Ferrite Devices	**16**	**18**	**22**
Filters	**38**	**45**	**70**
Loudspeakers	**60**	**65**	**75**
Magnetic Tape	**50**	**55**	**65**
Audio	20	20	20
Instrument	27	30	35
Video	3	5	10
Microwave Components (Less tubes & antennas)	**100**	**110**	**150**
Power Supplies (subassembly)	**30**	**32**	**40**
Printed Circuits	**80**	**85**	**100**
Quartz Crystals	**29**	**30**	**35**

[1]Packaged components; two or more components packaged and shipped as a single unit but not a complete circuit function. Also includes modules which have several components packaged and shipped as a single unit, which comprise a complete circuit function.

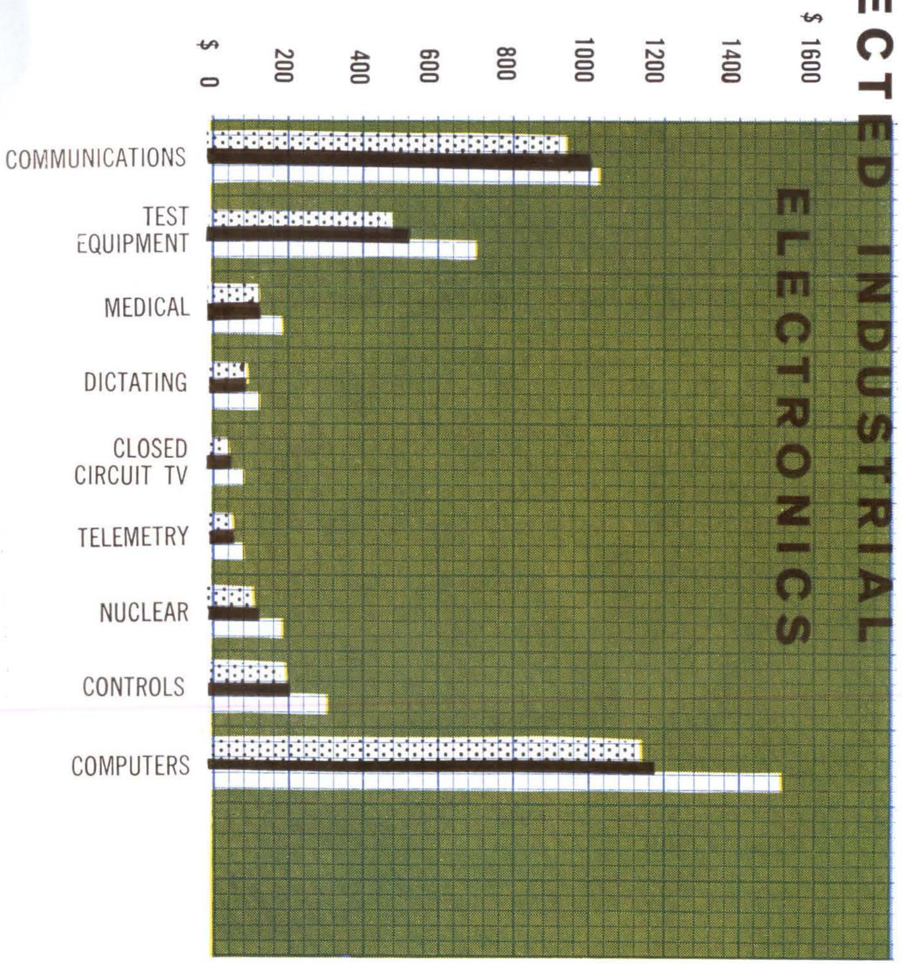
	1962	1963	1966
	(Millions of dollars)		
Relays Total	**200**	**205**	**220**
Electromagnetic	100	100	100
Telephone Type	32	32	32
Crystal Can	18	20	25
Coaxial (incl. switches)	7	8	14
Stepping	12	13	15
Thermal	7	8	10
Other (Dry Reed & mercury wetted motor driven)	24	24	24
Resistors Total	**300**	**300**	**290**
Fixed	145	139	125
Composition	59	55	48
Carbon	29	27	24
Metal Film	18	18	15
Wirewound	39	39	38
Variable (Potentiometers)	132	135	135
Non-wirewound	55	57	57
Wirewound	77	78	78
Non-precision	13	13	13
Precision	64	65	65
Varistors & Thermistors	15	18	23
Other (attenuators, meter resistors)	8	8	7
Semiconductors Total	**580**	**600**	**630**
Transistors	300	310	320
Silicon	100	105	110
Germanium	200	205	210
Diodes & Rectifiers	180	180	190
Silicon	120	120	130
Germanium	60	60	60
Special Devices	100	110	120
Silicon Controlled	15	20	25
Microwave & Variable Capacitance diodes	12	13	15
Tunnel diodes	2	2	3
Solar Cells	5	5	5
Infrared Detectors	12	14	15
Selenium, Copper Oxide, & Thermoelectric devices	12	14	15
Photo devices	1	1	1
Reference Voltage diodes	6	6	6
Regulator Voltage diodes	35	35	35
Servos & Synchros Total	**60**	**65**	**80**
Resolvers	5	7	10
Gyros	12	13	14
Servo Motors	15	16	20
Synchros	22	23	27
Rate Generators	3	3	5
Motor Generators	3	3	4
Timing Devices	**10**	**12**	**16**
Transducers Total	**120**	**130**	**150**
Accelerometers	15	17	20
Pressure	35	37	40
Displacement	30	35	40
Strain	20	21	25
Other	20	20	25
Transformers & Reactors	**185**	**190**	**195**
Wire & Cable	**240**	**245**	**255**
Hookup Wire	75	75	70
Magnet Wire	65	65	70
Resistance Wire	15	15	15
Coaxial Cable	45	50	60
Other	40	40	40


MAJOR FEDERAL ELECTRONICS EXPENDITURES
BILLIONS OF DOLLARS
$ 3.5
3.0
2.5
2.0
1.5
1.0
0.5
$ 0
D O D AIRBORNE
D O D MISSILES
SHIPS
MOBILE AND ORDNANCE
ELECTRONICS AND COMMUNICATIONS
RES. DEV. TEST. EVAL.
N A S A


CONSUMER ELECTRONICS PRODUCTS
1100
1000
900
800
700
600
500
400
300
200
100
$ 0
TV RECEIVERS
RADIO SETS
PHONOGRAPHS
TAPE RECORDERS
RECORDS AND TAPES
HI-FI COMPONENTS
ELECTRONIC ORGANS
LEGEND:
1962
1963
1966


BILLIONS OF DOLLARS
$ 18
15
12
9
6
$ 3
1961
1962

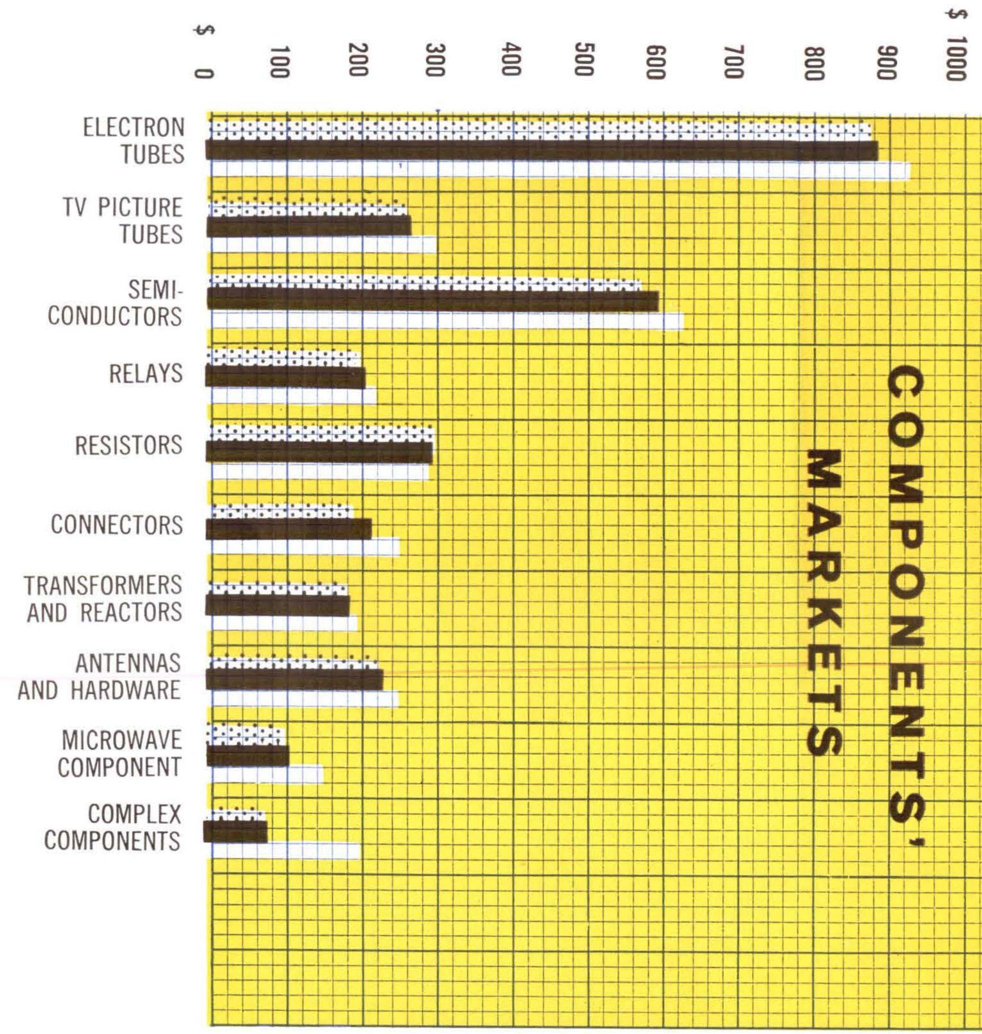
MILLIONS OF DOLLARS



MILLIONS OF DOLLARS

LEGEND: 1962 1963 1966

MILLIONS OF DOLLARS



BILLIONS OF DOLLARS

1963 1966

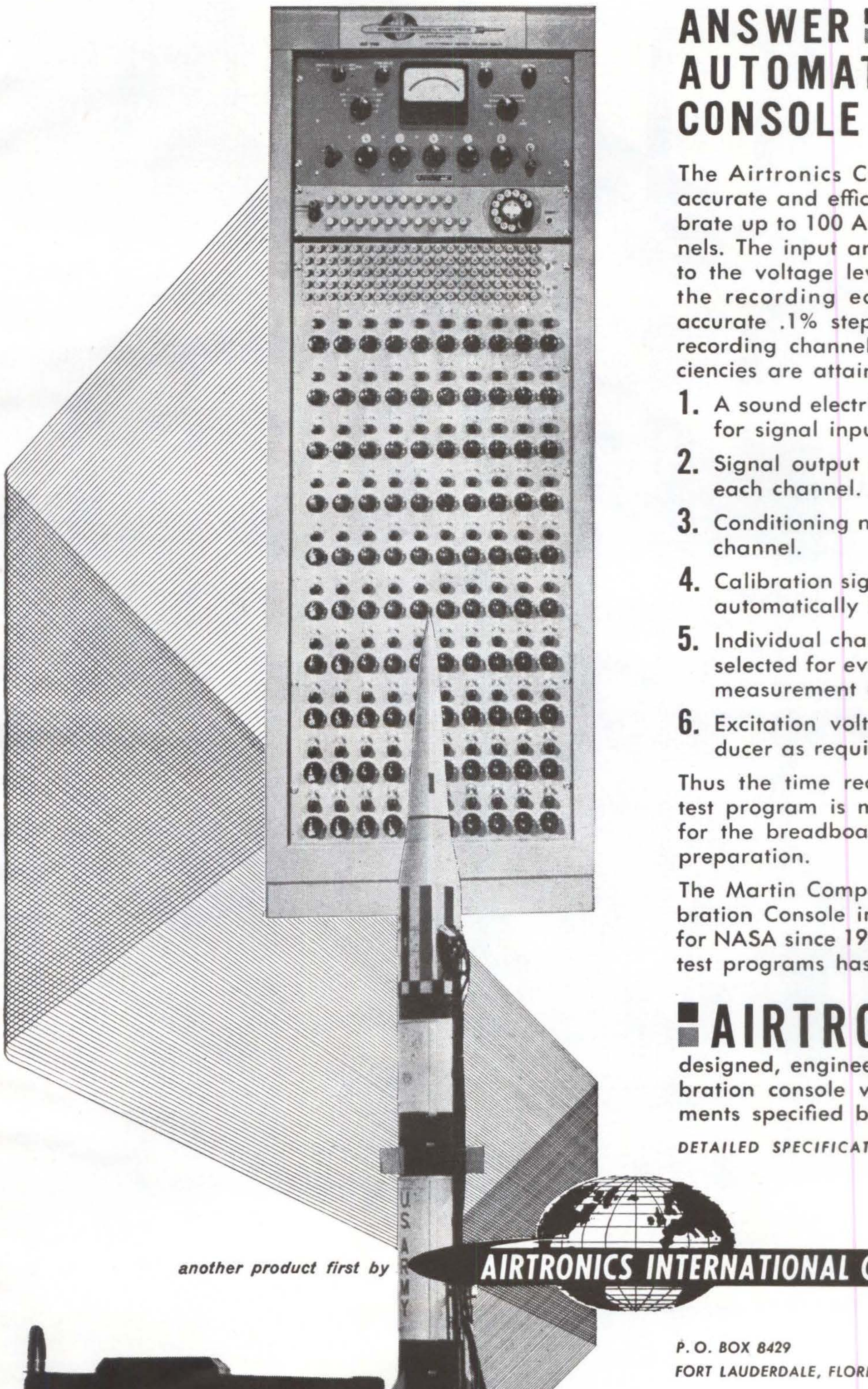
INDUSTRIAL ELECTRONICS

	1962	1963	1966
	(Millions of dollars)		
INDUSTRIAL ELECTRONICS TOTAL	**3,211**	**3,485**	**4,433**
Test & Measuring Total	**490**	**540**	**700**
Spectrum Analyzers	10	10	15
Signal Generators	36	36	40
Phasemeters	3	5	10
Oscilloscopes	60	65	80
Recorders, Graphic	30	35	50
Voltage, Current & Power Meters (Multimeters)	15	18	22
Components Testers (tube, transistor, etc.)	17	18	20
Calibrators, Instrument	26	28	30
Recorders, Data Tape	30	35	50
Bridges & Decades	10	10	15
Power Supplies (lab type)	50	55	75
Counters, Frequency & Time	50	52	55
Engine Analyzers	27	28	30
Waveform Measuring	20	20	25
Impedance & SWR	5	6	10
Radiometers	5	6	10
Panel Meters, Indicating	21	24	30
Active & Passive Networks	6	7	10
Microwave Test Equipment	17	20	25
Spectrometers	20	22	30
Infrared Detectors	25	30	50
Digital Voltmeters	2	3	6
Colorimeters	2	3	6
Spectrophotometers	3	4	6
Nuclear Instruments & Controls Total	**110**	**130**	**180**
Gaging & Process Control	8	10	15
Reactor Controls	40	45	60
Amplifiers	4	5	7
Detecting Heads	6	7	10
Portable Survey Instruments	8	9	10
Power Supplies	8	9	10
Monitoring Instruments	6	7	10
Pulse Height Analyzers	4	4	6
Dosimeters & Chargers	6	10	15
Radiation Sources	4	5	10
Counting Rate Meters	3	4	7
Particle Accelerators	13	15	20
Industrial Controls Total	**190**	**215**	**305**
Numerical Controls	27	28	30
Infrared Ovens	20	25	55
Ultrasonics	20	24	30
Tv Remote	10	12	20
Magnetic Tape Controls	15	15	20
Photoelectric Controls	8	9	10
Servo Remote Controls	70	72	80
Computer Control	20	30	60

	1962	1963	1966
	(Millions of dollars)		
Closed Circuit TV Total	**41**	**50**	**78**
Industrial	32	35	50
Educational	3	5	15
Theater	1	2	3
Medical	5	8	10
Telemetry Equipment	**60**	**65**	**80**
Teaching Devices	**5**	**10**	**40**
Dictating Devices	**90**	**100**	**120**
Medical Equipment Total	**125**	**145**	**190**
Radioactive Tracer Equipment	5	8	12
X-Ray Equipment	50	60	80
Hearing Aids	50	53	60
Electrocardiographs	2	2	4
Monitoring Systems	3	5	10
Pressure Recorders	3	4	9
Ultrasonic Diagnosis	2	3	5
Other	10	10	10
Computers & Related Equipment Total	**1,150**	**1,205**	**1,510**
Digital	950	970	1,200
Analog	50	60	90
Peripheral Equipment	150	175	220
Converters A to D	20	24	30
Converters D to A	20	24	30
Converters Card to Tape	7	8	12
Readers, Paper Tape	15	16	15
Readout Devices	13	15	20
Magnetic Tape Equipment	60	70	90
Other	15	18	23
Communications Equipment Total	**950**	**1,025**	**1,230**
Land Mobile	120	130	160
Microwave (pt to pt)	70	80	120
Radio Relay	20	25	40
Terminal Equipment	40	45	60
Marine Commercial	10	12	20
Facsimile	16	18	20
Airborne	80	85	90
Carrier Current Equipment	12	15	20
Antennas	140	145	180
Intercom & Sound Systems	170	175	190
Navigational Aids	200	205	220
Vehicular Traffic Control	17	18	20
Broadcast Equipment	55	70	90
Transmitters A-M	3	5	5
Transmitters F-M	3	8	12
Transmitters Tv	10	12	18
Consoles & Accessories	10	12	15
Tv Cameras, Color	12	15	20
Tv Cameras, Monochrome	17	18	20

THE MARTIN COMPANY HAD A PROBLEM

How to condition and calibrate 100 variable missile signals simultaneously, select any circuit from 1 to 100, and monitor the calibration voltage on the transducer output voltage during test.



ANSWER: THE AIRTRONICS AUTOMATIC CALIBRATION CONSOLE REDUCES TEST & CALIBRATION TIME BY 75%

The Airtronics Calibration console provides an accurate and efficient means to condition and calibrate up to 100 AC and DC transducer signal channels. The input and output signals are conditioned to the voltage level and impedances required by the recording equipment and transducers. An accurate .1% step calibration is provided to each recording channel. The following operational efficiencies are attained in a test program:

1. A sound electrical and orderly termination point for signal input and recorder cables.
2. Signal output sensitivities may be adjusted for each channel.
3. Conditioning networks may be selected for each channel.
4. Calibration signals may be selected manually or automatically for one or all channels.
5. Individual channel input signals may be switch-selected for evaluation on the oscilloscope or for measurement on an auxiliary voltmeter.
6. Excitation voltage is available for each transducer as required.

Thus the time required to set up and perform a test program is materially less than that required for the breadboard and patch panel type of test preparation.

The Martin Company has used the Airtronics Calibration Console in Pershing missile test operations for NASA since 1961. The performance time of these test programs has been reduced as much as 75%!

AIRTRONICS...is proud to have designed, engineered, and built an automatic calibration console which has met the rigid requirements specified by the Martin Company.

DETAILED SPECIFICATIONS GLADLY FURNISHED ON REQUEST

another product first by **AIRTRONICS INTERNATIONAL CORPORATION**

P. O. BOX 8429
FORT LAUDERDALE, FLORIDA

electronics

January 4, 1963

MICROPAC *weighs in at only 90 pounds, but is a complete digital computer for tactical applications*

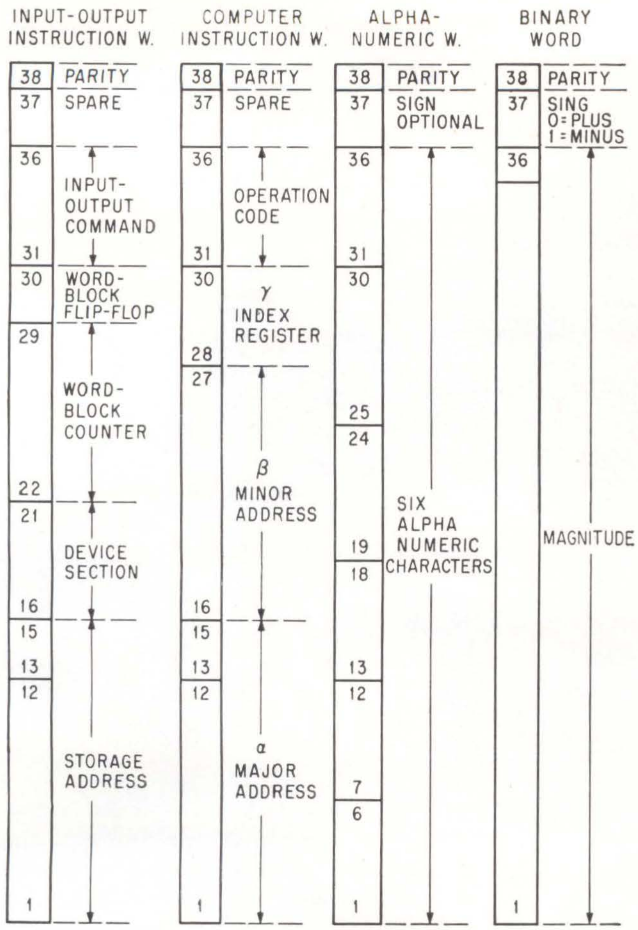
Computers in the Front Lines:

Micromodules Make it Possible

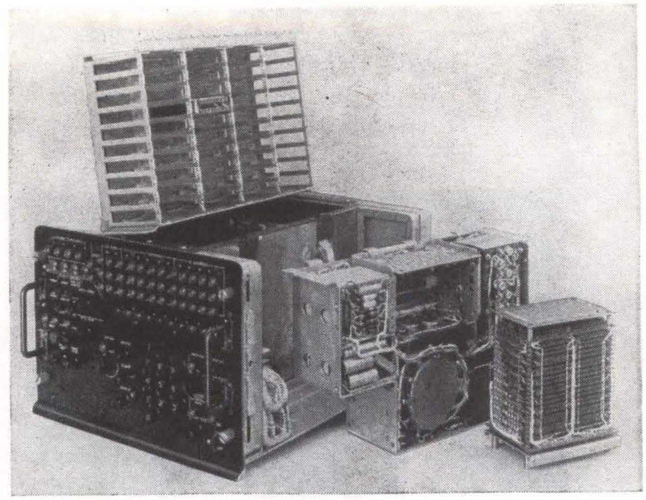
Development of micromodules has significantly reduced the size and weight of electronic equipment. This computer has a wide range of uses. It takes advantage of micromodular construction

By A. S. RETTIG, Surface Communications Div., Defense Electronics Products, Radio Corporation of America, Camden, N. J.

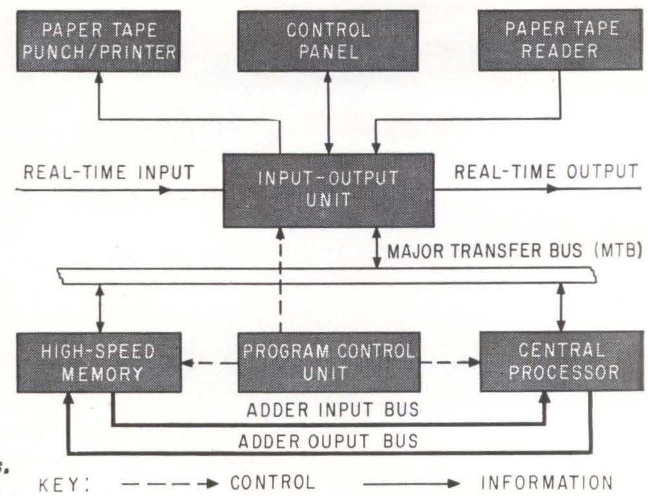
THIS GENERAL-PURPOSE military digital computer will be used in tactical applications where high reliability, small size and weight and low power requirements are primary considerations. The computer uses micromodular construction, providing high packaging density, excellent reliability and a predicted failure rate of 0.04-percent per 1,000 hours per two-circuit micromodule. The computer, as a whole, has a mean-time-before-fail-



FORMAT *of computer words conforming to Fieldata—Fig. 1*



LOGIC RACK *(top), power supply and memory stack (right) of computer*



THE COMPUTER *is divided into five major subsections, all of which have micromodular features—Fig. 2*

ure of over 1,000 hours at a 60-percent confidence level.

Much of the equipment in the computer is time-shared to further reduce the required circuits. Developed under the Signal Corps micromodule program, its name MICROPAC, which stands for Micromodule Data Processor and Computer, was designed to be compatible with the U. S. Army's Fieldata automatic data-processing equipment.

The high packaging density gained with micromodules (about 150,000 components per cubic foot in the circuit section) permits the effective use of a single-case design of 2.7 cu ft that weighs 90 pounds. It requires 250 watts d-c power and 270 v-a generator power.

SYSTEM ORGANIZATION—The computer accommodates a wide variety of problems and has 21 mechanized instructions as shown in the table. It also has register provisions and is a binary synchronous computer operating in a completely serial mode at a clock frequency of 1.6 Mc, permitting a reasonably short execution time per instruction.

The clock pulses drive a timing-level generator producing a sequence of gate levels of varying lengths within a 63-clock pulse period. This 63-clock pulse period of about 40 μsec is called a minor cycle, and is abbreviated during certain instructions to decrease operation time. An instruction is executed in one or more minor cycles plus a minor cycle for instruction access.

The various 38-bit word formats are provided. Figure 1 shows the format of a binary word, an alphanumeric word, a computer instruction word or an input-output instruction word. The basic random-access ferrite core memory of 2,048 word capacity is expandable in multiples of 2,048 to a maximum of 8,192 words.

The computer is divided into five major subsections as shown in Fig. 2. These include: high-speed memory, central processor, program control, input-output and major transfer bus.

HIGH-SPEED MEMORY — The high-speed memory unit contains the core-memory and registers for data storage, controls for reading, writing and word selection. The memory operates with coincident-current selection (destructive readout with regeneration) having a duty cycle of 40 μsec between read interrogations.

The memory array consists of 20 double planes, each containing two 64 × 32 core matrices; also included in the stack are a diode board, heater assembly and header board containing plugs for external connection. This section appears in the lower right-hand corner of the photo. The 20 double planes provide two spare bits per word. These spares can be utilized by connecting the sense winding output to any input circuit and completing a circuit between the digit winding to the digit drive of the corresponding regenerative loop. The memory module bank is a completely self-contained plug-in unit. Four banks may be used with the computer.

A 13-bit address generated by the central processor determines which one of four memory banks and which of 8,192 words will be selected and sent to the two memory output registers. Register 1 is a temporary buffer for parallel data flow to and from the memory; register 2 is both a buffer effecting parallel-to-serial conversion of data and an operand register for several instructions.

CENTRAL PROCESSOR — The central processor performs internal data-processing functions. It has a one-bit adder, various shift registers that, among other functions are used with the adder to form the arithmetic unit, gates to transfer data between registers and adder, and control timing and logic.

All arithmetic operations are done in binary-serial form using a one-bit adder. Subtraction is accomplished by two's-complement addition. Multiplication is performed by successive addition of partial products, and division is executed by a nonrestoring algorithm. Computer operands are fixed-point, signed magnitude.

The accumulator, instruction and program-counter registers are contained within this section. The accumulator contains first the operand and then the result of the arithmetic instructions. In divide, the remainder is stored in the accumulator and the quotient in the Q-register (a register simulated in high-speed memory). In multiply, the high-order result is stored in the accumulator while the low-order result is in the Q-register. The instruction register holds the instruction during execution in the computer. The program counter stores the address of the next instruction to be executed in the program sequence. Other registers required for the central processing function are simulated in the memory.

PROGRAM CONTROL UNIT — The program control unit generates the various controls required by the high-speed memory, central processor and input-output sections. It comprises the decoders, signal generators, and control flip-flops.

INPUT-OUTPUT DEVICES—The input-output section controls data exchange between the central processor and control panel, a paper-tape reader and printer-punch plus a real-time channel. The standard Fieldata intercommunication conventions, 8-bit characters, ready-busy line and strobe line, are used for all input-output operations. On-line insertion of information may be accomplished at 300-characters-per-second by a paper-tape reader or by a programmed instruction requesting operator input at the console. In the latter mode, the computer waits until a specified quantity of information has been inserted and then automatically continues program execution.

Similarly, on-line output of information may also be performed by a paper-tape punch-printer at 30 characters-per-second or through the control panel. In the last case, the computer waits until the operator has requested the display of the instruction-specified number of words and then automatically continues program execution.

The computer can communicate with other computers with real-time input and output channels on a computer-interrupt basis at a maximum rate of 300 characters-per-second.

The computer may concurrently perform real-time input, real-time output, and data-processing functions. When a character has been received from the real-time input unit or when the real-time output unit signifies that it is ready to accept a character, the computer temporarily interrupts its data-processing function, services the character and then resumes data processing from the point of interruption. One to seven-character storage or retrieval operations are implemented by computer interrupts until a complete data word or a single control character has been stored or retrieved. A program interrupt will then transfer the completed word to the message storage section of the high-speed memory, or retrieve a complete word from the message-storage section for output.

HOW COMPACT CAN A COMPUTER GET?

This computer won't fit in a man's pocket, but it represents an achievement in size and weight reduction.

It is possible because of micromodules that permit a good deal of circuit to occupy a minimum of physical space. Groups of these tiny circuits make possible a design of high packaging density, excellent reliability and low power needs

INSTRUCTIONS AND TIMING

Instruction	Approximate Time μsec (including IAC)
Arithmetic:	
1 Add	80
2 Subtract	80
3 Multiply Fast (18 bits)	325
4 Multiply	1035
5 Divide	1075
Transfer:	
6 Transfer Unconditional	40
7 Transfer and Load Pcs.	120
8 Transfer on Negative	40
9 Transfer on Zero	40
10 Transfer on Index	200
Logical	
11 Shift Right	280, max.
12 Shift Left	280, max.
13 Store	80
14 Logical Multiply	80
15 Load	120
16 Halt	40
Sense	
17 Sense	40
18 Sense and Set	40
19 Sense and Reset	40
Input-Output	
20 Read Alphanumeric	variable
21 Write Alphanumeric	variable

MAJOR TRANSFER BUS—Most transfers are accomplished by a major transfer bus; some transfers to and from the adder that occur concurrently with transfers of data through the major bus are executed by minor transfer buses.

CIRCUIT DESCRIPTION — Requirements of +90 C maximum internal ambient temperature to permit reliable circuit performance within the high-density micromodule packaging, made silicon semiconductor components mandatory. For the bulk of the micromodule logic circuits, the 2N914 switching transistor was selected for its relatively high-speed switching and good reliability record.

The basic circuit is the standard logic gate of Fig. 3A with the following characteristics: fan in—20 maximum; fan out—4; power dissipation—75 mw average; pair delay—60 nsec nominal, and rise time —30 nsec nominal.

This standard gate is the most frequently used micromodule in the computer. Low-power gates are provided when the speed and power capabilities of these standard gates are not required. Several micromodule configurations of the standard and low-power gates were designed. Gates are packaged two to a micromodule. Several gate micromodules were designed with different input-diode arrangements so that the module's 12 standard outputs could accommodate the input-terminal requirements of a number of different logical configurations. Diode-cluster micromodules are provided to handle unusual cases.

Although the gates make up the bulk of micromodules in the computer, many other special-purpose circuits are required. Figure 3B shows a shift register capable of shifting at a 1.6-Mc clock rate with an output drive of two standard gates and one steering resistor of another shift register stage.

A starting point for the design of the shift register was the standard gate. Two standard gates were interconnected in a flip-flop arrangement and capacitor-resistor-diode gates tied to the bases for the trigger input. This was satisfactory except for a worst-case condition at 125 C which had a turn-off time of 0.15 μsec instead of 0.13 μsec. The worst-case test included a maximum load of four standard gates and the steering resistor input of the shift register. The maximum output load was reduced to two standard gates, and the steering input and base drive loads were also reduced slightly. These modifications that permitted operation under worst-case temperature conditions were satisfactory and therefore consequently adopted.

The studies were continued to determine the requirements for even better operation. Inductors added in series with the steering input resistors permitted a substantial increase in operation speed and a reduction in trigger power.

The addition of the two inductors decouples the collector from the following trigger steering network during the time of the trigger pulse. After the trigger pulse, there is over 0.5 μsec for the capacitor to assume its new voltage state.

This circuit would be the most desirable one to use from an electrical viewpoint; however, the addition of the two inductors would require more than one micromodule for a shift-register stage and, in the interests of economy of volume, the design without the inductors was chosen.

All logic micromods are compatible and use common supply voltages and signal-voltage characteristics. Line receivers and drivers are provided for the transition from computer signal voltage to Fieldata operation.

All electronic components are operated well below rating to assure maximum reliability. Resistors are operated at a maximum of 20-percent of rating. Silicon transistors are junction-temperature limited to 100 C in operation, although circuits were designed and tested for 125 C operating temperatures.

POWER SUPPLY — The power supply is operationally typical of digital computers in that it furnishes a large number of well-regulated output voltages with low source impedance. However, it differs from most computer supplies in two major respects that complicate the design: the requirement for small overall size and poor regulation of the primary power source. A block diagram of this supply is shown in Fig. 4.

The input voltage source for the computer may range from a poorly regulated field-type to a well regulated commercial power line. The d-c power supply has been designed for the following input power conditions: voltage—120 v, 10 percent single phase; frequency—50 to 60 cps, 10 percent; transient voltage range—(5 sec) 31 to 86 cps.

The required d-c output of the supply with two memory packages (4,096 word capacity) is 250 watts, consisting of 13 different voltages. The wide range of input voltage and frequency coupled with the requirement of minimum size and weight, made unsatisfactory the conventional design approach using a power transformer with individual rectifiers and regulators for each voltage. Instead, a power supply incorporating the following features was designed: (1) controlled bridge rectifiers operating directly from the a-c line, to achieve rough regulation in the order of 15-percent; (2) single-section L-C-filter to reduce ripple to less than 10-percent after 60-cycle line input rectification; (3) Morgan regulator circuit, using a silicon-controlled rectifier and a square-loop core to achieve regulation in the order of 2-percent; (4) single-section L-C-filter to reduce ripple to less than 1-percent after high-frequency regulation; (5) silicon-controlled rectifier parallel inverter operating at 1,000 cycles, using a power transformer with separate windings for individual supplies; and (6) individual rectifiers and regulators for each output voltage, where required.

In the bridge rectifier and filter, silicon-controlled rectifiers are used as the primary type of rectification to provide lossless voltage regulation to the Morgan circuit. The regulation required is relatively crude with a large ripple voltage inasmuch as the Morgan circuit can operate with pure or pulsating dc-inputs. Severe voltage and frequency variations of the primary power source make the exclusive use of a Morgan circuit or controlled bridge awkward. If only a controlled bridge is used, the filter choke required is large and heavy, although the capacitor is reasonable. If a Morgan circuit is used exclusively with a conventional full-wave bridge input, the filter capacitor required on the bridge must have a high voltage rating, which represents height, weight, and volume, since physical size increases with voltage rating. In addition, the nearly 2:1 voltage variations from the bridge would make acceptable regulation difficult. The use of a combination of two circuits allows much smaller chokes and capacitors to achieve the same regulation and transient load response for the input to the inverter.

The Morgan regulator and filter circuit provides lossless, tighter regulation for the inverter input.

The circuit generates pulses of approximately constant width to the load, by virtue of the silicon-controlled rectifier acting as a switch in series with the load. The repetition rate of these pulses is controlled by a voltage-sensing feedback network that regulates average potential. The repetition rate ranges from 500 to 2,000 cps; thus, the filter choke and capacitor may be much smaller and lighter than those required if the controlled bridge were used to operate the inverter. The Morgan circuit regulation response is inherently faster than the controlled bridge since its repetition rate is so high. This is an advantage for transient load changes, because the controlled bridge response is always at least a half-cycle behind at line frequencies.

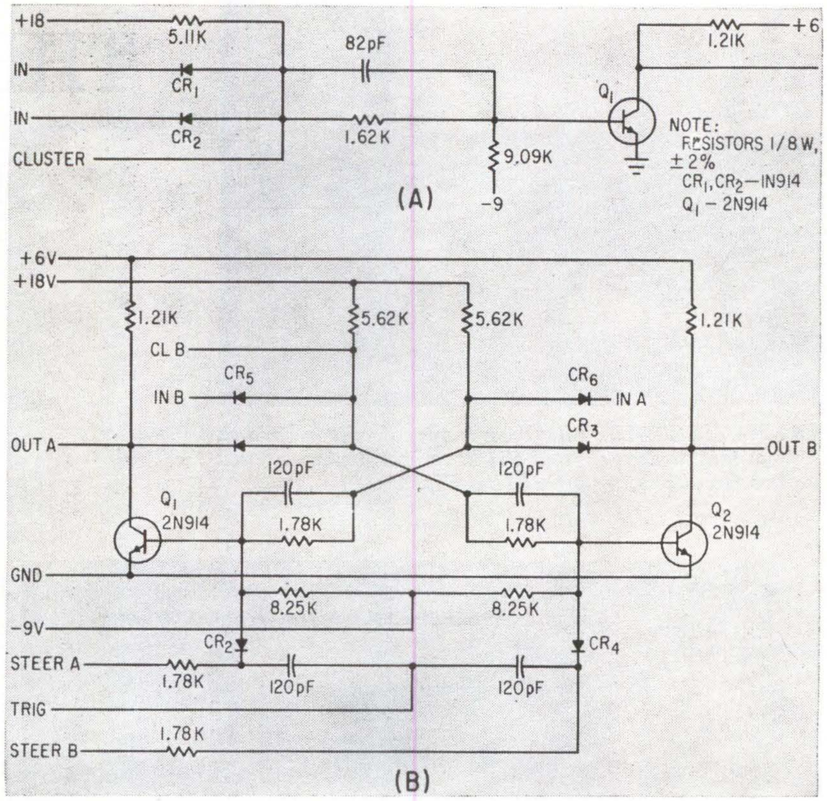
The parallel silicon inverter uses two silicon-controlled rectifiers in a parallel inverter to convert 50 volts d-c to 1,000 cycles a-c. Two additional silicon rectifiers are used for 400 cycles a-c. The scr requirements are 5 amperes average current and about 150 volts peak-inverse voltage to allow for switching transients. These are reasonable ratings, well within the range of available scr's. The rectifiers are triggered 180-degrees out of phase by a binary counter to insure symmetry of the applied square wave to the transformer.

Insuring symmetry of the 1,000-cycle square wave minimizes the 1,000-cycle ripple in the rectified outputs of the individual supplies and reduces the amount of regulation required.

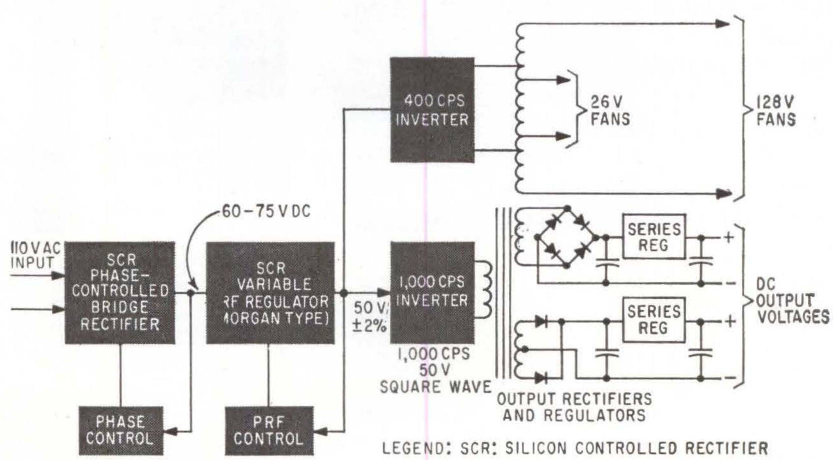
The power transformer has eight output windings for the various voltage supplies. Bridge rectifiers are used on the higher-voltage windings to minimize winding space, while full-wave center-tapped windings are used for low voltage to minimize diode drops. Where voltages are close in value, or load currents are small, one winding is used for several voltage outputs.

The 128-v and 26-v fan-motor supplies are derived from taps on the primary winding of the 400-cycle auto-transformer.

The individual output regulators are of the series and shunt types. The series regulators are used for high-current supplies, with shunt zener-diode regulators for low-current supplies. These regulators are standard. Little regulation is required to compensate for input changes, because of good regulation preceding the inverter; hence, a minimum of power is wasted in series regulators, and power-supply efficiency and cooling are not problems.



STANDARD GATE *circuit is the most frequently used micromodule in the computer (A); shift register operates at a 1.6-Mc clock rate (B)—Fig. 3*

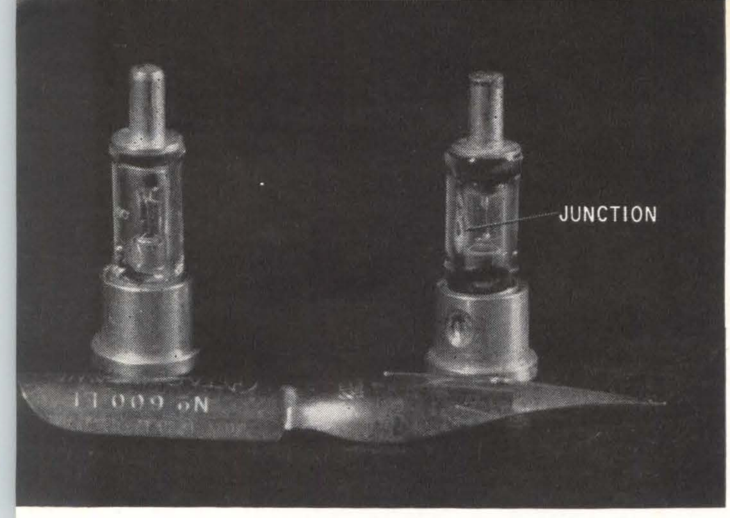


POWER SUPPLY *for the computer uses several modern techniques to achieve high regulation from a widely varying power source—Fig. 4*

CONTROL PANEL—The control panel provides for manual insertion of information into the computer and for monitoring and selecting the various operational modes.

Information may be entered manually by the keyboard on the control panel. Input or output data may be displayed in digital and binary forms by 10 Nixie tubes and 38 neons, respectively.

This work was a joint effort by the Tactical Data Processing activity of the Digital Data Communications Department of RCA Defense Electronic Products. The author thanks A. Coleman, E. Schlain, R. Torrey, W. Miller and H. Sauer for their work.

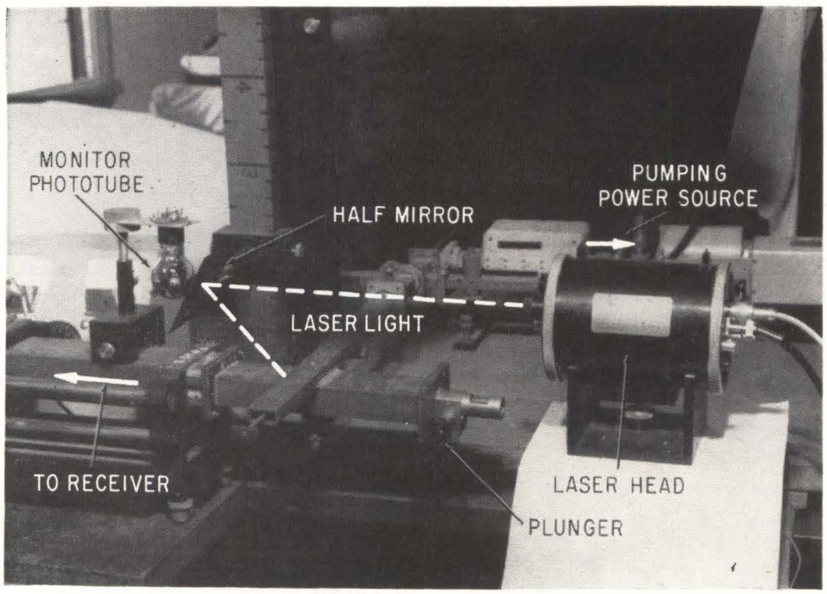


PARAMETRIC DIODES. *Two kinds of silver-bonded, point-contact diodes (Ge and Si) have been tested. Shown here are Ge diodes, type GSB1B—Fig. 1*

THE VERSATILE
How It Detects

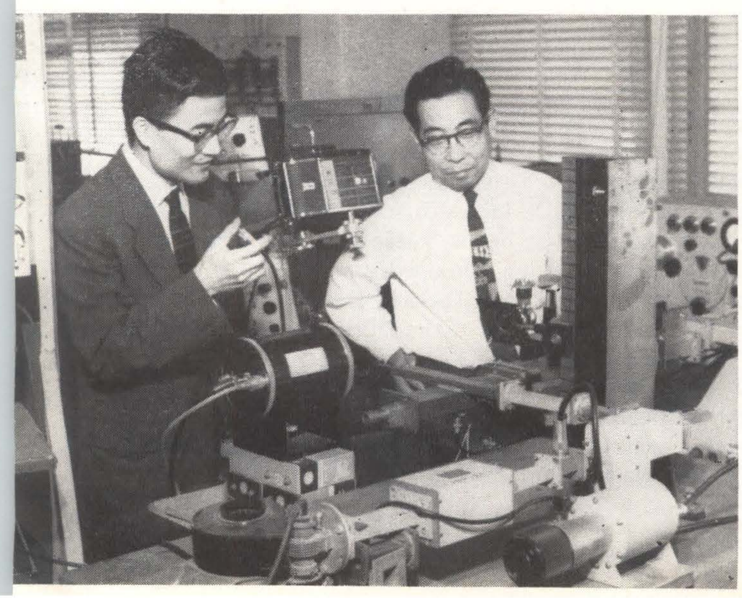
By S. SAITO, K. KUROKAWA,
Y. FUJII T. KIMURA and Y. UNO
Institute of Industrial Science,
University of Tokyo, Tokyo, Japan

SEVERAL methods of demodulating laser signals into microwave have been tested and it has been found that the semiconductor diode has a high quantum efficiency. Further, the diode, which can be used in the infrared region, allows parametric amplification of the demodulated signal. Experiments show that parametric diodes can demodulate and amplify the signal from a ruby laser.



DOTTED WHITE LINE *shows path of laser beam in experimental setup—Fig. 2*

AUTHORS *Shigebumi Saito (right) and Kaneyuki Kurokawa (left) demonstrate the experimental setup used in demodulating and amplifying laser signals*



PRINCIPLES—For frequency conversion, especially demodulation of laser light, nonlinear devices are necessary. A. T. Forrester[1] demonstrated the square-law characteristics and microwave response of a photocathode, and B. J. McMurtry and A. E. Siegman[2] succeeded in detecting and amplifying the beat components in laser light. They used the external photoelectric effect, or photoelectric emission, in which the electrons are carried away from the cathode material by photon energy. There is another photoelectric effect, the so-called internal photoelectric effect (a general term for photoconductivity, photovoltaic effect, etc.) that uses the same principle — electrons are taken away from the filled band to the conduction band by acquisition of photon energy.

To discuss the applicability of these photoelectric effects to a laser detector, consider quantum efficiency. The signal-to-noise ratio of optical superheterodyne reception is proportional to the quantum efficiency η, as

$$S/N = \eta P_{in}/h\nu B$$

where P_{in} is input light power, h is Planck's constant, ν is light frequency and B is receiver band-

POINT-CONTACT DIODE and Amplifies Laser Light

Laser signals are demodulated and converted into microwave by a semiconductor diode that also parametrically amplifies the demodulated signal

width. The quantum efficiency of the usual photocathode material is poor. To 6,943 A light from the ruby laser, for example, $\eta = 10^{-2}$ to 10^{-3} for a Ag Cs photocathode and $\eta = 10^{-5}$ to 10^{-6} for an oxide cathode. By contrast, the internal photoelectric effect of the semiconductor has a quantum efficiency of nearly 100 percent. Thus it can be an efficient detector. This detector also has the possibility of infrared light detection. The infrared limit of the photoemission is about 1.2 microns in wavelength obtained from a Ag Cs photocathode. For semiconductors, however, the limit it determined by the energy-band gap between the filled band and the conduction band. Many semiconductors have a low energy gap; for example, an intermetallic compound semiconductor InSb has an extremely narrow band gap, 0.17 ev, which means that light of 10 microns wavelength is still detectable.

H. Inaba and A. E. Siegman[3] and L. U. Kibler[4] first reported the detection of the laser light by a *pin* silicon diode and a germanium diode, respectively. We have detected the laser light by a point-contact diode and parametrically amplified the microwave signals.

POINT CONTACT DIODE—Since the excitation of electrons by incident light may take place without any appreciable time delay, the frequency response of the detecting device is restricted chiefly by the velocity of holes or electrons, recombination, and the additional resistance or capacitance. Since the semiconductor point-contact diode is conventionally used for microwave detection, it has sufficiently fast response.

Because these diodes are made for parametric amplification, both detection and amplification can be obtained by the parametric principle. This device gives high gain, low noise figure and a wide bandwidth. It may be an excellent and sensitive laser detector.

LASER—The laser used is a Raytheon model LH-1. The crystal is 0.05 percent trivalent chromium ion doped ruby, 2.5 inches long and 0.25 inch in diameter. The pumping xenon flash tube is a EG&G type FX-38. The crystal and xenon flash tube are placed at the two foci of an elliptical mirror. This laser is usually pumped to a level of 300 joules in the experiment. Threshold is about 150 joules. Output power of the laser light is several watts at the peak. The beat frequency f_b of two adjacent longitudinal modes is generally given by $f_b = c/2Ln$, where L is the ruby rod length, n is the refractive index of ruby, c is the light velocity in vacuum; (see Fig. 3A). The third harmonic of beat frequency should be 4,026 Mc. 3,960 Mc is obtained experimentally with both photodiode and photocathode.

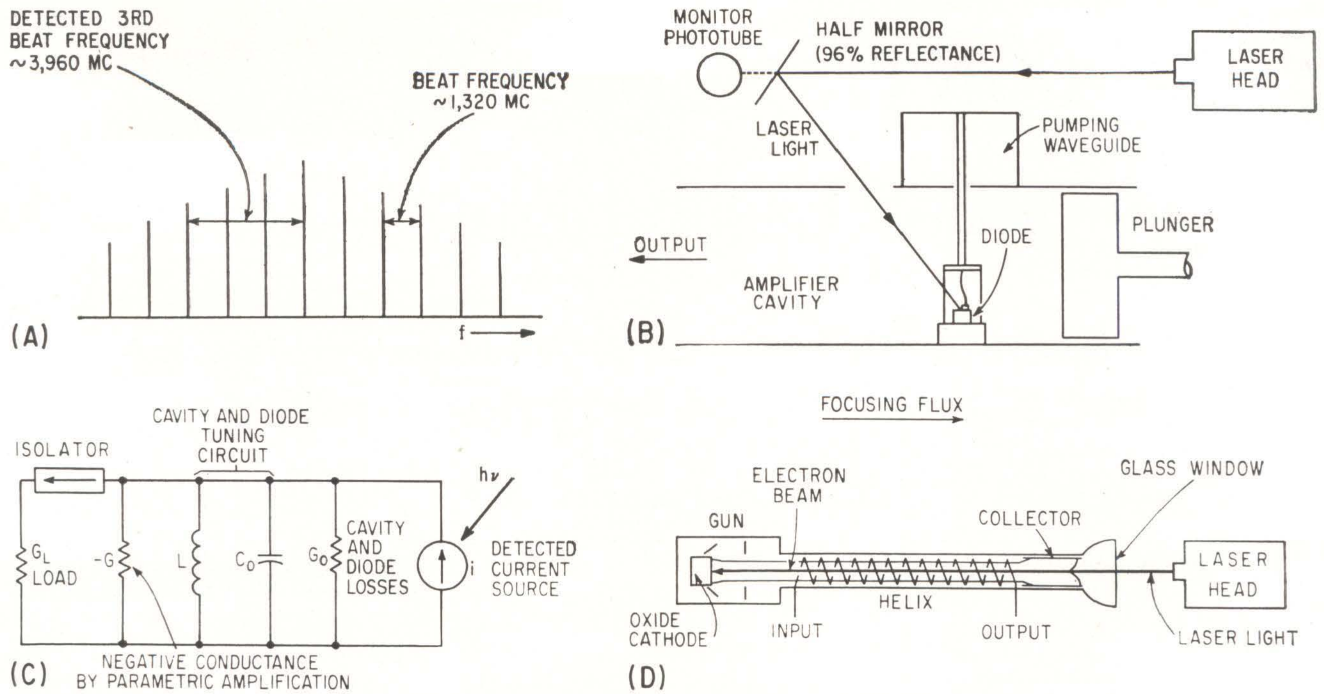
LASER COMMUNICATION

If, as seems possible, photodiodes can be used for down conversion and amplification of laser light, these semiconductor devices could play an important role in laser communication systems of the future. These experiments show that the photodiode is indeed a promising device

Two kinds of silver-bonded, point-contact parametric diodes were tested. They are germanium and silicon (Fig. 1), manufactured by Nippon Electric Co. The germanium diode is a GSB1B; the silicon diode is a test specimen. These diodes are all glass-sealed, and the junction is visible (Fig. 1). The crystals are about 1 mm square, with n-type doping; the point-contact is made by Ag-Ga wire 0.05 mm in diameter. Junction capacitance is 0.1 to 0.3 pf.

EXPERIMENTAL SETUP—The experimental equipment for diode-type detection is shown in Fig. 3B. (See also Fig. 2 and photo). The diode is placed in the 4,000 Mc waveguide cavity. Laser light from the ruby is reflected by a partially transparent mirror (96 percent reflectance) used to adjust the position of incident spot. Neither collimation nor a focusing system is employed. The laser light is projected obliquely to the junction of the diode through a hole drilled on the cavity wall. Behind the mirror, a phototube monitors the laser output power. The 8,000-Mc pumping-power waveguide is placed across the 4,000-Mc waveguide. Pumping power is coupled to the 4,000-Mc cavity by a stub in a hole. A dual beam oscilloscope displays any two of these three: receiver output, diode current or monitor phototube output.

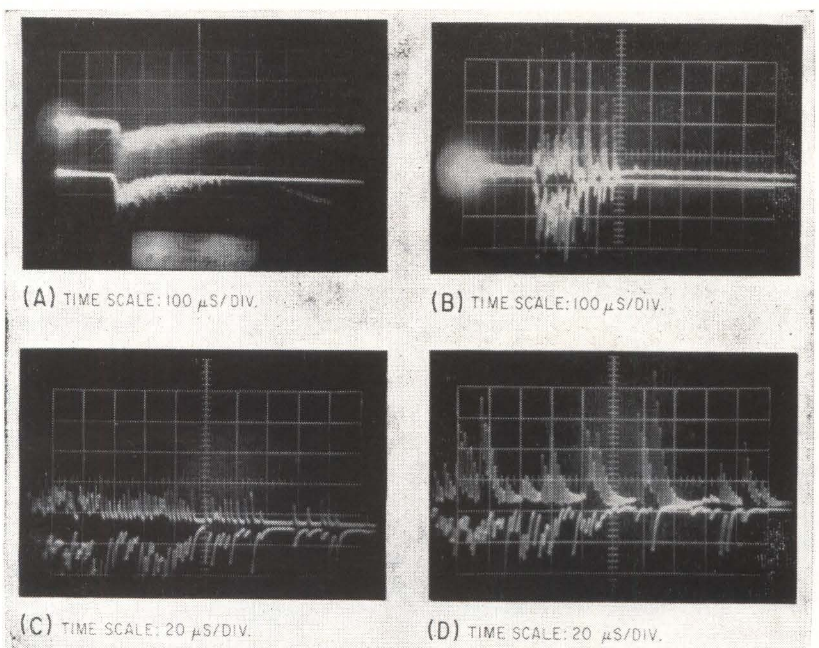
An equivalent circuit of the photodiode including the detector is shown in Fig. 3C. When no pumping power is applied, the negative conductance should be excluded. The signal source is a current generator at the junction excited by photon energy. The isolator de-



SPECTRUM *of laser light (A); diode detector-amplifier system (B); equivalent circuit of detector system (C); and twt photodetector (D)—Fig. 3*

couples the detector from the receiver and stabilize the parametric amplifier.

A similar detection experiment was done with a phototube twt. The experimental equipment for a phototube twt is almost identical with that for the diode. Instead of the junction of the diode as shown in Fig. 3B, a traveling-wave tube with oxide-coated cathode plays a main role. See Fig. 3D. The laser light is projected to the cathode through a transparent glass window and cylindrical collector. The emitted photoelectrons form an electron beam that amplifies the detected signal contained in the electron beam in a conventional way. Twt output is fed to the receiver.

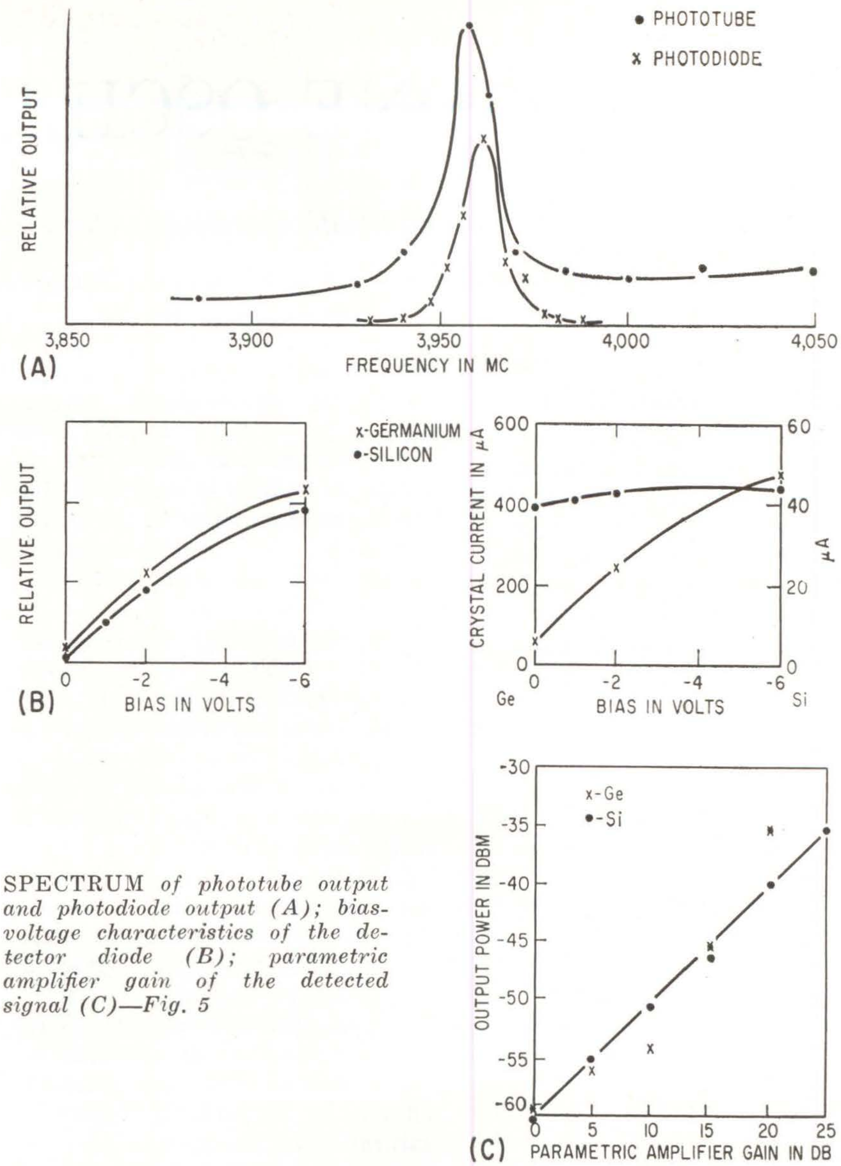


DETECTED OUTPUT *of phototube twt (A) is upper trace; lower trace is beam current (500 μa/div). Detected output of Ge diode (B) is upper trace; lower trace is diode current (100 μa/div). Coincidence between laser output and diode current (C) shows monitor phototube current in upper trace and diode current (100 μa/div) in lower trace. Coincidence between diode current (lower trace, 100 μa/div) and detected output (upper trace) of Ge diode is shown in (D)—Fig. 4*

RESULTS—The output of the photodiode detector not parametrically amplified is shown in Fig. 4B. The spectrum of the detector outputs is shown in Fig. 5A. The half width of the spectrum is about 10 Mc. This photodiode spectrum is almost identical with that of the phototube twt. The output of the phototube twt is shown in Fig 4A. The peak emitted current is about 500 μa and the net amplifier gain at this level of beam current is 0 db. Since the receiver bandwidth is about 10 Mc, the details of the spectrum cannot be found from these data. The equivalent input power of the detected beat component is about −60 dbm for both types of the detectors. The equivalent input power is the input power that could produce the same output as the detected signal of the laser light. Considering the extremely small area of the junction, the diode detectors are much more sensitive than the oxide cathode twt. This is also clear from considerations of the quantum efficiency.

The waveform of the ruby laser output has many irregular spikes. The coincidences of the spikes between the three waveforms of the monitor phototube output, diode current and detected output are important. The coincidence between the phototube output and the diode current is nearly perfect (Fig. 4C); the coincidence between the diode current and the microwave output is less perfect (Fig. 4D). Figure 5B shows the changes of the photodiode current and the detected output. The negative bias voltage increases the detector output because the increase of junction impedance makes the junction capacitance smaller. Thus the available output power may be increased.

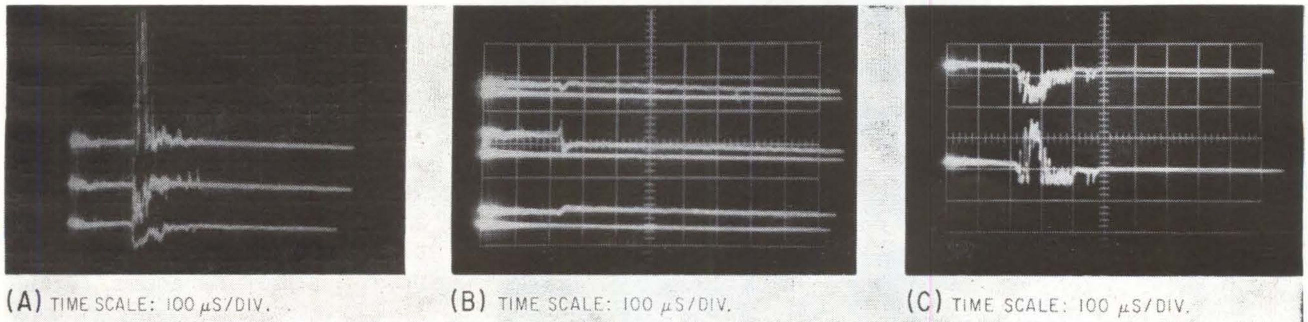
With pumping power, the diode detector system operates as a parametric amplifier. The detected current through the junction is amplified, increasing linearly with the parametric amplifier gain as shown in Fig. 5C. The change of diode impedance, probably the increase of the d-c capacitance C_o in Fig. 3C, is observed during illumination. This could be explained by the increase of capacitance due to decrease of bias voltage induced by photovoltaic emf. This conclusion is supported in that the gain of the parametric amplifier increases during laser illumination if the cavity is detuned by reducing L in Fig. 3C (moving the plunger toward the diode). But gain decreases (Fig. 6A) if the cavity is detuned by increasing L (moving the plunger away from the diode). This change of gain corresponds to the junction voltage. When the diode bias is open-circuited, the photovoltaic emf. appears with the incidence of the light beam and cannot decay. The gain changes suddenly with incidence of light (Fig. 6B). The change of impedance is also observed in direct impedance measurements by the standing-wave detector during illumination. Figure 6C shows an example of the output of the standing-wave detector. The standing-wave ratio changes with laser light.



SPECTRUM *of phototube output and photodiode output (A); bias-voltage characteristics of the detector diode (B); parametric amplifier gain of the detected signal (C)—Fig. 5*

REFERENCES

(1) A. T. Forrester, et. al., *Phys Rev* **99**, p 1,691, 1955.
(2) B. J. McMurtry and A. E. Siegman, *Appl Opt*, **1**, p 51, 1962.
(3) H. Inaba and A. E. Siegman, *Proc IRE*, **50**, p 1,823, 1962.
(4) L. U. Kibler, *Proc IRE*, **50**, p 1,835, 1962.



CHANGE *of parametric amplifier gain for Ge diode (A)—upper trace is for reduced L, middle trace for tuned L, and lower trace for increased L. Gain change when Si diode circuit is open-circuited (B)—upper trace is for large L, middle trace for tuned L, and lower trace for small L. Standing-wave detector output for Ge diode (C) is shown in lower trace and diode current is in upper trace—Fig. 6*

MULITONE OSCILLATORS-New

Transferring the amplitude stabilizing elements to individual tank circuits permits sinusoidal oscillation at several frequencies with no mutual mixing

PICK A FREQUENCY

Here's how to design five oscillators, all tuned to different frequencies, using only two transistors. The multitone circuit can operate at any of the five frequencies, or in any frequency combination.

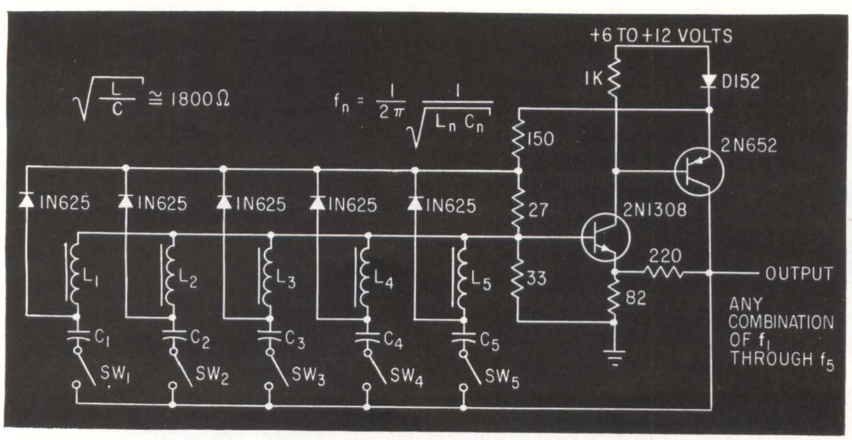
The circuit forms the basis of a five-bit parallel data encoder for telemetry use

THE SIMPLE two-transistor circuit, Fig. 1, represents a large class of multitone oscillator circuits that can be designed for simultaneous oscillations at many independent frequencies. There is negligible interaction between the frequency determining tank circuits, and output has low harmonic distortion. The circuits use noncritical components

The key to multitone oscillator design is the amplitude stabilization process in an ordinary oscillator. Fig. 2A depicts the starting transient of a series-tank oscillator. If the switch is closed at $t = 0$ there will be a buildup of an oscillation at a frequency $\omega_0 \cong 1/\sqrt{LC}$ with oscillation envelope amplitude increasing exponentially proportionally to $t\ (|R_n| - R)/2L$.

In any practical circuit this exponential buildup is eventually limited by nonlinearities in the circuit—usually in the negative-resistance device itself. The amplitude of oscillation stabilizes at a steady state value where energy added by the negative resistance source equals the energy lost in the tank. This steady-state amplitude of oscillation permits the average negative resistance of the source to equal the equivalent positive resistance R of the series tank circuit.

The terminal characteristics of the negative-resistance source are modified by the steady-state oscillation. Not only is there a sinusoidal oscillation at the tank frequency ω_0, but terminal characteristics of the source at frequencies other than ω_0 have been seriously affected by the periodic clipping or saturation of the source, which is necessary to maintain the steady-state amplitude of oscillation. Any attempt to use the negative-resistance source simultaneously at a frequency other than ω_0 will consequently introduce mixing and amplitude-modulation effects.



DIFFERENT PERMUTATIONS *of one through five tones are generated by this circuit, enabling it to operate as a five-bit parallel encoder for industrial telemetry—Fig. 1*

NONLINEAR TANK—If, instead, the equivalent series resistance of the tank circuit can be made to adjust itself upward to equal the negative resistance of the source, steady-state oscillations can be achieved without ever driving the negative resistance source into its nonlinear region (see curves, Fig. 2B and 2C).

In conventional oscillator operation (Fig. 2B), the envelope amplitude increases exponentially until the nonlinear portion of the negative-resistance source curve is reached and equilibrium $R = |R_n|$ established. This equilibrium lies in the nonlinear region and will be maintained by the periodic clipping or saturation of the transistor, tube or tunnel diode used as the negative-resistance source.

In the tank-stabilized oscillator, Fig. 2C, the envelope amplitude increases exponentially, but is limited by the increasing positive series resistance of the nonlinear tank circuit; $R = |R_n|$ in the steady state, but now the equilibrium of positive and negative resistances occurs in the linear region of the negative-resistance source. The source can be used simultaneously at other frequencies without mixing occurring, if the instantaneous sum of all oscillation voltages never drives the source into its nonlinear region.

Nonlinear series tank circuits can be achieved in many different ways (see Fig. 2D). The basic requirement is that the effective series resistance of the tank circuit at resonance must increase with rms current amplitude. The V/I nonlinearity of the added circuit element in each tank causes the equivalent positive series resistance of the tank to increase above the low-level equivalent value $R_{eq} = \omega L/Q = 1/Q\omega C$ of the simple series L-C tank circuit, Fig. 2A. The parallel nonlinear elements cause a nonlinear

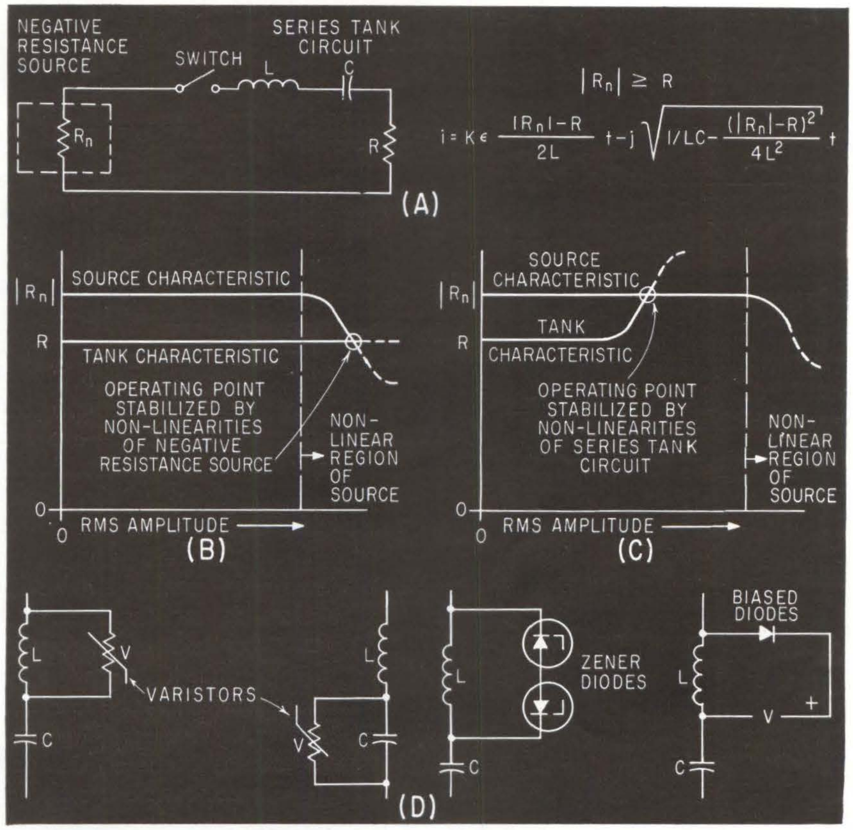
Source of Simultaneous Frequencies

By ROELIF STAPELFELDT
Research Department, Union Switch & Signal Div., Westinghouse Air Brake Company, Pittsburgh, Pa.

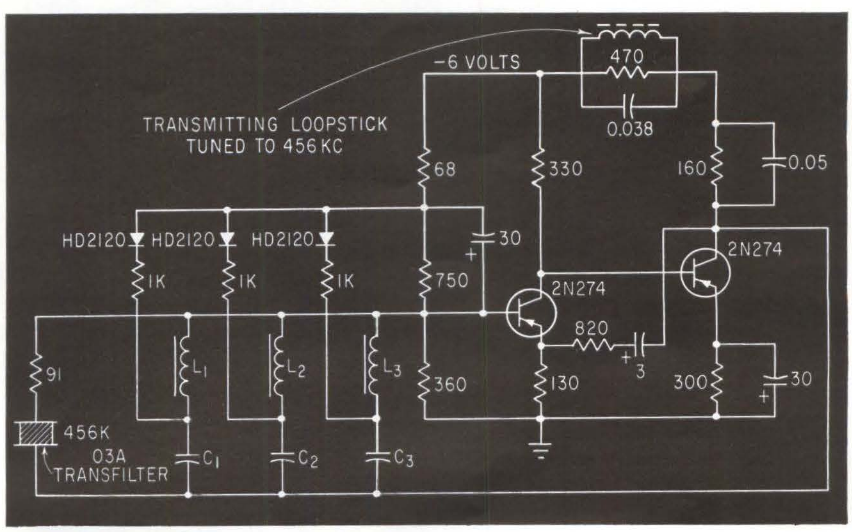
change in the effective Q of the reactive element being shunted and thus affect the equivalent series resistance of the tank circuit. The nonlinear device can be placed in parallel with either the tank capacitor or the tank inductor, depending on d-c bias requirements.

AMPLIFIER CHARACTERISTICS—Many linear negative-resistance sources can be used when designing multitone oscillator circuits. The source's negative resistance must be in excess of the low-level equivalent series resistances of the tanks to be driven by it. But if there is too much excess negative resistance, the operating Q of the tank circuits may be reduced to the point where undesired loading effects and harmonic distortion become appreciable.

APPLICATION—An extension of the multitone oscillator principle is used in the vehicle identification beacon shown in Fig. 3. This circuit achieves amplitude modulation by using an unstabilized r-f tank circuit (a BaTi Transfilter) in parallel with the stabilized a-f tanks. The restriction that the negative-resistance source always must be operating in its linear range is not mandatory if only a single r-f tank is present and its resonant frequency is much greater than the highest a-f frequency tank. Then the r-f is amplitude-limited by saturation or clipping in the negative-resistance source but at such a rapid rate that the effective negative resistance at the lower frequencies remains virtually constant. Moreover the r-f oscillations will be a-m modulated by the much lower audio frequencies and will be suitable for transmission by conventional r-f techniques. The loopstick transmitting antenna and the bypassed 160-ohm resistor comprise a collector load of enough impedance at all frequencies present to allow the transistor amplifier to develop adequate open loop gain at the audio frequencies while effectively driving the loopstick at 456 Kc.



STARTING TRANSIENT *in a simple series-tank oscillator (A). Conventional oscillator is stabilized by adjusting equivalent resistance of negative-resistance source (B); multitone oscillator uses nonlinearities to adjust tank circuit equivalent resistance (C); methods for using nonlinear elements in tank-circuit stabilization (D)—Fig. 2*



LOOPSTICK *of vehicle identification beacon broadcasts 465-Kc carrier amplitude-modulated by sum of a-f signals generated by three plug-in tank circuits—Fig. 3*

Here is a squelch circuit designed for point-to-point vhf and uhf receivers. It is self-adaptive to changing noise levels and receiver gain. It has smooth, noiseless, on-off transition ideal for use in remote unattended receivers, in aircraft, or in mobile communications

FAIL-SAFE SQUELCH CIRCUIT

By H. G. MICHAEL*
Collins Radio Company
Cedar Rapids, Iowa

RECEIVERS for point-to-point communication in vhf and uhf bands have a squelch scheme that supressses the noise output of the receiver when no carrier is present.

Previous squelch schemes had several drawbacks; they required either adjustment of a manual threshold control, or could be turned on accidentally by high ambient noise, or the squelch threshold level would vary with varying receiver gain.

* Presently at Space Craft, Incorporated, 8620 South Memorial Parkway, Huntsville, Alabama.

This squelch overcomes these drawbacks; it has fast attack and release times; it self adjusts to changing noise levels; and it is fail-safe, that is, the squelch opens and remains opened when the receiver gain is below the threshold level.

The squelch does not require external controls, and may not be accidentally turned on by high ambient noise; moreover, it will not permit simultaneous reception of two channels if their frequency difference is greater than the upper cutoff frequency of the receiver audio system.

The system is based on the fact that the carrier-to-noise ratio at the i-f output of the receiver depends on the noise bandwidth of the i-f stage; therefore, the minimum squelch threshold is also related to the i-f bandwidth. The self-adjusting squelch is obtained using the relationship between carrier-to-noise ratio and bandwidths.

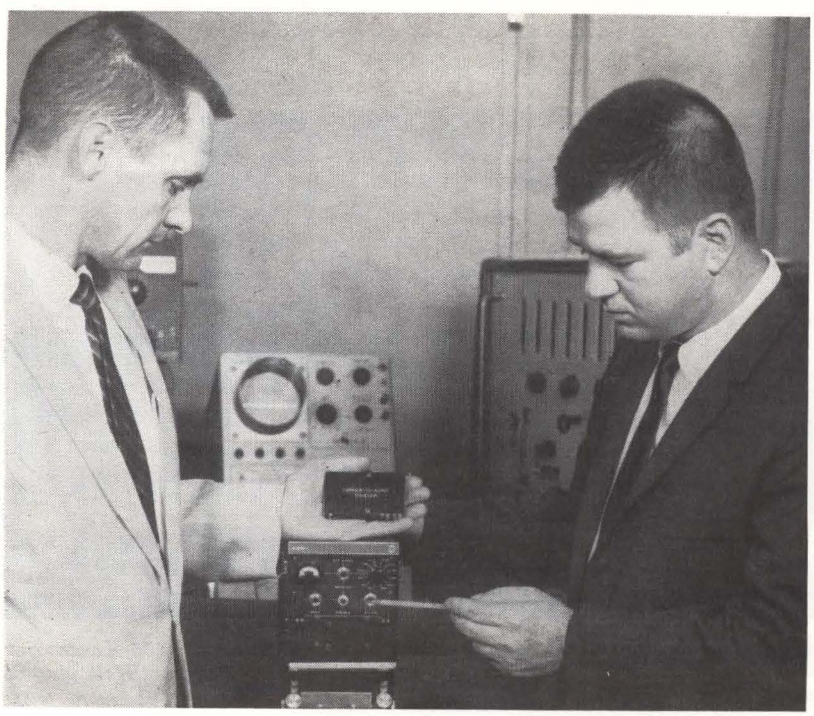
THEORY OF OPERATION—The carrier-to-noise ratio at the i-f output of a receiver is

$$\frac{C}{N} = \frac{C_{in}G}{(KTBF + N_a)G} = \frac{C_{in}}{KTBF + N_a}$$

where C/N = carrier-to-noise power ratio at the i-f output, C_{in} = carrier power at receiver input terminals, G = overall gain, K = Boltzman's constant, T = equivalent noise temperature of antenna in degrees Kelvin, B = receiver i-f bandwidth, N_a = noise power due to ambient noise at receiver input terminals, and F = receiver noise figure expressed as a power ratio.

Thus, assuming that the receiver has sufficient gain to produce a measurable power, the carrier-to-noise ratio at the i-f output is independent of receiver gain. For a given modulation percentage, the signal-to-noise ratio of the detector output, and the carrier-to-noise ratio at the i-f output are proportional; therefore, satisfactory squelch is obtained by actuating it at a fixed carrier-to-noise ratio at the i-f output.

The squelch threshold must be low enough to operate on signals that produce approximately 1-db



AUTHOR, *H. G. Michael (left) and C. P. Womack discuss first working model of carrier-to-noise squelch incorporated to a transistor vhf transceiver*

SQUELCH CIRCUITS: HOW GOOD ARE THEY?

Squelch circuits are designed to quiet a receiver when desired signals are not present. While the object of the squelch action is to eliminate unwanted noise, not all squelch circuits achieve the goal successfully, or conveniently. For example, some squelches are triggered by ignition or other peak signals; others require frequent adjustment of the threshold control; still others introduce clicks and noises when keyed

Adapts To Changing Noise Levels

signal-to-noise ratio at the audio output terminals when the carrier is modulated 30 percent. Since a linear a-m detector changes the signal-to-noise ratio, it is necessary to find a relationship between the output signal-to-noise ratio and the carrier-to-noise ratio at the detector input. This relationship is discussed in the literature[5, 6, 7] and curves are available for receivers with a high ratio of i-f to audio bandwidth. A new curve has been plotted and is shown in Fig. 1A for a typical vhf receiver with a 40-Kc i-f bandwidth and a 4-Kc audio bandwidth. At 30 percent modulation an output signal-to-noise ratio of 1 db occur for approximately 7 db carrier-to-noise ratio at the detector input. It is of interest to determine the signal level required at the receiver antenna terminals to produce a 7-db carrier-to-noise ratio at the i-f output. For a receiver with a 40 Kc i-f bandwidth and a 10-db noise figure, the noise power referred to the receiver input terminals in the absence of external ambient noise is

$$N = KTBF = 1.65 \times 10^{-15} \text{ watt}$$

For a 50-ohm antenna impedance R, the rms noise voltage referred to the antenna terminals is

$$E_n = \sqrt{NR} = 0.29\ \mu\text{v}$$

Therefore, the r-f carrier voltage at the receiver antenna terminals is 0.62 μv for a 7-db carrier-to-noise ratio. This corresponds to 1.24 μv open circuit. Thus, a minimum squelch threshold at a 7-db carrier-to-noise ratio is adequate to obtain squelch action at the lowest usable signal level.

One method of operating the receiver squelch at a given carrier-to-noise ratio uses the noise suppression properties of a band-pass limiter and provides nearly ideal squelch performance. Another method uses the noise reduction properties of a conventional receiver agc system and performs nearly as well as the limiter method but with considerable circuit simplification.

NOISE SUPPRESSION — The noise suppression characteristics of a band-pass limiter may be used to provide an output voltage proportional to the carrier-to-noise ratio at the receiver i-f output. To illustrate the limiter properties that make this possible consider a perfect limiter with band-pass filters. The power output P_o is constant for any given input level above zero. The noise power output with no carrier at the input (N_{nc}) and carrier P_o. The carrier power output with no noise at the input (C_{nn}) is also equal to P_o. Noise power output with carrier is N_o and carrier power output with noise present is C_o. When noise and carrier are both present at the input, the output ($C_o + N_o$) is still equal to P_o. Thus

$$P_o = N_{nc} = C_{nn} = C_o + N_o = \text{constant}$$

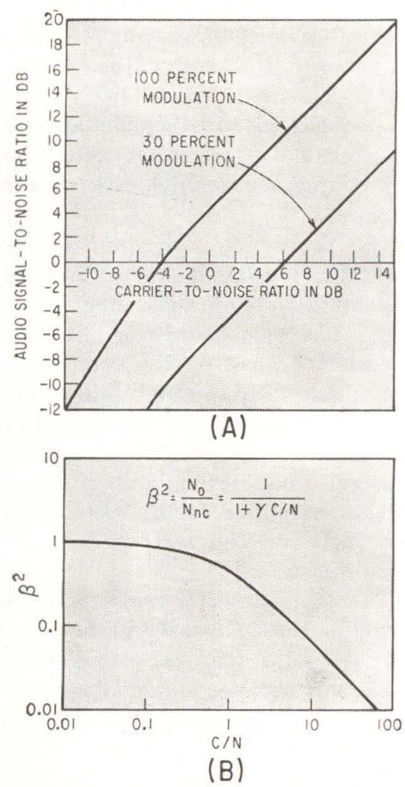
The noise suppression characteristics of the limiter as a function of the carrier-to-noise power ratio at the limiter output may be determined by

$$\beta^2 = \frac{N_o}{N_{nc}} = \frac{N_o}{N_o + C_o} = \frac{1}{1 + C_o/N_o}$$

The term β denotes the ratio of rms noise voltage at the limiter output in the presence of a carrier to the noise voltage when no carrier is present. Thus, β^2 is the noise power suppression factor of the limiter when noise and carrier are both present at the limiter input. Davenport[4] has shown that the carrier-to-noise ratio at the limiter output is related to the carrier-to-noise ratio at the limiter input by

$$\frac{C_o}{N_o} = \gamma \frac{C}{N}$$

where γ is a function of the carrier-



SIGNAL-TO-NOISE *ratio at output of linear a-m detector plotted against carrier-to-noise ratio for 40-Kc i-f bandwidth, and 4-Kc audio bandwidth (A); ideal band-pass limiter noise-suppression characteristic (B)—Fig. 1* to-noise ratio at the limiter input. Thus, the noise power suppression factor in terms of carrier-to-noise ratio at the limiter input is

$$\beta^2 = \frac{1}{1 + \gamma \dfrac{C}{N}}$$

A plot of β^2 for various C/N ratios is shown in Fig. 1B. Sufficient change in noise power is available at the limiter output to operate a squelch circuit at a carrier-to-noise ratio of about 6 db at the limiter input. Therefore, the band-pass limiter is an ideal sensing device for operating a squelch system at a fixed carrier-to-noise ratio.

DESIGN CONSIDERATIONS — A limiter is followed by circuits that operate a squelch gate at a predetermined carrier-to-noise ratio. The squelch circuit includes an a-m detector, noise amplifier, noise detector, and modified Schmitt trigger (Fig. 2).

The limiter provides noise suppression; ideally, it should provide at least 20 db of amplitude limiting. The series diode limiter, selected because of its symmetry, has a flat output amplitude characteristic, and a controllable output amplitude. However, it requires a high input level. Therefore, a 500-Kc amplifier stage was necessary between the receiver i-f and the limiter.

The a-m detector converts the noise in the i-f passband to noise in the audio frequency spectrum. Whatever carrier component may be present is removed from the low-frequency noise at the detector output by a band-rejection filter. The low-frequency noise power at the output of a linear a-m detector when no carrier is present is approximately[6]

$$N_a = \frac{\pi}{8} N_{i-f}$$

where N_a is the low frequency noise power and N_{i-f} is the noise power in the i-f passband. This equation applies when the audio bandwidth is at least twice the i-f bandwidth so that the noise-noise beats near the i-f band edge are included. When a modulated carrier is present at the detector input, the low-frequency noise power for C/N_{i-f} greater than unity is approximately[7]

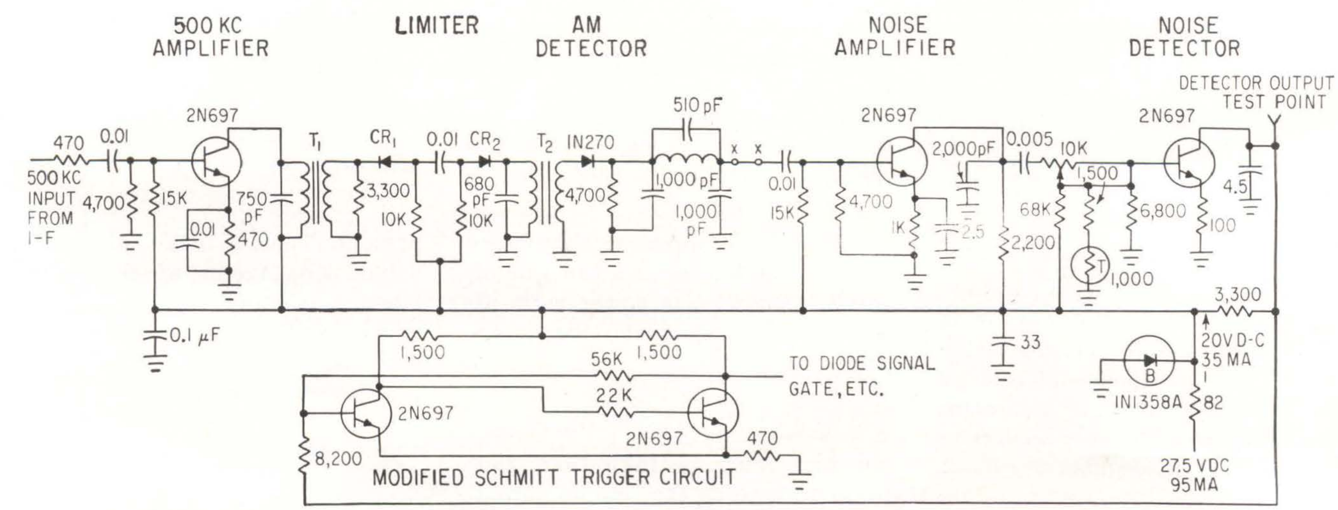
$$N_a = N_{i-f}\left[\frac{1 + \dfrac{M^2}{2} + \dfrac{N_{i-f}}{2C}}{1 + \dfrac{N_{i-f}}{C}}\right]$$

Thus, the low-frequency noise power at the a-m detector output increases in the presence of a carrier. For example, at a 6-db carrier-to-noise power ratio, the low-frequency noise power is increased by approximately 3.5 db.

The noise amplifier increases the noise power from a-m detector to a level sufficient to operate the noise detector. The frequency response of the noise amplifier extends from the upper end of the audio range to at least one-half the i-f bandwidth. This insures that most of the noise power will be amplified and that any modulation components not removed by the limiter will be attenuated.

A noise detector converts the amplified noise to d-c voltage that operates the squelch control circuit. The d-c output from the noise detector varies with the noise power. A transistor for the noise detector and its d-c gain enhances the voltage change associated with a given change in noise power. In addition, the transistor detector can be arranged so that a decrease in noise power at the input produces an increase in d-c voltage at the output (see Fig. 3A). It is easy to actuate a trigger circuit at a d-c output level from the noise detector.

A trigger circuit assures fast snap-action turn-on and turn-off of the receiver audio output at predetermined carrier-to-noise ratios. The snap-action eliminates intermittent or distorted audio output on threshold-level signals. The trigger circuit accurately controls the hysteresis (range between turn-on and turn-off voltages) for optimum performance of the squelch in the presence of weak signals that may have a changing level due to fading. The hysteresis effect is also useful in minimizing the effects of carrier shift or modulation components that may show up on heavily-modulated signals. Therefore, the trigger circuit can be adjusted to turn on at a selected d-c voltage and turn off at a lower d-c voltage. The hysteresis range can be varied to suit applications. The modified Schmitt trigger has all of these desirable characteristics



EVALUATION *circuit diagram of the carrier-to-noise squelch system; modified Schmitt is triggered by output of noise detector—Fig. 2* and is fail-safe; that is, failure of any stage ahead of the trigger input causes the squelch gate to remain in the state that allows the receiver audio output to be heard.

The squelch gate either passes or blocks the audio signal according to whether the Schmitt trigger is on or off; a diode gate is used. When the trigger is on the diode, which is forward biased, lets the audio signal pass to the output circuits. When the trigger is off the diode, which is now reverse biased, blocks the audio signal.

The turn-on threshold of the carrier-to-noise squelch is a function of the i-f bandwidth preceding the limiter input, noise ampliger gain, noise detector gain and operating point, and Schmitt trigger turn-on voltage. The noise amplifier gain is easiest to control. Tests were run to determine the range of control. The curves (Fig. 3B) show that the threshold can be varied from about 3 μv to over 100 μv by varying the noise amplifier gain.

CIRCUIT PERFORMANCE—The threshold control resistor (Fig. 2) was adjusted to minimum resistance to find the maximum turn-on threshold with the given circuit. The upper limit was approximately 2 μv open circuit. Reliable operation can be obtained at r-f input levels as low as 0.5 μv from the generator by increasing the control resistor. The threshold was adjusted to 1.0 μv (open circuit) and the variation in carrier level required for turn-on was checked over the entire frequency range of the receiver (108.95 Mc to 135.95 Mc). The turn-on threshold was never less than 1.0 μv nor greater than 1.2 μv for any of the channels checked. The threshold control resistor had to be placed at the input to the noise detector rather than the more desirable position across the points marked *X-X*. Therefore, the upper limit of adjustment was limited to 2 μv.

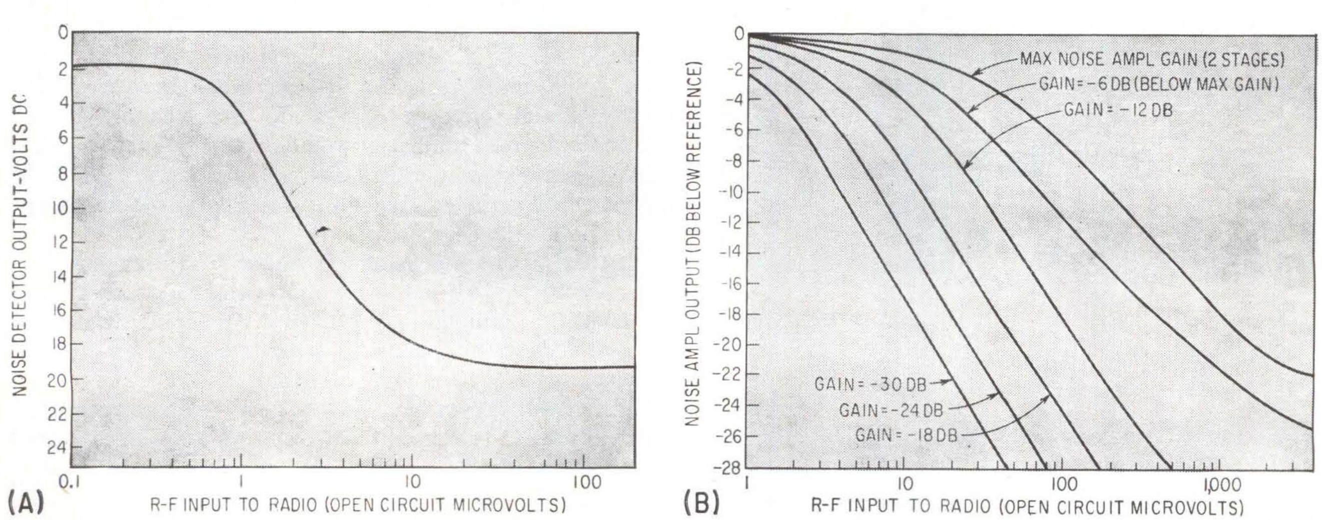
The threshold control was set to turn on the squelch at 0.7 μv. The r-f generator was modulated 30 percent with a 1,000-cps signal; the output $(S + N)/N$ ratio was 1.5 db. The noise generator fed the receiver i-f strip just ahead of the 40-Kc band-pass filter. The turn-on threshold was 300 μv and the output $(S + N)/N$ ratio still was 1.5 db. Thus, the squelch circuit is a true carrier-to-noise device with external white noise. An additional test, using the noise output from the brushes of a 28-volt d-c motor was run; the noise, fed into the receiver antenna terminals through a small capacitor, was observed on a scope, and contained many variable-amplitude pulses and spikes. The motor noise raised the turn-on threshold to 100 μv and changed the output $(S + N)/N$ ratio to 1.0 db. Thus, the performance was still essentially determined by the carrier-to-noise ratio.

With the receiver tuned to 118.7 Mc through an attenuator, the squelch performed well at all signal levels. The squelch threshold was set so low that the received signal could not be understood; the operation of the squelch was reliable and consistent. The threshold was also set so high as to give a readable signal with an estimated 15-db $(S+ N)/N$ ratio; the operation of the squelch was also excellent. The turn-on and turn-off times were fast and operation was smooth. No undesirable characteristics were observed during several days of listening at periodic intervals. Ignition noise from cars in a nearby parking lot, observed on a scope at the receiver i-f output, raised, at some times, the noise level by several db; its effect was to raise the turn-on threshold of the squelch. Listening tests, showed that the optimum value of hysteresis is from 4 to 6 db.

The squelch unit was mounted on the front panel of the test receiver. This model has been flown in several two-engine aircraft; circuit performance was excellent.

BIBLIOGRAPHY

(1) W. G. Klehfoth, Squelch System Controlled by Signal-to-Noise Ratio, Collins Tech. Rep. CTR-137, May 10, 1955.
(2) J. M. Tewksbury, A Carrier Operated Squelch System Using Double Superheterodyne Reflex Techniques, Eighth Annual East Coast Conference on Aerospace and Navigational Electronics, October 23,1961, pp 2.1.2-1 to 2.1.2-5.
(3) J. M. Tewksbury, Receiver Squelch Control Uses Double Superheterodyne, ELECTRONICS, Jan. 19, 1962, pp 44-46.
(4) W. B. Davenport, Jr., Signal-to-Noise Ratios in Bandpass Limiters, *Jour. of Applied Physics*, June 1953, pp 720-727.
(5) E. G. Fubini and D. C. Johnson, Signal-to-Noise Ratio in AM Receivers, *Proc. IRE*, Dec. 1948, pp 1461-1466.
(6) W. R. Bennett, Response of a Linear Rectifier to Signal and Noise, B. S. T. J., Jan. 1944, pp 97-113.
(7) J. R. Ragazzini, The Effect of Fluctuation Voltages on the Linear Detector, *Proc. IRE*, June 1942, pp 277-288



NOISE DETECTOR *d-c output plotted against r-f input of the test receiver (A) and noise-quieting characteristics of various noise amplifier gains (B)—Fig. 3*

IMPROVED Air Traffic Communication

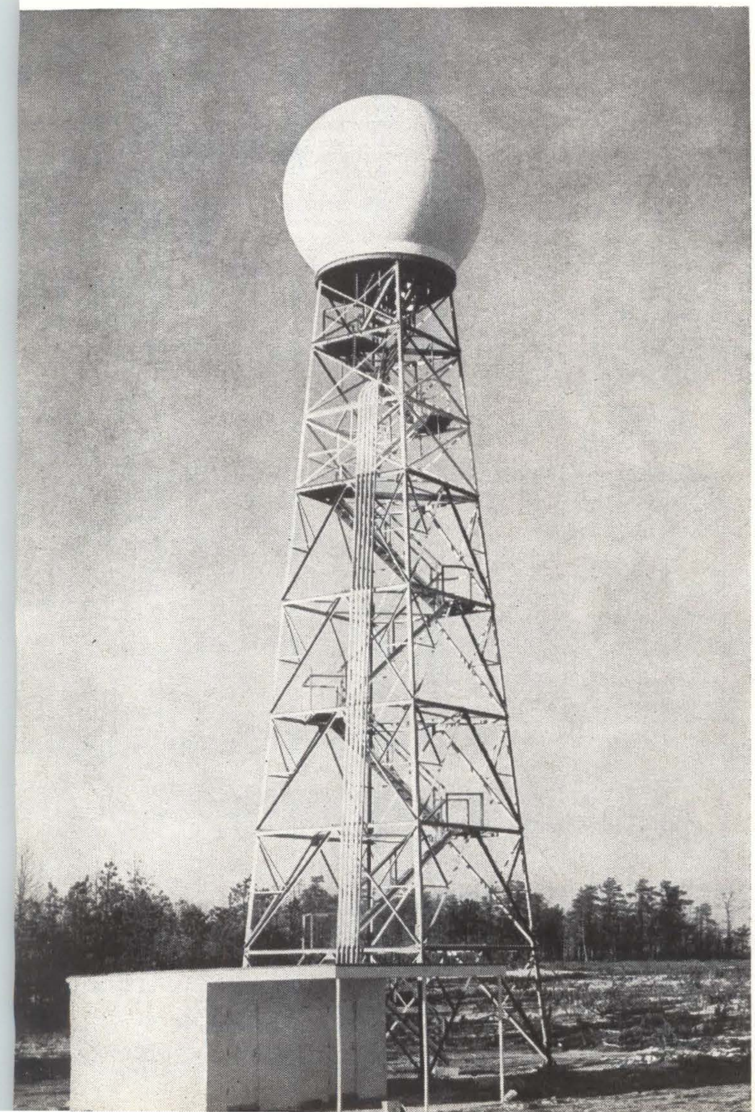
Communications network will be improved in a number of ways now under study. Weather network will undergo comprehensive long-range buildup

By JOHN F. MASON, Senior Associate Editor

THE PILOT of a six-hour jet flight from New York to San Francisco talks to air traffic control men on the ground approximately fifty times. On a one-hour flight from New York to Washington, he uses his voice communications gear eleven times. He averages, on the long flight, one voice contact with the ground every seven minutes; on the short flight, one every five minutes.

The result of all this loquacity is that the pilot and controller are often talking when they need to be doing something else; the available frequencies are loaded; and the entire air traffic control system slows down. The situation is bad today, and will undoubtedly get worse, since by 1975, the number of hours flown per year will increase by one third.

WSR-57 WEATHER *radar at FAA's experimental station can detect precipitation at ranges up to 200 miles*



Solution to the problem will not be sought by advanced data link—although such equipment will be developed for the future; nor will additional frequency allocations be requested. Instead, the need for voice communications will be reduced.

The pilot who now makes fifty voice reports on a transcontinental flight will make approximately 16 in the future. He can dispense with the remaining 34 since his beacon transponder will automatically tell the controller his altitude and identity; ground radar will reveal his position; and his computer-processed flight plan will be transmitted from center to center and presented to controllers on electronic displays (ELECTRONICS, p 37, Dec. 7). Point-to-point data link will also relieve the pilot of much time-consuming conversation with other ground facilities.

In view of the lightened load on voice communication, vhf-uhf will continue to be the basic means of control through 1975. The system will, nevertheless, be improved.

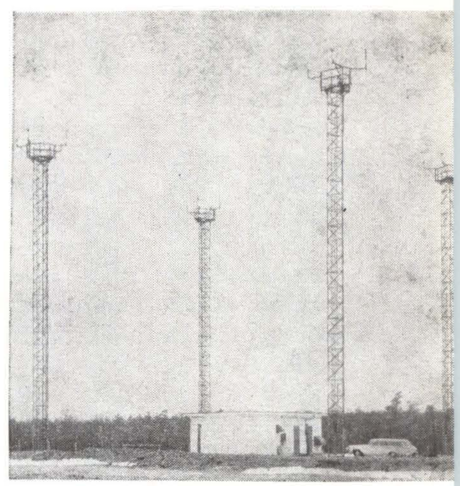
VOICE - SYSTEM IMPROVEMENTS — Six techniques are being considered for increasing the capability of uhf-vhf radio.

• Minor improvements of the current system—Vhf will be changed from 100-Kc channel selectivity to 50 Kc by 1966. (Uhf will continue to operate with 100 Kc separation.) This will increase the number of available channels from 185 to 253. More channels would become available if it were possible to assign vhf transmitters and receivers on adjacent 50 Kc frequencies at the same ground site. To do this, a new generation of ground receivers and transmitters with more exacting specifications than present gear would have to be built, and sharply-tuned antenna coupling devices would have to be developed. Such gear is now being tested at FAA's National Aviation Facilities Experimental Center (NAFEC), near Atlantic City, N. J.

Other minor improvements under study include the possibility of using directional antenna patterns to reduce the number of required frequencies; and the possible benefit of separately operating the vhf/uhf switches of each paired assignment.

• Increase sector size and capacity—Larger sectors would reduce the number of channels needed, by putting more planes on the same channel. It is hoped that with computers, displays and data link, one controller can increase his sector capacity from seven to 20 aircraft.

and Weather Nets Planned



REMOTE SITES *pick up voice messages (vhf and uhf) from pilots and relay them by land line to distant centers below the horizon*

WHAT THE INITIALS MEAN

A/G—Air/Ground
AMIS—Air Movements Information Service
ASR—Airport Surveillance Radar
ARSR—Air Route Surveillance Radar
ARTCC—Air Route Traffic Control Center
ATC—Air Traffic Control
ATCRB—Air Traffic Control Radar Beacon
CARF—Central Altitude Reservation Facility
DME—Distance Measuring Equipment
FSS—FAA Flight Service Station
ILS—Instrument Landing System
L/MF—Low and Medium Frequency
LRCO—Limited Radio Communication Outlet
NDB—Nondirectional
R—Receiver
RAPCON—Radar Approach Control Facility (USAF)
RATCC—Radar Air Traffic Control Center (U. S. Navy)
RCAG—Remote Control Air to Ground
RCO—Radio Communication Outlet
SAGE—Semi-Automatic Ground Environment (of the air defense system)
SVC—Service
T—Transmitter
TVOR—Terminal VHF Omnidirectional Range
UHF—Ultra High Frequency
VHF—Very High Frequency
VOR—VHF Omnidirectional Range
VORTAC—VHF Omnidirectional Range Collocated with TACAN
Wx—Weather Station

In some cases, radio coverage will have to expand beyond line-of-sight. Two methods for doing this are site-switching and the offset carrier (or multiple site transmission) method. The former requires no equipment modification in the aircraft. The ground implementation, however, includes transmitters and receivers and a switching capability appropriate to the way each service is being provided.

The offset carrier method is used in Great Britain and the U.S. (but not by FAA). With a few exceptions, existing 50-Kc airborne receivers have sufficient frequency stability to accommodate the off-set carrier method. One slight modification required for receivers not already equipped would be the addition of a 3 Kc filter.

• Radio trunking on a center-wide basis—This method requires a greater number of transmitters and receivers at each site than exist at present. Also, automatic switching directed from the ground would be necessary. Main consideration is cost.

• One channel per aircraft—Feasibility of assigning each plane a frequency for the entire trip, or even the entire lifetime of the plane will be studied. Cost and complexity of ground gear would be high.

• Wide band voice—Digital techniques can be used to accommodate in a discrete manner a large number of voice messages at the same time, in the same wide band channel. Many examples of this technique have been developed for the Defense Department. Given the proper parameters and utilizing both audio frequency and time multiplexing, this technique would distribute the communications workload over an entire ARTC center. It would also eliminate frequency switching within the center area and provide a multichannel service where the use of adjacent 50-Kc channels is now prevented. Cost of scuttling all airborne and ground equipment and putting in wide band gear would, of course, be very high. The concept will, nevertheless, be studied.

• Data link—FAA does not plan to use air/ground data link in the national system before 1975. The controller will acquire position reports by radar and beacons, and voice will be used for control. Possible future applications for vhf/uhf data link include: confirmation of identity; confirmation of frequency change (for example, after radar hand-off), printing routine weather information, and printing departure clearances. Although no need for such equipment is foreseen in the near future, FAA is supporting the development of components to a limited extent.

REMOTING RADAR DATA—The need for radar remoting stems from two design decisions: (1) that primary radar and beacon, or beacon alone, will be the primary means of monitoring aircraft position and identity; and (2) within each large en route control area a centralized control facility will acquire, process and display the radar data to controllers.

Techniques for remoting radar data include coaxial cable, microwave, and narrow band wire line. Coaxial cable is used for distances up to two miles.

For longer distances, FAA has initiated a study—results of which will soon be released—for determining costs and feasibility of six configurations for processing and remoting radar data: (1) microwave remoting of decoded beacon data to a control center where the data are displayed by one electron gun of 945-line tv display; (2) microwave remoting of both decoded beacon data and radar video data to the same display; (3) microwave remoting of beacon video data (without decoding) to the control center; (4) microwave remoting of beacon video (without decoding) and radar video data to the control center; (5) analog to digital conversion of decoded beacon data at the radar site and remoting of this data by wire line to a control center; (6) analog to digital conversion of decoded beacon and radar video data at the radar site and remoting by wire line to a center.

WEATHER—On a recent flight from New York to Washington, an FAA official was surprised to see the stewardess busily hauling out trays to serve lunch. He could see the small cups of what the airlines believe is soup, the boiled chicken resting in a white fluid, the fruit compote piled high with whipped cream, and the cups for the scalding water later.

Although forbidding under the best of conditions, the menu was particularly formidable because of what was going to take place in fifteen minutes. The stewardess had apparently not been told that the thunderstorm ahead would put every tray and every delicacy on it into a quick state of weightlessness, followed, just as suddenly, by at least two g's. The official knew this because he had visited friends in the airport weather station before boarding the plane. The pilot, he learned later, had not had time between flights to check the weather.

To avoid perils of travel such as this one, and others that are far worse, FAA is developing the Common Aviation Weather System (CAWS). "The objective of the system is to communicate weather data to the airspace user," FAA's W. Eggert, head of research for CAWS, said. "The CAWS is actually an engineering problem. We are not trying to improve the science of meteorology."

The system is being coordinated with the Weather Bureau, the Defense Department, and other government agencies. When operative, it will service all airspace users, both civil and military, in the United States through the 1975 period. FAA has taken over the Air Force's 433-L Weather Observation and Forecasting System in the U. S., the Air Force will handle it for its operations overseas.

The CAWS will consist of four subsystems: observing, processing, presenting, and communicating.

OBSERVING—By 1975, there will be 1,000 surface observing stations—600 will be automatic stations at terminals and generate observations on a five-minute cycling time; 200 will be manual stations at terminals, and 200 will be automatic remote stations—all 400 providing hourly observations.

There will be 100 upper-air radiosonde/rocketsonde stations at hub terminals; 100 pilot-to-forecaster service stations at hub terminals; and 100 longrange radar stations at hub terminals and gap filling radars as dictated by topography. Implementation of this equipment will begin in 1964 and be finished in 1970.

PROCESSING—The CAWS design includes a single national processing center, four regional processing centers, and 100 local centers at hub terminals. Processing subsystem design and implementation is dependent upon the availability of adequate forecasting techniques—many of which do not exist today. Implementation of the subsystem will begin in 1965, and finish in 1975.

PRESENTING—Displays must be numerous, standard and readily understandable. There are five display situations in the CAWS: pilot ground briefing, which will use direct display, tv, telephone and radio; airborne pilot briefing—radio; ATC towers, ATC centers and processing centers will all use direct displays and tv.

The design provides for up to 750 ground briefing stations, 100 continuous weather broadcasting stations and 100 pilot-to-forecaster stations. It anticipates a total of up to 750 tower displays and 20 to 30 center installations.

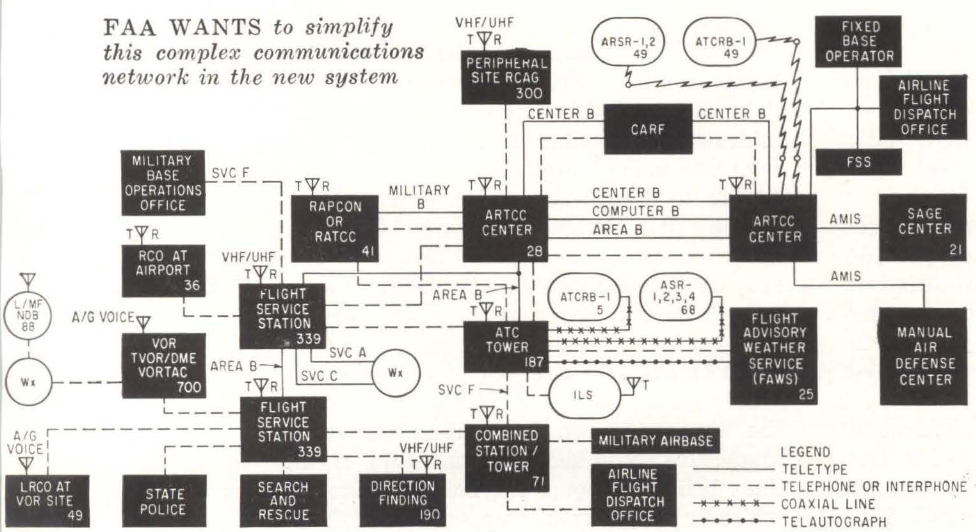
COMMUNICATING—The CAWS design includes an evolutionary transition from the present multiple civil and military communication circuits to a configuration that uses only two primary circuits—both transmitting alphanumeric and graphic messages. One of these circuits is used by aviation meteorologists, civil and military, for collecting observations and exchanging intra-processing products. The other circuit transmits only operational products to CAWS users—pilots, dispatchers, and the ATC system. Both circuits use the normal telephone line bandwidth.

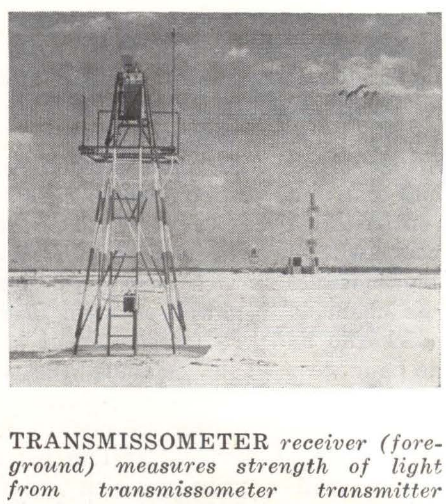
Telephone links with automatic telephone briefing equipment will be used for pilot ground briefings. Radio links (L/MF, vhf, uhf) will be used for pilot-to-forecaster, continuous weather broadcast and advanced planning transmissions.

Around-the-base circuits, ATC tower and center displays and local processing centers will use tv, mainly to present local weather radar data.

LAST IN A SERIES OF THREE ARTICLES.
First appeared on Dec. 7, second on Dec. 14

FAA WANTS *to simplify this complex communications network in the new system*

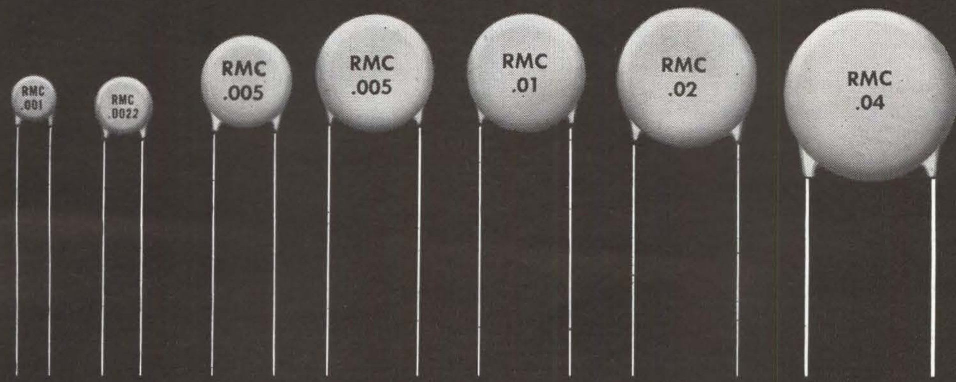




TRANSMISSOMETER *receiver (foreground) measures strength of light from transmissometer transmitter (background) to determine visibility*

Top Performance at Lower Cost!

RMC
TYPE B DISCAPS



150	680	.0015	.0033	.0047	.0068	.01	.02
220	750	.0018	.0039	.005	.0082	.02*	+80%—20%
330	800	.002	.0047*	2x.002	.01*	+80%—20%	.04*
470	820	.0022	.005*	.01*	.02*	2x.004	+80%—20%
500	.001	2 x 800	2x.0015	±20%		2x.005	
560	.0012	2 x .001	2x.002*	.02*			
				+80%—20%			

*Rated 500 V.D.C.W. Flash test 1250 V.D.C.
Life test per EIA RS-198

Disc sizes under ½" diameter have lead spacing of .250. Discs ½" diameter and over have .375 spacing.

SPECIFICATIONS

POWER FACTOR: 1.5% Max. @ 1 KC (initial)

POWER FACTOR: 2.5% Max. @ 1 KC (after humidity)

WORKING VOLTAGE: 1000 V.D.C.

TEST VOLTAGE (FLASH): 2000 V.D.C.

LEADS: No. 22 tinned copper (.026 dia.)

INSULATION: Durez phenolic—vacuum waxed

INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms

AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms

Type B DISCAPS are rated at 1000 working volts yet cost no more than ordinary lighter constructed units. Designed for by-passing, coupling or filtering, applications, Type B DISCAPS are available in capacities between .00015 and .04 MFD. They meet or exceed all EIA RS-165 specifications for Z5U ceramic capacitors and show a minimum capacity change between +10° C and +85° C.

Type BTM values to meet MIL C 11015B available on special order.

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS COMPANY
A DIVISION OF P. R. MALLORY & CO., INC.
GENERAL OFFICE: 4242 W. Bryn Mawr Ave., Chicago 46, Ill.
Two RMC Plants Devoted Exclusively to Ceramic Capacitors
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

New Approaches to Electronic Self-Repair

Natural physical phenomena may increase electronic reliability

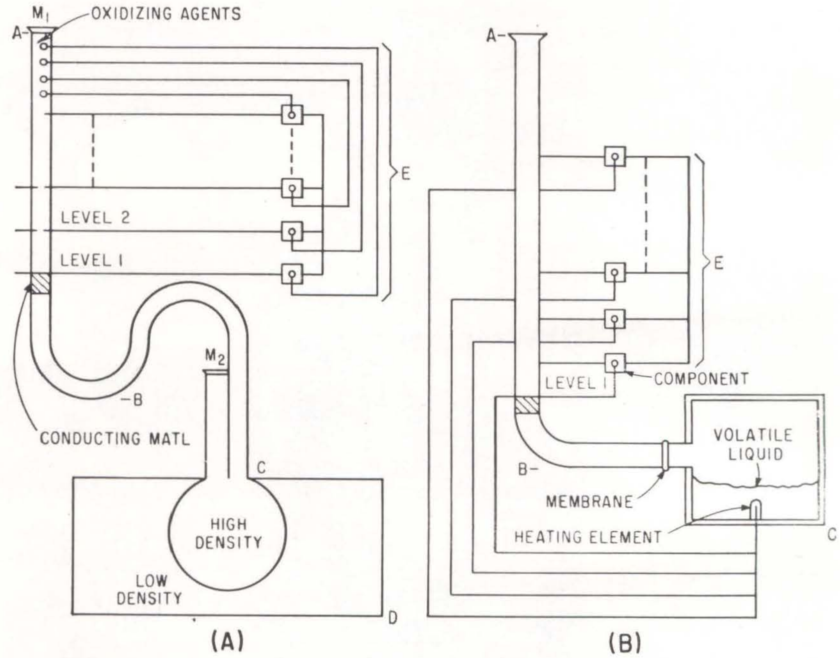
AS MILITARY and space requirements necessitate the construction of more and more complex systems, the contemporary philosophies of reliability and maintainability will become inadequate for successful performance of mission objectives. Most severely affected will be the systems on which maintenance cannot be performed, such as satellite-borne systems, and strategic military systems where the luxury of even a small downtime cannot be afforded.

A paper investigating various models of self-repair presented at the Aerospace Science and Engineering Symposium at Brooks AFB by Jerome Klion, of the Rome Air Development Center, Griffiss AFB, included the following:

Practical self-repair consists of sensing failure, discarding the failed component, and replacing it with a working one. The comparable requirements in redundant systems have been met with relays, solenoids, and other complex devices. However, dependence on these devices has been the major drawback to satisfactory redundant configurations.

An alternate approach is the use of natural phenomena to effect switching, sensing and interconnection. These may be more reliable and more easily implemented than conventional methods.

One phenomenon that could be used to sense failure is the Peltier effect. Electronic component failure is generally followed or immediately preceded by a change in temperature; by using thermocouples, this temperature change reflected in terms of a voltage outside a preset range can activate replacement. It appears there are more means of reliably implementing replacement and discard than of sensing failure.



OSMOSIS SELF-REPAIR *uses oxidation and osmosis for interconnecting electronic components, (A); diffusion self-repair depends on vaporizing measured amounts of volatile liquid, (B)—Fig. 1*

Replacement or discard might be accomplished by an efficient and reliable phenomenon such as osmosis, gaseous diffusion, tropisms, gravity, induction, or anisotrophy.

OSMOSIS SELF-REPAIR—In osmosis self-repair, automatic switching is accomplished by an air pressure differential caused by failure of an on-line electronic component. If the pressure differential fails to occur, a process of osmosis working independently of the pressure differential provides a backup to restore operation.

In Fig. 1A, section AB is a cylindrical tube with a pressure-sensitive semipermeable membrane, valve or one-way diaphragm M_1, N equally spaced paths along the length of the section, each connected to a separate electronic component in section E, a column of mercury or other conducting material, and N oxidizing agents each connected electrically to a failure-sensing device in each component.

Section *CD* contains solutions of high and low densities separated by a semipermeable membrane. Section *BC* contains a gaseous medium, a pressure-sensitive semipermeable membrane, valve, or one-way diaphragm M_2, and the current level of osmosis.

Initially the column of conducting material is at level 1, providing a conductive path for the necessary power to operate component 1. No power is being provided to the remaining components. If an active component fails, the failure sensor for that component activates its respective oxidizing agent. The ensuing oxidation consumes a prescribed portion of the environmental medium in section *AB*, decreasing the environmental pressure between the column of conducting material and the upper end of section *AB*. The pressure loss causes conducting material to rise to level 2 and complete the upper electrical circuit. At the same time, the failed component is disconnected, stopping the oxidation process.

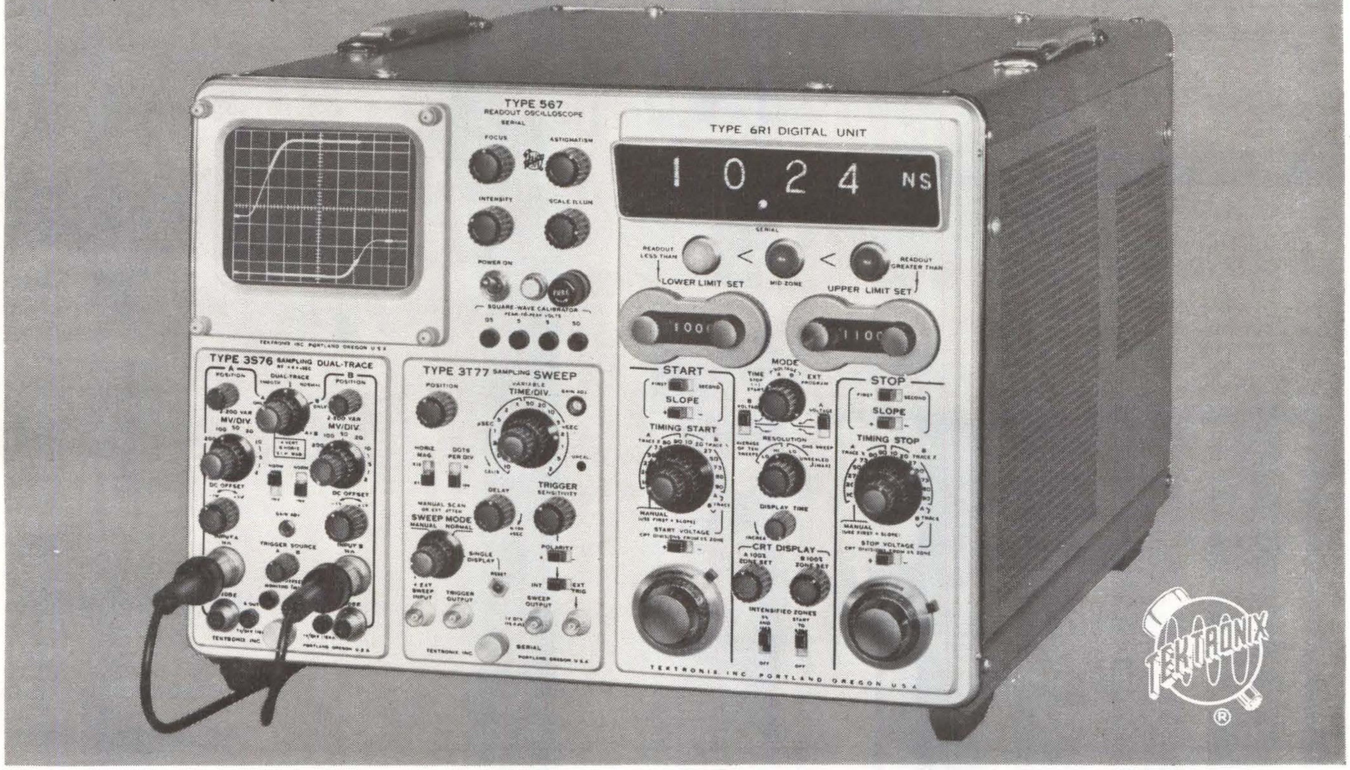
If the oxidizing agent fails, os-

DIGITAL READOUT

of pulse amplitudes *as small as* 2 millivolts peak-to-peak.

of pulse risetimes *as fast as* 0.4 nanosecond.

of time differences *as small as* 50 picoseconds up to 100 microseconds.



TEKTRONIX READOUT OSCILLOSCOPE

with Dual-Trace Sampling

With this new Tektronix Readout Oscilloscope you can measure pulse amplitudes and time increments faster and easier. For, after selecting measurement points on the displayed waveform *once* for all successive similar measurements, you make the tests and read the digital data directly. Indicators light to designate the readout status—whether *in* the preset-limit range, *below* it, or *above* it.

In a typical test application, such as measuring transistor switching times, you can read directly such characteristics as the delay, rise, storage, and fall times; the total turn-on and turn-off times; the width of pulse A and pulse B; and time and amplitude between two selected points on either waveform. You know immediately by the digital presentation and indicator lights whether or not the item tested has met specifications.

Also, the Tektronix Readout Oscilloscope—with digital and sampling plug-in units—can be externally programmed for automatic sequential operation.

On a production line, in a laboratory, or for sustained testing programs, the digital convenience of this Tektronix Readout Oscilloscope can speed up and simplify your measurement applications.

Type 567 Readout Oscilloscope (without plug-ins)	$ 700
Plug-In Units include:	
Type 6R1 Digital Unit	$2500
Type 3S76 Sampling Dual-Trace Unit .	$1100
Type 3T77 Sampling Sweep Unit . . .	$ 650

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

*FOR A DEMONSTRATION—
PLEASE CALL YOUR
TEKTRONIX FIELD ENGINEER*

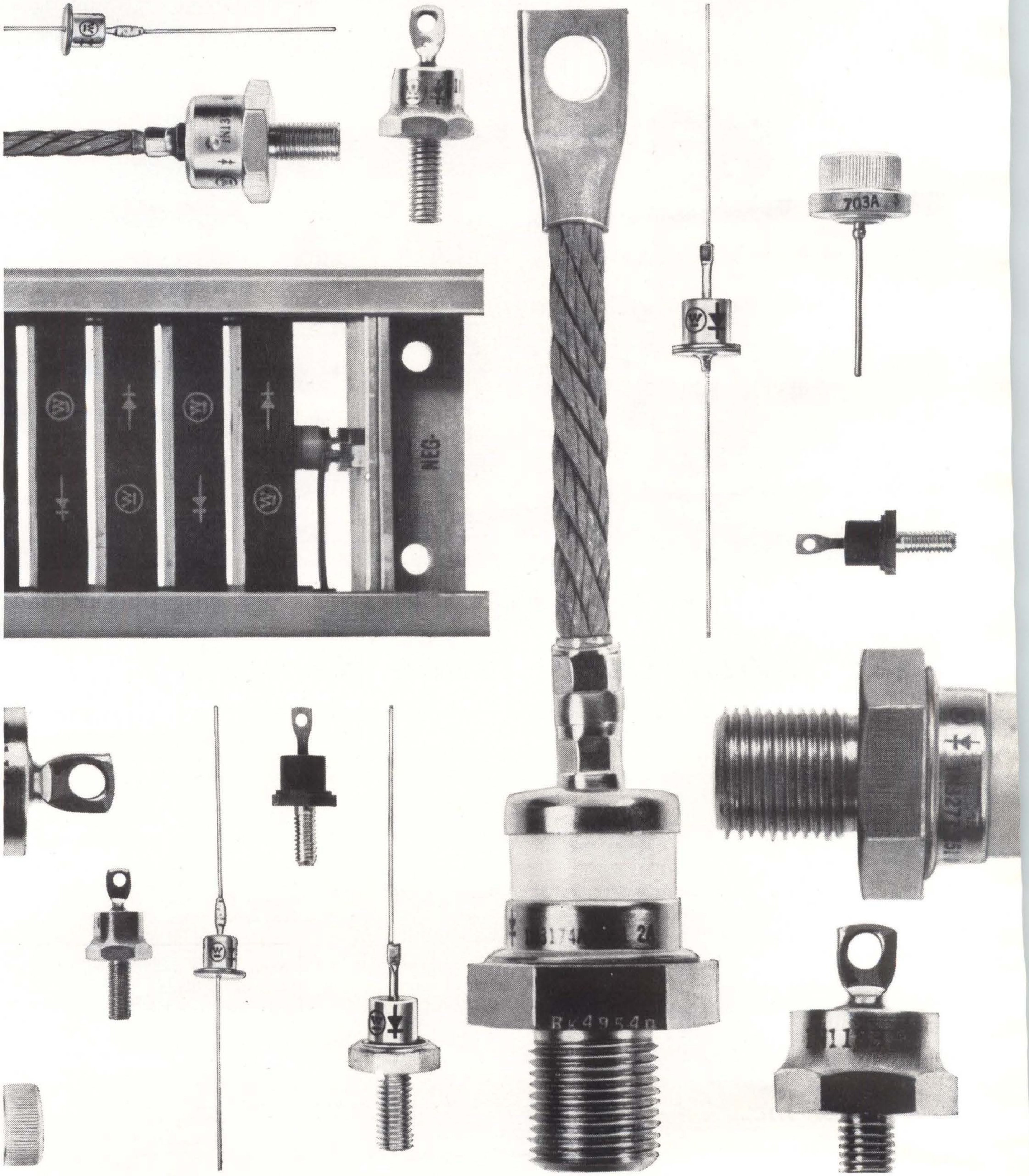
Soon Available—2 new plug-in units to extend digital readout of signal information to low and medium frequency applications.

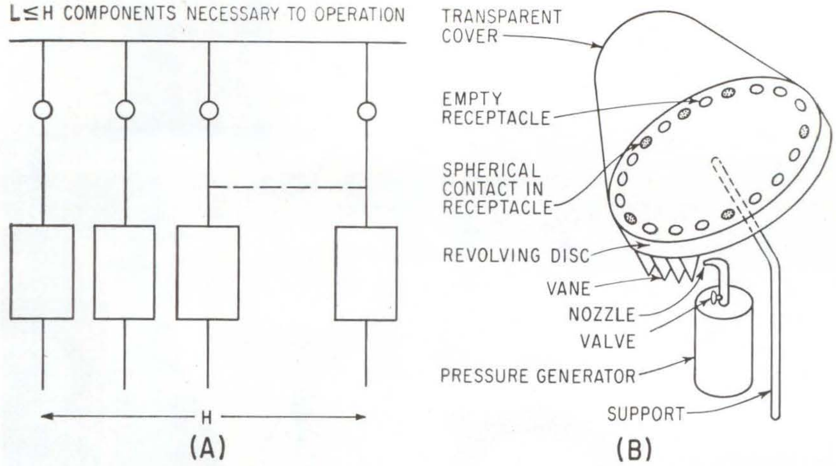
Tektronix, Inc. / *P. O. BOX 500 • BEAVERTON, OREGON / MItchell 4-0161 • TWX—503-291-6805 • Cable: TEKTRONIX. OVERSEAS DISTRIBUTORS IN 27 COUNTRIES AND HONOLULU, HAWAII.*

Tektronix Field Offices are located in principal cities throughout the United States. Please consult your Telephone Directory.
Tektronix Canada Ltd: Montreal, Quebec • Toronto (Willowdale) Ontario • Tektronix International A. G., Terrassenweg 1A, Zug, Switzerland.

For Your Needs . . . One Source

WE RECTIFY ANYTHING!
(except broken romances)





PINBALL PRINCIPLE *of circuit interconnection, (A), is implemented by steel balls held in receptacles by individual magnetic fields, (B)—Fig. 2*

mosis continues at a prescribed rate, which disconnects the failed component and activates the next.

DIFFUSION SELF-REPAIR—As in osmosis self-repair, automatic switching is accomplished by a pressure differential caused by failure of an on-line electronic component. If the pressure differential fails to occur, a process of diffusion provides the necessary pressure differential and restores operation.

In Fig. 1B, cylindrical section *AB* is open at the upper end and bounded at the lower end by a membrane. Electronic paths equally spaced along the tube connect to separate electronic components in section *E*. The tube also contains a column of mercury or other conducting material of length equal to the distance separating any two adjacent electronic paths. Section *BC* is sealed at its far end and contains a reservoir of a volatile substance that partly vaporizes with a relatively small amount of heat. A heating element in the reservoir is activated by a pulse from a failure sensor.

Initially the column of conducting material is at level 1 providing a conduction path for component 1, and no power is provided to the remaining components. On failure of component 1, an electrical impulse is conveyed to the heating element in the reservoir. Vapor pressure in section *BC* increases and diffusion through the membrane increases. The conducting material rises, activating the upper circuit, disconnecting the failed component and deactivating the heating element.

If the heating element fails, diffusion, which continues at a modest rate without heat, ultimately disconnects the failed component and activates the next component.

PINBALL SELF-REPAIR—A possible model of a simple "pinball" binomial self-repair is shown in the system in Fig. 2A. The system is composed of *H* components but only *L* components are needed for operation. The remaining components are inactive.

In the possible design of Fig. 2B, replacement is accomplished by a pinball concept in conjunction with an electromagnetic field. The system is arranged in the disk-like platform in accordance with the configuration of Fig. 2. A circular aperture along the conduction path of each component breaks electrical contact to each component. Magnets are placed in each aperture. A sphere is placed on the discs, having satisfactory conductive and magnetic characteristics. The disc is positioned at an angle to the horizontal plane, and the disk revolves on an axis. The underside of the disk contains an arrangement of vanes. An air nozzle is positioned so that a jet of air introduced through it to the vanes would cause the disk to revolve. The air nozzle and its corresponding valve are constructed so that if air enters the valve at a given rate, it is expelled through the nozzle only after a definite internal air pressure is reached. The result of such a design is that given a constant input of air, the valve expels air in individual bursts of a given force equally spaced in time.

The system is composed of *L*

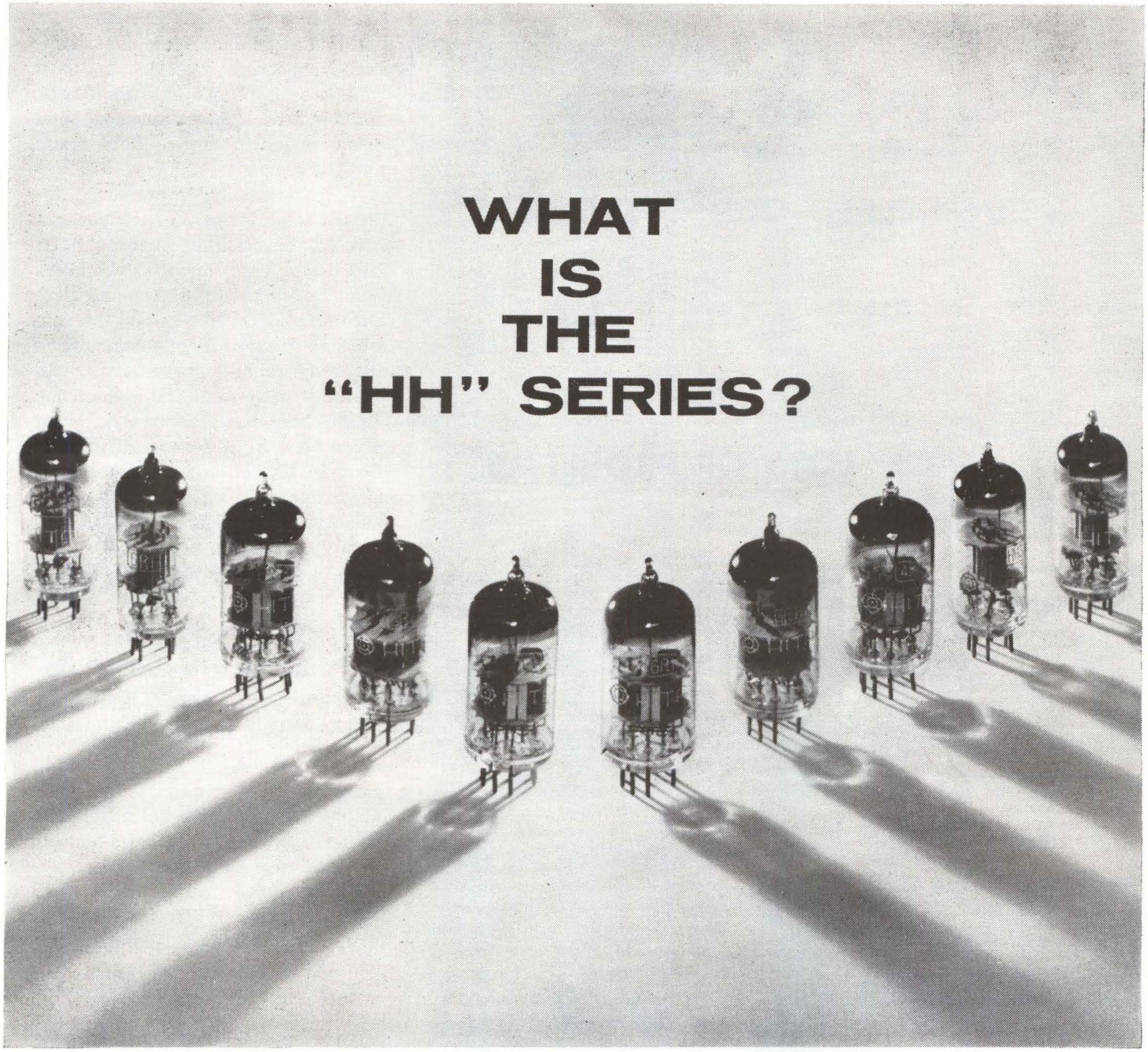
spherical contacts, seated in receptacles around the circumference of the disk, and acting as conducting paths that activate *L* components. An independent magnetic field in each receptacle holds its respective sphere firmly in position. When a component fails, the failure sensor reverses the magnetic field of its receptacle and also supplies air to revolve the disk. On reaching its apex with no applied magnetic field (or at any point if the reversed magnetic field is enough to expel the receptacle), the affected sphere drops out and seeks another receptacle with a favorable magnetic field. At this time, the disk stops and system operation is restored.

BIOLOGICAL SELF-REPAIR — The best-known self-repairing device, and in spite of its shortcomings the most reliable to date, is the human body. On the system level, a remarkable example of an expanding, never-dying system is the human race.

The human body has an average life of 70 years. During this time, the skin appears almost constant and continues to perform its function, yet the mean time to wear-out or replacement of each surface cell is measured in months. Moreover, in the event of a cut, built-in failure sensors immediately begin removal of damaged cells and replacement with working cells.

It is not outside the realm of possibility to consider an electronic system having similar characteristics. The system could be a matrix arrangement of organic semiconductor blocks that could function successfully if enough blocks were operative. In the event of a random, wearout or incipient failure of one or more blocks, a built-in sensing system inherent to the makeup of the material would initiate formation of a new block. Wearout or incipient failures could be predicted or sensed in advance and an automatic replacement rate chemically adjusted and maintained.

One straight-forward approach to self-repair involves a flux and an atmosphere, where the flux could be contained within a given element not unlike that within hollow-core solder and released by breakage of the element. This approach is analogous to blood glucose and air facili-



The "HH" series is Hitachi's new superior line of television receiver tubes, the ultimate in far-reaching reception of television waves.

For RF amplifier of VHF television tuners, specify the 4R-HH2 and 6R-HH2 which feature very high transconductance, high sensitivity and low noise. These twin triode tubes replace the 4BQ7A and 6BQ7A without change of circuit.

For frequency convertor and local oscillator of VHF television tuners, specify 5M-HH3 and 6M-HH3 twin triodes which replace the 5J6 and 6J6 without change of circuit.

The "HH" series is another fine quality line from Hitachi, one of the most completely integrated electrical manufacturers in the world.

INTERNATIONAL IMPORTER INC.

2242 South Western Avenue,
Chicago 8, Illinois, U.S.A.

Hitachi, Ltd.
Tokyo Japan

tating the repair of tissue. Many flux-atmosphere combinations are possible: liquid solders, dental silver, suspended metals. In most cases air could act as atmosphere, resulting in a hardening of bond between the otherwise fluid metal and the element.

A particularly promising approach to self-repair of components involves crystalline anisotropy. It is known that metallic whiskers form on capacitor plates and produce short circuits. It may be possible to turn this phenomenon to advantage; metallic whiskers are an example of crystalline anisotropy where the material has different properties in different directions. Conceivably, circuit elements could be made as single crystals with anisotropic properties, to facilitate repair of a given break.

High-Frequency Optical Phonon Masing Reported

By SY VOGEL
Associate Editor

NEW YORK—A recently observed phenomenon — stimulated emission of phonons with frequencies almost as high as light frequencies—might be used in a new light or acoustical generator or amplifier.

C. D. Becker of Precision Instrument Co. described this phenomenon at the Ultrasonics Symposium. Becker induced stimulated emission of phonons (defined as packets, or quanta, of elastic energy) with an alpha quartz tube filled with mercury vapor (illustration A). The mercury discharge provides ultraviolet (uv) energy that raises (pumps) the energy levels of the quartz molecules; the ultraviolet light spectra that go into the quartz ensuing are thereby affected by the phonon maser action within the quartz.

The spectrometer looks at one of these spectral lines and at the line spectra (Raman lines) whose frequencies are slightly above and below the frequency of the incident-light line; the differences between the spectral intensities observed at low (B) and high (C) values of ultraviolet pumping energies are due to, and indicate, optical-phonon maser action within the quartz.

When enough electrical power is

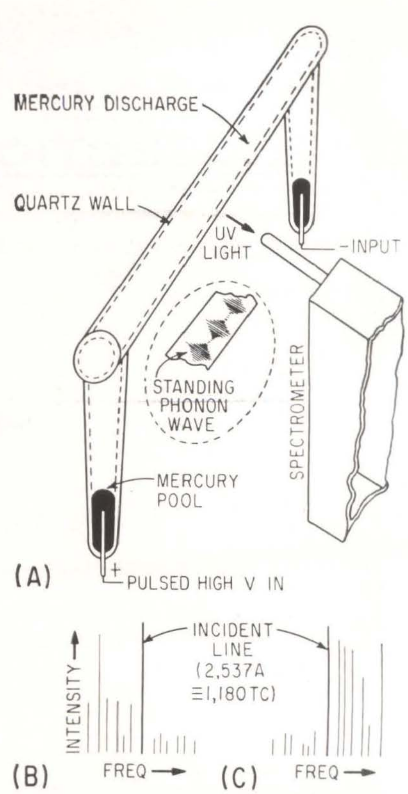
DROPOUT PROTECTION

MINCOM SERIES CM-100 RECORDER / REPRODUCER

Data loss from dropouts is practically eliminated in the CM-100, due to this unique system's predetection recording capability. In ordinary post-recording, a dropout more than 6 db down is generally considered a data loss; the CM-100's operational predetection performance retains such signals through superior phase characteristics and extended bandwidth. **Mincom's CM-100 Recorder/Reproducer,** performing longitudinal recording with fixed heads up to 1.5 mc at 120 ips, also offers 7 or 14 tracks, trouble-free dynamic braking, complete modular plug-in assembly, built-in calibration, instant push-button selection of six speeds. Versatile, reliable, a model of simple maintenance and operation, the CM-100 is tops in its field. Write today for detailed specifications.

Mincom Division 3M COMPANY

Los Angeles 25, California • Washington 4, D. C.



OPTICAL-PHONON MASER *action is produced within quartz walls of tube (A). Spectral lines for low- (B) and high-intensity (C) inputs*

applied, the ultraviolet radiation produced by the mercury discharge is increased enough to drive more than half the quartz molecules to higher energy levels. When the molecules drop to lower energy levels, they emit phonons. The phonons build up a field of elastic energy that stimulates further emission of phonons. (This might be described as "phaser action"—*ph*onon *a*mplification by *s*timulated *e*mission of *r*adiation.) The phonon field comprises several frequencies that are in the order of teracycles, the highest being 100 Tc (10^{14} cps).

When pumping energy is low, the spectrometer sees the normal distribution of spectral lines (B) produced by the scattering of the incident light by the quartz; the lines scattered to either side of the incident frequency are quanta that have either lost or gained energy from the quartz molecules (Raman effect). When pumping energy is increased above a critical level, stimulated emission of phonons occurs within the quartz and the phonon frequencies subtract and add to the incident frequency, thus producing spectral distribution in (C).

WHAT IS HAPPENING IN ELECTRONICS IN 1963 ?

See for yourself
by visiting the

6th international exhibition of electronic components

FROM 8th - 12th FEBRUARY 1963
IN PARIS PORTE DE VERSAILLES

The largest display
in the world
covering the field
of electronics

All components, valves
and semiconductors,
measuring, testing
and electro-acoustic equipments

Send now for full information
and literature :

FÉDÉRATION NATIONALE
DES INDUSTRIES ÉLECTRONIQUES
23, rue de Lübeck - PARIS 16e PASsy 01-16

Under the patronage of the F.N.I.E.

3rd international congress of quantum electronics

organised by the French section
of the I.R.E. and by the S.F.E.R.

FROM 10th - 15th FEBRUARY 1963

FROM 10th - 15th FEBRUARY 1963

Unesco-House
Information : 7, rue de Madrid PARIS 8e

28 years ago...

In 1933, the French National Association of Radio-Electrical Industries, which for ten years had been organizing the annual Wireless Show, decided to exhibit separately the receivers appealing to consumers and components used only by manufacturers and technicians. Thus was born, in January 1934 the first French components Exhibition. By 1957 its international character had already been well established, and since then the International Exhibition of Electronic Components, is reserved exclusively to manufacturers, and opens its doors every year to firms specialized in the field of Electronics.

Largest specialized display.

To-day, it is considered to be the world largest display in the field of components and electronic accessories. Its success grows year by year.
Not only does it display, on a vast scale the world's production of electronic components, but it is also a privileged occasion for specialized constructors and technical elite of all countries to meet and to compare equipment and techniques, and also to build up together the trends of to-morrow's developments.

7 Times more foreign exhibitors in 5 years.

Year by year the international character of the Exhibition is increasing. Whereas in 1957 only about thirty foreign stands could be counted, to-day the Golden Book of foreign exhibitors enlists 250 Firms. As for foreign visitors, the high technical qualification of which was particularly noticeable last year, their number is increasing proportionately. In 1962 they accounted for 12 % of all visitors, coming from 30 different countries.

Products exhibited

In order to maintain the specific character of the Exhibition which is entirely devoted to the field of electronic components, the participation is reserved exclusively to Firms actually manufacturing the equipment listed underneath.
— Variable and adjustable capacitors — fixed capacitors — radiofrequency coils — coils and transformers for industrial and audio frequencies — resistors — terminal and wiring accessories — switching — safety devices — power supplies — racks and chassis — aerials — electro-acoustical material — tubes — semiconductors — meters — relays — equipment and materials for electronic purposes — miscellaneous.

25.000 m² • 800 exhibitors

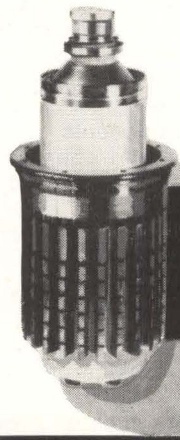
PUBLI-SERVICE - PARIS

CIRCLE 107 ON READER SERVICE CARD

6 th INTERNATIONAL EXHIBITION OF ELECTRONIC COMPONENTS PARIS

CAMPAGNIE FRANCAISE THOMSON-HOUSTON

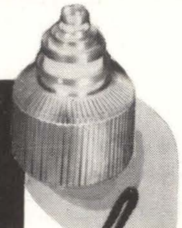
ELECTRON TUBES FOR BROADCASTING TELEVISION—RADARS COMMUNICATIONS INDUSTRY—MEDICINE AND SPECIAL PURPOSES



VAPOTRONS

POWER GRID VAPOR COOLED TUBES

From 15 kW up to 300 kW
From 30 mc/s up to 1000 mc/s



CERAMIC U.H.F. POWER TUBES

CW AND RF PULSE TRIODES AND TETRODES

From 20 W up to 25 kW CW
From 15 kW up to 2.5 MW (peak)
From 200 mc/s up to 3000 mc/s

Engineered to be the finest

TRAVELING WAVE TUBES

CW AND PULSED EM AND PPM FOCUSED

From 30 W up to 4 kW CW
From 100 mc/s up to 6000 mc/s

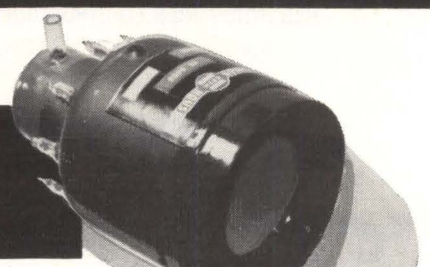


IMAGE TUBES

PICK-UP TUBES (VIDICONS — IMAGE-ORTHICON)
MONOSCOPES
X-RAYS IMAGE INTENSIFIERS
IMAGE CONVERTERS

SPECIAL PURPOSE TUBES

HARD TUBES MODULATOR
SPECIAL APPLICATIONS
GAS-TIGHT THROUGH TERMINALS FOR
HIGH TEMPERATURE AND ULTRA-HIGH VACUUM

GE/SDI

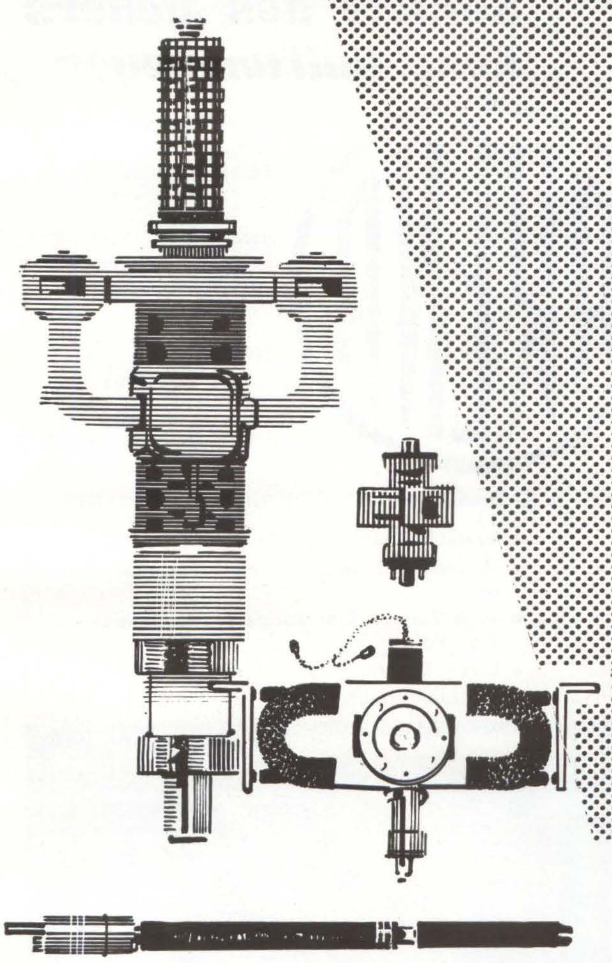
THOMSON CFTH HOUSTON

DIVISION TUBES ELECTRONIQUES • 6, RUE MARIO NIKIS-PARIS XV^{e}-Tel.: SUFfren 91-00
U. S. REPRESENTATIVE: THOMSON ELECTRIC CO. • 50 ROCKEFELLER PLAZA, ROOM 916 • NEW YORK 20 (N. Y.), U. S. A.

6 th INTERNATIONAL EXHIBITION OF ELECTRONIC COMPONENTS PARIS

TUBES AND MICROWAVE COMPONENTS

THOMSON-VARIAN

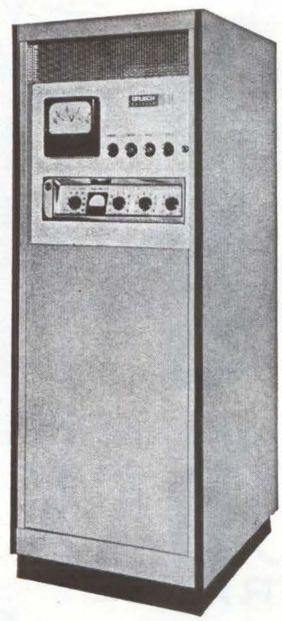


- AMPLIFIERS KLYSTRON
- REFLEX KLYSTRONS
- TRAVELING WAVE TUBES
- MAGNETRONS
- **TR** AND **ATR** TUBES

GE/SDI

THOMSON-VARIAN
6, RUE MARIO NIKIS-PARIS XV^e • Tel.: SUFfren 91-00

CIRCLE 204 ON READER SERVICE CARD



HIGH SPEED STATIC VOLTAGE REGULATORS

Input:
—Mains supply voltage fluctuation ± 15%
—Mains supply frequency 48–52 cycles
—Power factor of regulator at full load more than 0.86

Output:
—Regulation accuracy ± 0.2%
—Overall harmonic distortion Less than 3%
—Admissible load variation 5 to 100%
—Recovery time constant:
—For 20% mains variation 0.04 sec.
—For 95% load variation 0.03 sec.
—Efficiency at full load 96%
—Radiation free—Instantaneous start up
—10 Standard ratings: 0.5—1-2-5-10-15-20-30-40-60 Kva
—Mains supply: 110–117–127 and 220 V.

•

SATURABLE REACTORS

—Power rating from 0.05 to 300 Kva (oven supply, motor control, etc.)

•

MAGNETIC AMPLIFIERS

—For proportional temperature regulation

•

STATIC CONSTANT-CURRENT SUPPLIES FOR ELECTROMAGNETS

Input:
—Single-phase or three-phase mains supply ± 10%

Output:
—Power rating 1 to 100 Kva
—Regulation accuracy: Drift less than 0.005% in 8 hours
—Set point adjustment to 100%
—Recovery time constant for 10% mains supply fluctuations, 3 millisec.
Also: field stabilization with Hall effect and nuclear resonance-devices

•

STABILIZED POWER SUPPLIES

—For electron-beam furnaces

DRUSCH
V O L T R E G

138, RUE GALLIÉNI—PARIS/RUEIL-MALMAISON (S.-&-O.)

Tel.: 967-11-33 et 967-20-54

RAPY

CIRCLE 109 ON READER SERVICE CARD

6th INTERNATIONAL EXHIBITION OF ELECTRONIC COMPONENTS PARIS

Rochar electronique France

and

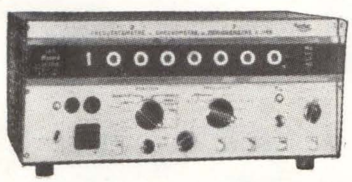
WESTON

present

a complete line of all solid-state frequency time-interval period COUNTERS

basic instruments

	A 1149	A 1213	A 1197	A 1211
Max. Frequency	> 22 MC	> 2.2 MC	> 220 KC	> 220 KC
Count capacity	99.999.999	999.999	99.999	99.999
Counting time	0.1–1–10 Sec.	0.1–1–10 Sec.	0.1–1–10 Sec.	0.1–1–10 Sec.
Standard frequency	5 MC	1 MC	100 KC	100 KC
Standard stability (± 1 part in...)	10^7 a week 10^8 a week	10^6 a week	10^6 a week	10^6 a week
Standard frequencies outputs	1c/s; 10 c/s;...10 MC	1 c/s ; 10 c/s;... 1 MC	1c/s; 10 c/s;...100 KC	1c/s; 10 c/s;...100KC
Input characteristics (2 frequency inputs): Frequency measurements I_1	50 mV to 100 Vrms Z=100 KΩ/50μμF	50 mV to 100 Vrms Z=100KΩ/50μμF	0.2 V to 100 Vrms Z=500KΩ, 30μμF	d° A-1197
I_2	200 mV to 100 Vrms Z=100 KΩ/30 μμF	200 mV to 100 Vrms Z=100 KΩ/30μμF	1 V to 10 Vrms Z = 10 KΩ	d° A-1197
Period measurements	1 or 10 periods Period input: I_2 (A-1149 and A-1213)		or I_1 (A-1197 and A-1211	
Time Interval measurements	Polarity: +; Sensitivity: 5 to 8V; Z=10 KΩ/100μμF		Polarity + Sensitivity: 6 to 50V	+ and – polarity built in pulse shaper
Pulse duration and radio measurements	•	•	•	•



A 1149

Plug-in and accessories such as
TYPE A 1215 : Aperiodic divider permitting direct counting

up to ⟩60 Mc

TYPE A 1212 : Preset time-base
TYPE A 1170 : Universal codeverter

and some other extra features

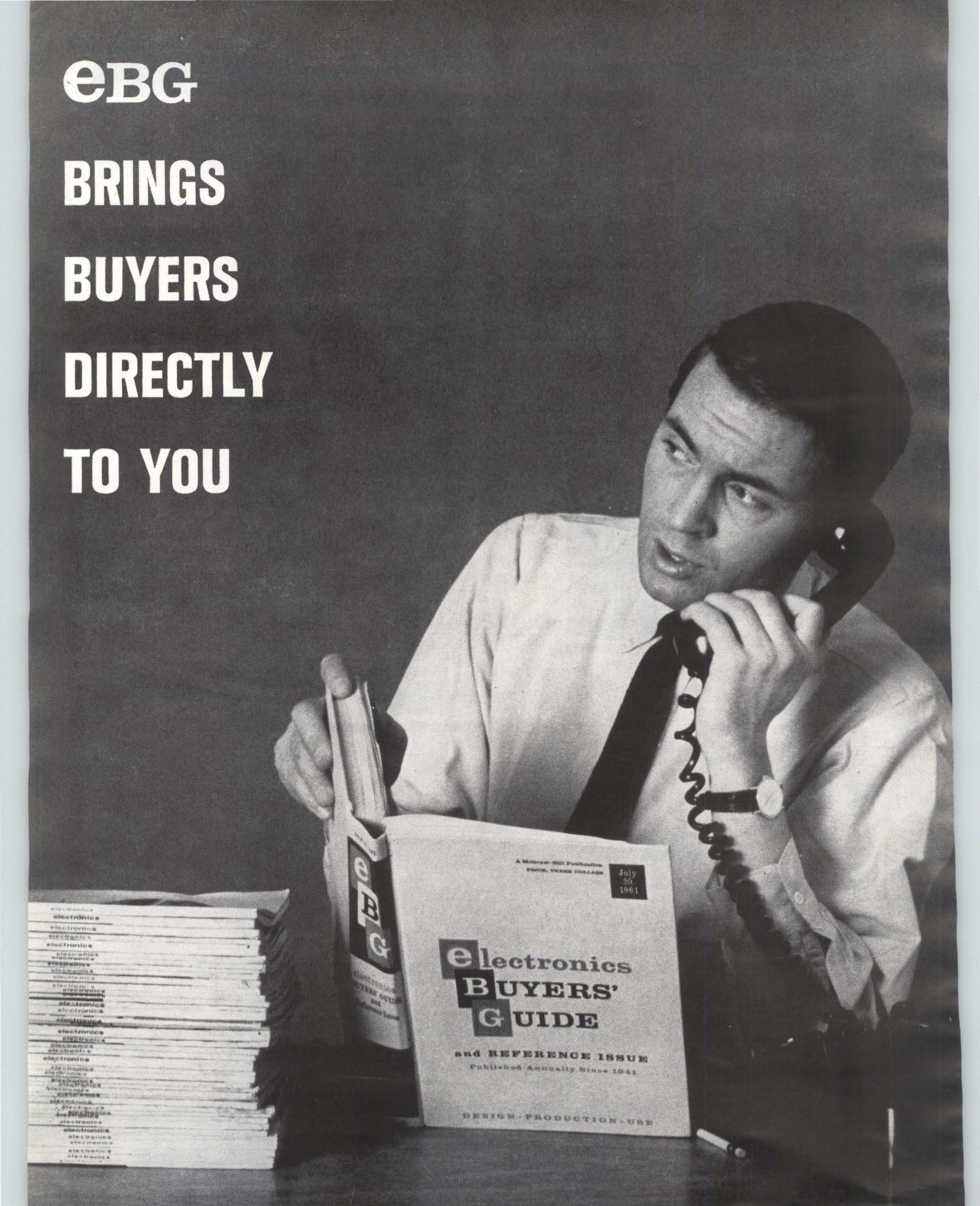
according to their very low consumption all this instruments can easily be

DC powered.

ask for built-in battery power-pack models, [8 hours duty] and DC to AC converters.

Rochar electronique

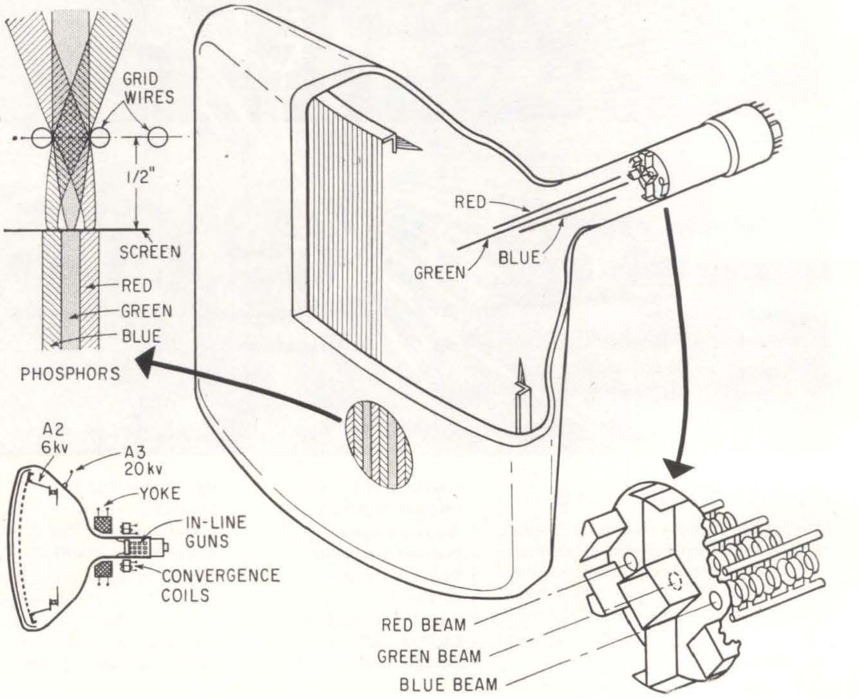
Distributed in U.S.A. and Canada by:
WESTON - Newark (N.J.)
for complete information on our line of products and address of our agency in your country please apply to
ROCHAR-ELECTRONIQUE, 51, rue Racine
MONTROUGE (Seine) FRANCE.


eBG
BRINGS
BUYERS
DIRECTLY
TO YOU
electronics BUYERS' GUIDE
and REFERENCE ISSUE
Published Annually Since 1941
DESIGN · PRODUCTION · USE
July 20 1961

Brighter Color Tv in Offing?

Proposed tv tube claims 300 foot-lamberts, is independent of ambient light

By LESLIE SOLOMON
Associate Editor



COLOR TUBE *uses three electron guns, lower right, that focus on vertical array of color phosphors. Intense color image is produced after beams pass through relatively transparent second anode grid in front of phosphor array. Second anode is array of vertical grid wires*

LATEST version of the Lawrence tube is a new three-gun Chromatron that uses conventional color tv circuits to process signals.

Prototype tube is a 25-inch, 90-degree direct-view color crt proposed primarily for home receivers, according to engineers of the Chromatic Division of Paramount Pictures Corp. Company claims multi-gun Chromatron can produce at least 300 foot-lambert highlight brightness.

Other picture qualities claimed for new tube are usefulness in well-lighted rooms or outside in open, with no protection necessary either inside or outside. Sets developed using proposed tube could be portable, and small-area contrast ratios are excellent, according to company.

CONTRAST — Basic mechanical configuration of the new tube is shown above. Although the phosphors are shown as a continuing sequence of red-green-blue vertical stripes, a slender black stripe is laid between each color to improve contrast.

The vertical array of color phosphors lead to the choice of a horizontal three-in-line electron gun. In combination with the second anode grid located ½-inch in front of the phosphors, the beams from the three electron guns are electron-optically directed to their respective color phosphor stripes. The two outer guns have a slight inward inclination so that the three beams converge on the phosphor screen as a unit.

During raster scan, the deflection yoke can distort the converged unity of the triple-beam array and a complex color image would lose the desired superposition of the red and blue picture areas (by the outside pair of electron guns) with the green (detailed by center gun).

In the horizontal plane, there will be directed displacement between the three beams in their transit through the deflection field. Vertical convergence errors are inherently small since in effect the beams have no relative vertical displacement. The small angular difference between the center and outer beams path length through the vertical deflection field may be compensated by a slight negative gradient from the desired uniform vertical field.

In the horizontal direction of de-

COLORFUL NEWS FROM ALL OVER

There was an international flurry of activity in color tv last year. From Britain came the banana-tube display (ELECTRONICS, Jan 26, p 44); from Bermuda, the Harries sunflower optics system (ELECTRONICS, Dec 14, p 44); and from Canada came news of a color tv set that claimed to operate using human body heat as a power source (ELECTRONICS, Nov 23, p 7).

Now from the U. S. A., we have taken a look at a proposed new version of the Lawrence tube. Designers of this tube claim that the highlight brightness makes it possible to view color tv in a well-lighted room. Unlike the original Lawrence tube that used one gun and horizontally-laid color phosphors, this new version uses three in-line guns and vertically-laid phosphors.

IN 45 SECONDS

45 DIFFERENT TESTS

150 TEST CONDITIONS!

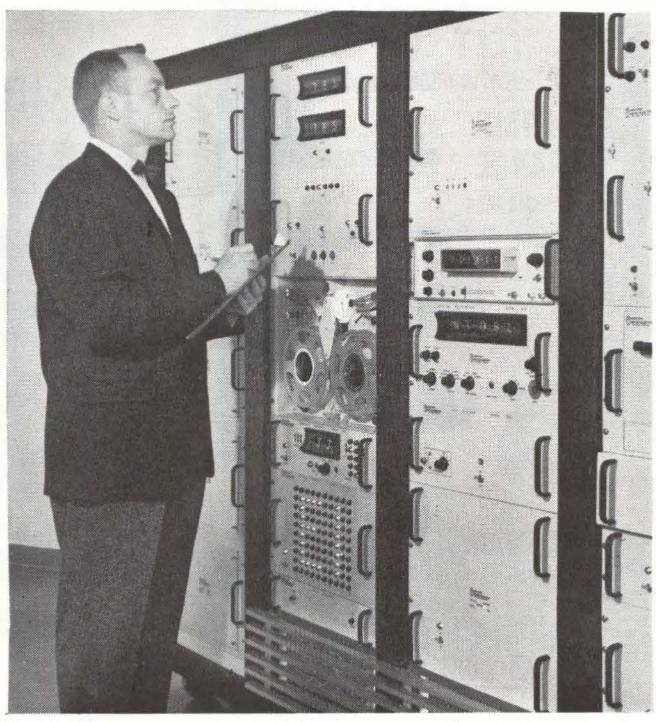
BETTER
MEASURING
FROM EI

While originally designed as a system tester for Doppler Radar, the extreme versatility of the Electro Instruments Digital Multimeter permitted Raytheon to check the integrated circuit elements of the Apollo Spacecraft systems. The EI system performed 45 different tests under 150 test conditions in *45 seconds!* These test operations formerly required 45 minutes of manual effort.

As demonstrated by this fully automatic system tester created for Raytheon, your key to greater speed, higher reliability, significant cost savings and lower investment lies in EI *all solid state* Digital Multimeters.

Your desires for similar savings, whether they be in connection with spacecraft, components or purely industrial processes, can be realized with digital measuring. Available to you in this regard are instruments for measuring DC volts, AC volts, DC ratios, resistance, capacitance, inductance and impedance. EI *all solid state* Digital Multimeters provide swift, accurate answers to your measurement and display problems. Put digital measuring to work for you now — the benefits will be worth your while.

For full details on EI's individual digital instruments, or our complete capabilities in the field of measurement, display and recording — write direct in care of Department MA-1.



Versatile . . . cost cutting automatic system tester built for RAYTHEON by Electro Instruments.

Electro Instruments, Inc.
8611 Balboa Avenue, San Diego 12, California

CIRCLE 117 ON READER SERVICE CARD

flection, a comparatively larger positive magnetic gradient (a saddle-shaped distribution of flux density) effectively maintains beam convergence along this axis.

STABILITY—Thus by a small change in winding distribution of a conventional deflection yoke, automatic dynamic convergence in the rectangular axes of the display is attained. Trapezoidal error, evident in diagonal corners, is corrected by a magnetically-driven convergence magnet assembly atop the outer electron guns. Corrections are electrically symmetrical and convergence stability is a high order since a major portion of the correcting function is tied directly to the deflection yoke which is the actual disturbance source.

The post-deflection focusing second-anode grid is an array of closely-spaced parallel taut wires, located ½-inch from the phosphors operating at a potential of 6 Kv. Approximately 20 Kv is applied to the final anode consisting of the Aquedag internal coating and the phosphor coating.

As the screen of the evacuated bulb must withstand air pressure, it is designed with a convex arc arranged along the horizontal axis of view similar to a theatre stage. Since the electronic nature of this crt dictates that the phosphor screen surface be nearly co-planar with the second-anode grid, this determines a virtually flat panel section along the vertical axis. Thus, the second-anode grid is an arrangement of vertically strung wires arrayed in a smoothly-bowed curtain.

Component Makers Urged To Revamp Thinking

MORE manufacturers of electronic systems are acquiring the know how to make component for their own systems, according to G. B. Mallory, President of P. R. Mallory and Co.

Company has evaluated a study of a group of the largest users of components in the country. Survey reveals that 21 percent of them already have component or module production capability, and 14 percent of firms that use components

Rectifiers Assembled in Nitrogen

NITROGEN *replaces air in specially built glassed-in boxes, used to weld pigtailed-mounted silicon rectifiers. Technique prevents oxygen contamination, keeps moisture down to one part in million or less, according to General Instrument. Station is part of new rectifier facility that costs quarter million dollars. Company says the facility produces super-reliable devices at cost of conventional units, due to high yield*

IN THIS BIG TRIANGLE OF SAFE OPERATION, PHILCO MADT*® SWITCHES

Philco triangle of safe operation includes all current-voltage conditions under which a Philco MADT is *guaranteed* against avalanche (and resultant latching).

TRIANGLE OF GUARANTEED LATCH-FREE OPERATION

2N779A
2N1499A
2N2048
2N2401
2N2402

Now you can forget about avalanche (and resultant latching) as a pitfall in circuit design. Philco Micro Alloy Diffused-base Transistors—inherently resistant to avalanche—now are *certified* avalanche-resistant with a Philco guarantee. Philco MADT switch specifications now include an I-V triangle of (guaranteed) safe operation—at no extra cost.

For more reliable switching at every clock-frequency, there's a Philco MADT. For complete data on specific types, write Dept. E1462.

**Micro Alloy Diffused-base Transistor*

All Philco MADT types are in stock at your Philco Industrial Semiconductor Distributor.

PHILCO®
A SUBSIDIARY OF Ford Motor Company
LANSDALE DIVISION • LANSDALE, PENNSYLVANIA

SOLID-STATE CENTER U.S.A. TM

have production capabilities for making discrete components. Over half of these large users of components are engaged in R & D activities in the components area. However every one of the companies included in this survey have their own component evaluation groups.

What does this mean for firms who just stick to components?

Some may fall by the wayside, says Mallory, unless they revamp their thinking to anticipate the future needs of the major users of electronic components. Research is a requirement for survival.

Mallory suggests needs for a basic scientific understanding in these areas: Fundamental electrochemical processes occurring in material systems, structure and physics of thin and bulk films, depth studies in solid-state phenomena centering around dielectric and semiconductor materials, and physical properties and important characteristics of metallurgical systems.

Company has made products in fields that were separable and distinct — metallurgical, electromechanical, electronic, electrochemical. These fields are now interrelated and, for Mallory interdependent.

Mallory's new Laboratory for Physical Sciences, recently opened in Burlington, Mass., has been established for basic research in these interrelated fields.

Do Radical Changes Lie Ahead for Components?

LACK of proper materials is major difficulty in development of most high-performance aerospace vehicles, according to Aerospace Industries Association. Aerospace Technical Forecast notes that temperature resistance of refractory metal alloys will increase about 1,000 F during the next ten years. Plastic materials will increase between 500 to 1,000 F for short term applications, according to report.

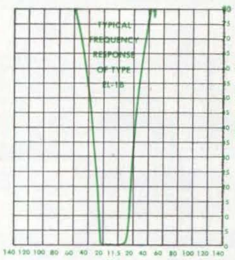
Report presents a broad outline of the technological capability industry is developing and technical problem areas to be solved to meet anticipated national aerospace re-

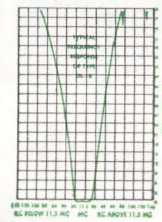
CHANNEL SEPARATION?

SPECIFY MIDLAND CRYSTAL FILTERS

Years ago, Midland knew of the impending high frequency spectrum "jam". Today it's here! The steep attenuation slope exhibited by a crystal filter is an important characteristic in design of H.F. communications systems for maximum channel separation. Crystal filters are small, reliable, rugged and stable over a wide temperature range. They are more in demand now than ever before. That's why Midland, through purchase, is integrating Itek's Electro-Products Division's production, test equipment and filter designs into Midland's already established 100,000 square foot facility — to further enhance the ability to serve the growing needs of the communications industry. Two typical Midland production filters are the EL-1B and DL-1B. Check the response, inband ripple and ultimate attenuation, with only 3 db insertion loss. Approx. size 2"x1"x 3/4". Write for Engineering Bulletins NBS-104 and NBS-105 for complete technical information.

EL-1B



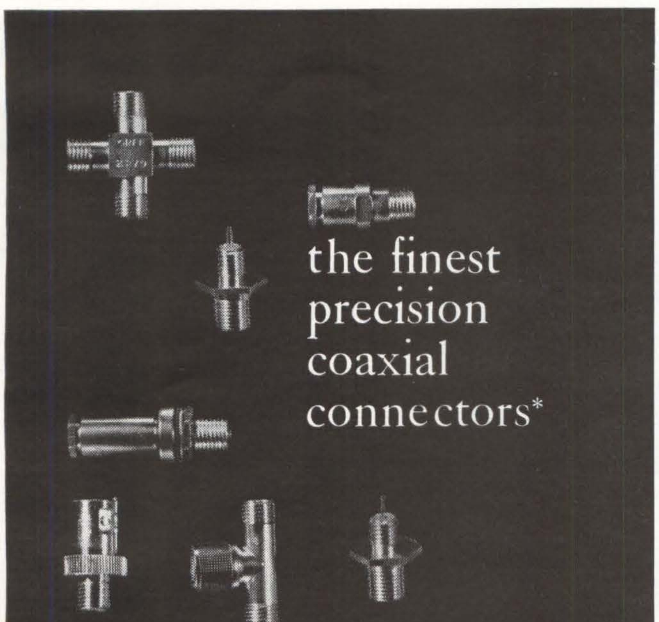


DL-1B

Midland
MANUFACTURING COMPANY
3155 Fiberglas Road • Kansas City 15, Kansas

WORLD'S LARGEST PRODUCER OF QUARTZ CRYSTALS & CRYSTAL FILTERS • Division PACIFIC INDUSTRIES, INC.

CIRCLE 209 ON READER SERVICE CARD



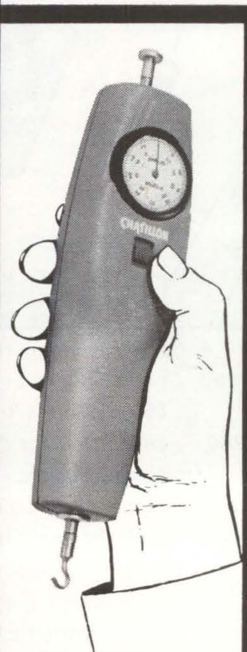
General RF Fittings, Inc.

702 BEACON STREET, BOSTON 15, MASSACHUSETTS
Telephone: 617 267-5120

CIRCLE 210 ON READER SERVICE CARD

CHATILLON

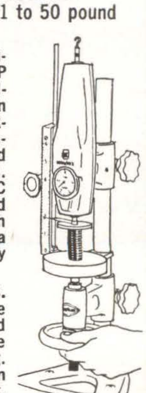
FOR PRECISION MEASUREMENT OF PUSH AND PULL



Completely New Model DPP

MAGNETICALLY ACTIVATED CLUTCH . . . holds maximum readings
VERSATILE . . . hundreds of uses . . . checking tension and compression in lab, factory or field
TESTS PUSH AND PULL FROM EITHER END . . . does the work of two gauges
ACCURATE . . . within 1/2 of 1%
RANGE . . . models in 1 to 50 pound capacities

As a hand-held instrument, the Chatillon DPP gives complete flexibility. It may be used in any position for checking tension or compression in an unlimited variety of applications. With the Chatillon LTC test stand, designed specifically for use with the DPP, it becomes a compact, low capacity laboratory tester.



SEND FOR DATA SHEETS. Full details on both the DPP Push/Pull gauge and the LTC Test Stand are yours for the asking. Write to John Chatillon & Sons, 85 Cliff Street, New York 38, N. Y.

CHATILLON since 1835 . . . *the force in force measurement*

Manufacturers of scales, force measuring instruments and precision springs.

CIRCLE 121 ON READER SERVICE CARD

quirements in the next decade.[1]

Tensile strength of glass fiber reinforced plastics will increase from 200,000 psi to 300,000 psi during the next ten years. Structural weight can be reduced by one-third in rocket motor casing.

Forecast sees more radical changes in components. Use of small parts and molecular electronics and thin films will increase by at least 20 percent and as high as 80 percent, according to report. Present densities, largely using printed wiring, are about 10,000 equivalent parts per square foot. Use of molecular techniques is expected to increase this density to one billion equivalent parts in the next ten years.

Report predicts improvement in reliability of electronic systems as much as 100 times greater than today. Aerospace industry also predicts that memory capacity of ground-based data processing equipment will increase about a million times. "An entirely new methodology must be developed to obtain the necessary reliability of space missions. It is virtually certain that redundant systems incorporating self-checking, fault-locating and indicating, self-organizing and adaptive features will have to be devised," forecast notes.

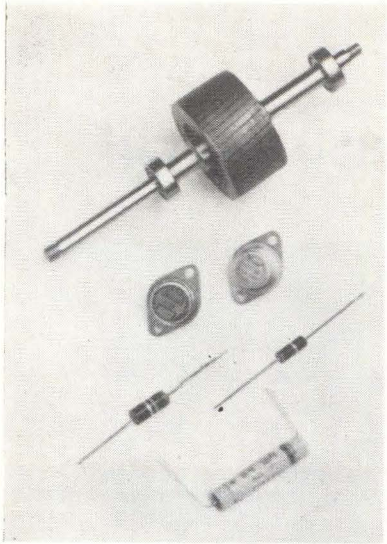
REFERENCE

(1) Aerospace Technical Forecast, Aerospace Industries Association, 1725 De Sales St., N. W., Washington 6, D. C. ($3.00)

Motor Commutates With Transistor Flip-Flop

KEY to new brushless motor lies in use of simple oscillator circuit that commutates electronically. There are no brushes to wear out, and motor is said to last as long as the bearings. Cycle output is variable, and good starting torque is claimed. Ametek motor, named Komlectro, does not rely on sparking contacts for operation. Continuous rotation is achieved through switching action of the commutator which sequences the current in the rotor, thereby causing the d-c motor to operate on a-c.

Other advantages claimed for small fractional horsepower motor, packaged in small cube: reduction



BRUSHLESS *motor parts show squirrel-cage type rotor, two power transistors, two resistors, one capacitor*

in both electrical noise and acoustical noise, reduced maintenance, wider variations of speed control characteristics.

Present designs are available for motors from 1/20 hp up to one hp. Limiting factor is the transistors' junction temperatures.

Wire Woven on Cloth Looms

METAL wire can be woven in cloth patterns using tantalum, columbium, molybdenum, and tungsten. With 0.6-mil wire, meshes up to 350 × 2,300 can be produced in some materials, says Fansteel.

Although cloth weaving technique was developed for ion emitters, refractory metal cloth could be used for directly heated dispenser cathodes, filters for high-temperature fluids and liquid metals, flame holders and catalysts.

Microfilament Wire

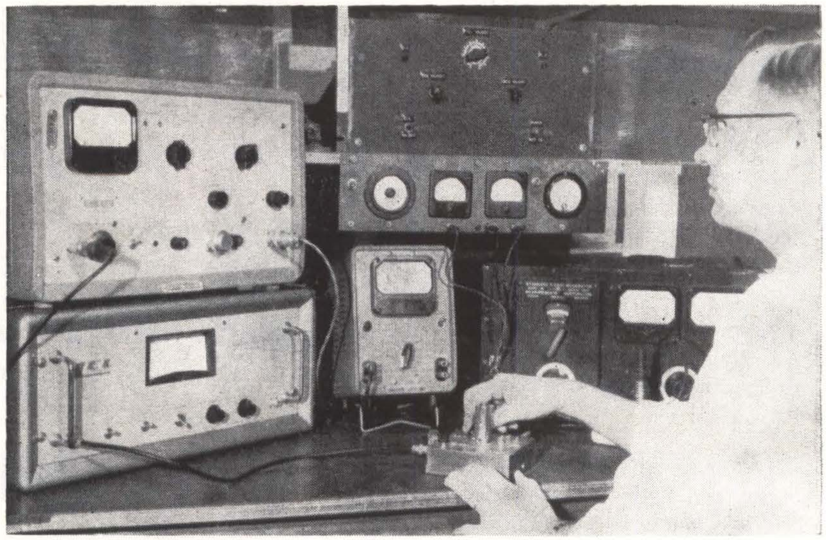
WIRE of pure tungsten is being drawn in 0.0002-in. to 0.029-in. diameters. Pure molybdenum is being drawn in the 0.0008-in. to 0.019-in. diameter range. Tolerances on diameters are 0.5 percent with a typical 0.0005-in. diam tungsten wire. A 0.5 percent tolerance provides an actual variation of 0.000001 inch. Thermionic Products reports applications other than in electronic devices in aerospace.

Standardizing Noise-Figure Measurement

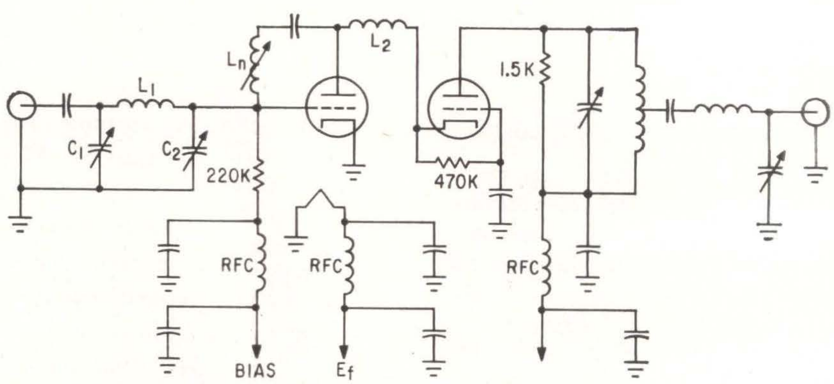
Long-sought r-f amplifier technique gives 95 percent repeatability

By THOMAS E. GAUSMAN
Electronic Tube Division
Sylvania Electric Products, Inc.
Emporium, Pa.

NOISE-FIGURE measuring technique having 95 percent repeatability was recently devised by the Noise Advisory Group of the Electronics Industry Association. This group, a subcommittee of EIA's Joint Electronic Devices Engineering Committee, (JEDC), will present complete specifications in a forthcoming JEDC publication.



NOISE FIGURE *of r-f amplifier in test jig (center) is measured using a meter that continually monitors noise figure and gives a direct noise-figure readout in db.*



JIG CIRCUIT *for cascode type tubes typifies jig requirements—Fig. 1*

BASIC EQUIPMENT—Measuring equipment consists of a noise source, a tube test jig circuit and a high-gain post amplifier.

A 50-ohm noise generator is needed to rapidly measure noise figure with a high degree of repeatability. An instrument like the Hewlett-Packard noise figure meter, Model 342A used with the Hewlett-Packard vhf noise source, Model 343A will continually monitor noise figure as the amplifier input is tuned for noise-matched conditions.

Basic requirements for the tube test jig circuit (Fig. 1) are:

(1) 200-megacycle center frequency

(2) A 3-db bandwidth of 10 ± 2 megacycles

(3) A pi input circuit adjustable to noise-matched conditions

(4) A pi output circuit tunable to 50 ohms impedance

(5) Single frequency neutralization for triodes, including the grounded cathode section of cascode tubes

(6) Rated voltages applied to the tube

The cascode-tube jig circuit shown here illustrates these specifications. C_1, L_1 and C_2 form the input-pi section that matches the 50-ohm input to the tube input impedance. A 1,500-ohm 5-percent resistor loads the output section plate coil to approximately 10-megacycles bandwidth. The output-pi network is tapped to the center of the output coil and matches-down to the 50-ohm output. Peaking coil

NOISE-FIGURE MEASUREMENT

Standardized method for measuring noise figure of r-f amplifiers has been a long-time industry goal. During 1955 and 1956, EIA conducted a series of round-robin tests on noise figure and input impedance of cascode r-f amplifiers. Poor correlation of findings stymied development of a noise-figure specification expressed directly as noise figure or indirectly by describing tube parameters. This prompted EIA to form the Noise Advisory Group, an engineering study task force. Company members are: Sylvania, RCA, GE, Westinghouse and Tung-Sol

WHAT'S $1/turn?

Daystrom's new ten-turn precision 349 series pots...that's what.

Here's a new computer-grade Multipot® produced to provide *all* the precision and reliability you need...and priced at reasonable levels.

The series 349 Multipot® gives you ten quick turns with resistances to 1 full Megohm and with torques which never exceed 2.5 oz.-inches. Look at these specs...

MECHANICAL

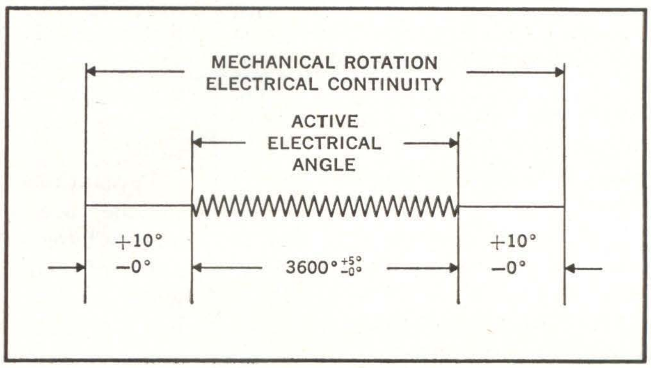
Mechanical Rotation	Refer to Schematic
Starting Torque (Max.)	2.5 oz.-in.
Running Torque (Max.)	2.5 oz.-in.

ELECTRICAL

Linearity	±.25% 1K and above
Total Resistance	1K to 1 Meg.
Resistance Tolerance	±5%
Power Dissipation	2.5 W
Electrical Angle	$3600^{\circ}{}^{+5^{\circ}}_{-0^{\circ}}$
Insulation Resistance (500 VDC)	50 Meg. Minimum
Dielectric Strength (1 Minute)	1000 VAC
Equivalent Noise Resistance (Max.)	.1% or 100 Ω
Max. Continuous Working Voltage	500 VDC

ENVIRONMENTAL

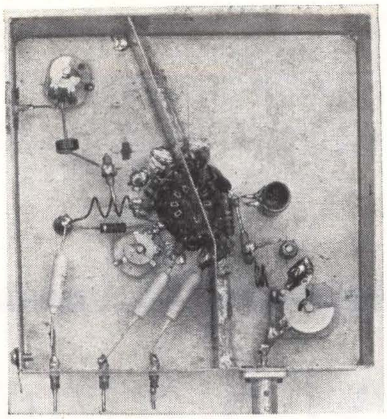
Vibration	10-2000 CPS (MIL-STD-202 Method 204 Condition "B")
Shock	50 G's (MIL-STD-202 Method 205)
Operating Temperature	−55°C to +105°C



Contact your local Daystrom representative for technical assistance, volume prices, and deliveries. Or write:

ACTUAL SIZE

DAYSTROM, INCORPORATED
POTENTIOMETER DIVISION
ARCHBALD, PENNSYLVANIA • LOS ANGELES, CALIFORNIA



SHIELDING *of test jig's input and output sections is shown in bottom view—Fig. 2*

L_2 is adjusted for minimum noise figure with the first tube measured. Neutralizing coil L_n is resonated with the grid-to-plate capacitance at test frequency to minimize plate-to-grid feedback.

Eliminating the grounded grid section and moving the output circuit over to the grounded cathode section forms a triode jig circuit. Then, addition of a screen connection and removal of the neutralization coil produce a pentode jig circuit.

Precautions in jig construction include use of short-lead high-quality bypass capacitors and placement of coils in different planes when used in the same compartment (Fig. 2).

Specifications for the post amplifier include (Fig. 3):

(1) A 200-megacycle center frequency at the input

(2) A maximum 3-db bandwidth of 5 megacycles

(3) Sufficient gain in conjunction with the noise figure meter to read the noise figure of the unit itself

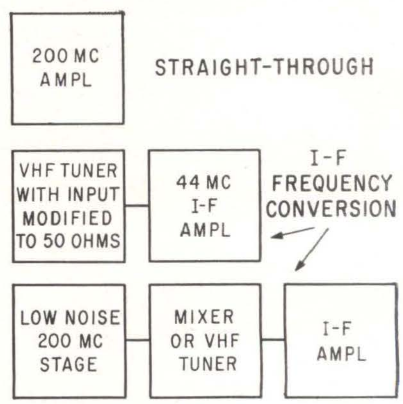
(4) A maximum noise figure of 6-db

(5) A 50-ohm input and output

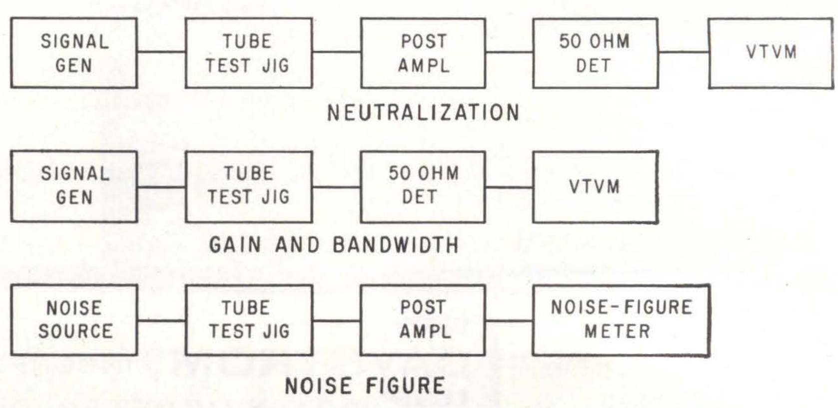
The post amplifier can assume several configurations. A straight-through 200-megacycle amplifier or frequency conversion to an i-f frequency can be used. With frequency conversion, a commercial vhf tuner with its input modified to 50 ohms (unbalanced) can be coupled to a 44-megacycle i-f amplifier. Total gain of the post amplifier should be approximately 75-db and should be reducable by 20-db.

MEASUREMENT PROCEDURES—Block diagrams in Fig. 4 illustrate setups for neutralization, gain, bandwidth and noise-figure measurements.

Neutralization of single triodes and cascode tubes begins with B+ to the tube under test off. A modu-



AMPLIFIER *configurations connected to test jig output may be straight-through or conversion to i-f frequency may be used—Fig. 3*



SUCCESSIVE *procedures shown are performed before making noise-figure measurement—Fig. 4* lated 200-megacycle signal is then applied and the neutralization coil tuned for a null on the vtvm.

Gain and bandwidth are then checked with the indicated setup.

With rated voltages applied to the tube, maximum vtvm indication adjustments on the input and output pi networks and the plate circuit tuning are made. Signal generator is then tuned to 3-db points on either side of center frequency to determine bandwidth (characteristic of crystal detector should be checked to determine what 3-db reduction represents on the vtvm). The bandwidth measurement checks output circuit loading to assure proper jig operation.

In measuring gain, a reference point is established on the vtvm with the jig in the circuit. The jig is then removed and the signal generator output increased to obtain the same reference point. Gain is the ratio of the two output voltages. Gain measurement serves three purposes: checks tube under test, checks the jig, and helps correct for second-stage noise.

The noise-figure measurement setup is shown in Fig. 4. Following the manufacturer's manual for setting up the noise figure meter, the gain of the post amplifier is adjusted so that the total gain of the jig and post amplifier is sufficient for noise-figure meter functioning. The input pi network of the tube under test is then adjusted for a minimum noise-figure reading. The second-stage noise figure and the noise-matched gain of the jig is read in a similar manner and the corrected noise figure calculated from the well-known Friis formula.

The Hewlett-Packard test set is specified for use in the system because it has the capability of continually monitoring the noise figure with a direct readout in db.

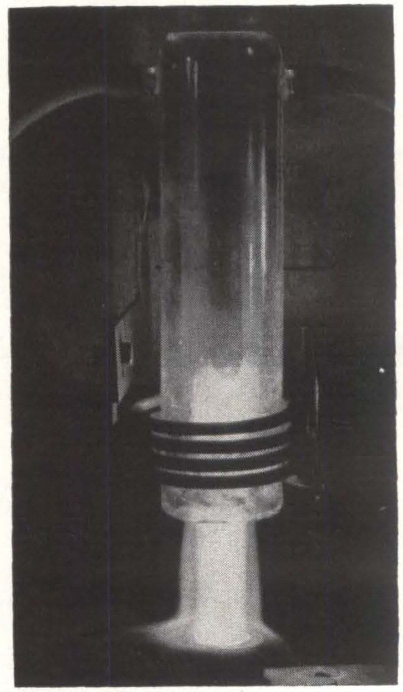
Aerospace Production Aided by Automated System

AUTOMATIC PRODUCTION management system installed by Sperry Phoenix is claimed to be first large-scale computer control in the production of varying quantities of complex electronic equipment. Cen-

CIRCLE 127 ON READER SERVICE CARD

tered in a Univac Solid State 90 magnetic tape computer, the $100,000 system is expected to cut current inventories by more than $1-million dollars. Also, it may reduce by 30 days systems' negotiating, planning procurements and component purchasing.

Torch for Industrial Use Has Extra Electrodes



PLASMA TORCH *with superimposed electrodes provides 10,000-15,000 degree K temperatures. Anode lies inside silica glass cylinder above high-frequency induction coil*

LOW-COST technique to boost ionizing power of high-frequency plasma torches has been found by a French research team. Higher power increases the 10-15,000 K degree temperature zone at center of torch flame. This would facilitate work in: preparation of high-purity metals with high melting points (tantalum, molybdenum, tungsten, etc.); thermal treatment of refractory oxides; drawing monocrystals.

A pair of electrodes on the axis of the high-frequency ionizing coil and located above and below the plasma gives power boost. Direct current or line frequency power is applied to electrodes. Threshold voltage required for additional ionizing power is 20 volts. Applied potentials up to 50 volts at currents of 450 amps were used. No obstacle is seen for using power of several hundred kilowatts qualifying the torch as an industrial tool.

Development is joint effort of Centre National de la Recherche Scientifique's metallurgical chemistry laboratory and Societe de Traitements Electrolytiques et Electrothermiques, subsidiary of CSF.

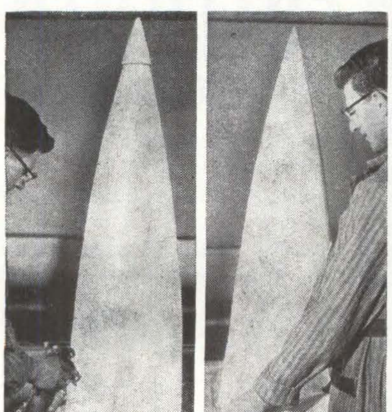
Computer Determines Tolerances for Optics

RESEARCH scientists of the Armour Research Foundations have successfully programmed an IBM 7090 computer to design optical systems.

Computer design is expected to help determine manufacturing tolerances of high-performance optical components—a problem previously solved by trial-and-error experimentation.

Computer design reduces the large amount of time and labor expended in the early stages of lens system design. With the basic programming set into the computer, a finished system design is generated using fed-in specifications on required characteristics.

Skin-Tight Packaging



EVALUATION *by Raytheon of spray-on, strip-off plastic coating for packaging radome and other Hawk missile components indicated 95-percent saving on repainting and restenciling during production. Material, designated SC-1071T, is manufactured by Spraylat Corp.*

MORE TIMING PROBLEMS

*more **effectively** solved . . .*

. . . because HANSEN takes more time to be sure!

HANSEN SYNCHRON® Timing Motors and Movements are results of thorough and continuous research and development. None is released until it has been solidly tested and proved for its applications. Each is a product of more than 50 years of specializing in this one area.

This adds up to an unequalled backlog of engineering experience that you command at Hansen. Whatever your timing problem, you can count on Hansen engineers to come up with the most effective solution — with the timing motor or movement that has been *pre-proved right* for the job.

Distance no obstacle to Hansen service

Hansen service knows no limits — as present customers know from profitable experience. A company airplane stands ready to fly Hansen engineers to study "on-the-job" difficulties — and to determine the surest solution to every timing problem.

SEND TODAY for complete data on all Hansen SYNCHRON Motors and Clock Movements.

**HANSEN
MANUFACTURING
COMPANY, INC.
PRINCETON, INDIANA**

HANSEN REPRESENTATIVES:

THE FROMM COMPANY
Chicago, Illinois

H. C. JOHNSON AGENCIES, INC.
Binghamton, N.Y.
Fayetteville, N.Y.
Rochester, N.Y.
Schenectady, N.Y.
Williamsville, N.Y.

WINSLOW ELECTRIC COMPANY
Essex, Connecticut
New York, N.Y.
Philadelphia, Pa.

EXPORT DEPARTMENT
15 Moore Street, New York, N.Y.

Test Equipment Cart Model 30-1

The Model 30-1 Basic Cart was designed for easy handling of counters. It is large enough to handle single large or several small test units. The base provides storage for test leads and auxiliary equipment. To provide maximum utility, various alternative modifications have been developed. Shipped knocked down.

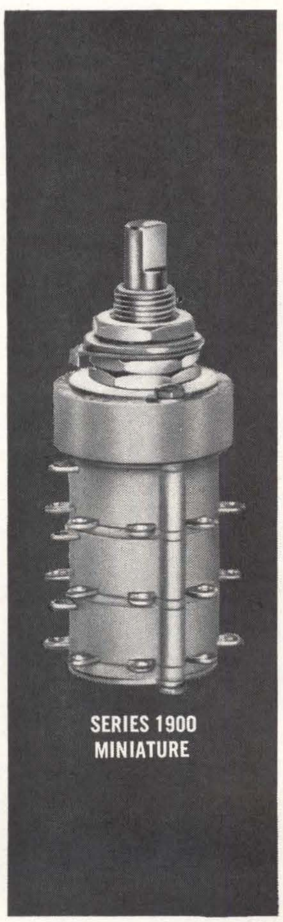
$131.50

Specifications

- Color . . . . Dark Brown
- Handles . . . . Nickel Plated
- Hardware . . . . Nickel Plated
- Cushion . . . . 5/16″ Felt
- Construction . . . . Heavy Gauge
- Size . . . . 23″ x 23″ x 36½″
- Weight . . . . 90 Pounds (basic cart)
- Basic Model (less drawers) $59.50

**NORTHEASTERN
ENGINEERING INCORPORATED**
DEPT. 2A, MANCHESTER, NEW HAMPSHIRE
AFFILIATE OF ATLANTIC RESEARCH CORPORATION
Employment Opportunities Open At All Levels

CIRCLE 213 ON READER SERVICE CARD



Janco rotary selector switches have been tested to independent requirements which exceed MIL-S-6807A and MIL-S-3786A.

reliable
ROTARY SELECTOR SWITCHES

The following are examples of these exceeded requirements: ALTITUDE tests prove capabilities of continuous operation at a pressure and temperature equivalent to 120,000 feet. VIBRATION tests prove capabilities of normal operation while being subjected to frequencies between 10 and 2000 cps with an applied acceleration of 40 G's.

QPL SR04E36C3HP, SR04E30C3HP.

For further information and new 12-page catalog, write Janco Corporation, 3111 Winona Avenue, Burbank, Calif.

**JANCO
CORPORATION**

CIRCLE 214 ON READER SERVICE CARD

Are you a

COMPLETELY INFORMED

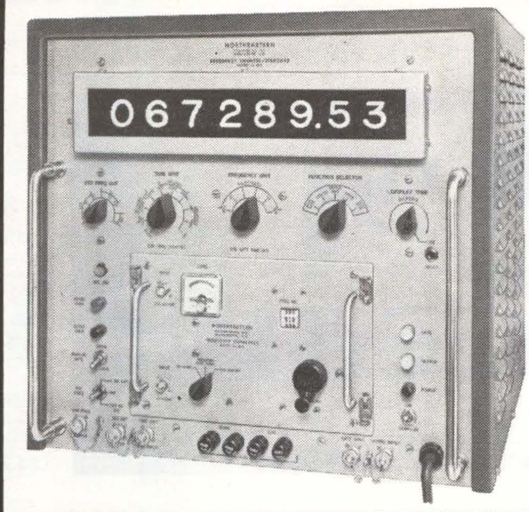
electronics engineer?

Today you may be working in microwaves. But on what project will you be working tomorrow? You *could* have read **electronics** this past year and kept abreast of, say, microwave technology. *There were 96 individual microwave articles between July, 1961 and June, 1962!*

But suppose tomorrow you work in some area of standard electronic components, in semiconductors, in systems? Would you be up-to-date in these technologies? Did you read the more than 3,000 editorial pages that **electronics'** 28-man editorial staff prepared last year?

electronics is edited to keep you current *wherever* you work in the industry, *whatever* your job function (s). If you do not have your own copy of **electronics**, subscribe today via the Reader Service Card in this issue. Only 7½ cents a copy at the 3 year rate.

electronics



10 MC frequency counter/standard

A New Concept In Precision Measuring

The Model 14-20C 10 MC Frequency Counter/Standard combines the features of a precision counter and a high stability frequency standard into an advanced-design unit.

Specifications:

Simultaneous and independent use of both frequency standard and counter.

Stability of ±1 part in 10^8 per day; ±5 part in 10^8 per week.

Nine standard decade output frequency steps of 0.1 cps to 10 mc provided by frequency synthesizer. Gate time from 1 millisecond to 100 seconds.

Counts any one of nine decade frequencies from 0.1 cps to 10 mc for period and time interval measurements.

Self checks counting and gate circuits at any of these frequencies in all combinations of available gate times.

Operates within all ratings over a temperature range of $-20°$ C to $+55°$ C, and humidities up to 95%.

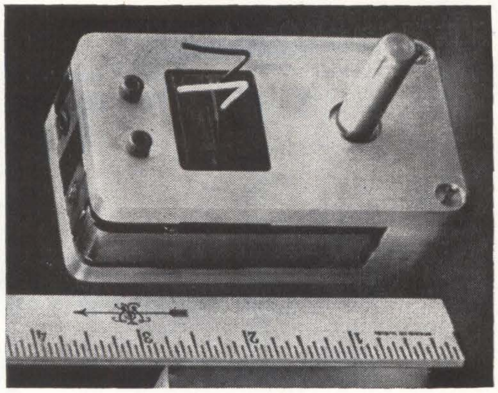
Operates from an external 100 kc or 1 megacycle reference frequency.

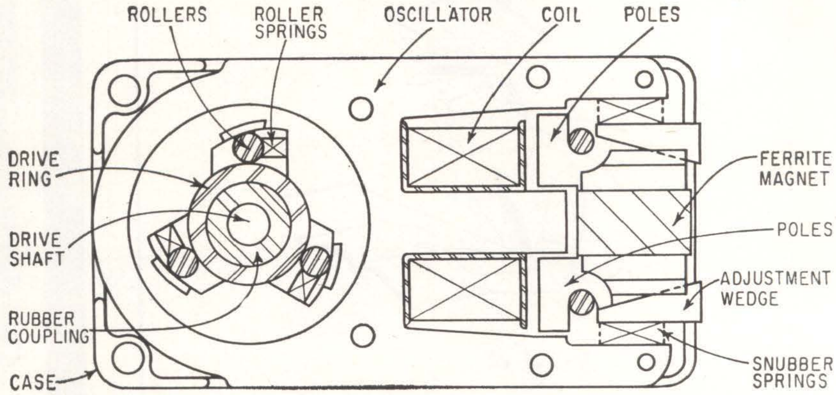
Other features include:

Frequency range.... 10 cps — 10.1 mc
Period .... DC to 100 kc
Input power .... 115 vac; 50-60 cps (400 cps opt.)
In-line Readout 8 place $2,200
Vertical Readout $1975

NORTHEASTERN
ENGINEERING INCORPORATED
DEPT. 1A, MANCHESTER, NEW HAMPSHIRE
AFFILIATE OF ATLANTIC RESEARCH CORP.

Employment Opportunities Open At All Levels





Infinite Resolution Stepping Motor

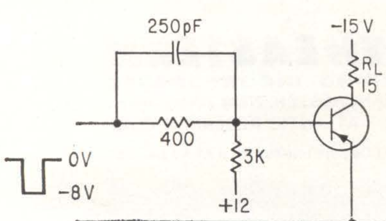
Uses cam and wedge for 0 to 25 rpm adjustable at 80 inch-pounds torque

ANNOUNCED by Energy Conversion Systems Corp., Grafton, Wisconsin, the Enercon oscillating-type electric motor is adjustable between 0 and 25 rpm and develops up to 80 inch-pounds torque with detent accuracy within 5 minutes of arc. Typical dimensions (Model 45) are $2\frac{1}{2} \times 1\frac{3}{8} \times 1$ inch, weight is 12 oz and the device is equivalent to a conventional electric motor with gear train, clutch and brake mechanism. Power required is 110 v, 60 cps. Efficiency is approximately 85 percent, it contains four moving parts and has either forward or reverse rotation. Speed and direction of rotation is either by manual or automatic methods, and the unit can be stalled and overloaded without damage to the drive mechanism. The oscillator is formed in the shape of an E-magnet with the coil wound around the center pole. Since the current is alternating, polarity of the electromagnet is reversed 60 times per second. Into the gaps of the electromagnet are inserted the poles of a ferrite magnet which is permanently polarized to supply four sets of working pole faces. Oscillatory motion between the ferrite magnet and electromagnet is transformed into increments of shaft motion by a cam and wedge having a 17-degree wedging angle. Roller springs bear against the rollers and the face of the wedging chamber. Motion of the oscillator causes the rollers to bite in one direction and slip in the other. Motion is a few thousandths of an inch and the wedge and roller also act as a reverse brake.

CIRCLE **301,** READER SERVICE CARD

Medium Power Transistor Has Multiple Uses

NEW from General Instrument Corp., 600 West John St., Hicksville, N. Y., is the 2N2648 pnp germanium alloy junction transistor capable of linear operation at collector currents in excess of one ampere. It is also an efficient high-current, high-speed switch with extremely low collector saturation resistance. Useful frequency range is to 10 Mc. Typical rise time switching 1 ampere with gain of 10 is 0.12 μsec, switching 1 ampere with gain of 50 is 0.8 μsec, V_{CBO} at I_C of 100 μa is 35 v minimum, I_{CBO} at V_{CB} of 15 v is 5 μa maximum, h_{FE} at I_C of 1 ampere and V_{CE} of 0.5 v is 80 minimum, h_{FE} at I_C of 100 ma and V_{CE} of 0.3 v is 100 minimum, and h_{fab} at V_{CE} of 5 v and I_C of 1 ma is 10 Mc minimum. As a lamp driver, minimum gain is 80. Alpha cutoff frequency of 10 Mc combined with saturation resistance of less than 0.5 ohm at one ampere allows use as core driver or magnetic drum and tape head drivers. The sketch shows typical operation with rise time of 0.8 and delay plus storage of 1.4 μsecs. Dissipation at 25 C case temperature is 1.2 w. **(302)**



Reed Relay Uses Nylon Frame to Reduce Stress

RECENTLY announced by Wheelock Signals, Inc., 273 Branchport Ave., Long Branch, N. J., the series 260

Exceeds Adjustment Life Requirements of Mil-C-14409A by 600%

new from JFD

SUPER MAX-C®

CANADIAN PATENT #604,810
U.S. PATENT #2,922,093

■ IT IS HERE...a new kind of capacitor that combines the precise tuning capability of a piston trimmer, the long-lived adjustment of an air variable—and the rugged Max-C construction with its triple range. ■ THE REASON: A new ultra reliable anti-backlash adjustment mechanism with full-thread engagement. ■ THE PROOF?—Virtually no thread wear after 500 cycles of adjustment. Mil-C-14409A specifications call for 75 cycles. ■ Other Super Max-C capacitor advantages are: 1. MULTI-TURN instead of 180 degree rotation of air variables. 2. FACTORY PRESET TORQUE at any value between 1 and 8 inch ounces can be supplied upon special request. 3. HIGHER SHOCK AND VIBRATION RESISTANCE. 4. KNOB CONTROL possible when panel mounted because of the fixed position of the adjustment screw throughout the tuning range. 5. EXTENDED CAPACITANCE RANGE of 300 per cent beyond that of conventional precision piston trimmers due to proven Max-C embedded electrode construction. 6. COMPLETELY SEALED INTERIOR CONSTRUCTION locks out humidity and other atmospheric elements (greatly exceeds salt spray and humidity cycling requirements of Mil-C-14409A). 7. ULTRA-LINEAR TUNING—absolute repeatability. 8. Q FACTOR IS: 500 guaranteed minimum at 1 MC. 9. INSULATION RESISTANCE is 10^6 megohms. 10. DC working voltage is 1000 VDC. 11. LOW temperature coefficient of capacitance. 12. LOW inductance and low loss for higher frequency use. 13. No derating from $-55°C$ to $+125°C$. 14. Rugged shock and vibration resistance. 15. Dielectric strength is 2000 VDC. 16. New JFD plating for excellent RF conductivity and noise-free tuning protects all metal parts from corrosion and improves life of adjustment.

Panel mounting and printed circuit types are available: 1-14 pf., 1-28 pf., 1-42 pf., 1-60 pf., 1-90 pf. Write for Bulletin MCD-62

Model MCD643 (range: 1-28 pf.)
Shown approx. 3X actual size

actual size

JFD ELECTRONICS CORPORATION
Components Division

15th Avenue at 62nd Street, Brooklyn 19, N. Y.
Phone 212 DE 1-1000 • TWX212-833-7001 Cable-JEFDEE N.Y.

JFD WESTERN • 909 So. First Ave. • Arcadia, Calif.
Phone: HIllcrest 6-0312

JFD MIDWESTERN • 6330 Hermione St. • Chicago 46, Ill.
Phone: 775-5424

JFD MIDWESTERN-OHIO • 7415 Montgomery Rd.
Cincinnati 36, Ohio • Phone 421-1166

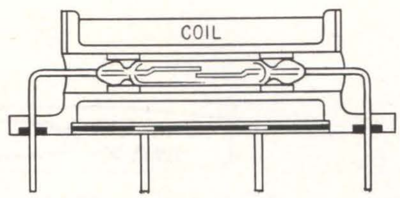
JFD NORTHEASTERN • Ruth Drive, P. O. Box 228
Marlboro, Mass. • Phone: HUntley 5-7311

JFD CANADA • 51 McCormack Street • Toronto, Ontario, Canada • Phone ROger 2-7571

JFD ELECTRONICS (ISRAEL) LTD. • Industrial area B.
Building 23 • Azor, Israel • Cable Address: JFD AZUR, ISRAEL

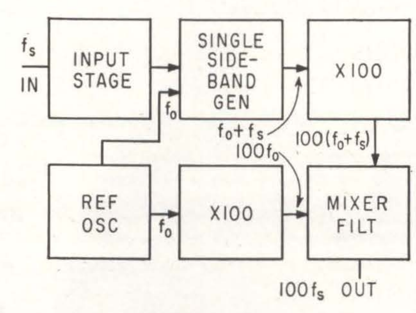
CIRCLE 133 ON READER SERVICE CARD

reed relays are cradled and locked within the cavity of a shock-absorbing nylon frame with relay leads pre-cut, pre-bent and pre-positioned. Coil voltages range from 6 to 48 v, nominal rated power from 125 to 400 mw, dissipation from 1 to 2.7 w, operate time between 0.6 and 1.2 ms, release time from 0.06 to 0.2 ms, and contact bounce is 0.2 ms. Contacts are rated at 125 ma, 250



v at 4 w although up to 0.8 ampere may be switched at reduced life. Expected contact life is 3 × 10^6 at rated load, closed resistance is typically 100 milliohms and open resistance typically 1.5 × 10^{12} ohms. Open contact capacitance is less than 1 pf and contact-to-coil capacitance is less than 2 pf. Relay height is 0.4 inch to allow card stacking in printed circuit applications. Internal atmosphere is an inert gas and contact material is diffused gold in nickel iron. The design features one molded part serving both as coil bobbin and relay frame as shown in the sketch. The reed is protected from stresses by the unitized shock-absorbing frame and the leads are formed, cut and positioned before anchoring. Mounting strains applied to the terminal leads are transmitted to the frame rather than the glass capsule.

CIRCLE **303**, READER SERVICE CARD

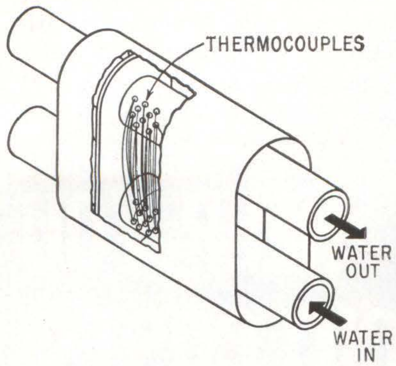


Frequency Multiplier For Audio Region

RECENTLY announced by Oread Electronics Lab., Inc., 925 Iowa Street, Lawrence, Kansas, the model MX-101 wideband frequency multiplier features precision frequency multiplication by 100 over entire decades of frequency in the audio region. It accepts sine-wave inputs from 100 mv to 100 v rms and produces a pulse 100 times the input frequency. Input bandwidth is 300 to 3,300 cps, but any 3 Kc band between 150 cps and 50 Kc is available. The device can be used to increase accuracy by 100 and/or decrease time required by 100 in measurement of audio frequencies by digital counters. Straightforward frequency multiplication is limited to narrow bandwidths making it impossible to directly multiply over a wide range of low frequencies. The device overcomes this limitation of small bandwidth by transplanting the low input frequency to a high single-sideband frequency where the wide change in input frequency results in a small bandwidth. The sketch shows operation. After conventional multiplication of both the single sideband and reference signals by 100, a mixer and low-pass filter develops the difference between the two multiplied signals. This frequency is exactly 100 times the input frequency. Various 3 Kc input frequency ranges are obtained by changing the reference oscillator frequency while using the same single-sideband filter. **(304)**

Measuring Temperature Difference of Liquids

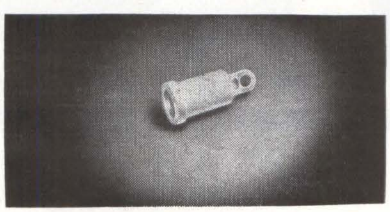
MANUFACTURED by Delta-T Co., P. O. Box 473, Santa Clara, California, the model 75 differential temperature transducer can be used to indicate, record and control the true difference in temperature between flowing liquids. Sensitivity is 0.223 mv per degree F temperature differential, accuracy is ±0.07 F and maximum operating temperature level is 250 F. Fluid pressures in excess of 1,500 psi may be accommodated. Time response to step change in temperature differential is less than 0.5 second. The device requires no calibration, amplification or power supply. A 20 junction thermocouple arrangement connected 10 hot and 10 cold in series senses temperature differential. Output comes from a 3-connector plug isolated from the metal casing.



The transducer is a very low impedance source (80 ohms) and generates a relatively large signal (typical 10 mv) linear in terms of temperature difference with excellent common-mode rejection and effective electromagnetic shielding. It is ideal for use in the vicinity of electric-arc heaters where strong electric or magnetic fields, high pressures and stray electric currents are present. **(305)**

Potentiometer Wire of Precious Metal Alloy

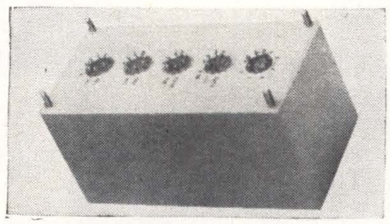
SECON METALS CORP., 7 Intervale St., White Plains, N. Y., has developed a potentiometer wire designated Secon Alloy 20-245. This precious metal alloy has a temperature coefficient of resistance of less than 20 parts per million, and a specific resistance of 245 ohms per circular mil foot. It has a tensile strength of 140,000 ppsi. It can be used with light wiper pressures. Excellent life and noise results can be obtained even in sizes below 0.001 in. diameter. **(306)**



Test Jack Designed For Limited Space

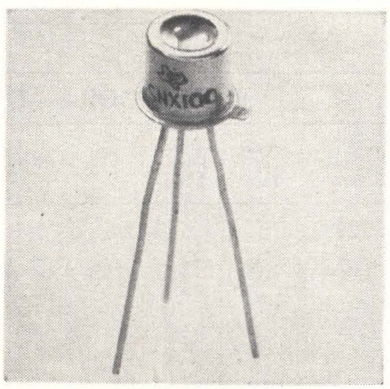
SEALECTRO CORP., 139 Hoyt St., Mamaroneck, N. Y., announces a Press-Fit test jack for application in chassis where extension below chassis must be held to a minimum and costs dictate the use of an inexpensive test jack. The SKT-0500 features a stamped beryllium copper contact and virgin Teflon bushing. It will accept an 0.050 in. (±0.001 in.) diameter probe. Overall length of the test jack is 0.207 in. For applications where color coding is desired, they may be had in any of 10 EIA colors.

CIRCLE 307, READER SERVICE CARD



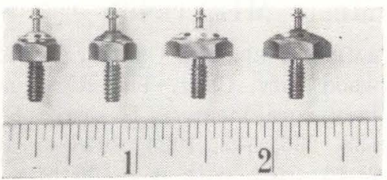
Precision Delay Line Offers Low Distortion

COLUMBIA TECHNICAL CORP., Woodside 77, N. Y. Type CTC-1853 has ten matched units to within ±0.25 percent. Time delay of the 5,000 ohm unit is 1.0 millisec ±0.25 percent. Operating temperature range is −55 C to 125 C. Distortion is less than 2 percent. Other features: phase linearity within ±0.5 percent; attenuation 1.5 db max; frequency response 14 Kc −3 db down; multi-taps of ±0.75 percent accuracy. Size is 3½ in. by 3½ in. by 6⅜ in. (308)



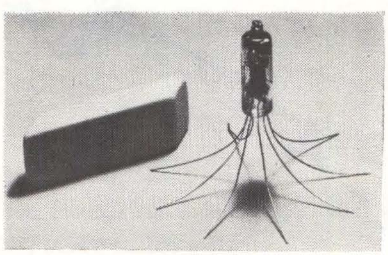
IR Source Diode for Optical Communications

TEXAS INSTRUMENTS INC., P.O. Box 5012, Dallas 22, Texas. A gallium arsenide infrared source diode, the SNX-100, has been announced as an experimental device for engineering evaluation. It may be applied in such applications as a source for equipment in secured optical communication links, transmission of tv signals, light source for tape or card reader on computers and source in IR radar equipment. It is designed to operate as a forward biased diode to emit light of a relatively narrow spectral width in the near infrared. The output can be easily modulated linearly with the forward bias current. The device has been successfully modulated at frequencies from d-c through 900 Mc. **(309)**



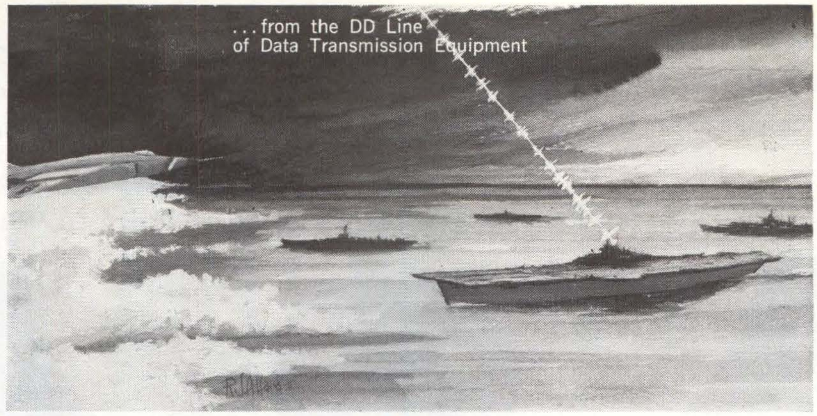
Standoff Capacitors Rated at 500 V D-C

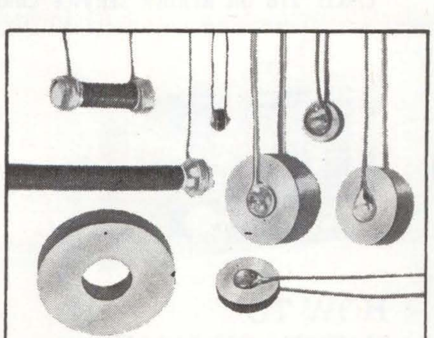
CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass., has added four new series of general-purpose, ceramic dielectric, fixed, standoff capacitors to its line. Ideal for by-pass, filter and noncritical coupling circuits, they meet the rugged performance characteristics of MIL-C-11015. All are designed for operation from −55 C to +85 C and are rated at 500 v d-c. The 3251 series is available with capacitance values from 47 to 470 $\mu\mu$f; the 3252, from 47 to 1500 $\mu\mu$f; the 3254, from 680 to 1500 $\mu\mu$f; and the 3255, from 1,000 to 4,700 $\mu\mu$f. All are available with tolerances of either ±10 percent or ±20 percent. **(310)**

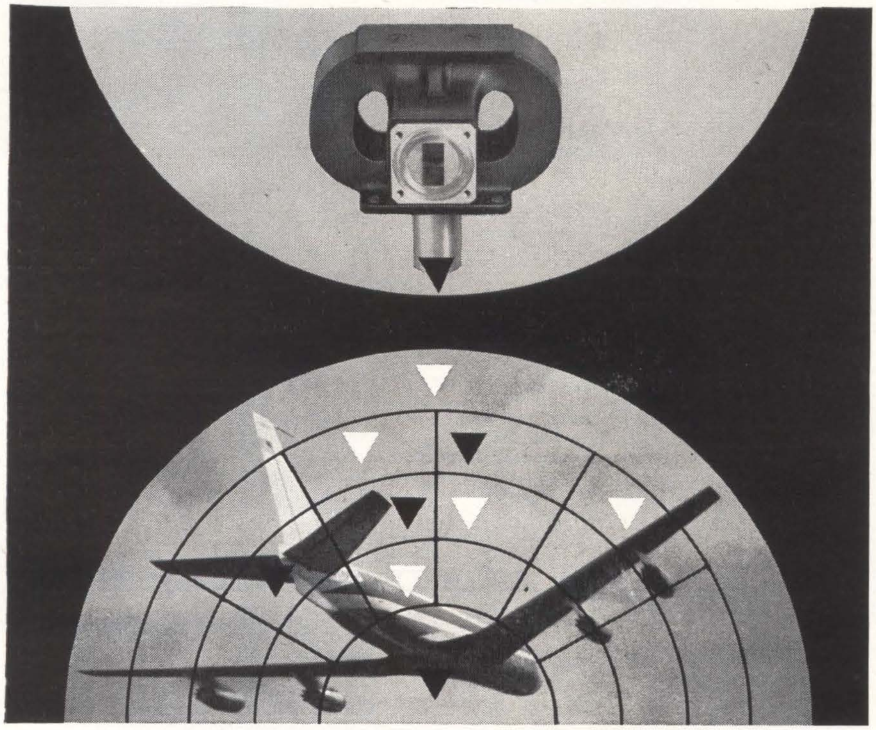


Heater-Cathode Triode Has Low Noise Output

RAYTHEON CO., 55 Chapel St., Newton 58, Mass. The high mu CK8096 subminiature heater-cathode triode is said to be about 20 db lower than conventional triodes in microphonic noise output due to reductions of structural resonances within the audio frequency range. Quiescent noise referred to the grid at 10 cps is −130 dbv per cycle and at







1,000 cps is −153 dbv per cycle. Built to withstand impact shock of 450 g, acceleration of 1,000 g, and vibration of 10g over extended periods, the tube has been tested to operate at altitudes of 60,000 ft.

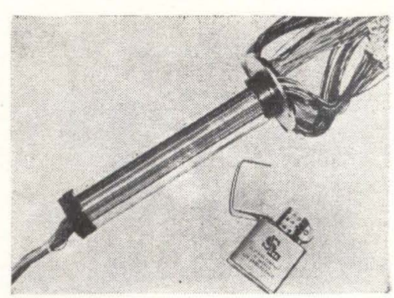
CIRCLE **311**, READER SERVICE CARD

Core Memory Meets MIL 16400

AMPEX CORP., 934 Charter St., Redwood City, Calif. The RM-3 military core memory is available in 128, 256, 512, 1024, 2048 or 4096 word sizes, with 4 to 36 bits per word in two-bit increments. It has a memory cycle of 3 μsec and a buffer cycle of 2 μsec. It can perform split-cycle operation in 4 μsec. A temperature stabilizing enclosure chamber permits operation at temperatures from 85 C to below zero deg C. **(312)**

Casting Compound

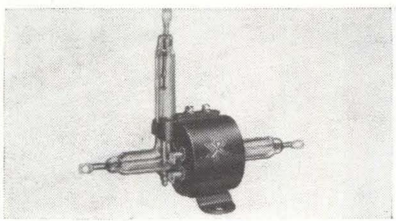
WEMS, INC., 4807 W. 118th Place, Hawthorne, Calif. WEMS-105, a two-component epoxy based resin system that cures at room temperature, is used to embed or pot welded electronic modules where light weight is important. Kits available in $\frac{3}{4}$ and $1\frac{1}{2}$ pint sizes. **(313)**



Slip Ring Capsule Contains 136 Circuits

SLIP RING CO. OF AMERICA, 3612 W. Jefferson Blvd., Los Angeles 16, Calif. Series 1517 inertial guidance slip ring capsule is designed for missile flight simulator tests. This low noise level assembly performs up to 10,000 hr continuous operation for accurate checks of components alignment and calibration of complete inertial guidance navigational systems. It contains 136 circuits: 18 five-amp, 8 two-amp and 110 one-amp circuits. Overall dimensions: 6 in. long by 1.25 in. diameter.

CIRCLE 314, READER SERVICE CARD



High Vacuum Relay Has SPDT Contacts

RESITRON LABORATORIES, INC., 3860 Centinela Ave., Los Angeles 66, Calif. Type R-7 high vacuum relay has applications in switching pulse forming networks, antenna change-over system, switching in explosive atmospheres and general switching in high voltage equipment for ground and airborne applications. The high vacuum minimizes contact arcing and maintains the contacts free from oxidation which insures stable and low contact resistance. **(315)**

A-C Null Detector Tunes From 20 to 200 Kc

BOONTON ELECTRONICS CORP., 738 Speedwell Ave., Morris Plains, N. J., offers model 51-A a-c null detector. Intended primarily as an indicator for use with l-f impedance bridges, there is a provision for discriminating against all frequencies but the one to which it is tuned. Tuning range is 20 to 200 Kc. When used as an impedance bridge indicator, it can be adjusted to show separately when resistive or reactive balancing takes place. External frequency standards can be switched in for checking or accurately setting the frequency of the generator which is to power the bridge. **(316)**

Literature of the Week

WIRE WOUND RESISTOR Dale Electronics Inc., Columbus, Neb. Bulletin R-72-T describes the type G series precision wire wound power resistor.
CIRCLE 317, READER SERVICE CARD

MAGNETIC COMPUTER Burroughs Corp., Detroit 32, Mich. An 8-page technical information bulletin contains a well illustrated article on the D210 magnetic computer. (318)

PRECISION VARIABLE ATTENUATOR Weinschel Engineering, Gaithersburg, Md. Single-sheet bulletin describes model 905 variable attenuator that covers continuously the attenuation range to 10 db from d-c to 1,000 Gc. (319)

MEMORY CORES Electronic Memories, Inc., 9430 Bellanca Ave., Los Angeles 45 Calif., has available a one-page guide to ferrite memory core types. (320)

CLUTCHES/BRAKES Vibrac Corp., Alpha Industrial Park, Route 129, Chelmsford, Mass. Brochure presents data on small (servo size 11, 15, 16) magnetic dry particle clutches and brakes for precision instruments and servo systems. (321)

MIXERS Brinkmann Instruments, Inc., 115 Cutter Mill Road, Great Neck, N. Y. Four-page folder covers three-dimensional Turbula mixers designed for unusual mixing and cleaning problems. (322)

SUBMINIATURE CONNECTORS Continental Connector Corp., 34-63 56th St., Woodside 77, N. Y., has available Form SM1062, a 16-page subminiature connector catalog. (323)

RESEARCH/ENGINEERING Ryan Industries, Inc., 888 E. 70th St., Cleveland 2, O., has available a brochure on applied and basic research/project engineering services in cryogenics and related subjects. (324)

STRAIN GAGE ACCELEROMETER Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. Bulletin 4204 describes a tri-axis strain gage accelerometer. (325)

PELLET TYPE THERMISTORS Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J. Bulletin T104 covers the D series of pellet type thermistors for three-dimensional circuit packages. (326)

DIGITAL MODULES Engineered Electronics Co., 1441 E. Chestnut Ave., Santa Ana, Calif. A 48-page catalog deals with the G-series transistorized digital circuit board modules. (327)

OVERVOLTAGE/UNDERVOLTAGE SENSORS Perkin Electronics Corp., 345 Kansas St., El Eegundo, Calif., Technical data sheet describes three overvoltage/undervoltage sensors developed for use in conjunction with d-c power supplies. **(328)**

CIRCUIT MODULES LFE Electronics, 1079 Commonwealth Ave., Boston 15, Mass. Use of germanium and silicon circuit modules for low power, high density efficiencies in digital systems is described in data bulletin series 2300 and 2350. **(329)**

H-F DISCRIMINATOR Data-Control Systems, Inc., Danbury, Conn., offers a series of specification sheets describing model GFD-4 high frequency discriminator. **(330)**

WHITE ROOM CLEANERS Branson Instruments, Inc., 37 Brown House Road, Stamford, Conn., has released a 4-page illustrated folder entitled "Ultrasonic Cleaning for White Rooms." **(331)**

TEST EQUIPMENT PRD Electronics, Inc., 202 Tillary St., Brooklyn 1, N. Y. Bulletin 900 describes a line of electronic instrumentation for microwave systems. **(332)**

SILICON RUBBER Dow Corning Corp., Midland, Mich. Bulletin 09-036 provides designers with detailed engineering data on a complete line of elastomeric raw materials. **(333)**

UHF TRANSLATORS Adler Electronics Inc., One Lefevre Lane, New Rochelle, N. Y., has available an eight-page paper titled "UHF Translators for Expanding Television Coverage." **(334)**

RESIN CORE SOLDER Kester Solder Co., 4201 Wrightwood Ave., Chicago 39, Ill. Kester "44" resin core solder is described in a two-color envelope size pamphlet. **(335)**

DIODE REFERENCE GUIDES National Transistor, 500 Broadway, Lawrence, Mass., has released two new subminiature glass diode reference guides. **(336)**

MICROWAVE TUBE BROCHURE Varian Associates, 611 Hansen Way, Palo Alto, Calif., offers a brochure featuring tubes and components for heavy radar, radar astronomy and linear accelerator use. **(337)**

D-C PREAMPLIFIER Inland Motor Corp., Northampton, Mass. Bulletin describes an *npn*-transistor plug-in type d-c voltage preamplifier, with reversible polarity, for use in servo systems. **(338)**

DIODE TESTER Test Devices, Inc., 3014-B So. Halladay St., Santa Ana, Calif., has released a technical bulletin on the model 1050 diode tester. **(339)**

ENGINEERED PLASTICS Taunton Division, Haveg Industries, Inc., Taunton, Mass., has published an updated brochure on engineered plastics for space, electronics, aviation and industrial applications. **(340)**

SELENIUM SURGE SUPPRESSORS Fansteel Metallurgical Corp., North Chicago, Ill. Selenium surge suppressors designed to protect silicon devices from transient surges that might otherwise destroy them are described in a bulletin. **(341)**

WEMA Board Elects Officers

WEMA EXECUTIVE COMMITTEE. *Newly elected officers of the Western Electronic Manufacturers Association include, seated, from left, Philip E. Renshaw, Emmet G. Cameron, Burgess Dempster; standing, Virden E. Scranton, Orison Wade, William H. Heflin, and E. E. Ferrey*

EMMET G. CAMERON, executive vice president of Varian Associates, was elected president of the Western Electronic Manufacturers Association (WEMA) at a recent meeting of the association's board of directors in Palo Alto. He was among the founders of WEMA 20 years ago. Cameron is president of the Palo Alto Chamber of Commerce.

Elected vice presidents of the western industry group were Burgess Dempster, president, Electronic Engineering Co. of Calif., Santa Ana; William H. Heflin, general manager, Beckman & Whitley Inc., San Carlos; Orison Wade, assistant chief engineer, General Dynamics/Astronautics, San Diego; Philip E. Renshaw, chairman of the board, Tally Register Corp., Seattle, and Virden E. Scranton, assistant general manager, Motorola Semiconductor Products division, Phoenix.

Kenneth T. Larkin, associate director of electronics research, Lockheed Missiles & Space Co., Palo Alto, was elected secretary of the association, and Robert M. Ward, vice president, Beckman Instruments Inc., Fullerton, has been appointed treasurer.

Other directors of the association include Henry M. Bailey, Cohu Electronics Inc., San Diego; James H. Cannon, Cannon Electric Co., Los Angeles; Kenneth F. Julin, Leach Corp., Los Angeles; James G. Kirwan, Electro Scientific Industries, Portland; John S. McCullough, Litton Industries, Electron Tube division, San Carlos; William J. Miller, Burton Manufacturing Co., Northridge, Calif.; Albert J. Morris, Radiation at Stanford, Palo Alto; John S. Rydz, Nuclear Corp. of America, Phoenix; Walter G. Scott, IBM, San Jose, and Andrew J. Unetic, Bourns Inc., Riverside.

ITT Promotes Two Executives

PROMOTION of two executives of International Telephone and Telegraph Corp. has been announced by Harold S. Geneen, president.

William M. Duke was elevated to general manager—defense operations for ITT and will continue as president of ITT Federal Laboratories, Nutley, N. J.

George A. Banino was appointed executive vice president of ITT Federal Laboratories. He also continues as division president of ITT Kellogg Communications Systems.

Aerojet-General Elects Fletcher

ELECTION of James C. Fletcher as vice president-advanced systems of Aerojet-General Corp., Azusa, Calif., has been announced by W. E. Zisch, Aerojet executive vice president.

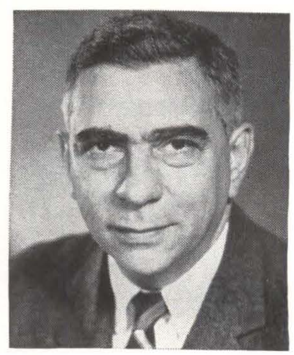
Fletcher is chairman of the board of Space-General Corp., Aerojet's space systems subsidiary. He is also at present a consultant of the President's Science Advisory Committee and a member of the Command and Control Planning Panel.

In his new position, Zisch pointed out, Fletcher will be responsible for assuring that Aerojet and its subsidiaries are marshaling their entire resources to assure maximum capability to undertake over-all systems or subsystems.

Philco Board Names Wilson Oelkers

THE BOARD of directors of Philco Corporation has elected Wilson H. Oelkers a vice president.

Oelkers is general manager of the company's Lansdale division which manufactures tubes, transistors and solid state devices at plants in Lansdale and Spring City, Pa.



IBM Elects Piore As Board Member

INTERNATIONAL BUSINESS MACHINES CORP., New York City, has announced the election of Emanuel R.

COLLEGE IS BUSINESS' BEST FRIEND

Business employs almost half of the product of colleges—the college graduate. Business management is largely composed of college graduates. Business concerns benefit extensively from the research colleges engage in. Business owes college a great debt.

Higher education is facing during the next decade greatly enlarged student enrollments, the problems of an explosion of knowledge, and the need to meet ever growing demands for ever better educated men and women.

These problems involve vastly increased costs which cannot be met out of present income.

The operating cost of higher education today is over four and a half billion dollars a year and will at least double in this decade.

Business and industry, as major beneficiaries of American higher education, must recognize a responsibility to contribute their fair share.

American business corporations produce much of the nation's wealth. They have enormous power for good. We believe they can exercise it in a meaningful way—as many do now—by providing voluntary support for colleges and universities of their choice.

These conclusions, and the following statement of conviction, were outcomes of a recent conference of business leaders sponsored in New York by the Council for Financial Aid to Education, Inc.

A STATEMENT OF CONVICTION

We believe that, in the light of the present urgency, now is the time for a broader and deeper participation by the business community in the support of higher education.

We therefore call upon our colleagues in American business and industry to help spread the base of voluntary support of higher education as a necessary supplement to the extensive support which business now provides to education through taxes.

We urge responsible management to think through its opportunity and its obligation to adopt meaningful programs of voluntary corporate support to those colleges and universities whose service and quality they wish to encourage and nurture. We on our part will do no less.

KENNETH H. KLIPSTEIN, *American Cyanamid Co.*

JOSEPH A. GRAZIER, *American Radiator & Standard Sanitary Corporation*

M. NIELSEN, *The Babcock & Wilcox Co.*

HARMON S. EBERHARD, *Caterpillar Tractor Co.*

HAROLD H. HELM, *Chemical Bank New York Trust Company*

F. W. MISCH, *Chrysler Corporation*

FRANK O. H. WILLIAMS, *Connecticut General Life Insurance Company*

WESLEY M. DIXON, *Container Corporation of America*

THOMAS C. FOGARTY, *Continental Can Company, Inc.*

SAMUEL LENHER, *E. I. du Pont de Nemours & Company*

MARION B. FOLSOM, *Eastman Kodak Company*

LEWIS B. CUYLER, *First National City Bank*

RALPH J. CORDINER, *General Electric Company*

LEONARD F. GENZ, *General Foods Corporation*

GEORGE RUSSELL, *General Motors Corporation*

JOHN C. GRISWOLD, *W. R. Grace & Company*

JERRY McAFEE, *Gulf Oil Corporation*

GEORGE S. DIVELY, *Harris-Intertype Corporation*

FRANK R. MILLIKEN, *Kennecott Copper Corporation*

JAMES C. DONNELL II, *Marathon Oil Company*

REINHARD A. HOHAUS, *Metropolitan Life Insurance Co.*

STUART T. SAUNDERS, *Norfolk & Western Railway Co.*

STANLEY DE J. OSBORNE, *Olin Mathieson Chemical Corp.*

WILLIAM CARPENTER, *Pittsburgh Plate Glass Co.*

CHAMP CARRY, *Pullman, Incorporated*

JAMES T. GRIFFIN, *Sears, Roebuck and Company*

H. GERSHINOWITZ, *Shell Development Company Shell Oil Company*

E. L. STEINIGER, *Sinclair Oil Corporation*

JOHN E. SWEARINGEN, *Standard Oil Company (Indiana)*

M. J. RATHBONE, *Standard Oil Company (N. J.)*

CHARLES E. SPAHR, *Standard Oil Company (Ohio)*

J. ERIK JONSSON, *Texas Instruments, Inc.*

HARRY B. McCLURE, *Union Carbide Corporation*

J. S. JOHNSON, *U. S. Rubber Company*

W. HOMER TURNER, *U. S. Steel Foundation, Inc.*

R. D. LILLEY, *Western Electric Company, Inc.*

ALFRED S. GLOSSBRENNER, *Youngstown Sheet & Tube Co.*

*JAMES B. BLACK, *Pacific Gas & Electric Co.*

*G. KEITH FUNSTON, *New York Stock Exchange*

*NEIL McELROY, *The Procter & Gamble Co.*

*DE WITT WALLACE, *The Reader's Digest*

*IRVING S. OLDS, *Former Chairman of the Board U. S. Steel Corp.*

*FRANK W. ABRAMS, *Former Chairman of the Board Standard Oil Co. (N. J.)*

*WALTER D. FULLER, *The Curtis Publishing Co.*

*DEVEREUX C. JOSEPHS, *Former Chairman of the Board New York Life Insurance Co.*

*ROBERT E. WILSON, *U. S. Atomic Energy Commission*

*FRANK H. SPARKS, *President Council for Financial Aid to Education, Inc.*

**Director, Council for Financial Aid to Education*

ADVERTISING COUNCIL 1942-1962

HIGHER EDUCATION KEEP IT BRIGHT

Published as a public service in cooperation with The Advertising Council and the Council for Financial Aid to Education.

Piore as a member of the board of directors. Piore is IBM vice president, research and engineering.

The former chief scientist of the Office of Naval Research joined IBM in 1956 as director of research. He was elected a vice president in 1960.

Tamar Hires Barnhart As Chief Engineer

SIMON W. BARNHART has been appointed chief engineer of Tamar Electronics, a division of Tamar Electronics Industries, Inc., Gardena, Calif.

Prior to joining Tamar, Barnhart was department manager of the Armament Control division of Autonetics where he supervised 200 engineering personnel in all phases of engineering on airborne radar, armament control systems, and associated ground support equipment.

Kollmeyer Joins Adler Electronics

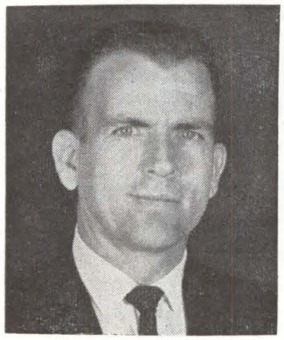
JASPER C. KOLLMEYER has joined the Systems Engineering department, Government Products division of Adler Electronics, Inc., New Rochelle, N. Y., as an executive engineer. He was formerly manager of systems design with ITT-Kellogg Co.

Adler produces telecommunications systems and communications equipment.

TRW Microwave Names Price

APPOINTMENT of Oliver R. Price as manager advanced development, TRW Microwave division, Canoga Park, Calif., has been announced. He will be responsible for TRW's increased activity in company and contract supported R&D programs in microwave antennas and components.

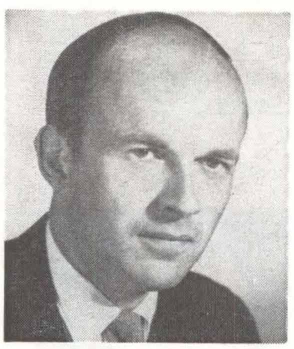
Prior to joining the Thompson Ramo Wooldridge Inc. division, Price was chief engineer at Micro-Radionics and for several years was a member of the R&D Laboratories at Hughes Aircraft where he headed the advanced studies section.



McCulloh Takes New Position

WILLIAM L. MCCULLOH has joined Frequency Engineering Laboratories as senior electronic engineer in the firm's Systems division. His new duties will involve engineering development of countermeasures equipment.

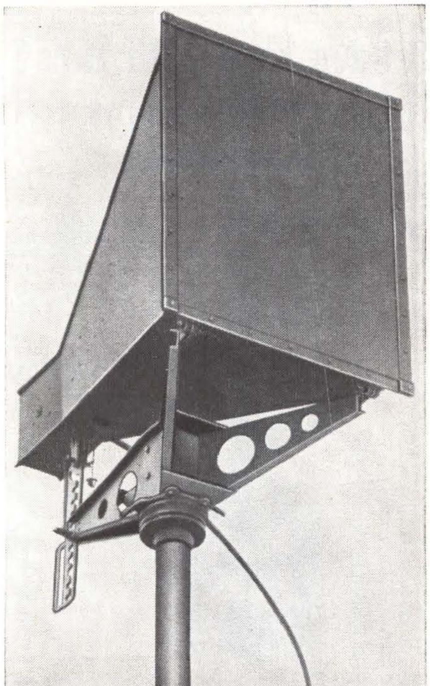
McCulloh was formerly senior electrical engineer at Lockheed Electronics Co.



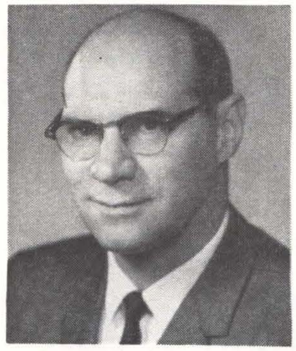
Hare Accepts Post At CTS of Canada

WILLIAM F. J. HARE has been named director of research at CTS of Canada, Ltd., Ontario, Canada. He will head research on solid state devices and investigate the development of new and diversified products for the firm's Canadian electronics market.

Prior to joining CTS, Hare was a member of the technical staff of



semiconductor device development at Bell Laboratories, Murray Hill, N. J.



Newbury Accepts Century Position

WILLIAM F. NEWBURY, former manufacturing manager of Sylvania Electric Products, has been named production manager for Century Electronics & Instruments, Inc., Tulsa, Okla., developer and manufacturer of electronic instruments for the aerospace industry.

Newbury was affiliated with Sylvania from 1952 until recently joining Century.

Blumkin Assumes New Post

R. BLUMKIN, formerly chief engineer at General Resistance Inc., has been appointed vice president of engineering at R-Tronics, Inc., Jamaica, N. Y.

R-Tronics manufactures resistors and networks.

Electronic Memories Hires Hathaway

APPOINTMENT of Bernard Hathaway as director of manufacturing for Electronic Memories, Inc., Los Angeles, Calif., is announced.

Electronic Memories, Inc., is engaged in the development, design and manufacture of ferrite memory cores and core memory systems for both military and commercial applications.

Before joining EMI, Hathaway was director of manufacturing engineering for Ampex Computer Products Co.

PEOPLE IN BRIEF

Executone, Inc., promotes **Albert Bower** to exec v-p and **R. T. Capodanno** to v-p in charge of manufacturing and engineering. New titles at United Aircraft's Norden div.: **Ernest J. Greenwood,** from operations mgr. to div. v-p, operations; **Will M. Quinn, Jr.,** from engineering mgr. to div. v-p, engineering. **James F. Manning** advances to systems mgr. for information storage systems at IBM's General Products div. **Richard C. Lindsay,** formerly with the Rand Corp., appointed asst. to the president of Electronic Communications, Inc., for operations analysis and planning. **Walter D. Eisenhower,** previously with Western Electric, named mgr. of the Semiconductor Development dept. at the Electronic Components div. of Burroughs Corp. **John J. Bohrer,** director of R&D for International Resistance Co., elected a v-p of the firm. **Hugh S. Allen, Jr.,** leaves Lang Worth Feature Programs to join Kahn Research Labs, Inc., as director of engineering applications. Joy Mfg. Co. ups **Patrick W. Zilliacus** to mgr. in the electrical products dept. of the Industrial div. **Albert N. Leman,** from Leece-Neville Co. to Heinze Electric Co. as chief engineer. **Hirschel Schwartz,** recently with Gudeman Co., appointed chief engineer at PCA Electronics, Inc. **Donald C. Wright,** formerly with General Electric Co., now a member of the technical staff of Micromega Corp. **John J. Burke,** senior v-p of Lear Siegler Inc., elected a director of Technical Systems Inc. **Daniel C. Sweeney** moves up to v-p of U.S. Sonics Corp.

EMPLOYMENT OPPORTUNITIES

electronics

WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

ATTENTION: ENGINEERS, SCIENTISTS, PHYSICISTS

This Qualification Form is designed to help you advance in the electronics industry. It is unique and compact. Designed with the assistance of professional personnel management, it isolates specific experience in electronics and deals only in essential background information.

The advertisers listed here are seeking professional experience. Fill in the Qualification Form below.

STRICTLY CONFIDENTIAL

Your Qualification form will be handled as "Strictly Confidential" by ELECTRONICS. Our processing system is such that your form will be forwarded within 24 hours to the proper executives in the companies you select. You will be contacted at your home by the interested companies.

WHAT TO DO

1. Review the positions in the advertisements.
2. Select those for which you qualify.
3. Notice the key numbers.
4. Circle the corresponding key number below the Qualification Form.
5. Fill out the form completely. *Please print clearly.*
6. Mail to: Classified Advertising Div., ELECTRONICS, Box 12, New York 36, N. Y. (No charge, of course).

COMPANY	SEE PAGE	KEY #
ATOMIC PERSONNEL INC. Philadelphia, Penna.	84**	1
BUREAU OF NAVAL WEAPONS Sunnyvale, Calif.	82**	2
DOUGLAS AIRCRAFT CO. Missile & Space Systems Division Santa Monica, California	19*	3
HARVARD UNIVERSITY Cambridge 38, Mass.	153	4
NAVY DEPT. (BUREAU OF SHIPS) Washington 25, D. C.	152	5
PAN AMERICAN WORLD AIRWAYS INC. Guided Missiles Range Div. Patrick Air Force Base, Fla.	151	6
ROME AIR MATERIEL AREA (AFLC) Griffiss Air Force Base, Rome, N. Y.	153	7
SPACE TECHNOLOGY LABORATORIES INC. Sub. of Thompson Ramo Wooldridge Inc. Redondo Beach, Calif.	15	8
U. S. ARMY Harry Diamond Laboratories Washington, D. C.	152	9
P 1179	84**	10

** These advertisements appeared in the Dec. 14th issue.

* This advertisement appeared in the Dec. 28th. issue.

(cut here) **electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE** (cut here)

(Please type or print clearly. Necessary for reproduction.)

Personal Background

NAME ....

HOME ADDRESS ....

CITY .... ZONE .... STATE ....

HOME TELEPHONE ....

Education

PROFESSIONAL DEGREE(S) ....

MAJOR(S) ....

UNIVERSITY ....

DATE(S) ....

FIELDS OF EXPERIENCE (Please Check)

1463

- ☐ Aerospace
- ☐ Antennas
- ☐ ASW
- ☐ Circuits
- ☐ Communications
- ☐ Components
- ☐ Computers
- ☐ ECM
- ☐ Electron Tubes
- ☐ Engineering Writing
- ☐ Fire Control
- ☐ Human Factors
- ☐ Infrared
- ☐ Instrumentation
- ☐ Medicine
- ☐ Microwave
- ☐ Navigation
- ☐ Operations Research
- ☐ Optics
- ☐ Packaging
- ☐ Radar
- ☐ Radio—TV
- ☐ Simulators
- ☐ Solid State
- ☐ Telemetry
- ☐ Transformers
- ☐ Other ....
- ☐ ....
- ☐ ....
- ☐ ....

CATEGORY OF SPECIALIZATION

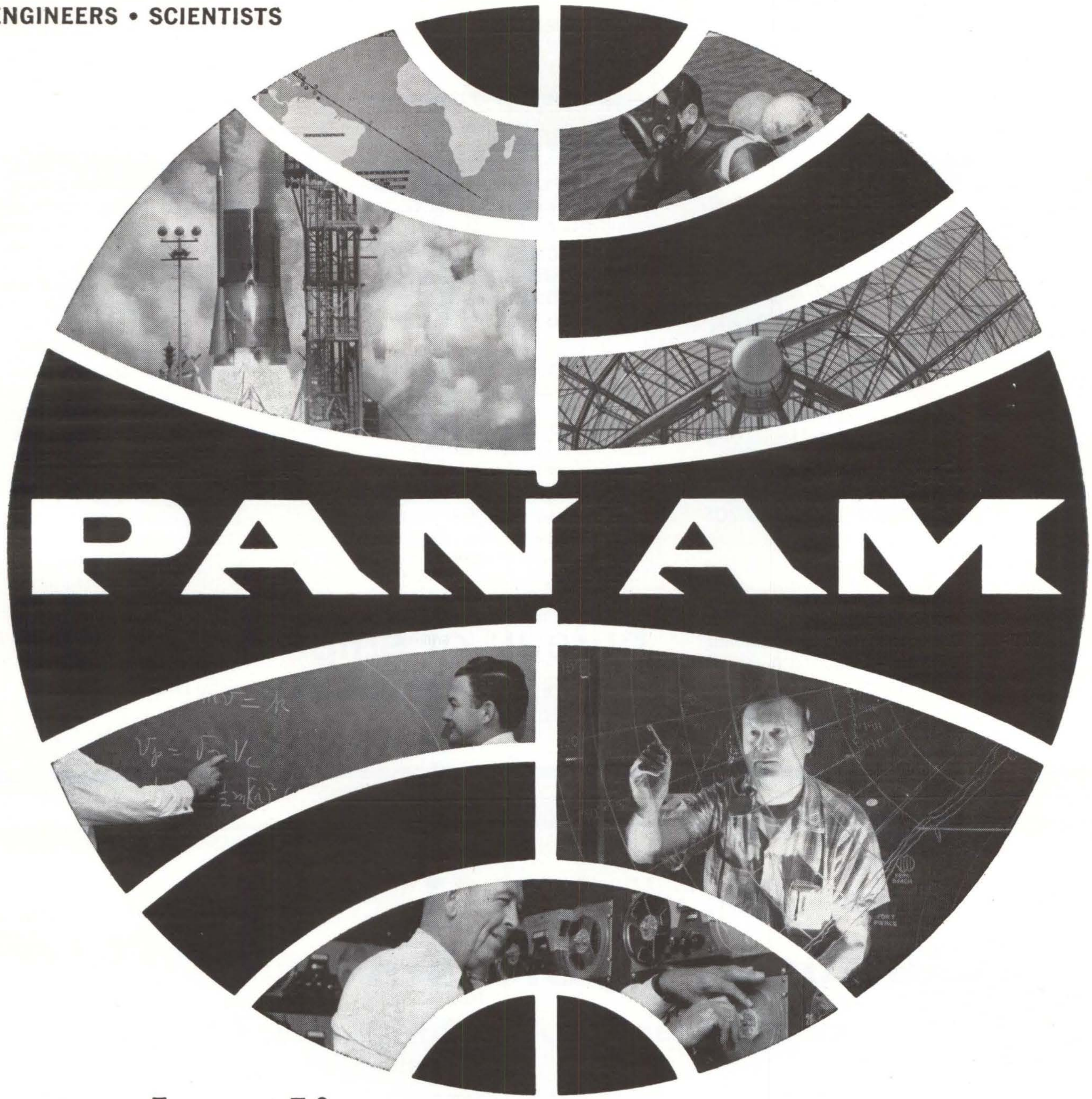
Please indicate number of months experience on proper lines.

	Technical Experience (Months)	Supervisory Experience (Months)
RESEARCH (pure, fundamental, basic)	......	......
RESEARCH (Applied)	......	......
SYSTEMS (New Concepts)	......	......
DEVELOPMENT (Model)	......	......
DESIGN (Product)	......	......
MANUFACTURING (Product)	......	......
FIELD (Service)	......	......
SALES (Proposals & Products)	......	......

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

ENGINEERS • SCIENTISTS



encyclopedic exposure to the whole world of space vehicle & missile technology

is basic to engineering with PAN AM* at the Atlantic Missile Range. □ The reason: engineers and scientists here strive to **match** the capabilities of each new launch vehicle with range test systems of equal or greater accuracy. Our engineers and scientists have pushed the past and present instrumentation systems to their operational limits—and have gone on to create **a whole new range technology.** They have developed design criteria and are providing technical direction for global tracking and telemetry systems, combining the latest techniques from all areas of electronics, optics and infrared. □ Today, forward looking groups at PAN AM's Guided Missiles Range Division are not only planning for this year's and next year's tests but are considering range requirements five through fifteen years ahead—requirements to test manned space vehicles still on the drawing boards or "existing in concept" only.

OPPORTUNITIES NOW EXIST to join PAN AM at the Cape in developing range systems hemispheric, global and celestial in scope—and share in the exceptional professional development implicit in these assignments.

Systems Engineers-EE's, Physicists & Mathematicians capable of assuming complete project responsibility for new range systems.

Instrumentation Planning Engineers—EE's, Physicists to be responsible for specific global range instrumentation concepts.

Senior Engineers & Scientists—PhD's in Math, Physics, Celestial Mechanics, Astronomy or Electronics.

Experience in one or more of these areas: Pulse radar, CW techniques, telemetry, infrared, data handling, communications, closed circuit TV, frequency analysis, command control, command guidance, underwater sound, timing, shipboard instrumentation.

Why not write us today, describing your interests and qualifications in any of the areas above. Address Dr. Charles Carroll, Dept. 28A-1, Pan American World Airways, Incorporated, P.O. Box 4336, Patrick Air Force Base, Florida.

*Carrying on Range Planning, Engineering and Operation of Atlantic Missile Range for the USAF since 1953. An equal opportunity employer.

PAN AM

GUIDED MISSILES RANGE DIVISION

PATRICK AIR FORCE BASE, FLORIDA

EMPLOYMENT OPPORTUNITIES

The advertisements in this section include all employment opportunities — executive, management, technical, selling, office, skilled, manual, etc.

Look in the forward section of the magazine for additional Employment Opportunities advertising.

— RATES —

DISPLAYED: The advertising rate is $40.17 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

UNDISPLAYED: $2.70 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Box numbers—count as 1 line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

An opportunity in the area of High Energy Particle Physics

HARVARD UNIVERSITY

has openings for

ELECTRONICS ENGINEERS

to join small groups of scientists and engineers in the development of instrumentation for the world's largest electron accelerator—a 6-BEV alternating gradient synchrotron. Experience or knowledge of fast pulse transistor circuitry, power supplies and interconnections desirable.

Resumes and inquiries concerning this opportunity are invited

PERSONNEL DEPARTMENT

HARVARD UNIVERSITY

1352 Massachusetts Avenue
Harvard Square, Cambridge 38, Mass.

An equal opportunity employer

"IN-SERVICE" ENGINEERS
ROME AIR MATERIEL AREA

(A major component of Air Force Logistics Command)

Rome Air Materiel Area has been assigned the mission of providing Ground Communications-Electronic logistic support to the Air Force. A very vital facet for fulfilling this responsibility involves those engineering functions necessary to insure the performance integrity of the C-E equipments and systems once they become operational.

TYPICAL RESPONSIBILITIES OF ROAMAs "IN-SERVICE ENGINEERS" ARE:

- Modification or rehabilitation of operational Ground C&E equipments by correction of design deficiencies.
- Development of engineering specifications for support of procurement.
- Providing engineering design criteria to insure maintainability, serviceability and reliability of operational C&E equipment.
- Performing engineering liaison with AF Contractors.

CURRENT AND FUTURE ASSIGNMENTS CREATE AN EVER INCREASING DEMAND FOR:

Electronic Engineers (all options)
Electrical Engineers
Mechanical Engineers
General Engineers

TO MONITOR AND PERFORM WORK ON VITAL PROJECTS IN THE FOLLOWING AREAS:

Search and Detection Radar
Missile Guidance and Tracking
Digital and Analog Computers
Beacon and Identification Equipments
ICBM Communications Sub-Systems
Communications Ancillary Equipments
Electronics Systems (Warning, Intelligence, Command, Support)

We have an immediate and urgent need for Graduate engineers, to insure the operational readiness of Ground C-E systems and equipments. Current demands at Rome Air Materiel Area for in-service engineering support are heavy. Increased mission responsibilities will entail even heavier demands in the future.

ROAMAs Directorate of Materiel Management provides an immediate career opportunity for graduate Electronic, Electrical, General and Mechanical Engineers. Ground Communications and operational Electronics Systems and Equipments are subject to continuous change consistent with advances in the state of the art. Keep abreast of the continuous scientific advancements as a contributor to the engineering accomplishments of the Air Force in the highly specialized fields of communications electronics.

For more information about Air Force Civilian career opportunities in "In-Service" Engineering submit your resume to:

Mr. William Pagano
Professional Scientific Recruiter
ROAMA
GRIFFISS AIR FORCE BASE
Rome, New York

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES — EQUIPMENT - USED or RESALE

DISPLAYED ——***RATES***——

The advertising is $27.25 per inch for all advertising other than on a contract basis. AN ADVERTISING INCH is measured ⅞" vert. on a column, 3 cols.—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED

$2.70 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.

BOX NUMBERS count as one line additional.

DISCOUNT of 10% if full payment is made in advance for four consecutive insertions.

Send NEW ADVERTISEMENTS or Inquiries to Classified Adv. Div. of Electronics, P. O. Box 12, N. Y. 36, N. Y.

EXCELLENT USED LABORATORY EQUIPMENT

H-P #626A SHF SIG. GEN. 10-15.5 G.C., LIKE NEW	$1685
H-P #628A SHF SIG. GEN. 15-21 G.C., LIKE NEW	$1490
G.R. #805C STD. SIG. GEN. 50 KC-50 MC, EXCELLENT	$ 695
MEAS. CORP #84R SIG. GEN. 300 MC-1000 MC, EXCELLENT	$ 695
KAY MEGAMATCH SWEEPER 10 MC-1 G.C., 30 MC SWEEP WIDTH	$ 415
RUTHERFORD B7 PULSE GENERATOR ALMOST NEW	$ 430
DUMONT 401 SCOPE, DC-200 KC, 10 MV/CM, NEW CRT	$ 190
TEKTRONIX PLUGINS 53/54 "B", 53/54 "K", each	$ 65

— SELL OR TRADE, MAKE OFFER —

ELECTRO DIGITAL VOLTMETER, DUA 400, .001-999.9 VDC, .01% AUTO RANGING.
ENDEVCO TRIAXIAL ACCELEROMETER #2223 & 2616 3 CHANNEL LAB. AMPLIFIER
FREQ. METERS—PRD 579A, 1.6-2.6 GC; FXR N410A, 1—4 GC
LINK AVIATION 250400 PHASE COMPARATOR & PWR SUPPLY, SERVO ANALYSIS.
ALL WITH MONEY-BACK GUARANTEE, FOB BERKELEY, ADD. CALIF. TAX IN CALIF.

SPECIALTIES RESEARCH, BOX 2116 S. BERKELEY STA., BERKELEY 5, CALIF.

CIRCLE 950 ON READER SERVICE CARD

FOR RESEARCH — DEVELOPMENT & EXPERIMENTAL WORK

Over 10,000 different electronic parts: waveguide, radar components and parts, test sets, pulsers, antennas, pulse xmfrs, magnetrons. IF and pulse amplifiers, dynamotors, 400 cycle xmfrs, 584 ant. pedestals, etc.
PRICES AT A FRACTION OF ORIGINAL COST!

COMMUNICATIONS EQUIP CO.
343 CANAL ST., N. Y. 13, WO 6-4045
CHAS. ROSEN (Fomerly at 131 Liberty St.)

CIRCLE 951 ON READER SERVICE CARD

RADIO RESEARCH INSTRUMENT CO.

AUTO-TRACK & TELEMETRY ANTENNA PEDESTALS
3 & 10 CM. SCR. 584 AUTOTRACK RADARS.
AN/TPS-1D SEARCH. AN/TPS-10 HT. FINDERS.
AN/FPN-32GCA. AN/APS-10 NAVIG. & WEATHER.
AN/APS-15B PRECISION. AN/APQ-35B PRECISION.
AN/APS-31A SEARCH. DOZENS MORE.
.5-1-2 MEGAWATT HIGH POWER PULSERS.

RADIO RESEARCH INSTRUMENT CO.
550 Fifth Ave., New York — Judson 6-4691

RADAR SYSTEMS & COMPONENTS/ IMMEDIATE DELIVERY

CIRCLE 952 ON READER SERVICE CARD

LOOKING FOR
USED/SURPLUS ELECTRONIC EQUIPMENT/COMPONENTS?

For an up-to-date listing of such equipment see Searchlight Section of Dec. 14th.

OVER 2,000,000

RELAYS

IN STOCK!

Send for Catalog SS

Universal RELAY CORP.
42 WHITE ST., N.Y. 13, N.Y. • WAlker 5-6900

CIRCLE 953 ON READER SERVICE CARD

INDEX TO ADVERTISERS

Audited Paid Circulation

■

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

INDEX TO CLASSIFIED ADVERTISERS

• See advertisement in the July 25, 1962 issue of Electronics Buyers' Guide for complete line of products or services.

electronics

Audit Bureau of Circulations

Associated Business Publications

Audited Paid Circulation

JAMES T. HAUPTLI

Advertising Sales Manager

R. S. QUINT: Assistant Publisher Buyers' Guide and Business Manager
FRED STEWART: Promotion Manager
B. ANELLO: Market Services Manager

RICHARD J. TOMLINSON: Production Manager
GEORGE E. POMEROY: Classified Manager
HUGH J. QUINN: Circulation Manager

ADVERTISING REPRESENTATIVES

ATLANTA (9): Michael H. Miller, Robert C. Johnson 1375 Peachtree St. N.E., Trinity 5-0523 (area code 404)

BOSTON (16): William S. Hodgkinson, Donald R. Furth McGraw-Hill Building, Copley Square, Congress 2-1160 (area code 617)

CHICAGO (11): Harvey W. Wernecke, Robert M. Denmead 645 North Michigan Avenue, Mohawk 4-5800 (area code 312)

CLEVELAND (13): Paul T. Fegley 55 Public Square, Superior 1-7000 (area code 216)

DALLAS (1): Frank Le Beau The Vaughn Bldg., 1712 Commerce St. Riverside 7-9721 (area code 214)

DENVER (2): J. W. Patten Tower Bldg., 1700 Broadway, Alpine 5-2981 (area code 303)

HOUSTON (25): Joseph C. Page, Jr. Prudential Bldg., Halcombe Blvd., Riverside 8-1280 (area code 713)

LOS ANGELES (17): Peter S. Carberry, Ashley P. Hartman, W. C. Gries 1125 W. 6th St., Huntley 2-5450 (area code 213)

NEW YORK (36): Donald H. Miller, Henry M. Shaw, George F. Werner 500 Fifth Avenue, LO-4-3000 (area code 212)

PHILADELPHIA (3): Warren H. Gardner, William J. Boyle 6 Penn Center Plaza, LOcust 8-4330 (area code 215)

SAN FRANCISCO (11): R. C. Alcorn 255 California Street, Douglas 2-4600 (area code 415)

LONDON W1: Edwin S. Murphy Jr. 34 Dover St.

FRANKFURT/Main: Matthée Herfurth 85 Westendstrasse

GENEVA: Michael R. Zeynel 2 Place du Port

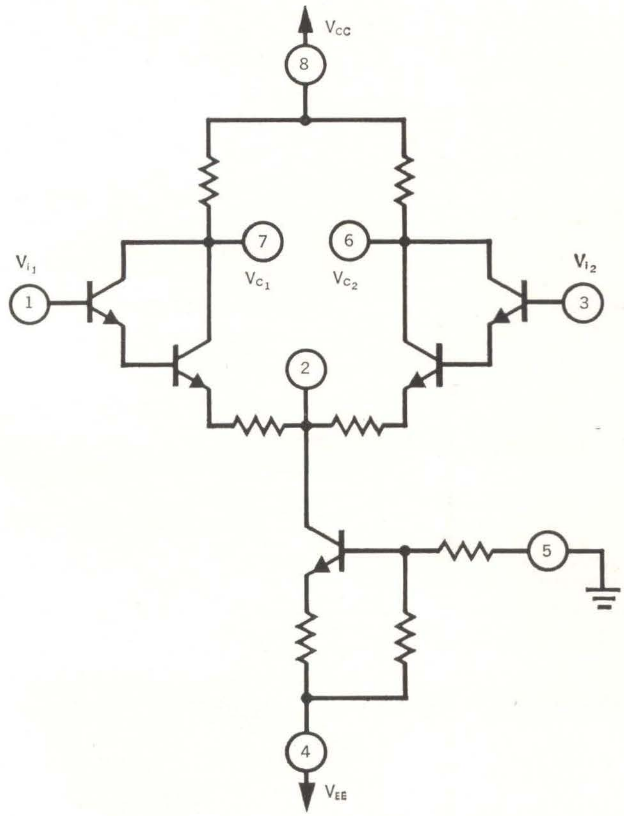
"Headquarters for Business Information"

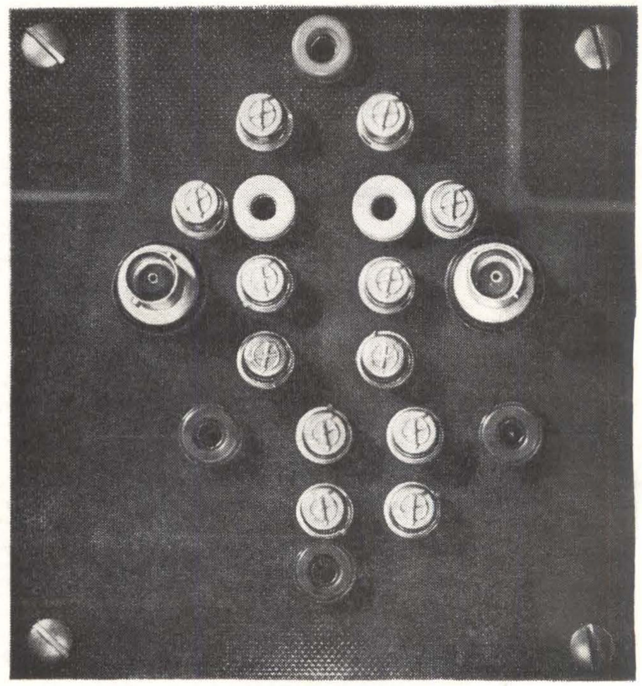
McGraw-Hill Technical and Business Publications

American Machinist/Metalworking Manufacturing
Aviation Week and Space Technology
Business Week
Chemical Engineering
Chemical Week
Coal Age
Construction Methods and Equipment
Construction Daily
Control Engineering
Electrical Construction and Maintenance
Electrical Merchandising Week
Electrical Newsletter
Electrical West
Electrical Wholesaling
Electrical World
Electronics
Engineering Digest
Engineering and Mining Journal
E & MJ Metal and Mineral Markets
Engineering News-Record
Factory
Fleet Owner
Industrial Distribution
National Petroleum News
Nucleonics
Nucleonics Week
Platt's Oilgram News
Platt's Oilgram Price Service
Power
Product Engineering
Purchasing Week
Science Week
Textile World

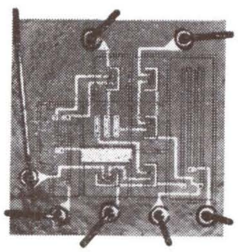
Overseas only:
Automobile International (English, Spanish)
Ingenieria Internacional Construccion (Spanish)
International Management (English, Spanish Portuguese editions)
Metalworking Production (Great Britain)

Available by subscription only — to qualified persons actively engaged in the field of the publication. For subscription rates and information describing the editorial coverage of any of the above publications, write to: *Subscription Manager, Circulation Department, McGraw-Hill Publishing Company, 330 West 42nd Street, New York 36, N. Y.*




Breadboard of custom microcircuit components.

You design and breadboard it.



(Actual size ⟶ ■)

We integrate it.

What you do: Using data sheet information for Fairchild custom design components, you develop a worst-case circuit design. You can then breadboard the components and experiment until circuit performance meets your requirements exactly. The transistors, resistors, capacitors and diode arrays are Fairchild production microcircuit components physically separated and mounted in standard packages. Thus, your breadboard working model is a functional replica of the finished integrated microcircuit.

What we do: Fairchild uses your proven breadboard design with its specifications to develop masks and test equipment for manufacturing the integrated microcircuit. The circuit elements are diffused into a single chip of silicon using the Planar* process and intraconnected using an evaporated metal over oxide process†. Delivery is within ninety days from acceptance of your custom design. The finished microcircuit product possesses the same reliability demonstrated in over nine million hours of operating life tests on Fairchild Micrologic units. Data sheets sent on request.

FAIRCHILD
SEMICONDUCTOR

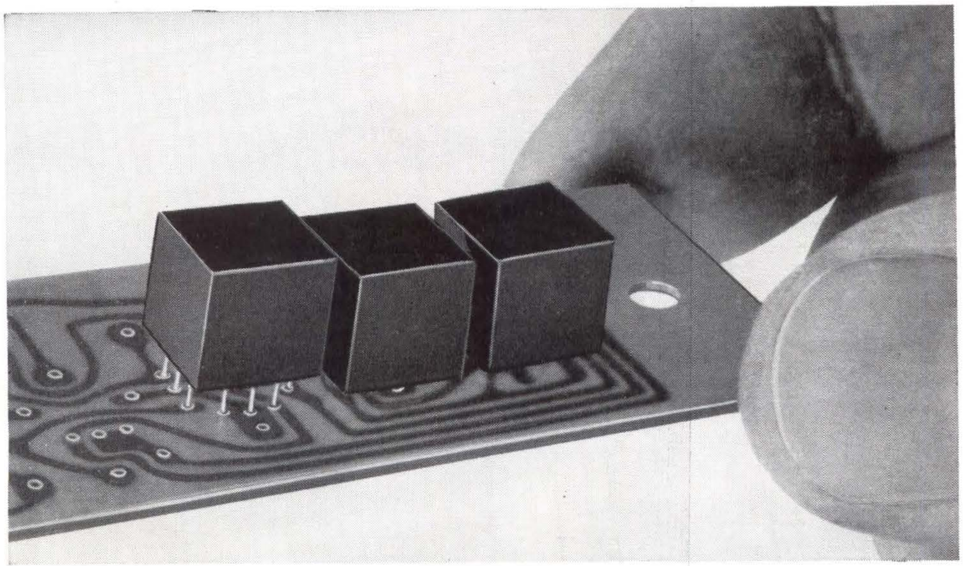
FAIRCHILD SEMICONDUCTOR/545 WHISMAN RD., MOUNTAIN VIEW, CALIF./YORKSHIRE 8-8161/TWX: 415-969-9165/A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

* Planar: a patented Fairchild process. † M.O.O.: a patented Fairchild process.

CIRCLE 901 ON READER SERVICE CARD

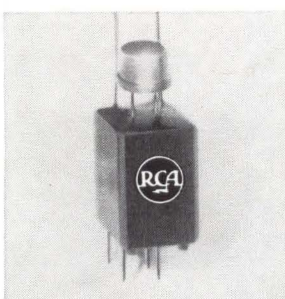
RCA MICROELECTRONIC PACKAGES OFFER FOUR PROVED WAYS TO MINIATURIZE YOUR CIRCUITS

RCA's Broad Line of Packaged Circuits Meets Today's Needs for High Component Density, Proved Reliability, Broad Circuit Applications, and Volume Availability



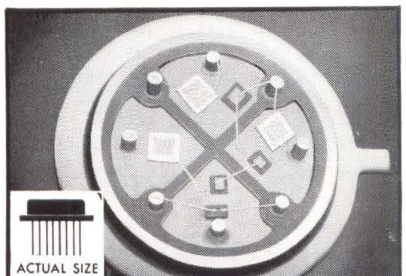
RCA Micromodules Offer Proved Reliability Backed By Over 100 Million Element-Hours of Life-Test Experience

Today's only high-density packaged circuits with this kind of life-test experience. Failure rates for RCA Micromodules are now less than 0.02% per 1000 hours at full ratings. Your *digital, analog,* or *linear* circuits can be supplied as RCA Micromodules...you can get working samples in a matter of days, quantity deliveries within 2 to 3 weeks. For example, RCA engineers converted one aircraft electronic package from conventional printed board construction to 16 working Micromodules in just 76 hours.



RCA Minimodules Offer Conventional-Component Economy in High-Density Format

Low-cost RCA Minimodules are precision built using reliable, conventional components, closely-packed, interconnected and encapsulated to meet the mechanical and environmental requirements of MIL specifications. RCA Minimodules can be supplied in the quantity you require, in the format you need, with terminal arrangements to meet your assembly requirements. Minimodules are available now for immediate delivery.

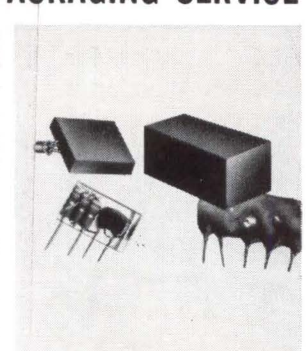


New RCA Digital Micro Circuits Switch in 7 Nanoseconds

First of a series of compact logic circuits—the RCA DMC-100 uses advanced silicon elements for ultra-high speed and new design flexibility. The RCA DMC offers excellent noise immunity, switching speeds to seven nanoseconds, high operating reliability and low power dissipation. The RCA DMC-100—designed for use in gates, adders, flip-flops, shift registers and multivibrators—is now available for immediate delivery.

RCA OFFERS MADE-TO-ORDER CUSTOM PACKAGING SERVICE

If your requirements call for special configurations, RCA packaging specialists—drawing on RCA's broad background in miniature packaging and using RCA's wide range of facilities—will develop special versions of RCA's standard packages, new advanced packaging techniques for your circuit designs, or new solid state circuit packages to solve your packaging problems.



For complete information on RCA's broad circuit packaging capability call your RCA Field Representative. For further technical data, write RCA Semiconductor & Materials Division, Commercial Engineering, Section MN1-1, Somerville, New Jersey.

THE MOST TRUSTED NAME IN ELECTRONICS

EAST: 744 Broad St., Newark 2, N. J., HU 5-3900 • 731 James St., Room 402, Syracuse 3, N. Y., GA 4-5591 • **NORTHEAST:** 64 "A" St., Needham Heights 94, Mass., HI 4-7200 • **SOUTHEAST:** 1520 Edgewater Dr., Suite No. 1, Orlando, Fla., GA 4-4768 • **CENTRAL:** Suite 1154 Merchandise Mart Plaza, Chicago 54, Ill., WH 4-2900 • 2132 East 52 St., Indianapolis 5, Ind., CL 1-1405 • 5805 Excelsior Blvd., Minneapolis 15, Minn., WE 9-0676 • 714 New Center Bldg., Detroit 2, Mich., TR 5-5600 • 7905 Carpenter Freeway, Dallas 7, Tex., ME 1-9720 • Continental Terrace Bldg., 2785 North Speer Blvd., Room 301, Denver 11, Colorado, 477-1688 • 605 Marlton Pike, Erlton, N. J., WO 3-8000 • Greater Baltimore Area, 1725 "K" Street, N.W., Washington 6, D.C., FE 7-8500 • **WEST:** 6801 E. Washington Blvd., Los Angeles 22, Calif., RA 3-8361 • 1838 El Camino Real, Burlingame, Calif., OX 7-1620 • 2250 First Avenue So., Seattle 4, Wash., MA 2-8816 • **GOVERNMENT:** 224 N. Wilkinson St., Dayton 2, Ohio, BA 6-2366 • 1725 "K" Street, N.W., Washington 6, D. C., FE 7-8500. RCA International Div.: 30 Rockefeller Plaza, N.Y. 20, N.Y. Cable Address: Radiointer, N.Y.